NBSIR 74-398



# PROVISIONAL VALUES FOR THE THERMODYNAMIC FUNCTIONS OF ETHANE

Robert D. Goodwin



Cryogenics Division
Institute for Basic Standards
National Bureau of Standards
Boulder, Colorado 80302



June 1, 1974

Prepared for
The American Gas Association
Wilson Boulevard
ton, Virginia 22209

NBSIR 74-398

# PROVISIONAL VALUES FOR THE THERMODYNAMIC FUNCTIONS OF ETHANE

Robert D. Goodwin

Cryogenics Division
Institute for Basic Standards
National Bureau of Standards
Boulder, Colorado 80302

June 1, 1974

Prepared for
The American Gas Association
1515 Wilson Boulevard
Arlington, Virginia 22209

U.S. DEPARTMENT OF COMMERCE, Frederick B. Dent, Secretary

NATIONAL BUREAU OF STANDARDS, Richard W. Roberts, Director

TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)



LIST OF FIGURES

TABLE OF CONTENTS (Continued)



LIST OF TABLES

TABLE OF CONTENTS (Continued)

# PREFACE

The Cryogenics Division of the National Bureau of Standards, with support from the American Gas Association, is engaged in a program to provide input data and computational methods for physical and thermodynamic properties of the constituents of liquefied natural gas mixtures (LNG). These thermophysical properties are the basis of all LNG technology. All operations such as liquefaction, separation, storage, pumping, transport, custodial transfer, and regasification will benefit from accurate data. As the commercial value of LNG depends on its heat of combustion, the densities of LNG mixtures and other requisite properties are important data.

The compositions of LNG mixtures vary widely, depending on the source and selective vaporization during handling. To predict properties of mixtures, it is essential to know accurately the properties of the pure components and of selected binary mixtures, so that the excess property (over the mole-fraction average of the components) can be examined.

The equation of state of pure components is an essential tool in work on mixtures because from this single formulation there can be obtained not only the density but also thermodynamic properties such as the enthalpy and specific heats at any desired temperature and pressure for which the component exists as a fluid.

A major contribution from this laboratory for computations on LNG and its components is the development of a simple, rational equation of state which originates on the liquid-vapor coexistence boundary, and gives a qualitatively correct behavior for derived specific heats, especially about the critical point. A form of this equation was used in our recently completed, comprehensive project on the major component of LNG, namely methane, "The Thermophysical Properties of Methane from 90 to 500 K at Pressures to 700 bar." NBS Technical Note 653, April, 1974.

In addition to the above publication, this laboratory has provided accurate experimental data on the compressibilities, vapor pressures, saturated liquid densities, specific heats, sound velocities, dielectric constants, refractive indices, and viscosities of compressed and liquid methane at temperatures down to 90 K.

A similar comprehensive project on ethane now is under way. The present report makes use of available physical properties data to obtain tables of thermodynamic functions, and provides the first of such tables available for liquid ethane below its normal boiling point temperature (184.5 K). In this work we use a simplified and more highly constrained version of the equation of state formerly used for methane. Auxiliary functions also are improved to accommodate the enormous range of ethane vapor pressures and saturated vapor densities. The use of these new analytical descriptions of PVT data for ethane does not in any way invalidate the methods used to compute the thermodynamic properties of methane in NBS TN 653. The equation of state used for methane in TN 653 had nine least-squares coefficients, and thereby gives a better representation of some of the experimental PVT data than does the present, more highly constrained equation with only five such coefficients. For ethane, the present equation of state is valuable because the available PVT data are less precise (over the entire $P(\rho, T)$ surface) than those used for methane in TN 653. Further work on the equation of state has been carried out to obtain the simplest possible form, amenable to corresponding states computations on mixtures. This work, "Equation of State for Thermodynamic Properties of Fluids," was submitted to the NBS Journal of Research in October, 1974.

# PROVISIONAL VALUES FOR THE THERMODYNAMIC FUNCTIONS OF ETHANE*

Robert D. Goodwin

Thermophysical properties are tabulated at integral temperatures over the entire range of fluid states from 90 to 600 K along isobars to 700 bar. A new, rational equation of state is employed for the first time. Thermodynamic functions in the compressed liquid at $T<T_c$ are obtained by use of specific heats $C_p(T)$ along a high-pressure isobar.

Key words: Densities; enthalpies, entropies; equation of state; internal energies; isobars; isochores; isotherms; Joule-Thomson inversion; latent heats of vaporization; melting line; orthobaric densities; specific heats; speeds of sound; vapor pressures.

## 1. INTRODUCTION

The economic importance of methane and ethane, as the major components of liquefied natural gas (LNG), is well known. Our objective is to produce basic thermodynamic information, needed for the prediction of properties of the constituents of liquefied natural gas mixtures. For the wide range of compositions encountered, it will be necessary to utilize accurate thermodynamic properties of the pure components.

We recently have published the properties of methane [25]. The present work on ethane provides background on available physical properties data, and may serve engineering needs for thermodynamic properties until such time as new physical data permit a revision of the tables.

---

* This work was carried out at the National Bureau of Standards under sponsorship of The American Gas Association.

All of the analytical formulations of physical properties data in this report are new as compared with [25]. The major contribution of present work is development of a rational equation of state. As in [25], our description of the $P(\rho, T)$ surface originates on a given liquid-vapor coexistence boundary (vapor-pressure and orthobaric densities equations). It yields a maximum in the specific heats $C_v(\rho, T)$ at the critical point, and has only five arbitrary coefficients to be found by least squares from experimental $P$-$\rho$-$T$ data. We give constants of this equation of state both for methane and for ethane because uniform methods of computation will be helpful with mixtures.

Some recent thermal data have been especially valuable for our computation of the thermodynamic network. These are the ideal gas functions of Chao et al. [8], and the low temperature specific heats $C_p(T)$ of Furtado along isobars [20].

Symbols and units of this report, listed in Appendix A, are the same as for methane [25]. For equation of state (5) the gas constant is $R = (0.0831434) \cdot (d_t)$ bar/K, consistent with use of the dimensionless density, $\rho \equiv d/d_t$.

## 2. PHYSICAL PROPERTIES AND THEIR REPRESENTATION

### 2.1 Fixed-Point Constants

These values are listed in Appendix B. For methane, they are taken from [25].

The triple-point temperature and pressure for ethane are from our analysis of ethane vapor pressures [26]. The liquid density is a short extrapolation of the saturated liquid densities of Miller [48]. The vapor density is given by intersection of our present virial equation of state with our vapor-pressure locus [27].

The critical-point temperature and density for ethane were adjusted by examination of the critical isotherm from the present equation of state. Our value of $T_c$ = 305.37 K agrees with the recent experimental observation of Strumpf et al [68-a], namely $T_c$ = 305.368 ± 0.005 K. Our critical density, $d_c$ = 6.74 mol/ℓ may be compared with 6.83 ± 0.07 mol/ℓ from [68-a], with 6.79 ± 0.02 mol/ℓ from [49], and with 6.87 mol/ℓ from [14]. Critical densities reviewed in [14, 17, 70] range from 6.75 ± 0.07 to as high as 7.32 mol/ℓ, a spread of 8%.

Our critical pressure of 48.755 bar at $T_c$ = 305.37 K may be compared with other authors by use of the slope of the vapor pressure curve at the critical point, namely $dP_\sigma/dT$ = 1.04 bar/K. Most recently, for example, Douslin and Harrison [14] give $P_c$ = 48.718 bar at $T_c$ = 305.33 K.

The reader should note that our "critical density" is essential for the present equation of state to give a critical isotherm with no negative slopes, $(\partial P/\partial \rho)_{T_c} \geq 0$. Our procedure is an altogether new method for finding this characteristic constant, but may depend heavily on the analytical form of the equation of state used [29a]. It follows that our "critical density," $d_c$, should be regarded as a fitting parameter, and not necessarily as the best value for this characteristic constant.

2.2 Melting Line and Vapor Pressures

For the melting line of ethane we have found only the rough data of Clusius and Weigand to 42 bar [11]. In the Simon equation [25],

$$P = P_t + A\cdot\left[(T/T_t)^{\epsilon}-1\right]$$

we assumed $\epsilon = 2$, finding A = (1.01325)·(2840.0) bar from their data by averaging $P/\left[(T/T_t)^{\epsilon}-1\right]$.

The vapor pressure equation (2) for ethane is an extension [26] of our early form [23],

$$\ell n(P/P_t) = a\cdot x + b\cdot x^2 + c\cdot x^3 + d\cdot x^4 + e\cdot x\cdot(1-x)^{3/2}, \qquad (2)$$

where the argument is $x \equiv (1-T_t/T)/(1-T_t/T_c)$, and the coefficients are

Coefficients for Vapor Pressure Equation (2)

| | Methane | Ethane |
|---|---|---|
| a = | 4.7774 8580 | 10.7954 9166 |
| b = | 1.7606 5363 | 8.3589 9001 |
| c = | -0.5678 8894 | -3.1149 0770 |
| d = | 0.0 | -0.6496 9799 |
| e = | 1.3278 6231 | 6.0734 9549 |

Table 1 for ethane compares the data.

After the present report was completed, we received the vapor pressures of Regnier [58] from 80 to 135 K. His results for the liquid were described in mm Hg by

$$\log_{10}(P) = 7.75 - 881/T.$$

The following Table 2 compares results from our present vapor pressure equation (2) with his calculated pressures. If we use the ideal gas law to obtain the vapor density, and obtain dP/dT from the above equation, the Clapeyron equation gives the heat of vaporization independent of temperature. The Clapeyron equation is -

$$Q_{vap} = T \cdot (dP/dT) \cdot (v_g - v_\ell).$$

From the above vapor pressure equation, $P = \exp[a - b/T]$, one obtains -

$$(dP/dT) = b \cdot P/T^2$$

At low pressures, $v_\ell$ is negligible relative to $v_g$, hence via the ideal gas law -

$$(v_g - v_\ell) = R \cdot T/P.$$

Introducing the last two expressions into the first yields

$$Q_{vap} = b \cdot R = 16.87 \text{ kJ/mol}.$$

The smoothed experimental value of previous workers at 100 K is 17.3 ± 0.2 kJ/mol (Table 15). Regnier's duplicate pressure gages agreed to 1% or better, but he makes no estimate of absolute accuracy.

Table 2. Comparison with vapor pressures of Regnier
(Units of bar $\cdot 10^{-3}$)

| T,K | This Report | Regnier [58] |
|---|---|---|
| 89.899 | 0.0101 | 0.0119 |
| 90 | 0.0104 | 0.0122 |
| 95 | 0.0363 | 0.0399 |
| 100 | 0.1110 | 0.1161 |
| 105 | 0.3025 | 0.3051 |
| 110 | 0.7463 | 0.7342 |
| 115 | 1.689 | 1.637 |
| 120 | 3.546 | 3.414 |
| 125 | 6.967 | 6.713 |
| 130 | 12.92 | 12.53 |
| 135 | 22.77 | 22.33 |

## 2.3 The Orthobaric Densities

For the saturated liquid and vapor densities, $\rho(T)$, we have developed analytical expressions which are constrained to any given boundaries, namely the triple and critical points [28]. In eqs (3-a) and (3-b) the basic behavior is given by $Y(\rho, T) = \text{const.}$, and polynomials on the right side are selected to describe small deviations.

a) For the saturated liquid, define the variables-

$$x(T) \equiv (T_c - T)/(T_c - T_t),$$
$$y(\rho) \equiv (\rho - \rho_c)/(\rho_t - \rho_c),$$
$$Y(\rho, T) \equiv (y - x)/(x^{\epsilon} - x),$$

when the equation is

$$Y \equiv a + b \cdot x^{2/3} + c \cdot x, \tag{3-a}$$

with the following coefficients

| | Methane | Ethane |
|---|---|---|
| $\epsilon$ = | 0.36 | 0.33 |
| a = | 0.8595 3758 | 0.7219 0944 |
| b = | 0.0243 6448 | 0.2965 7790 |
| c = | -0.0268 5285 | -0.3003 6548 |

Table 3 compares data with (3-a).

b) For the saturated vapor, define the variables--

$$x(T) \equiv (T_c/T-1)/(T_c/T_t-1),$$
$$y(\rho) \equiv \ln(\rho_c/\rho)/\ln(\rho_c/\rho_t),$$
$$Y(\rho,T) \equiv (\dot{y}-x)/(x^{\epsilon}-x),$$

when the equation is--

$$Y = A_1 + \sum_{i=2}^{5} A_i \cdot x^{i/3}, \qquad (3\text{-b})$$

with the following coefficients--

| | Methane | Ethane |
|---|---|---|
| $\epsilon$ = | 0.41 | 0.39 |
| $A_1$ = | 0.4171 4211 | 0.2158 7515 |
| $A_2$ = | -0.5194 9762 | -0.0852 2342 |
| $A_3$ = | 1.2077 7553 | -0.6152 3457 |
| $A_4$ = | -1.4613 0509 | 0.2545 2490 |
| $A_5$ = | 0.5765 8540 | 0.1517 7230 |

The data of Table 4 are obtained from the virial and vapor pressure equations [27]. The heading PLANK/KAMB refers to [52]. The data of Table 5 for ethane are compared with (3-b).

c) For the equation of state, we use the liquid-vapor, equilibrium (saturation) temperature $T_\sigma(\rho)$ as a function of density. Densities are obtained from the following expressions for $T_\sigma(\rho)$ by iteration, using eqs (3-a) and (3-b) only to find the initial density. We shall describe $T_\sigma(\rho)$ in two parts, according as $\rho \lesssim \rho_c$. This simplifies the design of constraints to the boundaries (vapor and liquid triple points). At the critical point the two parts are continuous because the derivatives of all orders n, $d^n T_\sigma / d\rho^n$, from each are zero. For each range the dependent variable is

$$Y(T_\sigma(\rho)) \equiv (T_c/T_\sigma - 1)/(T_c/T_t - 1),$$

and we use the following function,

$$U(\sigma) \equiv -\gamma \cdot (1/x - 1/x_t),$$

where

$$x \equiv |\sigma - 1|, \qquad x_t \equiv |\sigma_t - 1|,$$

$$\sigma \equiv d/d_c, \qquad \sigma_t \equiv d_t/d_c,$$

and $d_t$ refers to vapor or liquid at the triple point according as $\sigma \lesssim 1$.

For the liquid range at $\sigma \geq 1$ the equation is --

$$\ln(Y) = U(\sigma) + \sum_{i=1}^{5} B_i \cdot (\sigma^i - \sigma_t^i). \qquad \text{(3-c)}$$

For the vapor range at $\sigma \leq 1$ we need a modification for extremely low densities approaching the triple point. The form is selected for qualitative consistency with the ideal gas law and the basic vapor pressure equation. Define--

$$W(\sigma) \equiv \ell n(1+\epsilon/\sigma)/\ell n(1+\epsilon/\sigma_t),$$

when the equation is--

$$\ell n(Y) = U(\sigma) + A_o \cdot \ell n[W(\sigma)] + A_1 \cdot (\sigma^{1/3} - \sigma_t^{1/3})$$

$$+ A_2 \cdot (\sigma^{2/3} - \sigma_t^{2/3}) + \sum_{i=3}^{7} A_i \cdot (\sigma^{i-2} - \sigma_t^{i-2}) \qquad (3\text{-d})$$

The coefficents for (3-c) and (3-d) are--

Coefficients for Saturation Temperatures, Eqs. (3-c, d)

| | Methane | Ethane |
|---|---|---|
| $\gamma$ | 1/2 | 1/2 |
| $\epsilon$ | 1/4 | 1/4 |
| $A_o$ | 0.9034 9557 | 0.8681 0517 |
| $A_1$ | 0.0 | 0.0151 6978 |
| $A_2$ | 0.0 | -0.7296 0432 |
| $A_3$ | -0.3834 4338 | 1.0096 5493 |
| $A_4$ | -3.9210 8638 | -8.7340 2710 |
| $A_5$ | 6.2600 3837 | 21.1071 2823 |
| $A_6$ | -9.3296 0083 | -31.4499 4087 |
| $A_7$ | 5.6060 2816 | 17.8637 0397 |
| $B_1$ | 11.4317 7230 | 23.7245 1840 |
| $B_2$ | -3.8765 9480 | -14.8860 5161 |
| $B_3$ | 0.5378 8326 | 5.4317 7443 |
| $B_4$ | 0.0 | -1.0715 0566 |
| $B_5$ | 0.0 | 0.0913 5183 |

For ethane the liquid saturation temperatures appear in Table 6, and the vapor temperatures in Table 7. Densities of the freezing liquid are obtained by use of the equation of state in present work.

## 2.4 The Virial Equation

For the virial equation of state,

$$Pv/RT = 1 + B(T)\cdot\sigma + C(T)\cdot\sigma^2 + ---, \tag{4}$$

the second and third coefficients B(T), C(T) are dimensionless. We reduce temperature and density of the critical point, $x \equiv T/T_c$, $\sigma \equiv d/d_c$. Following initial research on the representation of these coefficients [27], we now have adopted McGlashan's formula for B(T),

$$B(T) = B_1 + B_2/x + B_3/x^2 + B_4/x^{4.5} \tag{4-a}$$

$B_1 = 0.552\ 671$, $B_3 = -0.592\ 947$,

$B_2 = -1.106\ 244$, $B_4 = -0.041\ 944$.

These constants were obtained with our values for $\rho_c$, $T_c$. Date from McGlashan were increased by 0.5 percent in absolute value to improve consistency with the data of Michels and of Douslin near 300 K. Table 8 compares data and calculated values.

For C(T) our new representation from [27] is,

$$C(T) = \left[C_1/x + C_2/x^3 + C_3/x^5\right]\cdot(1 - T_o/T), \tag{4-b}$$

$T_o = 217.8$ K, $C_2 = 0.83253$,

$C_1 = 0.24423$, $C_3 = 0.53488$,

using critical constants of the present report. Table 9 compares data and calculated values.

Table 10. Summary of P-$\rho$-T Data

| | | | Range of the Variables | | | | Deviations, % | |
|---|---|---|---|---|---|---|---|---|
| ID | Authors | | mol/$\ell$ | T, K | P, bar | N | $\Delta d/d$ | $\Delta P/P$ |
| 2 | Virial equation | | 0.4 -- | 230 - 600 | 7 - 20 | 38 | 0.04 | 0.03 |
| 8 | Reamer et al. | [57] | 0 - 15 | 310 - 510 | 50 - 700 | 176 | 0.61 | 1.22 |
| 9 | Michels et al. | [47] | 0.9 - 8 | 273 - 423 | 15 - 220 | 101 | 0.35 | 0.14 |
| 10 | Douslin et al. | [14] | 0.7 - 16 | 248 - 623 | 12 - 410 | 298 | 0.40 | 0.26 |
| $100^{+}$ | A. K. Pal | [54] | 14 - 19 | 157 - 320 | 19 - 700 | 125 | 0.08 | 1.85 |

## 2.5 The Equation of State

Data reproduced in the present report are summarized by Table 10. The locus of recent data is shown by Figure 1. From the data of A. K. Pal we selected only twelve isochores at the highest densities, runs Nos. 13 through 24 of Table 12, because they were found to be self-consistent. An increase of all densities by 0.5 percent than made these PVT data compatible with data of other authors (Table 10) via our equation of state. We finally used adjusted data of A. K. Pal kindly provided by Professor R. Kobayashi, J. R. Ely, et al of the Chemical Engineering Department, Rice University. We omitted the data of Reamer et al because those of Douslin and Harrison are believed to be more accurate.

For background on this equation of state, the reader may refer to our work on methane [25]. We consider density to be a parameter in the description of P(T) isochores, Figure 2. (In Figure 3 we show the well-known zero slope and curvature of the critical isotherm.) For any density we obtain the liquid-vapor coexistence temperature from our function for $T_\sigma(\rho)$, eqs (3-c, 3-d). Placing this in the vapor pressure equation gives the coexistence pressure. The equation of state thus is defined as a function of density on the coexistence boundary. By subtraction we shift the origin to this boundary. Define the variables--

$$x(T) \equiv T/T_c, \qquad x_\sigma(\rho) \equiv T_\sigma(\rho)/T_c$$

$$Y(P,\rho,T) \equiv (Z-1)\cdot x/\rho, \qquad Y_\sigma(\rho) \equiv (Z_\sigma - 1)\cdot x_\sigma/\rho,$$

when the equation of state is--

$$(Y - Y_\sigma) = B(\rho)\cdot\Phi(\rho,T) + C(\rho)\cdot\Psi(\rho,T) \tag{5}$$

where $B(\rho)$, $C(\rho)$ are polynomial coefficients to be found by least squares, and the temperature-dependent functions are

$$\Phi(\rho, T) \equiv x^{1/2} \cdot \ln[T/T_\sigma(\rho)], \tag{5-a}$$

$$\Psi(\rho, T) \equiv [1-\omega \cdot \ln(1+1/\omega)]/x - [1-\omega_\sigma \cdot \ln(1+1/\omega_\sigma)]/x_\sigma . \tag{5-b}$$

Each of these functions is zero on the coexistence boundary at $T = T_\sigma(\rho)$. The second gives nonanalytic behavior for $C_v(\rho, T)$ about the critical point by use of the variables,

$$\omega(\rho, T) \equiv \delta \cdot [T/\theta(\rho)-1], \qquad \omega_\sigma(\rho) \equiv \delta \cdot [T_\sigma(\rho)/\theta(\rho)-1],$$

where $\delta$ is an adjustable constant and $\theta(\rho)$ is our locus of temperatures inside the coexistence envelope, Figure 4,

$$\theta(\rho) \equiv T_\sigma(\rho) \cdot \exp\left[-\alpha \cdot |\sigma - 1|^3/(\sigma_t - 1)^3\right]. \tag{5-c}$$

In the above, $\sigma_t = d_t/d_c$ for liquid at the triple point. Figures 5 and 6 show behavior of the functions $\Phi(\rho, T)$ and $\Psi(\rho, T)$.

The coefficients of (5) are--

$$B(\rho) \equiv B_o + B_1 \cdot \rho + B_2 \cdot \rho^2/(1+b \cdot \rho^2), \tag{5-d}$$

$$C(\rho) \equiv (\sigma - 1) \cdot (\sigma - C_o) \cdot (C_1 + C_2 \cdot \rho), \tag{5-e}$$

and the constants are--

Constants for Equation of State (5)

| | Methane | Ethane |
|---|---|---|
| $\alpha$ = | 2 | 2 |
| b = | 1 | 1 |
| $\delta$ = | 1/2 | 1/2 |
| $B_o$ = | 1.5082 12989 | 1.8481 67996 |
| $B_1$ = | 0.6544 90304 | 1.5697 04511 |
| $B_2$ = | 4.1320 82291 | 5.5601 86452 |
| $C_o$ = | 1.90 | 1.90 |
| $C_1$ = | -0.7654 09076 | -1.0428 42462 |
| $C_2$ = | -0.0590 88717 | +0.2249 78299 |

Behavior of $B(\rho)$ and $C(\rho)$ for ethane is given by Table 11. For methane the behavior is shown by Figure 7. Figure 8 shows the presumed behavior of $C(\rho)$ for hydrogen, discussed in Appendix C. Deviations of experimental data for ethane appear in Table 12. Appendix C explains the rationale of this equation of state.

2.6 The Ideal Gas Functions

For use in our computations we have represented the internal energies of Chao et al. [8], by the following empirical power series--

$$(E^o - E^o_o)/RT = 3.0 + \sum_{i=1}^{9} A_i \cdot (T/100)^{(i+3)/3}, \qquad (6)$$

with coefficients

| | | | | | |
|---|---|---|---|---|---|
| $A_o$ | = | 21.705 718 | $A_5$ | = | 906.218 4427 |
| $A_1$ | = | 65.498 641 | $A_6$ | = | -459.230 2545 |
| $A_2$ | = | -362.011 5914 | $A_7$ | = | 143.030 0226 |
| $A_3$ | = | 853.340 8616 | $A_8$ | = | -25.074 95605 |
| $A_4$ | = | -1123.601 6220 | $A_9$ | = | 1.897 540044 |

The specific heats are obtained by differentiation,

$$C_v^o(T) = dE^o/dT,$$

and the entropies by integration of $C_v^o$,

$$\Delta S^o = \int C_v^o \cdot dT/T$$

The dimensionless integration constant for $S^o/R$ is the value $A_o$ tabulated above. The concise computations are given by computer subroutine IDEAL, below. Table 13 gives the comparisons, and Table 14 gives values interpolated by means of (6).

We have compared the results of Chao et al [8] with those obtained earlier by Ziegler et al [77]. At temperature, 200 K, (values in Joules, moles, kelvins)-

| | $H^o - H_o^o$ | $S^o$ | $C_p^o$ |
|---|---|---|---|
| Ziegler et al [77] | 7281.4 | 210.72 | 42.45 |
| Chao et al [8], | 7257.6 | 210.50 | 42.26 |

We see a difference of 24 Joules in $(H^o - H_o^o)$, or 0.3 percent. We have not further compared these independent calculations.

2.7 The Heats of Vaporization

The data of Table 15 are represented as follows,

$$Q_{vap} = \sum_{i=1}^{6} A_i \cdot x^{i/3}, \text{ kJ/mol}, \tag{7}$$

where the argument is $x(T) \equiv (T_c - T)/(T_c - T_t)$

| | |
|---|---|
| $T_t$ = 89.899 K | $T_c$ = 305.37 K |
| $A_1$ = 12.102 730 | $A_4$ = -71.854 695 |
| $A_2$ = 11.165 588 | $A_5$ = 82.166 239 |
| $A_3$ = 16.539 265 | $A_6$ = -32.610 514 |

Comparisons are given in Table 15.

2.8 Specific Heats for Saturated Liquid

Data shown in Table 16 have been represented in J/mol/K with a minimum of arbitrary constants as follows by use of the argument, $x \equiv T/T_c$, ($T_c$ = 305.37 K) -

$$C_\sigma(T) = a + b\cdot x + c\cdot x/(1-x)^\epsilon, \quad \text{J/mol/K}, \tag{8}$$

with these constants,

| | |
|---|---|
| $\epsilon$ = 0.5 | b = -16.5876 |
| a = 67.3153 | c = 16.3526 |

The form of (8) permits integration,

$$\Delta S_\sigma = \int C_\sigma \cdot dx/x,$$

giving results in closed form. Comparisons are given in Table 16.

2.9 Specific Heats $C_p(T)$ along Isobar $P_b$

In our computations of the thermodynamic functions we have entered the compressed liquid region at T<340 K by use of specific heats $C_p(T)$ kindly provided by André Furtado, as obtained with the flow calorimeter at the University of Michigan [20].

Data shown in Table 17 for the isobar at $P_b$ = 137.895 bar are represented by use of the argument,

$$x(T) \equiv (T - T_t)/(T_m - T_t),$$

as follows in J/mol/K,

$$C_p(T) = k\cdot[C_m - \exp(Y)]\ , \quad J/mol/K, \tag{9}$$

where

$$Y \equiv A_1 + A_2\cdot x^2/(1-x) + A_3\cdot x^2 + A_4\cdot x^3 + A_5\cdot x^4\ ,$$

with constants $T_t$ = 89.899 K, and--

| | | | | | |
|---|---|---|---|---|---|
| $T_m$ | = | 354.0 K | $A_2$ | = | -0.154 423 |
| $C_m$ | = | 62.60 | $A_3$ | = | -0.141 489 |
| k | = | 1.874 335 | $A_4$ | = | -0.506 438 |
| $A_1$ | = | 3.263 288 | $A_5$ | = | 0.276 992 |

The data were estimated by the author to be accurate to 0.7% on average, with a few values uncertain by several percent.

## 3. COMPUTATIONAL METHODS

The numerical values for E and H in this report are on the same absolute basis as those of Tester [70], obtained by use of $E_o^o$ = (4.1868)·(4827.2) J/mol.

### 3.1 The Homogeneous Domain

With reference to Figure 9, we start our computations with ideal gas values at zero density, and then integrate along isotherms by use of the equation of state in the following relations,

$$\Delta E = \int [P - T\cdot(\partial P/\partial T)]\cdot d\rho/\rho^2, \tag{10}$$

$$\Delta C_v = -T\cdot \int (\partial^2 P/\partial T^2)\cdot d\rho/\rho^2\ , \tag{11}$$

$$\Delta S = R\cdot \ln [P^o/(\rho RT)] + \int [R - (\partial P/\partial T)/\rho]\cdot d\rho/\rho . \tag{12}$$

Equation (12) is for use with initial entropies in hypothetical gas states at $P^o$ = 1 atm. For the compressed liquid at $T<T_b$ and $\rho>\rho_c$

(the cross-hatched region of Figure 9) we start with values of $S(T, P_b)$ on isobar $P_b$, and then use

$$\Delta S = - \int (\partial P/\partial T) \cdot d\rho/\rho^2 . \qquad (12\text{-a})$$

In each ($\rho$, T) state, reached by above integrations, we compute

$$H = E + P \cdot v , \qquad (13)$$

$$Cp = C_v + T \cdot (\partial P/\partial T)^2 / (\partial P/\partial \rho)/\rho^2 , \qquad (14)$$

$$W^2 = C_p \cdot (\partial P/\partial \rho)/C_v . \qquad (15)$$

3.2 The Vapor-Liquid Transition

As discussed below, we have used this computation only as a check against experimental heats of vaporization, and for closed-loop checks terminating on the saturated liquid.

We traverse the vapor-to-liquid "dome" of Figure 9 by use of the Clapeyron equation, and $\Delta v \equiv (v_\ell - v_g)$,

$$\Delta H = T \cdot (dP/dT) \cdot \Delta v , \qquad (16)$$

$$\Delta E = \Delta H - P \cdot \Delta v , \qquad (17)$$

$$\Delta S = \Delta H/T , \qquad (18)$$

where (dP/dT) is slope of the vapor pressure curve.

3.3 Compressed Liquid States

Computations along isotherms which pass close to the critical point, Figure 9, cannot be expected to be accurate, as discussed in [25]. For ethane there is an additional problem for use of the Clapeyron equation to enter compressed liquid states. At low temperatures the vapor pressures become so small that they have yet to be measured accurately, and the saturated vapor densities obtained here are correspondingly uncertain. We therefore have used the following procedure to compute around the critical point into the cross-hatched region of Figure 9:

We use the isobar of specific heats $C_p(T)$ at $P_b = 137.895$ bar from [20]. We then select $T_b = 340$ K, obtaining (by integration along $T_b$)- - -

$$H(T_b, P_b) = 25\,737.97 \text{ J/mol}, \qquad S(T_b, P_b) = 176.4384 \text{ J/mol/K}.$$

By use of our description (9) for $C_p(T, P_b)$ we then integrate down to any $T<T_b$,

$$\Delta H = \int_{T_b}^{T} C_p \cdot dT, \qquad \Delta S = \int_{T_b}^{T} C_p \cdot dT/T.$$

We finally integrate along isotherm T as described among eqs (10) through (18). On the saturated liquid boundary we compute the specific heat $C_\sigma(T)$ of liquid along the coexistence path from the following relation [61],

$$C_\sigma(T) = C_v(\rho, T) - T\cdot(\partial P/\partial T)\cdot(d\rho_\ell/dT)/\rho_\ell^2, \tag{19}$$

where $(d\rho_\ell/dT)$ is the slope of saturated liquid density vs. T.

## 4. TESTS AND COMPARISONS

### 4.1 The P-ρ-T Compressibility Data

Deviations of experimental densities and pressures from the smooth $P(\rho, T)$ surface of the equation of state (5) are given in Table 12, using author identifications from Table 10. The data of Michels [47] and Douslin [14] are highly precise, and the deviations generally are systematic, as might be expected from an equation of state with as little freedom as (5). Any inaccuracies in the liquid-vapor boundary will be propagated along calculated isochores because the equation of state originates on this boundary. At high densities in the compressed liquid, the derivative $\partial P/\partial\rho$ becomes extremely large, hence pressure deviations should be ignored.

4.2 Calculated $P(\rho)$ Critical Isotherm

Table 18 gives a high-resolution examination of the $P(\rho)$ critical isotherm from equation of state (5). This was obtained by adjusting the assigned critical point ($\rho_c$, $T_c$) to eliminate negative slopes $\partial P/\partial\rho$ in the neighborhood of $\rho_c$. The selected critical point is within the range of values found by previous workers.

4.3 Heats of Vaporization and Closure Computation

The last column of Page 1 of Table 26 gives experimental heats of vaporization from eq (7) for comparison with values in column Q, VAP computed by the Clapeyron equation. The differences are plotted in Figure 10 as ($Q_{xptl}$-$Q_{calc}$).

Table 19 gives loop-closure computations for the saturated liquid. Values for enthalpy in Column H and for entropy in Column S are obtained by computing around the critical point, whereas values in Columns HC and SC are via the Clapeyron equation (see Sections 3.2, 3.3). The enthalpy differences are plotted in Figure 10 as ($H_{calc}$-$H_{Furt}$) in which $H_{Furt}$ refers to computation around the C. P. by use of $C_p(T)$ data of Furtado [20].

Heats of vaporization via the Clapeyron equation at low temperatures are uncertain by several percent (up to about 500 J/mol) due to uncertainty in the vapor-pressure equation and the vapor densities. In Table 16, moreover, we see that experimental heats of vaporization may differ by over 2 percent at 100 K, (about 350 J/mol). The apparently large deviations seen in Figure 10 therefore do not exceed known uncertainties. The heats of vaporization have not been used for present computations.

4.4 Heat Capacity for Saturated Liquid

The last column of the second page of Table 26 gives experimental heat capacities for the saturated liquid from eq (8) for comparison with values in column CS computed as described above in Section 3.3. As seen in eq (19), this is a difficult computation from which to obtain high accuracy. We also have computed $C_\sigma(T) = T\cdot(dS_\sigma/dT)$, but prefer to omit this further complication of present work.

4.5 Specific Heats, $C_p(\rho, T)$

Table 20 compares specific heats of [20] at constant pressure with values calculated by present methods. Except near the sharp maxima in $C_p$ in the critical region, the differences generally do not exceed combined uncertainties of a few percent.

4.6 Comparison of Enthalpies

Table 21 compares our saturated liquid enthalpies (obtained by computation around the critical point) with results of Tester [70]. From low-temperature specific heat data on the solid, and the heat of fusion, he obtained the third-law entropy of liquid at the triple point. He then used experimental $C_\sigma(T)$ data, liquid densities and $dP/dT$ from the vapor-pressure equation to obtain $\Delta H(T)$ on the liquid coexistence path.

Table 22 compares enthalpies of three authors for the homogeneous domain at a few, selected (P, T) points. To make use of the values of Eubank et al., we have added $H^o(T)$ obtained from Tester. This comparison shows that our results from the present very simple equation of state are consistent with the work of other authors.

4.7 Speed of Sound for Saturated Liquid

Figure 11 compares the speed of sound W for saturated liquid from Table 26 of present work with the experimental data of Poole and Aziz [53]. Positive curvature of our calculated results below the boiling point (184.55 K) suggests that derivatives of our $P(\rho, T)$ surface are not sufficiently accurate in the compressed liquid. Below 105 K the calculated dependence of the saturated liquid densities on the temperature in Table 6 also has a positive curvature, which probably is qualitatively incorrect.

# 5. TABLES OF PHYSICAL AND THERMODYNAMIC PROPERTIES

## 5.1 Calculated P-ρ-T Isochores and Isotherms

A selection of calculated isochores and isotherms is given by Tables 23 and 24. They are useful to examine behavior of the surface generated by the equation of state, and to supplement the isobars of Table 27 in obtaining P-ρ-T values and their derivatives.

## 5.2 The Joule-Thomson Inversion Locus

Table 25 gives our calculated P-ρ-T locus for the J. T. inversion, $(\partial T/\partial P)_H = 0$. These results are obtained from the equation of state under the condition, $T\cdot(\partial P/\partial T) = \rho\cdot(\partial P/\partial \rho)$.

## 5.3 Thermophysical Properties of the Saturated Liquid

Table 26 gives physical and thermodynamic properties for the saturated liquid. Column headings are interpreted on the first page of this table.

## 5.4 Thermophysical Properties Along Selected Isobars

Table 27 gives physical and thermodynamic properties on isobars, as computed by methods of Section 3. Explanations for the table are given on the first page. This table is extrapolated beyond the range of P-ρ-T data used for adjusting the equation of state ($P \sim 350$ bar).

# 6. COMMENTS AND RECOMMENDATIONS

Uncertainty of the saturated liquid densities (Table 3) is estimated to be 0.1 percent from 90 to 140 K. Greatest uncertainty, approaching 0.5 percent, exists in mid-range (160 to 250 K) where no experimental data were found. Whereas several sets of precise data exist approaching the critical temperature, we have not been able to represent them with a function of simple form to better than 0.2 to 0.3 percent [28].

Saturated vapor densities at very low temperatures are uncertain by several percent because they have been estimated by use of the vapor-pressure equation which is uncertain by at least 2 percent at these temperatures [26], and the virial equation of state. The latter is extrapolated below the range of data for the virial coefficients where, however, we approach ideal gas behavior [27].

Our calculated densities (Table 27) over the homogeneous domain ($\rho<\rho_c$, or $T>T_c$) are uncertain by an estimated 0.2 percent, except for the critical region ($\rho_c/3<\rho<2\cdot\rho_c$ at $0.9\cdot T_c<T<1.2\cdot T_c$) where deviations from experimental data may exceed one percent, Table 12. For the compressed liquid at low temperatures, densities probably are uncertain by about 0.2 percent (adjusted P-$\rho$-T data of A. K. Pal [54]).

Uncertainty of enthalpy differences is most difficult to estimate. Along isotherm $T_b$ of Figure 9, we compute $C_p(\rho, T)$ at point $(T_b, P_b)$ within one percent of the experimental value from [20]. For the homogeneous domain, having an adequate density of P-$\rho$-T data, therefore, the uncertainty of enthalpy differences probably is comparable with that estimated for methane [25], namely about 2 percent. For compressed liquid, as seen in Section 4 above, however, the uncertainty may be several-fold greater.

The purpose of this report has been, in part, to find the inadequacies in physical properties data needed for thermal computations. Some recommendations can be made, based on the inaccuracies shown in Section 4 above. The possible methods for preparing a thermodynamic network are so numerous and varied, however, that the reader may wish to draw his own conclusions. We make only the following simple observations and recommendations:

1) The melting line is poorly defined. Accurate P-$\rho$-T data for the freezing liquid would provide a boundary for the equation of state. The triple-point temperatures which have been published are highly discordant. Extrapolation of the P(T) melting line to zero pressure might yield a reliable value. This is needed especially for the vapor pressure equation.

2) More accurate P-$\rho$-T data (better than 0.1% in density) are needed for the low-temperature compressed liquid. From such data accurate saturated liquid densities may be obtained by intersection with an accurate vapor-pressure line.

3) Accurate densities for the saturated liquid are needed in mid-range where few if any experimental data exist.

4) Accurate vapor pressure measurements apparently exist only from 200 K (2 atm) upwards. These could be extended down to 150 K (0.1 atm) by use of the "air dead-weight gage." Their use might give a vapor pressure equation with more reliable derivatives, dP/dT, over the entire range.

5) Sound velocity measurements over a wide range, as well as additional specific heat measurements, e.g. $C_v(\rho, T)$, would provide further tests of the thermodynamic computations.

## 7. ACKNOWLEDGMENTS

We are indebted to The American Gas Association for generous support of this work, to Robert D. McCarty for the essential least-squares program, and to Dwain E. Diller and Lloyd A. Weber for discussions and valuable suggestions. Importance of the nonanalytic behavior of $C_v(\rho, T)$ about the critical point, in formulating an equation of state, was emphasized for us by Anneke Levelt Sengers, for which we are most grateful. The PVT compressibility data of Douslin and Harrison, of A.K. Pal as revised at Rice University, and the specific heat data of A. Furtado, have all been essential ingredients making possible the present provisional computations of thermodynamic functions.

# 8. BIBLIOGRAPHY


[1] Amer. Petrol. Inst. Res. Proj. 44, Selected Values of Properties of Hydrocarbons and Related Compounds (loose-leaf). Table 20 k, (Part 1), p. 1, Dec. 31 (1952), (Vapor Pressures).

[2] C. H. Barkelew, J. L. Valentine and C. O. Hurd, Thermodynamic properties of ethane, Trans. Amer. Inst. Chem. Eng. 43, 25 (1947).

[3] L. A. Bulavin, Yu. M. Ostanevich, A. P. Simkina, and A. V. Strelkov. Density of ethane near the liquid-vapor critical point, Ukrainain Physics Journal 16, 90 and 183 (1971).

[4] L. J. Burnett and B. H. Muller, Melting points of ethane and three of its deuterated modifications, J. Chem. and Eng. Data 15(1), 154 (1970).

[5] L. N. Canjar, P-V-T and related properties for methane and ethane, Chem. Eng. Data Series 3(2), 185 (1958).

[6] L. N. Canjar, C. M. Tejada and F. S. Manning, Thermo Properties of ethane, Hydrocarbon Processing and Petroleum Refiner, 41(10), 149 (1962).

[7] F. G. Carruth, Determination of the vapor pressure of n-paraffins and extension of a corresponding states correlation to low reduced temperatures, Thesis, Dept. Chemical Engineering, Rice University, Houston, Texas, (Nov. 1970).

[8] J. Chao, R. C. Wilhoit, and B. J. Zwolinski, Ideal gas thermodynamic properties of ethane and propane, J. Phys. Chem. Ref. Data 2(2), 427 (1973).

[9] P. L. Chueh and J. M. Prausnitz, Third virial coefficients of nonpolar gases and their mixtures, A. I. Ch. E. Journal 13(5) 898 (1967).

[10] C. H. Chui and F. B. Canfield, Liquid density and excess properties of argon + krypton and krypton + xenon binary liquid mixtures, and liquid density of ethane, Trans. Faraday. 67, 2933). (1971).

[11] K. Clusius and K. Weigand, The melting curves of the gases A. Kr, X, $CH_4$, $CH_3D$, $CD_4$, $C_2H_4$, $C_2H_6$, COS, and $PH_3$ to 200 atm pressure, Z, physikal, Chem. B46 (1), 1 (1940).

[12] R. K. Crawford and W. B. Daniels, Equation of state measurements in compressed argon, J. Chem. Phys. 50(8), 3171 (1969).

[13] D. E. Diller, The specific heats ($C_v$) of dense, simple fluids, Cryogenics 11, 186 (June, 1971).

[14] D. R. Douslin and R. H. Harrison, Pressure-volume-temperature relations of ethane, J. Chem. Thermodynamics, 5(4),491 (1973).

[15] N. M. Dykhno, M. V. Tsyrulnikova and M. V. Mochalova, Hydrocarbon vapor pressures at low temperatures, Zh. Fiz. Khim. 42(9), 2310-1 (1968).

[16] J. H. Dymond and E. B. Smith, The virial coefficients of gases, Oxford Science Research Papers 2, Clarendon Press, Oxford, England, (1969).

[17] P. T. Eubank, Thermodynamic properties of ethane: vapor-liquid coexistence, Advances in Cryogenic Engineering, 17, 270 (Plenum Pub. Corp., New York, N. Y. 10011, (1971)).

[18] P. T. Eubank, B. F. Fort, and C. C. Reed, Jr., Thermodynamic properties of ethane: PVT surface and corresponding thermodynamic properties, Advances in Cryogenic Engineering, 17, 282 (1971).

[19] A. Eucken and A. Parts, Z. Phys. Chem. B20, 184 (1933), (virial coeffs. quoted by Ziegler et al. [77].

[20] André Furtado, The measurement and prediction of thermal properties of selected mixtures of methane, ethane, and propane, (Ph.D. Thesis, Dept. of Chemical Engineering, Univ. of Michigan, Ann Arbor, Mich., Dec., (1973)).

[21] R. D. Goodwin, An equation of state for fluid parahydrogen from the triple-point to 100°K at pressures to 350 atmospheres, J. Res. Nat. Bur. Stand. 71A (3), 203 (1967).

[22] R. D. Goodwin, Formulation of a nonanalytic equation of state for parahydrogen, J. Res. Nat. Bur. Stand. 73A (6), 585 (1969).

[23] R. D. Goodwin, Nonanalytic vapor pressure equation with data for nitrogen and oxygen, J. Res. Nat. Bur. Stand. 73A (5), 487 (1969).

[24] R. D. Goodwin and R. Prydz, Densities of compressed liquid methane, and the equation of state, J. Res. Nat. Bur. Stand. 76A(2), 81 (1972).

[25] R. D. Goodwin, The thermophysical properties of methane from 90 to 500 K at pressures to 700 bar, NBS Tech. Note 653, April (1974).

[26] R. D. Goodwin, The vapor pressures of ethane, Unpublished Report, Nat. Bur. Stand., Boulder, Colorado, 9 July, 1973. Appendix D, this report.

[27] R. D. Goodwin, Ethane virial coefficients and saturated vapor densities, Unpublished Report, Nat. Bur. Stand., Boulder, Colorado, 15 Aug., 1973. Appendix E, this report.

[28] R. D. Goodwin. The orthobaric densities of ethane, methane, oxygen, and flourine, Unpublished Report., Nat. Bur. Stand., Boulder, Colorado 18 Sept., 1973. Appendix F. this report.

[29] R. D. Goodwin, Liquid-vapor saturation (orthobaric) temperatures of ethane and methane, Unpublished Report, Nat. Bur. Stand., Boulder, Colorado, 28 Nov., 1973. Appendix G, this report.

[29a] R. D. Goodwin, Equation of state for thermodynamic properties of fluids, Submitted to J. Res. Nat. Bur. Stand., Boulder, Colorado, October, (1974).

[30] R. D. Gunn, M. S. Thesis, Univ. Calif. (Berkeley), 1958, quoted by J. A. Huff and T. M. Reed, J. Chem. Eng. Data 8, 306 (1963). (Virial coefficients.)

[31] K. R. Hall and P. T. Eubank, Experimental technique for direct measurement of interaction second virial coefficients. J. Chem. Phys. 59(2), 709 (1973).

[32] A. Harmens, Orthobaric densities of liquefied light hydrocarbons, Chem. Eng. Science 20, 813 (1965), 21, 725 (1966).

[33] A. S. Holmes, W. G. Braun and M. R. Fenske, Bibliography of vapor-pressure data for hydrocarbons, Amer. Petrol. Inst., New York, Bibliog. No. 2, 1964.

[34] A. E. Hoover, I. Nagata, T. W. Leland and R. Kobayashi, Virial coefficients of methane, ethane, and their mixtures at low temperatures, J. Chem. Phys. 48 (6), 2633 (1968).

[35] J. A. Huff and T. M. Reed, Second virial coefficients of mixtures of nonpolar molecules from correlations on pure components, J. Chem. and Eng. Data 8(3), 306 (1963).

[36] E. E. Hughes and S. G. Lias, Vapor pressures of organic compounds in the range below one millimeter of mercury, NBS Tech. Note No. 70., Washington, D. C. (Oct., 1960).

[37] J. G. Hust, A compilation and historical review of temperature scale differences, Cryogenics 9(6), 443 (Dec., 1969).

[38] J. D. Kemp and K. S. Pitzer, The entropy of ethane and the third law of thermodynamics. Hindered rotation of methyl groups, J. Am. Chem. Soc. 59, 276 (1937).

[39] G. Klipping and F. Schmidt, Dampfdrucktabellen tiefsiedender gase (V), Kaltetechnik 18(11), (Nov. 1966).

[40] J. Klosek and C. McKinley, Densities of liquified natural gas and of low molecular weight hydrocarbons, paper 22, Session 5, Proc. First Internat. Conf. on LNG, Chicago, April (1968).

[41] J. D. Lambert, G. A. H. Roberts, J. S. Rowlinson and V. J. Wilkinson, Proc. Roy. Soc., (London) A 196, 113 (1949). (Virial coefficients, quoted by Tester [70].)

[42] A. G. Loomis and J. E. Walters, The vapor pressure of ethane near the normal boiling point, J. Amer. Chem. Soc. 48, 2051 (1926).

[43] O. Maass and C. H. Wright, J. Am. Chem. Soc. 43, 1098 (1921). Vapor pressures, quoted by Tester [70].)

[44] E. A. Mason and T. H. Spurling, The virial equation of state, Pergamon Press, Oxford (England), (1969).

[45] R. D. McCarty, Least-squares computer subroutine, Unpublished report, Nat. Bur. Stand., Boulder, Colorado, (3 Jan., 1972).

[46] M. L. McGlashan and D. J. B. Potter, An apparatus for the measurement of the second virial coefficients of vapors; the second virial coefficients of some n-alkanes and of some mixtures of n-alkanes, Proc. Roy. Soc. (London) A267, 478 (1962).

[47] A. Michels, W. van Straaten and J. Dawson, Isotherms and thermodynamic functions of ethane at temperatures between $0^\circ$ C and $150^\circ$ C and pressures up to 200 atm, Physica XX, 17 (1954).

[48] J. B. Rodosevich and R. C. Miller, Experimental liquid mixture densities for testing and improving correlations for liquefied natural gas, A I Ch E Journal 19(4), 729 (1973).

[49] V. M. Minovich and G. A. Sorina, P-V-T relations in dilute solutions of propane in ethane in the vicinity of the cirtical point of ethane. 1. P-V-T relations for ethane in the vicinity of its critical point, Russian J. Phys. Chem. 45, (3) 306 (1971).

[50] T. Miyazaki, ($C_p$measurements near the critial point), Ph. D. Thesis, Dept. Chem. Eng., Univ. Michigan, (1974).

[51] J. Mollerup and J. S. Rowlinson, The prediction of the densities of liquified natural gas and of lower molecular weight hydrocarbons. Chem. Eng. Sci. 29, 1373 (1974).

[52] Plank and Kambeitz, Z. Ges. Kälte Ind. 10, 209 (1936), (Saturated vapor densities formula, quoted by Tester [70].

[53] G. R. Poole and R. A. Aziz, The law of corresponding states as applied to sound velocity in liquids consisting of elliptical molecules, Canadian J. Phys. 50, 721 (1972).

[54] G. A. Pope, Calculation of argon, methane, and ethane virial coefficients at low reduced temperature based on data obtained by isochorically coupled Burnett experiments, Thesis, Dept. Chemical Engineering, Rice University, Houston, Texas (July, 1971). (Includes vapor pressure data, also vapor pressures and PVT data of A. K. Pal.)

[55] G. A. Pope, P. S. Chappelear, and R. Kobayashi, Virial coefficients of argon, methane, and ethane at low reduced temperatures. J. Chem. Phys. 59 (1), 423 (1973).

[56] Frank Porter, The vapor pressures and specific volumes of the saturated vapor of ethane, J. Am. Chem. Soc. 48, 2055 (1926).

[57] H. H. Reamer, R. H. Olds, B. H. Sage, and W. N. Lacey, Phase equilbria in hydrocarbon systems: Volumetric behavior of ethane, Ind. Eng. Chem. 36, 956 (1944).

[58] J. Regnier, Vapor pressure of ethane between 80 and 135°K, J. Chim. Phys. 69(6), 942-4 (June, 1972).

[59] F. D. Rossini, Report on international practical temperature scale of 1968, J. Chem. Thermodynamics 2, 447 (1970).

[60] J. S. Rowlinson, Molecular theories of liquids and mixtures, Ind. Eng. Chem. 59(12), 28 (1967).

[61] J. S. Rowlinson, Liquids and liquid mixtures, Plenum Press, New York, N.Y., (1969).

[62] H. Sackmann and F. Sauerwald, The volume change upon melting of organic substances, especially in homologous series, Z, Physik. Chem. (Leipzig) A195, 295 (1950).

[63] B. H. Sage and W. N. Lacey, Thermodynamic Properties of the Lighter Paraffin Hydrocarbons and Nitrogen, American Petroleum Institute, New York (1950).

[64] C. T. Science, C. P. Colver and C. M. Sliepcevich, Bring your $C_1$-$C_4$ up to date, Hydrocarbon Process, 46(9), 173 (1967).

[65] M. Y. Shana'a and F. B. Canfield, Liquid density and excess volume of light hydrocarbon mixtures at -165° C, Trans. Faraday Soc. 64, 2281 (1968).

[66] P. Sliwinski, The Lorenz-Lorenz function of gaseous and liquid ethane, propane and butane, Zeit, Phys. Chem. Neue Folge 63, 263 (1969).

[67] N. E. Sondak and G. Thodos, Vapor pressures, the aliphatic hydrocarbons, A.I.Ch.E. Journal 2, 347 (1956).

[68] K. E. Starling, Fluid thermodynamic properties for light petroleum systems, Gulf Publishing Co., Houston, Texas (1973).

[68a] H. J. Strumpf, A. F. Collings and C. J. Pings, Viscosity of Xenon and Ethane in the Critical Region, J. Chem Phys. 60(8), 3109 (1974).

[69] A. S. Teja and J. S. Rowlinson, The prediction of the thermodynamic properties of fluids and fluid mixtures--IV. Critical and azeotropic states, Chem. Eng. Sci. 28, 529 (1973).

[70] H. E. Tester, Ethane, in Thermodynamic Functions of Gases, Vol 3, F. Din, Editor, (Butterworths Scientific Publications, London, 1961).

[71] A. W. Tickner and F. P. Lossing, The measurement of low vapor pressures by means of a mass spectrometer, J. Phys. Colloid Chem. 55, 733 (1951).

[72] J. R. Tomlinson (Gulf Research and Development Co., Pittsburgh, Pa.), Liquid densities of ethane, propane and ethane-propane mixtures, Tech. Pub. TP-1, Natural Gas Processors Assoc., (808 Home Federal Bldg., Tulsa, Okla. 74103, Feb. 1971).

[73] R. Wiebe, K. H. Hubbard and M. J. Brevoort, The heat capacity of saturated liquid ethane from the boiling point to the critical temperature and heat of fusion of the solid, J. Am. Chem. Soc. 52, 611 (1930).

[74] G. M. Wilson, R. G. Clark and F. L. Hyman, Thermodynamic properties of cryogenic fluids, Ind. Eng. Chem. 60(6), 58 (1968).

[75] R. K. Witt and J. D. Kemp, The heat capacity of ethane from 15°K to the boiling point. The heat of fusion and the heat of vaporization, J. Am. Chem. Soc. 59, 273 (1937).

[76] W. T. Ziegler, The vapor pressures of some hydrocarbons in the liquid and solid state at low temperatures, NBS Tech. Note 4, (May, 1959).

[77] W. T. Ziegler, B. S. Kirk, J. C. Mullins and A. R. Berquist, Calculation of the vapor pressure and heats of vaporization and sublimation of liquids and solids below one atmosphere pressure. VII Ethane, Tech. Report No. 2, Proj. A-764, Eng. Expt. Sta., Georgia Inst. Tech., Atlanta, Georgia, (Dec., 1964).

## APPENDIX A. Symbols and Units

Subscripts c and t refer to critical and liquid triple points.

Subscripts g and $\ell$ refer to saturated vapor and liquid.

Subscript $\sigma$ refers to liquid-vapor coexistence (usually the liquid).

Superscript o refers to ideal gas states.

| | |
|---|---|
| $\alpha$, b, $\gamma$, $\epsilon$, | non-linear constants in the equation of state |
| $B(\rho)$, $C(\rho)$, | density-dependent coefficients in the equation of state |
| $C_v(\rho, T)$, | molal heat capacity at constant volume, J/(mol· K) |
| $C_p(\rho, T)$, | molal heat capacitu at constant pressure, J/(mol· K) |
| $C_\sigma(T)$, | molal heat capacity for saturated liquid, J/(mol· K) |
| d, | density, mol/$\ell$ |
| $E(\rho, T)$, | the internal energy, J/mol |
| $H(\rho, T)$, | the enthalpy, J/mol |
| J, | the joule, 1 N-m, |
| $\ell$, | the liter, $10^{-3}m^{-3}$, |
| mol, | 30.07 grams of ethane ($C^{12}$ = 12 scale) |
| P, | pressure in bars, 1 bar = $10^5 N/m^2$ (1 atm = 1.01325 bar) |
| $P_\sigma(\rho)$, | the vapor pressure, bar |
| $\Phi(\rho, T)$, | function in the equation of state |
| $\psi(\rho, T)$, | function in the equation of state |
| $Q_{vap}$, | $\Delta H_{vap}$, the heat of vaporization |
| R, | the gas constant, 8.31434 (J/mol)/K, 0.0831434 (bar-$\ell$/mol)/K |
| $\rho$, | $d/d_t$, density reduced at the liquid triple point |
| $\sigma$, | $d/d_c$, density reduced at the critical point |
| $S(\rho, T)$, | the entropy, (J/mol)/K |
| T, | temperature, K, (IPTS-68) [59] |
| $T_\sigma(\rho)$, | liquid-vapor coexistence temperature, K |
| $\theta(\rho)$, | defined locus of temperatures, Fig. 4 |

APPENDIX A. (Continued)

| | |
|---|---|
| $U(\sigma)$, | defined function for eq (3-c) |
| v, | 1/d, molal volume, $\ell$/mol |
| $\omega(\rho, T)$, | $\delta \cdot [T/\theta - 1]$, for the equation of state |
| $W(\sigma)$, | defined function for eq (3-d) |
| $W(\rho, T)$, | the speed of sound, meters/second |
| $x(T)$, | $T/T_c$, for the equation of state |
| Y, | variously defined functions |
| Z, | Pv/RT, the "compressibility factor" |

## APPENDIX B. Fixed-Point Values

| | Methane | Ethane |
|---|---|---|
| Triple Point | | |
| Density Mol/$\ell$ | | |
| Vapor | $1.567\,865 \cdot 10^{-2}$ | $1.35114 \cdot 10^{-6}$ |
| Liquid | 28.1470 | 21.680 |
| Temperature, K | 90.680 | 89.899 |
| Pressure, bar | 0.1174 35675 | $1.009\,906 \cdot 10^{-5}$ |
| Critical Point | | |
| Density, mol/$\ell$ | 10.0 | 6.74 |
| Temperature, K | 190.555 | 305.37 |
| Pressure, bar | 45.988 | 48.755 |

APPENDIX C. Exposition of the Equation of State

Equation (5) may be written explicitly--

$$P = P_\sigma(\rho) + \rho R \cdot [T - T_\sigma(\rho)]$$

$$+ \rho^2 R T_c \cdot [B(\rho) \cdot \Phi(\rho, T) + C(\rho) \cdot \Psi(\rho, T)]. \quad (5\text{-}1)$$

This has only two temperature-dependent terms (in addition to $\rho RT$), which is the minimum number needed to describe the sigmoid shape of isochores [61] in the range $\rho_c < \rho < 2 \cdot \rho_c$, Figure 2. Each of these terms is zero on the coexistence boundary at $T = T_\sigma(\rho)$.

The first term, $\Phi(\rho, T)$, is shown by Figure 5. It is linear ($\partial^2 \Phi / \partial T^2 = 0$) on the coexistence boundary. It gives a critical isochore which is linear at the critical point because $C(\rho) = 0$ along this isochore.

The second term, $\Psi(\rho, T)$, is shown by Figure 6. It starts with infinite curvature ($\partial^2 \Psi / \partial T^2$) on the locus of temperatures, $\theta(\rho)$, inside the coexistence envelope of Figure 4. Sufficiently far away from the critical point it behaves like $1/T^2$, found in the well-known Beattie-Bridgeman equation.

The sign of the curvature ($\partial^2 P / \partial T^2$) of isochores at the coexistence boundary is determined uniquely by the sign of $C(\rho)$. Figure 7 shows the behavior of $B(\rho)$ and of $C(\rho)$ for methane. The root in $C(\rho)$ at $\rho/\rho_c = 1.9$ was found by least squares both for methane and for ethane. It then was introduced as the non-linear constant, $C_o$, in the equation of state. This constraint is valuable. In its absence we quite often have failed to obtain any such root from $P$-$\rho$-$T$ data by least squares. Figure 8 shows the presumed behavior of $C(\rho)$ for hydrogen (a double root near $\rho/\rho_c = 1.9$), needed to give the observed positive curvature of isochores in the compressed liquid at the lowest temperatures [13, 21].

The critical isotherm from eq. (5) necessarily has zero slope, $\partial P/\partial \rho = 0$, at the critical point, Figure 3. This follows from our definitions of $T_\sigma(\rho)$, $\theta(\rho)$, $\Phi(\rho, T)$ and $\Psi(\rho, T)$. The second derivative, $\partial^2 P/\partial \rho^2$, also is zero because the vapor pressure here is expressed as a function of $T_\sigma(\rho)$. Our detailed examinations of this isotherm show however, that small changes in the assigned critical point $(\rho_c, T_c)$ give rise to irregularities nearby at $\rho \leq \rho_c$. Adjusting the critical density to $\rho_c = 6.74$ mol/ℓ yields a well-behaved critical isotherm having no negative slopes, i. e. $\partial P/\partial \rho \geq 0$.

Specific heats along the critical isotherm of Figure 4 are computed by integrating the curvatures of isochores, $(\partial^2 P/\partial T^2)$, in eq. (11), starting at $\rho = 0$. Curvatures from the term $C(\rho) \cdot \Psi(\rho, T)$ in the equation of state at first increase sharply (with negative sign) as $\rho \to \rho_c^-$, become zero at $\rho = \rho_c$, then strongly positive at first for $\rho > \rho_c$, finally diminishing at still higher densities. This behavior is seen along the critical isotherm in Table 24. It gives a maximum in $C_v(\rho, T)$ at the critical point via eq. (11).

| Cryogenics Division – NBS Institute for Basic Standards LABORATORY NOTE | PROJECT NO. 2750364 | FILE NO. 73-3 | PAGE 1 |
|---|---|---|---|
| SUBJECT The Vapor Pressures of Ethane | NAME R. D. Goodwin | | |
| | DATE July 9, 1973 | | |

This is the first of several reports planned on the physical properties of ethane. Our ultimate purpose is to compute tables of thermodynamic functions over the entire range of fluid states. We first will discover regions where data are inadequate or lacking by attempting to compute provisional tables based on existing data.

Accurate vapor pressures, and a proper analytical representation of these data, are essential for computing heats of vaporization via the Clapeyron equation.

In this note we give a limited bibliography. Not all of these references were available at this writing. We compare several sets of data by use of our new, non-analytic vapor pressure equation. We make a choice of the best for least squares, and we give deviations from this selected equation.

At the triple point near 90 K the vapor pressure of ethane is about 0.00001 atm (10 $\mu$-atm). Experimental methods therefore differ for the range below one atm (184.5K) and for the range of higher pressures to 48 atm at $T_c$ = 305 K.

Data to about 1960 are reviewed by Tester [19], who selected the representation of Barkelew et al. [3] for the entire range from triple- to critical point.

Below one atm the data to 1964 are reviewed by Ziegler et al., who give their own, high quality set of data computed for thermodynamic consistency with all related or derived data, in a work for the National Standard Reference Data Program [23]. More recently we have the measurements of Carruth, obtained by the gas saturation flow technique, employing a flame ionization detector for analysis of the gas mixture [4]. See also J. J. Chen et al. (Rice University), paper G-1, 1972 Cryogenic Engineering Conference, on the same technique.

For high pressures the only new data of which we presently are aware are those of Pope (Table 25) [13], and those attributed to Dr. A. K. Pal by Pope [13] in Table 31. For these latter data there is no description of experimental method.

After this note was written we received the new precise measurements of Douslin and Harrison [24], and therefore have recomputed our results including these data. Douslin and Harrison note especially the new, precise measurements of Miniovich and Sorina [25], which were not available to us at this writing.

SP 11342 A

| Cryogenics Division – NBS Institute for Basic Standards<br>LABORATORY NOTE | PROJECT NO.<br>2750364 | FILE NO.<br>73-3 | PAGE<br>2 |
|---|---|---|---|
| SUBJECT<br>The Vapor Pressures of Ethane | NAME R. D. Goodwin<br>DATE July 9, 1973 | | |

Our vapor pressure equation [6] uses the reduced argument,

$$x(T) \equiv (1 - T_t/T)/(1 - T_t/T_c) ,$$

where subscripts t and c refer to triple- and critical points,

$$\ln (P/P_t) = a \cdot x + b \cdot x^2 + c \cdot x^3 + d \cdot x^4 + e \cdot x \cdot (1-x)^{\epsilon} \qquad (1)$$

and the exponent is $\epsilon = 1.5$ for methane [15] and for oxygen [16]. Originally the term $d \cdot x^4$ was absent. It has been added here to improve representation of the ethane data.

The following discoveries are found with the original equation of four terms. Optimum exponents in the range $1.1 \le \epsilon \le 1.9$ are obtained merely by changing the sets of data used for least squares. Hence we must rely on the more precise methane and oxygen data to select $\epsilon = 1.5$. Varying the critical-point temperature within reasonable limits has no significant effect on the overall, rms relative pressure deviations.

By examining numerous results we have selected for least squares only the data of Ziegler at $P \le 1$ atm [23], and the data of Pope, Pal [13] and Douslin [24] at $P > 1.9$ atm. Whereas the temperature scale of Ziegler may be thermodynamic (the report is not clear), we nevertheless find that deviations (rms in relative P) are minimized by converting both sets of data to T-1968 as if they had been on T-1948 [1]. All T used in the following are T-68.

The triple-point temperature was reviewed by Ziegler et al. Their selection of 89.89 K becomes 89.899 on the 1968 scale. The critical-point temperature 305.42 K of Pope has been changed to 305.33 K for consistency with the data of Douslin [24]. A value $T_c = 305.33 \pm 0.005$ K is given by P. Sliwinski, Zeit. Phys. Chem. 68, 91 (1964) based on analysis of dielectric constants. This was kindly pointed out by D. E. Diller. We obtain pressures at these end points from the vapor pressure equation:

| | T, K (1968) | P, atm |
|---|---|---|
| Triple point | 89.899 | $9.616 \cdot 10^{-6}$ |
| Critical point | 305.33 | 48.07695 |

SP 11342 A

| Cryogenics Division – NBS Institute for Basic Standards<br>LABORATORY NOTE | PROJECT NO.<br>2750364 | FILE NO.<br>73-3 | PAGE<br>3 |
|---|---|---|---|
| SUBJECT<br>The Vapor Pressures of Ethane | NAME<br>R. D. Goodwin<br>DATE<br>July 9, 1973 | | |

The constants for eq (1) were obtained via the data of Ziegler, Pope, Pal and Douslin. They include $\epsilon = 1.6$ as shown at the head of table 1.

| | | | |
|---|---|---|---|
| a = | 8.4549 8734 | d = | -1.4138 6053 |
| b = | 12.4880 3978 | e = | 8.5265 2253 |
| c = | -4.1042 8155 | | |

In the following tables we give the author's ID, his temperature and as converted to T-68, and the published and calculated pressures. Next is the deviation of his temperature from our calculated value,

$$DT \equiv T_{xpt} - T_{calc} = -(P_{xpt} - P_{calc})/(dP/dT),$$

and finally his relative pressure deviation,

$$P, PCT \equiv 100 \cdot (P_{xpt} - P_{calc})/P_{calc}.$$

At the bottom of each table we give the number of datum pairs, NP, and the rms of relative pressure deviations in percent.

The source of data in each table is identified by the numerical code, ID, in the first column--

| Table No. | I.D. | Authors | Reference |
|---|---|---|---|
| 1 | 4 | A. K. Pal | [13] |
| | 7 | Ziegler et al. | [23] |
| | 9 | G. A. Pope | [13] |
| | 10 | Douslin, Harrison | [24] |
| 2 | 1 | Tickner, Lossing | [20] |
| | 2 | API Proj. 44 | [2] |
| | 3 | Carruth | [4] |
| 3 | 5 | Loomis, Walters | [11] |
| 4 | 6 | F. Porter | [14] |
| | 8 | Barkelew et al | [3] |
| 5 | Calculated vapor pressures (this report) | | |
| 6 | Reduced v.p. functions (this report) | | |

SP 11342 A

| Cryogenics Division – NBS Institute for Basic Standards LABORATORY NOTE | PROJECT NO. 2750364 | FILE NO. 73-3 | PAGE 4 |
|---|---|---|---|
| SUBJECT The Vapor Pressures of Ethane | NAME R. D. Goodwin | | |
| | DATE July 9, 1973 | | |

As additional data may be found, we reserve comment on the deviations of individual authors, and omit the labor of preparing deviation plots.

Calculated pressures, slopes and curvatures are given at uniform temperatures by Table 5.

For comparison with functions in our original vapor pressure publication [6], we give these functions in Table 6, as computed via eq (1) namely

$$x(T) \equiv (T - T_t/T)/(1 - T_t/T_c),$$

$$Y(P) \equiv \ell n(P/P_t)/\ell n(P_c/P_t). \tag{2}$$

These variables range from zero to unity. The equation

$$Y = x \tag{3}$$

represents the basic vapor pressure equation

$$\ell n(P) = a - b/T \tag{4}$$

when this is constrained to the end-points (triple and critical). Hence (Y-x) is the deviation of data from (4).

Finally, we give the computer programs used in this work as a means to check for errors, and to facilitate resumption of this research.

Addendum. Following work shows that the second virial coefficient used by Ziegler et al. to obtain vapor pressures is not consistent with our selection. At 200°K his B(T) = - 455 cc/mol, whereas our B(T) = - 417.5. We therefore have recomputed our vapor pressure constants using Ziegler's vapor pressure data from his Table IX for "Curve B" of his Figure 1, for which B(T) = - 410 cc/mol at 200 K. The difference in his vapor pressures at 90 K is (7.80-7.33)/7.33 = 6.4 percent, the new values being the greater. Our new results for eq (1) are given in Table 7, (pages 20, 21) and tables 8, 9 on pages 22, 23 of this report. We prefer these constants for future use.

SP 11342 A

| Cryogenics Division – NBS Institute for Basic Standards LABORATORY NOTE | PROJECT NO. 2750364 | FILE NO. 73-3 | PAGE 5 |
|---|---|---|---|
| SUBJECT The Vapor Pressures of Ethane | NAME R. D. Goodwin | | |
| | DATE July 9, 1973 | | |

## Bibliography


[1] The International Practical Temperature Scale of 1968, Metrologia 5 (2), 35 (1969).

[2] Amer. Petrol. Inst. Res. Proj. 44, Selected Values of Properties of Hydrocarbons and Related Compounds (loose-leaf), Table 20 k, (Part 1), p. 1, Dec. 31 (1952).

[3] C. H. Barkelew, J. L. Valentine and C. O. Hurd, Thermodynamic properties of ethane, Trans. Amer. Inst. Chem. Eng. 43, 25 (1947).

[4] F. G. Carruth, Determination of the vapor pressure of n-paraffins and extension of a corresponding states correlation to low reduced temperatures, Thesis, Dept. Chemical Engineering, Rice University, Houston, Texas, (Nov. 1970).

[5] N. M. Dykhno, M. V. Tsyrulnikova and M. V. Mochalova, Hydrocarbon vapor pressures at low temperatures, Zh. Fiz. Khim. 42 (9), 2310-1 (1968).

[6] R. D. Goodwin, Nonanalytic vapor pressure equation with data for nitrogen and oxygen, J. Res. NBS 73A (5), 487 (1969).

[7] A. S. Holmes, W. G. Braun and M. R. Fenske, Bibliography of Vapor Pressure Data for Hydrocarbons, Amer. Petrol. Inst., New York, Bibliog. No. 2, (1964).

[8] E. E. Hughes and S. G. Lias, Vapor Pressures of Organic Compounds in the Range Below one Millimeter of Mercury, NBS Tech. Note 70, Washington, D. C. (Oct., 1960).

[9] J. G. Hust, A compilation and historical review of temperature scale differences, Cryogenics 9 (6), 443 (Dec., 1969).

[10] G. Klipping and F. Schmidt, Dampfdrucktabellen Tiefsiedender Gase (V), Kaltetechnik 18 (11), (Nov. 1966).

[11] A. G. Loomis and J. E. Walters, The vapor pressure of ethane near the normal boiling point, J. Amer. Chem. Soc. 48, 2051 (1926).

[12] R. E. Perry and G. Thodos, Vapor pressures of the light normal saturated hydrocarbons, Ind. Eng. Chem. 44 (7), 1649 (1952).

[13] G. A. Pope (quotes v.p. of Dr. A. K. Pal), Calculation of Argon, Methane, and Ethane Virial Coefficients at Low Reduced Temperature Based on Data Obtained by Isochorically Coupled Burnett Experiments, Thesis, Dept. Chemical Engineering, Rice University, Houston, Texas (July, 1971).

[14] F. Porter, The vapor pressures and specific volumes of the saturated vapor of ethane, J. Amer. Chem. Soc. 48, 2055 (1926).

[15] R. Prydz and R. D. Goodwin, Experimental melting and vapor pressures of methane, J. Chem. Thermodynamics 4. 127 (1972).

[16] Rolf Prydz, An improved oxygen vapor pressure representation, Metrologia 8 (1), 1 (1972).


SP 11342 A

| Cryogenics Division – NBS Institute for Basic Standards LABORATORY NOTE | PROJECT NO. 2750364 | FILE NO. 73-3 | PAGE 6 |
|---|---|---|---|
| SUBJECT The Vapor Pressures of Ethane | NAME R. D. Goodwin DATE July 9, 1973 | | |


[17] C. T. Sciance, C. P. Colver and C. M. Sliepcevich, Bring your $C_1$-$C_4$ up to date, Hydrocarbon Process. 46(9), 173 (1967).

[18] N. E. Sondak, and G. Thodos, Vapor pressures, the saturated aliphatic hydrocarbons, A.I.Ch.E. Journal 2, 347 (1956).

[19] H. E. Tester, ETHANE, in Thermodynamic Functions of Gases, F. Din, Editor, Butterworths, London (1961).

[20] A. W. Tickner and F. P. Lossing, The measurement of low vapor pressures by means of a mass spectrometer, J. Phys. Colloid Chem. 55, 733 (1951).

[21] G. M. Wilson, R. G. Clark and F. L. Hyman, Thermodynamic properties of cryogenic fluids, Ind. Eng. Chem. 60 (6), 58 (1968).

[22] W. T. Ziegler, The Vapor Pressures of Some Hydrocarbons in the liquid and solid state at low temperatures, NBS Tech. Note 4, (May, 1959).

[23] W. T. Ziegler, B. S. Kirk, J. C. Mullins and A. R. Berquist, Calculation of the Vapor Pressure and Heats of Vaporization and Sublimation of Liquids and Solids below One Atmosphere Pressure. VII Ethane, Tech. Rpt. No. 2 Proj. A-764, Eng. Expt. Sta., Georgia Inst. Tech.; Atlanta, Georgia, Dec., 1964.

[24] D.R. Douslin and R. H. Harrison, Pressure-Volume-Temperature Relations of Ethane (manuscript for the Journal of Chemical Thermodynamics), 1973.

[25] V. M. Miniovich and G. A. Sorina, Russian J. Phys. Chem. 45, 306 (1971).


SP 11342 A

| Cryogenics Division – NBS Institute for Basic Standards<br>LABORATORY NOTE | PROJECT NO.<br>2750364 | FILE NO.<br>73-3 | PAGE<br>7 |
|---|---|---|---|
| SUBJECT The Vapor Pressures of Ethane<br>Table 1. Data of Pal (4), Ziegler (7), Pope (9), and Douslin (10). | NAME R. D. Goodwin<br>DATE July 9, 1973 | | |

ETHANE VAPOR PRESSURES, E = 1.60
TTRP = 89.899, TCRT = 305.330
PTRP, MUATM = 9.61600, PCRT, ATM = 48.07695

| | | |
|---|---|---|
| 8.454987344 | 12.488039775 | -4.104281551 |
| -1.413860533 | 8.526522526 | 0.000000000 |

| ID | T,XPTL | T-68 | P,ATM | CALCD | DEL T | P,PCT |
|---|---|---|---|---|---|---|
| 7 | 94.000 | 94.013 | 0.0000274 | 0.0000274 | -0.001 | 0.02 |
| 7 | 98.000 | 98.012 | 0.0000693 | 0.0000694 | 0.002 | -0.05 |
| 7 | 102.000 | 102.008 | 0.0001618 | 0.0001619 | 0.002 | -0.05 |
| 7 | 106.000 | 106.002 | 0.0003526 | 0.0003522 | -0.006 | 0.11 |
| 7 | 110.000 | 109.998 | 0.0007207 | 0.0007205 | -0.002 | 0.03 |
| 7 | 114.000 | 113.995 | 0.0013947 | 0.0013947 | -0.000 | 0.00 |
| 7 | 118.000 | 117.991 | 0.0025697 | 0.0025698 | 0.000 | -0.00 |
| 7 | 122.000 | 121.988 | 0.0045303 | 0.0045293 | -0.002 | 0.02 |
| 7 | 126.000 | 125.987 | 0.0076737 | 0.0076734 | -0.000 | 0.00 |
| 7 | 130.000 | 129.987 | 0.012538 | 0.012540 | 0.001 | -0.01 |
| 7 | 134.000 | 133.988 | 0.019830 | 0.019834 | 0.002 | -0.02 |
| 7 | 138.000 | 137.990 | 0.030447 | 0.030460 | 0.004 | -0.04 |
| 7 | 142.000 | 141.993 | 0.045504 | 0.045527 | 0.005 | -0.05 |
| 7 | 146.000 | 145.996 | 0.066355 | 0.066389 | 0.006 | -0.05 |
| 7 | 150.000 | 150.000 | 0.094608 | 0.094657 | 0.006 | -0.05 |
| 7 | 154.000 | 154.004 | 0.13213 | 0.13220 | 0.007 | -0.05 |
| 7 | 158.000 | 158.008 | 0.18109 | 0.18117 | 0.005 | -0.04 |
| 7 | 162.000 | 162.012 | 0.24392 | 0.24397 | 0.003 | -0.02 |
| 7 | 166.000 | 166.015 | 0.32333 | 0.32330 | -0.001 | 0.01 |
| 7 | 170.000 | 170.019 | 0.42230 | 0.42214 | -0.006 | 0.04 |
| 7 | 174.000 | 174.023 | 0.54409 | 0.54371 | -0.011 | 0.07 |
| 7 | 178.000 | 178.026 | 0.69224 | 0.69145 | -0.020 | 0.11 |
| 7 | 182.000 | 182.028 | 0.87047 | 0.86905 | -0.029 | 0.16 |
| 7 | 184.520 | 184.550 | 1.00000 | 0.99803 | -0.036 | 0.20 |
| 9 | 198.181 | 198.216 | 1.9737 | 1.9758 | 0.023 | -0.11 |
| 4 | 214.302 | 214.334 | 3.9209 | 3.9176 | -0.021 | 0.08 |
| 4 | 224.102 | 224.130 | 5.6367 | 5.6429 | 0.031 | -0.11 |
| 4 | 229.756 | 229.782 | 6.8569 | 6.8629 | 0.026 | -0.09 |
| 4 | 234.556 | 234.581 | 8.0335 | 8.0423 | 0.034 | -0.11 |
| 9 | 234.692 | 234.715 | 8.0741 | 8.0772 | 0.012 | -0.04 |
| 10 | 238.150 | 238.150 | 9.0097 | 9.0108 | 0.004 | -0.01 |
| 9 | 238.771 | 238.792 | 9.1843 | 9.1935 | 0.032 | -0.10 |
| 4 | 239.844 | 239.864 | 9.4959 | 9.5049 | 0.030 | -0.09 |
| 4 | 240.514 | 240.534 | 9.6960 | 9.7032 | 0.024 | -0.07 |
| 10 | 243.150 | 243.150 | 10.5063 | 10.5071 | 0.003 | -0.01 |
| 4 | 243.359 | 243.377 | 10.5760 | 10.5790 | 0.009 | -0.03 |
| 4 | 246.814 | 246.830 | 11.7137 | 11.7183 | 0.014 | -0.04 |
| 4 | 247.816 | 247.831 | 12.0502 | 12.0648 | 0.042 | -0.12 |
| 10 | 248.150 | 248.150 | 12.1756 | 12.1766 | 0.003 | -0.01 |
| 4 | 249.741 | 249.755 | 12.7520 | 12.7512 | -0.030 | 0.08 |
| 4 | 250.146 | 250.160 | 12.8985 | 12.8991 | 0.002 | -0.01 |
| 4 | 251.587 | 251.600 | 13.4425 | 13.4356 | -0.018 | 0.05 |
| 4 | 252.544 | 252.556 | 13.8065 | 13.8008 | -0.015 | 0.04 |
| 10 | 253.150 | 253.150 | 14.0310 | 14.0310 | -0.000 | 0.00 |
| 4 | 254.290 | 254.301 | 14.4898 | 14.4854 | -0.011 | 0.03 |
| 4 | 257.543 | 257.552 | 15.8252 | 15.8264 | 0.003 | -0.01 |
| 10 | 258.150 | 258.150 | 16.0835 | 16.0823 | -0.003 | 0.01 |

SP 11342 A

Cryogenics Division – NBS Institute for Basic Standards

LABORATORY NOTE

| PROJECT NO. | FILE NO. | PAGE |
|---|---|---|
| 2750364 | 73-3 | 8 |

SUBJECT The Vapor Pressures of Ethane

Table 1--continued.

NAME R. D. Goodwin

DATE July 9, 1973

| ID | T,XPTL | T-68 | P,ATM | CALCD | DEL T | P,PCT |
|---|---|---|---|---|---|---|
| 10 | 263.150 | 263.150 | 18.3464 | 18.3433 | -0.007 | 0.02 |
| 4 | 263.380 | 263.386 | 18.4543 | 18.4553 | 0.002 | -0.01 |
| 4 | 267.536 | 267.539 | 20.5197 | 20.5113 | -0.016 | 0.04 |
| 10 | 268.150 | 268.150 | 20.8318 | 20.8274 | -0.009 | 0.02 |
| 4 | 271.749 | 271.750 | 22.7661 | 22.7618 | -0.008 | 0.02 |
| 9 | 272.949 | 272.949 | 23.4515 | 23.4347 | -0.030 | 0.07 |
| 10 | 273.150 | 273.150 | 23.5549 | 23.5488 | -0.011 | 0.03 |
| 4 | 275.922 | 275.921 | 25.1584 | 25.1648 | 0.011 | -0.03 |
| 4 | 276.363 | 276.362 | 25.4558 | 25.4293 | -0.044 | 0.10 |
| 4 | 276.385 | 276.384 | 25.4491 | 25.4425 | -0.011 | 0.03 |
| 4 | 276.514 | 276.513 | 25.5472 | 25.5203 | -0.044 | 0.11 |
| 4 | 277.813 | 277.811 | 26.3185 | 26.3133 | -0.008 | 0.02 |
| 10 | 278.150 | 278.150 | 26.5309 | 26.5233 | -0.012 | 0.03 |
| 4 | 280.041 | 280.038 | 27.7039 | 27.7158 | 0.019 | -0.04 |
| 4 | 282.247 | 282.243 | 29.1537 | 29.1588 | 0.008 | -0.02 |
| 10 | 283.150 | 283.150 | 29.7763 | 29.7681 | -0.012 | 0.03 |
| 4 | 284.635 | 284.630 | 30.7664 | 30.7836 | 0.025 | -0.06 |
| 9 | 284.845 | 284.840 | 30.9555 | 30.9296 | -0.037 | 0.08 |
| 4 | 287.653 | 287.648 | 32.9289 | 32.9340 | 0.007 | -0.02 |
| 10 | 288.150 | 288.150 | 33.3110 | 33.3030 | -0.011 | 0.02 |
| 4 | 288.263 | 288.257 | 33.3899 | 33.3822 | -0.010 | 0.02 |
| 4 | 290.040 | 290.034 | 34.6873 | 34.7148 | 0.036 | -0.08 |
| 9 | 290.214 | 290.208 | 34.8748 | 34.8474 | -0.036 | 0.08 |
| 4 | 292.236 | 292.229 | 36.4440 | 36.4182 | -0.033 | 0.07 |
| 4 | 293.098 | 293.091 | 37.0816 | 37.1044 | 0.028 | -0.06 |
| 10 | 293.150 | 293.150 | 37.1583 | 37.1518 | -0.008 | 0.02 |
| 9 | 293.266 | 293.259 | 37.2672 | 37.2394 | -0.035 | 0.07 |
| 4 | 296.347 | 296.339 | 39.7598 | 39.7842 | 0.029 | -0.06 |
| 10 | 298.150 | 298.150 | 41.3494 | 41.3450 | -0.005 | 0.01 |
| 4 | 299.665 | 299.657 | 42.6543 | 42.6822 | 0.031 | -0.07 |
| 9 | 299.863 | 299.855 | 42.8863 | 42.8606 | -0.028 | 0.06 |
| 4 | 300.205 | 300.196 | 43.1650 | 43.1703 | 0.006 | -0.01 |
| 4 | 301.251 | 301.242 | 44.1085 | 44.1297 | 0.023 | -0.05 |
| 10 | 302.150 | 302.150 | 44.9809 | 44.9778 | -0.003 | 0.01 |
| 10 | 303.150 | 303.150 | 45.9327 | 45.9295 | -0.003 | 0.01 |
| 4 | 303.471 | 303.462 | 46.2032 | 46.2300 | 0.028 | -0.06 |
| 4 | 303.477 | 303.468 | 46.2798 | 46.2358 | -0.046 | 0.10 |
| 9 | 304.012 | 304.002 | 46.7736 | 46.7558 | -0.018 | 0.04 |
| 4 | 304.049 | 304.039 | 46.7698 | 46.7920 | 0.023 | -0.05 |
| 10 | 304.150 | 304.150 | 46.9040 | 46.9010 | -0.003 | 0.01 |
| 4 | 304.360 | 304.350 | 47.0931 | 47.0974 | 0.004 | -0.01 |
| 4 | 304.446 | 304.435 | 47.2198 | 47.1822 | -0.038 | 0.08 |
| 4 | 304.519 | 304.508 | 47.2025 | 47.2544 | 0.052 | -0.11 |
| 4 | 304.734 | 304.723 | 47.4310 | 47.4677 | 0.037 | -0.08 |
| 4 | 304.796 | 304.785 | 47.5185 | 47.5294 | 0.011 | -0.02 |
| 4 | 304.924 | 304.913 | 47.6846 | 47.6572 | -0.027 | 0.06 |
| 4 | 304.980 | 304.969 | 47.7131 | 47.7132 | 0.000 | -0.00 |
| 4 | 305.121 | 305.110 | 47.8496 | 47.8547 | 0.005 | -0.01 |
| 4 | 305.135 | 305.124 | 47.8251 | 47.8688 | 0.043 | -0.09 |
| 10 | 305.150 | 305.150 | 47.8992 | 47.8950 | -0.004 | 0.01 |
| 4 | 305.153 | 305.142 | 47.8807 | 47.8869 | 0.006 | -0.01 |
| 10 | 305.250 | 305.250 | 47.9994 | 47.9959 | -0.003 | 0.01 |

NP = 93, RMSPCT = 0.061

SP 11342 A

| Cryogenics Division – NBS Institute for Basic Standards LABORATORY NOTE | PROJECT NO. 2750364 | FILE NO. 73-3 | PAGE 9 |
|---|---|---|---|
| SUBJECT: The Vapor Pressures of Ethane | NAME: R. D. Goodwin | | |
| Table 2. Data of Tickner (1), API (2), and Carruth (3). | DATE: July 9, 1973 | | |

| ID | T,XPTL | T-68 | P,ATM | CALCD | DEL T | P,PCT |
|---|---|---|---|---|---|---|
| 1 | 91.350 | 91.361 | 0.0000132 | 0.0000141 | 0.265 | -6.86 |
| 1 | 94.450 | 94.463 | 0.0000263 | 0.0000306 | 0.582 | -13.98 |
| 1 | 98.550 | 98.562 | 0.0000658 | 0.0000783 | 0.730 | -15.98 |
| 1 | 101.850 | 101.858 | 0.0001316 | 0.0001571 | 0.797 | -16.23 |
| 1 | 105.350 | 105.353 | 0.0002632 | 0.0003118 | 0.825 | -15.60 |
| 1 | 110.550 | 110.548 | 0.0006579 | 0.0007914 | 0.992 | -16.87 |
| 1 | 114.650 | 114.644 | 0.0013158 | 0.0015453 | 0.947 | -14.85 |
| 1 | 119.050 | 119.040 | 0.0026316 | 0.0029942 | 0.839 | -12.11 |
| 1 | 125.550 | 125.537 | 0.0065789 | 0.0072450 | 0.717 | -9.19 |
| 1 | 130.650 | 130.637 | 0.013158 | 0.013539 | 0.240 | -2.81 |

NP = 10, RMSPCT = 13.226

| ID | T,XPTL | T-68 | P,ATM | CALCD | DEL T | P,PCT |
|---|---|---|---|---|---|---|
| 2 | 130.270 | 130.257 | 0.013158 | 0.012947 | -0.138 | 1.63 |
| 2 | 136.460 | 136.449 | 0.026316 | 0.025909 | -0.148 | 1.57 |
| 2 | 140.410 | 140.402 | 0.039474 | 0.038925 | -0.141 | 1.41 |
| 2 | 143.370 | 143.364 | 0.052632 | 0.051945 | -0.139 | 1.32 |
| 2 | 145.760 | 145.756 | 0.065789 | 0.064946 | -0.142 | 1.30 |
| 2 | 147.790 | 147.788 | 0.078947 | 0.078018 | -0.134 | 1.19 |
| 2 | 151.120 | 151.121 | 0.10526 | 0.10415 | -0.127 | 1.07 |
| 2 | 153.820 | 153.824 | 0.13158 | 0.13028 | -0.122 | 0.99 |
| 2 | 159.030 | 159.039 | 0.19737 | 0.19591 | -0.099 | 0.74 |
| 2 | 162.960 | 162.973 | 0.26316 | 0.26140 | -0.094 | 0.67 |
| 2 | 166.170 | 166.185 | 0.32895 | 0.32708 | -0.084 | 0.57 |
| 2 | 168.900 | 168.918 | 0.39474 | 0.39284 | -0.074 | 0.48 |
| 2 | 173.410 | 173.432 | 0.52632 | 0.52422 | -0.064 | 0.40 |
| 2 | 177.100 | 177.125 | 0.65789 | 0.65574 | -0.056 | 0.33 |
| 2 | 180.250 | 180.277 | 0.78947 | 0.78743 | -0.046 | 0.26 |
| 2 | 183.010 | 183.039 | 0.92105 | 0.91908 | -0.039 | 0.21 |
| 2 | 184.520 | 184.550 | 1.00000 | 0.99803 | -0.036 | 0.20 |
| 2 | 185.480 | 185.510 | 1.0526 | 1.0509 | -0.031 | 0.16 |
| 2 | 187.710 | 187.741 | 1.1842 | 1.1821 | -0.034 | 0.18 |
| 2 | 189.770 | 189.802 | 1.3158 | 1.3143 | -0.023 | 0.11 |
| 2 | 193.440 | 193.473 | 1.5789 | 1.5777 | -0.017 | 0.08 |
| 2 | 198.150 | 198.185 | 1.9737 | 1.9729 | -0.008 | 0.04 |

NP = 22, RMSPCT = 0.857

| ID | T,XPTL | T-68 | P,ATM | CALCD | DEL T | P,PCT |
|---|---|---|---|---|---|---|
| 3 | 91.340 | 91.351 | 0.0000152 | 0.0000141 | -0.315 | 8.14 |
| 3 | 93.700 | 93.712 | 0.0000270 | 0.0000255 | -0.237 | 5.83 |
| 3 | 96.240 | 96.253 | 0.0000491 | 0.0000466 | -0.235 | 5.42 |
| 3 | 100.700 | 100.710 | 0.0001297 | 0.0001239 | -0.222 | 4.64 |
| 3 | 105.600 | 105.603 | 0.0003263 | 0.0003268 | 0.009 | -0.16 |
| 3 | 114.240 | 114.235 | 0.0014461 | 0.0014487 | 0.012 | -0.19 |
| 3 | 120.380 | 120.369 | 0.0036066 | 0.0036185 | 0.023 | -0.33 |
| 3 | 129.810 | 129.797 | 0.012312 | 0.012260 | -0.036 | 0.42 |
| 3 | 135.770 | 135.759 | 0.024197 | 0.024065 | -0.051 | 0.55 |
| 3 | 140.550 | 140.542 | 0.040211 | 0.039472 | -0.188 | 1.87 |
| 3 | 144.140 | 144.135 | 0.056289 | 0.055871 | -0.080 | 0.75 |

NP = 11, RMSPCT = 3.759

SP 11342 A

Cryogenics Division – NBS Institute for Basic Standards
LABORATORY NOTE

| PROJECT NO. | FILE NO. | PAGE |
|---|---|---|
| 2750364 | 73-3 | 10 |

SUBJECT

NAME R. D. Goodwin

DATE July 9, 1973

The Vapor Pressures of Ethane

Table 3. Data (5) of Loomis, Walters [11].

| ID | T,XPTL | T-68 | P,ATM | CALCD | DEL T | P,PCT |
|---|---|---|---|---|---|---|
| 5 | 135.736 | 135.725 | 0.024500 | 0.023977 | -0.203 | 2.18 |
| 5 | 143.267 | 143.261 | 0.052200 | 0.051437 | -0.156 | 1.48 |
| 5 | 147.324 | 147.321 | 0.075900 | 0.074840 | -0.158 | 1.42 |
| 5 | 154.546 | 154.550 | 0.14000 | 0.13816 | -0.166 | 1.33 |
| 5 | 158.385 | 158.393 | 0.18860 | 0.18657 | -0.143 | 1.09 |
| 5 | 162.629 | 162.641 | 0.25730 | 0.25528 | -0.110 | 0.79 |
| 5 | 165.529 | 165.544 | 0.31600 | 0.31300 | -0.139 | 0.96 |
| 5 | 167.836 | 167.853 | 0.36930 | 0.36606 | -0.133 | 0.89 |
| 5 | 169.175 | 169.193 | 0.40330 | 0.40000 | -0.126 | 0.82 |
| 5 | 171.700 | 171.721 | 0.47430 | 0.47084 | -0.116 | 0.74 |
| 5 | 170.602 | 170.622 | 0.44300 | 0.43890 | -0.145 | 0.93 |
| 5 | 174.062 | 174.085 | 0.54980 | 0.54579 | -0.119 | 0.73 |
| 5 | 175.708 | 175.732 | 0.60730 | 0.60338 | -0.108 | 0.65 |
| 5 | 177.623 | 177.649 | 0.68040 | 0.67631 | -0.103 | 0.61 |
| 5 | 178.621 | 178.647 | 0.72100 | 0.71696 | -0.097 | 0.56 |
| 5 | 179.750 | 179.777 | 0.76960 | 0.76525 | -0.099 | 0.57 |
| 5 | 181.506 | 181.534 | 0.84990 | 0.84537 | -0.096 | 0.54 |
| 5 | 182.463 | 182.492 | 0.89630 | 0.89172 | -0.093 | 0.51 |
| 5 | 183.778 | 183.807 | 0.96340 | 0.95860 | -0.092 | 0.50 |
| 5 | 184.539 | 184.569 | 1.00400 | 0.99906 | -0.091 | 0.49 |
| 5 | 185.137 | 185.167 | 1.0366 | 1.0318 | -0.087 | 0.47 |
| 5 | 185.914 | 185.944 | 1.0830 | 1.0755 | -0.078 | 0.42 |
| 5 | 186.609 | 186.640 | 1.1206 | 1.1158 | -0.084 | 0.44 |
| 5 | 187.302 | 187.333 | 1.1619 | 1.1572 | -0.077 | 0.40 |
| 5 | 187.726 | 187.757 | 1.1881 | 1.1831 | -0.081 | 0.42 |
| 5 | 188.379 | 188.410 | 1.2289 | 1.2239 | -0.080 | 0.41 |
| 5 | 189.114 | 189.146 | 1.2757 | 1.2710 | -0.072 | 0.37 |
| 5 | 189.858 | 189.890 | 1.3248 | 1.3202 | -0.069 | 0.35 |
| 5 | 190.791 | 190.823 | 1.3885 | 1.3839 | -0.067 | 0.33 |
| 5 | 191.430 | 191.463 | 1.4334 | 1.4288 | -0.064 | 0.32 |
| 5 | 192.286 | 192.319 | 1.4953 | 1.4908 | -0.061 | 0.30 |
| 5 | 192.777 | 192.810 | 1.5318 | 1.5273 | -0.060 | 0.29 |
| 5 | 196.244 | 196.278 | 1.8088 | 1.8049 | -0.046 | 0.22 |
| 5 | 199.909 | 199.944 | 2.1417 | 2.1384 | -0.034 | 0.15 |

NP = 34, RMSPCT = 0.789

| Cryogenics Division – NBS Institute for Basic Standards LABORATORY NOTE | PROJECT NO. 2750364 | FILE NO. 73-3 | PAGE 11 |
|---|---|---|---|
| SUBJECT The Vapor Pressures of Ethane Table 4. Data of Porter (6), and Barkelew (8). | NAME R. D. Goodwin | DATE July 9, 1973 | |

| ID | T,XPTL | T-68 | P,ATM | CALCD | DEL T | P,PCT |
|---|---|---|---|---|---|---|
| 6 | 184.470 | 184.500 | 0.99940 | 0.99534 | -0.075 | 0.41 |
| 6 | 203.490 | 203.524 | 2.4960 | 2.5076 | 0.106 | -0.46 |
| 6 | 205.620 | 205.653 | 2.7330 | 2.7489 | 0.135 | -0.58 |
| 6 | 210.960 | 210.992 | 3.4140 | 3.4308 | 0.121 | -0.49 |
| 6 | 216.310 | 216.341 | 4.2250 | 4.2338 | 0.054 | -0.21 |
| 6 | 221.880 | 221.910 | 5.2070 | 5.2104 | 0.018 | -0.06 |
| 6 | 225.100 | 225.128 | 5.8380 | 5.8456 | 0.037 | -0.13 |
| 6 | 226.180 | 226.207 | 6.0730 | 6.0709 | -0.010 | 0.03 |
| 6 | 234.580 | 234.603 | 8.0440 | 8.0481 | 0.016 | -0.05 |
| 6 | 238.900 | 238.921 | 9.2290 | 9.2305 | 0.005 | -0.02 |
| 6 | 243.220 | 243.238 | 10.5360 | 10.5350 | -0.003 | 0.01 |
| 6 | 248.650 | 248.665 | 12.3540 | 12.3588 | 0.013 | -0.04 |
| 6 | 253.030 | 253.042 | 14.0430 | 13.9889 | -0.139 | 0.39 |
| 6 | 258.800 | 258.809 | 16.4210 | 16.3679 | -0.122 | 0.32 |
| 6 | 263.280 | 263.286 | 18.4480 | 18.4078 | -0.085 | 0.22 |
| 6 | 268.730 | 268.732 | 21.1850 | 21.1317 | -0.101 | 0.25 |
| 6 | 273.090 | 273.090 | 23.5440 | 23.5147 | -0.051 | 0.12 |
| 6 | 278.640 | 278.638 | 26.8370 | 26.8276 | -0.015 | 0.04 |
| 6 | 283.580 | 283.576 | 30.1060 | 30.0575 | -0.071 | 0.16 |
| 6 | 288.260 | 288.254 | 33.4680 | 33.3800 | -0.119 | 0.26 |

NP = 20, RMSPCT = 0.274

| ID | T,XPTL | T-68 | P,ATM | CALCD | DEL T | P,PCT |
|---|---|---|---|---|---|---|
| 8 | 110.000 | 109.998 | 0.0007600 | 0.0007205 | -0.319 | 5.49 |
| 8 | 120.000 | 119.989 | 0.0034600 | 0.0034295 | -0.063 | 0.89 |
| 8 | 130.000 | 129.987 | 0.012720 | 0.012540 | -0.121 | 1.44 |
| 8 | 140.000 | 139.992 | 0.037850 | 0.037359 | -0.131 | 1.31 |
| 8 | 150.000 | 150.000 | 0.095600 | 0.094657 | -0.116 | 1.00 |
| 8 | 160.000 | 160.010 | 0.21200 | 0.21068 | -0.084 | 0.63 |
| 8 | 170.000 | 170.019 | 0.42360 | 0.42214 | -0.053 | 0.35 |
| 8 | 180.000 | 180.027 | 0.77780 | 0.77628 | -0.034 | 0.20 |
| 8 | 190.000 | 190.032 | 1.3300 | 1.3297 | -0.004 | 0.02 |
| 8 | 200.000 | 200.035 | 2.1462 | 2.1472 | 0.011 | -0.05 |
| 8 | 210.000 | 210.033 | 3.2970 | 3.2998 | 0.020 | -0.08 |
| 8 | 220.000 | 220.030 | 4.8580 | 4.8639 | 0.033 | -0.12 |
| 8 | 230.000 | 230.025 | 6.9120 | 6.9196 | 0.032 | -0.11 |
| 8 | 240.000 | 240.020 | 9.5510 | 9.5508 | -0.001 | 0.00 |
| 8 | 250.000 | 250.014 | 12.8500 | 12.8456 | -0.012 | 0.03 |
| 8 | 260.000 | 260.008 | 16.9100 | 16.8973 | -0.028 | 0.08 |
| 8 | 270.000 | 270.001 | 21.8000 | 21.8066 | 0.012 | -0.03 |
| 8 | 280.000 | 279.997 | 27.6500 | 27.6895 | 0.062 | -0.14 |
| 8 | 290.000 | 289.994 | 34.6500 | 34.6843 | 0.045 | -0.10 |

NP = 19, RMSPCT = 1.383

| Cryogenics Division – NBS Institute for Basic Standards<br>LABORATORY NOTE | PROJECT NO.<br>2750364 | FILE NO.<br>73-3 | PAGE<br>12 |
|---|---|---|---|
| SUBJECT<br>The Vapor Pressures of Ethane<br>Table 5. Calculated Ethane Vapor Pressures. | NAME<br>R. D. Goodwin<br>DATE<br>July 9, 1973 | | |

ETHANE VAPOR PRESSURES

| T,K | P,ATM | DP/DT | D2P/DT2 |
|---|---|---|---|
| 89.399 | 0.0000096 | 0.0000026 | 0.00000063 |
| 90.000 | 0.0000099 | 0.0000026 | 0.00000064 |
| 95.000 | 0.0000348 | 0.0000083 | 0.00000177 |
| 100.000 | 0.0001067 | 0.0000226 | 0.00000430 |
| 105.000 | 0.0002916 | 0.0000555 | 0.00000942 |
| 110.000 | 0.0007207 | 0.0001239 | 0.00001881 |
| 115.000 | 0.0016337 | 0.0002545 | 0.00003475 |
| 120.000 | 0.0034347 | 0.0004868 | 0.00005997 |
| 125.000 | 0.0067608 | 0.0008749 | 0.00009759 |
| 130.000 | 0.012559 | 0.001489 | 0.0001508 |
| 135.000 | 0.022167 | 0.002414 | 0.0002228 |
| 140.000 | 0.037390 | 0.003753 | 0.0003164 |
| 145.000 | 0.060574 | 0.005618 | 0.0004339 |
| 150.000 | 0.094659 | 0.008135 | 0.0005771 |
| 155.000 | 0.14323 | 0.01143 | 0.000747 |
| 160.000 | 0.21052 | 0.01565 | 0.000944 |
| 165.000 | 0.30146 | 0.02091 | 0.001167 |
| 170.000 | 0.42162 | 0.02736 | 0.001415 |
| 175.000 | 0.57722 | 0.03511 | 0.001688 |
| 180.000 | 0.77507 | 0.04428 | 0.001984 |
| 185.000 | 1.0226 | 0.0550 | 0.00230 |
| 190.000 | 1.3276 | 0.0673 | 0.00263 |
| 195.000 | 1.6984 | 0.0813 | 0.00298 |
| 200.000 | 2.1439 | 0.0972 | 0.00335 |
| 205.000 | 2.6731 | 0.1148 | 0.00372 |
| 210.000 | 3.2954 | 0.1344 | 0.00411 |
| 215.000 | 4.0205 | 0.1560 | 0.00451 |
| 220.000 | 4.8585 | 0.1795 | 0.00492 |
| 225.000 | 5.8194 | 0.2052 | 0.00533 |
| 230.000 | 6.9136 | 0.2329 | 0.00576 |
| 235.000 | 8.1519 | 0.2628 | 0.00619 |
| 240.000 | 9.5450 | 0.2948 | 0.00664 |
| 245.000 | 11.1040 | 0.3292 | 0.00710 |
| 250.000 | 12.8406 | 0.3658 | 0.00757 |
| 255.000 | 14.7664 | 0.4049 | 0.00806 |
| 260.000 | 16.8936 | 0.4465 | 0.00858 |
| 265.000 | 19.2357 | 0.4907 | 0.00913 |
| 270.000 | 21.8058 | 0.5378 | 0.00972 |
| 275.000 | 24.6190 | 0.5880 | 0.01036 |
| 280.000 | 27.6914 | 0.6416 | 0.01108 |
| 285.000 | 31.0410 | 0.6990 | 0.01192 |
| 290.000 | 34.6895 | 0.7610 | 0.01294 |
| 295.000 | 38.6612 | 0.8289 | 0.01429 |
| 300.000 | 42.9922 | 0.9053 | 0.01649 |
| 305.000 | 47.7442 | 1.0029 | 0.02894 |
| 305.330 | 48.0770 | 1.0160 | 0.00000 |

SP 11342 A

SUBJECT The Vapor Pressures of Ethane
Table 6. Reduced Vapor Pressure Functions.

NAME R. D. Goodwin

DATE July 9, 1973

ETHANE REDUCED VAPOR PRESSURE FUNCTIONS

| T,K | X | Y | (Y-X) |
|---|---|---|---|
| 89.899 | 0.00 | 0.00000 | 0.00000 |
| 91.186 | 0.02 | 0.02199 | 0.00199 |
| 92.510 | 0.04 | 0.04392 | 0.00392 |
| 93.873 | 0.06 | 0.06578 | 0.00578 |
| 95.277 | 0.08 | 0.08759 | 0.00759 |
| 96.723 | 0.10 | 0.10934 | 0.00934 |
| 98.215 | 0.12 | 0.13102 | 0.01102 |
| 99.753 | 0.14 | 0.15264 | 0.01264 |
| 101.339 | 0.16 | 0.17419 | 0.01419 |
| 102.977 | 0.18 | 0.19568 | 0.01568 |
| 104.669 | 0.20 | 0.21710 | 0.01710 |
| 106.418 | 0.22 | 0.23845 | 0.01845 |
| 108.226 | 0.24 | 0.25972 | 0.01972 |
| 110.096 | 0.26 | 0.28093 | 0.02093 |
| 112.032 | 0.28 | 0.30205 | 0.02205 |
| 114.037 | 0.30 | 0.32310 | 0.02310 |
| 116.116 | 0.32 | 0.34406 | 0.02406 |
| 118.272 | 0.34 | 0.36495 | 0.02495 |
| 120.509 | 0.36 | 0.38574 | 0.02574 |
| 122.832 | 0.38 | 0.40645 | 0.02645 |
| 125.247 | 0.40 | 0.42706 | 0.02706 |
| 127.759 | 0.42 | 0.44758 | 0.02758 |
| 130.373 | 0.44 | 0.46800 | 0.02800 |
| 133.097 | 0.46 | 0.48832 | 0.02832 |
| 135.937 | 0.48 | 0.50854 | 0.02854 |
| 138.901 | 0.50 | 0.52866 | 0.02866 |
| 141.997 | 0.52 | 0.54866 | 0.02866 |
| 145.234 | 0.54 | 0.56855 | 0.02855 |
| 148.622 | 0.56 | 0.58833 | 0.02833 |
| 152.172 | 0.58 | 0.60800 | 0.02800 |
| 155.896 | 0.60 | 0.62755 | 0.02755 |
| 159.807 | 0.62 | 0.64698 | 0.02698 |
| 163.919 | 0.64 | 0.66629 | 0.02629 |
| 168.248 | 0.66 | 0.68548 | 0.02548 |
| 172.812 | 0.68 | 0.70455 | 0.02455 |
| 177.630 | 0.70 | 0.72350 | 0.02350 |
| 182.725 | 0.72 | 0.74233 | 0.02233 |
| 188.121 | 0.74 | 0.76105 | 0.02105 |
| 193.845 | 0.76 | 0.77965 | 0.01965 |
| 199.928 | 0.78 | 0.79815 | 0.01815 |
| 206.405 | 0.80 | 0.81655 | 0.01655 |
| 213.317 | 0.82 | 0.83486 | 0.01486 |
| 220.707 | 0.84 | 0.85309 | 0.01309 |
| 228.627 | 0.86 | 0.87126 | 0.01126 |
| 237.138 | 0.88 | 0.88938 | 0.00938 |
| 246.306 | 0.90 | 0.90749 | 0.00749 |
| 256.212 | 0.92 | 0.92562 | 0.00562 |
| 266.948 | 0.94 | 0.94381 | 0.00381 |
| 278.623 | 0.96 | 0.96216 | 0.00216 |
| 291.366 | 0.98 | 0.98078 | 0.00078 |
| 305.330 | 1.00 | 1.00000 | 0.00000 |

| Cryogenics Division – NBS Institute for Basic Standards LABORATORY NOTE | PROJECT NO. 2750364 | FILE NO. 73-3 | PAGE 14 |
|---|---|---|---|
| SUBJECT The Vapor Pressures of Ethane | NAME R. D. Goodwin | | |
| | DATE July 9, 1973 | | |

```
      PROGRAM PSATFIT
C     ETHANE VAPOR PRESSURES,    X = (1-TT/T)/(1-TT/TC),
C     LN(P/PTRP) = A1*X + A2*X2 + A3*X3 + A4*X4 + A5*X*(1-X)**E.
C     AUTHORS ID = (1)TICKNER, (2)ROSSINI, (3)CARRUTH, (4)PAL/POPE,
C     (5)LOOMIS, (6)PORTER, (7)ZIEGLER, (8)BARKELEW/TESTER
C     (9)POPE, (10)DOUSLIN,PREPRINT(1973).
C
      COMMON TTRP,TCRT,PTRP, E,A(9), FZ,F1,F2, DLPDT,D2LPDT2
      COMMON/999/NFUN,Y,F(30)
      DIMENSION TEMP(130),DELT(130)
      DIMENSION ID(999),T(999),TX(999),P(999)
      DIMENSION G(30)
    1 FORMAT(I5, 2F10.0)
    2 FORMAT(1H1 17X *ETHANE VAPOR PRESSURES, E =* F5.2//
     1 18X 6HTTRP =F7.3, 8H, TCRT =F8.3//
     2 18X 12HPTRP,MUATM =F9.5, 12H, PCRT,ATM =F9.5// 2(15X 3F16.9/) )
    3 FORMAT(     18X 2HID 4X6HT,XPTL 6X4HT-68 7X5HP,ATM 7X5HCALCD
     1 5X5HDEL T   5X5HP,PCT)
    4 FORMAT(1H1 17X 2HID 4X6HT,XPTL 6X4HT-68 7X5HP,ATM 7X5HCALCD
     1 5X5HDEL T   5X5HP,PCT)
    5 FORMAT(15X I5, 2F10.3, 2F12.7, F10.3, F10.2)
    6 FORMAT(15X I5, 2F10.3, 2F12.6, F10.3, F10.2)
    7 FORMAT(15X I5, 2F10.3, 2F12.5, F10.3, F10.2)
    8 FORMAT(15X I5, 2F10.3, 2F12.4, F10.3, F10.2)
    9 FORMAT(1H0 17X 4HNP =I4, 10H, RMSPCT =F7.3)
   10 FORMAT(F8.3, F9.5, 63X)
   11 FORMAT(1H1 16X *ETHANE VAPOR PRESSURES* // 17X3HT,K 6X5HP,ATM
     1 6X5HDP/DT 5X7HD2P/DT2 )
   12 FORMAT(10X F10.3, 2F11.7, F12.8)
   13 FORMAT(10X F10.3, 2F11.6, F12.7)
   14 FORMAT(10X F10.3, 2F11.5, F12.6)
   15 FORMAT(10X F10.3, 2F11.4, F12.5)
   16 FORMAT(1H1 15X *ETHANE REDUCED VAPOR PRESSURE FUNCTIONS* //
     1 17X 3HT,K 7X1HX 9X1HY 5X5H(Y-X) )
   17 FORMAT(10X F10.3, F8.2, 2F10.5)
   18 FORMAT(18X 2HEP 6X2HSS)
   19 FORMAT(10X 2F10.4)
C     READ-IN THE T48 - T68 TEMP. CONVERSION TABLE.
   20 READ 10, ((TEMP(J),DELT(J)),J=1,130)
   21 TTRP=89.899 $ TCRT=305.33 $ PTRP=9.638E-6   $  E=1.5   $  N=0
C
C     READ (7)ZIEGLER, KELVIN, MM HG.
   22 DO 24 J=1,99   $  READ 1, IDD,TT,PP   $  IF(IDD) 23,25
   23 N = N+1   $  ID(N)=IDD   $  P(N)=PP/760   $  TX(N)=TT
   24 T(N)  = T68(TT,DELT,TEMP)
   25 NF1 = N
C     READ MIXED (4)PAL, (9)POPE, (10)DOUSLIN DATA.
C     (4)KELVIN,PSIA,   (9)KELVIN,ATMOS,   (10)CENTIG.,ATMOS.
   26 DO 35 J=1,200   $  READ 1, IDD,TT,PP   $  IF(IDD) 27,36
   27 N = N+1   $  ID(N) = IDD   $  IF(IDD-4) 28,30
   28 IF(IDD-9) 34,32
   30 P(N)  = PP/14.69595   $  T(N)  = T68(TT,DELT,TEMP)
   31 TX(N)  = TT   $  GO TO 35
   32 P(N)  = PP   $  T(N)  = T68(TT,DELT,TEMP)
   33 TX(N)  = TT   $  GO TO 35
```

SP 11342 A

| Cryogenics Division – NBS Institute for Basic Standards<br>LABORATORY NOTE | PROJECT NO.<br>2751364 | FILE NO.<br>73-3 | PAGE<br>15 |
|---|---|---|---|
| SUBJECT<br>The Vapor Pressures of Ethane | NAME R. D. Goodwin<br>DATE July 9, 1973 | | |

```
        PSATFIT                                              07/23/73

    34 P(N) = PF   $  T(N) = TX(N) = TT + 273.15
    35 CONTINUE
    36 NF = N    $    NF = 5
 C      READ (1) DATA, CENTIGRADE, MM HG.
    38 DO 40 J=1,99   $  READ 1, IDD,TT,PP   $  IF(IDD) 39,41
    39 N = N+1   $  ID(N) = IDD   $  P(N) = PP/760   $  TX(N) = 273.15 + TT
    40 T(N)  = T68(TX(N),DELT,TEMP)
    41 NP2 = N
 C      READ (2) DATA, CENTIGRADE, MM HG.
    42 DO 44 J=1,99   $  READ 1, IDD,TT,PP   $  IF(IDD) 43,45
    43 N = N+1   $  ID(N) = IDD   $  P(N) = PP/760   $  TX(N) = 273.15 + TT
    44 T(N)  = T68(TX(N),DELT,TEMP)
    45 NF3 = N
 C      READ (3) DATA, KELVIN, MM HG.
    46 DO 48 J=1,99   $  READ 1, IDD,TT,PP   $  IF(IDD) 47,49
    47 N = N+1   $  ID(N) = IDD   $  P(N) = PP/760   $  TX(N) = TT
    48 T(N)  = T68(TT,DELT,TEMP)
    49 NP4 = N
 C      READ (5) DATA, KELVIN, ATMOS.
    50 DO 52 J=1,99   $  PEAD 1, IDD,TT,PP   $  IF(IDD) 51,53
    51 N = N+1   $  ID(N) = IDD   $  P(N) = PP   $  TX(N) = TT
    52 T(N)  = T68(TT,DELT,TEMP)
    53 NP5 = N
 C      READ (6) DATA, KELVIN, ATMOS.
    54 DO 56 J=1,99   $  READ 1, IDD,TT,PP   $  IF(IDD) 55,57
    55 N = N+1   $  ID(N) = IDD   $  P(N) = PP   $  TX(N) = TT
    56 T(N)  = T68(TT,DELT,TEMP)
    57 NP6 = N
 C      READ (8)DATA, KELVIN, ATMOS.
    60 DO 62 J=1,99   $  READ 1, IDD,TT,PP   $  IF(IDD) 61,63
    61 N = N+1   $  ID(N)=IDD $ P(N)=PP $ TX(N)=TT
    62 T(N)  = T68(TT,DELT,TEMP)
    63 NPP = NP7 = N
 C
 C      EXPLORE VALUES FOR PTRP.
    79 E  = 1.6   $  PRINT 18   $  SSK = 1.0E+010
    80 XK = 1 - TTRP/TCRT
    81 DO 92 IP=1,26   $  PTP  = 9.600 + 0.001*IP   $  PTRP = PTR*1.0E-6
    82 NFUN = NF   $  DO 85 J=1,NP   $  X = (1-TTRP/T(J))/XK
    83 F(1)=X $ F(2)=X**2 $ F(3)=X**3 $ F(4)=X**4 $ F(5)=X*(1-X)**E
    84 Y = LOGF(P(J)/PTRP)
    85 CALL FIT  $  CALL COEFF   $  SS = 0   $  DO 86 K=1,9
    86 A(K)  = F(K)
    87 DO 88 J=1,NP   $  PC=PSATF(T(J))   $  SS = SS+(P(J)/PC-1)**2
    88 CONTINUE  $  SS=100*SQRTF(SS/NP)   $  IF(SS.LT.SSK) 89,92
    89 SSK=SS $ EK=E $ TCK=TCRT $ TTK=TTRP $ PTK=PTRP
    90 DO 91 K=1,9
    91 G(K)  = F(K)
    92 PRINT 19, PTR, SS
    93 E=EK $ TCRT=TCK $ TTRP=TTK $ PTRP=PTK   $  DO 94 K=1,9
    94 A(K)  = G(K)   $  PCRT = PTRP*EXPF(A(1)+A(2)+A(3)+A(4))
    95 PTR = 1.0E6*PTRP
```

SP 11342 A

| Cryogenics Division – NBS Institute for Basic Standards LABORATORY NOTE | PROJECT NO. 2750364 | FILE NO. 73-3 | PAGE 16 |
|---|---|---|---|
| SUBJECT The Vapor Pressures of Ethane | NAME R. D. Goodwin | | |
| | DATE July 9, 1973 | | |

```
C     PRINT DEVIATIONS, INCLUDING DT = -DP/(DP/DT).
  105 L = 9   $  SS = 0
  106 PRINT 2, E,TTRP,TCRT,PTR,PCRT, (A(K),K=1,6)  $  PRINT 3
  107 DO 125 J=1,NP   $  L = L+1   $  IF(L-57) 112,108
  108 L = 0   $  PRINT 4
  112 PC = PSATF(T(J))   $  DPDT = PC*DLPDT
  113 DP = P(J)-PC   $  DT = -DP/DPDT
  114 PCT = 100*DP/PC   $  SS = SS + PCT**2
  117 IF(PC-0.01) 120,118,118
  118 IF(PC-0.1) 121,119,119
  119 IF(PC-1.0) 122,123,123
  120 PRINT 5, ID(J),TX(J),T(J),P(J),PC,DT,PCT  $  GOTO 125
  121 PRINT 6, ID(J),TX(J),T(J),P(J),PC,DT,PCT  $  GOTO 125
  122 PRINT 7, ID(J),TX(J),T(J),P(J),PC,DT,PCT  $  GOTO 125
  123 PRINT 8, ID(J),TX(J),T(J),P(J),PC,DT,PCT
  125 CONTINUE
  126 SS = SQRTF(SS/NP)   $  PRINT 9, NP,SS
C
C     PRINT OTHER DATA DEVIATIONS.
  140 K = NP+1   $  SS = N = 0   $  PRINT 4
  141 DO 157 J=K,NPP   $  IF(J-NPP) 143,142
  142 SS = SQRTF(SS/N)   $  PRINT 9, N,SS   $  GO TO 158
  143 N = N+1   $  PC=PSATF(T(J))   $  DPDT = PC*DLPDT
  144 DP = P(J)-PC   $  DT = -DP/DPDT
  145 PCT = 100*DP/PC   $  SS = SS + PCT**2
  146 IF(PC-0.01) 150,147,147
  147 IF(PC-0.1) 151,148,148
  148 IF(PC-1.0) 152,153,153
  150 PRINT 5, ID(J),TX(J),T(J),P(J),PC,DT,PCT  $  GO TO 155
  151 PRINT 6, ID(J),TX(J),T(J),P(J),PC,DT,PCT  $  GO TO 155
  152 PRINT 7, ID(J),TX(J),T(J),P(J),PC,DT,PCT  $  GO TO 155
  153 PRINT 8, ID(J),TX(J),T(J),P(J),PC,DT,PCT
  155 IF(ID(J+1)-ID(J)) 156,157
  156 SS = SQRTF(SS/N)   $  PRINT 9, N,SS   $  SS=N=0   $  PRINT 4
  157 CONTINUE
  158 CONTINUE
C
C     PRINTOUT UNIFORM TABLE FOR PUBLICATION.
  200 PRINT 11   $  DO 220 J=1,46   $  IF(J-1) 202,201
  201 TT = TTRP   $  GO TO 205
  202 IF(J-46) 204,203
  203 TT = TCRT   $  GO TO 205
  204 TT = 80 + 5*J
  205 PS=PSATF(TT) $ DPDT=PS*DLPDT $ D2PDT2=PS*(DLPDT**2 + D2LPDT2)
  207 IF(PS-0.01) 210,208,208
  208 IF(PS-0.1) 211,209,209
  209 IF(PS-1.0) 212,215,213
  210 PRINT 12, TT,PS,DPDT,D2PDT2  $  GOTO 220
  211 PRINT 13, TT,PS,DPDT,D2PDT2  $  GOTO 220
  212 PRINT 14, TT,PS,DPDT,D2PDT2  $  GOTO 220
  213 IF(J-46) 215,214
  214 D2PDT2 = 0
  215 PRINT 15, TT,PS,DPDT,D2PDT2
  220 CONTINUE
```

SP 11342 A

```
      PSATFIT                                                07/23/73

C     PRINT UNIFORM REDUCED TABLE.
C     Y = LN(P/PTRP)/YN,    YN = LN(PCRT/PTRP).
C     YC = (A(1)*X + . . . + A(5)*X*(1-X)**E)/YN.
  250 XN = 1-TTRP/TCRT   $   YN = A(1) + A(2) + A(3) + A(4)
  251 PRINT 16   $   DO 270 J=1,51   $   X = 0.02*(J-1)
  252 IF(J-1) 254,253
  253 TT = TTRP   $   GOTO 257
  254 IF(J-51) 256,255
  255 TT = TCRT   $   GOTO 257
  256 TT = TTRP/(1-X*XN)
  257 IF(J-51) 259,258
  258 Z = 0   $   GO TO 260
  259 Z = X*(1-X)**E
  260 YC = A(5)*Z   $   DO 261 K=1,4
  261 YC = YC + A(K)*X**K
  262 YC = YC/YN   $   YX = YC - X
  270 PRINT 17, TT, X, YC, YX
  999 CONTINUE    $    STOP    $    END

SINGLE-BANK COMPILATION.




      FUNCTION PSATF(T)
C     LN(P/PTRP) = A1*X + A2*X2 + A3*X3 + A4*X4 + A5*X*(1-X)**E.
C     ARGUMENT,  X = (1-TT/T)/(1-TT/TC).
C     YIELDS ALSO DLPDT = (DP/DT)/P,  AND D2LPT = (D2P/DT2)/P.
      COMMON TTRP,TCRT,PTRP, E,A(9), FZ,F1,F2, DLPDT,D2LPDT2
    1 FORMAT(1H0 9X *PSATF = 0, T EXCEEDS TCRT. * / )
    2 XN=1-TTRP/TCRT $ X=(1-TTRP/T)/XN $ X2=X**2 $ X3=X**3 $ X4=X**4
    3 DXDT = TTRP/XN/T**2   $   D2XDT2 = -2*DXDT/T
    4 Q = 1-X    $   IF(Q) 5,5,7
    5 PSATF = DLPDT = D2LPDT2 = 0   $   PRINT 1   $   RETURN
    6 Z = Z1 = Z2 = 0   $   GOTO 9
    7 W = Q**E   $   W1 = -E*W/Q   $   W2 = (1-E)*W1/Q
    8 Z = X*W   $   Z1 = X*W1 + W   $   Z2 = X*W2 + 2*W1
    9 FZ = A(1)*X + A(2)*X2 + A(3)*X3 + A(4)*X4 + A(5)*Z
   10 PSATF = PTRP*EXPF(FZ)
   11 F1 = A(1) + 2*A(2)*X + 3*A(3)*X2 + 4*A(4)*X3 + A(5)*Z1
   12 DLPDT = F1*DXDT
   13 F2 = 2*A(2) + 6*A(3)*X + 12*A(4)*X2 + A(5)*Z2
   15 D2LPDT2 = F1*D2XDT2 + F2*DXDT**2    $    RETURN   $   END
```

| Cryogenics Division – NBS Institute for Basic Standards LABORATORY NOTE | PROJECT NO. | FILE NO. 73-3 | PAGE 18 |
|---|---|---|---|
| SUBJECT The Vapor Pressures of Ethane | NAME R. D. Goodwin | | |
| | DATE July 9, 1973 | | |

```
      FUNCTION T68(X,YMAT,XMAT)
      THIS PROGRAM HAS BEEN CHANGED SO THAT THE OSCILLATING NATURE OF
      THE MATRIX TO BE INTERPOLATED EXISTS ONLY AT THE UPPER END OF THE
      TABLE
      THIS ROUTINE WILL TAKE INPUT MATRICES OF UP TO 999 ELEMENTS EACH,
      ARRANGED SO THAT THE X MATRIX(XMAT) IS IN EITHER ASCENDING OR
      DESCENDING ORDER,SELECT NMAX OF THESE POINTS,CHOSEN SO THAT
      SUCESSIVE X VALUES OSCILATE ABOUT THE VALUE OF THE ARGUMENT X
      UNLESS THE ENDS OF THE XMATRIX INTERFERE (IN THIS CASE THE
      OSCILATORY NATURE IS LOST BUT THE PROGRAM WILL STILL PERFORM AN
      INTERPOLATION), INTERPOLATE ON THESE NMAX PAIRS OF DATA BY
      AN OSCILATING VARIABLE POINT AITKEN INTERPOLATION ALGORITHM
      EITHER UNTIL THE PERCENTAGE CHANGE IN THE INTERPOLANT IS LESS
      THAN THE ACRCY ARGUMENT(THE ARGUMENT NESSY INDICATES THE
      NUMBER OF THE POINT JUST BEFORE THE LAST ONE CHECKED) OR UNTIL
      THE NMAX POINTS ARE ALL USED.  IT IS SUGGESTED THAT NMAX
      BE LESS THAN 10, AND OF COURSE LESS THAN NELMTS.  NELMTS
      INDICATES THE NUMBER OF ELEMENTS IN XMAT OR YMAT.
      IF NESSY IS ZERO IT INDICATES THAT THE INTERPOLATION REQUIREMENT
      HAS NOT BEEN SATISFIED.  IF NESSY IS 1 IT MEANS THAT THE VALUE OF
      X LIES OUT SIDE THE RANGE OF XMAT.
      DIMENSION YMAT(999), XMAT(999),A(21,20)
  100 FORMAT(42HINTERPOLATION REQUIREMENT NOT SATISFIED(X=,E16.8,1H)/33H
     1LAST 2 APPROXIMATIONS OF Y ARE(Y=,E16.8,1H,,E16.8,1H))
  200 FORMAT(55HTHIS REPRESENTS AN EXTRAPOLATION OF THE  XMAT MATRIX(X=,
     1E16.8,1H)/33HNO CALCULATION HAS BEEN PERFORMED)
  300 FORMAT(24HNELMTS IS LESS THAN NMAX)
  400 FORMAT(22HNMAX IS LARGER THAN 20)
      NELMTS=130 $ NMAX=9 $ ACRCY=0.01
      IF(NMAX-20)71,71,69
   69 WRITE OUTPUT TAPE 6,400
      T68 = X   $  RETURN
   71 IF(NMAX-NELMTS)75,75,73
   73 WRITE OUTPUT TAPE 6,300
      T68 = X   $  RETURN
   75 CONTINUE
      FIRST TWO SUCCESSIVE VALUES OF THE XMATRIX THAT STRADDLE THE
      VALUE X WILL BE SOUGHT
      JJ1=NELMTS-1
      DO 20 I=1,JJ1
      DIF1=X-XMAT(I)
      DIF2=XMAT(I+1)-X
      IF(DIF1)16,15,16
   15 T68 = X + YMAT(I)
      NESSY =NMAX
      RETURN
   16 IF(DIF2)18,17,18
   17 T68 = X + YMAT(I+1)
      NESSY =NMAX
      RETURN
   18 RATIO=DIF1/ DIF2
      IF(RATIO)20,20,19
   19 IMID=I
      GO TO 32
   20 CONTINUE
```

SP 11

```
      AT THIS POINT ONE COULD PRINT THE FOLLOWING STATEMENT
      WRITE OUTPUT TAPE 6,200,X
      NESSY=1
      T68 = X   $   RETURN
   32 CONTINUE
      NOTE THAT RATIO IS POSITIVE IF THE TWO POINTS STRADDLE X
      REGARDLESS WHICH IS LARGER
      JJJ=IMID
      JUP=IMID
      JDN=IMID
      IF(JJJ+NMAX-NELMTS+1)98,98,102
   98 DO 201 J=1,NMAX
      JJJ=IMID+J-1
      A(1,J)=XMAT(JJJ)
  201 A(2,J)=YMAT(JJJ)
      GO TO 203
  102 DO 41 J=1,NMAX
      JJ=J/2
      JOE=J-2*JJ
      JOE IS 0 IF J IS EVEN AND 1 IF J IS ODD
      IF(J-1)33,40,33
   33 IF(JDN-1)34,36,34
   34 IF(JUP-NELMTS)35,37,35
   35 IF(JOE)37,36,37
   36 JUP=JUP+1
      JJJ=JUP
      GO TO 40
   37 JDN=JDN-1
      JJJ=JDN
      GO TO 40
   40 A(1,J)=XMAT(JJJ)
      A(2,J)=YMAT(JJJ)
   41 CONTINUE
  203 NNN=NMAX+1
      DO 6 J=3,NNN
      L=J-1
      DO 5 K=L,NMAX
      J IS THE COLUMN NUMBER
      K IS THE ROW NUMBER
     0A(J,K)=(A(J-1,K)-A(J-1,J-2))*(X-A(1,J-2))/(A(1,K)-A(1,J-2))
     1       +A(J-1,J-2)
      IF(K-L)3,2,3
    2 IF(ABSF((A(J,L)-A(J-1,L-1))/A(J,L))-ACRCY/100.0)7,7,3
    3 CONTINUE
    5 CONTINUE
    6 CONTINUE
      NESSY=0
      AT THIS POINT ONE COULD PRINT OUT THE FOLLOWING STATEMENT.
      WRITE OUTPUT TAPE 6,100,X,A(NNN,NMAX),A(NNN-1,NMAX-1)
      T68 = X + A(NNN,NMAX)
      RETURN
    7 NESSY=J-1
      T68 = X + A(J,L)    $    RETURN   $   END
```

This program by
Rolf Prydz.

| Cryogenics Division – NBS Institute for Basic Standards LABORATORY NOTE | PROJECT NO. 2750364 | FILE NO. 73-3 | PAGE 20 |
|---|---|---|---|
| SUBJECT The Vapor Pressures of Ethane | NAME R. D. Goodwin | | |
| | DATE July 9, 1973 | | |

ETHANE VAPOR PRESSURES, E = 1.50
TTRP = 89.899, TCRT = 305.330

PTRP, MUATM = 9.96700, PCRT, ATM = 48.07723

7/31/73

| | | |
|---|---|---|
| 10.806922651 | 8.344715938 | -3.119603823 |
| -0.642995191 | 6.059966098 | 0.000000000 |

| ID | T,XPTL | T-68 | P,ATM | CALCD | DEL T | P,PCT |
|---|---|---|---|---|---|---|
| 7 | 90.000 | 90.010 | 0.0000103 | 0.0000103 | 0.000 | -0.01 |
| 7 | 100.000 | 100.010 | 0.0001098 | 0.0001098 | -0.001 | 0.01 |
| 7 | 110.000 | 109.998 | 0.0007364 | 0.0007363 | -0.001 | 0.02 |
| 7 | 120.000 | 119.989 | 0.0034934 | 0.0034939 | 0.001 | -0.01 |
| 7 | 130.000 | 129.987 | 0.012728 | 0.012732 | 0.003 | -0.04 |
| 7 | 140.000 | 139.992 | 0.037792 | 0.037803 | 0.003 | -0.03 |
| 7 | 150.000 | 150.000 | 0.095474 | 0.095476 | 0.000 | -0.00 |
| 7 | 160.000 | 160.010 | 0.21196 | 0.21192 | -0.003 | 0.02 |
| 7 | 170.000 | 170.019 | 0.42387 | 0.42369 | -0.007 | 0.04 |
| 7 | 180.000 | 180.027 | 0.77824 | 0.77783 | -0.009 | 0.05 |
| 7 | 184.520 | 184.550 | 1.00000 | 0.99944 | -0.010 | 0.06 |
| 9 | 198.181 | 198.216 | 1.9737 | 1.9761 | 0.027 | -0.12 |
| 4 | 214.302 | 214.334 | 3.9209 | 3.9159 | -0.032 | 0.13 |
| 4 | 224.102 | 224.130 | 5.6367 | 5.6402 | 0.017 | -0.06 |
| 4 | 229.756 | 229.782 | 6.8569 | 6.8598 | 0.012 | -0.04 |
| 4 | 234.558 | 234.581 | 8.0335 | 8.0392 | 0.022 | -0.07 |
| 9 | 234.692 | 234.715 | 8.0741 | 8.0741 | -0.000 | 0.00 |
| 10 | 238.150 | 238.150 | 9.0097 | 9.0077 | -0.007 | 0.02 |
| 9 | 238.771 | 238.792 | 9.1843 | 9.1905 | 0.021 | -0.07 |
| 4 | 239.844 | 239.864 | 9.4959 | 9.5019 | 0.020 | -0.06 |
| 4 | 240.514 | 240.534 | 9.6960 | 9.7003 | 0.014 | -0.04 |
| 10 | 243.150 | 243.150 | 10.5063 | 10.5045 | -0.006 | 0.02 |
| 4 | 243.359 | 243.377 | 10.5760 | 10.5764 | 0.001 | -0.00 |
| 4 | 246.814 | 246.830 | 11.7137 | 11.7162 | 0.007 | -0.02 |
| 4 | 247.816 | 247.831 | 12.0502 | 12.0628 | 0.036 | -0.10 |
| 10 | 248.150 | 248.150 | 12.1756 | 12.1747 | -0.003 | 0.01 |
| 4 | 249.741 | 249.755 | 12.7620 | 12.7496 | -0.034 | 0.10 |
| 4 | 250.146 | 250.160 | 12.8985 | 12.8976 | -0.002 | 0.01 |
| 4 | 251.587 | 251.600 | 13.4425 | 13.4344 | -0.022 | 0.06 |
| 4 | 252.544 | 252.556 | 13.8065 | 13.7997 | -0.018 | 0.05 |
| 10 | 253.150 | 253.150 | 14.0310 | 14.0301 | -0.002 | 0.01 |
| 4 | 254.290 | 254.301 | 14.4898 | 14.4848 | -0.012 | 0.03 |
| 4 | 257.543 | 257.552 | 15.8252 | 15.8266 | 0.003 | -0.01 |
| 10 | 258.150 | 258.150 | 16.0835 | 16.0827 | -0.002 | 0.00 |
| 10 | 263.150 | 263.150 | 18.3464 | 18.3452 | -0.003 | 0.01 |
| 4 | 263.380 | 263.386 | 18.4543 | 18.4573 | 0.006 | -0.02 |
| 4 | 267.536 | 267.539 | 20.5197 | 20.5145 | -0.010 | 0.03 |
| 10 | 268.150 | 268.150 | 20.8318 | 20.8308 | -0.002 | 0.00 |
| 4 | 271.749 | 271.750 | 22.7661 | 22.7662 | 0.000 | -0.00 |
| 9 | 272.949 | 272.949 | 23.4515 | 23.4394 | -0.021 | 0.05 |
| 10 | 273.150 | 273.150 | 23.5549 | 23.5536 | -0.002 | 0.01 |
| 4 | 275.922 | 275.921 | 25.1584 | 25.1702 | 0.020 | -0.05 |
| 4 | 276.363 | 276.362 | 25.4558 | 25.4347 | -0.035 | 0.08 |
| 4 | 276.385 | 276.384 | 25.4491 | 25.4479 | -0.002 | 0.00 |
| 4 | 276.514 | 276.513 | 25.5472 | 25.5257 | -0.036 | 0.08 |
| 4 | 277.813 | 277.811 | 26.3185 | 26.3189 | 0.001 | -0.00 |
| 10 | 278.150 | 278.150 | 26.5309 | 26.5290 | -0.003 | 0.01 |

SP 11342 A

| Cryogenics Division – NBS Institute for Basic Standards LABORATORY NOTE | PROJECT NO. 2750364 | FILE NO. 73-3 | PAGE 21 |
|---|---|---|---|
| SUBJECT The Vapor Pressure of Ethane | NAME R. D. Goodwin | | |
| | DATE July 9, 1973 | | |

| ID | T,XPTL | T-68 | P,ATM | CALCD | DEL T | P,PCT |
|---|---|---|---|---|---|---|
| 4 | 280.041 | 280.038 | 27.7039 | 27.7217 | 0.028 | -0.06 |
| 4 | 282.247 | 282.243 | 29.1537 | 29.1647 | 0.016 | -0.04 |
| 10 | 283.150 | 283.150 | 29.7763 | 29.7739 | -0.003 | 0.01 |
| 4 | 284.635 | 284.630 | 30.7664 | 30.7893 | 0.033 | -0.07 |
| 9 | 284.845 | 284.840 | 30.9555 | 30.9353 | -0.029 | 0.07 |
| 4 | 287.653 | 287.648 | 32.9289 | 32.9392 | 0.014 | -0.03 |
| 10 | 288.150 | 288.150 | 33.3110 | 33.3080 | -0.004 | 0.01 |
| 4 | 288.263 | 288.257 | 33.3899 | 33.3872 | -0.004 | 0.01 |
| 4 | 290.040 | 290.034 | 34.6873 | 34.7192 | 0.042 | -0.09 |
| 9 | 290.214 | 290.208 | 34.8748 | 34.8518 | -0.030 | 0.07 |
| 4 | 292.236 | 292.229 | 36.4440 | 36.4216 | -0.028 | 0.06 |
| 4 | 293.098 | 293.091 | 37.0816 | 37.1074 | 0.032 | -0.07 |
| 10 | 293.150 | 293.150 | 37.1583 | 37.1547 | -0.005 | 0.01 |
| 9 | 293.266 | 293.259 | 37.2672 | 37.2422 | -0.031 | 0.07 |
| 4 | 296.347 | 296.339 | 39.7598 | 39.7852 | 0.030 | -0.06 |
| 10 | 298.150 | 298.150 | 41.3494 | 41.3446 | -0.005 | 0.01 |
| 4 | 299.665 | 299.657 | 42.6543 | 42.6808 | 0.030 | -0.06 |
| 9 | 299.863 | 299.855 | 42.8863 | 42.8591 | -0.030 | 0.06 |
| 4 | 300.205 | 300.196 | 43.1650 | 43.1686 | 0.004 | -0.01 |
| 4 | 301.251 | 301.242 | 44.1085 | 44.1274 | 0.020 | -0.04 |
| 10 | 302.150 | 302.150 | 44.9809 | 44.9751 | -0.006 | 0.01 |
| 10 | 303.150 | 303.150 | 45.9327 | 45.9268 | -0.006 | 0.01 |
| 4 | 303.471 | 303.462 | 46.2032 | 46.2273 | 0.025 | -0.05 |
| 4 | 303.477 | 303.468 | 46.2798 | 46.2331 | -0.048 | 0.10 |
| 9 | 304.012 | 304.002 | 46.7736 | 46.7533 | -0.021 | 0.04 |
| 4 | 304.049 | 304.039 | 46.7698 | 46.7896 | 0.020 | -0.04 |
| 10 | 304.150 | 304.150 | 46.9040 | 46.8987 | -0.005 | 0.01 |
| 4 | 304.360 | 304.350 | 47.0931 | 47.0953 | 0.002 | -0.00 |
| 4 | 304.446 | 304.435 | 47.2198 | 47.1802 | -0.040 | 0.08 |
| 4 | 304.519 | 304.508 | 47.2025 | 47.2525 | 0.050 | -0.11 |
| 4 | 304.734 | 304.723 | 47.4310 | 47.4661 | 0.035 | -0.07 |
| 4 | 304.796 | 304.785 | 47.5185 | 47.5280 | 0.009 | -0.02 |
| 4 | 304.924 | 304.913 | 47.6846 | 47.6560 | -0.028 | 0.06 |
| 4 | 304.980 | 304.969 | 47.7131 | 47.7122 | -0.001 | 0.00 |
| 4 | 305.121 | 305.110 | 47.8496 | 47.8541 | 0.004 | -0.01 |
| 10 | 305.150 | 305.150 | 47.8992 | 47.8945 | -0.005 | 0.01 |
| 4 | 305.153 | 305.142 | 47.8807 | 47.8864 | 0.006 | -0.01 |
| 10 | 305.250 | 305.250 | 47.9994 | 47.9958 | -0.004 | 0.01 |

NP = 85, RMSPCT = 0.050

$\epsilon = 1.5$ 7/31/73

SP 11342 A

| Cryogenics Division – NBS Institute for Basic Standards LABORATORY NOTE | PROJECT NO. 2750364 | FILE NO. 73-3 | PAGE 22. |
|---|---|---|---|
| SUBJECT The Vapor Pressures of Ethane | NAME R. D. Goodwin | | |
| | DATE July 9, 1973 | | |

ETHANE VAPOR PRESSURES

| T,K | P,ATM | DP/DT | D2P/DT2 |
|---|---|---|---|
| 89.899 | 0.0000100 | 0.0000027 | 0.00000064 |
| 90.000 | 0.0000102 | 0.0000027 | 0.00000066 |
| 95.000 | 0.0000358 | 0.0000085 | 0.00000181 |
| 100.000 | 0.0001095 | 0.0000232 | 0.00000439 |
| 105.000 | 0.0002985 | 0.0000567 | 0.00000960 |
| 110.000 | 0.0007365 | 0.0001264 | 0.00001915 |
| 115.000 | 0.0016670 | 0.0002592 | 0.00003529 |
| 120.000 | 0.0034991 | 0.0004948 | 0.00006077 |
| 125.000 | 0.0068762 | 0.0008875 | 0.00009864 |
| 130.000 | 0.012752 | 0.001507 | 0.0001521 |
| 135.000 | 0.022468 | 0.002439 | 0.0002242 |
| 140.000 | 0.037834 | 0.003785 | 0.0003177 |
| 145.000 | 0.061192 | 0.005656 | 0.0004350 |
| 150.000 | 0.095478 | 0.008177 | 0.0005776 |
| 155.000 | 0.14426 | 0.01148 | 0.000747 |
| 160.000 | 0.21176 | 0.01569 | 0.000942 |
| 165.000 | 0.30288 | 0.02095 | 0.001165 |
| 170.000 | 0.42317 | 0.02738 | 0.001412 |
| 175.000 | 0.57882 | 0.03511 | 0.001684 |
| 180.000 | 0.77662 | 0.04426 | 0.001979 |
| 185.000 | 1.0239 | 0.0549 | 0.00229 |
| 190.000 | 1.3287 | 0.0672 | 0.00263 |
| 195.000 | 1.6991 | 0.0812 | 0.00298 |
| 200.000 | 2.1440 | 0.0970 | 0.00334 |
| 205.000 | 2.6726 | 0.1147 | 0.00372 |
| 210.000 | 3.2943 | 0.1343 | 0.00411 |
| 215.000 | 4.0188 | 0.1558 | 0.00451 |
| 220.000 | 4.8561 | 0.1794 | 0.00492 |
| 225.000 | 5.8165 | 0.2051 | 0.00534 |
| 230.000 | 6.9105 | 0.2329 | 0.00577 |
| 235.000 | 8.1487 | 0.2628 | 0.00620 |
| 240.000 | 9.5420 | 0.2949 | 0.00665 |
| 245.000 | 11.1016 | 0.3293 | 0.00711 |
| 250.000 | 12.8390 | 0.3660 | 0.00758 |
| 255.000 | 14.7659 | 0.4052 | 0.00807 |
| 260.000 | 16.8947 | 0.4468 | 0.00858 |
| 265.000 | 19.2381 | 0.4910 | 0.00913 |
| 270.000 | 21.8098 | 0.5381 | 0.00971 |
| 275.000 | 24.6242 | 0.5882 | 0.01034 |
| 280.000 | 27.6972 | 0.6416 | 0.01105 |
| 285.000 | 31.0467 | 0.6989 | 0.01187 |
| 290.000 | 34.6934 | 0.7607 | 0.01288 |
| 295.000 | 38.6630 | 0.8283 | 0.01425 |
| 300.000 | 42.9905 | 0.9046 | 0.01657 |
| 305.000 | 47.7433 | 1.0055 | 0.03283 |
| 305.330 | 48.0772 | 1.0228 | 0.00000 |

7/31/73, Via Ziegler "Type B" data

SP 11342 A

| Cryogenics Division – NBS Institute for Basic Standards LABORATORY NOTE | PROJECT NO. 2750364 | FILE NO. 73-3 | PAGE 23 |
|---|---|---|---|
| SUBJECT The Vapor Pressures of Ethane | NAME R. D. Goodwin | | |
| | DATE July 9, 1973 | | |

ETHANE REDUCED VAPOR PRESSURE FUNCTIONS

| T,K | X | Y | (Y-X) |
|---|---|---|---|
| 89.899 | 0.00 | 0.00000 | 0.00000 |
| 91.186 | 0.02 | 0.02190 | 0.00190 |
| 92.510 | 0.04 | 0.04376 | 0.00376 |
| 93.873 | 0.06 | 0.06558 | 0.00558 |
| 95.277 | 0.08 | 0.08734 | 0.00734 |
| 96.723 | 0.10 | 0.10906 | 0.00906 |
| 98.215 | 0.12 | 0.13073 | 0.01073 |
| 99.753 | 0.14 | 0.15234 | 0.01234 |
| 101.339 | 0.16 | 0.17389 | 0.01389 |
| 102.977 | 0.18 | 0.19538 | 0.01538 |
| 104.669 | 0.20 | 0.21680 | 0.01680 |
| 106.418 | 0.22 | 0.23816 | 0.01816 |
| 108.226 | 0.24 | 0.25945 | 0.01945 |
| 110.096 | 0.26 | 0.28066 | 0.02066 |
| 112.032 | 0.28 | 0.30180 | 0.02180 |
| 114.037 | 0.30 | 0.32285 | 0.02285 |
| 116.116 | 0.32 | 0.34382 | 0.02382 |
| 118.272 | 0.34 | 0.36471 | 0.02471 |
| 120.509 | 0.36 | 0.38551 | 0.02551 |
| 122.832 | 0.38 | 0.40621 | 0.02621 |
| 125.247 | 0.40 | 0.42682 | 0.02682 |
| 127.759 | 0.42 | 0.44733 | 0.02733 |
| 130.373 | 0.44 | 0.46774 | 0.02774 |
| 133.097 | 0.46 | 0.48805 | 0.02805 |
| 135.937 | 0.48 | 0.50825 | 0.02825 |
| 138.901 | 0.50 | 0.52835 | 0.02835 |
| 141.997 | 0.52 | 0.54833 | 0.02833 |
| 145.234 | 0.54 | 0.56820 | 0.02820 |
| 148.622 | 0.56 | 0.58796 | 0.02796 |
| 152.172 | 0.58 | 0.60760 | 0.02760 |
| 155.896 | 0.60 | 0.62713 | 0.02713 |
| 159.807 | 0.62 | 0.64654 | 0.02654 |
| 163.919 | 0.64 | 0.66583 | 0.02583 |
| 168.248 | 0.66 | 0.68501 | 0.02501 |
| 172.812 | 0.68 | 0.70406 | 0.02406 |
| 177.630 | 0.70 | 0.72301 | 0.02301 |
| 182.725 | 0.72 | 0.74184 | 0.02184 |
| 188.121 | 0.74 | 0.76056 | 0.02056 |
| 193.845 | 0.76 | 0.77917 | 0.01917 |
| 199.928 | 0.78 | 0.79769 | 0.01769 |
| 206.405 | 0.80 | 0.81611 | 0.01611 |
| 213.317 | 0.82 | 0.83445 | 0.01445 |
| 220.707 | 0.84 | 0.85272 | 0.01272 |
| 228.627 | 0.86 | 0.87093 | 0.01093 |
| 237.138 | 0.88 | 0.88910 | 0.00910 |
| 246.306 | 0.90 | 0.90726 | 0.00726 |
| 256.212 | 0.92 | 0.92544 | 0.00544 |
| 266.948 | 0.94 | 0.94369 | 0.00369 |
| 278.623 | 0.96 | 0.96208 | 0.00208 |
| 291.366 | 0.98 | 0.98074 | 0.00074 |
| 305.330 | 1.00 | 1.00000 | 0.00000 |

7/31/73, Via Ziegler "Type B" data

SP 11342 A

| Cryogenics Division – NBS Institute for Basic Standards LABORATORY NOTE | PROJECT NO. 2750364 | FILE NO. 73-4 | PAGE 1 |
|---|---|---|---|
| SUBJECT Ethane Virial Coefficients and Saturated Vapor Densities | NAME R. D. Goodwin | | |
| | DATE August 14, 1973 | | |

## 1. Introduction

The virial equation of state for low densities is needed for thermal computations to generate P-ρ-T data, and to obtain saturated vapor densities via the vapor pressure equation.

In this report we develop analytical representations for the virial coefficients of ethane and obtain the corresponding saturated vapor densities.

In the truncated virial equation,

$$Z(T,d) \equiv P/(R\cdot T\cdot d) = 1 + B(x)\cdot\sigma + C(x)\cdot\sigma^2 + D(x)\cdot\sigma^3, \tag{1}$$

P is pressure, R the gas constant, T the absolute temperature, d the density, and $\sigma \equiv d/d_c$ is reduced density. The second, third, and fourth coefficients B(x), C(x), D(x) are dimensionless functions of reduced temperature $x \equiv T/T_c$. We use $T_c \equiv 305.33$ K, and $V_c \equiv 1/d_c = 145.56$ cc/mol from Douslin [2]. In the tables we use symbols $B^*$, $C^*$ and $D^*$ for the coefficients of (1).

## 2. The Second Virial Coefficient

Data for B(x) through about 1960 are reviewed by Tester [16]. Since then we have data from Gunn [8], Hoover [9], Pope [15], McGlashan [12], and Douslin [2]. Data of Gunn and of Douslin extend from 273 K upwards to 623 K. McGlashan gives outstanding experimental work on the hydrocarbon series (but not on ethane) down to $T/T_c = 0.5$. From his formulations he concludes that the low-temperature data of Eucken and Parts [4] are wrong. This suspicion also was expressed by Ziegler et al. [17].

For least squares we have selected for low temperatures only the data from McGlashan's formula because all other data diverge widely therefrom (Table 2). For high temperatures we have selected Douslin's recent data because the experimental work [2] was executed with great care. Table 2 shows that Michels (ID=3) and Gunn (ID=8) are in substantial agreement with Douslin. For consistency with Douslin, we have increased the absolute values of McGlashan's data by one percent, well within the uncertainty of his $V_c$ ~ 148 cc/mol.

Our formula for B(x), selected from many variations, finally is similar to that developed for methane [6],

$$B(x) = \left[B_1 + B_2/x^{1/4} + B_3/x + B_4/x^2 + B_5/x^3\right] \cdot \left[1-(T_o/T)^{1/4}\right], \tag{2}$$

$T_o$ = 740.0 K, $B_3$ = 9.21 7322,

$B_1$ = 7.99 3156, $B_4$ = -2.48 1668,

$B_2$ = -10.67 2497, $B_5$ = 0.84 2328.

Table 1 gives results for (2) with the data used for least squares: (6) McGlashan; (10) Douslin. Data not used for ℓ.s. are compared with (2) in Table 2: (1) Eucken; (2) Lambert; (3) Michels: (4) Hoover; (5) Pope; (8) Gunn.

## 3. The Third Virial Coefficient

For C(x) relatively few data are known to us. The data of Michels [13] and Hoover [9] were generalized in 1967 by Chueh [1], using a formula similar to that developed by Goodwin [5]. In 1971 Pope [15] gave five low-temperature values from 210 to 306 K. For temperatures above 273 K we are fortunate to have the recent, carefully-derived data of Douslin [2].

A comparison of Chueh's generalized function with Douslin's data at $T/T_c = 2$ shows $C^* = 0.20$ (Chueh), and $C^* = 0.15$ (Douslin). Whereas the Chueh formula gives nearly constant values at high temperatures, the Douslin data are trending asymptotically toward zero.

For least squares we have selected the data of Douslin at high temperatures, and data generated by Chueh's formula at low temperatures. For consistency we have diminished these latter values by two percent. (Chueh fails to give his critical densities.) At low temperatures the third virial coefficient is not important in the computation of eq (1) because the maximum possible density (saturated vapor) is diminishing exponentially with temperature, $e^{-\alpha/T}$, (see Table 4).

| Cryogenics Division – NBS Institute for Basic Standards LABORATORY NOTE | PROJECT NO. 2750364 | FILE NO. 73-4 | PAGE 3 |
|---|---|---|---|
| SUBJECT Ethane Virial Coefficients and Saturated Vapor Densities | NAME R. D. Goodwin | | |
| | DATE August 14, 1973 | | |

Our formula for C(x) is much simpler than that of Chueh, and is similar to that developed for methane [6],

$$C(x) = \left[C_1/x + C_2/x^3 + C_3/x^5\right] \cdot \left(1 - T_o/T\right), \tag{3}$$

$T_o$ = 217.80 K, $C_2$ = 0.865 299,

$C_1$ = 0.253 773, $C_3$ = 0.556 075.

Least squares results are in the upper part of Table 3: (7) Chueh; (10) Douslin. Other data in the lower part are: (4) Hoover; (5) Pope.

## 4. The Fourth Virial Coefficient

Recent data of Douslin [2] are plotted in Figure 1. The general behavior expected for $D^*$ is shown in the book by Mason and Spurling [11]. As present data exist only at $T > T_c$, we use the simple formula,

$$100 \cdot D^* = x^{-1/4} \cdot \exp\left[a - b/(x-1)\right], \tag{4}$$

where $x \equiv T/T_c$, and a = 4.00, b = 1.84 from Figure 1.

## 5. Examination of the Virial Equation

It is valuable to know the relative importance of the terms of eq (1). In Table 4 we compute these for the saturated vapor, using densities from the formula of Plank and Kambeitz quoted by Tester [16]. We have increased the P.K. densities by 0.088% to agree with the virial equation at 90 K. Pressures are from our vapor pressure equation [7].

In the fourth column of Table 4 we give the ratio DI/DN of ideal gas density to the P.K calculated densities. Fifth and sixth columns give $B(x) \cdot \sigma$ and $C(x) \cdot \sigma^2$. If all data were accurate, we should expect Z(T,d) in the last column to be the same as DI/DN.

The vapor pressures of Ziegler [17] were based on second virial coefficients of Eucken and Parts [4], the accuracy of which Ziegler questioned. Our selection for $B^*$ also disagrees with Eucken and Parts. We therefore have recomputed our vapor

| Cryogenics Division – NBS Institute for Basic Standards LABORATORY NOTE | PROJECT NO. 2750364 | FILE NO. 73-4 | PAGE 4 |
|---|---|---|---|
| SUBJECT Ethane Virial Coefficients and Saturated Vapor Densities | NAME R. D. Goodwin | | |
| | DATE August 14, 1973 | | |

pressure constants using alternate vapor pressure data of Ziegler, as shown in the addendum to our Laboratory Note [7]. This revised vapor pressure equation is used in the following to obtain the densities of saturated vapor.

## 6. Derivation of the Saturated Vapor Densities

For a given temperature we iterate density in the virial equation to obtain a pressure therefrom which is the same as the vapor pressure. Results are in Table 5. In previous work we have found that this method gives acceptable results at densities up to about $\rho_c/3$, which for ethane occurs near T = 286 K. We see that data from the Plank-Kambeitz formula diverge increasingly from our results on approach to $T_c$. The highest temperature at which our results are accurate remains to be seen by comparison with data from other sources. Figure 2 shows,however, that in the region of overlap with Douslin's vapor densities [2], our results (the filled circles) appear reasonable.

Figure 3 shows the results at lower temperatures. We see that powers of (1/T) greater than the first will be needed to describe these data.

## 7. Discussion of Uncertainties

Experimental uncertainties for virial coefficients vary inversely as the significance of these coefficients in giving departure from ideal gas behavior, see Table 4. For the second coefficient only, for example,

$$\delta B/B = \frac{\delta Z}{Z} \cdot \frac{Z}{Z-1} ,$$

where $\delta B$ and $\delta Z$ are small variations in B and Z. Assume a tolerable error of 0.01 percent in Z. From Table 4 we compute the approximate tolerable uncertainty in B, neglecting the effect of C(T),

| T, K | mol/ℓ | δB/B, % |
|---|---|---|
| 100 | 0.000013 | 357.0 |
| 120 | 0.000349 | 21.6 |
| 140 | 0.00327 | 3.37 |
| 160 | 0.01626 | 0.915 |
| 180 | 0.05434 | 0.352 |
| 200 | 0.1401 | 0.170 |
| 220 | 0.3035 | 0.096 |
| 240 | 0.5864 | 0.060 |
| 260 | 1.057 | 0.040 |

Not all authors give estimates of uncertainty for experimental virial coefficients. Hoover et al, however, give these estimates for ethane,

| T, K | δB/B, % | δC/C, % |
|---|---|---|
| 215 | 1.0 | 10.0 |
| 240 | 0.4 | 4.0 |
| 273 | 0.1 | 1.0 |

and we believe these to be reasonable estimates for very careful work. In Table 2, however, we see that Hoover's data, ID=4, differ from our selection by up to five percent at low temperatures (215 and 240 K).

Our derived densities depend on the vapor pressure equation. This we estimate to be uncertain by several percent at the lowest temperatures approaching the triple point. The virial equation, on the other hand, approaches ideal gas behavior at these low temperatures. At the higher temperatures above 270 K, we believe the virial coefficients and vapor pressures of Douslin to be accurate as can be derived from the best of PVT measurements.

| Cryogenics Division – NBS Institute for Basic Standards LABORATORY NOTE | PROJECT NO. 2750364 | FILE NO. 73-4 | PAGE 6 |
|---|---|---|---|
| SUBJECT Ethane Virial Coefficients and Saturated Vapor Densities | NAME R. D. Goodwin | | |
| | DATE August 14, 1973 | | |

## 8. Bibliography

[1] P. L. Chueh and J. M. Prausnitz, Third virial coefficients of non polar gases and their mixtures, AIChE Journal 13 (5) 896 (1967).

[2] D. R. Douslin and R. H. Harrison, Pressure-volume-temperature relations of ethane, (U.S. Bureau of Mines, Bartlesville, Okla. 74003). Manuscript for J. Chem. Thermodynamics, July, 1973.

[3] J. H. Dymond and E. B. Smith, The Virial Coefficients of Gases, Oxford Science Research Papers 2, Clarendon Press, Oxford, England, (1969).

[4] A. Eucken and A. Parts, Z. Phys. Chem. B20, 184 (1933).

[5] R. D. Goodwin, D. E. Diller, H. M. Roder, L. A. Weber, Second and third virial coefficients for hydrogen, J. Res. NBS 68A (1), 121 (1964).

[6] R. D. Goodwin, Thermophysical Properties of Methane from 90 to 500 K at Pressures to 700 Bar, NBS Tech. Note, manuscript, April, 1973.

[7] The Vapor Pressures of Ethane, Laboratory Note 73-3, July 9, 1973.

[8] R. D. Gunn, M. S. Thesis, University. Calif. (Berkeley), 1958, quoted by J. A. Huff and T. M. Reed, J. Chem. Eng. Data 8, 306 (1963).

[9] A. E. Hoover, I. Nagata, T. W. Leland, R. Kobayashi, Virial coefficients of methane, ethane, and their mixtures at low temperatures, J. Chem. Phys. 48 (6), 2633 (1968).

[10] J. D. Lambert, G. A. H. Roberts, J. S. Rowlinson, V. J. Wilkinson, Proc. Roy. Soc. (London) A 196, 113 (1949).

[11] E. A. Mason and T. H. Spurling, The Virial Equation of State, Pergamon Press, Oxford (England), 1969.

[12] M. L. McGlashan and D. J. B. Potter, An apparatus for the measurement of the second virial coefficients of some n-alkanes and of some mixtures of n-alkanes, Proc. Roy. Soc. (London) A267, 478 (1962).

[13] A. Michels, W. van Straaten and J. Dawson, Physica 20, 17 (1954).

[14] Plank and Kambeitz, Z. Ges. Kälte Ind. 10, 209 (1936), quoted by Tester.

[15] G. A. Pope, Calculation of Argon, Methane and Ethane Virial Coefficients, etc., Thesis, Rice Univ., July 1971.

[16] H. E. Tester, ETHANE, in Thermodynamic Functions of Gases, F. Din, Editor, vol. 3, Butterworths, London, 1961.

| Cryogenics Division – NBS Institute for Basic Standards LABORATORY NOTE | PROJECT NO. 2750364 | FILE NO. 73-4 | PAGE 7 |
|---|---|---|---|
| SUBJECT Ethane Virial Coefficients and Saturated Vapor Densities | NAME R. D. Goodwin | DATE August 14, 1973 | |

[17] Ziegler, Kirk, Mullins, Berquist, Calculation of the vapor pressures, etc., VII Ethane, Eng. Expt. Sta., Georgia Inst. Tech.,Atlanta, Ga., Dec. 1964.

[18] F. Porter, J. Am. Chem. Soc. 48, 2055 (1926).

[19] P. Sliwinski, Z. Phys. Chem. 63 263 (1969).

[20] K. R. Hall and P. T. Eubank, Experimental technique for direct measurement of interaction second virial coefficients, J. Chem. Phys. 59(2), 709 (1973).

[21] R. D. Goodwin, Estimation of critical constants $T_c$, $\rho_c$ from the $\rho(T)$ and $T(\rho)$ relations at coexistence, J. Res. NBS 74A(2), 221 1970).

## Table Captions

Table 1. Second virial data of (6) McGlashan, (10) Douslin.

Table 2. Second virial, (1) Eucken, (2) Lambert, (3) Michels, (4) Hoover, (5) Pope, (8) Gunn.

Table 3. Third virial, (7) Chueh, (10) Douslin, (4) Hoover, (5) Pope.

Table 4. Terms of the virial equation for saturated vapor.

Table 5. Saturated vapor densities derived via V.P. and virial equations.

SP 11342 A

| Cryogenics Division – NBS Institute for Basic Standards<br>LABORATORY NOTE | PROJECT NO.<br>2750364 | FILE NO.<br>73-4 | PAGE<br>8 |
|---|---|---|---|
| SUBJECT<br>Ethane Virial Coefficients and Saturated Vapor Densities | NAME<br>R. D. Goodwin<br>DATE<br>August 14, 1973 | | |

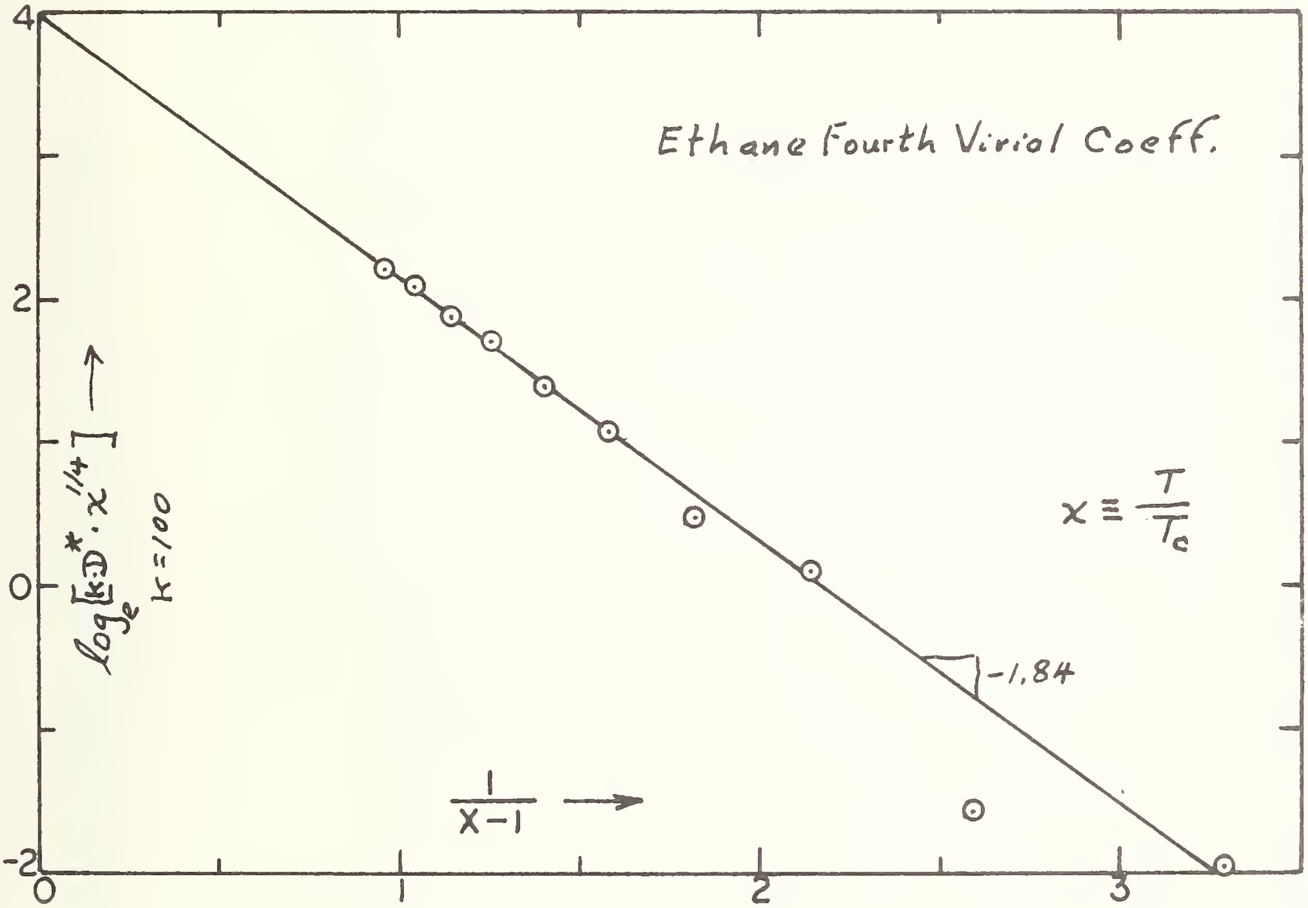


Figure 1. Ethane fourth virial coefficients of Douslin [2],

$$100 \cdot D^* = x^{-1/4} \cdot \exp[4.0 - 1.84/(x-1)].$$

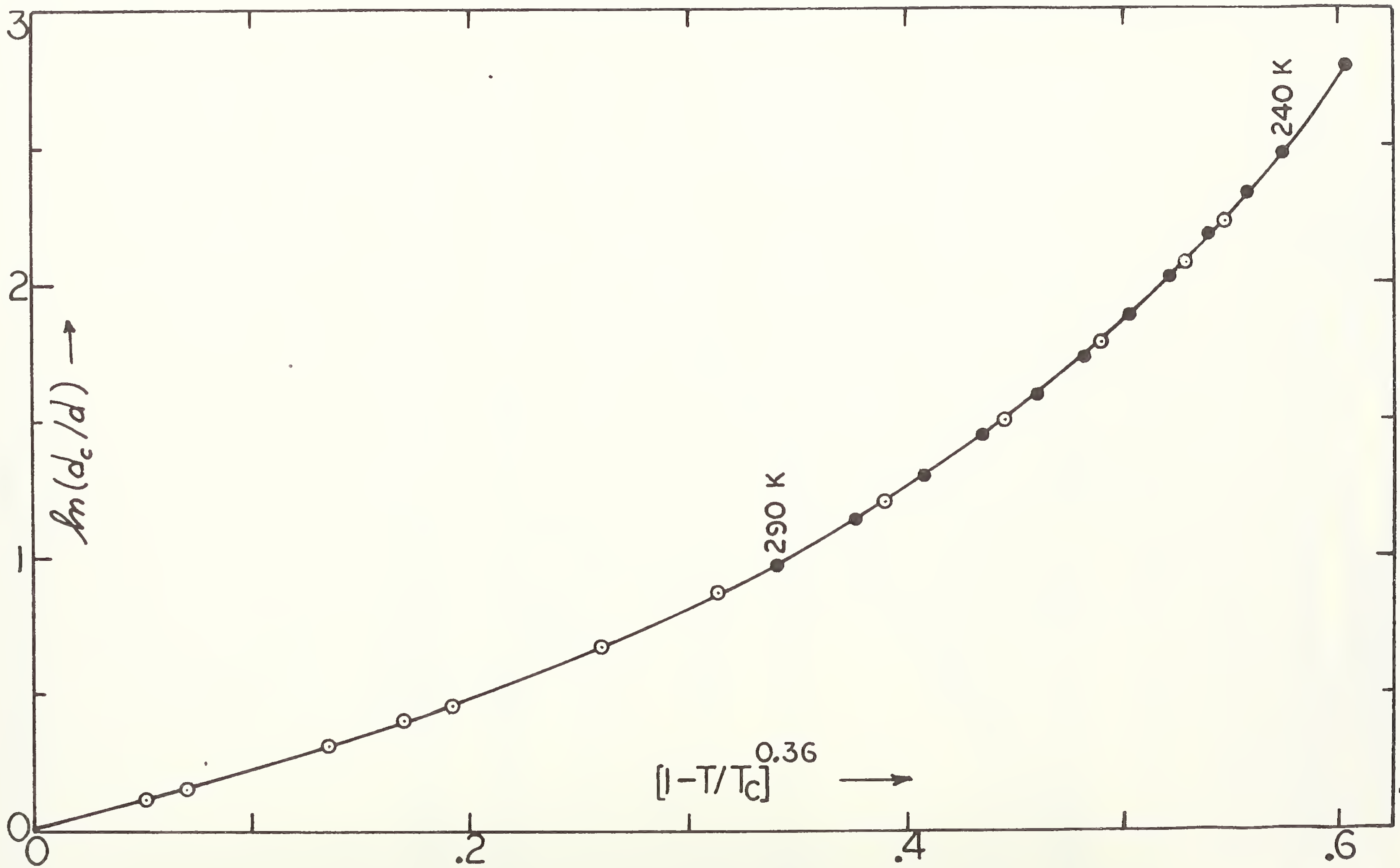


Figure 2. Ethane saturated vapor densities. Open circles from Douslin [2]; filled circles from Table 5, this report.

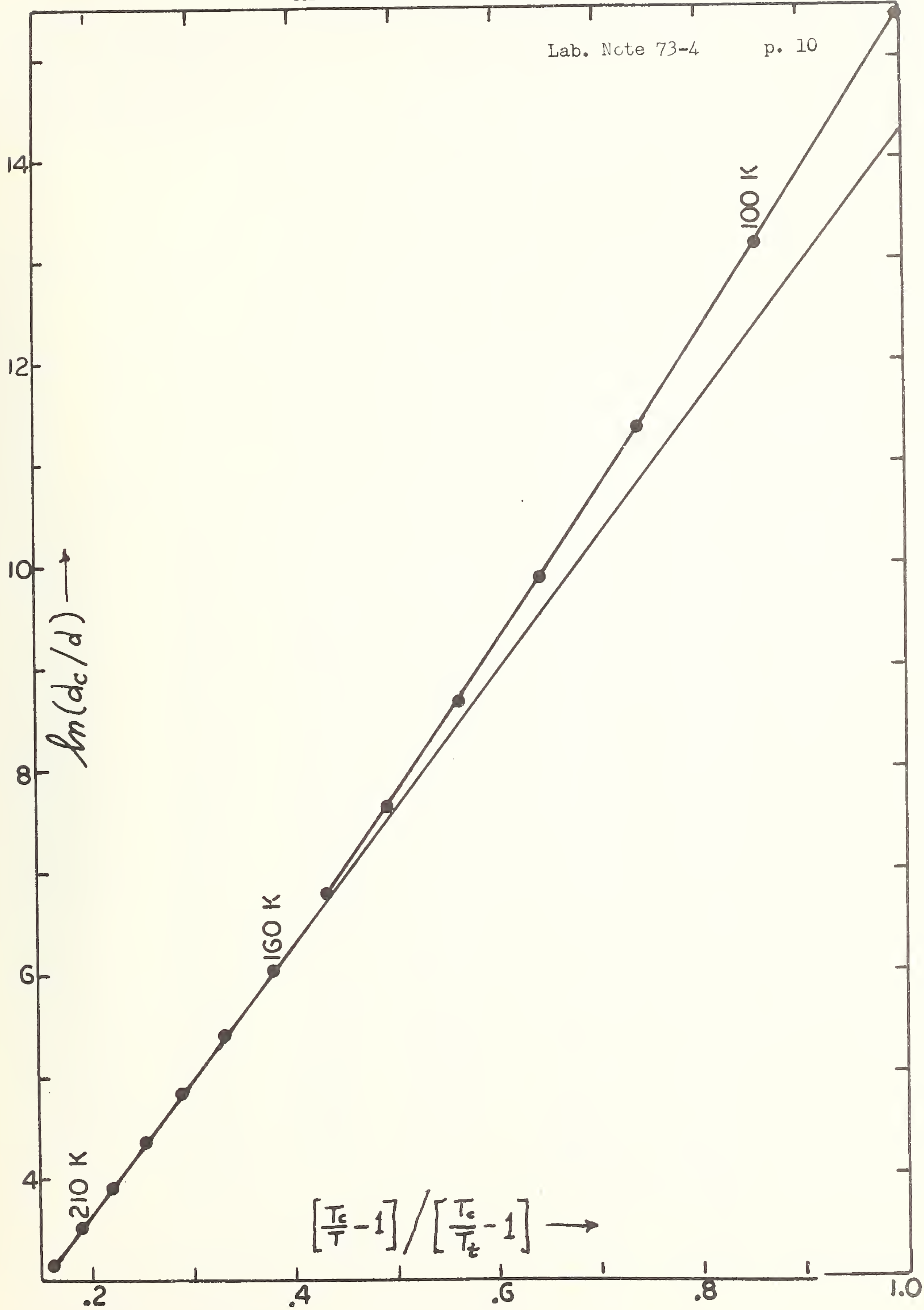


Figure 3. Ethane saturated vapor densities from Table 5, this report.

| Cryogenics Division – NBS Institute for Basic Standards LABORATORY NOTE | PROJECT NO. 2750364 | FILE NO. 73-4 | PAGE 11 |
|---|---|---|---|
| SUBJECT Ethane Virial Coefficients and Saturated Vapor Densities | NAME R. D. Goodwin | | |
| | DATE August 14, 1973 | | |

Table 1. Second virial data of (6) McGlashan, (10) Douslin.

ETHANE SECOND VIRIAL COEFFICIENT

EB = 0.250, TZ = 740.0

7.993156 -10.672497 9.217322 -2.481668 0.842328

| ID | T,K | T/TC | B* | CALC | DIFF | PCNT |
|---|---|---|---|---|---|---|
| 6 | 150.000 | 0.4913 | -5.309 | -5.310 | 0.001 | 0.01 |
| 6 | 160.000 | 0.5240 | -4.598 | -4.597 | -0.001 | -0.01 |
| 6 | 170.000 | 0.5568 | -4.031 | -4.030 | -0.001 | -0.02 |
| 6 | 180.000 | 0.5895 | -3.569 | -3.569 | -0.000 | -0.01 |
| 6 | 190.000 | 0.6223 | -3.188 | -3.188 | 0.000 | 0.01 |
| 6 | 200.000 | 0.6550 | -2.868 | -2.869 | 0.001 | 0.02 |
| 6 | 210.000 | 0.6878 | -2.597 | -2.597 | 0.001 | 0.03 |
| 6 | 220.000 | 0.7205 | -2.363 | -2.364 | 0.001 | 0.03 |
| 6 | 230.000 | 0.7533 | -2.161 | -2.162 | 0.000 | 0.02 |
| 6 | 240.000 | 0.7860 | -1.984 | -1.984 | -0.000 | -0.00 |
| 6 | 250.000 | 0.8188 | -1.828 | -1.828 | -0.001 | -0.04 |
| 6 | 260.000 | 0.8515 | -1.690 | -1.688 | -0.002 | -0.09 |
| 10 | 273.150 | 0.8946 | -1.527 | -1.527 | 0.001 | 0.06 |
| 10 | 298.150 | 0.9765 | -1.276 | -1.275 | -0.001 | -0.08 |
| 10 | 303.150 | 0.9929 | -1.232 | -1.232 | -0.001 | -0.05 |
| 10 | 323.150 | 1.0584 | -1.077 | -1.076 | -0.001 | -0.06 |
| 10 | 348.150 | 1.1402 | -0.914 | -0.914 | 0.001 | 0.08 |
| 10 | 373.150 | 1.2221 | -0.780 | -0.781 | 0.001 | 0.10 |
| 10 | 398.150 | 1.3040 | -0.668 | -0.670 | 0.001 | 0.16 |
| 10 | 423.150 | 1.3859 | -0.574 | -0.575 | 0.000 | 0.06 |
| 10 | 448.150 | 1.4678 | -0.493 | -0.493 | 0.000 | 0.10 |
| 10 | 473.150 | 1.5496 | -0.423 | -0.422 | -0.000 | -0.08 |
| 10 | 498.150 | 1.6315 | -0.360 | -0.360 | -0.000 | -0.01 |
| 10 | 523.150 | 1.7134 | -0.306 | -0.305 | -0.001 | -0.27 |
| 10 | 548.150 | 1.7953 | -0.256 | -0.256 | -0.000 | -0.19 |
| 10 | 573.150 | 1.8771 | -0.212 | -0.212 | -0.001 | -0.30 |
| 10 | 598.150 | 1.9590 | -0.172 | -0.172 | -0.000 | -0.02 |
| 10 | 623.150 | 2.0409 | -0.135 | -0.135 | 0.001 | 0.53 |

NP = 28, MEANPCT = 0.088

| Cryogenics Division – NBS Institute for Basic Standards<br>LABORATORY NOTE | PROJECT NO.<br>2750364 | FILE NO.<br>73-4 | PAGE<br>12 |
|---|---|---|---|
| SUBJECT<br>Ethane Virial Coefficients and Saturated Vapor Densities | NAME<br>R. D. Goodwin | DATE<br>August 14, 1973 | |

Table 2. Second Virial, (1) Eucken, (2) Lambert, (3) Michels, (4) Hoover (5) Pope, (8) Gunn.

| ID | T,K | T/TC | B* | CALC | DIFF | PCNT |
|---|---|---|---|---|---|---|
| 1 | 200.000 | 0.6550 | -3.112 | -2.869 | -0.243 | -8.48 |
| 2 | 200.000 | 0.6550 | -3.119 | -2.869 | -0.250 | -8.72 |
| 5 | 209.534 | 0.6863 | -2.533 | -2.609 | 0.076 | 2.93 |
| 1 | 210.000 | 0.6878 | -2.817 | -2.597 | -0.219 | -8.44 |
| 2 | 210.000 | 0.6878 | -2.817 | -2.597 | -0.219 | -8.44 |
| 4 | 215.000 | 0.7042 | -2.340 | -2.477 | 0.137 | 5.52 |
| 1 | 220.000 | 0.7205 | -2.542 | -2.364 | -0.178 | -7.52 |
| 2 | 220.000 | 0.7205 | -2.576 | -2.364 | -0.212 | -8.97 |
| 1 | 230.000 | 0.7533 | -2.288 | -2.162 | -0.126 | -5.84 |
| 2 | 230.000 | 0.7533 | -2.343 | -2.162 | -0.181 | -8.38 |
| 5 | 238.759 | 0.7820 | -1.972 | -2.005 | 0.033 | 1.63 |
| 1 | 240.000 | 0.7860 | -2.095 | -1.984 | -0.111 | -5.61 |
| 2 | 240.000 | 0.7860 | -2.116 | -1.984 | -0.132 | -6.65 |
| 4 | 240.000 | 0.7860 | -1.900 | -1.984 | 0.085 | 4.26 |
| 1 | 250.000 | 0.8188 | -1.924 | -1.828 | -0.096 | -5.26 |
| 2 | 250.000 | 0.8188 | -1.944 | -1.828 | -0.117 | -6.39 |
| 5 | 254.807 | 0.8345 | -1.733 | -1.759 | 0.026 | 1.45 |
| 1 | 250.000 | 0.8515 | -1.759 | -1.688 | -0.070 | -4.17 |
| 2 | 260.000 | 0.8515 | -1.786 | -1.688 | -0.098 | -5.80 |
| 1 | 270.000 | 0.8843 | -1.614 | -1.564 | -0.051 | -3.23 |
| 2 | 270.000 | 0.8843 | -1.649 | -1.564 | -0.085 | -5.43 |
| 3 | 273.150 | 0.8946 | -1.521 | -1.527 | 0.006 | 0.39 |
| 4 | 273.150 | 0.8946 | -1.535 | -1.527 | -0.007 | -0.48 |
| 5 | 273.150 | 0.8946 | -1.507 | -1.527 | 0.020 | 1.33 |
| 8 | 273.200 | 0.8948 | -1.527 | -1.527 | 0.000 | 0.02 |
| 1 | 280.000 | 0.9170 | -1.470 | -1.452 | -0.018 | -1.25 |
| 2 | 280.000 | 0.9170 | -1.511 | -1.452 | -0.059 | -4.09 |
| 2 | 290.000 | 0.9498 | -1.408 | -1.351 | -0.058 | -4.26 |
| 3 | 298.138 | 0.9764 | -1.275 | -1.275 | 0.000 | 0.03 |
| 8 | 298.200 | 0.9766 | -1.284 | -1.275 | -0.009 | -0.71 |
| 2 | 300.000 | 0.9825 | -1.305 | -1.259 | -0.046 | -3.68 |
| 5 | 306.062 | 1.0024 | -1.204 | -1.207 | 0.003 | 0.27 |
| 3 | 322.748 | 1.0570 | -1.078 | -1.079 | 0.001 | 0.07 |
| 8 | 323.200 | 1.0585 | -1.082 | -1.076 | -0.006 | -0.60 |
| 3 | 347.652 | 1.1386 | -0.916 | -0.917 | 0.002 | 0.19 |
| 3 | 372.522 | 1.2201 | -0.784 | -0.784 | 0.001 | 0.09 |
| 8 | 377.600 | 1.2367 | -0.752 | -0.760 | 0.008 | 1.10 |
| 3 | 397.844 | 1.3030 | -0.671 | -0.671 | -0.001 | -0.08 |
| 8 | 410.900 | 1.3458 | -0.616 | -0.619 | 0.004 | 0.61 |
| 3 | 422.700 | 1.3844 | -0.576 | -0.576 | -0.000 | -0.04 |
| 8 | 444.300 | 1.4551 | -0.508 | -0.505 | -0.003 | -0.69 |
| 8 | 477.600 | 1.5642 | -0.423 | -0.411 | -0.013 | -3.09 |
| 8 | 510.900 | 1.6733 | -0.350 | -0.331 | -0.019 | -5.83 |

SP 11342 A

Cryogenics Division – NBS Institute for Basic Standards
LABORATORY NOTE

| PROJECT NO. | FILE NO. | PAGE |
|---|---|---|
| 2750364 | 73-4 | 13 |

SUBJECT Ethane Virial Coefficients and Saturated Vapor Densities
NAME R. D. Goodwin
DATE August 14, 1973

Table 3. Third virial, (7) Chueh, (10) Douslin, (4) Hoover, (5) Pope.

THIRD VIRIAL,

217.800 0.253773 0.865299 0.556075 0.000000

| ID | T,K | T/TCRT | C* | CALCD | DIFF |
|---|---|---|---|---|---|
| 7 | 210.000 | 0.6878 | -0.251 | -0.247 | -0.004 |
| 7 | 220.000 | 0.7205 | 0.055 | 0.055 | 0.000 |
| 7 | 230.000 | 0.7533 | 0.249 | 0.247 | 0.002 |
| 7 | 240.000 | 0.7860 | 0.367 | 0.366 | 0.001 |
| 7 | 250.000 | 0.8188 | 0.436 | 0.438 | -0.002 |
| 7 | 260.000 | 0.8515 | 0.472 | 0.477 | -0.006 |
| 10 | 273.150 | 0.8946 | 0.489 | 0.499 | -0.010 |
| 10 | 298.150 | 0.9765 | 0.500 | 0.489 | 0.011 |
| 10 | 303.150 | 0.9929 | 0.491 | 0.483 | 0.008 |
| 10 | 323.150 | 1.0584 | 0.455 | 0.453 | 0.003 |
| 10 | 348.150 | 1.1402 | 0.409 | 0.410 | -0.001 |
| 10 | 373.150 | 1.2221 | 0.364 | 0.369 | -0.004 |
| 10 | 398.150 | 1.3040 | 0.328 | 0.332 | -0.003 |
| 10 | 423.150 | 1.3859 | 0.295 | 0.299 | -0.004 |
| 10 | 448.150 | 1.4678 | 0.268 | 0.271 | -0.003 |
| 10 | 473.150 | 1.5496 | 0.250 | 0.247 | 0.002 |
| 10 | 498.150 | 1.6315 | 0.228 | 0.227 | 0.002 |
| 10 | 523.150 | 1.7134 | 0.212 | 0.209 | 0.004 |
| 10 | 548.150 | 1.7953 | 0.195 | 0.193 | 0.002 |
| 10 | 573.150 | 1.8771 | 0.182 | 0.180 | 0.002 |
| 10 | 598.150 | 1.9590 | 0.167 | 0.168 | -0.001 |
| 10 | 623.150 | 2.0409 | 0.154 | 0.157 | -0.003 |

NP = 22, MEANDIFF = 0.004

| ID | T,K | T/TCRT | C* | CALCD | DIFF |
|---|---|---|---|---|---|
| 5 | 209.534 | 0.6863 | -2.770 | -0.264 | -2.506 |
| 4 | 215.000 | 0.7042 | -3.356 | -0.079 | -3.277 |
| 5 | 238.769 | 0.7820 | 0.175 | 0.354 | -0.180 |
| 4 | 240.000 | 0.7860 | -0.121 | 0.366 | -0.487 |
| 5 | 254.807 | 0.8345 | 0.401 | 0.460 | -0.059 |
| 5 | 273.150 | 0.8946 | 0.489 | 0.499 | -0.010 |
| 4 | 273.150 | 0.8946 | 0.501 | 0.499 | 0.002 |
| 4 | 273.150 | 0.8946 | 0.537 | 0.499 | 0.038 |
| 4 | 298.138 | 0.9764 | 0.507 | 0.489 | 0.017 |
| 5 | 306.062 | 1.0024 | 0.473 | 0.479 | -0.006 |
| 4 | 322.748 | 1.0570 | 0.456 | 0.453 | 0.003 |
| 4 | 347.652 | 1.1386 | 0.405 | 0.411 | -0.006 |
| 4 | 372.522 | 1.2201 | 0.364 | 0.370 | -0.006 |
| 4 | 397.844 | 1.3030 | 0.330 | 0.332 | -0.002 |
| 4 | 422.700 | 1.3844 | 0.301 | 0.300 | 0.001 |

SP 11342 A

Cryogenics Division – NBS Institute for Basic Standards
LABORATORY NOTE

| PROJECT NO. | FILE NO. | PAGE |
|---|---|---|
| 2750364 | 73-4 | 14 |

SUBJECT: Ethane Virial Coefficients and Saturated Vapor Densities

NAME: R. D. Goodwin

DATE: August 14, 1973

Table 4. Terms of the virial equation for saturated vapor.

TERMS OF THE VIRIAL EQUATION FOR SATURATED VAPOR

| T,K | P,ATM | MOL/L | DI/DN | B*S | C*S2 | Z(T,D) |
|---|---|---|---|---|---|---|
| 90 | 0.0000099 | 0.0000013 | 0.999996 | -0.000004 | -0.000000 | 0.999996 |
| 95 | 0.0000348 | 0.0000045 | 0.999987 | -0.000011 | -0.000000 | 0.999989 |
| 100 | 0.0001057 | 0.0000130 | 0.999966 | -0.000028 | -0.000000 | 0.999972 |
| 105 | 0.0002916 | 0.0000338 | 0.999920 | -0.000064 | -0.000000 | 0.999936 |
| 110 | 0.0007207 | 0.0000799 | 0.999831 | -0.000133 | -0.000000 | 0.999867 |
| 115 | 0.0016337 | 0.0001732 | 0.999670 | -0.000256 | -0.000000 | 0.999744 |
| 120 | 0.0034347 | 0.0003490 | 0.999398 | -0.000462 | -0.000000 | 0.999538 |
| 125 | 0.0067608 | 0.0006598 | 0.998969 | -0.000787 | -0.000000 | 0.999213 |
| 130 | 0.0125592 | 0.0011793 | 0.998323 | -0.001276 | -0.000001 | 0.998723 |
| 135 | 0.0221670 | 0.0020063 | 0.997397 | -0.001982 | -0.000002 | 0.998016 |
| 140 | 0.0373903 | 0.0032674 | 0.996119 | -0.002961 | -0.000005 | 0.997034 |
| 145 | 0.0605738 | 0.0051196 | 0.994420 | -0.004276 | -0.000009 | 0.995715 |
| 150 | 0.0946592 | 0.0077508 | 0.992228 | -0.005991 | -0.000016 | 0.993994 |
| 155 | 0.1432275 | 0.0113809 | 0.989479 | -0.008171 | -0.000026 | 0.991803 |
| 160 | 0.2105236 | 0.0162608 | 0.986113 | -0.010882 | -0.000042 | 0.989077 |
| 165 | 0.3014633 | 0.0226721 | 0.982082 | -0.014185 | -0.000063 | 0.985752 |
| 170 | 0.4216243 | 0.0309256 | 0.977343 | -0.018141 | -0.000090 | 0.981769 |
| 175 | 0.5772221 | 0.0413607 | 0.971866 | -0.022806 | -0.000124 | 0.977070 |
| 180 | 0.7750743 | 0.0543439 | 0.965625 | -0.028233 | -0.000164 | 0.971603 |
| 185 | 1.0225573 | 0.0702692 | 0.958606 | -0.034470 | -0.000206 | 0.965324 |
| 190 | 1.3275563 | 0.0895573 | 0.950796 | -0.041563 | -0.000248 | 0.958189 |
| 195 | 1.6984137 | 0.1126577 | 0.942186 | -0.049554 | -0.000281 | 0.950164 |
| 200 | 2.1438785 | 0.1400503 | 0.932771 | -0.058485 | -0.000299 | 0.941217 |
| 205 | 2.6730575 | 0.1722494 | 0.922541 | -0.068395 | -0.000287 | 0.931318 |
| 210 | 3.2953721 | 0.2098093 | 0.911484 | -0.079325 | -0.000230 | 0.920445 |
| 215 | 4.0205218 | 0.2533319 | 0.899587 | -0.091321 | -0.000107 | 0.908571 |
| 220 | 4.8584553 | 0.3034770 | 0.886826 | -0.104432 | 0.000108 | 0.895676 |
| 225 | 5.8193516 | 0.3609763 | 0.873177 | -0.118715 | 0.000448 | 0.881732 |
| 230 | 6.9136108 | 0.4266509 | 0.858605 | -0.134238 | 0.000952 | 0.866714 |
| 235 | 8.1518573 | 0.5014347 | 0.843069 | -0.151085 | 0.001671 | 0.850586 |
| 240 | 9.5449551 | 0.5864036 | 0.826523 | -0.169358 | 0.002667 | 0.833309 |
| 245 | 11.1040386 | 0.6828144 | 0.808912 | -0.189185 | 0.004017 | 0.814832 |
| 250 | 12.8405603 | 0.7921552 | 0.790174 | -0.210725 | 0.005818 | 0.795093 |
| 255 | 14.7663588 | 0.9162120 | 0.770240 | -0.234180 | 0.008194 | 0.774014 |
| 260 | 16.8937542 | 1.0571595 | 0.749033 | -0.259804 | 0.011305 | 0.751500 |
| 265 | 19.2356771 | 1.2176851 | 0.726466 | -0.287925 | 0.015361 | 0.727436 |
| 270 | 21.8058475 | 1.4011641 | 0.702440 | -0.318963 | 0.020642 | 0.701679 |
| 275 | 24.6190249 | 1.6119133 | 0.676839 | -0.353469 | 0.027531 | 0.674063 |
| 280 | 27.6913739 | 1.8555713 | 0.649528 | -0.392177 | 0.036563 | 0.644386 |
| 285 | 31.0410283 | 2.1396901 | 0.620339 | -0.436086 | 0.048505 | 0.612418 |
| 290 | 34.6890345 | 2.4747097 | 0.589059 | -0.486600 | 0.064498 | 0.577898 |
| 295 | 38.6611522 | 2.8756823 | 0.555393 | -0.545771 | 0.086320 | 0.540549 |
| 300 | 42.9921502 | 3.3657409 | 0.518891 | -0.616818 | 0.116916 | 0.500098 |
| 305 | 47.7441963 | 3.9859334 | 0.478608 | -0.705645 | 0.161805 | 0.456160 |

SP 11342 A

| Cryogenics Division – NBS Institute for Basic Standards LABORATORY NOTE | PROJECT NO. 2750364 | FILE NO. 73-4 | PAGE 15 |
|---|---|---|---|
| SUBJECT Ethane Virial Coefficients and Saturated Vapor Densities | NAME R. D. Goodwin | DATE August 14, 1973 | |

Table 5. Saturated vapor densities derived via V.P. and virial equations.

ETHANE SATD. VAPOR DENSITIES VIA V.P. AND VIRIAL EQNS.

| ID | T,K | P,ATM | PLANK/KAMB | MOL/L | PCT |
|---|---|---|---|---|---|
| 1 | 89.899 | 9.9670-006 | 1.3511-006 | 1.3511-006 | 0.00 |
| 1 | 90.000 | 1.0238-005 | 1.3863-006 | 1.3863-006 | 0.00 |
| 1 | 95.000 | 3.5808-005 | 4.5936-006 | 4.5936-006 | 0.00 |
| 1 | 100.000 | 1.0952-004 | 1.3347-005 | 1.3347-005 | 0.00 |
| 1 | 105.000 | 2.9851-004 | 3.4649-005 | 3.4648-005 | 0.00 |
| 1 | 110.000 | 7.3654-004 | 8.1615-005 | 8.1612-005 | 0.00 |
| 1 | 115.000 | 1.6670-003 | 1.7671-004 | 1.7670-004 | 0.01 |
| 1 | 120.000 | 3.4991-003 | 3.5558-004 | 3.5552-004 | 0.01 |
| 1 | 125.000 | 6.8762-003 | 6.7110-004 | 6.7093-004 | 0.02 |
| 1 | 130.000 | 1.2752-002 | 1.1974-003 | 1.1970-003 | 0.04 |
| 1 | 135.000 | 2.2468-002 | 2.0336-003 | 2.0323-003 | 0.06 |
| 1 | 140.000 | 3.7834-002 | 3.3064-003 | 3.3033-003 | 0.09 |
| 1 | 145.000 | 6.1192-002 | 5.1721-003 | 5.1653-003 | 0.13 |
| 1 | 150.000 | 9.5478-002 | 7.8184-003 | 7.8043-003 | 0.18 |
| 1 | 155.000 | 1.4426-001 | 1.1464-002 | 1.1436-002 | 0.24 |
| 1 | 160.000 | 2.1176-001 | 1.6358-002 | 1.6308-002 | 0.31 |
| 1 | 165.000 | 3.0288-001 | 2.2781-002 | 2.2694-002 | 0.38 |
| 1 | 170.000 | 4.2317-001 | 3.1042-002 | 3.0899-002 | 0.46 |
| 1 | 175.000 | 5.7882-001 | 4.1479-002 | 4.1252-002 | 0.55 |
| 1 | 180.000 | 7.7662-001 | 5.4457-002 | 5.4111-002 | 0.64 |
| 1 | 185.000 | 1.0239+000 | 7.0369-002 | 6.9860-002 | 0.73 |
| 1 | 190.000 | 1.3287+000 | 8.9635-002 | 8.8911-002 | 0.81 |
| 1 | 195.000 | 1.6991+000 | 1.1271-001 | 1.1171-001 | 0.89 |
| 1 | 200.000 | 2.1440+000 | 1.4006-001 | 1.3872-001 | 0.97 |
| 1 | 205.000 | 2.6726+000 | 1.7222-001 | 1.7047-001 | 1.03 |
| 1 | 210.000 | 3.2943+000 | 2.0973-001 | 2.0750-001 | 1.08 |
| 1 | 215.000 | 4.0186+000 | 2.5321-001 | 2.5043-001 | 1.11 |
| 1 | 220.000 | 4.8561+000 | 3.0331-001 | 2.9993-001 | 1.13 |
| 1 | 225.000 | 5.8165+000 | 3.6077-001 | 3.5674-001 | 1.13 |
| 1 | 230.000 | 6.9105+000 | 4.2642-001 | 4.2173-001 | 1.11 |
| 1 | 235.000 | 8.1487+000 | 5.0120-001 | 4.9585-001 | 1.08 |
| 1 | 240.000 | 9.5420+000 | 5.8618-001 | 5.8025-001 | 1.02 |
| 1 | 245.000 | 1.1102+001 | 6.8262-001 | 6.7626-001 | 0.94 |
| 1 | 250.000 | 1.2839+001 | 7.9203-001 | 7.8551-001 | 0.83 |
| 1 | 255.000 | 1.4766+001 | 9.1618-001 | 9.0997-001 | 0.68 |
| 1 | 260.000 | 1.6895+001 | 1.0572+000 | 1.0522+000 | 0.48 |
| 1 | 265.000 | 1.9238+001 | 1.2179+000 | 1.2154+000 | 0.21 |
| 1 | 270.000 | 2.1810+001 | 1.4016+000 | 1.4041+000 | -0.18 |
| 1 | 275.000 | 2.4624+001 | 1.6125+000 | 1.6245+000 | -0.74 |
| 1 | 280.000 | 2.7697+001 | 1.8563+000 | 1.8861+000 | -1.58 |
| 1 | 285.000 | 3.1047+001 | 2.1404+000 | 2.2047+000 | -2.91 |
| 1 | 290.000 | 3.4693+001 | 2.4754+000 | 2.6108+000 | -5.19 |

SP 11342 8

| Cryogenics Division – NBS Institute for Basic Standards LABORATORY NOTE | PROJECT NO. 2750364 | FILE NO. 73-4 | PAGE 16 |
|---|---|---|---|
| SUBJECT Ethane Virial Coefficients and Saturated Vapor Densities | NAME R. D. Goodwin | DATE August 14, 1973 | |

```
      PROGRAM VIRUS
C     ETHANE VIRIAL COEFFICIENTS,     X = T/TCRT,   Q = X**1/2,
C     BV = (B1 + B2/X**EB + B3/X + B4/X2 + B5/X3)*(1-(TZ/T)**1/4).
C     CV = (C1/X**EC + C2/X3 + C3/X5)*(1-TZ/T).
C    ID, (1)EUCKEN, (2)LAMBERT, (3)MICHELS, (4)HOOVER, (5)POPE,
C     (6)MCGLASHAN, (7)CHUEH, (8)GUNN, (10)DOUSLIN,PREPRINT.
C     VCRT,CC/MOL, ROSSINI(1953)/MCGLASHAM=148, EUBANK/POPE=146.2,
C                  TESTER(1961)=141.7, DOUSLIN(1973)=145.56.
      COMMON/1/M,EB,EC,TZB,TZC, BVS,CVS, B(5),C(4)
      COMMON/3/ DPSDT
      COMMON/999/NP,NF,H(15),Y(200),G(200,15)
      DIMENSION ID(200),T(200),BV(200),CV(200),X(200),XQ(200)
    1 FORMAT(I5, 2F10.0)
    2 FORMAT(1H1 13X 1HM 5X5HE(BC) 8X2HTZ 8X2HSS)
    3 FORMAT(10X I5, 2F10.3, F10.4)
    4 FORMAT(1H1 17X *ETHANE SECOND VIRIAL COEFFICIENT*//
     1 18X4HEB =F6.3, 5H, TZ =F6.1// 15X 5F12.6//
     2 18X2HID 7X3HT,K 5X4HT/TC 7X2HB* 5X4HCALC 5X4HDIFF 5X4HPCNT)
    5 FORMAT(15X I5, F10.3, F9.4, 3F9.3, F9.2)
    6 FORMAT(1H117X*THIRD VIRIAL, M =*I2, 6H, EC =F6.3// 16X F10.3,
     1 4F11.6// 18X2HID 7X3HT,K 4X6HT/TCRT 8X2HC* 5X5HCALCD 6X4HDIFF )
    7 FORMAT(15X I5, F10.3, F10.4, 3F10.3)
    8 FORMAT(18X 4HNP =I3, 12H, MEANDIFF = F7.3)
    9 FORMAT(18X 4HNP =I3, 11H, MEANPCT =F6.3)
   10 FORMAT(1H1 15X*TERMS OF THE VIRIAL EQUATION FOR SATURATED VAPOR*//
     1 17X3HT,K 7X5HP,ATM 7X5HMOL/L 5X5HDI/DN
     2 7X3HB*S 6X4HC*S2 4X6HZ(T,D)    )
   11 FORMAT(10X F10.0, 2F12.7, 4F10.6)
   12 FORMAT(1H1 17X 2HID 7X3HT,K 5X4HT/TC 7X2HB* 5X4HCALC
     1 5X4HDIFF 5X4HPCNT)
   13 FORMAT(1H117X2HID 7X3HT,K 4X6HT/TCRT 8X2HC* 5X5HCALCD 6X4HDIFF)
   15 TTRP=89.899 $ TCRT=305.33 $ DCRT=1.0/145.56
C     GENERATE MCGLASHAM DATA FOR BV(T), CC/MOL.
C     INCREASE ABS(MCGLASHAM) BY ONE PERCENT (148/145.56 = 1.017).
   16 N=0   $  DO 19 J=1,12   $   N = N+1   $   TT = T(N) = 140 + 10*J
   17 X(N)=TT/TCRT $ XQ(N)=SQRTF(X(N))   $   ID(N) = 6
   18 BV(N) = 1.01*GLABF(TT)   $   Y(N) = BV(N)*DCRT
   19 CONTINUE
C     READ DOUSLIN(1973) DATA, CC/MOL.
   20 DO 23 J=1,99   $   READ 1, IDD,TT,BB   $   IF(IDD) 21,24
   21 N = N+1   $  ID(N)=IDD   $   T(N)=TT   $   BV(N)=BB
   22 X(N)=TT/TCRT $ XQ(N)=SQRTF(X(N)) $ Y(N)=BB*DCRT
   23 CONTINUE
   24 NP = N   $   NF = 5   $   SSK = 1.0E+010
C     READ SECOND VIRIAL DATA.
   25 DO 28 J=1,99   $   READ 1, IDD,TT,BB   $   IF(IDD) 26,29
   26 N = N+1   $   ID(N)=IDD $ T(N)=TT $ BV(N)=BB
   27 X(N)=TT/TCRT $ XQ(N)=SQRTF(X(N)) $ Y(N)=BB*DCRT
   28 CONTINUE
   29 NPP = N    $    M = 0                                  7/26/73
C     EXPLORE VALUES FOR EB AND FOR TZB.
C     MCGLASHAM TZB NEAR 2.7*TCRT = 824 K.
   30 EB = 0.25   $   TZ = TZB = 740   $   PRINT 2
C  31 DO 44 IE=1,3   $   EB = 0.25*IE
C  32 DO 44 IT=1,17   $   TZ = 640 + 10*IT
```

SP 11342 A

| Cryogenics Division – NBS Institute for Basic Standards LABORATORY NOTE | PROJECT NO. 2750364 | FILE NO. 73-4 | PAGE 17 |
|---|---|---|---|
| SUBJECT Ethane Virial Coefficients and Saturated Vapor Densities | NAME R. D. Goodwin | | |
| | DATE August 14, 1973 | | |

```
    33 DO 36 J=1,NP  $  U=X(J)  $  Q=XQ(J)  $  W = 1-(TZ/T(J))**0.25
    34 G(J,1)=W $ G(J,2)=W/U**EB $ G(J,3)=W/U $ G(J,4)=W/U**2
    35 G(J,5)=W/U**3
    36 CONTINUE  $  CALL EGENFT  $  SS = 0
    37 DO 39 J=1,NP  $  YC = 0  $  DO 38 K=1,NF
    38 YC = YC + H(K)*G(J,K)
    39 SS = SS + ABSF(Y(J)/YC-1)  $  SS = 100*SS/NP
    40 IF(SS.LT.SSK) 41,44
    41 SSK=SS $ EK=EB $ TK=TZ  $  DO 42 K=1,5
    42 B(K) = H(K)
    44 PRINT 3, M,EB,TZ,SS  $  EB=EK $ TZ=TZB=TK  $  SS = 0
C     USE SAVED CONSTANTS FOR DEVIATIONS.
    45 PRINT 4, EB, TZ, (B(K),K=1,5)
    46 DO 51 J=1,NPP $  U=X(J)  $  Q=XQ(J)  $  W = 1-(TZ/T(J))**0.25
    47 YC = W*(B(1) + B(2)/U**EB + B(3)/U + B(4)/U**2 + B(5)/U**3)
    48 DIF=Y(J)-YC $ PCT=-100*DIF/YC $ SS=SS+ABSF(PCT)
    49 PRINT 5, ID(J),T(J),X(J),Y(J),YC,DIF,PCT  $  IF(J-NP) 51,50
    50 SS = SS/NP  $  PRINT 9, NP,SS  $  PRINT 12
    51 CONTINUE  $  N = 0
C     GENERATE THIRD VIRIAL DATA VIA CHUEH(1967), ID = 7.
C     DIMINISH CHUEH DATA BY 2 PERCENT.
    52 DO 55 J=1,6  $  N = N+1  $  TT = T(N) = 200 + 10*J
    53 X(N)=TT/TCRT $ XQ(N)=SQRTF(X(N))  $  ID(N) = 7
    54 CV(N) = 0.98*CHUCF(TT)  $  Y(N) = CV(N)*DCRT**2
    55 CONTINUE  $  K = N + 1
C     READ DOUSLIN(1973) DATA, (CC/MOL)**2.
    56 DO 58 J=K,99  $  READ 1, ID(J),T(J),CV(J)  $  IF(ID(J)) 57,59
    57 X(J)=T(J)/TCRT $ XQ(J)=SQRTF(X(J)) $ Y(J)=CV(J)*DCRT**2
    58 CONTINUE
    59 NP = J-1  $  NF = 3  $  SSK = 1.0E+010
C     READ THIRD VIRIAL DATA.  TZC NEAR 220 K.
    60 K = NP+1  $  DO 63 J=K,99
    61 READ 1, ID(J),T(J),CV(J)  $  IF(ID(J)) 62,64
    62 X(J) = T(J)/TCRT  $  XQ(J)=SQRTF(X(J))  $  Y(J)=CV(J)*DCRT**2
    63 CONTINUE
    64 NPP = J-1  $  EC = 1.0  $  PRINT 2
C     EXPLORE VALUES FOR EC AND FOR TZ.
C   65 DO 76 IE=1,4  $  EC = 0.5*IE
    66 DO 76 IT=1,11  $  TZ = 217.60 + 0.05*IT
    67 DO 69 J=1,NP  $  U = X(J)  $  W = 1-TZ/T(J)
    68 G(J,1)=W/U**EC  $  G(J,2)=W/U**3  $  G(J,3)=W/U**5
    69 CONTINUE  $  CALL EGENFT  $  SS = 0
    70 DO 72 J=1,NP  $  YC = 0  $  DO 71 K=1,NF
    71 YC = YC + H(K)*G(J,K)                                7/26/73
    72 SS = SS + ABSF(Y(J)-YC)  $  SS = SS/NP
    73 IF(SS.LT.SSK) 74,76
    74 SSK=SS $ TK=TZ $ EK=EC $ MK=M  $  DO 75 K=1,4
    75 C(K) = H(K)
    76 PRINT 3, M,EC,TZ,SS  $  M = MK
    77 TZC = TZ = TK  $  EC = EK  $  SS = 0
C     USE SAVED CONSTANTS FOR DEVIATIONS.
    79 PRINT 6, M,EC,TZ, (C(K),K=1,4)
    80 DO 85 J=1,NPP $  U = X(J)  $  W = 1-TZ/T(J)
    81 YC = W*(C(1)/U**EC + C(2)/U**3 + C(3)/U**5)
    82 PCT = Y(J)-YC  $  SS = SS + ABSF(PCT)
```

SP 11342 A

```
        VIRUS                                                   07/26/73

   83 PRINT 7, ID(J),T(J),X(J),Y(J),YC,PCT  $  IF(J-NP) 85,84
   84 SS = SS/NP   $  PRINT 8, NP,SS   $  PRINT 13
   85 CONTINUE
 C     NOW EXAMINE TERMS OF THE VIRIAL EQUATION AT SATURATION.
 C     THE IDEAL GAS DENSITY IS DI = P/(R*T),
   90 PRINT 10   $  DO 95 J=1,44   $  TT = 85 + 5*J
   91 PS=PSATF(TT)   $  DN=DNGSF(TT)   $  Z = ZIPF(TT,DN)
   92 DI = PS/TT/0.082056156   $  DR = DI/DN
   95 PRINT 11, TT,PS,DN, DR, BVS,CVS, Z
   99 STOP   $   END

SINGLE-BANK COMPILATION.


       FUNCTION CHUCF(T)
 C     ETHANE THIRD VIRIAL VIA CHUEH FORMULA(1967), (CC/MOL)**2.
 C     CV(T)/VCRT**2 = FA*FB + FC,  FA = A/Q + B/X5,
 C     FB = 1 - EXP(1-AL*X2),   FC = EXP(-C + D*X - E*X2),   X = T/TCRT.
       DATA (TCRT=305.33),(VCRT=145.56),(AL=1.89)
       DATA (A=0.232),(B=0.468),(C=2.49),(D=2.30),(E=2.70)
     1 X=T/TCRT $ Q=SQRTF(SQRTF(X)) $ X2=X**2 $ X5=X**5
     2 FA = A/Q + B/X5   $  FB = 1 - EXPF(1-AL*X2)
     3 FC = EXPF(-C + D*X - E*X2)
     4 CHUCF = (FA*FB+FC)*VCRT**2    $    RETURN  $  END


       FUNCTION DNGSF(T)
 C     PLANK/KAMBEITZ VIA TESTER (P.171)/DIN.  VALID 170 TO 305 K.
 C     V = R*T/P - C1/X**A - C2*P**2/X**B,    X = T/100,
 C     V IN CC/GRAM,   T IN KELVINS,   P IN KG/CM**2,
 C     1 ATM = 1.03323 KG/CM**2, R=2.822, C1=89.0, C2=27.9, A=2.4, B=9.0
       DATA (R=2.822),(C1=89.0),(C2=27.9),(A=2.4),(B=9.0),(WM=30.07)
     1 P = PSATF(T)   $  P = 1.03323*P   $  P2 = P**2
     2 X = T/100   $  XA = X**A   $  XB = X**B
     3 V = R*T/P - C1/XA - C2*P2/XB
     4 DNGSF = 1000.88/V/WM   $   RETURN  $  END
```

| Cryogenics Division – NBS Institute for Basic Standards LABORATORY NOTE | PROJECT NO. 2750364 | FILE NO. 73-4 | PAGE 19 |
|---|---|---|---|
| SUBJECT Ethane Virial Coefficients and Saturated Vapor Densities | NAME R. D. Goodwin | | |
| | DATE August 14, 1973 | | |

```
      FUNCTION GLABF(T)
C     ETHANE SECOND VIRIAL COEFF. VIA MC GLASHAM FORMULA (1962).
C     MC G. BELIEVES EUCKEN/PARTS ARE WRONG.
C     BV(T)/VCRT = B1 - B2/X - B3/X2 - B4/X**4.5,   X = T/TCRT.
      DATA (TCRT=305.4),(VCRT=148.0)
      DATA (B1=0.430),(B2=0.886),(B3=0.694),(B4=0.0375)
    1 X=T/TCRT $ X2=X**2 $ XN = X**4.5
    2 F = B1 - B2/X - B3/X2 - B4/XN
    9 GLABF = VCRT*F    $   RETURN  $  END
```

07/26/73

```
      FUNCTION PSATF(T)
C     LN(P/PTRP) = A*X + B*X2 + C*X3 + D*X4 + E*X*(1-X)**EP.
      COMMON/3/ DPSDT
      DATA (TTRP=89.899),(TCRT=305.33),(PTRP=9.616E-6),(EP=1.6)
      DATA (A=8.454987344),(B=12.488039775),(C=-4.104281551),
     1 (D=-1.413860533),(E=8.526522526)
    1 FORMAT(1H0 9X *PSATF = 0, T EXCEEDS TCRT. * / )
    2 XN=1-TTRP/TCRT $ X=(1-TTRP/T)/XN $ X2=X**2 $ X3=X**3 $ X4=X**4
    3 DXDT = TTRP/XN/T**2  $  Q = 1-X  $  IF(Q) 4,5,6
    4 PSATF = DPSDT = 0  $  PRINT 1  $  RETURN
    5 Z = Z1 = 0  $  GO TO 7
    6 W = Q**EP  $  W1 = -EP*W/Q  $  Z = X*W  $  Z1 = W + X*W1
    7 F = A*X + B*X2 + C*X3 + D*X4 + E*Z
    8 F1 = A + 2*B*X + 3*C*X2 + 4*D*X3 + E*Z1
    9 PSATF=PTRP*EXPF(F) $ DPSDT=F1*PSATF*DXDT  $  RETURN  $  END
```

07/26/73

```
      FUNCTION ZIPF(T,D)
C     Z(T,D) = 1 + BV(T)*S + CV(T)*S**2,   S = D/DCRT,  X = T/TCRT.
C     BV = (B1 + B2/X**EB + B3/X + B4/X2 + B5/X3)*(1-(TZ/T)**1/4).
C     CV = (C1/X**EC + C2/X3 + C3/X5)*(1-TZ/T).
      COMMON/1/M,EB,EC,TZB,TZC, BVS,CVS, B(5),C(4)
      DATA (TCRT=305.33),(VCRT=0.14556)
    1 S=D*VCRT $ X=T/TCRT $ Q=SQRTF(X) $ R=X**EC
    2 X2=X**2 $ X3=X**3 $ X4=X**4 $ X5=X**5
    3 ZB = 1 - (TZB/T)**0.25  $  ZC = 1 - TZC/T
    4 BV = ZB*(B(1) + B(2)/X**EB + B(3)/X + B(4)/X2 + B(5)/X3)
    5 CV = ZC*(C(1)/R + C(2)/X3 + C(3)/X5)
    6 BVS = BV*S  $  CVS = CV*S**2
    7 ZIPF = 1 + BVS + CVS    $    RETURN  $  END
```

SP 11342 A

Cryogenics Division – NBS Institute for Basic Standards
LABORATORY NOTE

| PROJECT NO. | FILE NO. | PAGE |
|---|---|---|
| 2750364 | 73-4 | 20 |

SUBJECT: Ethane Virial Coefficients and Saturated Vapor Densities

NAME: R. D. Goodwin

DATE: August 14, 1973

07/26/73

```
      PROGRAM VAPORDEN
C     ETHANE SATVAPORDEN VIA V.P. AND VIRIAL EQNS.
C     ON ISOTHERMS, ITERATE DEN IN VIRIAL EQN. TO MINIMIZE (P-PSAT).
      COMMON/3/ DPSDT
    1 FORMAT(18X *ETHANE SATD. VAPOR DENSITIES VIA V.P. AND VIRIAL EQNS.
     1 *//18X2HID 7X3HT,K 7X5HP,ATM 2X10HPLANK/KAMB 7X5HMOL/L 7X3HPCT)
    2 FORMAT(15X I5, F10.3, 3E12.4, F10.2)
    3 FORMAT(I5, F10.3, 2E15.5)
   19 ID = 1  $  TTRP = 89.893  $  PRINT 1
   20 DO 30 J=1,42  $  IF(J-1) 23,22
   22 T = TTRP  $  GO TO 24
   23 T = 80 + 5*J
   24 DI = DNGSF(T)  $  P = PSATF(T)  $  DEN = FINDF(T,P,DI)
   26 PUNCH 3, ID,T,DEN,P
   27 DIF = DI-DEN  $  PCT = 100*DIF/DEN
   29 PRINT 2, ID, T,P, DI,DEN, PCT
   30 CONTINUE  $  STOP  $  END

SINGLE-BANK COMPILATION.
```

```
      FUNCTION FINDF(T,P,DI)
C     ON ISOTHERM T, ITERATE DEN TO MINIMIZE (P-PCALC).
      COMMON DZDS
      DATA (GK=0.082056156),(VCRT=0.14556)
    1 FORMAT(1H0 9X *FINDF = 0, FAILS TO CONVERGE.* / )
    2 D = DI  $  GT = GK*T  $  DO 9 J=1,50
    3 Z = ZIPF(T,D)  $  PC = D*GT*Z  $  DP = P-PC  $  AP = ABSF(DP)
    4 Q = AP/P-1.0E-6  $  IF(Q) 10,10,5
    5 DPDD = GT*(Z + D*DZDS*VCRT)  $  ADP = ABSF(DPDD)
    6 Q = AP/ADP/D-1.0E-6  $  IF(Q) 10,10,7
    7 D = D + DP/DPDD  $  IF(D) 8,8,9
    8 D = P/T/GK
    9 CONTINUE  $  FINDF = 0  $  PRINT 1  $  RETURN
   10 FINDF = D  $  RETURN  $  END
```

SP 11342 A

| Cryogenics Division – NBS Institute for Basic Standards<br>LABORATORY NOTE | PROJECT NO.<br>2750364 | FILE NO.<br>73-4 | PAGE<br>21 |
|---|---|---|---|
| SUBJECT<br>Ethane Virial Coefficients and Saturated Vapor Densities | NAME R. D. Goodwin | | |
| | DATE August 14, 1973 | | |

```
      FUNCTION DNGSF(T)
C     PLANK/KAMBEITZ VIA TESTER.
      DATA (R=2.822),(C1=39.0),(C2=27.9),(A=2.4),(IB=9),(WM=30.07)
    1 P = 1.03323*PSATF(T)   $   P2 = P**2
    2 X = T/100   $   XA = X**A   $   XB = X**IB
    3 V = R*T/P - C1/XA - C2*P2/XB
    4 DNGSF = 1000.88/V/WM    $    RETURN   $   END
```

08/01/73

```
      FUNCTION PSATF(T)
C     LN(P/PTRP) = A*X + B*X2 + C*X3 + D*X4 + E*X*(1-X)**EP.
      COMMON/3/ DPSDT
C     CONSTANTS VIA ZIEGLER TYPE B V.P. DATA.
      DATA (TTRP=89.899),(TCRT=305.33),(PTRP=9.967E-6),(EP=1.5)
      DATA (A=10.806922651),(B=8.344715938),(C=-3.119603823)
      DATA (D=-0.642995191),(E=6.059966098)
    1 FORMAT(1H0 9X *PSATF = 0, T EXCEEDS TCRT. * / )                    4
    2 XN=1-TTRP/TCRT $ X=(1-TTRP/T)/XN $ X2=X**2 $ X3=X**3 $ X4=X**4
    3 DXDT = TTRP/XN/T**2   $   Q = 1-X   $   IF(Q) 4,5,6
    4 PSATF = DPSDT = 0   $   PRINT 1   $   RETURN
    5 Z = Z1 = 0   $   GO TO 7
    6 W = Q**EP   $   W1 = -EP*W/Q   $   Z = X*W   $   Z1 = W + X*W1
    7 F = A*X + B*X2 + C*X3 + D*X4 + E*Z
    8 F1 = A + 2*B*X + 3*C*X2 + 4*D*X3 + E*Z1
    9 PSATF=PTRP*EXPF(F) $ DPSDT=F1*PSATF*DXDT   $   RETURN   $   END
```

```
      FUNCTION ZIPF(T,D)
C     Z(T,D) = 1 + BV(X)*S + CV(X)*S**2.
C     BV = (B1 + B2/Q + B3/X + B4/X2 + B5/X3)*(1-(TZB/T)**1/4).
C     CV = (C1/X + C2/X3 + C3/X5)*(1-TZC/T).
      COMMON DZDS
      DATA (TCRT=305.33),(VCRT=0.14556),(TZB=740.0),(TZC=217.8),
     1 (B1=7.993156),(B2=-10.672497),(B3=9.217322),(B4=-2.481668),
     2 (B5=0.842328),(C1=0.253773),(C2=0.865299),(C3=0.556075)
    1 S=D*VCRT $ X=T/TCRT $ Q=X**0.25 $ X2=X**2 $ X3=X**3 $ X5=X**5
    2 ZB = 1 - (TZB/T)**0.25   $   ZC = 1 - TZC/T
    3 BV = ZB*(B1 + B2/Q + B3/X + B4/X2 + B5/X3)
    4 CV = ZC*(C1/X + C2/X3 + C3/X5)
    6 ZIPF = 1 + BV*S + CV*S**2   $   DZDS = BV + 2*CV*S
    9 RETURN   $   END
```

SP 11342 A



USCOMM - ERL

| Cryogenics Division – NBS Institute for Basic Standards LABORATORY NOTE | PROJECT NO. 2750364 | FILE NO. 73-5 | PAGE 1 |
|---|---|---|---|
| SUBJECT The Orthobaric Densities of Ethane, Methane, Oxygen and Fluorine | NAME R. D. Goodwin | | |
| | DATE Sept. 18, 1973 | | |

## 1. Introduction.

These densities, and accurate analytical descriptions thereof, are essential for the computation of thermodynamic functions, in particular to obtain heats of vaporization via the Clapeyron equation, and to formulate the equation of state which originates on this locus [4].

We have had difficulties in representing the available ethane data, and therefore have returned to fundamentals. For comparison we shall include oxygen [18], fluorine [13], and methane [4]. Previous formulations occur in [4, 7]. We start with the saturated liquid densities because their representation is much simpler than that of the saturated vapor densities.

## 2. The Saturated Liquids.

It is well known that these densities are described near the critical point by the form

$$\rho = \rho_c + a \cdot (T_c - T) + b \cdot (T_c - T)^{\epsilon} \tag{1}$$

wherein the first two terms are the rectilinear diameter, and the exponent is near $\epsilon = 0.35$.

Let us constrain (1) at the boundaries by use of the variables,

$$x(T) \equiv (T_c - T)/(T_c - T_t), \tag{2}$$

$$W(\rho) \equiv (\rho - \rho_c)/(\rho_t - \rho_c), \tag{3}$$

where subscripts c and t refer to critical and triple points. Equation (1) now becomes,

$$W(\rho) = a \cdot x + b \cdot x^{\epsilon}, \tag{4}$$

and the constraint requires that $a + b = 1$. If we solve this for the constant b, we may expect to obtain a function $Y(\rho, x)$ which is nearly constant over the entire range $0 \le x \le 1$,

$$Y(\rho, x) \equiv [W(\rho) - x]/(x^{\epsilon} - x). \tag{5}$$

This sensitive function is useful for examining data.

In past work we found that three arbitrary coefficients are required to describe saturated liquid densities. We now find the following results via many exploratory computations. For the smoothed data used here for oxygen and fluorine, the use of five arbitrary coefficients gives an improvement in the "fit". For the rough experimental data used here for methane and ethane, the use of five arbitrary coefficients gives virtually no improvement in the "fit" as compared with only three coefficients. With only three, the first equation used was,

SP 11342 A

$$Y(\rho, x) = A_1 + A_2 \cdot x + A_3 \cdot x^{\alpha}, \tag{6}$$

and we found exponent $\alpha = 4/3$ for oxygen, fluorine and methane, but $\alpha = 8/3$ for ethane. After much exploration we have selected the following representation,

$$Y(\rho, x) = A_1 + A_2 \cdot x^{2/3} + A_3 \cdot x \tag{7}$$

Table 1 gives the fixed-point constants. Table 2A gives the exponent $\epsilon$ found by trial, the least-squares coefficients, the rms of relative density deviations in percent, and the number of datum pairs, NP.

Tables 3, 4, 5, 6 compare calculated with experimental densities. No temperature-scale adjustments have been made in present work. Column YX gives the experimental value of $Y(\rho, x)$ via (5), whereas column YC gives the value calculated by the right side of (7). Table 7 compares ethane data not used for least squares.

Tables 8, 9, 10, 11 give saturated liquid densities computed by (7) at uniform temperatures, and also their slopes and curvatures.

The small deviations for oxygen and fluorine necessarily are systematic because the data were smoothed by the authors. The overall methane deviation is large because experimental data from various sources are included in the critical region.

The low-temperature ethane data of Miller were used to estimate the triple-point liquid density. Other data are from Canfield et al., and from Klosek/McKinley. The high-temperature "data" of Eubank are a correlation of available experimental data down to the boiling point 184.5 K, ($x = 0.561$). We estimate uncertainty in our calculation of these densities to be about 0.1 percent over the entire range.

Concerning assignment of critical densities, we at first found both $\rho_c$ and exponent $\epsilon$ simultaneously by trial to minimize the overall deviation. The results are rough because these two parameters are mutually compensating for data in the critical region. Hence we have adjusted $\rho_c$ one step at a time for both saturated liquid and saturated vapor, examining the values of $\epsilon$ found by trial. We select that value of $\rho_c$ which yields reasonable exponents $\epsilon$ for both liquid and vapor. For methane it thus is necessary to select $\rho_c = 10.2$ mol/$\ell$, at the upper limit of uncertainty in the experimental values [4].

## 3. The Saturated Vapors

Densities of the ethane vapors range thru a factor of about $10^6$. We have given reasons for using the logarithm of vapor densities, with arguments in powers of $(1/T)$, [7]. Define the normalized variables

$$z(T) \equiv (T_c/T - 1)/(T_c/T_t - 1), \tag{8}$$

$$W(\rho) \equiv \ell n\, (\rho_c/\rho)/\ell n(\rho_c/\rho_t). \tag{9}$$

| Cryogenics Division – NBS Institute for Basic Standards LABORATORY NOTE | PROJECT NO. 2750364 | FILE NO. 73-5 | PAGE 3 |
|---|---|---|---|
| SUBJECT The Orthobaric Densities of Ethane, Methane, Oxygen and Fluorine | NAME R. D. Goodwin | | |
| | DATE Sept. 18, 1973 | | |

We write the vapor densities equation for the critical region as follows,

$$-W(\rho) = (b-1) \cdot z - b \cdot z^{\epsilon} \tag{10}$$

wherein the minus sign on the left arises merely from our definition of $W(\rho)$. Solving (10) for $\underline{b}$ yields the dependent variable,

$$Y(\rho, z) \equiv [W(\rho) - z]/(z^{\epsilon} - z) . \tag{11}$$

For the present work we have explored all kinds of representations, finally selecting the expression,

$$Y(\rho, z) = A_1 + \sum_{i=2}^{5} A_i \cdot z^{i/3} . \tag{12}$$

Table 2B gives results for (12), analagous to table 2A for the liquid. Tables 12, 13, 14, 15 compare calculated with experimental vapor densities. Column YX is the experimental value of $Y(\rho, z)$ via (11), whereas YC is calculated by the right side of (12). Table 16 compares ethane data not used for least squares. Tables 17, 18, 19, 20 give uniformly computed densities and derivatives via (12).

Computer programs used in this work are attached as an appendix.

| Cryogenics Division – NBS Institute for Basic Standards LABORATORY NOTE | PROJECT NO. 2750364 | FILE NO. 73-5 | PAGE 4 |
|---|---|---|---|
| SUBJECT The Orthobaric Densities of Ethane, Methane, Oxygen and Fluorine | NAME R. D. Goodwin | | |
| | DATE Sept. 18, 1973 | | |

## 4. Bibliography


[1] C.H. Chui and F. B. Canfield, Trans. Faraday Soc. 67, 2933 (1971).

[2] D. R. Douslin and R. H. Harrison, Pressure-volume-temperature relations for ethane, (U.S.Bureau of Mines, Bartlesville, Okla. 74003, Manuscript for J. Chem. Thermodynamics, 1973).

[3] P. T. Eubank, Thermodynamic properties of ethane: vapor-liquid coexistence, Advances in Cryogenic Engineering 17, 270 (Plenum Pub. Corp., New York, N.Y. 10011, 1971).

[4] R. D. Goodwin, The Thermophysical Properties of Methane from 90 to 500 K at Pressures to 700 Bar, NBS IR 73-342, October, 1973. Also, NBSIR 73-300, February, 1973.

[5] R. D. Goodwin, The Vapor Pressures of Ethane, Laboratory Note 73-3, July 9, 1973.

[6] R. D. Goodwin, Ethane Virial Coefficients and Saturated Vapor Densities, Lab. Note 73-4, Aug. 15, 1973.

[7] R. D. Goodwin, Estimation of critical constants $T_c$, $\rho_c$ from the $\rho(T)$ and $T(\rho)$ relations at coexistence, J. Res. NBS 74A (2), 221 (1970).

[8] A. Harmens, Orthobaric densities of liquefied light hydrocarbons, Chem. Engrng. Science 20, 813 (1965); 21, 725 (1966).

[9] J. Klosek and C. McKinley, Densities of liquefied natural gas and of low molecular weight hydrocarbons, paper 22, Session 5, Proc. First Internat. Conf. on LNG, Chicago, April (1968).

[10] O. Maass and C. H. Wright, J. Am. Chem. Soc. 43, 1098 (1921).

[11] Reid C. Miller, Ann. Rpt. to AGA, "Experimental Liquid Mixture Densities for Testing and Improving Correlations of LNG," Proj. BR-76-1, Univ. Wyoming, July 1, 1972.

[12] Frank Porter, The vapor pressures and specific volumes of the saturated vapor of ethane, J. Am. Chem. Soc. 48, 2055 (1926).

[13] Rolf Prydz and G. C. Straty, The Thermodynamic Properties of Compressed Gaseous and Liquid Fluorine, NBS Tech. Note 392, October, 1970.

[14] M. J. Shana'a and F. B. Canfield, Trans. Faraday Soc. 64, 2281 (1968).


SP 11342 A

| Cryogenics Division – NBS Institute for Basic Standards LABORATORY NOTE | PROJECT NO. 2750364 | FILE NO. 73-5 | PAGE 5 |
|---|---|---|---|
| SUBJECT The Orthobaric Densities of Ethane, Methane, Oxygen and Fluorine | NAME R. D. Goodwin | | |
| | DATE Sept. 18, 1973 | | |


[15] P. Sliwinski, The Lorenz-Lorenz function of gaseous and liquid ethane, propane, and butane, Zeit. Phys. Chem. Neúe Folge 63, 263 (1969).

[16] H. E. Tester, ETHANE, in Thermodynamic Functions of Gases, vol. 3, F. Din, Editor (Butterworths, London, 1961).

[17] J. R. Tomlinson (Gulf Res. and Devel. Co., Pittsburgh, Pa.), Liquid Densities of Ethane, Propane, and Ethane-Propane Mixtures, Tech. Pub. TP-1, Nat. Gas Processors Assoc. (808 Home Federal Bldg., Tulsa, Okla. 74103, Feb. 1971).

[18] Lloyd A. Weber, P-V-T, thermodynamic and related properties of oxygen from the triple point to 300 K at pressures to 33 MN/m$^2$, NBS J. Res. 74A (1), 93 (1970).

[19] David Zudkevitch (Esso Res. & Engrng. Co., Florham Park, N.J.), The importance of accuracy in physical and thermodynamic data to chemical plant design, October, 1972. (Offered for publication in the Proceedings of the NBS.)

| Cryogenics Division – NBS Institute for Basic Standards LABORATORY NOTE | PROJECT NO. 2750364 | FILE NO. 73-5 | PAGE 6 |
|---|---|---|---|
| SUBJECT The Orthobaric Densities of Ethane, Methane, Oxygen and Fluorine | NAME R. D. Goodwin | | |
| | DATE Sept. 18, 1973 | | |

List of Tables



SP 11342 A

| Cryogenics Division – NBS Institute for Basic Standards LABORATORY NOTE | PROJECT NO. 2750364 | FILE NO. 73-5 | PAGE 7 |
|---|---|---|---|
| SUBJECT The Orthobaric Densities of Ethane, Methane, Oxygen and Fluorine | NAME R. D. Goodwin | DATE Sept. 18, 1973 | |

List of Authors for Computer Tables

| ID* | Author(s) | Reference |
|---|---|---|
| 1 | Goodwin (Virial + V.P.) | [6] |
| 6 | Porter | [12] |
| 9 | Tester | [16] |
| 10 | Douslin | [2] |
| 11 | Sliwinski | [15] |
| 12 | Canfield et al. | [1, 14] |
| 13 | Klosek | [9] |
| 14 | Miller | [11] |
| 15 | Eubank | [3] |
| 16 | Tomlinson | [17] |
| 98 | Prydz | [13] |
| 99 | Weber | [18] |

* For METHANE, see references in [4].

Cryogenics Division – NBS Institute for Basic Standards
LABORATORY NOTE

| PROJECT NO. | FILE NO. | PAGE |
|---|---|---|
| 2750364 | 73-5 | 8 |

SUBJECT The Orthobaric Densities of Ethane, Methane, Oxygen and Fluorine
NAME R. D. Goodwin
DATE Sept. 18, 1973

Table 1. The fixed-point constants.

| | Oxygen | Fluorine | Methane | Ethane |
|---|---|---|---|---|
| $T_t$, K | 54.3507 | 53.4811 | 90.680 | 89.899 |
| $T_c$, K | 154.576 | 144.310 | 190.555 | 305.330 |
| $\rho_c$, mol/$\ell$ | 13.63 | 15.15 | 10.20 | 6.87 |
| $\rho_t$, liquid | 40.830 | 44.8623 | 28.147 | 21.680 |
| $\rho_t$, vapor | $3.36122 \cdot 10^{-4}$ | $5.670 \cdot 10^{-4}$ | $1.567865 \cdot 10^{-2}$ | $1.35114 \cdot 10^{-6}$ |

Table 2A. Constants for liquid equation (7)

| | Oxygen | Fluorine | Methane | Ethane |
|---|---|---|---|---|
| $\epsilon$ | 0.349 | 0.354 | 0.361 | 0.350 |
| $A_1$ | 0.758 8805 | 0.791 3438 | 0.837 0910 | 0.761 7350 |
| $A_2$ | 0.228 3200 | 0.112 9132 | 0.084 1613 | 0.298 6535 |
| $A_3$ | -0.230 4342 | -0.100 6980 | -0.074 7858 | -0.327 6239 |
| rms, % | 0.014 | 0.010 | 0.084 | 0.142 |
| NP | 50 | 46 | 49 | 29 |

Table 2B. Constants for vapor equation (12)

| | Oxygen | Fluorine | Methane | Ethane |
|---|---|---|---|---|
| $\epsilon$ | 0.382 | 0.362 | 0.382 | 0.362 |
| $A_1$ | 0.277 3707 | 0.257 1572 | 0.374 1014 | 0.192 7743 |
| $A_2$ | -0.338 6621 | -0.227 0644 | -0.261 5731 | 0.041 5501 |
| $A_3$ | 0.769 0708 | 0.605 3864 | 0.675 3322 | -0.789 2263 |
| $A_4$ | -1.576 1185 | -1.391 6332 | -1.012 2063 | 0.357 6675 |
| $A_5$ | 0.939 8713 | 0.792 5719 | 0.439 8834 | 0.124 5438 |
| rms, % | 0.052 | 0.134 | 0.148 | 0.104 |
| NP | 50 | 46 | 96 | 29 |

Table 3. Comparison of oxygen liquid densities.

TCRT = 154.576, TTRP = 54.3507

DCRT = 13.630, DTRP = 40.8300

$\epsilon = 0.349$

7.5888052-001 2.2832003-001 -2.3043415-001
0.0000000+000 0.0000000+000 0.0000000+000

| ID | T,K | MOL/L | CALC | PCNT | X | YX | YC | YDIF |
|---|---|---|---|---|---|---|---|---|
| 99 | 56.000 | 40.601 | 40.603 | -0.00 | 0.98354 | 0.75202 | 0.75805 | -0.00603 |
| 99 | 58.000 | 40.323 | 40.326 | -0.01 | 0.96359 | 0.75397 | 0.75958 | -0.00561 |
| 99 | 60.000 | 40.048 | 40.049 | -0.00 | 0.94363 | 0.76038 | 0.76109 | -0.00072 |
| 99 | 62.000 | 39.777 | 39.770 | 0.02 | 0.92368 | 0.76779 | 0.76258 | 0.00520 |
| 99 | 64.000 | 39.494 | 39.491 | 0.01 | 0.90372 | 0.76630 | 0.76405 | 0.00225 |
| 99 | 66.000 | 39.216 | 39.210 | 0.01 | 0.88377 | 0.76840 | 0.76550 | 0.00291 |
| 99 | 68.000 | 38.926 | 38.928 | -0.00 | 0.86381 | 0.76610 | 0.76692 | -0.00081 |
| 99 | 70.000 | 38.655 | 38.644 | 0.03 | 0.84386 | 0.77243 | 0.76831 | 0.00411 |
| 99 | 72.000 | 38.358 | 38.358 | -0.00 | 0.82390 | 0.76966 | 0.76969 | -0.00002 |
| 99 | 74.000 | 38.081 | 38.071 | 0.03 | 0.80395 | 0.77392 | 0.77103 | 0.00289 |
| 99 | 76.000 | 37.779 | 37.782 | -0.01 | 0.78399 | 0.77145 | 0.77235 | -0.00090 |
| 99 | 78.000 | 37.495 | 37.491 | 0.01 | 0.76404 | 0.77482 | 0.77364 | 0.00118 |
| 99 | 80.000 | 37.202 | 37.197 | 0.01 | 0.74408 | 0.77614 | 0.77490 | 0.00124 |
| 99 | 82.000 | 36.900 | 36.901 | -0.00 | 0.72413 | 0.77599 | 0.77613 | -0.00014 |
| 99 | 84.000 | 36.603 | 36.602 | 0.00 | 0.70417 | 0.77750 | 0.77733 | 0.00017 |
| 99 | 86.000 | 36.298 | 36.301 | -0.01 | 0.68422 | 0.77788 | 0.77850 | -0.00061 |
| 99 | 88.000 | 35.997 | 35.996 | 0.00 | 0.66426 | 0.77979 | 0.77963 | 0.00016 |
| 99 | 90.000 | 35.689 | 35.688 | 0.00 | 0.64431 | 0.78081 | 0.78073 | 0.00007 |
| 99 | 92.000 | 35.373 | 35.377 | -0.01 | 0.62435 | 0.78118 | 0.78180 | -0.00061 |
| 99 | 94.000 | 35.063 | 35.062 | 0.00 | 0.60440 | 0.78305 | 0.78282 | 0.00023 |
| 99 | 96.000 | 34.734 | 34.742 | -0.02 | 0.58444 | 0.78261 | 0.78381 | -0.00120 |
| 99 | 98.000 | 34.412 | 34.418 | -0.02 | 0.56449 | 0.78376 | 0.78475 | -0.00099 |
| 99 | 100.000 | 34.083 | 34.090 | -0.02 | 0.54453 | 0.78472 | 0.78565 | -0.00093 |
| 99 | 102.000 | 33.750 | 33.756 | -0.02 | 0.52458 | 0.78563 | 0.78651 | -0.00088 |
| 99 | 104.000 | 33.411 | 33.417 | -0.02 | 0.50462 | 0.78659 | 0.78732 | -0.00072 |
| 99 | 106.000 | 33.069 | 33.072 | -0.01 | 0.48467 | 0.78772 | 0.78807 | -0.00035 |
| 99 | 108.000 | 32.712 | 32.720 | -0.02 | 0.46471 | 0.78780 | 0.78878 | -0.00098 |
| 99 | 110.000 | 32.362 | 32.361 | 0.00 | 0.44476 | 0.78960 | 0.78943 | 0.00017 |
| 99 | 112.000 | 31.990 | 31.995 | -0.02 | 0.42480 | 0.78946 | 0.79001 | -0.00056 |
| 99 | 114.000 | 31.616 | 31.620 | -0.01 | 0.40485 | 0.79005 | 0.79054 | -0.00049 |
| 99 | 116.000 | 31.230 | 31.236 | -0.02 | 0.38489 | 0.79038 | 0.79100 | -0.00062 |
| 99 | 118.000 | 30.845 | 30.842 | 0.01 | 0.36494 | 0.79169 | 0.79138 | 0.00031 |
| 99 | 120.000 | 30.441 | 30.438 | 0.01 | 0.34498 | 0.79208 | 0.79169 | 0.00039 |
| 99 | 122.000 | 30.021 | 30.021 | -0.00 | 0.32503 | 0.79190 | 0.79192 | -0.00001 |
| 99 | 124.000 | 29.595 | 29.591 | 0.01 | 0.30507 | 0.79239 | 0.79205 | 0.00034 |
| 99 | 126.000 | 29.146 | 29.147 | -0.00 | 0.28512 | 0.79203 | 0.79209 | -0.00006 |
| 99 | 128.000 | 28.686 | 28.685 | 0.00 | 0.26516 | 0.79210 | 0.79201 | 0.00008 |
| 99 | 130.000 | 28.209 | 28.205 | 0.01 | 0.24521 | 0.79216 | 0.79182 | 0.00033 |
| 99 | 132.000 | 27.709 | 27.704 | 0.02 | 0.22525 | 0.79192 | 0.79150 | 0.00042 |
| 99 | 134.000 | 27.181 | 27.179 | 0.01 | 0.20530 | 0.79129 | 0.79103 | 0.00026 |
| 99 | 136.000 | 26.631 | 26.625 | 0.02 | 0.18534 | 0.79103 | 0.79039 | 0.00063 |
| 99 | 138.000 | 26.042 | 26.037 | 0.02 | 0.16539 | 0.78999 | 0.78956 | 0.00043 |
| 99 | 140.000 | 25.413 | 25.410 | 0.01 | 0.14543 | 0.78883 | 0.78851 | 0.00032 |
| 99 | 142.000 | 24.734 | 24.733 | 0.01 | 0.12548 | 0.78733 | 0.78719 | 0.00014 |
| 99 | 144.000 | 23.992 | 23.993 | -0.00 | 0.10552 | 0.78549 | 0.78555 | -0.00006 |
| 99 | 146.000 | 23.164 | 23.170 | -0.02 | 0.08557 | 0.78287 | 0.78350 | -0.00063 |
| 99 | 148.000 | 22.227 | 22.230 | -0.01 | 0.06561 | 0.78057 | 0.78090 | -0.00033 |
| 99 | 150.000 | 21.106 | 21.108 | -0.01 | 0.04566 | 0.77724 | 0.77753 | -0.00029 |
| 99 | 152.000 | 19.646 | 19.647 | -0.00 | 0.02570 | 0.77280 | 0.77284 | -0.00004 |
| 99 | 154.000 | 17.106 | 17.104 | 0.01 | 0.00575 | 0.76528 | 0.76488 | 0.00040 |

NP = 50, RMSPCT = 0.014

Table 4. Comparison of fluorine liquid densities.

E = 0.354

TCRT = 144.310, TTRP = 53.4811

DCRT = 15.150, DTRP = 44.8623

7.9134383-001 1.1291315-001 -1.0069804-001
0.0000000+000 0.0000000+000 0.0000000+000

| ID | T,K | MOL/L | CALC | PCNT | X | YX | YC | YDIF |
|---|---|---|---|---|---|---|---|---|
| 98 | 54.000 | 44.781 | 44.781 | 0.00 | 0.99429 | 0.80556 | 0.80370 | 0.00186 |
| 98 | 56.000 | 44.465 | 44.464 | 0.00 | 0.97227 | 0.80524 | 0.80425 | 0.00099 |
| 98 | 58.000 | 44.146 | 44.146 | 0.00 | 0.95025 | 0.80550 | 0.80479 | 0.00071 |
| 98 | 60.000 | 43.825 | 43.825 | 0.00 | 0.92823 | 0.80574 | 0.80532 | 0.00042 |
| 98 | 62.000 | 43.501 | 43.501 | 0.00 | 0.90621 | 0.80603 | 0.80583 | 0.00021 |
| 98 | 64.000 | 43.174 | 43.174 | -0.00 | 0.88419 | 0.80632 | 0.80633 | -0.00000 |
| 98 | 66.000 | 42.845 | 42.845 | -0.00 | 0.86217 | 0.80662 | 0.80681 | -0.00019 |
| 98 | 68.000 | 42.512 | 42.513 | -0.00 | 0.84015 | 0.80693 | 0.80728 | -0.00034 |
| 98 | 70.000 | 42.176 | 42.177 | -0.00 | 0.81813 | 0.80728 | 0.80773 | -0.00045 |
| 98 | 72.000 | 41.836 | 41.838 | -0.01 | 0.79611 | 0.80760 | 0.80817 | -0.00056 |
| 98 | 74.000 | 41.493 | 41.496 | -0.01 | 0.77409 | 0.80796 | 0.80859 | -0.00063 |
| 98 | 76.000 | 41.146 | 41.149 | -0.01 | 0.75207 | 0.80831 | 0.80899 | -0.00068 |
| 98 | 78.000 | 40.795 | 40.799 | -0.01 | 0.73005 | 0.80868 | 0.80938 | -0.00069 |
| 98 | 80.000 | 40.440 | 40.444 | -0.01 | 0.70803 | 0.80903 | 0.80974 | -0.00071 |
| 98 | 82.000 | 40.081 | 40.085 | -0.01 | 0.68602 | 0.80941 | 0.81009 | -0.00068 |
| 98 | 84.000 | 39.717 | 39.720 | -0.01 | 0.66400 | 0.80977 | 0.81042 | -0.00065 |
| 98 | 86.000 | 39.347 | 39.351 | -0.01 | 0.64198 | 0.81011 | 0.81073 | -0.00061 |
| 98 | 88.000 | 38.973 | 38.976 | -0.01 | 0.61996 | 0.81047 | 0.81101 | -0.00054 |
| 98 | 90.000 | 38.592 | 38.596 | -0.01 | 0.59794 | 0.81080 | 0.81127 | -0.00047 |
| 98 | 92.000 | 38.206 | 38.209 | -0.01 | 0.57592 | 0.81112 | 0.81151 | -0.00039 |
| 98 | 94.000 | 37.813 | 37.815 | -0.01 | 0.55390 | 0.81143 | 0.81172 | -0.00029 |
| 98 | 96.000 | 37.413 | 37.415 | -0.00 | 0.53188 | 0.81171 | 0.81191 | -0.00019 |
| 98 | 98.000 | 37.005 | 37.006 | -0.00 | 0.50986 | 0.81197 | 0.81206 | -0.00009 |
| 98 | 100.000 | 36.590 | 36.590 | 0.00 | 0.48784 | 0.81220 | 0.81219 | 0.00001 |
| 98 | 102.000 | 36.165 | 36.164 | 0.00 | 0.46582 | 0.81240 | 0.81229 | 0.00012 |
| 98 | 104.000 | 35.731 | 35.729 | 0.01 | 0.44380 | 0.81256 | 0.81235 | 0.00021 |
| 98 | 106.000 | 35.286 | 35.283 | 0.01 | 0.42178 | 0.81268 | 0.81238 | 0.00030 |
| 98 | 108.000 | 34.829 | 34.826 | 0.01 | 0.39976 | 0.81274 | 0.81236 | 0.00038 |
| 98 | 110.000 | 34.361 | 34.356 | 0.01 | 0.37774 | 0.81276 | 0.81231 | 0.00045 |
| 98 | 112.000 | 33.878 | 33.873 | 0.01 | 0.35572 | 0.81272 | 0.81221 | 0.00050 |
| 98 | 114.000 | 33.379 | 33.374 | 0.02 | 0.33370 | 0.81261 | 0.81206 | 0.00055 |
| 98 | 116.000 | 32.864 | 32.858 | 0.02 | 0.31168 | 0.81243 | 0.81186 | 0.00056 |
| 98 | 118.000 | 32.330 | 32.324 | 0.02 | 0.28967 | 0.81218 | 0.81161 | 0.00057 |
| 98 | 120.000 | 31.774 | 31.768 | 0.02 | 0.26765 | 0.81183 | 0.81129 | 0.00055 |
| 98 | 122.000 | 31.193 | 31.188 | 0.02 | 0.24563 | 0.81139 | 0.81090 | 0.00049 |
| 98 | 124.000 | 30.584 | 30.579 | 0.02 | 0.22361 | 0.81086 | 0.81042 | 0.00043 |
| 98 | 126.000 | 29.942 | 29.939 | 0.01 | 0.20159 | 0.81020 | 0.80986 | 0.00034 |
| 98 | 128.000 | 29.262 | 29.260 | 0.01 | 0.17957 | 0.80942 | 0.80920 | 0.00022 |
| 98 | 130.000 | 28.535 | 28.534 | 0.00 | 0.15755 | 0.80850 | 0.80842 | 0.00009 |
| 98 | 132.000 | 27.750 | 27.751 | -0.00 | 0.13553 | 0.80742 | 0.80749 | -0.00007 |
| 98 | 134.000 | 26.891 | 26.894 | -0.01 | 0.11351 | 0.80617 | 0.80638 | -0.00022 |
| 98 | 136.000 | 25.935 | 25.939 | -0.01 | 0.09149 | 0.80470 | 0.80506 | -0.00036 |
| 98 | 138.000 | 24.839 | 24.843 | -0.02 | 0.06947 | 0.80300 | 0.80343 | -0.00043 |
| 98 | 140.000 | 23.521 | 23.524 | -0.01 | 0.04745 | 0.80096 | 0.80137 | -0.00040 |
| 98 | 142.000 | 21.769 | 21.770 | -0.00 | 0.02543 | 0.79843 | 0.79855 | -0.00012 |
| 98 | 144.000 | 18.327 | 18.328 | -0.00 | 0.00341 | 0.79340 | 0.79356 | -0.00016 |

NP = 46, RMSPCT = 0.010

APPENDIX F. (Continued)

| NATIONAL BUREAU OF STANDARDS, CRYOGENIC ENGINEERING LABORATORY LABORATORY NOTE | PROJECT NO. 2750364 | FILE NO. 73-5 | PAGE 11 |
|---|---|---|---|
| SUBJECT The Orthobaric Densities of Ethane, Methane, Oxygen and Fluorine | NAME R.D.Goodwin | DATE Sept. 18, 1973 | |

Table 5. Comparison of methane liquid densities.

E = 0.361

TCRT = 190.555, TTRP = 90.6800

DCRT = 10.200, DTRP = 28.1470

E=0.361

8.3709103-001 8.4161267-002 -7.4785753-002
0.0000000+000 0.0000000+000 0.0000000+000

| ID | T,K | MOL/L | CALC | PCNT | X | YX | YC | YDIF |
|---|---|---|---|---|---|---|---|---|
| 1 | 93.512 | 27.910 | 27.912 | -0.01 | 0.97164 | 0.84050 | 0.84699 | -0.00649 |
| 1 | 97.173 | 27.605 | 27.605 | 0.00 | 0.93499 | 0.84830 | 0.84764 | 0.00066 |
| 1 | 101.434 | 27.243 | 27.240 | 0.01 | 0.89233 | 0.85043 | 0.84836 | 0.00207 |
| 1 | 105.165 | 26.916 | 26.916 | 0.00 | 0.85497 | 0.84900 | 0.84896 | 0.00003 |
| 1 | 109.611 | 26.527 | 26.521 | 0.02 | 0.81045 | 0.85231 | 0.84964 | 0.00267 |
| 1 | 113.772 | 26.146 | 26.144 | 0.01 | 0.76879 | 0.85112 | 0.85023 | 0.00089 |
| 1 | 117.746 | 25.782 | 25.775 | 0.03 | 0.72900 | 0.85327 | 0.85074 | 0.00252 |
| 1 | 121.893 | 25.388 | 25.380 | 0.03 | 0.68748 | 0.85373 | 0.85123 | 0.00249 |
| 1 | 125.825 | 24.999 | 24.995 | 0.02 | 0.64811 | 0.85272 | 0.85165 | 0.00107 |
| 1 | 129.657 | 24.611 | 24.610 | 0.01 | 0.60974 | 0.85236 | 0.85201 | 0.00035 |
| 101 | 130.000 | 24.558 | 24.575 | -0.07 | 0.60631 | 0.84803 | 0.85204 | -0.00400 |
| 1 | 133.773 | 24.186 | 24.182 | 0.01 | 0.56853 | 0.85313 | 0.85233 | 0.00080 |
| 1 | 133.878 | 24.176 | 24.171 | 0.02 | 0.56748 | 0.85338 | 0.85234 | 0.00104 |
| 102 | 135.000 | 24.041 | 24.052 | -0.05 | 0.55625 | 0.85002 | 0.85242 | -0.00240 |
| 1 | 139.352 | 23.578 | 23.579 | -0.00 | 0.51267 | 0.85249 | 0.85266 | -0.00017 |
| 103 | 140.000 | 23.500 | 23.507 | -0.03 | 0.50618 | 0.85132 | 0.85269 | -0.00137 |
| 104 | 145.000 | 22.932 | 22.934 | -0.01 | 0.45612 | 0.85255 | 0.85285 | -0.00030 |
| 1 | 145.448 | 22.880 | 22.881 | -0.00 | 0.45163 | 0.85272 | 0.85286 | -0.00013 |
| 105 | 150.000 | 22.329 | 22.328 | 0.01 | 0.40606 | 0.85315 | 0.85287 | 0.00027 |
| 601 | 150.000 | 22.332 | 22.328 | 0.02 | 0.40606 | 0.85357 | 0.85287 | 0.00070 |
| 1 | 151.553 | 22.130 | 22.132 | -0.01 | 0.39051 | 0.85255 | 0.85285 | -0.00030 |
| 106 | 155.000 | 21.686 | 21.682 | 0.02 | 0.35599 | 0.85341 | 0.85274 | 0.00067 |
| 1 | 157.199 | 21.379 | 21.383 | -0.02 | 0.33398 | 0.85201 | 0.85263 | -0.00062 |
| 107 | 160.000 | 20.991 | 20.986 | 0.02 | 0.30593 | 0.85311 | 0.85242 | 0.00069 |
| 1 | 163.659 | 20.428 | 20.438 | -0.05 | 0.26930 | 0.85048 | 0.85205 | -0.00157 |
| 108 | 165.000 | 20.234 | 20.227 | 0.03 | 0.25587 | 0.85289 | 0.85188 | 0.00102 |
| 1 | 169.326 | 19.492 | 19.502 | -0.05 | 0.21256 | 0.84962 | 0.85117 | -0.00155 |
| 109 | 170.000 | 19.387 | 19.362 | 0.03 | 0.20581 | 0.85180 | 0.85104 | 0.00076 |
| 110 | 175.000 | 18.417 | 18.414 | 0.01 | 0.15574 | 0.85022 | 0.84981 | 0.00042 |
| 602 | 175.000 | 18.420 | 18.414 | 0.03 | 0.15574 | 0.85080 | 0.84981 | 0.00100 |
| 1 | 175.053 | 18.390 | 18.403 | -0.07 | 0.15521 | 0.84777 | 0.84979 | -0.00203 |
| 111 | 180.000 | 17.249 | 17.250 | -0.00 | 0.10568 | 0.84786 | 0.84800 | -0.00014 |
| 603 | 180.000 | 17.254 | 17.250 | 0.02 | 0.10568 | 0.84867 | 0.84800 | 0.00067 |
| 112 | 184.000 | 16.054 | 16.061 | -0.04 | 0.06563 | 0.84466 | 0.84588 | -0.00121 |
| 604 | 184.000 | 16.060 | 16.061 | -0.00 | 0.06563 | 0.84575 | 0.84588 | -0.00013 |
| 6 | 185.030 | 15.710 | 15.688 | 0.14 | 0.05532 | 0.84922 | 0.84517 | 0.00405 |
| 113 | 186.000 | 15.286 | 15.299 | -0.08 | 0.04561 | 0.84203 | 0.84442 | -0.00240 |
| 6 | 186.030 | 15.302 | 15.286 | 0.11 | 0.04530 | 0.84765 | 0.84440 | 0.00325 |
| 6 | 187.031 | 14.836 | 14.826 | 0.07 | 0.03528 | 0.84572 | 0.84351 | 0.00221 |
| 5 | 187.489 | 14.582 | 14.589 | -0.05 | 0.03070 | 0.84158 | 0.84305 | -0.00147 |
| 114 | 188.000 | 14.284 | 14.298 | -0.10 | 0.02558 | 0.83922 | 0.84248 | -0.00327 |
| 6 | 188.031 | 14.285 | 14.279 | 0.04 | 0.02527 | 0.84388 | 0.84245 | 0.00143 |
| 6 | 189.032 | 13.578 | 13.578 | 0.00 | 0.01525 | 0.84114 | 0.84113 | 0.00002 |
| 5 | 189.331 | 13.300 | 13.315 | -0.11 | 0.01226 | 0.83640 | 0.84065 | -0.00425 |
| 5 | 189.707 | 12.879 | 12.920 | -0.31 | 0.00849 | 0.82667 | 0.83996 | -0.01329 |
| 6 | 190.032 | 12.474 | 12.477 | -0.02 | 0.00524 | 0.83812 | 0.83924 | -0.00111 |
| 5 | 190.068 | 12.397 | 12.418 | -0.17 | 0.00488 | 0.83082 | 0.83915 | -0.00833 |
| 7 | 190.070 | 12.440 | 12.415 | 0.20 | 0.00486 | 0.84908 | 0.83914 | 0.00994 |
| 7 | 190.170 | 12.270 | 12.235 | 0.28 | 0.00385 | 0.85369 | 0.83887 | 0.01482 |

NP = 49, RMSPCT = 0.084



OGILVIE PRESS, INC., BROOKLYN 17, N. Y. STOCK NO. 400

Table 6. Comparison of ethane liquid densities.

ETHANE SATURATED LIQUID DENSITIES, E = 0.350

TCRT = 305.330, TTRP = 89.8990

DCRT = 6.870, DTRP = 21.6800

7.6173503-001 2.9865351-001 -3.2762394-001
0.0000000+000 0.0000000+000 0.0000000+000

| ID | T,K | MOL/L | CALC | PCNT | X | YX | YC | YDIF |
|---|---|---|---|---|---|---|---|---|
| 14 | 91.010 | 21.639 | 21.640 | -0.00 | 0.99484 | 0.72131 | 0.73343 | -0.01212 |
| 14 | 100.020 | 21.313 | 21.315 | -0.01 | 0.95302 | 0.73294 | 0.73873 | -0.00579 |
| 14 | 108.110 | 21.025 | 21.024 | 0.01 | 0.91547 | 0.74474 | 0.74338 | 0.00136 |
| 12 | 108.150 | 21.026 | 21.022 | 0.02 | 0.91528 | 0.74831 | 0.74341 | 0.00490 |
| 13 | 110.928 | 20.915 | 20.922 | -0.03 | 0.90239 | 0.73724 | 0.74498 | -0.00774 |
| 14 | 115.050 | 20.771 | 20.772 | -0.00 | 0.88325 | 0.74640 | 0.74729 | -0.00089 |
| 12 | 115.770 | 20.747 | 20.746 | 0.00 | 0.87991 | 0.74816 | 0.74769 | 0.00047 |
| 13 | 116.483 | 20.717 | 20.721 | -0.02 | 0.87660 | 0.74515 | 0.74809 | -0.00293 |
| 13 | 122.039 | 20.521 | 20.519 | 0.01 | 0.85081 | 0.75269 | 0.75115 | 0.00154 |
| 13 | 127.594 | 20.323 | 20.316 | 0.03 | 0.82503 | 0.75847 | 0.75415 | 0.00432 |
| 13 | 133.150 | 20.126 | 20.112 | 0.07 | 0.79924 | 0.76479 | 0.75709 | 0.00770 |
| 15 | 184.470 | 18.175 | 18.138 | 0.20 | 0.56101 | 0.79083 | 0.78108 | 0.00975 |
| 15 | 190.000 | 17.944 | 17.910 | 0.19 | 0.53535 | 0.79186 | 0.78325 | 0.00861 |
| 15 | 200.000 | 17.516 | 17.485 | 0.18 | 0.48893 | 0.79408 | 0.78690 | 0.00718 |
| 15 | 210.000 | 17.068 | 17.042 | 0.15 | 0.44251 | 0.79576 | 0.79019 | 0.00557 |
| 15 | 220.000 | 16.595 | 16.577 | 0.11 | 0.39609 | 0.79668 | 0.79304 | 0.00364 |
| 15 | 230.000 | 16.093 | 16.085 | 0.05 | 0.34967 | 0.79707 | 0.79541 | 0.00167 |
| 15 | 240.000 | 15.545 | 15.557 | -0.08 | 0.30325 | 0.79496 | 0.79719 | -0.00222 |
| 15 | 250.000 | 14.957 | 14.984 | -0.18 | 0.25683 | 0.79329 | 0.79826 | -0.00497 |
| 10 | 253.150 | 14.753 | 14.792 | -0.26 | 0.24221 | 0.79127 | 0.79843 | -0.00716 |
| 10 | 263.150 | 14.089 | 14.136 | -0.33 | 0.19579 | 0.78970 | 0.79829 | -0.00858 |
| 10 | 273.150 | 13.342 | 13.386 | -0.33 | 0.14937 | 0.78874 | 0.79687 | -0.00813 |
| 10 | 283.150 | 12.458 | 12.489 | -0.24 | 0.10296 | 0.78769 | 0.79361 | -0.00592 |
| 10 | 293.150 | 11.297 | 11.314 | -0.15 | 0.05654 | 0.78358 | 0.78721 | -0.00362 |
| 10 | 298.150 | 10.499 | 10.498 | 0.01 | 0.03333 | 0.78193 | 0.78175 | 0.00019 |
| 10 | 302.150 | 9.544 | 9.543 | 0.01 | 0.01476 | 0.77510 | 0.77487 | 0.00022 |
| 10 | 303.150 | 9.201 | 9.196 | 0.05 | 0.01012 | 0.77416 | 0.77239 | 0.00177 |
| 10 | 304.150 | 8.737 | 8.730 | 0.08 | 0.00548 | 0.77227 | 0.76922 | 0.00305 |
| 10 | 305.150 | 7.830 | 7.820 | 0.13 | 0.00084 | 0.77224 | 0.76411 | 0.00813 |

NP = 29, RMSPCT = 0.142

Table 7. Ethane liquid data not used for least squares.

| ID | T,K | MOL/L | CALC | PCNT | X | YX | YC | YDIF |
|---|---|---|---|---|---|---|---|---|
| 9 | 100.000 | 21.371 | 21.316 | 0.26 | 0.95311 | 0.86067 | 0.73872 | 0.12196 |
| 9 | 120.000 | 20.549 | 20.593 | -0.21 | 0.86028 | 0.71692 | 0.75003 | -0.03311 |
| 9 | 140.000 | 19.777 | 19.859 | -0.41 | 0.76744 | 0.72238 | 0.76064 | -0.03826 |
| 9 | 160.000 | 19.050 | 19.105 | -0.29 | 0.67460 | 0.75146 | 0.77044 | -0.01898 |
| 9 | 180.000 | 18.337 | 18.320 | 0.10 | 0.58176 | 0.78411 | 0.77926 | 0.00484 |
| 9 | 200.000 | 17.595 | 17.485 | 0.63 | 0.48893 | 0.81258 | 0.78690 | 0.02567 |
| 9 | 220.000 | 16.755 | 16.577 | 1.07 | 0.39609 | 0.82969 | 0.79304 | 0.03665 |
| 9 | 240.000 | 15.782 | 15.557 | 1.45 | 0.30325 | 0.83996 | 0.79719 | 0.04277 |
| 9 | 260.000 | 14.638 | 14.351 | 2.00 | 0.21042 | 0.85097 | 0.79845 | 0.05252 |
| 9 | 280.000 | 13.183 | 12.792 | 3.05 | 0.11758 | 0.86915 | 0.79489 | 0.07426 |
| 9 | 290.000 | 12.122 | 11.729 | 3.35 | 0.07116 | 0.87113 | 0.78971 | 0.08143 |
| 9 | 300.000 | 10.516 | 10.112 | 4.00 | 0.02474 | 0.88848 | 0.77899 | 0.10949 |
| 10 | 305.250 | 7.600 | 7.583 | 0.22 | 0.00037 | 0.78096 | 0.76316 | 0.01780 |
| 11 | 283.200 | 12.423 | 12.484 | -0.49 | 0.10272 | 0.78179 | 0.79359 | -0.01180 |
| 11 | 288.190 | 11.895 | 11.946 | -0.43 | 0.07956 | 0.78051 | 0.79092 | -0.01041 |
| 11 | 293.180 | 11.270 | 11.309 | -0.34 | 0.05640 | 0.77867 | 0.78718 | -0.00851 |
| 11 | 295.670 | 10.899 | 10.934 | -0.32 | 0.04484 | 0.77672 | 0.78474 | -0.00802 |
| 11 | 298.170 | 10.472 | 10.494 | -0.21 | 0.03324 | 0.77610 | 0.78172 | -0.00562 |
| 11 | 300.660 | 9.937 | 9.955 | -0.18 | 0.02168 | 0.77281 | 0.77785 | -0.00504 |
| 11 | 302.160 | 9.534 | 9.540 | -0.07 | 0.01471 | 0.77282 | 0.77485 | -0.00203 |
| 11 | 303.160 | 9.190 | 9.192 | -0.02 | 0.01007 | 0.77159 | 0.77236 | -0.00078 |
| 11 | 304.150 | 8.732 | 8.730 | 0.02 | 0.00548 | 0.76994 | 0.76922 | 0.00072 |
| 11 | 304.650 | 8.397 | 8.395 | 0.03 | 0.00316 | 0.76825 | 0.76713 | 0.00112 |
| 11 | 305.150 | 7.827 | 7.820 | 0.09 | 0.00084 | 0.77012 | 0.76411 | 0.00601 |
| 13 | 105.372 | 21.105 | 21.122 | -0.08 | 0.92818 | 0.71576 | 0.74182 | -0.02606 |
| 13 | 99.817 | 21.298 | 21.323 | -0.11 | 0.95396 | 0.68284 | 0.73861 | -0.05577 |
| 13 | 94.261 | 21.490 | 21.523 | -0.15 | 0.97975 | 0.56468 | 0.73535 | -0.17068 |
| 16 | 283.200 | 12.434 | 12.484 | -0.39 | 0.10272 | 0.78404 | 0.79359 | -0.00955 |
| 16 | 288.190 | 11.909 | 11.946 | -0.31 | 0.07956 | 0.78335 | 0.79092 | -0.00757 |
| 16 | 293.180 | 11.290 | 11.309 | -0.17 | 0.05640 | 0.78302 | 0.78718 | -0.00416 |
| 16 | 295.670 | 10.924 | 10.934 | -0.08 | 0.04484 | 0.78262 | 0.78474 | -0.00211 |
| 16 | 298.170 | 10.502 | 10.494 | 0.07 | 0.03324 | 0.78367 | 0.78172 | 0.00195 |
| 16 | 300.660 | 9.980 | 9.955 | 0.25 | 0.02168 | 0.78497 | 0.77785 | 0.00712 |
| 16 | 302.160 | 9.578 | 9.540 | 0.39 | 0.01471 | 0.78669 | 0.77485 | 0.01184 |

Table 8. Calculated oxygen liquid densities

| T,K | R,MOL/L | DR/DT | D2R/DT2 |
|---|---|---|---|
| 54.351 | 40.830 | -0.1377 | -0.00019 |
| 56.000 | 40.603 | -0.1380 | -0.00021 |
| 58.000 | 40.326 | -0.1385 | -0.00023 |
| 60.000 | 40.049 | -0.1390 | -0.00026 |
| 62.000 | 39.770 | -0.1395 | -0.00029 |
| 64.000 | 39.491 | -0.1401 | -0.00032 |
| 66.000 | 39.210 | -0.1408 | -0.00035 |
| 68.000 | 38.928 | -0.1415 | -0.00038 |
| 70.000 | 38.644 | -0.1423 | -0.00041 |
| 72.000 | 38.358 | -0.1432 | -0.00045 |
| 74.000 | 38.071 | -0.1441 | -0.00049 |
| 76.000 | 37.782 | -0.1451 | -0.00053 |
| 78.000 | 37.491 | -0.1462 | -0.00057 |
| 80.000 | 37.197 | -0.1474 | -0.00061 |
| 82.000 | 36.901 | -0.1487 | -0.00066 |
| 84.000 | 36.602 | -0.1500 | -0.00071 |
| 86.000 | 36.301 | -0.1515 | -0.00077 |
| 88.000 | 35.996 | -0.1531 | -0.00083 |
| 90.000 | 35.688 | -0.1548 | -0.00089 |
| 92.000 | 35.377 | -0.1567 | -0.00096 |
| 94.000 | 35.062 | -0.1586 | -0.00103 |
| 96.000 | 34.742 | -0.1608 | -0.00111 |
| 98.000 | 34.418 | -0.1631 | -0.00119 |
| 100.000 | 34.090 | -0.1655 | -0.00129 |
| 102.000 | 33.756 | -0.1682 | -0.00139 |
| 104.000 | 33.417 | -0.1711 | -0.00150 |
| 106.000 | 33.072 | -0.1742 | -0.00162 |
| 108.000 | 32.720 | -0.1776 | -0.00176 |
| 110.000 | 32.361 | -0.1813 | -0.00191 |
| 112.000 | 31.995 | -0.1852 | -0.00207 |
| 114.000 | 31.620 | -0.1896 | -0.00226 |
| 116.000 | 31.236 | -0.1943 | -0.00248 |
| 118.000 | 30.842 | -0.1995 | -0.00272 |
| 120.000 | 30.438 | -0.2052 | -0.00300 |
| 122.000 | 30.021 | -0.2115 | -0.00332 |
| 124.000 | 29.591 | -0.2185 | -0.00369 |
| 126.000 | 29.147 | -0.2263 | -0.00413 |
| 128.000 | 28.685 | -0.2351 | -0.00466 |
| 130.000 | 28.205 | -0.2450 | -0.00530 |
| 132.000 | 27.704 | -0.2564 | -0.00608 |
| 134.000 | 27.179 | -0.2695 | -0.00707 |
| 136.000 | 26.625 | -0.2848 | -0.00833 |
| 138.000 | 26.037 | -0.3031 | -0.01000 |
| 140.000 | 25.410 | -0.3253 | -0.01229 |
| 142.000 | 24.733 | -0.3529 | -0.01555 |
| 144.000 | 23.993 | -0.3886 | -0.02051 |
| 146.000 | 23.170 | -0.4370 | -0.02869 |
| 148.000 | 22.230 | -0.5079 | -0.04396 |
| 150.000 | 21.108 | -0.6253 | -0.07893 |
| 152.000 | 19.647 | -0.8749 | -0.20084 |
| 154.000 | 17.104 | -2.1732 | -2.34479 |
| 154.576 | 13.630 | 0.0000 | 0.00000 |

SUBJECT The Orthobaric Densities of Ethane, Methane, Oxygen and Fluorine

NAME R.D.Goodwin

DATE Sept. 18, 1973

Table 9. Calculated fluorine liquid densities.

| T,K | R,MOL/L | DR/DT | D2R/DT2 |
|---|---|---|---|
| 53.481 | 44.862 | -0.1573 | -0.00054 |
| 54.000 | 44.781 | -0.1576 | -0.00055 |
| 56.000 | 44.464 | -0.1587 | -0.00058 |
| 58.000 | 44.146 | -0.1599 | -0.00061 |
| 60.000 | 43.825 | -0.1612 | -0.00065 |
| 62.000 | 43.501 | -0.1625 | -0.00068 |
| 64.000 | 43.174 | -0.1639 | -0.00072 |
| 66.000 | 42.845 | -0.1654 | -0.00076 |
| 68.000 | 42.513 | -0.1670 | -0.00081 |
| 70.000 | 42.177 | -0.1686 | -0.00085 |
| 72.000 | 41.838 | -0.1704 | -0.00090 |
| 74.000 | 41.496 | -0.1722 | -0.00095 |
| 76.000 | 41.149 | -0.1742 | -0.00101 |
| 78.000 | 40.799 | -0.1763 | -0.00107 |
| 80.000 | 40.444 | -0.1785 | -0.00114 |
| 82.000 | 40.085 | -0.1808 | -0.00121 |
| 84.000 | 39.720 | -0.1833 | -0.00129 |
| 86.000 | 39.351 | -0.1860 | -0.00137 |
| 88.000 | 38.976 | -0.1888 | -0.00146 |
| 90.000 | 38.596 | -0.1918 | -0.00156 |
| 92.000 | 38.209 | -0.1951 | -0.00167 |
| 94.000 | 37.815 | -0.1985 | -0.00179 |
| 96.000 | 37.415 | -0.2022 | -0.00192 |
| 98.000 | 37.006 | -0.2062 | -0.00207 |
| 100.000 | 36.590 | -0.2105 | -0.00223 |
| 102.000 | 36.164 | -0.2151 | -0.00242 |
| 104.000 | 35.729 | -0.2202 | -0.00262 |
| 106.000 | 35.283 | -0.2257 | -0.00286 |
| 108.000 | 34.826 | -0.2316 | -0.00313 |
| 110.000 | 34.356 | -0.2382 | -0.00344 |
| 112.000 | 33.873 | -0.2454 | -0.00380 |
| 114.000 | 33.374 | -0.2534 | -0.00422 |
| 116.000 | 32.856 | -0.2624 | -0.00472 |
| 118.000 | 32.324 | -0.2724 | -0.00533 |
| 120.000 | 31.768 | -0.2838 | -0.00606 |
| 122.000 | 31.188 | -0.2967 | -0.00696 |
| 124.000 | 30.579 | -0.3118 | -0.00811 |
| 126.000 | 29.939 | -0.3294 | -0.00959 |
| 128.000 | 29.260 | -0.3505 | -0.01156 |
| 130.000 | 28.534 | -0.3762 | -0.01428 |
| 132.000 | 27.751 | -0.4084 | -0.01821 |
| 134.000 | 26.894 | -0.4504 | -0.02426 |
| 136.000 | 25.939 | -0.5081 | -0.03440 |
| 138.000 | 24.843 | -0.5939 | -0.05377 |
| 140.000 | 23.524 | -0.7400 | -0.09999 |
| 142.000 | 21.770 | -1.0696 | -0.27704 |
| 144.000 | 18.328 | -3.6894 | -7.49794 |
| 144.310 | 15.150 | 0.0000 | 0.00000 |

| NATIONAL BUREAU OF STANDARDS, CRYOGENIC ENGINEERING LABORATORY LABORATORY NOTE | PROJECT NO. 2750364 | FILE NO. 73-5 | PAGE 16 |
|---|---|---|---|
| SUBJECT The Orthobaric Densities of Ethane, Methane, Oxygen and Fluorine | NAME R.D.Goodwin | | |
| | DATE Sept. 18, 1973 | | |

Table 10. Calculated methane liquid densities

| T,K | R,MOL/L | DR/DT | D2R/DT2 |
|---|---|---|---|
| 90.680 | 28.147 | -0.0825 | -0.00031 |
| 92.000 | 28.038 | -0.0829 | -0.00032 |
| 94.000 | 27.871 | -0.0836 | -0.00033 |
| 96.000 | 27.704 | -0.0842 | -0.00035 |
| 98.000 | 27.534 | -0.0849 | -0.00036 |
| 100.000 | 27.364 | -0.0857 | -0.00038 |
| 102.000 | 27.192 | -0.0865 | -0.00040 |
| 104.000 | 27.018 | -0.0873 | -0.00041 |
| 106.000 | 26.843 | -0.0881 | -0.00043 |
| 108.000 | 26.665 | -0.0890 | -0.00045 |
| 110.000 | 26.486 | -0.0899 | -0.00048 |
| 112.000 | 26.306 | -0.0909 | -0.00050 |
| 114.000 | 26.123 | -0.0919 | -0.00052 |
| 116.000 | 25.938 | -0.0930 | -0.00055 |
| 118.000 | 25.751 | -0.0941 | -0.00058 |
| 120.000 | 25.561 | -0.0953 | -0.00061 |
| 122.000 | 25.369 | -0.0966 | -0.00064 |
| 124.000 | 25.175 | -0.0979 | -0.00068 |
| 126.000 | 24.978 | -0.0993 | -0.00072 |
| 128.000 | 24.778 | -0.1008 | -0.00076 |
| 130.000 | 24.575 | -0.1023 | -0.00080 |
| 132.000 | 24.368 | -0.1040 | -0.00085 |
| 134.000 | 24.158 | -0.1057 | -0.00090 |
| 136.000 | 23.945 | -0.1076 | -0.00096 |
| 138.000 | 23.728 | -0.1096 | -0.00103 |
| 140.000 | 23.507 | -0.1117 | -0.00110 |
| 142.000 | 23.281 | -0.1140 | -0.00117 |
| 144.000 | 23.051 | -0.1164 | -0.00126 |
| 146.000 | 22.815 | -0.1190 | -0.00136 |
| 148.000 | 22.574 | -0.1219 | -0.00147 |
| 150.000 | 22.328 | -0.1249 | -0.00159 |
| 152.000 | 22.075 | -0.1282 | -0.00173 |
| 154.000 | 21.815 | -0.1318 | -0.00188 |
| 156.000 | 21.547 | -0.1358 | -0.00207 |
| 158.000 | 21.271 | -0.1401 | -0.00228 |
| 160.000 | 20.986 | -0.1449 | -0.00253 |
| 162.000 | 20.691 | -0.1503 | -0.00282 |
| 164.000 | 20.385 | -0.1562 | -0.00318 |
| 166.000 | 20.066 | -0.1630 | -0.00361 |
| 168.000 | 19.732 | -0.1707 | -0.00414 |
| 170.000 | 19.362 | -0.1797 | -0.00481 |
| 172.000 | 19.012 | -0.1901 | -0.00568 |
| 174.000 | 18.620 | -0.2026 | -0.00683 |
| 176.000 | 18.200 | -0.2177 | -0.00841 |
| 178.000 | 17.747 | -0.2367 | -0.01068 |
| 180.000 | 17.250 | -0.2612 | -0.01415 |
| 182.000 | 16.696 | -0.2947 | -0.01988 |
| 184.000 | 16.061 | -0.3440 | -0.03064 |
| 186.000 | 15.299 | -0.4261 | -0.05538 |
| 188.000 | 14.298 | -0.6021 | -0.14217 |
| 190.000 | 12.527 | -1.5385 | -1.72796 |
| 190.555 | 10.200 | 0.0000 | 0.00000 |

| NATIONAL BUREAU OF STANDARDS, CRYOGENIC ENGINEERING LABORATORY LABORATORY NOTE | PROJECT NO. 2750364 | FILE NO. 73-5 | PAGE 17 |
|---|---|---|---|
| SUBJECT The Orthobaric Densities of Ethane, Methane, Oxygen and Fluorine | NAME R.D.Goodwin | DATE Sept. 18, 1973 | |

Table 11. Calculated ethane liquid densities.

ETHANE SATURATED LIQUID DENSITIES

| T,K | R,MOL/L | DR/DT | D2R/DT2 |
|---|---|---|---|
| 89.899 | 21.680 | -0.0360 | 0.00000 |
| 90.000 | 21.676 | -0.0360 | 0.00000 |
| 95.000 | 21.496 | -0.0360 | -0.00000 |
| 100.000 | 21.316 | -0.0360 | -0.00001 |
| 105.000 | 21.136 | -0.0361 | -0.00001 |
| 110.000 | 20.955 | -0.0362 | -0.00002 |
| 115.000 | 20.774 | -0.0363 | -0.00002 |
| 120.000 | 20.593 | -0.0364 | -0.00003 |
| 125.000 | 20.411 | -0.0365 | -0.00003 |
| 130.000 | 20.228 | -0.0367 | -0.00004 |
| 135.000 | 20.044 | -0.0369 | -0.00004 |
| 140.000 | 19.859 | -0.0371 | -0.00005 |
| 145.000 | 19.673 | -0.0374 | -0.00006 |
| 150.000 | 19.485 | -0.0377 | -0.00006 |
| 155.000 | 19.296 | -0.0380 | -0.00007 |
| 160.000 | 19.105 | -0.0384 | -0.00008 |
| 165.000 | 18.912 | -0.0388 | -0.00009 |
| 170.000 | 18.717 | -0.0392 | -0.00010 |
| 175.000 | 18.520 | -0.0398 | -0.00011 |
| 180.000 | 18.320 | -0.0403 | -0.00012 |
| 185.000 | 18.116 | -0.0410 | -0.00013 |
| 190.000 | 17.910 | -0.0417 | -0.00015 |
| 195.000 | 17.700 | -0.0424 | -0.00016 |
| 200.000 | 17.485 | -0.0433 | -0.00018 |
| 205.000 | 17.266 | -0.0443 | -0.00020 |
| 210.000 | 17.042 | -0.0453 | -0.00022 |
| 215.000 | 16.813 | -0.0465 | -0.00025 |
| 220.000 | 16.577 | -0.0478 | -0.00028 |
| 225.000 | 16.335 | -0.0493 | -0.00031 |
| 230.000 | 16.085 | -0.0509 | -0.00035 |
| 235.000 | 15.826 | -0.0527 | -0.00039 |
| 240.000 | 15.557 | -0.0548 | -0.00045 |
| 245.000 | 15.277 | -0.0572 | -0.00051 |
| 250.000 | 14.984 | -0.0600 | -0.00059 |
| 255.000 | 14.676 | -0.0632 | -0.00069 |
| 260.000 | 14.351 | -0.0669 | -0.00082 |
| 265.000 | 14.005 | -0.0715 | -0.00099 |
| 270.000 | 13.635 | -0.0770 | -0.00123 |
| 275.000 | 13.233 | -0.0839 | -0.00156 |
| 280.000 | 12.792 | -0.0929 | -0.00208 |
| 285.000 | 12.299 | -0.1053 | -0.00295 |
| 290.000 | 11.729 | -0.1238 | -0.00463 |
| 295.000 | 11.040 | -0.1554 | -0.00871 |
| 300.000 | 10.112 | -0.2288 | -0.02539 |
| 305.000 | 8.048 | -1.2696 | -2.44167 |
| 305.330 | 6.870 | 0.0000 | 0.00000 |

NATIONAL BUREAU OF STANDARDS, CRYOGENIC ENGINEERING LABORATORY
LABORATORY NOTE

PROJECT NO. 2750364 | FILE NO. 73-5 | PAGE 18

SUBJECT The Orthobaric Densities of Ethane, Methane, Oxygen and Fluorine

NAME R.D.Goodwin

DATE Sept. 18, 1973

Table 12. Comparison of oxygen vapor densities.

E = 0.382

TCRT = 154.576, TTRP = 54.3507
DCRT = 13.630, DTRP = 3.36122-004

2.7737066-001 -3.3866205-001 7.6907075-001 -1.5761185+000
9.3987130-001 0.0000000+000 0.0000000+000 0.0000000+000

| ID | T,K | MOL/L | CALCD | PCNT | Z | YX | YC | YDIF |
|---|---|---|---|---|---|---|---|---|
| 99 | 56.000 | 5.3300-004 | 5.3288-004 | 0.02 | 0.95458 | 0.07082 | 0.07159 | -0.00077 |
| 99 | 58.000 | 8.9930-004 | 8.9941-004 | -0.01 | 0.90296 | 0.07289 | 0.07270 | 0.00019 |
| 99 | 60.000 | 1.4640-003 | 1.4644-003 | -0.03 | 0.85479 | 0.07505 | 0.07474 | 0.00031 |
| 99 | 62.000 | 2.3057-003 | 2.3068-003 | -0.05 | 0.80972 | 0.07792 | 0.07752 | 0.00040 |
| 99 | 64.000 | 3.5233-003 | 3.5251-003 | -0.05 | 0.76747 | 0.08123 | 0.08089 | 0.00034 |
| 99 | 66.000 | 5.2367-003 | 5.2388-003 | -0.04 | 0.72778 | 0.08497 | 0.08473 | 0.00024 |
| 99 | 68.000 | 7.5880-003 | 7.5899-003 | -0.02 | 0.69042 | 0.08906 | 0.08893 | 0.00013 |
| 99 | 70.000 | 1.0742-002 | 1.0742-002 | -0.00 | 0.65520 | 0.09343 | 0.09341 | 0.00001 |
| 99 | 72.000 | 1.4885-002 | 1.4883-002 | 0.01 | 0.62194 | 0.09804 | 0.09811 | -0.00006 |
| 99 | 74.000 | 2.0227-002 | 2.0220-002 | 0.04 | 0.59048 | 0.10281 | 0.10296 | -0.00015 |
| 99 | 76.000 | 2.6996-002 | 2.6983-002 | 0.05 | 0.56067 | 0.10773 | 0.10792 | -0.00019 |
| 99 | 78.000 | 3.5441-002 | 3.5421-002 | 0.06 | 0.53239 | 0.11275 | 0.11296 | -0.00021 |
| 99 | 80.000 | 4.5831-002 | 4.5802-002 | 0.06 | 0.50552 | 0.11781 | 0.11804 | -0.00023 |
| 99 | 82.000 | 5.8449-002 | 5.8412-002 | 0.06 | 0.47996 | 0.12292 | 0.12314 | -0.00022 |
| 99 | 84.000 | 7.3595-002 | 7.3552-002 | 0.06 | 0.45562 | 0.12804 | 0.12823 | -0.00019 |
| 99 | 86.000 | 9.1589-002 | 9.1542-002 | 0.05 | 0.43242 | 0.13313 | 0.13330 | -0.00017 |
| 99 | 88.000 | 1.1276-001 | 1.1271-001 | 0.04 | 0.41026 | 0.13821 | 0.13833 | -0.00012 |
| 99 | 90.000 | 1.3745-001 | 1.3741-001 | 0.03 | 0.38910 | 0.14323 | 0.14331 | -0.00008 |
| 99 | 92.000 | 1.6603-001 | 1.6601-001 | 0.01 | 0.36885 | 0.14820 | 0.14824 | -0.00004 |
| 99 | 94.000 | 1.9887-001 | 1.9887-001 | -0.00 | 0.34946 | 0.15311 | 0.15310 | 0.00000 |
| 99 | 96.000 | 2.3637-001 | 2.3641-001 | -0.01 | 0.33088 | 0.15794 | 0.15790 | 0.00004 |
| 99 | 98.000 | 2.7894-001 | 2.7902-001 | -0.03 | 0.31306 | 0.16270 | 0.16262 | 0.00008 |
| 99 | 100.000 | 3.2702-001 | 3.2716-001 | -0.04 | 0.29596 | 0.16738 | 0.16726 | 0.00012 |
| 99 | 102.000 | 3.8108-001 | 3.8127-001 | -0.05 | 0.27952 | 0.17196 | 0.17182 | 0.00014 |
| 99 | 104.000 | 4.4162-001 | 4.4186-001 | -0.05 | 0.26372 | 0.17645 | 0.17630 | 0.00015 |
| 99 | 106.000 | 5.0914-001 | 5.0943-001 | -0.06 | 0.24851 | 0.18086 | 0.18070 | 0.00016 |
| 99 | 108.000 | 5.8421-001 | 5.8455-001 | -0.06 | 0.23387 | 0.18518 | 0.18502 | 0.00016 |
| 99 | 110.000 | 6.6747-001 | 6.6783-001 | -0.05 | 0.21975 | 0.18940 | 0.18925 | 0.00015 |
| 99 | 112.000 | 7.5953-001 | 7.5992-001 | -0.05 | 0.20615 | 0.19355 | 0.19341 | 0.00014 |
| 99 | 114.000 | 8.6121-001 | 8.6155-001 | -0.04 | 0.19302 | 0.19759 | 0.19748 | 0.00011 |
| 99 | 116.000 | 9.7325-001 | 9.7353-001 | -0.03 | 0.18034 | 0.20156 | 0.20148 | 0.00008 |
| 99 | 118.000 | 1.0965+000 | 1.0967+000 | -0.02 | 0.16809 | 0.20545 | 0.20540 | 0.00005 |
| 99 | 120.000 | 1.2321+000 | 1.2322+000 | -0.00 | 0.15625 | 0.20926 | 0.20925 | 0.00000 |
| 99 | 122.000 | 1.3812+000 | 1.3810+000 | 0.01 | 0.14480 | 0.21299 | 0.21303 | -0.00004 |
| 99 | 124.000 | 1.5450+000 | 1.5445+000 | 0.03 | 0.13372 | 0.21666 | 0.21674 | -0.00008 |
| 99 | 126.000 | 1.7250+000 | 1.7243+000 | 0.04 | 0.12299 | 0.22027 | 0.22039 | -0.00012 |
| 99 | 128.000 | 1.9230+000 | 1.9220+000 | 0.05 | 0.11259 | 0.22383 | 0.22398 | -0.00015 |
| 99 | 130.000 | 2.1411+000 | 2.1399+000 | 0.06 | 0.10252 | 0.22735 | 0.22751 | -0.00017 |
| 99 | 132.000 | 2.3819+000 | 2.3805+000 | 0.06 | 0.09275 | 0.23083 | 0.23100 | -0.00017 |
| 99 | 134.000 | 2.6483+000 | 2.6470+000 | 0.05 | 0.08327 | 0.23429 | 0.23444 | -0.00016 |
| 99 | 136.000 | 2.9444+000 | 2.9433+000 | 0.04 | 0.07407 | 0.23773 | 0.23786 | -0.00012 |
| 99 | 138.000 | 3.2750+000 | 3.2745+000 | 0.01 | 0.06514 | 0.24119 | 0.24124 | -0.00005 |
| 99 | 140.000 | 3.6468+000 | 3.6474+000 | -0.02 | 0.05646 | 0.24468 | 0.24462 | 0.00006 |
| 99 | 142.000 | 4.0692+000 | 4.0712+000 | -0.05 | 0.04803 | 0.24819 | 0.24801 | 0.00018 |
| 99 | 144.000 | 4.5552+000 | 4.5592+000 | -0.09 | 0.03983 | 0.25176 | 0.25143 | 0.00033 |
| 99 | 146.000 | 5.1261+000 | 5.1316+000 | -0.11 | 0.03185 | 0.25536 | 0.25493 | 0.00043 |
| 99 | 148.000 | 5.8177+000 | 5.8225+000 | -0.08 | 0.02410 | 0.25892 | 0.25857 | 0.00035 |
| 99 | 150.000 | 6.7056+000 | 6.6967+000 | 0.13 | 0.01654 | 0.26182 | 0.26247 | -0.00065 |
| 99 | 152.000 | 7.9239+000 | 7.9138+000 | 0.13 | 0.00919 | 0.26616 | 0.26692 | -0.00076 |
| 99 | 154.000 | 1.0225+001 | 1.0230+001 | -0.05 | 0.00203 | 0.27367 | 0.27313 | 0.00054 |

NP = 50, RMSPCT = 0.052

| NATIONAL BUREAU OF STANDARDS, CRYOGENIC ENGINEERING LABORATORY LABORATORY NOTE | PROJECT NO. 2750364 | FILE NO. 73-5 | PAGE 19 |
|---|---|---|---|
| SUBJECT The Orthobaric Densities of Ethane, Methane, Oxygen and Fluorine | NAME R.D.Goodwin | | |
| | DATE Sept. 18, 1973 | | |

Table 13. Comparison of fluorine vapor densities.

E = 0.362

TCRT = 144.310, TTRP = 53.4811
DCRT = 15.150, DTRP = 5.67000-004

2.5715721-001 -2.2706443-001 6.0538644-001 -1.3916332+000
7.9257188-001 0.0000000+000 0.0000000+000 0.0000000+000

| ID | T,K | MOL/L | CALCD | PCNT | Z | YX | YC | YDIF |
|---|---|---|---|---|---|---|---|---|
| 98 | 54.000 | 6.6000-004 | 6.6001-004 | -0.00 | 0.98473 | 0.03779 | 0.03768 | 0.00010 |
| 98 | 56.000 | 1.1500-003 | 1.1518-003 | -0.16 | 0.92853 | 0.04645 | 0.04297 | 0.00348 |
| 98 | 58.000 | 1.9300-003 | 1.9272-003 | 0.14 | 0.87621 | 0.04693 | 0.04877 | -0.00184 |
| 98 | 60.000 | 3.1100-003 | 3.1038-003 | 0.20 | 0.82738 | 0.05309 | 0.05493 | -0.00184 |
| 98 | 62.000 | 4.8400-003 | 4.8291-003 | 0.23 | 0.78169 | 0.05968 | 0.06135 | -0.00167 |
| 98 | 64.000 | 7.2900-003 | 7.2821-003 | 0.11 | 0.73887 | 0.06725 | 0.06792 | -0.00067 |
| 98 | 66.000 | 1.0680-002 | 1.0675-002 | 0.05 | 0.69863 | 0.07434 | 0.07459 | -0.00026 |
| 98 | 68.000 | 1.5250-002 | 1.5253-002 | -0.02 | 0.66077 | 0.08139 | 0.08130 | 0.00009 |
| 98 | 70.000 | 2.1280-002 | 2.1293-002 | -0.06 | 0.62507 | 0.08827 | 0.08799 | 0.00028 |
| 98 | 72.000 | 2.9070-002 | 2.9105-002 | -0.12 | 0.59135 | 0.09515 | 0.09464 | 0.00051 |
| 98 | 74.000 | 3.8970-002 | 3.9029-002 | -0.15 | 0.55945 | 0.10181 | 0.10121 | 0.00060 |
| 98 | 76.000 | 5.1350-002 | 5.1434-002 | -0.16 | 0.52923 | 0.10829 | 0.10769 | 0.00060 |
| 98 | 78.000 | 6.6600-002 | 6.6713-002 | -0.17 | 0.50057 | 0.11466 | 0.11406 | 0.00060 |
| 98 | 80.000 | 8.5150-002 | 8.5291-002 | -0.17 | 0.47333 | 0.12086 | 0.12030 | 0.00056 |
| 98 | 82.000 | 1.0745-001 | 1.0761-001 | -0.15 | 0.44742 | 0.12691 | 0.12641 | 0.00050 |
| 98 | 84.000 | 1.3397-001 | 1.3416-001 | -0.14 | 0.42275 | 0.13281 | 0.13238 | 0.00044 |
| 98 | 86.000 | 1.6523-001 | 1.6541-001 | -0.11 | 0.39923 | 0.13854 | 0.13820 | 0.00034 |
| 98 | 88.000 | 2.0174-001 | 2.0191-001 | -0.08 | 0.37677 | 0.14413 | 0.14388 | 0.00025 |
| 98 | 90.000 | 2.4407-001 | 2.4420-001 | -0.05 | 0.35532 | 0.14956 | 0.14940 | 0.00015 |
| 98 | 92.000 | 2.9280-001 | 2.9286-001 | -0.02 | 0.33479 | 0.15484 | 0.15478 | 0.00006 |
| 98 | 94.000 | 3.4857-001 | 3.4852-001 | 0.01 | 0.31514 | 0.15997 | 0.16001 | -0.00004 |
| 98 | 96.000 | 4.1203-001 | 4.1184-001 | 0.05 | 0.29631 | 0.16496 | 0.16509 | -0.00013 |
| 98 | 98.000 | 4.8389-001 | 4.8352-001 | 0.08 | 0.27824 | 0.16981 | 0.17003 | -0.00021 |
| 98 | 100.000 | 5.6491-001 | 5.6432-001 | 0.10 | 0.26090 | 0.17453 | 0.17482 | -0.00029 |
| 98 | 102.000 | 6.5591-001 | 6.5507-001 | 0.13 | 0.24424 | 0.17912 | 0.17947 | -0.00035 |
| 98 | 104.000 | 7.5778-001 | 7.5667-001 | 0.15 | 0.22822 | 0.18358 | 0.18398 | -0.00040 |
| 98 | 106.000 | 8.7151-001 | 8.7012-001 | 0.16 | 0.21281 | 0.18792 | 0.18836 | -0.00044 |
| 98 | 108.000 | 9.9817-001 | 9.9651-001 | 0.17 | 0.19796 | 0.19215 | 0.19261 | -0.00046 |
| 98 | 110.000 | 1.1390+000 | 1.1371+000 | 0.17 | 0.18366 | 0.19627 | 0.19673 | -0.00046 |
| 98 | 112.000 | 1.2953+000 | 1.2932+000 | 0.16 | 0.16986 | 0.20028 | 0.20072 | -0.00044 |
| 98 | 114.000 | 1.4687+000 | 1.4666+000 | 0.15 | 0.15655 | 0.20419 | 0.20460 | -0.00041 |
| 98 | 116.000 | 1.6610+000 | 1.6590+000 | 0.12 | 0.14370 | 0.20801 | 0.20836 | -0.00035 |
| 98 | 118.000 | 1.8743+000 | 1.8725+000 | 0.09 | 0.13129 | 0.21174 | 0.21200 | -0.00027 |
| 98 | 120.000 | 2.1111+000 | 2.1099+000 | 0.06 | 0.11928 | 0.21538 | 0.21554 | -0.00016 |
| 98 | 122.000 | 2.3744+000 | 2.3741+000 | 0.01 | 0.10768 | 0.21894 | 0.21898 | -0.00004 |
| 98 | 124.000 | 2.6680+000 | 2.6690+000 | -0.04 | 0.09644 | 0.22243 | 0.22232 | 0.00011 |
| 98 | 126.000 | 2.9965+000 | 2.9992+000 | -0.09 | 0.08556 | 0.22584 | 0.22556 | 0.00027 |
| 98 | 128.000 | 3.3661+000 | 3.3709+000 | -0.14 | 0.07503 | 0.22917 | 0.22873 | 0.00045 |
| 98 | 130.000 | 3.7848+000 | 3.7921+000 | -0.19 | 0.06481 | 0.23243 | 0.23181 | 0.00062 |
| 98 | 132.000 | 4.2641+000 | 4.2739+000 | -0.23 | 0.05491 | 0.23560 | 0.23484 | 0.00076 |
| 98 | 134.000 | 4.8207+000 | 4.8319+000 | -0.23 | 0.04530 | 0.23862 | 0.23782 | 0.00081 |
| 98 | 136.000 | 5.4816+000 | 5.4905+000 | -0.16 | 0.03598 | 0.24138 | 0.24077 | 0.00061 |
| 98 | 138.000 | 6.2910+000 | 6.2909+000 | 0.00 | 0.02692 | 0.24374 | 0.24375 | -0.00000 |
| 98 | 140.000 | 7.3226+000 | 7.3133+000 | 0.13 | 0.01813 | 0.24625 | 0.24683 | -0.00058 |
| 98 | 142.000 | 8.7854+000 | 8.7644+000 | 0.24 | 0.00958 | 0.24889 | 0.25023 | -0.00133 |
| 98 | 144.000 | 1.1888+001 | 1.1893+001 | -0.04 | 0.00127 | 0.25552 | 0.25509 | 0.00044 |

NP = 46, RMSPCT = 0.134

Table 14. Comparison of methane vapor densities.

E = 0.382

TCRT = 190.555, TTRP = 90.6800
DCRT = 10.200, DTRP = 1.56787-002

3.7410143-001 -2.6157309-001 6.7533217-001 -1.0122063+000
4.3988336-001 0.0000000+000 0.0000000+000 0.0000000+000

| ID | T,K | MOL/L | CALCD | PCNT | Z | YX | YC | YDIF |
|---|---|---|---|---|---|---|---|---|
| 2 | 92.000 | 1.8280-002 | 1.8280-002 | 0.00 | 0.97263 | 0.21853 | 0.21874 | -0.00021 |
| 2 | 94.000 | 2.2860-002 | 2.2858-002 | 0.01 | 0.93261 | 0.22329 | 0.22354 | -0.00025 |
| 2 | 96.000 | 2.8290-002 | 2.8294-002 | -0.01 | 0.89427 | 0.22864 | 0.22828 | 0.00036 |
| 2 | 98.000 | 3.4690-002 | 3.4691-002 | -0.00 | 0.85749 | 0.23301 | 0.23295 | 0.00006 |
| 2 | 100.000 | 4.2160-002 | 4.2159-002 | 0.00 | 0.82218 | 0.23752 | 0.23755 | -0.00003 |
| 2 | 102.000 | 5.0810-002 | 5.0813-002 | -0.01 | 0.78826 | 0.24213 | 0.24207 | 0.00007 |
| 2 | 104.000 | 6.0770-002 | 6.0772-002 | -0.00 | 0.75564 | 0.24653 | 0.24650 | 0.00003 |
| 2 | 106.000 | 7.2160-002 | 7.2161-002 | -0.00 | 0.72425 | 0.25086 | 0.25084 | 0.00002 |
| 2 | 108.000 | 8.5110-002 | 8.5110-002 | -0.00 | 0.69402 | 0.25510 | 0.25510 | 0.00000 |
| 2 | 110.000 | 9.9750-002 | 9.9753-002 | -0.00 | 0.66490 | 0.25928 | 0.25926 | 0.00002 |
| 2 | 112.000 | 1.1623-001 | 1.1623-001 | 0.00 | 0.63681 | 0.26332 | 0.26333 | -0.00000 |
| 2 | 114.000 | 1.3468-001 | 1.3468-001 | -0.00 | 0.60971 | 0.26732 | 0.26730 | 0.00002 |
| 2 | 116.000 | 1.5527-001 | 1.5527-001 | 0.00 | 0.58354 | 0.27117 | 0.27119 | -0.00002 |
| 2 | 118.000 | 1.7814-001 | 1.7813-001 | 0.00 | 0.55826 | 0.27495 | 0.27498 | -0.00002 |
| 2 | 120.000 | 2.0346-001 | 2.0345-001 | 0.01 | 0.53383 | 0.27864 | 0.27868 | -0.00004 |
| 2 | 122.000 | 2.3139-001 | 2.3138-001 | 0.00 | 0.51019 | 0.28226 | 0.28228 | -0.00003 |
| 2 | 124.000 | 2.6212-001 | 2.6211-001 | 0.00 | 0.48732 | 0.28577 | 0.28580 | -0.00003 |
| 2 | 126.000 | 2.9583-001 | 2.9582-001 | 0.00 | 0.46517 | 0.28921 | 0.28923 | -0.00002 |
| 2 | 128.000 | 3.3272-001 | 3.3271-001 | 0.00 | 0.44372 | 0.29255 | 0.29257 | -0.00002 |
| 2 | 130.000 | 3.7299-001 | 3.7299-001 | 0.00 | 0.42292 | 0.29582 | 0.29583 | -0.00001 |
| 2 | 132.000 | 4.1686-001 | 4.1687-001 | -0.00 | 0.40276 | 0.29902 | 0.29900 | 0.00002 |
| 2 | 134.000 | 4.6457-001 | 4.6461-001 | -0.01 | 0.38320 | 0.30213 | 0.30209 | 0.00004 |
| 2 | 136.000 | 5.1638-001 | 5.1644-001 | -0.01 | 0.36421 | 0.30515 | 0.30510 | 0.00006 |
| 2 | 138.000 | 5.7255-001 | 5.7264-001 | -0.02 | 0.34577 | 0.30811 | 0.30803 | 0.00008 |
| 2 | 140.000 | 6.3337-001 | 6.3351-001 | -0.02 | 0.32786 | 0.31099 | 0.31088 | 0.00011 |
| 2 | 142.000 | 6.9916-001 | 6.9937-001 | -0.03 | 0.31046 | 0.31380 | 0.31366 | 0.00014 |
| 2 | 144.000 | 7.7028-001 | 7.7055-001 | -0.04 | 0.29353 | 0.31654 | 0.31637 | 0.00016 |
| 2 | 146.000 | 8.4711-001 | 8.4745-001 | -0.04 | 0.27708 | 0.31920 | 0.31901 | 0.00019 |
| 2 | 148.000 | 9.3007-001 | 9.3049-001 | -0.05 | 0.26106 | 0.32179 | 0.32158 | 0.00021 |
| 2 | 150.000 | 1.0196+000 | 1.0201+000 | -0.05 | 0.24548 | 0.32431 | 0.32409 | 0.00022 |
| 2 | 152.000 | 1.1164+000 | 1.1169+000 | -0.05 | 0.23030 | 0.32675 | 0.32653 | 0.00022 |
| 2 | 154.000 | 1.2209+000 | 1.2214+000 | -0.05 | 0.21552 | 0.32912 | 0.32891 | 0.00021 |
| 2 | 156.000 | 1.3338+000 | 1.3343+000 | -0.04 | 0.20111 | 0.33140 | 0.33123 | 0.00017 |
| 2 | 158.000 | 1.4560+000 | 1.4563+000 | -0.02 | 0.18707 | 0.33361 | 0.33350 | 0.00011 |
| 2 | 160.000 | 1.5884+000 | 1.5884+000 | -0.00 | 0.17339 | 0.33571 | 0.33571 | 0.00000 |
| 2 | 162.000 | 1.7322+000 | 1.7316+000 | 0.03 | 0.16004 | 0.33772 | 0.33788 | -0.00016 |
| 2 | 164.000 | 1.8886+000 | 1.8870+000 | 0.08 | 0.14701 | 0.33961 | 0.34000 | -0.00039 |
| 2 | 166.000 | 2.0593+000 | 2.0561+000 | 0.16 | 0.13430 | 0.34135 | 0.34208 | -0.00073 |
| 2 | 168.000 | 2.2465+000 | 2.2408+000 | 0.26 | 0.12190 | 0.34291 | 0.34412 | -0.00121 |
| 1616 | 169.067 | 2.3488+000 | 2.3463+000 | 0.11 | 0.11540 | 0.34469 | 0.34520 | -0.00051 |
| 1614 | 169.270 | 2.3687+000 | 2.3670+000 | 0.07 | 0.11417 | 0.34506 | 0.34540 | -0.00035 |
| 912 | 169.417 | 2.3858+000 | 2.3821+000 | 0.16 | 0.11328 | 0.34480 | 0.34555 | -0.00075 |
| 1612 | 169.468 | 2.3881+000 | 2.3873+000 | 0.03 | 0.11297 | 0.34545 | 0.34560 | -0.00015 |
| 910 | 169.601 | 2.4054+000 | 2.4011+000 | 0.18 | 0.11217 | 0.34488 | 0.34573 | -0.00085 |
| 308 | 169.794 | 2.4236+000 | 2.4213+000 | 0.10 | 0.11101 | 0.34547 | 0.34593 | -0.00046 |
| 1716 | 173.088 | 2.7972+000 | 2.7964+000 | 0.03 | 0.09162 | 0.34905 | 0.34920 | -0.00015 |
| 1714 | 173.290 | 2.8203+000 | 2.8215+000 | -0.04 | 0.09046 | 0.34961 | 0.34940 | 0.00021 |

| NATIONAL BUREAU OF STANDARDS, CRYOGENIC ENGINEERING LABORATORY LABORATORY NOTE | PROJECT NO. 2750364 | FILE NO. 73-5 | PAGE 21 |
|---|---|---|---|
| SUBJECT The Orthobaric Densities of Ethane, Methane, Oxygen and Fluorine | NAME R.D.Goodwin | DATE Sept. 18, 1973 | |

Table 14 (Continued). Methane vapor densities.

| ID | T,K | MOL/L | CALCD | PCNT | Z | YX | YC | YDIF |
|---|---|---|---|---|---|---|---|---|
| 1712 | 173.489 | 2.8457+000 | 2.8465+000 | -0.03 | 0.08931 | 0.34973 | 0.34959 | 0.00014 |
| 1012 | 173.473 | 2.8480+000 | 2.8445+000 | 0.12 | 0.08940 | 0.34896 | 0.34958 | -0.00062 |
| 1010 | 173.675 | 2.8700+000 | 2.8701+000 | -0.00 | 0.08824 | 0.34980 | 0.34978 | 0.00002 |
| 1008 | 173.857 | 2.8935+000 | 2.8934+000 | 0.00 | 0.08720 | 0.34995 | 0.34996 | -0.00001 |
| 1816 | 177.094 | 3.3501+000 | 3.3513+000 | -0.03 | 0.06901 | 0.35333 | 0.35315 | 0.00018 |
| 1814 | 177.292 | 3.3801+000 | 3.3822+000 | -0.06 | 0.06792 | 0.35369 | 0.35335 | 0.00034 |
| 1114 | 177.328 | 3.3863+000 | 3.3879+000 | -0.05 | 0.06772 | 0.35364 | 0.35339 | 0.00025 |
| 1812 | 177.485 | 3.4108+000 | 3.4128+000 | -0.06 | 0.06686 | 0.35386 | 0.35354 | 0.00031 |
| 1112 | 177.509 | 3.4209+000 | 3.4166+000 | 0.12 | 0.06673 | 0.35290 | 0.35357 | -0.00067 |
| 1110 | 177.700 | 3.4602+000 | 3.4473+000 | 0.37 | 0.06568 | 0.35175 | 0.35376 | -0.00200 |
| 1916 | 181.105 | 4.0663+000 | 4.0686+000 | -0.06 | 0.04738 | 0.35755 | 0.35722 | 0.00033 |
| 1914 | 181.304 | 4.1077+000 | 4.1101+000 | -0.06 | 0.04633 | 0.35778 | 0.35743 | 0.00034 |
| 1213 | 181.389 | 4.1269+000 | 4.1281+000 | -0.03 | 0.04588 | 0.35769 | 0.35752 | 0.00017 |
| 1912 | 181.506 | 4.1496+000 | 4.1530+000 | -0.08 | 0.04527 | 0.35813 | 0.35765 | 0.00048 |
| 1211 | 181.589 | 4.1656+000 | 4.1708+000 | -0.12 | 0.04483 | 0.35848 | 0.35774 | 0.00074 |
| 1209 | 181.768 | 4.2042+000 | 4.2097+000 | -0.13 | 0.04389 | 0.35870 | 0.35793 | 0.00078 |
| 1516 | 183.117 | 4.5212+000 | 4.5240+000 | -0.06 | 0.03688 | 0.35978 | 0.35940 | 0.00038 |
| 1514 | 183.322 | 4.5704+000 | 4.5754+000 | -0.11 | 0.03582 | 0.36032 | 0.35963 | 0.00069 |
| 1512 | 183.514 | 4.6189+000 | 4.6246+000 | -0.12 | 0.03484 | 0.36063 | 0.35985 | 0.00078 |
| 1316 | 184.125 | 4.7622+000 | 4.7880+000 | -0.12 | 0.03171 | 0.36134 | 0.36055 | 0.00079 |
| 2108 | 184.087 | 4.7825+000 | 4.7775+000 | 0.10 | 0.03190 | 0.35982 | 0.36051 | -0.00068 |
| 2107 | 184.285 | 4.8263+000 | 4.8327+000 | -0.13 | 0.03089 | 0.36161 | 0.36074 | 0.00087 |
| 1314 | 184.370 | 4.8462+000 | 4.8567+000 | -0.22 | 0.03046 | 0.36228 | 0.36084 | 0.00144 |
| 2106 | 184.471 | 4.8797+000 | 4.8857+000 | -0.12 | 0.02994 | 0.36177 | 0.36096 | 0.00081 |
| 1312 | 184.510 | 4.8876+000 | 4.8969+000 | -0.19 | 0.02975 | 0.36228 | 0.36101 | 0.00127 |
| 6 | 185.030 | 5.0380+000 | 5.0524+000 | -0.28 | 0.02711 | 0.36359 | 0.36164 | 0.00195 |
| 6 | 186.030 | 5.3840+000 | 5.3838+000 | 0.00 | 0.02208 | 0.36290 | 0.36292 | -0.00002 |
| 2208 | 186.103 | 5.4077+000 | 5.4098+000 | -0.04 | 0.02172 | 0.36331 | 0.36302 | 0.00029 |
| 1416 | 186.129 | 5.4096+000 | 5.4192+000 | -0.18 | 0.02159 | 0.36436 | 0.36305 | 0.00131 |
| 1414 | 186.319 | 5.4795+000 | 5.4891+000 | -0.17 | 0.02064 | 0.36461 | 0.36331 | 0.00130 |
| 2207 | 186.304 | 5.4827+000 | 5.4835+000 | -0.01 | 0.02072 | 0.36339 | 0.36329 | 0.00010 |
| 2206 | 186.501 | 5.5571+000 | 5.5581+000 | -0.02 | 0.01974 | 0.36369 | 0.36356 | 0.00013 |
| 1412 | 186.518 | 5.5591+000 | 5.5646+000 | -0.10 | 0.01965 | 0.36434 | 0.36359 | 0.00075 |
| 6 | 187.031 | 5.7360+000 | 5.7723+000 | 0.24 | 0.01711 | 0.36244 | 0.36433 | -0.00189 |
| 6 | 188.031 | 6.2750+000 | 6.2474+000 | 0.44 | 0.01219 | 0.36201 | 0.36592 | -0.00392 |
| 2308 | 188.140 | 6.2930+000 | 6.3064+000 | -0.21 | 0.01165 | 0.36804 | 0.36612 | 0.00193 |
| 2307 | 188.343 | 6.4367+000 | 6.4218+000 | -0.24 | 0.01066 | 0.36868 | 0.36648 | 0.00213 |
| 2306 | 188.545 | 6.5278+000 | 6.5441+000 | -0.25 | 0.00968 | 0.36926 | 0.36686 | 0.00239 |
| 6 | 189.032 | 6.9180+000 | 6.8777+000 | 0.59 | 0.00732 | 0.36167 | 0.36787 | -0.00620 |
| 5 | 189.765 | 7.5510+000 | 7.5576+000 | -0.09 | 0.00378 | 0.37093 | 0.36975 | 0.00117 |
| 6 | 190.032 | 7.9600+000 | 7.9153+000 | 0.56 | 0.00250 | 0.36186 | 0.37065 | -0.00879 |
| 5 | 190.046 | 7.9350+000 | 7.9371+000 | -0.03 | 0.00243 | 0.37113 | 0.37070 | 0.00043 |
| 7 | 190.070 | 8.0000+000 | 7.9756+000 | 0.31 | 0.00232 | 0.36588 | 0.37079 | -0.00491 |
| 7 | 190.170 | 8.1700+000 | 8.1508+000 | 0.24 | 0.00184 | 0.36709 | 0.37120 | -0.00412 |
| 7 | 190.270 | 8.3600+000 | 8.3595+000 | 0.01 | 0.00136 | 0.37154 | 0.37166 | -0.00013 |
| 5 | 190.279 | 8.3420+000 | 8.3805+000 | 0.14 | 0.00132 | 0.36899 | 0.37171 | -0.00272 |
| 7 | 190.370 | 8.6200+000 | 8.6242+000 | -0.05 | 0.00088 | 0.37333 | 0.37221 | 0.00112 |
| 7 | 190.470 | 9.0000+000 | 9.0116+000 | -0.13 | 0.00041 | 0.37689 | 0.37291 | 0.00397 |
| 5 | 190.500 | 9.1610+000 | 9.1867+000 | -0.28 | 0.00026 | 0.38333 | 0.37319 | 0.01014 |

NP = 96, RMSPCT = 0.148

OGILVIE PRESS, INC., BROOKLYN 17, N. Y. STOCK NO. 480

NATIONAL BUREAU OF STANDARDS, CRYOGENIC ENGINEERING LABORATORY
LABORATORY NOTE

| PROJECT NO. | FILE NO. | PAGE |
|---|---|---|
| 2750364 | 73-5 | 22 |

SUBJECT: The Orthobaric Densities of Ethane, Methane, Oxygen and Fluorine

NAME: R.D.Goodwin

DATE: Sept. 18, 1973

Table 15. Comparison of ethane vapor densities.

ETHANE SATURATED VAPOR DENSITIES, E = 0.362

TCRT = 305.330, TTRP = 89.8990
DCRT = 6.870, DTRP = 1.35114-006

1.3277432-001 4.1550086-002 -7.8922629-001 3.5766750-001
1.2454376-001 0.0000000+000 0.0000000+000 0.0000000+000

| ID | T,K | MOL/L | CALCD | PCNT | Z | YX | YC | YDIF |
|---|---|---|---|---|---|---|---|---|
| 1 | 90.000 | 1.3863-006 | 1.3863-006 | 0.00 | 0.99841 | -0.07301 | -0.07257 | -0.00044 |
| 1 | 100.000 | 1.3347-005 | 1.3356-005 | -0.07 | 0.85684 | -0.05815 | -0.05863 | 0.00048 |
| 1 | 110.000 | 8.1612-005 | 8.1696-005 | -0.10 | 0.74101 | -0.04219 | -0.04262 | 0.00043 |
| 1 | 120.000 | 3.5552-004 | 3.5568-004 | -0.04 | 0.64448 | -0.02573 | -0.02587 | 0.00014 |
| 1 | 130.000 | 1.1970-003 | 1.1963-003 | 0.05 | 0.56281 | -0.00924 | -0.00911 | -0.00014 |
| 1 | 140.000 | 3.3033-003 | 3.2990-003 | 0.13 | 0.49280 | 0.00698 | 0.00728 | -0.00030 |
| 1 | 150.000 | 7.8043-003 | 7.7918-003 | 0.16 | 0.43213 | 0.02275 | 0.02309 | -0.00034 |
| 1 | 160.000 | 1.6308-002 | 1.6284-002 | 0.15 | 0.37904 | 0.03793 | 0.03823 | -0.00029 |
| 1 | 170.000 | 3.0899-002 | 3.0869-002 | 0.10 | 0.33219 | 0.05247 | 0.05266 | -0.00019 |
| 1 | 180.000 | 5.4111-002 | 5.4094-002 | 0.03 | 0.29056 | 0.06634 | 0.06639 | -0.00006 |
| 1 | 190.000 | 8.8911-002 | 8.8944-002 | -0.04 | 0.25330 | 0.07952 | 0.07945 | 0.00007 |
| 1 | 200.000 | 1.3872-001 | 1.3885-001 | -0.09 | 0.21977 | 0.09203 | 0.09186 | 0.00017 |
| 1 | 210.000 | 2.0750-001 | 2.0777-001 | -0.13 | 0.18943 | 0.10390 | 0.10367 | 0.00024 |
| 1 | 220.000 | 2.9992-001 | 3.0036-001 | -0.14 | 0.16185 | 0.11517 | 0.11491 | 0.00026 |
| 1 | 230.000 | 4.2172-001 | 4.2230-001 | -0.14 | 0.13667 | 0.12588 | 0.12563 | 0.00025 |
| 1 | 240.000 | 5.8025-001 | 5.8088-001 | -0.11 | 0.11359 | 0.13607 | 0.13586 | 0.00021 |
| 1 | 245.000 | 6.7626-001 | 6.7685-001 | -0.09 | 0.10276 | 0.14098 | 0.14081 | 0.00017 |
| 1 | 250.000 | 7.8551-001 | 7.8599-001 | -0.06 | 0.09236 | 0.14578 | 0.14566 | 0.00012 |
| 10 | 253.150 | 8.6310-001 | 8.6237-001 | 0.08 | 0.08601 | 0.14848 | 0.14865 | -0.00017 |
| 10 | 263.150 | 1.1530+000 | 1.1519+000 | 0.10 | 0.06689 | 0.15771 | 0.15791 | -0.00020 |
| 10 | 273.150 | 1.5370+000 | 1.5359+000 | 0.07 | 0.04916 | 0.16665 | 0.16681 | -0.00017 |
| 10 | 283.150 | 2.0670+000 | 2.0666+000 | 0.02 | 0.03269 | 0.17533 | 0.17538 | -0.00005 |
| 10 | 293.150 | 2.8800+000 | 2.8727+000 | 0.25 | 0.01734 | 0.18285 | 0.18362 | -0.00077 |
| 10 | 298.150 | 3.5020+000 | 3.5014+000 | 0.02 | 0.01005 | 0.18755 | 0.18761 | -0.00006 |
| 10 | 302.150 | 4.3070+000 | 4.3040+000 | 0.07 | 0.00439 | 0.19036 | 0.19069 | -0.00033 |
| 10 | 303.150 | 4.6040+000 | 4.6123+000 | -0.18 | 0.00300 | 0.19241 | 0.19143 | 0.00098 |
| 10 | 304.150 | 5.0350+000 | 5.0389+000 | -0.08 | 0.00162 | 0.19267 | 0.19214 | 0.00053 |
| 10 | 305.150 | 5.9130+000 | 5.9127+000 | 0.01 | 0.00025 | 0.19268 | 0.19275 | -0.00007 |
| 10 | 305.250 | 6.1500+000 | 6.1484+000 | 0.03 | 0.00011 | 0.19233 | 0.19278 | -0.00046 |

NP = 29, RMSPCT = 0.104

Table 16. Ethane vapor data not used for least squares.

| ID | T,K | MOL/L | CALCD | PCNT | Z | YX | YC | YDIF |
|---|---|---|---|---|---|---|---|---|
| 1 | 255.000 | 9.0997-001 | 9.1025-001 | -0.03 | 0.08236 | 0.15046 | 0.15040 | 0.00006 |
| 1 | 260.000 | 1.0522+000 | 1.0521+000 | 0.01 | 0.07275 | 0.15502 | 0.15504 | -0.00002 |
| 1 | 265.000 | 1.2154+000 | 1.2147+000 | 0.06 | 0.06351 | 0.15946 | 0.15959 | -0.00012 |
| 1 | 270.000 | 1.4041+000 | 1.4023+000 | 0.13 | 0.05460 | 0.16377 | 0.16405 | -0.00028 |
| 1 | 275.000 | 1.6245+000 | 1.6207+000 | 0.23 | 0.04602 | 0.16789 | 0.16842 | -0.00053 |
| 1 | 280.000 | 1.8861+000 | 1.8784+000 | 0.41 | 0.03775 | 0.17173 | 0.17271 | -0.00098 |
| 1 | 285.000 | 2.2047+000 | 2.1886+000 | 0.73 | 0.02977 | 0.17504 | 0.17693 | -0.00189 |
| 1 | 290.000 | 2.6107+000 | 2.5736+000 | 1.44 | 0.02206 | 0.17701 | 0.18106 | -0.00405 |
| 6 | 184.500 | 6.8910-002 | 6.8143-002 | 1.12 | 0.27329 | 0.07029 | 0.07235 | -0.00206 |
| 6 | 226.207 | 3.7705-001 | 3.7217-001 | 1.31 | 0.14596 | 0.11923 | 0.12162 | -0.00239 |
| 6 | 234.603 | 4.9353-001 | 4.9022-001 | 0.67 | 0.12581 | 0.12914 | 0.13040 | -0.00126 |
| 6 | 238.921 | 5.6437-001 | 5.6173-001 | 0.47 | 0.11599 | 0.13390 | 0.13478 | -0.00089 |
| 6 | 243.238 | 6.4280-001 | 6.4162-001 | 0.18 | 0.10652 | 0.13873 | 0.13908 | -0.00035 |
| 6 | 248.665 | 7.5717-001 | 7.5546-001 | 0.23 | 0.09509 | 0.14393 | 0.14437 | -0.00044 |
| 6 | 253.042 | 8.6348-001 | 8.5964-001 | 0.45 | 0.08623 | 0.14767 | 0.14855 | -0.00089 |
| 6 | 258.809 | 1.0219+000 | 1.0166+000 | 0.52 | 0.07501 | 0.15288 | 0.15394 | -0.00107 |
| 6 | 263.286 | 1.1611+000 | 1.1564+000 | 0.41 | 0.06664 | 0.15718 | 0.15804 | -0.00086 |
| 6 | 268.732 | 1.3571+000 | 1.3521+000 | 0.37 | 0.05683 | 0.16211 | 0.16292 | -0.00081 |
| 6 | 273.090 | 1.5403+000 | 1.5332+000 | 0.46 | 0.04926 | 0.16572 | 0.16676 | -0.00104 |
| 6 | 278.638 | 1.8108+000 | 1.8037+000 | 0.39 | 0.03997 | 0.17061 | 0.17155 | -0.00094 |
| 6 | 283.576 | 2.0862+000 | 2.0939+000 | -0.36 | 0.03201 | 0.17666 | 0.17574 | 0.00092 |
| 6 | 288.254 | 2.4115+000 | 2.4286+000 | -0.70 | 0.02472 | 0.18155 | 0.17963 | 0.00193 |
| 11 | 283.200 | 2.0685+000 | 2.0698+000 | -0.06 | 0.03261 | 0.17558 | 0.17542 | 0.00016 |
| 11 | 288.190 | 2.4160+000 | 2.4235+000 | -0.31 | 0.02482 | 0.18042 | 0.17957 | 0.00085 |
| 11 | 293.180 | 2.8716+000 | 2.8758+000 | -0.15 | 0.01729 | 0.18409 | 0.18365 | 0.00045 |
| 11 | 295.670 | 3.1543+000 | 3.1589+000 | -0.14 | 0.01363 | 0.18612 | 0.18565 | 0.00048 |
| 11 | 298.170 | 3.5002+000 | 3.5045+000 | -0.12 | 0.01002 | 0.18807 | 0.18763 | 0.00044 |
| 11 | 300.660 | 3.9408+000 | 3.9499+000 | -0.23 | 0.00648 | 0.19052 | 0.18956 | 0.00096 |
| 11 | 302.160 | 4.2943+000 | 4.3067+000 | -0.29 | 0.00438 | 0.19208 | 0.19070 | 0.00138 |
| 11 | 303.160 | 4.6053+000 | 4.6158+000 | -0.23 | 0.00299 | 0.19269 | 0.19144 | 0.00125 |
| 11 | 304.150 | 5.0203+000 | 5.0389+000 | -0.37 | 0.00162 | 0.19464 | 0.19214 | 0.00250 |
| 11 | 304.650 | 5.3276+000 | 5.3544+000 | -0.50 | 0.00093 | 0.19659 | 0.19247 | 0.00412 |
| 11 | 305.150 | 5.8663+000 | 5.9127+000 | -0.78 | 0.00025 | 0.20313 | 0.19275 | 0.01038 |

Table 17. Calculated oxygen vapor densities.

| T,K | R,MOL/L | DR/DT | D2R/DT2 |
|---|---|---|---|
| 54.351 | 3.3612-004 | 9.6727-005 | 2.4354-005 |
| 56.000 | 5.3288-004 | 1.4452-004 | 3.4007-005 |
| 58.000 | 8.9941-004 | 2.2709-004 | 4.9253-005 |
| 60.000 | 1.4644-003 | 3.4449-004 | 6.8929-005 |
| 62.000 | 2.3068-003 | 5.0609-004 | 9.3527-005 |
| 64.000 | 3.5251-003 | 7.2213-004 | 1.2342-004 |
| 66.000 | 5.2388-003 | 1.0035-003 | 1.5884-004 |
| 68.000 | 7.5899-003 | 1.3613-003 | 1.9990-004 |
| 70.000 | 1.0742-002 | 1.8068-003 | 2.4655-004 |
| 72.000 | 1.4883-002 | 2.3511-003 | 2.9868-004 |
| 74.000 | 2.0220-002 | 3.0050-003 | 3.5605-004 |
| 76.000 | 2.6983-002 | 3.7786-003 | 4.1840-004 |
| 78.000 | 3.5421-002 | 4.6817-003 | 4.8543-004 |
| 80.000 | 4.5802-002 | 5.7233-003 | 5.5684-004 |
| 82.000 | 5.8412-002 | 6.9118-003 | 6.3239-004 |
| 84.000 | 7.3552-002 | 8.2554-003 | 7.1185-004 |
| 86.000 | 9.1542-002 | 9.7617-003 | 7.9510-004 |
| 88.000 | 1.1271-001 | 1.1438-002 | 8.8208-004 |
| 90.000 | 1.3741-001 | 1.3293-002 | 9.7286-004 |
| 92.000 | 1.6601-001 | 1.5332-002 | 1.0676-003 |
| 94.000 | 1.9887-001 | 1.7566-002 | 1.1666-003 |
| 96.000 | 2.3641-001 | 2.0002-002 | 1.2703-003 |
| 98.000 | 2.7902-001 | 2.2651-002 | 1.3793-003 |
| 100.000 | 3.2716-001 | 2.5523-002 | 1.4944-003 |
| 102.000 | 3.8127-001 | 2.8633-002 | 1.6164-003 |
| 104.000 | 4.4186-001 | 3.1994-002 | 1.7466-003 |
| 106.000 | 5.0943-001 | 3.5626-002 | 1.8865-003 |
| 108.000 | 5.8455-001 | 3.9548-002 | 2.0377-003 |
| 110.000 | 6.6783-001 | 4.3785-002 | 2.2023-003 |
| 112.000 | 7.5992-001 | 4.8368-002 | 2.3830-003 |
| 114.000 | 8.6155-001 | 5.3330-002 | 2.5829-003 |
| 116.000 | 9.7353-001 | 5.8715-002 | 2.8059-003 |
| 118.000 | 1.0967+000 | 6.4572-002 | 3.0569-003 |
| 120.000 | 1.2322+000 | 7.0965-002 | 3.3422-003 |
| 122.000 | 1.3810+000 | 7.7969-002 | 3.6695-003 |
| 124.000 | 1.5445+000 | 8.5678-002 | 4.0493-003 |
| 126.000 | 1.7243+000 | 9.4210-002 | 4.4951-003 |
| 128.000 | 1.9220+000 | 1.0371-001 | 5.0254-003 |
| 130.000 | 2.1399+000 | 1.1438-001 | 5.6657-003 |
| 132.000 | 2.3805+000 | 1.2647-001 | 6.4520-003 |
| 134.000 | 2.6470+000 | 1.4032-001 | 7.4368-003 |
| 136.000 | 2.9433+000 | 1.5641-001 | 8.6997-003 |
| 138.000 | 3.2745+000 | 1.7539-001 | 1.0366-002 |
| 140.000 | 3.6474+000 | 1.9828-001 | 1.2644-002 |
| 142.000 | 4.0712+000 | 2.2661-001 | 1.5903-002 |
| 144.000 | 4.5592+000 | 2.6300-001 | 2.0854-002 |
| 146.000 | 5.1316+000 | 3.1214-001 | 2.9031-002 |
| 148.000 | 5.8225+000 | 3.8373-001 | 4.4334-002 |
| 150.000 | 6.6967+000 | 5.0204-001 | 7.9575-002 |
| 152.000 | 7.9138+000 | 7.5420-001 | 2.0346-001 |
| 154.000 | 1.0230+001 | 2.0822+000 | 2.4109+000 |
| 154.576 | 1.3630+001 | 0.0000+000 | 0.0000+000 |

| NATIONAL BUREAU OF STANDARDS, CRYOGENIC ENGINEERING LABORATORY<br>LABORATORY NOTE | PROJECT NO. 2750364 | FILE NO. 73-5 | PAGE 25 |
|---|---|---|---|
| SUBJECT The Orthobaric Densities of Ethane, Methane, Oxygen and Fluorine | NAME R.D.Goodwin | | |
| | DATE Sept. 18, 1973 | | |

Table 18. Calculated fluorine vapor densities.

| T,K | R,MOL/L | DR/DT | D2R/DT2 |
|---|---|---|---|
| 53.481 | 5.6700-004 | 1.6771-004 | 4.2852-005 |
| 54.000 | 6.6001-004 | 1.9119-004 | 4.7718-005 |
| 56.000 | 1.1518-003 | 3.0817-004 | 7.0323-005 |
| 58.000 | 1.9272-003 | 4.7699-004 | 9.9683-005 |
| 60.000 | 3.1038-003 | 7.1188-004 | 1.3650-004 |
| 62.000 | 4.8291-003 | 1.0283-003 | 1.8127-004 |
| 64.000 | 7.2821-003 | 1.4424-003 | 2.3426-004 |
| 66.000 | 1.0675-002 | 1.9709-003 | 2.9554-004 |
| 68.000 | 1.5253-002 | 2.6301-003 | 3.6499-004 |
| 70.000 | 2.1293-002 | 3.4361-003 | 4.4236-004 |
| 72.000 | 2.9105-002 | 4.4046-003 | 5.2731-004 |
| 74.000 | 3.9029-002 | 5.5501-003 | 6.1945-004 |
| 76.000 | 5.1434-002 | 6.8869-003 | 7.1844-004 |
| 78.000 | 6.6713-002 | 8.4282-003 | 8.2395-004 |
| 80.000 | 8.5291-002 | 1.0187-002 | 9.3580-004 |
| 82.000 | 1.0761-001 | 1.2176-002 | 1.0539-003 |
| 84.000 | 1.3416-001 | 1.4407-002 | 1.1783-003 |
| 86.000 | 1.6541-001 | 1.6893-002 | 1.3094-003 |
| 88.000 | 2.0191-001 | 1.9649-002 | 1.4475-003 |
| 90.000 | 2.4420-001 | 2.2689-002 | 1.5935-003 |
| 92.000 | 2.9286-001 | 2.6029-002 | 1.7482-003 |
| 94.000 | 3.4852-001 | 2.9688-002 | 1.9129-003 |
| 96.000 | 4.1184-001 | 3.3688-002 | 2.0893-003 |
| 98.000 | 4.8352-001 | 3.8054-002 | 2.2793-003 |
| 100.000 | 5.6432-001 | 4.2816-002 | 2.4854-003 |
| 102.000 | 6.5507-001 | 4.8009-002 | 2.7105-003 |
| 104.000 | 7.5667-001 | 5.3674-002 | 2.9585-003 |
| 106.000 | 8.7012-001 | 5.9861-002 | 3.2339-003 |
| 108.000 | 9.9651-001 | 6.6631-002 | 3.5426-003 |
| 110.000 | 1.1371+000 | 7.4058-002 | 3.8918-003 |
| 112.000 | 1.2932+000 | 8.2232-002 | 4.2910-003 |
| 114.000 | 1.4666+000 | 9.1264-002 | 4.7523-003 |
| 116.000 | 1.6590+000 | 1.0129-001 | 5.2919-003 |
| 118.000 | 1.8725+000 | 1.1250-001 | 5.9315-003 |
| 120.000 | 2.1099+000 | 1.2511-001 | 6.7013-003 |
| 122.000 | 2.3741+000 | 1.3942-001 | 7.6437-003 |
| 124.000 | 2.6690+000 | 1.5584-001 | 8.8210-003 |
| 126.000 | 2.9992+000 | 1.7492-001 | 1.0328-002 |
| 128.000 | 3.3709+000 | 1.9746-001 | 1.2313-002 |
| 130.000 | 3.7921+000 | 2.2465-001 | 1.5026-002 |
| 132.000 | 4.2739+000 | 2.5834-001 | 1.8913-002 |
| 134.000 | 4.8319+000 | 3.0165-001 | 2.4841-002 |
| 136.000 | 5.4905+000 | 3.6028-001 | 3.4720-002 |
| 138.000 | 6.2909+000 | 4.4628-001 | 5.3532-002 |
| 140.000 | 7.3133+000 | 5.9079-001 | 9.8476-002 |
| 142.000 | 8.7644+000 | 9.1469-001 | 2.7251-001 |
| 144.000 | 1.1893+001 | 3.5620+000 | 7.7289+000 |
| 144.310 | 1.5150+001 | 0.0000+000 | 0.0000+000 |

| NATIONAL BUREAU OF STANDARDS, CRYOGENIC ENGINEERING LABORATORY LABORATORY NOTE | PROJECT NO. 2750364 | FILE NO. -73-5 | PAGE 26 |
|---|---|---|---|
| SUBJECT The Orthobaric Densities of Ethane, Methane, Oxygen and Fluorine | NAME R.D.Goodwin | DATE Sept. 18, 1973 | |

Table 19. Calculated methane vapor densities.

| T,K | R,MOL/L | DR/DT | D2R/DT2 |
|---|---|---|---|
| 90.680 | 1.5679-002 | 1.8523-003 | 1.7385-004 |
| 92.000 | 1.8280-002 | 2.0919-003 | 1.8937-004 |
| 94.000 | 2.2858-002 | 2.4952-003 | 2.1409-004 |
| 96.000 | 2.8294-002 | 2.9492-003 | 2.4020-004 |
| 98.000 | 3.4691-002 | 3.4569-003 | 2.6763-004 |
| 100.000 | 4.2159-002 | 4.0206-003 | 2.9634-004 |
| 102.000 | 5.0813-002 | 4.6430-003 | 3.2628-004 |
| 104.000 | 6.0772-002 | 5.3265-003 | 3.5744-004 |
| 106.000 | 7.2161-002 | 6.0736-003 | 3.8980-004 |
| 108.000 | 8.5110-002 | 6.8866-003 | 4.2339-004 |
| 110.000 | 9.9753-002 | 7.7680-003 | 4.5823-004 |
| 112.000 | 1.1623-001 | 8.7204-003 | 4.9439-004 |
| 114.000 | 1.3468-001 | 9.7465-003 | 5.3195-004 |
| 116.000 | 1.5527-001 | 1.0849-002 | 5.7100-004 |
| 118.000 | 1.7813-001 | 1.2032-002 | 6.1170-004 |
| 120.000 | 2.0345-001 | 1.3297-002 | 6.5420-004 |
| 122.000 | 2.3138-001 | 1.4650-002 | 6.9870-004 |
| 124.000 | 2.6211-001 | 1.6093-002 | 7.4545-004 |
| 126.000 | 2.9582-001 | 1.7633-002 | 7.9471-004 |
| 128.000 | 3.3271-001 | 1.9274-002 | 8.4681-004 |
| 130.000 | 3.7299-001 | 2.1023-002 | 9.0214-004 |
| 132.000 | 4.1687-001 | 2.2885-002 | 9.6113-004 |
| 134.000 | 4.6461-001 | 2.4870-002 | 1.0243-003 |
| 136.000 | 5.1644-001 | 2.6986-002 | 1.0922-003 |
| 138.000 | 5.7264-001 | 2.9242-002 | 1.1657-003 |
| 140.000 | 6.3351-001 | 3.1652-002 | 1.2454-003 |
| 142.000 | 6.9937-001 | 3.4229-002 | 1.3325-003 |
| 144.000 | 7.7055-001 | 3.6988-002 | 1.4280-003 |
| 146.000 | 8.4745-001 | 3.9948-002 | 1.5335-003 |
| 148.000 | 9.3049-001 | 4.3130-002 | 1.6506-003 |
| 150.000 | 1.0201+000 | 4.6559-002 | 1.7815-003 |
| 152.000 | 1.1169+000 | 5.0267-002 | 1.9288-003 |
| 154.000 | 1.2214+000 | 5.4288-002 | 2.0957-003 |
| 156.000 | 1.3343+000 | 5.8665-002 | 2.2865-003 |
| 158.000 | 1.4563+000 | 6.3453-002 | 2.5065-003 |
| 160.000 | 1.5884+000 | 6.8715-002 | 2.7627-003 |
| 162.000 | 1.7316+000 | 7.4534-002 | 3.0643-003 |
| 164.000 | 1.8870+000 | 8.1011-002 | 3.4240-003 |
| 166.000 | 2.0561+000 | 8.8280-002 | 3.8592-003 |
| 168.000 | 2.2408+000 | 9.6514-002 | 4.3945-003 |
| 170.000 | 2.4430+000 | 1.0595-001 | 5.0661-003 |
| 172.000 | 2.6656+000 | 1.1691-001 | 5.9289-003 |
| 174.000 | 2.9119+000 | 1.2985-001 | 7.0695-003 |
| 176.000 | 3.1867+000 | 1.4546-001 | 8.6322-003 |
| 178.000 | 3.4963+000 | 1.6482-001 | 1.0873-002 |
| 180.000 | 3.8497+000 | 1.8973-001 | 1.4288-002 |
| 182.000 | 4.2610+000 | 2.2344-001 | 1.9949-002 |
| 184.000 | 4.7537+000 | 2.7274-001 | 3.0592-002 |
| 186.000 | 5.3730+000 | 3.5464-001 | 5.5251-002 |
| 188.000 | 6.2307+000 | 5.3071-001 | 1.4281-001 |
| 190.000 | 7.8668+000 | 1.4868+000 | 1.7833+000 |
| 190.555 | 1.0200+001 | 0.0000+000 | 0.0000+000 |

Table 20. Calculated ethane vapor densities.

ETHANE SATURATED VAPOR DENSITIES

| T,K | R,MOL/L | DR/DT | D2R/DT2 |
|---|---|---|---|
| 89.899 | 1.3511-006 | 3.4418-007 | 7.9422-008 |
| 90.000 | 1.3863-006 | 3.5229-007 | 8.1081-008 |
| 95.000 | 4.5944-006 | 1.0378-006 | 2.1037-007 |
| 100.000 | 1.3356-005 | 2.6924-006 | 4.8256-007 |
| 105.000 | 3.4683-005 | 6.2648-006 | 9.9665-007 |
| 110.000 | 8.1696-005 | 1.3276-005 | 1.8818-006 |
| 115.000 | 1.7684-004 | 2.5955-005 | 3.2903-006 |
| 120.000 | 3.5568-004 | 4.7323-005 | 5.3851-006 |
| 125.000 | 6.7091-004 | 8.1216-005 | 8.3256-006 |
| 130.000 | 1.1963-003 | 1.3223-004 | 1.2254-005 |
| 135.000 | 2.0304-003 | 2.0559-004 | 1.7283-005 |
| 140.000 | 3.2990-003 | 3.0703-004 | 2.3493-005 |
| 145.000 | 5.1575-003 | 4.4257-004 | 3.0926-005 |
| 150.000 | 7.7918-003 | 6.1835-004 | 3.9592-005 |
| 155.000 | 1.1418-002 | 8.4051-004 | 4.9474-005 |
| 160.000 | 1.6284-002 | 1.1151-003 | 6.0539-005 |
| 165.000 | 2.2666-002 | 1.4478-003 | 7.2744-005 |
| 170.000 | 3.0869-002 | 1.8443-003 | 8.6050-005 |
| 175.000 | 4.1225-002 | 2.3101-003 | 1.0043-004 |
| 180.000 | 5.4094-002 | 2.8504-003 | 1.1588-004 |
| 185.000 | 6.9862-002 | 3.4707-003 | 1.3243-004 |
| 190.000 | 8.8944-002 | 4.1767-003 | 1.5014-004 |
| 195.000 | 1.1178-001 | 4.9742-003 | 1.6912-004 |
| 200.000 | 1.3885-001 | 5.8703-003 | 1.8956-004 |
| 205.000 | 1.7066-001 | 6.8727-003 | 2.1170-004 |
| 210.000 | 2.0777-001 | 7.9907-003 | 2.3587-004 |
| 215.000 | 2.5078-001 | 9.2355-003 | 2.6252-004 |
| 220.000 | 3.0036-001 | 1.0621-002 | 2.9224-004 |
| 225.000 | 3.5725-001 | 1.2164-002 | 3.2581-004 |
| 230.000 | 4.2230-001 | 1.3887-002 | 3.6425-004 |
| 235.000 | 4.9647-001 | 1.5817-002 | 4.0894-004 |
| 240.000 | 5.8088-001 | 1.7990-002 | 4.6176-004 |
| 245.000 | 6.7685-001 | 2.0453-002 | 5.2532-004 |
| 250.000 | 7.8599-001 | 2.3267-002 | 6.0330-004 |
| 255.000 | 9.1025-001 | 2.6519-002 | 7.0116-004 |
| 260.000 | 1.0521+000 | 3.0325-002 | 8.2712-004 |
| 265.000 | 1.2147+000 | 3.4858-002 | 9.9430-004 |
| 270.000 | 1.4023+000 | 4.0373-002 | 1.2246-003 |
| 275.000 | 1.6207+000 | 4.7273-002 | 1.5572-003 |
| 280.000 | 1.8784+000 | 5.6239-002 | 2.0691-003 |
| 285.000 | 2.1886+000 | 6.8532-002 | 2.9298-003 |
| 290.000 | 2.5736+000 | 8.6820-002 | 4.5876-003 |
| 295.000 | 3.0777+000 | 1.1813-001 | 8.6241-003 |
| 300.000 | 3.8180+000 | 1.9083-001 | 2.5135-002 |
| 305.000 | 5.6689+000 | 1.2377+000 | 2.4827+000 |
| 305.330 | 6.8700+000 | 0.0000+000 | 0.0000+000 |

| NATIONAL BUREAU OF STANDARDS, CRYOGENIC ENGINEERING LABORATORY LABORATORY NOTE | PROJECT NO. 2750364 | FILE NO. 73-5 | PAGE 28 |
|---|---|---|---|
| SUBJECT The Orthobaric Densities of Ethane, Methane, Oxygen and Fluorine | NAME R.D.Goodwin | | |
| | DATE Sept. 18, 1973 | | |

10/10/73

```
      PROGRAM LICKFIT
C     REPRESENT ETHANE SATURATED LIQUID DENSITIES.
C     DEFINE X = (TC-T)/TC-TT),  Q = X**1/3,  XE = X**E,  AND -
C     DEFINE  YY = (D-DC)/(DT-DC),  WHEN THE EQN. IS -
C     (YY-X)/(XE-X) = A1 + A2*Q2 + A3*Q3 + . . .
C     DCRT = 6.86, 6.87 POSSIBLY VIA MY VAPORDEN EQN.
C     DTRP = 21.68 ESTIM. VIA REID C. MILLER.
C     ID, (9)TESTER, (10)DOUSLIN, (11)SLIWINSKI, (12)CANFIELD ET AL.,
C     ID, (13)KLOSEK, (14)MILLER, (15)EUBANK, (16)TOMLINSON
      COMMON E,AZ,TTRP,TCRT,DTRP,DCRT, DRDT,D2RDT2, A(6)
      COMMON/999/NP,NF,H(15),Y(200),G(200,15)
      DIMENSION ID(99),T(99),DEN(99), U(99),W(99),XQ(99)
    1 FORMAT(I5, 2F10.0)
    2 FORMAT(1H1 13X 1HE 8X2HAZ 6X4HDCRT 8X2HSS)
    3 FORMAT(5X 4F10.3)
    4 FORMAT(1H1 17X *ETHANE SATURATED LIQUID DENSITIES, E =* F6.3//
     1 20X 6HTCRT =F8.3, 8H, TTRP =F8.4//
     2 20X 6HDCRT =F8.3, 8H, DTRP =F8.4// 2(13X 3E15.7/) /
     3 8X2HID 7X3HT,K 5X5HMOL/L 6X4HCALC 4X4HPCNT
     4 14X 1HX 8X2HYX 8X2HYC 6X4HYDIF )
    5 FORMAT(5X I5, 3F10.3, F8.2, F15.5, 3F10.5)
    6 FORMAT(1H1 16X *ETHANE SATURATED LIQUID DENSITIES* //
     1 17X 3HT,K 3X7HR,MOL/L 5X5HDR/DT 3X7HD2R/DT2 )
    7 FORMAT(10X 2F10.3, F10.4, F10.5)
    9 FORMAT(18X 4HNP =I3, 10H, RMSPCT =F7.3/)
C
C     DO ALL FOUR,  OXYGEN, FLUORINE, METHANE, AND ETHANE.
   10 DO 99 IG=1,4  $  GOTO(11,13,15,17),IG
C     CONSTANTS FOR OXYGEN.
   11 TTRP=54.3507 $ TCRT=154.576 $ TZ=52 $ DT=2 $ NZ=52
   12 DTRP=40.63 $ DCRT=13.63 $ DZ=13.58 $ EZ=0.340  $  GOTO 19
C     CONSTANTS FOR FLUORINE.
   13 TTRP=53.4811 $ TCRT=144.31 $ TZ=50 $ DT=2 $ NZ=48
   14 DTRP=44.6623 $ DCRT=15.15 $ DZ=15.10 $ EZ=0.342 $ GOTO 19
C     CONSTANTS FOR METHANE.
   15 TTRP=90.680 $ TCRT=190.555 $ TZ=88 $ DT=2 $ NZ=52
   16 DTRP=28.147      $ DCRT=10.20 $ DZ=10.05 $ EZ=0.350 $ GOTO 19
C     CONSTANTS FOR ETHANE.
   17 TTRP=89.899 $ TCRT=305.33 $ TZ=80 $ DT=5 $ NZ=46
   18 DTRP=21.68 $ DCRT= 6.87 $ DZ= 6.82 $ EZ=0.349
   19 XN = TCRT-TTRP  $  YN = DTRP-DCRT
C     READ NP DATA FOR LEAST SQUARES.
C     READ L.A.WEBER S  OXYGEN VOLUMES, CC/MOL.
   20 DO 27 J=1,99  $  READ 1, ID(J),T(J),DEN(J)  $  IF(ID(J)) 21,28
   21 IF(ID(J)-15) 23,22
   22 CONTINUE
   23 IF(ID(J)-99) 25,24
   24 DEN(J) = 1000/DEN(J)
   25 U(J) = X = (TCRT-T(J))/XN  $  Q = CUBERTF(X)  $  DO 26 K=2,6
   26 G(J,K) = Q**K  $  G(J,1) = 1
   27 W(J) = (DEN(J)-DCRT)/YN
   28 NPP = NP = J-1  $  NF = 3  $  E = 0.36
C     EXPLORE E, AZ, AND DCRT.
   29 AZ = NF  $  SSK = 1.0E+010
   30 DO 49 IE=1,21  $  E = EZ + 0.001*IE
```

```
:        LICKFIT                                                    10/10/73

C     SET UP THE LEAST SQUARES ARRAYS.
   36 DO 40 J=1,NP   $   X = U(J)   $   XQ(J) = XE = X**E
   37 Y(J) = (W(J)-X)/(XE-X)
   40 CONTINUE $ CALL EGENFT $ SS=0 $ DO 43 J=1,NP $ YC=0 $ DO 41 K=1,NF
   41 YC = YC + H(K)*G(J,K)   $   X = U(J)   $   XE = XQ(J)
   42 DC = DCRT + (X + (XE-X)*YC)*YN
   43 SS = SS + (DEN(J)/DC-1)**2   $   SS = 100*SQRTF(SS/NP)
   44 IF(SS.LT.SSK) 45,48
   45 SSK=SS $ EK=E $ AZK=AZ $ DK=DCRT
   46 DO 47 K=1,6
   47 A(K) = H(K)
   48 CONTINUE
   49 CONTINUE
   50 E=EK $ AZ=AZK $ DCRT=DK   $   YN = DTRP - DCRT
C     USE SAVED CONSTANTS FOR DEVIATIONS.
   60 PRINT 4, E,TCRT,TTRP,DCRT,DTRP,(A(K),K=1,6)   $   SS = 0
   61 DO 70 J=1,NPP   $   X = U(J)   $   XE = X**E   $   XEX = XE-X
   62 YC = 0   $   DO 63 K=1,NF
   63 YC = YC + A(K)*G(J,K)
   64 YS = X + XEX*YC   $   DC = DCRT + YN*YS
   65 YX = (W(J)-X)/XEX   $   YD = YX-YC
   66 PCT = 100*(DEN(J)/DC-1)   $   SS = SS + PCT**2
   67 PRINT 5, ID(J),T(J),DEN(J), DC,PCT, X,YX,YC,YD
   68 IF(J-NP) 70,69
   69 SS = SQRTF(SS/NP)   $   PRINT 9, NP, SS
   70 CONTINUE
C     PRINT UNIFORM TABLE FOR PUBLICATION.
   71 PRINT 6   $   DO 80 J=1,NZ   $   IF(J-1) 73,72
   72 TT = TTRP   $   GO TO 76
   73 IF(J-NZ) 75,74
   74 TT = TCRT   $   GO TO 76
   75 TT = TZ + DT*J
   76 R = DENLIQF(TT)
   80 PRINT 7, TT,R,DRDT,D2RDT2
   99 CONTINUE
C     DO OTHER ETHANE DATA WITH EXISTING COEFFICIENTS.
  100 PRINT 4, E,TCRT,TTRP,DCRT,DTRP,(A(K),K=1,6)   $   SS = 0
  101 DO 110 J=1,99   $   READ 1, IDD,TT,DN   $   IF(IDD) 102,999
  102 X=(TCRT-TT)/XN $ Q=CUBERTF(X) $ XE=X**E $ XEX=XE-X
  103 YC = A(1)   $   DO 104 K=2,NF
  104 YC = YC + A(K)*Q**K
  105 DC = DCRT + YN*(X+XEX*YC)   $   PCT = 100*(DN/DC-1)
  106 YY = (DN-DCRT)/YN   $   YX = (YY-X)/XEX   $   YD = YX-YC
  110 PRINT 5, IDD,TT,DN, DC,PCT, X,YX,YC,YD
  999 STOP   $   END
```

10/10/73

```
      PROGRAM VAPORFIT
C     REPRESENT ETHANE SATURATED VAPOR DENSITIES.
C     THIS FORM IS CONSTRAINED AT THE TRIPLE POINT, AND
C     DEFINE X(T) AS FOR THE VAPOR PRESSURE EQUATION -
C     Z = (1-X) = (TC/T-1)/(TC/TT-1),  ZE = Z**E, Q = Z**1/3,  AND -
C     DEFINE YY = LN(DC/D)/LN(DC/DT), AND THE DEPENDENT VARIABLE -
C     Y(Z,YY) = (YY-Z)/(ZE-Z),  WHEN THE L.S. EQN. IS -
C     Y(Z,YY) = A1 + A2*Q2 + A3*Q3 + A4*Q4 + . . .
C     ID., (1)VIRIAL/V.P., (6)PORTER, (10)DOUSLIN, (11)SLIWINSKI.
      COMMON E,AL, TTRP,TCRT, DTRP,DCRT, DRDT,D2RDT2, A(9)
      COMMON/999/NP,NF,H(15),Y(200),G(200,15)
      DIMENSION ID(99),T(99),DEN(99), U(99),W(99), ZQ(99)
    1 FORMAT(I5, F10.0, E15.5)
    2 FORMAT(1H1 18X 1HE 8X2HAL 6X4HDCRT 8X2HSS)
    3 FORMAT(10X 4F10.3)
    4 FORMAT(1H1 17X *ETHANE SATURATED VAPOR DENSITIES, E =* F6.3//
     1 20X   6HTCRT =F8.3, 8H, TTRP =F8.4/
     2 20X   6HDCRT =F8.3, 8H, DTRP =E12.5// 2(13X 4E15.7/) /
     2 8X2HID 7X3HT,K 8X5HMOL/L 8X5HCALCD 4X4HPCNT
     3 12X 1HZ 8X2HYX 8X2HYC 6X4HYDIF )
    5 FORMAT(5X I5, F10.3, 2E13.4, F8.2, F13.5, 3F10.5)
    6 FORMAT(I5, 2F10.0)
    7 FORMAT(1H1 16X *ETHANE SATURATED VAPOR DENSITIES* //
     1 17X 3HT,K 6X7HR,MOL/L 8X5HDR/DT 6X7HD2R/DT2 )
    8 FORMAT(10X F10.3, 3E13.4)
    9 FORMAT(18X 4HNP =I3, 10H, RMSPCT =F7.3/)
   61 FORMAT(1H1 7X2HID 7X3HT,K 8X5HMOL/L 8X5HCALCD 4X4HPCNT
     1 12X 1HZ 8X2HYX 8X2HYC 6X4HYDIF )
C
C     DO ALL FOUR, OXYGEN, FLUORINE, METHANE, ETHANE.
   10 DO 31 IG=1,4  $  GOTO(11,13,15,17),IG
C     CONSTANTS FOR OXYGEN.
   11 TTRP=54.3507 $ TCRT=154.576 $ TZ=52 $ DT=2 $ NZ=52
   12 DTRP=3.36122E-4 $ DCRT=13.63 $ DZ=13.58 $ EZ=0.360 $ GOTO 19
C     CONSTANTS FOR FLUORINE.
   13 TTRP=53.4811 $ TCRT=144.31 $ TZ=50 $ DT=2 $ NZ=48
   14 DTRP=5.670E-4 $ DCRT=15.15 $ DZ=15.10 $ EZ=0.340   $  GOTO 19
C     CONSTANTS FOR METHANE.
   15 TTRP=90.680 $ TCRT=190.555 $ TZ=88 $ DT=2 $ NZ=52
   16 DTRP=0.01567865 $ DCRT=10.20 $ DZ=10.05 $ EZ=0.360 $ GOTO 19
C     CONSTANTS FOR ETHANE.
C     OMIT 24, AND FIX DTRP.
   17 TTRP=89.899 $ TCRT=305.33 $ TZ=80 $ DT=5 $ NZ=46
   18 DTRP=        1.35114E-6 $ DCRT=6.87 $ DZ=6.84 $ EZ=0.340
   19 ZN = TCRT/TTRP-1  $  YN = LOGF(DCRT/DTRP)
C     READ OUR ID(1) DATA MIXED WITH DOUSLIN.
C     INCREASE OUR DEN BY 0.15 PCT TO AGREE WITH DOUSLIN.
   20 DO 27 J=1,200  $  IF(IG-4) 22,21
   21 READ 1, ID(J),T(J),DEN(J)  $  IF(ID(J)) 23,28
   22 READ 6, ID(J),T(J),DEN(J)  $  IF(ID(J)) 25,28
   23 IF(ID(J)-1) 25,24
   24 CONTINUE
   25 U(J) = Z = (TCRT/T(J)-1)/ZN  $  Q = CUBERTF(Z)  $  DO 26 K=2,7
   26 G(J,K) = Q**K  $  G(J,1) = 1
   27 W(J) = LOGF(DCRT/DEN(J))/YN
```

| NATIONAL BUREAU OF STANDARDS, CRYOGENIC ENGINEERING LABORATORY LABORATORY NOTE | PROJECT NO. 2750364 | FILE NO. 73-5 | PAGE 31 |
|---|---|---|---|
| SUBJECT The Orthobaric Densities of Ethane, Methane, Oxygen and Fluorine | NAME R.D.Goodwin | | |
| | DATE Sept. 18, 1973 | | |

```
      VAPORFIT                                                      10/10/73

   28 NP = J-1  $  AL = NF = 5  $  E = 0.360
C     EXPLORE DCRT, AND EXPONENT E.
   33 SSK = 1.0E+010
   34 DO 48 IE=1,21  $  E = EZ + 0.002*IE
C     SET UP THE ARRAYS FOR LEAST SQUARES.
   36 DO 39 J=1,NP  $  Z = U(J)  $  ZQ(J) = ZE = Z**E
   37 Y(J) = (W(J)-Z)/(ZE-Z)
   39 CONTINUE  $  CALL EGENFT  $  SS = 0
C     NOW GET THE RMS DEVIATION.
   40 DO 44 J=1,NP  $  YC = 0  $  DO 41 K=1,NF
   41 YC = YC + H(K)*G(J,K)
   42 Z = U(J)  $  YS = Z + (ZQ(J)-Z)*YC
   43 DC = DCRT*EXPF(-YN*YS)
   44 SS = SS + (DC/DEN(J)-1)**2  $  SS = 100*SQRTF(SS/NP)
   45 IF(SS.LT.SSK) 46,48
   46 SSK=SS $ EK=E $ ALK=AL $ DK=DCRT  $  DO 47 K=1,9
   47 A(K) = H(K)
   48 CONTINUE
   49 E=EK $ AL=ALK $ DCRT=DK  $  YN = LOGF(DK/DTRP)
C     USE SAVED CONSTANTS FOR DEVIATIONS.
   50 PRINT 4, E,TCRT,TTRP,DCRT,DTRP,(A(K),K=1,8)  $  SS = 0
   51 DO 59 J=1,NP  $  Z = U(J)  $  ZE = Z**E  $  ZEZ = ZE - Z
   52 YC = 0  $  DO 53 K=1,NF
   53 YC = YC + A(K)*G(J,K)
   54 YS = Z + ZEZ*YC  $  DC = DCRT*EXPF(-YN*YS)
   55 YX = (W(J)-Z)/ZEZ  $  YD = YX - YC
   56 PCT = 100*(DEN(J)/DC-1)  $  SS = SS + PCT**2
   57 IF(IG.EQ.3.AND.J.EQ.48) 58,59
   58 PRINT 61
   59 PRINT 5, ID(J),T(J),DEN(J), DC,PCT, Z,YX,YC,YD
   60 SS = SQRTF(SS/NP)  $  PRINT 9, NP, SS
C     PRINT UNIFORM TABLE FOR PUBLICATION.
   71 PRINT 7  $  DO 80 J=1,NZ  $  IF(J-1) 73,72
   72 TT = TTRP  $  GO TO 76
   73 IF(J-NZ) 75,74
   74 TT = TCRT  $  GO TO 76
   75 TT = TZ + DT*J
   76 R = DENGASF(TT)
   80 PRINT 8, TT,R, DRDT, D2RDT2
   81 CONTINUE  $  PRINT 61
C     DO OTHER ETHANE DATA WITH EXISTING COEFFICIENTS.
   82 DO 88 J=1,99  $  READ 6, IDD,TT,DN  $  IF(IDD) 83,99
   83 Z = (TCRT/TT-1)/ZN  $  ZE = Z**E  $  ZEZ = ZE - Z
   84 Q = CUBERTF(Z)  $  YC = A(1)  $  DO 85 K=2,NF
   85 YC = YC + A(K)*Q**K
   86 YY = LOGF(DCRT/DN)/YN  $  YX = (YY-Z)/ZEZ  $  YD = YX-YC
   87 DC = DCRT*EXPF(-YN*(Z+ZEZ*YC))  $  PCT = 100*(DN/DC-1)
   88 PRINT 5, IDD,TT,DN, DC,PCT, Z,YX,YC,YD
   99 STOP  $  END
```

| NATIONAL BUREAU OF STANDARDS, CRYOGENIC ENGINEERING LABORATORY<br>LABORATORY NOTE | PROJECT NO.<br>2750364 | FILE NO.<br>73-5 | PAGE<br>32 |
|---|---|---|---|
| SUBJECT The Orthobaric Densities of Ethane, Methane, Oxygen and Fluorine | NAME R.D. Goodwin | | |
| | DATE Sept. 18, 197[illegible] | | |

10/10/73

```
      FUNCTION DENLIQF(T)
C     ETHANE SATURATED LIQUID DENSITIES, MOL/L.
C     Y = A1 + A2*Q2 + A3*Q3 + . . . ,  YN = DTRP-DCRT,
C     DEN = DCRT + YN*(X + (XE-X)*Y).
      COMMON E,AZ,TTRP,TCRT,DTRP,DCRT, DRDT,D2RDT2, A(6)
    1 FORMAT(1H0 9X *DENLIQF = 0, T EXCEEDS TCRT. * / )
    2 IF(TCRT-T) 3,4,5
    3 PRINT 1   $   STOP
    4 DENLIQF=DCRT  $  DRDT=D2RDT2=0  $  RETURN
    5 XN=TCRT-TTRP $ YN=DTRP-DCRT $ X=(TCRT-T)/XN $ DXDT=-1/XN
    6 XE = X**E   $   XE1 = E*XE/X   $   XE2 = (E-1)*XE1/X
    7 W = CUBERTF(X)   $   W1 = W/3/X   $   W2 = -2*W1/3/X
    8 Q = XE-X   $   Q1 = XE1 - 1   $   Q2 = XE2
    9 NF = AZ   $   Y = A(1)   $   Y1 = Y2 = 0   $   DO 11 K=2,NF
   10 Y = Y + A(K)*W**K   $   Y1 = Y1 + K*A(K)*W**(K-1)
   11 Y2 = Y2 + K*(K-1)*A(K)*W**(K-2)
   12 Y2 = Y1*W2 + Y2*W1**2   $   Y1 = Y1*W1
   13 DENLIQF = DCRT + (X + Q*Y)*YN
   14 DRDT = (1 + Q*Y1 + Q1*Y)*YN*DXDT
   15 D2RDT2 = (Q*Y2 + 2*Q1*Y1 + Q2*Y)*YN*DXDT**2   $   RETURN   $   END
```

10/10/73

```
      FUNCTION DENGASF(T)
C     ETHANE SATURATED VAPOR DENSITIES, MOL/L.
C     Y = A1 + A2*Q2 + A3*Q3 + . . ,   NF = AL,   YN = LN(DCRT/DTRP),
C     U = Z + (ZE-Z)*Y,    DEN = DCRT*EXP(-YN*U).
C     NOTE THAT Z = 0 ONLY AT T = TCRT, WHICH IS EXCLUDED.
      COMMON E,AL, TTRP,TCRT, DTRP,DCRT, DRDT,D2RDT2, A(9)
    1 FORMAT(1H0 9X *DENGASF = 0, T EXCEEDS TCRT. * / )
    2 IF(TCRT-T) 3,4,5
    3 PRINT 1   $   STOP
    4 DENGASF = DCRT   $   DRDT = D2RDT2 = 0   $   RETURN
    5 ZN=TCRT/TTRP-1   $   YN=LOGF(DCRT/DTRP) $   Z=(TCRT/T-1)/ZN
    6 DZDT = -TCRT/ZN/T**2   $   D2ZDT2 = -2*DZDT/T
    7 ZE = Z**E   $   ZE1 = E*ZE/Z   $   ZE2 = (E-1)*ZE1/Z
    8 X = ZE-Z   $   X1 = ZE1 - 1   $   X2 = ZE2
    9 Q = CUBERTF(Z)   $   Q1 = Q/3/Z   $   Q2 = -2*Q1/3/Z
   10 NF = AL   $   Y = A(1)   $   Y1 = Y2 = 0   $   DO 13 K=2,NF
   11 Y = Y + A(K)*Q**K
   12 Y1 = Y1 + K*A(K)*Q**(K-1)
   13 Y2 = Y2 + K*(K-1)*A(K)*Q**(K-2)
   14 Y2 = Y1*Q2 + Y2*Q1**2   $   Y1 = Y1*Q1
   15 U = Z + X*Y   $   UA = 1 + X*Y1 + X1*Y   $   U1 = UA*DZDT
   16 U2 = UA*D2ZDT2 + (X*Y2 + 2*X1*Y1 + X2*Y)*DZDT**2
   17 XP = EXPF(-YN*U)   $   DENGASF = F = DCRT*XP   $   YU = -YN*U1
   18 DRDT = YU*F   $   D2RDT2 = (YU*YU-YN*U2)*F   $   RETURN   $   END
```

COMM-DC

| Cryogenics Division—NBS Institute for Basic Standards LABORATORY NOTE | COST CENTER 2750364 | FILE NO 73-6 | PAGE |
|---|---|---|---|
| SUBJECT Liquid-Vapor Saturation (Orthobaric) Temperatures of Ethane and Methane | NAME R.D. Goodwin | | |
| | DATE Nov. 28, 1973 | | |

## 1. Introduction.

The present, new investigation has been necessary to accommodate the extreme range of ethane saturated vapor densities (a factor of $10^7$). Our previous work on ethane appears in Lab. Notes 73-2, 3, 4, 5.

Analytical description of the two-phase, liquid-vapor equilibrium (temperature-density relationship) is needed for our new equation of state which originates on this locus (NBS IR 73-342). In particular, the forms used below give the important property that all derivatives are zero at the critical point.

In the following we split the range, using different functions according $\rho \lessgtr \rho_c$. In each case the dependent variable is

$$Y(T) \equiv (T_c/T-1)/(T_c/T_t-1) \tag{1}$$

The symbols used here appear in a LIST.

## 2. The Saturated Vapor Temperatures.

The analytical formulation is

$$Y(T) = U(\sigma) \cdot [1 + A_0 \cdot \ln(\sigma/\sigma_g) + W(\sigma)] \tag{2}$$

where

$$U(\sigma) \equiv \exp[\alpha \cdot (u_g - u)], \tag{2-a}$$

and

$$W(\sigma) = \sum_{i=1}^{n} A_i \cdot (q^i - q_g^i). \tag{2-b}$$

The notation is $q = \sigma^{1/3}$, $q_g = \sigma_g^{1/3}$, and $u_g = 1/|\sigma_g - 1|$.

This equation is constrained at the vapor triple point.

Fixed-point constants are given by table 1, and coefficients by table 2. The comparisons of results for ethane and for methane are in tables 3,5. Deviations necessarily are systematic because the "data" are smoothed analytically (Lab. Note 73-5). We believe all deviations to be well within the real accuracy of the data.

## 3. The Saturated Liquid Temperatures.

The analytical formulation is

$$\ln(Y) = \beta \cdot (u_t - u) + W(\sigma) \tag{3}$$

where

$$W(\sigma) = \sum_{i=1}^{n} B_i \cdot (x^i - x_t^i). \tag{3-a}$$



☆ U.S. GOVERNMENT PRINTING OFFICE 1973 — # 780-339

| Cryogenics Division–NBS Institute for Basic Standards LABORATORY NOTE | COST CENTER 2750364 | FILE NO 73-6 | PAGE 2 |
|---|---|---|---|
| SUBJECT Liquid-Vapor Saturation (Orthobaric) Temperatures of Ethane and Methane | NAME R.D. Goodwin | | |
| | DATE Nov. 28, 1973 | | |

The notation is $x_t \equiv |\sigma_t - 1|$, $u_t \equiv 1/x_t$ .

This equation is constrained at the liquid triple point.

The comparisons of results for ethane and for methane are in tables 4,6. Computer programs are attached.

## LIST OF SYMBOLS

| | | |
|---|---|---|
| $d$, | density, mol/ℓ, | DEN |
| $d_c$, | critical-point density, | DCRT |
| $d_g$, | vapor triple-point density, | DGAT |
| $d_t$, | liquid triple-point density, | DTRP |
| $q$, | $\sigma^{1/3}$, $q_g \equiv \sigma_g^{1/3}$ | |
| $\rho$, | $d/d_t$, density reduced at liquid triple point | |
| $\sigma$, | $d/d_c$, density reduced at the critical point | |
| $\sigma_g$, | $d_g/d_c$, reduced triple-point vapor density | |
| $\sigma_t$, | $d_t/d_c$, reduced triple-point liquid density | |
| $T$, | $T_s(\rho)$, the saturation temperature | |
| $T_c$, | critical-point temperature, | TCRT |
| $T_t$, | triple-point temperature, | TTRP |
| $u$, | $1/x$, $u_g \equiv 1/x_g$, $u_t \equiv 1/x_t$ | |
| $x$, | $|\sigma - 1|$, $x_g \equiv |\sigma_g - 1|$, $x_t \equiv |\sigma_t - 1|$ | |

Table 1. The fixed-point constants

| | Ethane | Methane |
|---|---|---|
| $T_t$, K | 89.899 | 90.680 |
| $T_c$, K | 305.330 | 190.555 |
| $d_c$, mol/ℓ | 6.87 | 10.20 |
| $d_t$, liquid | 21.68 | 28.147 |
| $d_g$, vapor | $1.35114 \cdot 10^{-6}$ | $1.567\,865 \cdot 10^{-2}$ |

| Cryogenics Division–NBS Institute for Basic Standards LABORATORY NOTE | COST CENTER 2750364 | FILE NO 73-6 | PAGE 3 |
|---|---|---|---|
| SUBJECT Liquid-Vapor Saturation (Orthobaric) Temperatures of Ethane and Methane | NAME R.D. Goodwin | | |
| | DATE Nov. 28, 1973 | | |

Table 2. Coefficients for the equations

| | | Ethane | Methane |
|---|---|---|---|
| Vapor | $\alpha$ | 3/2 | 1/2 |
| | $A_0$ | -0.0610 6983 | -0.1596 5159 |
| | $A_1$ | -0.5510 7806 | -0.6669 5380 |
| | $A_2$ | 1.8906 0757 | 1.0242 2995 |
| | $A_3$ | -4.8476 0684 | -0.5885 7993 |
| | $A_4$ | 8.5887 8625 | 0.2042 8358 |
| | $A_5$ | -8.3103 1296 | - |
| | $A_6$ | 3.3001 3887 | - |
| rms, % | d | 0.111 | 0.043 |
| | T | 0.009 | 0.004 |
| Liquid | $\beta$ | 1/3 | 1/3 |
| | $B_1$ | 9.1071 7170 | 8.5837 7917 |
| | $B_2$ | -7.9603 9387 | -7.0525 4699 |
| | $B_3$ | 4.8472 6284 | 4.1610 2443 |
| | $B_4$ | -1.5919 0104 | -1.3691 9291 |
| | $B_5$ | 0.2253 7899 | 0.2067 1342 |
| rms, % | d | 0.004 | 0.006 |
| | T | 0.016 | 0.006 |



☆ U.S. Government Printing Office 1973 – # 780-339

| Liquid-Vapor Saturation (Orthobaric) Temperatures of Ethane and Methane | COST CENTER 2750364 | FILE NO 73-6 | PAGE 4 |
|---|---|---|---|
| SUBJ: Table 3. Ethane Saturated Vapor Temperatures | NAME R. D. Goodwin | | |
| | DATE Nov. 28. 1973 | | |

NF = 7, AL = 1.500, PE = 0.000, DGAT = 1.35114-006

TTRP = 89.899, TCRT = 305.330, DTRP = 21.680, DCRT = 6.870

| | | | |
|---|---|---|---|
| -0.06106983 | -0.55107806 | 1.89060757 | -4.84760684 |
| 8.58878625 | -8.31031296 | 3.30013887 | 0.00000000 |
| 0.00000000 | 0.00000000 | 0.00000000 | 0.00000000 |

| MOL/L | CALC | PCNT | T,K | CALC | PCNT | DTS/DD |
|---|---|---|---|---|---|---|
| 1.35114-006 | 1.35114-006 | 0.00 | 89.899 | 89.899 | 0.00 | 2.915+006 |
| 1.38631-006 | 1.38619-006 | -0.01 | 90.000 | 90.000 | 0.00 | 2.848+006 |
| 4.59443-006 | 4.58134-006 | -0.28 | 95.000 | 95.013 | 0.01 | 9.651+005 |
| 1.33551-005 | 1.33129-005 | -0.32 | 100.000 | 100.016 | 0.02 | 3.714+005 |
| 3.46826-005 | 3.46067-005 | -0.22 | 105.000 | 105.012 | 0.01 | 1.594+005 |
| 8.16960-005 | 8.16454-005 | -0.06 | 110.000 | 110.004 | 0.00 | 7.518+004 |
| 1.76844-004 | 1.76987-004 | 0.08 | 115.000 | 114.995 | -0.00 | 3.846+004 |
| 3.55631-004 | 3.56292-004 | 0.17 | 120.000 | 119.987 | -0.01 | 2.111+004 |
| 6.70309-004 | 6.72259-004 | 0.20 | 125.000 | 124.983 | -0.01 | 1.231+004 |
| 1.19634-003 | 1.19845-003 | 0.18 | 130.000 | 129.984 | -0.01 | 7.567+003 |
| 2.03041-003 | 2.03275-003 | 0.12 | 135.000 | 134.989 | -0.01 | 4.870+003 |
| 3.29903-003 | 3.30029-003 | 0.04 | 140.000 | 139.996 | -0.00 | 3.262+003 |
| 5.15754-003 | 5.15568-003 | -0.04 | 145.000 | 145.004 | 0.00 | 2.263+003 |
| 7.79177-003 | 7.78449-003 | -0.09 | 150.000 | 150.012 | 0.01 | 1.619+003 |
| 1.14183-002 | 1.14040-002 | -0.13 | 155.000 | 155.017 | 0.01 | 1.191+003 |
| 1.62842-002 | 1.62628-002 | -0.13 | 160.000 | 160.019 | 0.01 | 8.969+002 |
| 2.26660-002 | 2.26402-002 | -0.11 | 165.000 | 165.018 | 0.01 | 6.903+002 |
| 3.08686-002 | 3.08446-002 | -0.08 | 170.000 | 170.013 | 0.01 | 5.415+002 |
| 4.12247-002 | 4.12114-002 | -0.03 | 175.000 | 175.006 | 0.00 | 4.322+002 |
| 5.40333-002 | 5.41016-002 | 0.01 | 180.000 | 179.997 | -0.00 | 3.502+002 |
| 6.98623-002 | 6.99003-002 | 0.05 | 185.000 | 184.989 | -0.01 | 2.877+002 |
| 8.89439-002 | 8.90172-002 | 0.08 | 190.000 | 189.982 | -0.01 | 2.392+002 |
| 1.11782-001 | 1.11888-001 | 0.10 | 195.000 | 194.979 | -0.01 | 2.009+002 |
| 1.38850-001 | 1.38978-001 | 0.09 | 200.000 | 199.978 | -0.01 | 1.704+002 |
| 1.70652-001 | 1.70787-001 | 0.07 | 205.000 | 204.982 | -0.01 | 1.457+002 |
| 2.07770-001 | 2.07862-001 | 0.04 | 210.000 | 209.988 | -0.01 | 1.253+002 |
| 2.50785-001 | 2.50803-001 | 0.01 | 215.000 | 214.997 | -0.00 | 1.085+002 |
| 3.00359-001 | 3.00280-001 | -0.03 | 220.000 | 220.007 | 0.00 | 9.434+001 |
| 3.57253-001 | 3.57050-001 | -0.06 | 225.000 | 225.017 | 0.01 | 8.234+001 |
| 4.22301-001 | 4.21977-001 | -0.08 | 230.000 | 230.023 | 0.01 | 7.208+001 |
| 4.96469-001 | 4.96061-001 | -0.08 | 235.000 | 235.026 | 0.01 | 6.322+001 |
| 5.80877-001 | 5.80460-001 | -0.07 | 240.000 | 240.023 | 0.01 | 5.553+001 |
| 6.76852-001 | 6.76541-001 | -0.05 | 245.000 | 245.015 | 0.01 | 4.879+001 |
| 7.85990-001 | 7.85922-001 | -0.01 | 250.000 | 250.003 | 0.00 | 4.286+001 |
| 9.10251-001 | 9.10553-001 | 0.03 | 255.000 | 254.989 | -0.00 | 3.760+001 |
| 1.05210+000 | 1.05283+000 | 0.07 | 260.000 | 259.976 | -0.01 | 3.291+001 |
| 1.21471+000 | 1.21579+000 | 0.09 | 265.000 | 264.969 | -0.01 | 2.867+001 |
| 1.40231+000 | 1.40343+000 | 0.08 | 270.000 | 269.972 | -0.01 | 2.482+001 |
| 1.62073+000 | 1.62131+000 | 0.04 | 275.000 | 274.988 | -0.00 | 2.124+001 |
| 1.87845+000 | 1.87773+000 | -0.04 | 280.000 | 280.013 | 0.00 | 1.788+001 |
| 2.18860+000 | 2.18618+000 | -0.11 | 285.000 | 285.035 | 0.01 | 1.463+001 |
| 2.57357+000 | 2.57061+000 | -0.11 | 290.000 | 290.032 | 0.01 | 1.146+001 |
| 3.07773+000 | 3.08011+000 | 0.08 | 295.000 | 294.980 | -0.01 | 8.351+000 |
| 3.81803+000 | 3.82168+000 | 0.10 | 300.000 | 299.980 | -0.01 | 5.426+000 |

NP = 44, DNRMSPCT = 0.111, TSRMSPCT = 0.009

| Cryogenics Division—NBS Institute for Basic Standards<br>**LABORATORY NOTE** | COST CENTER<br>2750364 | FILE NO<br>73-6 | PAGE<br>5 |
|---|---|---|---|
| SUBJECT Liquid-Vapor Saturation (Orthobaric) Temperatures of Ethane and Methane | NAME R. D. Goodwin<br>DATE Nov. 28, 1973 | | |

Table 4. Ethane Saturated Liquid Temperatures

NF = 5, AL = 0.000, BE = 0.333, DGAT = 1.35114-006

TTRP = 89.899, TCRT = 305.330, DTRP = 21.680, DCRT = 6.870

| | | | |
|---|---|---|---|
| 9.10717170 | -7.96039387 | 4.84726284 | -1.59190104 |
| 0.22537899 | 0.00000000 | 0.00000000 | 0.00000000 |
| 0.00000000 | 0.00000000 | 0.00000000 | 0.00000000 |

| MOL/L | CALC | PCNT | T,K | CALC | PCNT | DTS/DD |
|---|---|---|---|---|---|---|
| 2.16800+001 | 2.16800+001 | 0.00 | 89.899 | 89.899 | 0.00 | -2.753+001 |
| 2.16764+001 | 2.16763+001 | -0.00 | 90.000 | 89.999 | -0.00 | -2.753+001 |
| 2.14963+001 | 2.14951+001 | -0.01 | 95.000 | 94.967 | -0.04 | -2.764+001 |
| 2.13162+001 | 2.13145+001 | -0.01 | 100.000 | 99.952 | -0.05 | -2.771+001 |
| 2.11359+001 | 2.11341+001 | -0.01 | 105.000 | 104.951 | -0.05 | -2.773+001 |
| 2.09553+001 | 2.09538+001 | -0.01 | 110.000 | 109.958 | -0.04 | -2.771+001 |
| 2.07743+001 | 2.07732+001 | -0.01 | 115.000 | 114.969 | -0.03 | -2.766+001 |
| 2.05928+001 | 2.05921+001 | -0.00 | 120.000 | 119.983 | -0.01 | -2.758+001 |
| 2.04106+001 | 2.04105+001 | -0.00 | 125.000 | 124.997 | -0.00 | -2.746+001 |
| 2.02276+001 | 2.02280+001 | 0.00 | 130.000 | 130.010 | 0.01 | -2.733+001 |
| 2.00438+001 | 2.00445+001 | 0.00 | 135.000 | 135.020 | 0.01 | -2.717+001 |
| 1.98588+001 | 1.98598+001 | 0.01 | 140.000 | 140.027 | 0.02 | -2.698+001 |
| 1.96727+001 | 1.96739+001 | 0.01 | 145.000 | 145.031 | 0.02 | -2.678+001 |
| 1.94852+001 | 1.94864+001 | 0.01 | 150.000 | 150.032 | 0.02 | -2.655+001 |
| 1.92961+001 | 1.92972+001 | 0.01 | 155.000 | 155.031 | 0.02 | -2.631+001 |
| 1.91052+001 | 1.91062+001 | 0.01 | 160.000 | 160.027 | 0.02 | -2.604+001 |
| 1.89123+001 | 1.89132+001 | 0.00 | 165.000 | 165.021 | 0.01 | -2.575+001 |
| 1.87173+001 | 1.87178+001 | 0.00 | 170.000 | 170.014 | 0.01 | -2.544+001 |
| 1.85198+001 | 1.85201+001 | 0.00 | 175.000 | 175.006 | 0.00 | -2.511+001 |
| 1.83196+001 | 1.83195+001 | -0.00 | 180.000 | 179.999 | -0.00 | -2.476+001 |
| 1.81164+001 | 1.81160+001 | -0.00 | 185.000 | 184.992 | -0.00 | -2.438+001 |
| 1.79098+001 | 1.79092+001 | -0.00 | 190.000 | 189.986 | -0.01 | -2.397+001 |
| 1.76996+001 | 1.76987+001 | -0.00 | 195.000 | 194.981 | -0.01 | -2.354+001 |
| 1.74852+001 | 1.74843+001 | -0.01 | 200.000 | 199.978 | -0.01 | -2.308+001 |
| 1.72664+001 | 1.72653+001 | -0.01 | 205.000 | 204.977 | -0.01 | -2.260+001 |
| 1.70425+001 | 1.70415+001 | -0.01 | 210.000 | 209.978 | -0.01 | -2.208+001 |
| 1.68130+001 | 1.68121+001 | -0.01 | 215.000 | 214.981 | -0.01 | -2.153+001 |
| 1.65774+001 | 1.65767+001 | -0.00 | 220.000 | 219.985 | -0.01 | -2.094+001 |
| 1.63348+001 | 1.63344+001 | -0.00 | 225.000 | 224.990 | -0.00 | -2.033+001 |
| 1.60845+001 | 1.60843+001 | -0.00 | 230.000 | 229.996 | -0.00 | -1.967+001 |
| 1.58255+001 | 1.58256+001 | 0.00 | 235.000 | 235.002 | 0.00 | -1.898+001 |
| 1.55567+001 | 1.55571+001 | 0.00 | 240.000 | 240.007 | 0.00 | -1.825+001 |
| 1.52767+001 | 1.52773+001 | 0.00 | 245.000 | 245.011 | 0.00 | -1.749+001 |
| 1.49838+001 | 1.49846+001 | 0.01 | 250.000 | 250.013 | 0.01 | -1.668+001 |
| 1.46761+001 | 1.46770+001 | 0.01 | 255.000 | 255.014 | 0.01 | -1.582+001 |
| 1.43511+001 | 1.43518+001 | 0.01 | 260.000 | 260.012 | 0.00 | -1.493+001 |
| 1.40054+001 | 1.40059+001 | 0.00 | 265.000 | 265.008 | 0.00 | -1.398+001 |
| 1.36348+001 | 1.36350+001 | 0.00 | 270.000 | 270.002 | 0.00 | -1.298+001 |
| 1.32333+001 | 1.32331+001 | -0.00 | 275.000 | 274.997 | -0.00 | -1.191+001 |
| 1.27923+001 | 1.27917+001 | -0.00 | 280.000 | 279.994 | -0.00 | -1.076+001 |
| 1.22965+001 | 1.22978+001 | -0.01 | 285.000 | 284.993 | -0.00 | -9.500+000 |
| 1.17293+001 | 1.17290+001 | -0.00 | 290.000 | 289.997 | -0.00 | -8.090+000 |
| 1.10398+001 | 1.10403+001 | 0.00 | 295.000 | 295.003 | 0.00 | -6.441+000 |
| 1.01117+001 | 1.01117+001 | 0.00 | 300.000 | 300.000 | -0.00 | -4.358+000 |

NP = 44, DNRMSPCT = 0.004, TSRMSPCT = 0.016

Table 5. Methane Saturated Vapor Temperatures



NF = 5, AL = 0.500, BE = 0.000, DGAT = 1.56787-002

TTRP = 90.680, TCRT = 190.555, DTRP = 28.147, DCRT =10.200

| | | | |
|---|---|---|---|
| -0.15965159 | -0.66695380 | 1.02422995 | -0.58857993 |
| 0.20428358 | 0.00000000 | 0.00000000 | 0.00000000 |
| 0.00000000 | 0.00000000 | 0.00000000 | 0.00000000 |

| MOL/L | CALC | PCNT | T,K | CALC | PCNT | DTS/DD |
|---|---|---|---|---|---|---|
| 1.56786-002 | 1.56786-002 | 0.00 | 90.680 | 90.680 | 0.00 | 5.391+002 |
| 1.82791-002 | 1.82830-002 | 0.02 | 92.000 | 91.938 | -0.00 | 4.775+002 |
| 2.28579-002 | 2.28668-002 | 0.04 | 94.000 | 93.936 | -0.00 | 4.005+002 |
| 2.82943-002 | 2.83066-002 | 0.04 | 96.000 | 95.936 | -0.00 | 3.390+002 |
| 3.46926-002 | 3.47064-002 | 0.04 | 98.000 | 97.936 | -0.00 | 2.893+002 |
| 4.21625-002 | 4.21756-002 | 0.03 | 100.000 | 99.937 | -0.00 | 2.488+002 |
| 5.08186-002 | 5.08288-002 | 0.02 | 102.000 | 101.938 | -0.00 | 2.154+002 |
| 6.07803-002 | 6.07855-002 | 0.01 | 104.000 | 103.939 | -0.00 | 1.878+002 |
| 7.21719-002 | 7.21702-002 | -0.00 | 106.000 | 106.000 | 0.00 | 1.647+002 |
| 8.51224-002 | 8.51123-002 | -0.01 | 108.000 | 108.001 | 0.00 | 1.453+002 |
| 9.97658-002 | 9.97466-002 | -0.02 | 110.000 | 110.002 | 0.00 | 1.288+002 |
| 1.16241-001 | 1.16213-001 | -0.02 | 112.000 | 112.003 | 0.00 | 1.147+002 |
| 1.34692-001 | 1.34655-001 | -0.03 | 114.000 | 114.004 | 0.00 | 1.026+002 |
| 1.55269-001 | 1.55226-001 | -0.03 | 116.000 | 116.004 | 0.00 | 9.221+001 |
| 1.78128-001 | 1.78080-001 | -0.03 | 118.000 | 118.004 | 0.00 | 8.314+001 |
| 2.03431-001 | 2.03383-001 | -0.02 | 120.000 | 120.004 | 0.00 | 7.522+001 |
| 2.31348-001 | 2.31304-001 | -0.02 | 122.000 | 122.003 | 0.00 | 6.827+001 |
| 2.62058-001 | 2.62022-001 | -0.01 | 124.000 | 124.002 | 0.00 | 6.215+001 |
| 2.95748-001 | 2.95725-001 | -0.01 | 126.000 | 126.001 | 0.00 | 5.672+001 |
| 3.32616-001 | 3.32611-001 | -0.00 | 128.000 | 128.000 | 0.00 | 5.189+001 |
| 3.72870-001 | 3.72869-001 | 0.01 | 130.000 | 129.999 | -0.00 | 4.757+001 |
| 4.16733-001 | 4.16780-001 | 0.01 | 132.000 | 131.998 | -0.00 | 4.370+001 |
| 4.64444-001 | 4.64520-001 | 0.02 | 134.000 | 133.997 | -0.00 | 4.021+001 |
| 5.16255-001 | 5.16362-001 | 0.02 | 136.000 | 135.996 | -0.00 | 3.706+001 |
| 5.72441-001 | 5.72579-001 | 0.02 | 138.000 | 137.995 | -0.00 | 3.420+001 |
| 6.33297-001 | 6.33462-001 | 0.03 | 140.000 | 139.995 | -0.00 | 3.159+001 |
| 6.99144-001 | 6.99331-001 | 0.03 | 142.000 | 141.995 | -0.00 | 2.921+001 |
| 7.70334-001 | 7.70534-001 | 0.03 | 144.000 | 143.995 | -0.00 | 2.704+001 |
| 8.47251-001 | 8.47451-001 | 0.02 | 146.000 | 145.995 | -0.00 | 2.503+001 |
| 9.30320-001 | 9.30504-001 | 0.02 | 148.000 | 147.996 | -0.00 | 2.319+001 |
| 1.02001+000 | 1.02016+000 | 0.01 | 150.000 | 149.997 | -0.00 | 2.148+001 |
| 1.11685+000 | 1.11694+000 | 0.01 | 152.000 | 151.998 | -0.00 | 1.989+001 |
| 1.22143+000 | 1.22144+000 | 0.00 | 154.000 | 154.000 | -0.00 | 1.842+001 |
| 1.33441+000 | 1.33433+000 | -0.01 | 156.000 | 156.001 | 0.00 | 1.705+001 |
| 1.45656+000 | 1.45636+000 | -0.01 | 158.000 | 158.003 | 0.00 | 1.576+001 |
| 1.58877+000 | 1.58843+000 | -0.02 | 160.000 | 160.005 | 0.00 | 1.455+001 |
| 1.73204+000 | 1.73156+000 | -0.03 | 162.000 | 162.007 | 0.00 | 1.341+001 |
| 1.88759+000 | 1.88697+000 | -0.03 | 164.000 | 164.008 | 0.00 | 1.234+001 |
| 2.05685+000 | 2.05610+000 | -0.04 | 166.000 | 166.008 | 0.01 | 1.132+001 |
| 2.24155+000 | 2.24073+000 | -0.04 | 168.000 | 168.008 | 0.01 | 1.036+001 |
| 2.44331+000 | 2.44300+000 | -0.03 | 170.000 | 170.008 | 0.00 | 9.433+000 |
| 2.66631+000 | 2.66564+000 | -0.03 | 172.000 | 172.006 | 0.00 | 8.548+000 |
| 2.91249+000 | 2.91214+000 | -0.01 | 174.000 | 174.003 | 0.00 | 7.696+000 |
| 3.18691+000 | 3.18711+000 | 0.01 | 176.000 | 175.999 | -0.00 | 6.871+000 |
| 3.49581+000 | 3.49685+000 | 0.03 | 178.000 | 177.994 | -0.00 | 6.066+000 |
| 3.84823+000 | 3.85039+000 | 0.06 | 180.000 | 179.989 | -0.01 | 5.275+000 |
| 4.25806+000 | 4.26143+000 | 0.08 | 182.000 | 181.985 | -0.01 | 4.488+000 |
| 4.74867+000 | 4.75265+000 | 0.08 | 184.000 | 183.985 | -0.01 | 3.690+000 |
| 5.36526+000 | 5.36679+000 | 0.03 | 186.000 | 185.996 | -0.00 | 2.858+000 |
| 6.22000+000 | 6.20573+000 | -0.23 | 188.000 | 188.028 | 0.01 | 1.935+000 |

NP = 50, DLRMSPCT = 0.043, TSRMSPCT = 0.004

Liquid-Vapor Saturation (Orthobaric) Temperatures of Ethane and Methane

Table 6. Methane Saturated Liquid Temperatures



NF = 5, AL = 0.000, BE = 0.333, DGAT = 1.56787-002

TTRP = 90.680, TCRT = 190.555, DTRP = 28.147, DCRT =10.200

| | | | |
|---|---|---|---|
| 8.58377917 | -7.05254699 | 4.16102443 | -1.36919291 |
| 0.20671342 | 0.00000000 | 0.00000000 | 0.00000000 |

| MOL/L | CALC | PCNT | T,K | CALC | PCNT | DTS/DD |
|---|---|---|---|---|---|---|
| 2.81470+001 | 2.81470+001 | 0.00 | 90.680 | 90.680 | 0.00 | -1.208+001 |
| 2.80378+001 | 2.80375+001 | -0.00 | 92.000 | 91.996 | -0.00 | -1.203+001 |
| 2.78714+001 | 2.78706+001 | -0.00 | 94.000 | 93.991 | -0.01 | -1.194+001 |
| 2.77036+001 | 2.77026+001 | -0.00 | 96.000 | 95.988 | -0.01 | -1.186+001 |
| 2.75344+001 | 2.75332+001 | -0.00 | 98.000 | 97.986 | -0.01 | -1.176+001 |
| 2.73638+001 | 2.73625+001 | -0.00 | 100.000 | 99.985 | -0.01 | -1.167+001 |
| 2.71916+001 | 2.71904+001 | -0.00 | 102.000 | 101.986 | -0.01 | -1.157+001 |
| 2.70179+001 | 2.70167+001 | -0.00 | 104.000 | 103.987 | -0.01 | -1.147+001 |
| 2.68425+001 | 2.68415+001 | -0.00 | 106.000 | 105.988 | -0.01 | -1.136+001 |
| 2.66654+001 | 2.66645+001 | -0.00 | 108.000 | 107.990 | -0.01 | -1.125+001 |
| 2.64865+001 | 2.64857+001 | -0.00 | 110.000 | 109.992 | -0.01 | -1.113+001 |
| 2.63056+001 | 2.63051+001 | -0.00 | 112.000 | 111.994 | -0.01 | -1.101+001 |
| 2.61228+001 | 2.61224+001 | -0.00 | 114.000 | 113.996 | -0.00 | -1.089+001 |
| 2.59379+001 | 2.59377+001 | -0.00 | 116.000 | 115.998 | -0.00 | -1.076+001 |
| 2.57507+001 | 2.57507+001 | 0.00 | 118.000 | 118.000 | 0.00 | -1.063+001 |
| 2.55612+001 | 2.55615+001 | 0.00 | 120.000 | 120.002 | 0.00 | -1.050+001 |
| 2.53693+001 | 2.53697+001 | 0.00 | 122.000 | 122.004 | 0.00 | -1.036+001 |
| 2.51749+001 | 2.51754+001 | 0.00 | 124.000 | 124.006 | 0.00 | -1.022+001 |
| 2.49777+001 | 2.49784+001 | 0.00 | 126.000 | 126.007 | 0.01 | -1.008+001 |
| 2.47776+001 | 2.47784+001 | 0.00 | 128.000 | 128.008 | 0.01 | -9.928+000 |
| 2.45745+001 | 2.45754+001 | 0.00 | 130.000 | 130.009 | 0.01 | -9.775+000 |
| 2.43682+001 | 2.43692+001 | 0.00 | 132.000 | 132.009 | 0.01 | -9.618+000 |
| 2.41585+001 | 2.41595+001 | 0.00 | 134.000 | 134.009 | 0.01 | -9.457+000 |
| 2.39452+001 | 2.39462+001 | 0.00 | 136.000 | 136.009 | 0.01 | -9.292+000 |
| 2.37280+001 | 2.37290+001 | 0.00 | 138.000 | 138.009 | 0.01 | -9.122+000 |
| 2.35067+001 | 2.35076+001 | 0.00 | 140.000 | 140.008 | 0.01 | -8.948+000 |
| 2.32810+001 | 2.32816+001 | 0.00 | 142.000 | 142.007 | 0.01 | -8.768+000 |
| 2.30506+001 | 2.30513+001 | 0.00 | 144.000 | 144.006 | 0.00 | -8.584+000 |
| 2.28152+001 | 2.28158+001 | 0.00 | 146.000 | 146.005 | 0.00 | -8.395+000 |
| 2.25744+001 | 2.25746+001 | 0.00 | 148.000 | 148.003 | 0.00 | -8.200+000 |
| 2.23276+001 | 2.23278+001 | 0.00 | 150.000 | 150.002 | 0.00 | -7.999+000 |
| 2.20746+001 | 2.20745+001 | -0.00 | 152.000 | 152.000 | -0.00 | -7.793+000 |
| 2.18146+001 | 2.18143+001 | -0.00 | 154.000 | 153.998 | -0.00 | -7.579+000 |
| 2.15471+001 | 2.15466+001 | -0.00 | 156.000 | 155.996 | -0.00 | -7.359+000 |
| 2.12713+001 | 2.12705+001 | -0.00 | 158.000 | 157.995 | -0.00 | -7.132+000 |
| 2.09863+001 | 2.09853+001 | -0.00 | 160.000 | 159.993 | -0.00 | -6.896+000 |
| 2.06912+001 | 2.06901+001 | -0.01 | 162.000 | 161.992 | -0.00 | -6.652+000 |
| 2.03849+001 | 2.03835+001 | -0.01 | 164.000 | 163.991 | -0.01 | -6.399+000 |
| 2.00658+001 | 2.00643+001 | -0.01 | 166.000 | 165.991 | -0.01 | -6.135+000 |
| 1.97322+001 | 1.97307+001 | -0.01 | 168.000 | 167.992 | -0.00 | -5.859+000 |
| 1.93820+001 | 1.93807+001 | -0.01 | 170.000 | 169.993 | -0.00 | -5.570+000 |
| 1.90125+001 | 1.90114+001 | -0.01 | 172.000 | 171.994 | -0.00 | -5.265+000 |
| 1.86201+001 | 1.86195+001 | -0.00 | 174.000 | 173.997 | -0.00 | -4.943+000 |
| 1.82004+001 | 1.82004+001 | 0.00 | 176.000 | 176.000 | -0.00 | -4.600+000 |
| 1.77457+001 | 1.77475+001 | 0.00 | 178.000 | 178.003 | 0.00 | -4.232+000 |
| 1.72499+001 | 1.72516+001 | 0.01 | 180.000 | 180.006 | 0.00 | -3.833+000 |
| 1.66958+001 | 1.66963+001 | 0.01 | 182.000 | 182.008 | 0.00 | -3.394+000 |
| 1.60606+001 | 1.60632+001 | 0.02 | 184.000 | 184.008 | 0.00 | -2.903+000 |
| 1.52986+001 | 1.52997+001 | 0.01 | 186.000 | 186.003 | 0.00 | -2.338+000 |
| 1.42978+001 | 1.42937+001 | -0.03 | 188.000 | 187.993 | -0.00 | -1.652+000 |
| 1.25270+001 | 1.25276+001 | 0.00 | 190.000 | 190.000 | 0.00 | -6.700-001 |

NP = 51, DNRMSPCT = 0.006, TSRMSPCT = 0.006

| Cryogenics Division—NBS Institute for Basic Standards LABORATORY NOTE | COST CENTER 2750364 | FILE NO 73-6 | PAGE 8 |
|---|---|---|---|
| SUBJECT Liquid-Vapor Saturation (Orthobaric) Temperatures of Ethane and Methane | NAME R. D. Goodwin | | |
| | DATE Nov. 28, 1973 | | |

11/28/73

## Appendix I. The Computer Programs

```
      PROGRAM TSATFIT
C     DESCRIBE ETHANE SATN. TEMPS.,  TSAT(DEN).
C     DEFINE R=D/DTRP, S=D/DCRT, ST=DTRP/DCRT,   AND -
C     YY(TSAT) = (TCRT/T-1)/(TCRT/TTRP-1),   AND -
C
      COMMON NG,AL,BE,TTRP,TCRI, DGAT,DTRP,DCRT, DTSDR, A(15),B(15)
      COMMON/999/NP,NF,H(15),Y(200),G(200,15)
      DIMENSION  T(99),DEN(99),YY(99),F(15)
      DIMENSION UL(99)
    2 FORMAT(1H1 30X *ETHANE SATURATION TEMPERATURES* //
     1 16X4HNF =I3, 6H, AL =F7.3, 6H, BE =F7.3, 8H, DGAT =E13.5//
     1 16X 6HTTRP =F7.3, 8H, TCRT =F8.3, 8H, DTRP =F7.3,
     2 8H, DCRT =F6.3// 3(12X 4F16.8/ ) /
     315X5HMOL/L 11X4HCALC 5X4HPCNT 8X3HT,K 6X4HCALC 5X4HPCNT6X6HDTS/DD)
    3 FORMAT(1H1 14X 5HMOL/L 11X4HCALC 5X4HPCNT
     3 8X3HT,K 6X4HCALC 5X4HPCNT 6X6HDTS/DD )
    4 FORMAT(5X 2E15.5, F9.2, F11.3, F10.3, F9.2, E12.3)
    5 FORMAT(13X 2HNF 13X2HAL 13X2HBE 8X2HSS)
    6 FORMAT(10X I5, 2E15.5, F10.3)
    9 FORMAT(1H0 6X 4HNP =I3, 12H, DNRMSPCT =F6.3, 12H, TSRMSPCT =F6.3)
   11 TTRP=89.899 $ TCRT=305.33 $ YN = TCRT/TTRP-1
   12 DTRP=21.68  $  DCRT=6.87  $  DGAT=1.35114E-6
   13 ST=DGAT/DCRT $ VT=1/(1-ST) $ QT=CUBERTF(ST)
C
C     SATD. VAPOR TEMPS. CONSTRAINED AT T.P. BY SUBTRACTION  -
C     EQUATION,  YY = U(S)*(1+W(S)),   U = EXP(AL*(VT-V)),
C     V = 1/ABS(S-1),    Q = S**(1/3),   AND -
C     W = A1*LN(S/ST) + A2*(Q-QT) + A3*(Q2-QT2) + . . .
C     GENERATE THE SATD. VAPOR DATA.
   25 DO 29 J=1,44   $   IF(J-1) 27,26
   26 T(J) = TTRP   $   GO TO 28
   27 T(J) = 80 + 5*J
   28 DEN(J) = DENGASF(T(J))
   29 YY(J) = (TCRT/T(J)-1)/YN    $    NP = 44
C     PRINT FOR NF,  GET AL BY TRIAL.
   30 AL = 1.50
   31 DO 69 NF=4,10 $  NG = NF   $   SSK = 1.0E+100
   32 DO 40 J=1,NP   $  S=DEN(J)/DCRT $ Q=CUBERTF(S) $ V=1/(1-S)
   33 U = EXPF(AL*(VT-V))   $   G(J,1) = U*LOGF(S/ST)
   35 DO 36 K=2,NF   $   N = K-1
   36 G(J,K) = U*(Q**N - QT**N)
   40 Y(J) = YY(J) - U
   49 CALL EGENFT   $   DO 50 K=1,NF
   50 A(K) = H(K)   $   SD = SS = 0
   51 DO 52 J=1,NP   $   TC = TSATF(DEN(J))
   52 SS = SS + (TC/T(J)-1)**2  $   SS = 100*SQRTF(SS/NP)
   53 IF(SS.LT.SSK) 54,56
   54 SSK=SS $ NGK=NG $ ALK=AL $ BEK=BE  $  DO 55 K=1,NF
   55 F(K) = A(K)
   56 CONTINUE
   57 CONTINUE $ NG=NGK $ AL=ALK $ BE=BEK  $  DO 58 K=1,NF
   58 A(K) = F(K)   $   SS = SD = 0
```

| Cryogenics Division–NBS Institute for Basic Standards LABORATORY NOTE | COST CENTER 2750364 | FILE NO 73-6 | PAGE 9 |
|---|---|---|---|
| SUBJECT Liquid-Vapor Saturation (Orthobaric) Temperatures of Ethane and Methane | NAME R. D. Goodwin | | |
| | DATE Nov. 28, 1973 | | |

Appendix I. (continued)

```
C     PRINT CONSTANTS AND DEVIATIONS.
   60 PRINT 2, NG,AL,BE,DGAT, TTRP,TCRT,DTRP,DCRT, (A(K),K=1,12)
   61 DO 67 J=1,NP  $  D=DEN(J)  $  X=T(J)  $  DC=FINDSATF(0,X)
```

TSATFIT 11/28/73

```
   62 DPCT = 100*(DC/D-1)  $  SD = SD + DPCT*DPCT
   64 TC = TSATF(D)  $  DTSDD = DTSDR/DTRP
   65 TPCT = 100*(TC/X-1)  $  SS = SS + TPCT*TPCT
   67 PRINT 4, D,DC,DPCT, X,TC,TPCT, DTSDD
   68 SD=SQRTF(SD/NP) $ SS=SQRTF(SS/NP) $ PRINT 9, NP, SD, SS
   69 CONTINUE  $   AL = 0
C
C     SATD. LIQUID TEMPS. CONSTRAINED AT THE T.P. BY SUBTRACTION, -
C     EQN.,  LN(YY) = W(S),  WHERE  X=ABS(S-1),  XT=ABS(ST-1), AND -
C     W(S) = BE*(1/XT-1/X) + B1*(X-XT) + B2*(X2-XT2) + . . .
C     GENERATE LIQUID DATA.
   70 DO 74 J=1,44  $  IF(J-1) 72,71
   71 T(J) = TTRP  $  GO TO 73
   72 T(J) = 80 + 5*J
   73 DEN(J) = DENLIQF(T(J))
   74 YY(J) = LOGF((TCRT/T(J)-1)/YN)
   75 NP = 44  $  NG = NF = 5  $  XT = DTRP/DCRT - 1
C     SET UP FIXED LEAST SQUARES FUNCTIONS.
   80 DO 85 J=1,NP  $  S = DEN(J)/DCRT  $  X = ABSF(S-1)
   81 UL(J) = 1/XT - 1/X  $  DO 82 K=1,NF  $  N = K
   82 G(J,K) = X**N - XT**N
   85 CONTINUE
C     FIND NF, BE BY TRIAL.
   90 BE = 1.0/3.0  $  DO 91 J=1,NP
   91 Y(J) = YY(J) - BE*UL(J)  $  CALL EGENFT  $  DO 92 K=1,NF
   92 B(K) = H(K)  $  SD = SS = 0
C     PRINT LIQUID DEVIATIONS.
  100 PRINT 2, NG,AL,BE,DGAT, TTRP,TCRT,DTRP,DCRT, (B(K),K=1,12)
  101 DO 105 J=1,NP  $  D=DEN(J)  $  X=T(J)  $  DC = FINDSATF(1,X)
  102 DPCT = 100*(DC/D-1)  $  SD = SD + DPCT**2
  103 TC = TSATF(D)  $  DTSDD = DTSDR/DTRP
  104 TPCT = 100*(TC/X-1)  $  SS = SS + TPCT**2
  105 PRINT 4, D,DC,DPCT, X,TC,TPCT, DTSDD
  106 SD = SQRTF(SD/NP)  $  SS = SQRTF(SS/NP)
  107 PRINT 9, NP, SD,SS
  110 CONTINUE
  999 STOP  $  END
```



☆ U.S. GOVERNMENT PRINTING OFFICE 1973 – # 780-339

| Cryogenics Division—NBS Institute for Basic Standards LABORATORY NOTE | COST CENTER 2750364 | FILE NO. 73-6 | PAGE 10 |
|---|---|---|---|
| SUBJECT Liquid-Vapor Saturation (Orthobaric) Temperatures of Ethane and Methane | NAME R. D. Goodwin | | |
| | DATE Nov. 28, 1973 | | |

Appendix I. (continued) 11/28/73

```
      FUNCTION TSATF(DEN)
      COMMON NG,AL,BE,TTRP,TCRT, DGAT,DTRP,DCRT, DTSDR, A(15),B(15)
    1 R=DEN/DTRP $ S=DEN/DCRT $ QS = S-1 $ DSDR=DTRP/DCRT $ IF(QS) 2,30
    2 X = ABSF(QS)  $  X1 = DSDR*QS/X  $  YN = TCRT/TTRP - 1
    3 V = 1/X  $  V1 = -DSDR/QS/X   $   IF(QS) 4,30,15
C     SATD. VAPOR TEMPS. CONSTRAINED AT T.P. BY SUBTRACTION  -
C     EQUATION,  YY = U(S)*(1+W(S)),   U = EXP(AL*(VT-V)),
C     V = 1/ABS(S-1),   Q = S**(1/3),  AND -
C     W = A1*LN(S/ST) + A2*(Q-QT) + A3*(Q2-QT2) + . . .
    4 ST=DGAT/DCRT $ VT=1/(1-ST) $ QT=CUBERTF(ST)
    5 U = EXPF(AL*(VT-V))  $  U1 = -AL*V1*U
    6 Q = CUBERTF(S)  $  Q1 = C*DSDR/3/S
    7 W = 1 + A(1)*LOGF(S/ST)  $  W1 = A(1)*DSDR/S
    8 DO 10 K=2,NG  $  N = K-1
    9 W = W + A(K)*(Q**N - QT**N)
   10 W1 = W1 + N*A(K)*Q1*Q**(N-1)
   12 F = U*W  $  F1 = U*W1 + U1*W  $  Q = 1 + YN*F
   14 TSATF = TCRT/Q  $  DTSDR = -YN*F1*TSATF/Q   $   RETURN
C     SATD. LIQUID TEMPS. CONSTRAINED AT THE T.P. BY SUBTRACTION, -
C     EQN.,  LN(YY) = W(S),  WHERE  X=ABS(S-1),  XT=ABS(ST-1), AND -
C     W(S) = BE*(1/XT-1/X) + B1*(X-XT) + B2*(X2-XT2) + . . .
   15 XT = DSDR-1  $  W = BE*(1/XT-V)  $  W1 = -BE*V1
   17 DO 19 K=1,NG  $   N = K
   18 W = W + B(K)*(X**N - XT**N)
   19 W1 = W1 + B(K)*N*X1*X**(N-1)
   20 F = EXPF(W)  $  F1 = W1*F  $  Q = 1 + YN*F
   22 TSATF = TCRT/Q  $  DTSDR = -YN*F1*TSATF/Q   $   RETURN
   30 TSATF = TCRT  $  DTSDR = 0  $  RETURN  $  END


      FUNCTION DENGASF(T)
C     ETHANE SATURATED VAPOR DENSITIES, MOL/L.
C     Y = A1 + A2*Q2 + A3*Q3 + . . ,  NF = AL,  YN = LN(DCRT/DTRP),
C     U = Z + (ZE-Z)*Y,   DEN = DCRT*EXP(-YN*U).
      DIMENSION A(5)
      DATA (TTRP=89.899),(TCRT=305.33),(E=0.362)
      DATA (DCRT=6.87),(DTRP=1.35114E-6)
      DATA(A = 0.19277431, 0.04155009, -0.78922629,
     1 0.35766750, 0.12454376)
    1 FORMAT(1H0 9X *DENGASF = 0, T EXCEEDS TCRT. * / )
    2 IF(TCRT-T) 3,4,5
    3 PRINT 1  $  STOP
    4 DENGASF = DCRT  $  DRDT = D2RDT2 = 0  $  RETURN
    5 ZN=TCRT/TTRP-1  $  YN=LOGF(DCRT/DTRP) $  Z=(TCRT/T-1)/ZN
    6 DZDT = -TCRT/ZN/T/T  $  ZE = Z**E  $  ZE1 = E*ZE/Z
    8 X = ZE-Z  $  X1 = ZE1-1  $  Q = CUBERTF(Z)  $  Q1 = Q/3/Z
   10 Y = A(1)  $  Y1 = 0  $  DO 13 K=2,5
   11 Y = Y + A(K)*Q**K
   12 Y1 = Y1 + K*A(K)*Q**(K-1)
   13 CONTINUE  $  Y1 = Y1*Q1
   15 U = Z + X*Y  $  UA = 1 + X*Y1 + X1*Y  $  U1 = UA*DZDT
   16 XP = EXPF(-YN*U)  $  DENGASF = F = DCRT*XP
   17 DRDT = -YN*U1*F   $   RETURN  $  END
```

| Cryogenics Division—NBS Institute for Basic Standards LABORATORY NOTE | COST CENTER 2750364 | FILE NO 73-6 | PAGE 11 |
|---|---|---|---|
| SUBJECT Liquid-Vapor Saturation (Orthobaric) Temperatures of Ethane and Methane | NAME R.D. Goodwin | | |
| | DATE Nov. 28, 1973 | | |

Appendix I. (continued)

11/28/73

```
      FUNCTION FINDSATF(M,T)
C     THIS FINDSATF ADJUSTED FOR ETHANE.
C     ITERATE DEN TO MINIMIZE (T-TS) VIA TSATF(DEN).
C     M = 0 FOR VAPOR,  M = 1 FOR LIQUID.
      COMMON NG,AL,BE,TTRP,TCRT, DGAT,DTRP,DCRT, DTSDR, A(15),B(15)
      DATA (DGT=1.0E-6),(DLT=23.0)
    1 FORMAT(1H0 9X *FINDSATF = 0,  FAILS TO CONVERGE.* / )
    2 FORMAT(1H0 9X *FINDSATF = 0,  T EXCEEDS TCRT.* / )
    3 IF(T-TCRT) 4,22,23
    4 IF(M.EQ.0) 5,6
    5 D = DENGASF(T)  $  GO TO 7
    6 D = DENLIQF(T)
    7 DO 20 J=1,50 $ DT=T-TSATF(D) $ IF(ABSF(DT/T)-1.0E-6) 21,21,8
    8 DTDD = DTSDR/DTRP  $  IF(DTDD.EQ.0.0) 22,9
    9 DD = DT/DTDD  $  IF(ABSF(DD/D)-1.0E-6) 21,21,10
   10 D = D + DD  $  IF(M.EQ.0) 11,15
   11 IF(D.GT.DGT) 13,12
   12 D = DGT  $  GO TO 20
   13 IF(D.LT.DCRT) 20,14
   14 D = DCRT - 0.02  $  GO TO 20
   15 IF(D.GT.DLT) 16,17
   16 D = DLT  $  GO TO 20
   17 IF(D.GT.DCRT) 20,18
   18 D = DCRT + 0.02
   20 CONTINUE  $  FINDSATF = 0  $  PRINT 1  $  RETURN
   21 FINDSATF = D  $  RETURN
   22 FINDSATF = DCRT  $  RETURN
   23 FINDSATF = 0  $  PRINT 2  $  RETURN  $  END
```

11/28/73

```
      FUNCTION DENLIQF(T)
C     ETHANE SATURATED LIQUID DENSITIES, MOL/L.
C     Y = A1 + A2*Q2 + A3*Q3 + . . . ,  YN = DTRP-DCRT,
C     DEN = DCRT + YN*(X + (XE-X)*Y).
      DATA (TCRT=305.33),(TTRP=89.899),(DCRT=6.87),(DTRP=21.68),(E=0.35)
      DATA (A=0.76173503),(B=0.29865351),(C=-0.32762394)
    1 FORMAT(1H0 9X *DENLIQF = 0, T EXCEEDS TCRT. * / )
    2 IF(TCRT-T) 3,4,5
    3 PRINT 1  $  STOP
    4 DENLIQF=DCRT  $  DRDT=D2FDT2=0  $  RETURN
    5 XN=TCRT-TTRP $ YN=DTRP-DCRT $ X=(TCRT-T)/XN $ DXDT=-1/XN
    6 XE = X**E  $  XE1 = E*XE/X  $  W = CUBERTF(X)  $  W1 = W/3/X
    8 Q = XE-X  $  Q1 = XE1-1
    9 WW = W*W  $  Y = A + B*W + C*X
   10 Y1 = 2*B*W + 3*C*WW
   11 Y1 = Y1*W1
   13 DENLIQF = DCRT + (X + Q*Y)*YN
   14 DRDT = (1 + Q*Y1 + Q1*Y)*YN*DXDT  $  RETURN  $  END
```

| Cryogenics Division–NBS Institute for Basic Standards<br>LABORATORY NOTE | COST CENTER<br>2750364 | FILE NO<br>73-6 | PAGE<br>12 |
|---|---|---|---|
| SUBJECT Liquid-Vapor Saturation (Orthobaric) Temperatures of Ethane and Methane | NAME R.D. Goodwin | | |
| | DATE Nov. 28, 1973 | | |

Appendix I. (continued) 11/28/73

```
      FUNCTION DENGASF(T)
C     METHANE SAT. VAPOR DEN, MOL/L, VIA VAPORFIT, 11/19/73.
C     Y = A1 + A2*Q2 + A3*Q3 + . . ,   NF = AL,   YN = LN(DCRT/DTRP),
C     U = Z + (ZE-Z)*Y,    DEN = DCRT*EXP(-YN*U).
      DIMENSION A(5)
      DATA (TTRP=90.68),(TCRT=190.555),(E=0.388)
      DATA (DCRT=10.2),(DTRP=0.01567865)
      DATA(A = 0.3925579, -0.4976888, 1.3200516,
     1 -1.6817790, 0.6848609)
    1 FORMAT(1H0 9X *DENGASF = 0, T EXCEEDS TCRT. * / )
    2 IF(TCRT-T) 3,4,5
    3 PRINT 1   $   STOP
    4 DENGASF = DCRT   $   DRDT = D2RDT2 = 0   $   RETURN
    5 ZN=TCRT/TTRP-1   $   YN=LOGF(DCRT/DTRP)  $   Z=(TCRT/T-1)/ZN
    6 DZDT = -TCRT/ZN/T/T   $   ZE = Z**E   $   ZE1 = E*ZE/Z
    8 X = ZE-Z   $   X1 = ZE1-1   $   Q = CUBERTF(Z)   $   Q1 = Q/3/Z
   10 Y = A(1)   $   Y1 = 0   $   DO 13 K=2,5
   11 Y = Y + A(K)*Q**K
   12 Y1 = Y1 + K*A(K)*Q**(K-1)
   13 CONTINUE   $   Y1 = Y1*Q1
   15 U = Z + X*Y   $   UA = 1 + X*Y1 + X1*Y   $   U1 = UA*DZDT
   16 XP = EXPF(-YN*U)   $   DENGASF = F = DCRT*XP
   17 DRDT = -YN*U1*F    $     RETURN    $    END
```

```
      FUNCTION DENLIQF(T)
C     METHANE SATD. LIQUID DEN, MOL/L, VIA LAB. NOTE 73-5.
C     Y = A1 + A2*Q2 + A3*Q3 + . . . ,   YN = DTRP-DCRT,
C     DEN = DCRT + YN*(X + (XE-X)*Y).
      DATA (TTRP=90.68),(TCRT=190.555),(E=0.361)
      DATA (DCRT=10.2),(DTRP=28.147)
      DATA (A=0.83709103),(B=0.08416127),(C=-0.07478575)
    1 FORMAT(1H0 9X *DENLIQF = 0, T EXCEEDS TCRT. * / )
    2 IF(TCRT-T) 3,4,5
    3 PRINT 1    $   STOP
    4 DENLIQF=DCRT   $   DRDT=D2RDT2=0   $   RETURN
    5 XN=TCRT-TTRP $ YN=DTRP-DCRT $ X=(TCRT-T)/XN $ DXDT=-1/XN
    6 XE = X**E   $   XE1 = E*XE/X   $   W = CUBERTF(X)   $   W1 = W/3/X
    8 Q = XE-X   $   Q1 = XE1-1
    9 WW = W*W   $   Y = A + B*WW + C*X
   10 Y1 = 2*B*W + 3*C*WW
   11 Y1 = Y1*W1
   13 DENLIQF = DCRT + (X + Q*Y)*YN
   14 DRDT = (1 + Q*Y1 + Q1*Y)*YN*DXDT    $    RETURN   $   END
```



☆ U.S. GOVERNMENT PRINTING OFFICE. 1973 – # 780-339

USCOMM - ERL

APPENDIX H.

Computer Programs for Equation of State 06/05/74

```
      PROGRAM ETHANE
C     GOODWIN EQUATION OF STATE APPLIED TO ETHANE.
C     EQN. (Y-YSAT) = F(R,T),  WHERE  Y = (Z-1)*X/R,  AND -
C     F(R,T) = B*XBF + E*XEF,   NOTE ONLY TWO TERMS.
C     XBF = SQRT(T/TC)*LN(T/TS).
C     XEF = PSI-PSISAT,  PSI = (1-W*LN(1+1/W))/X,  W = EP*(T/TH-1).
C     B = B1 + B2*R + B3*R2/(1+BE*R2),   BE = 1, APPROX.,
C     E = (S-1)*(S-ER)*(E1 + E2*R),   ER = 1.9,     NF = 5.
C     NOTE,  PRESSURE IN BARS,   1.01325 BAR/ATM.
C     LET GAS CONSTANT GK = 0.0831434*DTRP,   PN = R*GK*T.
C     AUTHOR ID.  VIRIAL(2), PAL(4), REAMER(8), MICHELS(9), DOUSLIN(10).
      COMMON B1,B2,B3,B4, ER, E1,E2,E3
      COMMON/1/AL,BE,EP,GK, DCRT,TCRT,PCRT, DTRP,TTRP,PTRP
      COMMON/2/NP,NF,ID(999),T(999),P(999),DEN(999)
      COMMON/3/DPDT,D2PDT2,DPSDT,DPMCT,DPDD,DPCR,DTSDR,DTHDR
      COMMON/4/XB1,XB2, XC1,XC2, XE1,XE2, DXBDR,DXCDR,DXEDR
      COMMON/6/ TSAT, THETA, PSAT
      COMMON/7/ XB,XC,XD,XE
      COMMON/8/IP,NPP,P1,P2,P3,P4,P5, IDP(99),TPS(99),PPS(99)
      COMMON/9/IS,NPS,EG,EL,ALS,BES,AL1,AL2,AL3,CG(5),AV(8),AW(5)
      COMMON/10/ IDS(99), TSS(99), DNS(99)
      COMMON/11/ NP4, NP5
      COMMON/999/ NFUN,Y,F(30)
      DIMENSION G(30), DND(30),TD(16), PPD(30,16)
    1 FORMAT(I5, 3F10.0)
    2 FORMAT(I5, F10.3, E15.5)
    3 FORMAT(1H09X *EQN. OF STATE, DTRP =*F7.3, 8H, DCRT =F7.3,
     1 8H, TCRT =F8.3//10X4HAL =F5.2, 6H, BE =F5.2, 6H, EP =F5.2//
     2 10X 4HNP =I4, 10H, PAVPCT =F6.3)
    6 FORMAT(1H1 16X *THE ISOCHORE AT* F6.2, * MOL/L* //
     1 17X 3HT,K 5X5HP,BAR 5X5HDP/DD 5X5HDP/DT 4X7HD2P/DT2)
    7 FORMAT(10X F10.1, 2F10.3, F10.4, F11.5)
    8 FORMAT(1H1 14X *THE ISOTHERM AT* F7.2, * DEG. K* //
     1 10X 5HMOL/L 5X5HP,BAR 5X5HDP/CD 5X5HDP/DT 5X7HD2P/DT2 )
    9 FORMAT(5X F10.2, 2F10.3, F10.4, F12.6)
   11 FORMAT(1H1 7X *EQUATION OF STATE VS. PVT DATA* //
     1 8X 2HID 7X3HT,K 5X5HMOL/L 5X5HCALCD 4X5HD,PCT
     2 6X5HP,BAR 5X5HCALCD 4X5HP,PCT)
   12 FORMAT(5X I5, F10.3, 2F10.4, F9.2, F11.3, F10.3, F9.2)
   13 FORMAT(1H0 8X 4HNP =I4, 12H, DNRMSPCT =F6.3, 12H, PMEANPCT =F6.3)
   14 FORMAT(8F10.0)
   15 FORMAT(16X 8F8.0)
   16 FORMAT(10X 7F10.0)
   22 TTRP=89.899 $ DTRP=21.68 $ Q=1.01325 $ PTRP=Q*9.967E-6
   23 TCRT = 305.37  $  DCRT = 6.74
   24 WM=30.07 $ QP=Q/14.69595 $ GKK=0.0831434 $ GK=DTRP*GKK
   25 AL=2.0 $ BE=1.0 $ EP=0.5 $ ER=1.9
C
C      READ MIXED VAPOR PRESSURE DATA, ALL IN T-68, BAR.
   26 DO 27 J=1,99  $  READ 2, IDP(J),TPS(J),PPS(J)  $  IF(IDP(J))27,28
   27 CONTINUE
C      READ TSAT(DEN) DATA (ORTHOBARIC DENSITIES).
   28 NPP = J-1   $   DO 29 J=1,28
   29 READ 2, IDS(J),TSS(J),DNS(J)  $  DO 31 J=29,99
   30 READ 1, IDD,TSS(J),DNS(J)  $  IF(IDD) 31,32
```

ETHANE 06/05/74

```
   31 IDS(J) = IDD
   32 NPS = J - 1
C
C     GENERATE VIRIAL PVT DATA BELOW 1 MOL/L.
   34 NP1 = 38  $  DN = 0.4  $  DO 37 J=1,NP1  $  N = J
   35 TT = 220 + 10*N  $  ID(N) = 2  $  T(N) = TT  $  DEN(N) = DN
   37 P(N) = DN*GKK*TT*ZIPF(TT,DN)
C     READ DOUSLIN ETHANE PVT DATA.
   39 N=N+1 $ DEN(N)=0.70 $ T(N)=248.15 $ P(N)=Q*11.6087 $ ID(N)=10
C     SET UP HIS DENSITIES, AND READ HIS TEMPERATURES.
   40 DND(1) = 0.75  $  DO 41 I=2,30
   41 DND(I) = 0.5*I  $  READ 14, (TD(J),J=1,16)
C     READ PRESSURES(ATM) ALONG ISOCHORES (MANY BLANKS).
   42 DO 43 I=1,30  $  READ 15, (PPD(I,J),J=1,16)
C     CONVERT TO ONE PVT POINT PER INDEX, N.
   43 CONTINUE  $  DO 46 I=1,30  $  DO 46 J=1,16  $  IF(PPD(I,J)) 44,46
   44 N = N+1  $  ID(N) = 10  $  T(N) = 273.15 + TD(J)
   45 DEN(N) = DND(I)  $  P(N) = Q*PPD(I,J)
   46 CONTINUE  $  DO 48 J=1,5  $  READ 1, IDD,DN,TT,PP
   47 N=N+1 $ ID(N)=IDD $ DEN(N)=DN $ T(N)=TT $ P(N) = Q*PP
C     READ MICHELS, DEG. C, AMAGAT DEN, AMAGAT (PV).
   48 CONTINUE $ NP2 = N $ READ 16, (TD(J),J=1,7) $ DO 49 I=1,17
   49 READ 14, DND(I), (PPD(I,J),J=1,7)
   50 DO 53 I=1,17  $  DO 53 J=1,7  $  IF(PPD(I,J)) 51,53
   51 N = N+1  $  ID(N) = 9  $  T(N) = 273.15 + TD(J)
   52 DEN(N) = 0.045064*DND(I)  $  P(N) = Q*DND(I)*PPD(I,J)
   53 CONTINUE  $  NP3 = N
C     READ 8 PAL/POPE ISOCHORES NO. 17 THRU 24,  GRAM/CC; PSIA.
C     THESE DATA ADJUSTED BY RICE UNIV., APRIL, 1974.
   57 DO 62 I=1,12  $  DO 61 J=1,99
   58 READ 14, DN,TT,PP  $  IF(DN) 59,62
   59 N = N+1  $  ID(N) = 1200 + 100*I + J
   60 T(N) = TT  $  P(N) = QP*PP  $  DEN(N) = 1000*DN/WM
   61 CONTINUE
C     READ REAMER ET AL  UP TO NP5.
   62 CONTINUE  $  NP4 = N  $  CALL READIT
C     USE ONLY DATA THRU PAL/POPE FOR LEAST SQUARES.
   63 NP = NP4  $  NF = 5  $  SSK = 1.0E+100  $  IP = IS = 1
C
C     EXPLORE NONLINEAR PARAMETERS DTRP,DCRT,TCRT,AL,BE,EP.
   64 CALL PSATFIT  $  PCRT = PSATF(TCRT)
   65 CALL DSATFIT  $  CALL TSATFIT
C  66 DO 74 MA=1,3  $  AL = 0.5*(MA+2)
C  67 DO 74 ME=1,3  $  EP = 1.0/(6-ME)
   68 CALL SETUP  $  SS = 0  $  DO 69 J=1,NP
   69 SS = SS + ABSF(1-PVTF(T(J),DEN(J))/P(J))  $  SS = 100*SS/NP
   70 IF(SS-SSK) 71,74,74
   71 SSK=SS $ DCR=DCRT $ TCR=TCRT $ ALK=AL $ BEK=BE $ EPK=EP
   72 DO 73 K=1,NF
   73 G(K) = F(K)
   74 PRINT 3, DTRP,DCRT,TCRT, AL,BE,EP, NP,SS
   76 DCRT=DCR $ TCRT=TCR $ AL=ALK $ BE=BEK $ EP=EPK
   77 B1=G(1) $ B2=G(2) $ B3=G(3)
   78 E1=G(4) $ E2=G(5)
   80 CALL PEEK  $  CALL ISOTHERM
```

```
C
C    GET DEVIATIONS FOR INDIVIDUAL AUTHORS.
   83 DO 100 IG=1,5  $  GOTO(84,85,86,87,88),IG
   84 M=1   $ N=NP1 $ GO TO 90
   85 M=N+1 $ N=NP2 $ GO TO 90
   86 M=N+1 $ N=NP3 $ GO TO 90
   87 M=N+1 $ N=NP4 $ GO TO 90
   88 M=N+1 $ N=NP5 $ GO TO 90
   90 PRINT 11  $  SD = SS = K = L = 0
   91 DO 98 J=M,N  $  K=K+1 $ L=L+1  $  IF(L-53) 93,92
   92 L = 0  $  PRINT 11
   93 PC = PVTF(T(J),DEN(J))  $  DC = FINDENF(T(J),P(J),DEN(J))
   94 PPCT=100*(1-PC/P(J))  $  SS=SS+ABSF(PPCT)  $  IF(DC) 95,96
   95 DPCT = 100*(1-DC/DEN(J))  $  GO TO 97
   96 DPCT = 0.0
   97 SD = SD + DPCT**2
   98 PRINT 12, ID(J),T(J), DEN(J),DC,DPCT, P(J),PC,PPCT
   99 SS = SS/K  $  SD = SQRTF(SD/K)  $  PRINT 13, K, SD,SS
  100 CONTINUE
C
C    PRINTOUT ISOCHORES.
  130 DO 160 I=1,22  $  IF(I-7) 132,131
  131 DN = DCRT  $  GO TO 133
  132 DN = I
  133 PRINT 6, DN
  138 IF(DN-DTRP) 140,141,141
  140 TS = TSATF(DN)  $  GO TO 142
  141 TS = TTRP*(DN/DTRP)**4
  142 IF(I-11) 143,143,144
  143 IT = 8  $  GO TO 150
  144 IF(I-15) 145,145,146
  145 IT = 4  $  GO TO 150
  146 IF(I-19) 147,148,148
  147 IT = 2  $  GO TO 150
  148 IT = 1
  150 DO 159 J=90,600,IT  $  TT = J  $  IF(TT-TS) 159,159,151
  151 PP = PVTF(TT,DN)  $  PX = DPDRF(TT,DN)
  153 IF(PP-700.0) 155,155,160
  155 PRINT  7, TT,PP, DPDD,DPDT, D2PDT2
  159 CONTINUE
  160 CONTINUE
C    PRINTOUT ISOTHERMS (NEED FINDSATF).
  200 DO 230 I=1,99
  201 READ 1, IDD,TT,DS  $  IF(IDD) 210,999
  210 PRINT 8, TT
  211 DM = DTRP*(TT/TTRP)**0.25  $  IF(TT-TCRT) 212,212,213
  212 DG = FINDSATF(TT,0)  $  DL = FINDSATF(TT,1)
  213 DO 220 N=1,500  $  DN = N*DS  $  IF(TT-TCRT) 214,215,215
  214 IF(DN.GT.DG.AND.DN.LT.DL) 220,215
  215 IF(DN.GT.DM) 230,216
  216 PP = DPDRF(TT,DN)  $  IF(PP-750.0) 217,217,230
  217 PX = PVTF(TT,DN)
  219 PRINT 9, DN,PP, DPDD, DPDT,D2PDT2
  220 CONTINUE
  230 CONTINUE

  999 CONTINUE  $  STOP  $  END
```

06/05/74

```
      SUBROUTINE READIT
C     READ ETHANE PVT DATA OF REAMER ET AL.  T,F,  PSIA,  Z(P,R,T).
C     IND. ENG. CHEM. 36, 956-958, (OCT.,1944).
      COMMON/2/NP,NF,ID(999),T(999),P(999),DEN(999)
      COMMON/11/ NP4, NP5
      DIMENSION TA(7),PSI(22),Z(22,7)
      DATA (GKK=0.0831434),(Q=1.01325),(PA=14.69595)
    1 FORMAT(24X 7F8.0)
    2 FORMAT(I5, F11.0, 8X 7F8.0)
    3 FORMAT(I5, F11.0, F16.0)
C     READ THE SUPPLEMENTARY PVT DATA.  ONE POINT PER CARD.
    9 DO 15 I=1,99  $  READ 3, IDD,PP,ZA  $  IF(IDD) 10,16
   10 N = NP4 + I
   11 ID(N) = IDD  $  P(N) = Q*PP/PA  $  IF(I-13) 12,12,13
   12 TF = 100  $  GO TO 14
   13 TF = 160
   14 T(N) = 273.15 + (TF-32)/1.8
   15 DEN(N) = P(N)/ZA/GKK/T(N)
   16 CONTINUE
C     NOW READ 22 ISOBARS OF THE SQUARE TABLE 1.
   20 READ 1, (TA(J),J=1,7)  $  DO 21 I=1,22
   21 READ 2, IDD, PSI(I), (Z(I,J),J=1,7)
C     NOW CONVERT TO ONE POINT PER INDEX, N.
   25 DO 29 I=1,22  $  DO 29 J=1,7
   26 N = N+1  $  ID(N) = 8  $  P(N) = Q*PSI(I)/PA
   27 T(N) = 273.15 + (TA(J)-32)/1.8
   28 DEN(N) = P(N)/Z(I,J)/T(N)/GKK
   29 CONTINUE  $  NP5 = N
   30 RETURN  $  END

*    SINGLE-BANK COMPILATION.
```

06/05/74

```
      SUBROUTINE DSATFIT
C     FIND COEFFS. FOR DENGASF(T), DENLIGF(T),   ETHANE.
C     FUNCTIONS VIA GOODWIN LAB. NOTE 73-5.
C     DATA ARRANGED IN ORDER OF INCREASING DENSITIES.
      COMMON/1/AL,BE,EP,GK, DCRT,TCRT,PCRT, DTRP,TTRP,PTRP
      COMMON/9/IS,NPS,EG,EL,ALS,BES,AL1,AL2,AL3,CG(5),AV(8),AW(5)
      COMMON/10/ IDS(99), TSS(99), DNS(99)
      COMMON/999/ NFUN,Y,F(30)
      DIMENSION G(9)
      DATA (DGAT = 1.35114E-6)
    1 FORMAT(1H19X*SATURATED VAPOR DENSITIES, E =*F6.3//10X6HTTRP =F7.3,
     1 8H, TCRT =F8.3, 8H, DCRT =F6.3, 8H, DGAT =E12.5// 7X 5F13.8//
     2 13X2HID 7X3HT,K 8X5HMOL/L 8X5HCALCD 4X4HPCNT )
    2 FORMAT(10X I5, F10.3, 2E13.4, F8.2)
    3 FORMAT(1H19X*SATD. LIQUID DENSITIES, E =* F6.3// 10X6HTTRP =F7.3,
     1 8H, TCRT =F8.3, 8H, DCRT =F6.3, 8H, DTRP =F7.3// 9X 3F15.9//
     2 13X2HID 7X3HT,K 5X5HMOL/L 5X5HCALCD 5X5HPRCNT)
    4 FORMAT(10X I5, 3F10.3, F10.2)
    5 FORMAT(1H0 15X 4HNP =I3, 10H, RMSPCT =F6.3)
C     FOR THE SATURATED VAPOR, DEFINE -
C     Z = (TC/T-1)/(TC/TT-1),  Q = Z**1/3,  ZE = Z**E,
C     YY = LN(DC/D)/LN(DC/DT),  AND THE DEPENDENT VARIABLE -
C     Y(Z,YY) = (YY-Z)/(ZE-Z),  WHEN THE L.S. EQN. IS -
C     Y(Z,YY) = A1 + A2*Q2 + A3*Q3 + A4*Q4 + A5*Q5.
    6 ZN=TCRT/TTRP-1  $  YN=LOGF(DCRT/DGAT)  $  SSK=1.0E+100
C     EXPLORE VALUES FOR EXPONENT EG.
    7 DO 18 I=1,11  $  EG = 0.33 + 0.01*I
    8 NFUN = 5  $  DO 12 J=1,99  $  IF(DNS(J)-DCRT) 9,13,13
    9 Z = (TCRT/TSS(J)-1)/ZN  $  Q = CUBERTF(Z)
   10 YY = LOGF(DCRT/DNS(J))/YN  $  F(1) = 1  $  DO 11 K=2,5
   11 F(K) = Q**K  $  Y = (YY-Z)/(Z**EG-Z)
   12 CALL FIT
   13 NP = J-1  $  CALL COEFF  $  SS = 0  $  DO 14 K=1,5
   14 CG(K) = F(K)  $  DO 15 J=1,NP  $  DC = DENGASF(TSS(J))
   15 SS = SS + (DC/DNS(J)-1)**2  $  IF(SS.LT.SSK) 16,18
   16 SSK = SS  $  EGK = EG  $  DO 17 K=1,5
   17 G(K) = F(K)
   18 CONTINUE  $  EG = EGK  $  DO 19 K=1,5
   19 CG(K) = G(K)  $  IF(IS) 20,26
   20 PRINT 1, EG, TTRP,TCRT, DCRT,DGAT, (G(K),K=1,5)
   21 SS = 0  $  DO 24 J=1,NP  $  DC = DENGASF(TSS(J))
   22 PCT = 100*(DNS(J)/DC-1)  $  SS = SS + PCT**2
   24 PRINT 2, IDS(J), TSS(J),DNS(J), DC,PCT
   25 SS = SQRTF(SS/NP)  $  PRINT 5, NP, SS
C     FOR THE SATURATED LIQUID, DEFINE -
C     X = (TC-T)/(TC-TT),  Q = X**1/3,  XE = X**E,
C     YY = (D-DC)/(DT-DC),  WHEN THE L.S. EQN. IS -
C     (YY-X)/(XE-X) = A1 + A2*Q2 + A3*Q3.
   26 M = NP + 1  $  SSK = 1.0E+100
   27 XN = TCRT-TTRP  $  YN = DTRP-DCRT
C     EXPLORE VALUES FOR EXPONENT EL.
   28 DO 37 I=1,14  $  EL = 0.25 + 0.01*I  $  NFUN = 3
   29 DO 32 J=M,NPS  $  X = (TCRT-TSS(J))/XN
   30 Q = CUBERTF(X)  $  YY = (DNS(J)-DCRT)/YN
   31 F(1)=1 $ F(2)=Q*Q $ F(3)=X  $  Y = (YY-X)/(X**EL-X)
```

```
   DSATFIT                                                   06/05/74

32 CALL FIT  $  CALL COEFF  $  AL1=F(1) $ AL2=F(2) $ AL3=F(3)
33 SS = 0  $  DO 34 J=M,NPS  $  DC = DENLIQF(TSS(J))
34 SS = SS + (DC/DNS(J)-1)**2  $  IF(SS.LT.SSK) 35,37
35 SSK = SS  $  ELK = EL  $  DO 36 K=1,3
36 G(K) = F(K)
37 CONTINUE  $  EL = ELK  $  AL1=G(1) $ AL2=G(2) $ AL3=G(3)
38 IF(IS) 40,99
40 PRINT 3, EL, TTRP,TCRT, DCRT,DTRP, (G(K),K=1,3)
41 SS = N = 0
42 DO 44 J=M,NPS  $  N = N+1  $  DC = DENLIQF(TSS(J))
43 PCT = 100*(DNS(J)/DC-1)  $  SS = SS + PCT**2
44 PRINT 4, IDS(J),TSS(J),DNS(J), DC,PCT
45 SS = SQRTF(SS/N)  $  PRINT 5, N, SS
99 RETURN    $    END

*    SINGLE-BANK COMPILATION.
```

```
      SUBROUTINE TSATFIT
C     FIT TSAT DATA VIA FUNCTIONS OF TSATFIT(METHANE), 4/19/74 AT 09.00.
C     NOTE,  ALS = BES = 0.5,   E = 1/4,  VAPOR NF=6,  LIQUID NF=3.
C     NOTE DIFFERENT FUNCTIONS AS DEN L.T. OR G.T. DCRT.
C     DEFINE YY(TS) = (TCRT/T-1)/(TCRT/TTRP-1) FOR EACH FUNCTION.
C     DATA ARRANGED IN ORDER OF INCREASING DENSITIES.
      COMMON/1/AL,BE,EP,GK, DCRT,TCRT,PCRT, DTRP,TTRP,PTRP
      COMMON/3/DPDT,D2PDT2,DPSDT,DPMDT, DPDD,DPDR,DTSDR,DTHDR
      COMMON/9/IS,NPS,EG,EL,ALS,BES,AL1,AL2,AL3,CG(5),AV(8),AW(5)
      COMMON/10/ IDS(99), TSS(99), DNS(99)
      COMMON/999/ NFUN,Y,F(30)
      DATA (DGAT = 1.35114E-6)
    1 FORMAT(1H1 30X *ETHANE SATURATION TEMPERATURES* //
     1 16X 4HAL =F6.3, 6H, BE =F6.3, 8H, DGAT =E12.5//
     2 16X 6HTTRP =F7.3, 8H, TCRT =F8.3, 8H, DTRP =F7.3,
     3 8H, DCRT =F6.3// 2(13X 4F15.9/) )
    2 FORMAT(1H0 12X 2HID 10X5HMOL/L 11X4HCALC 5X4HPCNT
     1 8X3HT,K 6X4HCALC 5X4HPCNT 6X6HDTS/DD )
    3 FORMAT(10X I5, 2E15.5, F9.2, F11.3, F10.3, F9.2, E12.3)
    4 FORMAT(1H0 12X 4HNP =I3, 12H, DNRMSPCT =F6.3, 12H, TSRMSPCT =F6.3)
C     FOR SAT.VAPOR DEFINE, X=ABS(S-1), XT=ABS(ST-1), WHEN EQN. IS -
C     LN(YY) - AL*(1/XT-1/X) = A1*LOG(LN(1+E/S)/LN(1+E/ST)) + W(S),
C     W(S) = A2*(Q-QT) + A3*(Q2-QT2) + A4*(S-ST) + A5*(S2-ST2) + . . .
C     WHERE,  Q = S**1/3,  AND  QT = ST**1/3.
    5 ALS = BES = 0.5  $  E = 0.25  $  YN = TCRT/TTRP - 1
    6 ST=DGAT/DCRT $ XT=1-ST $ EK=LOGF(1+E/ST)
    7 QT = CUBERTF(ST)  $  NFUN = NF = 8
    9 DO 16 J=1,NPS  $  IF(DNS(J)-DCRT) 10,17,17
   10 S = DNS(J)/DCRT  $  X = 1-S  $  Q = CUBERTF(S)
   11 F(1) = LOGF(LOGF(1+E/S)/EK)
   12 F(2) = Q-QT  $  F(3) = Q*Q - QT*QT
   13 DO 14 K=4,NF  $  N = K-3
   14 F(K) = S**N - ST**N
   15 Y = LOGF((TCRT/TSS(J)-1)/YN) - ALS*(1/XT-1/X)
   16 CALL FIT
   17 NP = J-1  $  CALL COEFF  $  DO 18 K=1,NF
   18 AV(K) = F(K)  $  IF(IS) 20,28
   20 PRINT 1, ALS,BES,DGAT, TTRP,TCRT, DTRP,DCRT, (F(K),K=1,NF)
   21 PRINT 2   $   SD = SS = N = 0
   22 DO 26 J=1,NP  $  T = TSS(J)  $  D = DNS(J)
   23 DC=FINDSATF(T,0) $ DPCT=100*(1-DC/D) $ SD=SD+DPCT**2
   24 TC = TSATF(D)  $  DTSDD = DTSDR/DTRP
   25 TPCT = 100*(1-TC/T)  $  SS = SS + TPCT**2
   26 PRINT 3, IDS(J), D,DC,DPCT, T,TC,TPCT, DTSDD
   27 SD = SQRTF(SD/NP)  $  SS = SQRTF(SS/NP)  $  PRINT 4, NP,SD,SS
C     FOR SATD. LIQ. USE,   X=ABS(S-1),  XT=ABS(ST-1) IN THE EQN. -
C     LN(YY) = BE*(1/XT-1/X) + B1*(S-ST) + B2*(S2-ST2) + . . .
   28 NFUN = NF = 5  $  M = 1  $  ST = DTRP/DCRT  $  XT = ST-1
   29 DO 35 J=1,NPS  $  IF(DNS(J)-DCRT) 30,30,31
   30 M = M + 1  $  GO TO 35
   31 S = DNS(J)/DCRT  $  X = S-1  $  DO 32 K=1,NF
   32 F(K) = S**K - ST**K
   33 YY = (TCRT/TSS(J)-1)/YN  $  Y = LOGF(YY) - BES*(1/XT-1/X)
   34 CALL FIT
   35 CONTINUE  $  CALL COEFF  $  DO 36 K=1,NF
```

```
     TSATFIT                                                06/05/74

   36 AW(K) = F(K)  $  IF(IS) 40,99
   40 PRINT 1, ALS,BES,DGAT, TTRP,TCRT, DTRP,DCRT, (F(K),K=1,NF)
   41 PRINT 2  $  SD = SS = N = 0
   42 DO 46 J=M,NPS  $  N = N+1  $  D = DNS(J)  $  T = TSS(J)
   43 DC=FINDSATF(T,1) $ DPCT=100*(1-DC/D) $ SD=SD+DPCT**2
   44 TC = TSATF(D)  $  DTSDD = DTSDR/DTRP
   45 TPCT = 100*(1-TC/T)  $  SS = SS + TPCT**2
   46 PRINT 3, IDS(J), D,DC,DPCT, T,TC,TPCT, DTSDD
   47 SD = SQRTF(SD/N)  $  SS = SQRTF(SS/N)  $  PRINT 4, N, SD, SS
   99 RETURN     $     END
```

```
                                                            06/05/74

      SUBROUTINE PSATFIT
C    FIT GOODWIN EQN. TO VAPOR PRESSURE DATA, ALL ON T-68,  BAR.
C    LN(P/PT) = P1*X + P2*X2 + P3*X3 + P4*X4 + P5*X*(1-X)**1.5.
      COMMON/1/AL,BE,EP,GK, DCRT,TCRT,PCRT, DTRP,TTRF,PTRP
      COMMON/8/IP,NPP,P1,P2,P3,P4,P5, IDP(99),TPS(99),FPS(99)
      COMMON/999/NFUN,Y,F(30)
    1 FORMAT(1H1 14X *VAFOR PRESSURES, TTRP =*F7.3, 8H, TCRT =F8.3)
    2 FORMAT(1H0 12X 5F13.8)
    3 FORMAT(1H0 17X 2HID 7X3HT,K 10X5HP,BAR 10X5HCALCD 6X4HPCNT )
    4 FORMAT(15X I5, F10.3, 2E15.5, F10.3)
    5 FORMAT(1H0 16X 4HNP =I4, 10H, RMSPCT =F6.3)
    6 NFUN = 5  $  XK = 1 - TTRP/TCRT  $  DO 10 J=1,NPP
    7 X = (1-TTRP/TPS(J))/XK  $  QC = X*(1-X)*SQRTF(1-X)
    8 F(1)=X $ F(2)=X*X $ F(3)=X*X*X $ F(4)=F(2)*F(2) $ F(5)=QC
    9 Y = LOGF(PPS(J)/PTRP)
   10 CALL FIT   $   CALL COEFF
   11 P1=F(1) $ P2=F(2) $ P3=F(3) $ P4=F(4) $ P5=F(5)  $  IF(IP) 12,20
   12 SS = L = 0   $   PRINT 1, TTRP, TCRT
   13 PRINT 2, P1,P2,P3,P4,P5   $   FRINT 3
   14 DO 18 J=1,NPP  $  P = PPS(J)  $  PC = PSATF(TPS(J))
   15 L = L+1  $  PCT=100*(P/PC-1)  $  SS=SS+PCT**2  $  IF(L-45) 18,17
   17 L = 0  $  PRINT 1, TTRP,TCRT  $  PRINT 3
   18 PRINT 4, IDP(J),TPS(J), P,PC,PCT
   19 SS = SQRTF(SS/NPP)  $  PRINT 5, NPP, SS
   20 RETURN    $    END
```

06/05/74

```
      SUBROUTINE PEEK
C    EXAMINE BEHAVIOR OF THE COEFFICIENTS.
      COMMON B1,B2,B3,B4, ER, E1,E2,E3
      COMMON/1/AL,BE,EP,GK, DCRT,TCRT,PCRT, DTRP,TTRP,PTRP
      COMMON/6/ TSAT, THETA, PSAT
    4 FORMAT(1H1 14X *EQUATION OF STATE, COEFFICIENTS* //
     1 15X 6HDTRP =F8.4, 8H, TTRP =F8.3, 8H, PTRP =F13.9/
     2 15X 6HDCRT =F8.4, 8H, TCRT =F8.3, 8H, PCRT =F13.9//
     3 15X 4HAL =F5.2, 6H, BE =F5.2, 6H, EP =F5.2//
     5 12X 3F15.9/ 12X 2F15.9/ )
    5 FORMAT(15X 5HMOL/L 6X4HTSAT 5X5HTHETA 6X4HPSAT
     1 9X1HB 9X1HC )
    6 FORMAT(10X F10.1, 5F10.3)
   70 PRINT 4, DTRP,TTRP,PTRP, DCRT,TCRT,PCRT, AL,BE,EP,
     1 B1,B2,B3, E1,E2
   71 PRINT 5    $  DO 77 J=1,46  $  DN = 0.5*J  $  S = DN/DCRT
   72 R=DN/DTRP  $  R2=R**2  $  R3=R**3
   73 B = B1 + B2*R + B3*R2/(1+BE*R2)
   74 E = (S-1)*(S-ER)*(E1 + E2*R)
   76 TS=TSAT=TSATF(DN) $ TH=THETAF(DN) $ PS=PSATF(TS)
   77 PRINT 6, DN, TS,TH,PS, B, E
   99 RETURN     $     END
```

06/05/74

```
      SUBROUTINE ISOTHERM
C    PRINTOUT THE CRITICAL ISOTHERM.
      COMMON/1/AL,BE,EP,GK, DCRT,TCRT,PCRT, DTRP,TTRP,PTRP
      COMMON/3/DPDT,D2PDT2,DPSDT,DPMCT,DPDD,DPDR,DTSDR,DTHDR
      COMMON/4/XB1,XB2, XC1,XC2, XE1,XE2, DXBDR,DXCDR,DXEDR
    1 FORMAT(1H1 14X *THE CRITICAL ISOTHERM* //
     1 10X 4HTC =F8.3, 6H, DC =F7.3, 6H, PC =F8.4//
     2 11X 4HD/DC 9X4HP/PC 8X5HDP/DD 4X6HDTS/DR 4X6HDTH/DR
     3 4X6HDPS/DR 4X6HDXB/DR 4X6HDXC/DR )
    2 FORMAT(5X F10.2, 2F13.9, 5F10.5)
    5 PRINT 1, TCRT,DCRT,PCRT   $   DO 8  J=1,51
    6 DR = 0.74 + 0.01*J   $   DN = DCRT*DR
    7 PR = DPDRF(TCRT,DN)/PCRT   $   DPSDR = DPSDT*DTSDR
    8 PRINT 2, DR,PR,DPDD, DTSDR,DTHDR,DPSDR, DXBDR,DXEDR
    9 RETURN     $     END
```

06/05/74

```
      SUBROUTINE SETUP
C     SET UP THE ARRAYS FOR LEAST SQUARES.
      COMMON B1,B2,B3,B4, ER, E1,E2,E3
      COMMON/1/AL,BE,EP,GK, DCRT,TCRT,PCRT, DTRP,TTRP,PTRP
      COMMON/2/NP,NF,ID(999),T(999),P(999),DEN(999)
      COMMON/6/ TSAT, THETA, PSAT
      COMMON/999/ NFUN,Y,F(30)
    1 NFUN = NF   $  DO 10 J=1,NP
    2 TT = T(J)   $  X = TT/TCRT   $  D = DEN(J)   $  S = D/DCRT
    3 R = D/DTRP   $  R2 = R*R   $  R3 = R*R2   $  RG = R*GK
    4 TS=TSAT=TSATF(D) $ THETA=THETAF(D) $ PS=PSATF(TS) $ XS=TS/TCRT
    5 XB = XBF(TT,D)   $   XE = (S-1)*(S-ER)*XEF(TT,D)
    6 F(1)=XB $ F(2)=XB*R $ F(3)=XB*R2/(1+BE*R2)
    7 F(4)=XE $ F(5)=XE*R
    9 Y = (P(J)/RG/TT-1)*X/R - (PS/RG/TS-1)*XS/R
   10 CALL FIT  $  CALL COEFF  $  CALL STAT
   11 B1=F(1) $ B2=F(2) $ B3=F(3)
   12 E1=F(4) $ E2=F(5)
   30 RETURN    $    END
```

06/05/74

```
      FUNCTION THETAF(DEN)
C     THETA = TSAT*EXP(U(S)).
C     LET Q = (S-1)/(ST-1),  WHERE ST = DTRP/DCRT,  THEN -
C     IF S < 1, U = AL*Q**3,     IF S > 1,  U = -AL*Q**3,
C     YIELDS ALSO THE FIRST DERIVATIVE RSP. TO RHO ≡ DEN/DTRP.
      COMMON/1/AL,BE,EP,GK, DCRT,TCRT,PCRT, DTRP,TTRP,PTRP
      COMMON/3/DPDT,D2PDT2,DPSDT,DPMDT,DPDC,DPCR,DTSCR,DTHDR
      COMMON/6/ TSAT, THETA, PSAT
    1 S = DEN/DCRT  $  DSDR = DTRP/DCRT  $  C = DSDR-1
    2 Q = (S-1)/C  $  Q2 = Q*Q  $  U = AL*Q*Q2
    3 U1 = 3*AL*Q2*DSDR/C   $   IF(Q) 5,9,4
    4 U = -U   $   U1 = -U1
    5 XP = EXPF(U)   $   THETAF = TSAT*XP
    6 DTHDR = (TSAT*U1 + DTSDR)*XP    $    RETURN
    9 THETAF = TCRT  $  DTHDR = 0    $    RETURN   $   END
```

06/05/74

```
      FUNCTION PVTF(T,DEN)
C     YIELDS P,BAR,  ALSO DP/DT, D2P/DT2.
      COMMON B1,B2,B3,B4, ER, E1,E2,E3
      COMMON/1/AL,BE,EP,GK, DCRT,TCRT,PCRT, DTRP,TTRP,PTRP
      COMMON/3/DPDT,D2PDT2,DPSDT,DPMDT,DPDD,DPDR,DTSDR,DTHDR
      COMMON/4/XB1,XB2, XC1,XC2, XE1,XE2, DXBDR,DXCDR,DXEDR
      COMMON/6/ TSAT, THETA, PSAT
    1 Q = DEN  $  S = Q/DCRT  $  R = Q/DTRP
    2 R2 = R*R  $  R3 = R*R2  $  RG = R*GK
    3 TS=TSAT=TSATF(Q) $ THETA=THETAF(Q) $ PS=PSATF(TS)
    4 XB = XBF(T,Q)   $   XE = XEF(T,Q)
    5 B = B1 + B2*R + B3*R2/(1+BE*R2)
    6 E = (S-1)*(S-ER)*(E1 + E2*R)
    9 F = B*XB + E*XE  $  F1 = B*XB1 + E*XE1  $  F2 = B*XB2 + E*XE2
   11 YS = (PS/RG/TS-1)*TS/TCRT/R
   15 PVTF = (T + R*(F+YS)*TCRT)*RG  $  DPDT = (1+R*F1)*RG
   17 D2PDT2 = R*RG*F2/TCRT   $   RETURN  $  END
```

06/05/74

```
      FUNCTION DPDRF(T,DEN)
C     DPDRF = P,BAR.  DP/DR IS IN COMMON.  GK = 0.0831434*DTRP.
C     EQNSTATE IS  Y = YSAT + F(R,T),  WHERE  Y = (Z-1)*X/R,  AND -
C     F(R,T) = B*XB + C*XC + D*XD + E*XE,    YIELDS DERIV. -
C     DP/DR = 2*P/R - GK*T + R2*GK*TCRT*(F1 + YS1).
      COMMON B1,B2,B3,B4, ER, E1,E2,E3
      COMMON/1/AL,BE,EP,GK, DCRT,TCRT,PCRT, DTRP,TTRP,PTRP
      COMMON/3/DPDT,D2PDT2,DPSDT,DPMDT,DPDD,DPDR,DTSDR,DTHDR
      COMMON/4/XB1,XB2, XC1,XC2, XE1,XE2, DXBDR,DXCDR,DXEDR
      COMMON/6/ TSAT, THETA, PSAT
      COMMON/7/ XB,XC,XD,XE
    1 X=T/TCRT $ Q=DEN $ S=Q/DCRT $ DSDR=DTRP/DCRT
    2 R=Q/DTRP $ R2=R*R $ R3=R*R2  $  RG = R*GK
    3 TS=TSAT=TSATF(Q) $ THETA=THETAF(Q) $ PS=PSATF(TS) $ XS=TS/TCRT
    4 XB = XBF(T,Q)  $  XE = XEF(T,Q)
    5 BS = 1.+ BE*R2  $  BS1 = 2*BE*R
    6 B = B1 + B2*R + B3*R2/BS
    7 BD = B2 + B3*(2*R/BS - R2*BS1/BS/BS)
    8 SX = (S-1)*(S-ER)  $  E = E1 + E2*R
    9 ED = SX*E2 + (2*S - 1 - ER)*DSDR*E   $   E = SX*E
   12 F = B*XB + E*XE  $  YS = (PS/RG/TS-1)*XS/R
   13 F1 = B*DXBDR + BD*XB  +  E*DXEDR + ED*XE
   16 YS1 = (TS - R*DTSDR + DPSDT*DTSDR/GK - 2*PS/RG)/TCRT
   17 C = (F+YS)*R/X  $  DPDR = (1 + 2*Q + (R2*F1 + YS1)/X)*GK*T
   18 DPDRF = (1+Q)*RG*T  $  DPDD = DPDR/DTRP  $  RETURN  $  END
```

06/05/74

```
      FUNCTION XBF(T,D)
C     XBF = SQRT(T/TC)*LN(T/TS) = Q(T)*Z(R,T),
C     Z(R,T) = LN(U),   U(R,T) = T/TS(R).
      COMMON/1/AL,BE,EP,GK, DCRT,TCRT,PCRT, DTRP,TTRP,PTRP
      COMMON/3/DPDT,D2PDT2,DPSDT,DPMCT,DPDD,DPCR,DTSDR,DTHDR
      COMMON/4/XB1,XB2, XC1,XC2, XE1,XE2, DXBDR,DXCDR,DXEDR
      COMMON/6/ TSAT, THETA, PSAT
    1 TC = TCRT   $   TS = TSAT   $   X = T/TC
    2 U = T/TS   $   U1X = TC/TS   $   U1R = -U*DTSDR/TS
    3 Z = LOGF(U)   $   Z1R=U1R/U   $   Z1X=U1X/U   $   Z2X=-Z1X*Z1X
    4 Q = SQRTF(X)   $   Q1 = 0.5/Q   $   Q2 = -Q1/2/X
    5 XBF = Q*Z   $   DXBDR = Q*Z1R   $   XB1 = Q*Z1X + Q1*Z
    6 XB2 = Q*Z2X + 2*Q1*Z1X + Q2*Z    $    RETURN   $   END
```

06/05/74

```
      FUNCTION XEF(T,D)
C     XEF = PSI-PSISAT,   PSI = (1-W*LN(1+1/W))/X,   W = EP*(T/TH-1).
C     XEF = F(R,T)/X - FS(R)/XS   . . . . .
C     F(R,T) = 1-W*P(R,T),   P(R,T) = LN(U),   U = 1+1/W(R,T),
C     FS(R) = 1-WS*PS(R),   PS(R) = LN(V),   V = 1+1/WS(R).
      COMMON/1/AL,BE,EP,GK, DCRT,TCRT,PCRT, DTRP,TTRP,PTRP
      COMMON/3/DPDT,D2PDT2,DPSDT,DPMDT,DPDD,DPCR,DTSDR,DTHDR
      COMMON/4/XB1,XB2, XC1,XC2, XE1,XE2, DXBDR,DXCDR,DXEDR
      COMMON/6/ TSAT, THETA, PSAT
    1 E=EP $ TC=TCRT $ TH=THETA $ TS=TSAT $ W=E*(T/TH-1) $ IF(W) 30,30,2
    2 WW = W*W   $   W1X = E*TC/TH   $   W1R = -E*T*DTHDR/TH/TH
    3 U=1+1/W $ U1R=-W1R/WW $ U1X=-W1X/WW   $   U2X = -2*U1X*W1X/W
    4 P=LOGF(U) $ P1R=U1R/U $ P1X=U1X/U   $   P2X = U2X/U - P1X*P1X
    5 F = 1 - W*P   $   F1R = -W*P1R - W1R*P
    6 F1X = -W*P1X - W1X*P   $   F2X = -W*P2X - 2*W1X*P1X
    7 WS = E*(TS/TH-1)    $    IF(WS) 8,8,9
    8 FS = 1   $   FS1 = 0   $   GO TO 12
    9 WS1 = E*(DTSDR - TS*DTHDR/TH)/TH    $    U = 1+1/WS
   10 PS = LOGF(U)   $   PS1 = -WS1/U/WS/WS
   11 FS = 1-WS*PS   $   FS1 = -WS*PS1 - WS1*PS
   12 X=T/TC $ X2=X*X $ XS=TS/TC $ XS1=DTSDR/TC
   13 XEF = F/X - FS/XS   $   XE1 = F1X/X - F/X2
   14 XE2 = F2X/X - 2*F1X/X2 + 2*F/X/X2
   15 DXEDR = F1R/X - FS1/XS + FS*XS1/XS/XS    $    RETURN
   30 XEF = XE1 = XE2 = DXEDR = 0      $      RETURN     $     END
```

06/05/74

```
      FUNCTION DENGASF(T)
C    ETHANE SATD. VAPOR DENSITIES, MCL/L, VIA LAB. NOTE 73-4, 73-5.
C    Y = A1 + A2*Q2 + A3*Q3 + . . ,  NF = AL,  YN = LN(DCRT/DTRP),
C    U = Z + (ZE-Z)*Y,    DEN = DCRT*EXP(-YN*U).
      COMMON/1/AL,BE,EP,GK, DCRT,TCRT,PCRT, DTRP,TTRP,PTRP
      COMMON/9/IS,NPS,EG,EL,ALS,BES,AL1,AL2,AL3,CG(5),AV(8),AW(5)
      DATA (DGAT = 1.35114E-6)
    1 FORMAT(1H0 9X *DENGASF = 0, T EXCEEDS TCRT. * / )
    2 IF(TCRT-T) 3,4,5
    3 PRINT 1  $  STOP
    4 DENGASF = DCRT   $   RETURN
    5 YN = LOGF(DCRT/DGAT)  $  Z = (TCRT/T-1)/(TCRT/TTRP-1)
    6 G = CUBERTF(Z)  $  Y = CG(1)  $  DO 7 K=2,5
    7 Y = Y + CG(K)*Q**K  $  U = Z + (Z**EG-Z)*Y
    8 DENGASF = DCRT*EXPF(-YN*U)    $    RETURN   $   END
```

06/05/74

```
      FUNCTION DENLIQF(T)
C    ETHANE SATD. LIQUID DENSITIES, MOL/L, VIA LAB. NOTE 73-5.
C    Y = A1 + A2*Q2 + A3*Q3 + . . . ,   YN = DTRP-DCRT,
C    DEN = DCRT + YN*(X + (XE-X)*Y).
      COMMON/1/AL,BE,EP,GK, DCRT,TCRT,PCRT, DTRP,TTRP,PTRP
      COMMON/9/IS,NPS,EG,EL,ALS,BES,AL1,AL2,AL3,CG(5),AV(8),AW(5)
    1 FORMAT(1H0 9X *DENLIQF = 0, T EXCEEDS TCRT. * / )
    2 IF(TCRT-T) 3,4,5
    3 PRINT 1    $   STOP
    4 DENLIQF = DCRT   $   RETURN
    5 X = (TCRT-T)/(TCRT-TTRP)  $  W = X**EL - X
    6 G = CUBERTF(X)  $  Y = AL1 + AL2*G*Q + AL3*X
    7 DENLIQF = DCRT + (DTRP-DCRT)*(X + W*Y)   $   RETURN  $  END
```

06/05/74

```
      FUNCTION PMELTF(T)
C    ETHANE MELT P TO 42 ATM., CLUSIUS/WEIGAND, 1940.
C    SIMON EQN.,   P = PTRP + A*(X**2 - 1),    X = T/TTRP.
      COMMON/3/DPDT,D2PDT2,DPSDT,DPMDT,DPDD,DPDR,DTSDR,DTHDR
      DATA (TTRP=89.899),(PTRP=9.967E-6),(A=2840.0),(Q=1.01325)
    1 X = T/TTRP  $  PMELTF = Q*(PTRP + A*(X*X-1))
    2 DPMDT = Q*A*2*X/TTRP    $    RETURN   $   END
```

```
*    SINGLE-BANK COMPILATION.

ROGRAM LENGTH 00063
```

06/05/74

```
      FUNCTION PSATF(T)
C     ETHANE V.P., BAR, VIA LAB. NOTE 73-3.
      COMMON/1/AL,BE,EP,GK, DCRT,TCRT,PCRT, DTRP,TTRP,PTRP
      COMMON/3/DPDT,D2PDT2,DPSDT,DPMDT,DPDD,DPDR,DTSDR,DTHDR
      COMMON/8/IP,NPP,P1,P2,P3,P4,P5, IDP(99),TPS(99),PPS(99)
    1 FORMAT(1H0 9X *PSATF = 0, T EXCEEDS TCRT. * / )
    2 XN = 1-TTRP/TCRT   $   DXDT = TTRP/XN/T/T
    3 X=(1-TTRP/T)/XN $ X2=X*X $ X3=X*X2 $ X4=X2*X2
    4 V = 1-X   $   IF(V) 5,6,7
    5 PSATF = DPSDT = 0   $   PRINT 1   $   RETURN
    6 Z = Z1 = 0   $   GO TO 9
    7 Q = SQRTF(V)   $   W = V*Q   $   W1 = -3*Q/2
    8 Z = X*W   $   Z1 = W + X*W1
    9 F = P1*X + P2*X2 + P3*X3 + P4*X4 + P5*Z
   10 F1 = P1 + 2*P2*X + 3*P3*X2 + 4*P4*X3 + P5*Z1
   11 PSATF = PTRP*EXPF(F)   $   DPSDT = F1*DXDT*PSATF   $   RETURN   $   END
```

06/05/74

```
      FUNCTION TSATF(DEN)
C     THIS NEW TSATF VIA TSATFIT, 4/19/74 AT 09.00.
      COMMON/1/AL,BE,EP,GK, DCRT,TCRT,PCRT, DTRP,TTRP,PTRP
      COMMON/3/DPDT,D2PDT2,DPSDT,DPMDT,DPDD,DPDR,DTSDR,DTHDR
      COMMON/9/IS,NPS,EG,EL,ALS,BES,AL1,AL2,AL3,CG(5),AV(8),AW(5)
      DATA (NFG=8),(NFL=5)
      DATA (E = 0.25),(DGAT = 1.35114E-6)
C     SATD. VAPOR TEMPS. CONSTRAINED AT T.P. BY SUBTRACTION  -
C     DEFINE  X = ABS(S-1),  XT = ABS(ST-1),  WHEN THE EQN. IS -
C     LN(YY) = AL*(1/XT-1/X) + A1*LOG(LN(1+E/S)/LN(1+E/ST)) + W(S),
C     W(S) = A2*(Q-QT) + A3*(Q2-QT2) + A4*(S-ST) + A5*(S2-ST2) + . . .
C     WHERE,  Q = S**1/3,  AND  QT = ST**1/3.
    1 S = DEN/DCRT   $   DSDR = DTRP/DCRT   $   QS = S-1   $   IF(QS) 2,30
    2 X = ABSF(QS)   $   X1 = DSDR*QS/X   $   YN = TCRT/TTRP - 1
    3 V=1/X $ V1=-DSDR/X/QS $ ST=DGAT/DCRT   $   IF(QS) 4,30,15
    4 XT=1-ST $ VT=1/XT $ U=ALS*(VT-V) $ U1=-ALS*V1 $ EK=LOGF(1+ E/ST)
    5 P = 1 +  E/S   $   P1 =  -E*DSDR/S/S   $   PG = LOGF(P)/EK
    6 G = LOGF(PG)   $   G1 = P1/P/PG/EK
    7 Q = CUBERTF(S)   $   QT = CUBERTF(ST)   $   Q1 = Q*DSDR/3/S
    8 W = U + AV(1)*G + AV(2)*(Q-QT) + AV(3)*(Q*Q-QT*QT)
    9 W1 = U1 + AV(1)*G1 + AV(2)*Q1 + AV(3)*2*Q*Q1
   10 DO 11 K=4,NFG   $   N = K-3   $   W = W + AV(K)*(S**N-ST**N)
   11 W1 = W1 + N*DSDR*AV(K)*S**(N-1)   $   GO TO 18
C     SATD. LIQUID TEMPS. CONSTRAINED AT THE T.P. BY SUBTRACTION, -
C     EQN.,  LN(YY) = W(S),  WHERE  X=ABS(S-1),  XT=ABS(ST-1), AND -
C     W(S) = BE*(1/XT - 1/X) + B1*(S-ST) + B2*(S2-ST2) + . . .
   15 ST = DSDR   $   XT = ST-1   $   W = BES*(1/XT-V)   $   W1 = -BES*V1
   16 DO 17 K=1,NFL   $   W = W + AW(K)*(S**K - ST**K)
   17 W1 = W1 + AW(K)*K*DSDR*S**(K-1)
   18 F = EXPF(W)   $   F1 = W1*F   $   Q = 1 + YN*F
   19 TSATF = TCRT/Q   $   DTSDR = -YN*F1*TSATF/Q   $   RETURN
   30 TSATF = TCRT   $   DTSDR = 0   $   RETURN   $   END
```

06/05/74

```
      FUNCTION FINDENF(T,P,DI)
C     ON ISOTHERM T, ITERATE DEN TO MINIMIZE (P-PCALC).
C     NEWTON-RAPHSON ITERATION.  INITIAL DEN = DI.
C     NOTE STATEMENTS 14,15 FCR ETHANE.
      COMMON/1/AL,BE,EP,GK, DCRT,TCRT,PCRT, DTRP,TTRP,PTRP
      COMMON/3/DPDT,D2PDT2,DPSDT,DPMDT,DPDD,DPDR,DTSDR,DTHDR
    1 FORMAT(1H0 9X *FINDENF = 0,  FAILS TO CONVERGE.* / )
    2 FORMAT(1H0 9X *FINDENF = DCRT,  DP/DR ZERO OR NEG.* / )
    3 FORMAT(1H0 9X *FINDENF = 0,  DI INSIDE DOME.* / )
    4 D=DI $ DM=DTRP*(T/TTRP)**0.25 $ DX=DM+1  $  IF(T-TCRT) 5,7,8
    5 DG=DENGASF(T) $ DL=DENLIQF(T) $ PS=PSATF(T)
    6 IF(D.GT.DG.AND.D.LT.DL) 32,8
    7 DG=DL=DCRT  $  PS=PCRT  $  IF(D.EQ.DCRT) 33,8
    8 DO 30 J=1,50  $  DP = P - DPDRF(T,D)
    9 IF(ABSF(DP/P)-1.0E-6) 31,31,10
   10 IF(DPDD) 33,33,11
   11 DD = DP/DPDD  $  IF(ABSF(DD/D)-1.0E-6) 31,31,12
   12 D = D + DD  $  IF(D.GT.0.001) 14,13
   13 D = 0.001  $  GO TO 30
   14 IF(D.GT.DX) 15,16
   15 D = DM  $  GO TO 30
   16 IF(T-TCRT) 17,22,30
   17 IF(P.LT.PS) 18,20
   18 IF(D.GT.DG) 19,30
   19 D = DG  $  GO TO 30
   20 IF(D.LT.DL) 21,30
   21 D = DL  $  GO TO 30
   22 IF(P.LT.PCRT) 23,25
   23 IF(D.LT.DCRT) 30,24
   24 D = DCRT - 0.02  $  GO TO 30
   25 IF(D.GT.DCRT) 30,26
   26 D = DCRT + 0.02
   30 CONTINUE  $  FINDENF = 0  $  PRINT 1  $  RETURN
   31 FINDENF = D  $  RETURN
   32 FINDENF = 0  $  PRINT 3  $  RETURN
   33 FINDENF = DCRT  $  PRINT 2  $  RETURN  $  END

*    SINGLE-BANK COMPILATION.
```

06/05/74

```
      FUNCTION FINDSATF(T,M)
C     ITERATE DEN TO MINIMIZE (T-TS) VIA TSATF(DEN).
C     THIS FINDSATF ADJUSTED FOR ETHANE.
C     M = 0 FOR VAPOR,  M = 1 FOR LIQUID.
      COMMON/1/AL,BE,EP,GK, DCRT,TCRT,PCRT, DTRP,TTRP,PTRP
      COMMON/3/DPDT,D2PDT2,DPSDT,DPMDT,DPDD,DPCR,DTSDR,DTHDR
      DATA (DGT=5.0E-7),(DLT=23.0)
    1 FORMAT(1H0 9X *FINDSATF = 0,  FAILS TO CONVERGE.* / )
    2 FORMAT(1H0 9X *FINDSATF = 0,  T EXCEEDS TCRT.* / )
    3 IF(T-TCRT) 4,22,23
    4 IF(M.EQ.0) 5,6
    5 D = DENGASF(T)  $  GO TO 7
    6 D = DENLIQF(T)
    7 DO 20 J=1,50 $ DT=T-TSATF(D) $ IF(ABSF(DT/T)-1.0E-6) 21,21,8
    8 DTDD = DTSDR/DTRP  $  IF(DTDD.EQ.0.0) 22,9
    9 DD = DT/DTDD  $  IF(ABSF(DD/D)-1.0E-6) 21,21,10
   10 D = D + DD  $  IF(M.EQ.0) 11,15
   11 IF(D.GT.DGT) 13,12
   12 D = DGT  $  GO TO 20
   13 IF(D.LT.DCRT) 20,14
   14 D = DCRT - 0.02  $  GO TO 20
   15 IF(D.GT.DLT) 16,17
   16 D = DLT  $  GO TO 20
   17 IF(D.GT.DCRT) 20,18
   18 D = DCRT + 0.02
   20 CONTINUE  $  FINDSATF = 0  $  PRINT 1  $  RETURN
   21 FINDSATF = D  $  RETURN
   22 FINDSATF = DCRT  $  RETURN
   23 FINDSATF = 0  $  PRINT 2  $  RETURN  $  END
```

06/05/74

```
      FUNCTION ZIPF(T,D)
C     ETHANE VIRIAL EQN. VIA LAB. NOTE 73-4.
      DIMENSION B(5), C(3)
      DATA (TCRT=305.33),(VCRT=0.14556),(TB=740.0),(TC=217.8)
      DATA(B = 7.993156, -10.672497, 9.217322, -2.481668, 0.842328)
      DATA(C = 0.253773, 0.865299, 0.556075)
    1 S = D*VCRT  $  X = T/TCRT  $  Q = X**0.25
    2 X2 = X*X  $  X3 = X*X2  $  X5 = X2*X3
    3 ZB = 1 - (TB/T)**0.25   $   ZC = 1 - TC/T
    4 BV = ZB*(B(1) + B(2)/Q  + B(3)/X + B(4)/X2 + B(5)/X3)
    5 CV = ZC*(C(1)/X + C(2)/X3 + C(3)/X5)
    6 ZIPF = 1 + BV*S + CV*S*S    $    RETURN   $   END
```

05/09/74

```
      SUBROUTINE FITTER
      COMMON/999/ NCOF,Y,G(30)
      DIMENSION A(30,31),B(30,31)
      COMMON /777/ A,SY,SYY,RES
      TYPE DOUBLE SY,SYY,RES,A,B
      DATA (NTR=-1),(NDIM=30)
      EQUIVALENCE (A,B)
   37 FORMAT(*1THE COEFFICIENTS AND THEIR ESTIMATED ERRORS ARE0*//)
   38 FORMAT(*0*/*0*/*0ESTIMATED RESIDUAL SUM OF SQUARES =*E17.9/
     1               * ESTIMATED REGRESSION SUM OF SQUARES =*E17.9/
     2                    * ESTIMATED TOTAL SUM OF SQUARES =*E17.9/
     3* VARIANCE OF FIT =*E17.9/* DETERMINANT OF THE MATRIX =*E17.9/
     4* CORRELATION COEFFICIENT =*E17.9/* NUMBER OF POINTS =*I5)
   45 FORMAT(*1THE ARRAYS IN THE FITTING PROGRAM ARE TOO SMALL TO HOLD T
     1HE NUMBER OF CONSTRAINTS AND FUNCTIONS ASKED FOR IN THE CALLING PR
     2OGRAM*)
  371 FORMAT(E19.10,* +OR-*E9.2)
C     ENTER HERE TO FIT THE DATA
      ENTRY FIT
      IF(NTR) 1,3,3
    1 NP=0
      NF=NCOF
      IF(NF.GT.NDIM) GO TO 44
      NCON=0
      SY=0.
      SYY=0.
      NY=NF+1
      DO 2 I=1,NY
      DO 2 J=1,NF
    2 A(J,I)=0.
      IF(NTR.EQ.0) GO TO 11
      NTR=0
    3 SY=Y+SY
      SYY=SYY+Y*Y
      DO 4 J=1,NF
      A(J,NY)=A(J,NY)+Y*G(J)
      DO 4 I=1,NF
    4 A(I,J)=A(I,J)+G(I)*G(J)
      NP=NP+1
      RETURN
C     ENTER HERE TO CONSTRAIN THE EQUATION
      ENTRY CONSTR
      IF(NTR) 10,11,11
   10 NTR=0
      GO TO 1
   11 N=NY-1
      IF((NY+NCON+2).GT.NDIM) GO TO 44
      DO 12 I=1,N
      A(I,NY+1)=A(I,NY)
      A(NDIM-NCON,I)=G(I)
      A(NY,I)=G(I)
   12 A(I,NY)=G(I)
      NCON=NCON+1
      DO 13 I=NF,N
      A(NY,I+1)=0.0
```

```
      FITTER                                                  05/09/74
   13 A(I+1,NY)=0.0
      NY=NY+1
      A(NY-1,NY)=Y
      RETURN
C     ENTER HERE TO INVERT MATRIX AND GET COEFFICIENTS
      ENTRY COEFF
      N=NY-1
      DO 20 I=1,NF
   20 G(I)=A(I,NY)
      DO 22 I=2,N
      DO 21 J=I,NY
   21 A(I-1,J)=A(I-1,J)/A(I-1,I-1)
      DO 22 J=I,N
      DO 22 K=I,NY
   22 A(J,K)=A(J,K)-A(J,I-1)*A(I-1,K)
      A(N,NY)=A(N,NY)/A(N,N)
      DO 24 I=2,N
      L=N-I+2
      DO 24 J=L,N
   24 A(L-1,NY)=A(L-1,NY)-A(L-1,J)*A(J,NY)
      RES=SYY
      DO 25 I=1,NF
      RES=RES-A(I,NY)*G(I)
   25 G(I)=A(I,NY)
      DF=NP-NF+NCON
      Y=NCON
      NTR=-1
      RETURN
C     ENTER HERE FOR STATISTICS OF COEFFICIENTS
      ENTRY STAT
      DO 27 I=1,NCON
      DO 27 J=1,NF
   27 RES=RES-A(NDIM-I+1,J)*A(J,NY)*A(NF+I,NY)
      TOT=SYY-SY*SY/NP
      REG=TOT-RES
      SYY=RES/DF
      ST=1.96+2.72/DF+8.04/DF**3
      DET=1.
      DO 30 I=1,NF
      DET=DET*B   (I,I)
   30 A(I,I)=1.0/A(I,I)
      DO 32 I=2,NF
      DO 32 J=2,I
      SY=0.
      DO 31 K=J,I
   31 SY=SY-A(I,K-1)*A(K-1,J-1)
   32 A(I,J-1)=SY*A(I,I)
      PRINT 37
      DO 36 I=1,NF
      L=NF-I
      DO 33 J=1,L
      K=NF-J
      DO 33 M=1,J
      N=NF-M+1
   33 A(K,I)=A(K,I)-A(K,N)*A(N,I)
```

```
        FITTER                                                  05/09/74

      DO 34 J=2,I
   34 A(J-1,I)=A(I,J-1)*SYY
      DO 35 J=1,I
   35 A(I,J)=A(I,J)*SYY
      BB=B(I,I)
C     BB IS THE VARIANCE OF THE COEFFICIENTS
      IF(BB.LT.0.0)BB=-BB
      FF=ST*SQRT(BB)
      BBB=B(I,NY)
   36 PRINT 371,BBB,FF
      IF(SYY.LT.0.0) SYY=-SYY
      CORR=REG/TOT
      PRINT 38,RES,REG,TOT,SYY,DET,CORR,NP
      Y=SQRT(RES/DF)
      RETURN
   44 PRINT 45
      STOP
      END

*    SINGLE-BANK COMPILATION.
```

## Computer Programs for Thermofunctions

06/06/74

```
      PROGRAM ETHERMO2
C     START ETHANE PROVISIONAL THERMOFUNCTIONS, 14 FEB., 1974.
      COMMON B1,B2,B3, ER, E1,E2
      COMMON/1/AL,BE,EP,GK, DCRT,TCRT,PCRT, DTRP,TTRP,PTRP
      COMMON/3/DPDT,D2PDT2,DPSDT,DPMDT,DPDD,DTSDR,DTHDR
      COMMON/4/ XB1,XB2, XE1,XE2, DXBDR,DXEDR
      COMMON/6/ TSAT, THETA, PSAT
      COMMON/7/ TB,PB, HB,SB
      COMMON/8/ P,T,DEN, E,H,S, CV,CP,CSAT, W,WK
      COMMON/9/ EI(60),SI(60),CVI(60)
      COMMON/10/ DF(34),EF(34),SF(34),CVF(34)
      COMMON/99/ TI,EZZ, EZ,SZ,CVZ, HZ,CPZ
      DIMENSION PP(99)
    3 FORMAT(1H1 11X *LOOP CLOSURE CHECK FOR SATURATED LIQUID,* /
     1 12X *ENTHALPY, H, VIA FURTADO CP(T).  HC VIA CLAPEYRON EQN.* //
     2 12X 3HT,K 9X1HH 8X2HHC 7X3HPCT 9X1HS 8X2HSC 7X3HPCT )
    4 FORMAT(5X 3F10.0, 4F10.2)
    5 FORMAT(1X)
   10 FORMAT(1H1 9X *ETHANE FUNCTIONS AT TB ON THE CP ISOBAR AT PB.*//
     1 10X 5HTB  =F8.3, 6H, PB =F8.3, 6H, DB =F8.4//
     2 10X 5HEZ  =F10.2, 6H, E  =F10.2//
     3 10X 5HHZ  =F10.2, 6H, H  =F10.2//
     4 10X 5HSZ  =F10.4, 6H, S  =F10.4//
     5 10X 5HCVZ =F10.3, 6H, CV =F10.3//
     6 10X 5HCPZ =F10.3, 6H, CP =F10.3//
     7 10X 21HFURTADOS VALUE,  CP =F10.3)
   15 FORMAT(8F10.0)
   16 FORMAT(///////// 1H1 18X * ETHANE ISOBAR AT P =*F6.1, 4H BAR//
     1 19X 1HT 6X3HDEN 6X3HVOL 5X5HDP/DT 5X5HDP/DD 8X1HE 8X1HH 8X1HS
     2 6X2HCV 6X2HCP 5X1HW /
     3 15X 5HDEG K 4X5HMOL/L 4X5HL/MOL 5X5HBAR/K 1X9HBAR-L/MOL 4X5HJ/MOL
     4 4X5HJ/MOL 2X7HJ/MOL/K 1X7HJ/MOL/K 1X7HJ/MOL/K 1X5HM/SEC )
   17 FORMAT(10X F10.3, F9.3, F9.5, F10.4, F10.3, 2F9.1,F9.3,2F8.2,F6.0)
   18 FORMAT(10X F10.3, F9.5, F9.3, F10.6, F10.3, 2F9.1,F9.3,2F8.2,F6.0)
C
C     CONSTANTS OF EQNSTATE,  6/5/74 AT 8.21.
C     NOTE,  EZZ FROM TESTER.
   30 WM = 30.07  $  WK = 100000/WM  $  Q = 1.01325  $  GKK = 0.0831434
   31 TTRP = 89.899  $  DTRP = 21.68  $  PTRP = Q*9.967E-6
   32 TCRT = 305.37  $  DCRT = 6.74  $  PCRT = PSATF(TCRT)
   33 GK = DTRP*GKK  $  EZZ = 4.1868*4827.2
   34 AL = 2  $  BE = 1  $  EP = 0.5  $  ER = 1.90
   35 B1 = 1.848167996  $  B2 = 1.569704511  $  B3 = 5.560186452
   36 E1 = -1.042842462  $  E2 = 0.224978299
C     INTEGRATE ON ISOTHERM TB UP TO POINT (TB,PB),  THEN -
C     GET FURTADO,S CP(T) FOR COMPARISON, AND PRINT ALL VALUES.
   40 TB = T = 340  $  PB = P = 137.895
   41 CALL SAVIDEAL  $  CALL HOMOTHRM  $  TI = T  $  CALL IDEAL
   42 HB = H  $  SB = S  $  CPX = CPXF(T)
   43 PRINT 10, T,P,DEN, EZ,E, HZ,H, SZ,S, CVZ,CV, CPZ,CP, CPX
   44 CALL MEMORY
C
C     NOW COMPARE SATLIQ FUNCTIONS VIA FURTADO WITH CLAPEYRON.
   50 PRINT 3  $  DO 60 J=1,43  $  T = 85 + 5*J
   51 P = PS = PSATF(T)  $  CALL SATGSTRM  $  DG = DEN
```

```
      ETHERMO2                                                06/06/74

   52 DL = FINDSATF(T,1)  $  Q = 100*T*DPSDT*(1/DL-1/DG)
   53 HC = H + Q  $  SC = S + Q/T
   55 CALL SATLQTRM  $  HR = 100*(HC/H-1)  $  SR = 100*(SC/S-1)
   60 PRINT 4, T, H,HC,HR, S,SC,SR
   98 CALL JTLOCUS   $   CALL TABLIQ
C
C     COMPUTE THERMOFUNCTIONS ON ISOBARS.
C     EACH ISOBAR STARTS ON THE MELTING LINE.
C     ISOBARS AT P UNDER PCRT TRAVERSE THE DOME.
C     LET THE FIRST ISOBAR BE AT P = 0.1 BAR.
C     ENTER COMPRESSED LIQUID VIA FURTADC CP(T) ON 137.895 BARISOBAR.
C
  100 NI = 68  $  PP(1) = 0.1  $  READ 15, (PP(I),I=2,NI)
  102 DO 300 I=1,NI  $  P = PP(I)  $  PRINT 16, P
  103 CALL MELTHERM  $  V = 1/DEN
  104 PRINT 17, T,DEN,V, DPDT,DPDD, E,H,S, CV,CP,W
  105 IT = T/10  $  IF(P.LT.PCRT) 110,199
C
C     CASES FOR P LESS THAN PCRT.
  110 TS = FINDTSF(P)  $  TX = TS + 10  $  K = L = 0
  111 DO 150 J=1,99  $  T = JT = 10*(IT+J)
  112 IF(T.LT.TS) 113,115
  113 CALL LIQTHERM  $  V = 1/DEN
  114 PRINT 17, T,DEN,V, DPDT,DPDD, E,H,S, CV,CP,W  $  GO TO 150
  115 IF(T.LT.TX) 118,130
C     CASE FOR THE SATURATED LIQUID AND VAPOR.
  118 T = TS  $  CALL SATLQTRM  $  V = 1/DEN
  119 PRINT 17, T,DEN,V, DPDT,DPDD, E,H,S, CV,CP,W  $  PRINT 5
  120 CALL SATGSTRM  $  V = 1/DEN
  121 IF(P.LT.20.0) 122,123
  122 PRINT 18, T,DEN,V, DPDT,DPDD, E,H,S, CV,CP,W  $  GO TO 124
  123 PRINT 17, T,DEN,V, DPDT,DPDD, E,H,S, CV,CP,W
  124 T = JT
C     CASES FOR THE HOMOGENEOUS DOMAIN.
  130 IF(JT-500) 135,135,131
  131 K = K+1  $  T = JT = JT + 10*K
  132 IF(JT-600) 135,135,300
  135 CALL HOMOTHRM  $  V = 1/DEN
  136 IF(P.LT.20.0) 137,138
  137 PRINT 18, T,DEN,V, DPDT,DPDD, E,H,S, CV,CP,W  $  GO TO 150
  138 PRINT 17, T,DEN,V, DPDT,DPDD, E,H,S, CV,CP,W
  150 CONTINUE
C
C     CASES FOR P GREATER THAN PCRT.
  199 K = L = 0
  200 DO 250 J=1,99  $  T = JT = 10*(IT+J)
  201 IF(T.LT.TB) 202,210
  202 IF(T.GT.TCRT) 203,205
  203 PX = PVTF(T,DCRT,0)  $  IF(P.GT.PX) 205,220
C     CASE FOR THE COMPRESSED LIQUID.
  205 CALL LIQTHERM  $  V = 1/DEN
  206 PRINT 17, T,DEN,V, DPDT,DPDD, E,H,S, CV,CP,W  $  GO TO 250
C     CASES FOR THE HOMOGENEOUS DOMAIN.
  210 IF(JT-500) 220,220,211
  211 K = K+1  $  T = JT = JT + 10*K
```

```
      ETHERM02                                                06/06/74

  212 IF(JT-600) 220,220,300
  220 CALL HOMOTHRM   $  V = 1/DEN
  221 PRINT 17, T,DEN,V, DPDT,DPDD, E,H,S, CV,CP,W
  250 CONTINUE
  300 CONTINUE
  999 STOP    $    END
```

```
                                                              06/06/74

      SUBROUTINE SAVIDEAL
C     MEMORIZE IDEAL GAS FUNCTIONS EVERY 10 K THRU 600 K.
C     NOTE USE BY HOMOTHRM ONLY.
      COMMON/9/ EI(60),SI(60),CVI(60)
      COMMON/99/ TI,EZZ, EZ,SZ,CVZ, HZ,CPZ
    1 DO 9 J=9,60   $  TI = 10*J  $  CALL IDEAL
    2 EI(J) = EZ  $  SI(J) = SZ  $  CVI(J) = CVZ
    9 CONTINUE    $    RETURN   $   END
```

```
                                                              06/06/74

      SUBROUTINE MEMORY
C     MEMORIZE CPSUMIT RESULTS EVERY 10 K FROM 90 TO 340 K.
C     NOTE USE BY LIQTHERM ONLY.
      COMMON/8/P,T,DEN, E,H,S, CV,CP,CSAT, W,WK
      COMMON/10/ DF(34),EF(34),SF(34),CVF(34)
    1 DO 9 J=9,33  $  T = 10*J  $  CALL CPSUMIT
    2 DF(J) = DEN  $  EF(J) = E  $  SF(J) = S  $  CVF(J) = CV
    9 CONTINUE    $    RETURN   $   END
```

06/06/74

```
      SUBROUTINE JTLOCUS
C    DERIVE THE J-T INVERSION CURVE.  USE ROUTINE DELTAF(T,DI).
      DIMENSION TT(99),PP(99),DN(99)
      DATA (DCRT=6.76),(TCRT=305.43)
    1 FORMAT(1H1 16X *THE JOULE-THOMSON INVERSION LOCUS FOR  ETHANE*//
     1 17X3HT,K 5X5HP,BAR 5X5HMOL/L  7X3HT,K 5X5HP,BAR 5X5HMOL/L)
    2 FORMAT(10X F10.0, F10.1, F10.2,   F10.0, F10.1, F10.2)
    6 TA = 240   $  NP = 72
    7 PRINT 1  $  DO 25 I=1,NP  $  DX = 1.6
    8 T = TA + 5*I  $  X = T/TCRT
    9 DI = DCRT*(2.40 - 0.58*X + 0.24/X)
   10 IF(T-TCRT) 11,12,12
   11 DL = DENLIQF(T)  $  IF(DI-DL) 25,12,12
   12 SS = DELTAF(T,DI)  $  DO 20 IT=1,15
   14 D=DI-DX $ SL=DELTAF(T,D)   $   D=DI+DX $ SP=DELTAF(T,D)
   15 IF(SS-SL) 18,16,16
   16 IF(SP-SL) 19,17,17
   17 SS = SL  $  DI = DI - DX  $  GO TO 20
   18 IF(SS-SP) 20,20,19
   19 SS = SP  $  DI = DI + DX
   20 DX = DX/2
   23 TT(I) = T  $  DN(I) = DI  $  PP(I) = PVTF(T,DI,0)
   25 CONTINUE  $  N = NP/2  $  DO 29 J=1,N
   29 PRINT 2, TT(J),PP(J),DN(J),  TT(J+N),PP(J+N),DN(J+N)
   30 RETURN   $   END
```

06/06/74

```
      FUNCTION DELTAF(T,D)
C    GET (T*DP/DT - D*DP/DD) FOR THE J-T INVERSION CURVE.
      COMMON/3/DPDT,D2PDT2,DPSDT,DPMDT,DPDD,DTSDF,DTHDF
      DATA (DCRT=6.76),(TCRT=305.43)
    1 IF(T-TCRT) 2,4,4
    2 DL = DENLIQF(T)  $  IF(D-DL) 3,3,4
    3 DELTAF = 1.0E+100  $  RETURN
    4 P = PVTF(T,D,1)
    5 DELTAF = ABSF(T*DPDT-D*DPDD)   $   RETURN  $  END
```

06/06/74

```
      SUBROUTINE TABLIQ
C     TABULATE THE ETHANE SATURATED LIQUID FUNCTIONS.
      COMMON/1/AL,BE,EP,GK, DCRT,TCRT,PCRT, DTRP,TTRP,PTRP
      COMMON/3/DPDT,D2PDT2,DPSDT,DPMDT,DPDD,DTSDR,DTHDR
      COMMON/8/ P,T,DEN, E,H,S, CV,CP,CSAT, W,WK
      DIMENSION TSA(46), PSA(46)
    4 FORMAT(1H1 13X *PROPERTIES OF SATURATED LIQUID ETHANE* //
     1 14X1HT 10X1HP 5X3HDEN 4X5HV,LIQ 6X5HV,GAS 5X6HDPS/DT 3X6HDDL/DT
     2 6X5HDP/DT 6X5HDP/DD 2X5HQ,VAP 2X5HQ,XPT /
     3 10X5HDEG K 8X3HBAR 3X5HMOL/L 4X5HL/MOL 6X5HL/MOL 6X5HBAR/K
     4 2X7HMOL/L/K 6X5HBAR/K 2X9HBAR-L/MOL 2X5HJ/MOL 2X5HJ/MOL )
    5 FORMAT(5XF10.3, E11.3, F8.3, F9.5, 2E11.3, F9.4, 2E11.3, 2F7.0)
   11 FORMAT(1H1 13X *PROPERTIES OF SATURATED LIQUID ETHANE* //
     1 14X1HT 11X1HP 9X1HE 9X1HH 9X1HS
     2 6X2HCV 6X2HCS 6X2HCP 6X1HW 2X6HCS,XPT /
     3 10X5HDEG K 9X3HBAR 5X5HJ/MOL 5X5HJ/MOL 3X7HJ/MOL/K
     4 1X7HJ/MOL/K 1X7HJ/MOL/K 1X7HJ/MOL/K 2X5HM/SEC 1X7HJ/MOL/K )
   12 FORMAT(5X F10.3, E12.3, 2F10.1, F10.3, 3F8.2, F7.0, F8.2)
C     FOR PAGE ONE OF TABLIQ.
  140 PRINT 4   $   NP = 46
  141 DO 151 J=1,NP   $  IF(J.EQ.1) 142,143
  142 T = TTRP   $  GO TO 147
  143 IF(J.EQ.NP) 144,146
  144 T = TCRT   $  DG = DL = DCRT   $  DDLDT = 0
  145 VG = VL = 1/DG   $  GO TO 149
  146 T = 80 + 5*J
  147 DL = FINDSATF(T,1)   $  DDLDT = DTRP/DTSDR
  148 DG = FINDSATF(T,0)   $  VG = 1/DG   $  VL = 1/DL
  149 TSA(J) = T   $   PSA(J) = PS = PSATF(T)
  150 QC = 100*T*DPSDT*(VG-VL)   $  PX = PVTF(T,DL,1)   $  QX = QVAPXF(T)
  151 PRINT 5, T,PS,DL, VL,VG, DPSDT,DDLDT, DPDT,DPDD, QC,QX
C     FOR PAGE TWO OF TABLIQ.
C     NOW INTEGRATE ALONG PB, THEN ON ISOTHERM T DOWN TO THE SATLIQ.
C     USE SUBROUTINE SATLQTRM FOR THIS OPERATION.
  160 PRINT 11  $  DO 165 J=1,NP
  161 T = TSA(J)    $    P = PSA(J)
  162 CALL SATLQTRM   $   CSX = CSATXF(T)
  165 PRINT 12, T,P, E,H,S, CV,CSAT,CP, W, CSX
  999 RETURN    $    END

*    SINGLE-BANK COMPILATION.
```

06/06/74

```
      FUNCTION PVTF(T,D,M)
C     PVTF = P,BAR. M=0 YIELDS DP/DT,D2P/DT2. M=1 YIELDS ALSO DP/DD.
C     NOTE GK = 0.0831434*DTRP,  AND R = DEN/DTRP.
C     P = PS(R) + R*GK*(T-TS) + R2*GK*TC*(B*XB + E*XE).
      COMMON B1,B2,B3, ER, E1,E2
      COMMON/1/AL,BE,EP,GK, DCRT,TCRT,PCRT, DTRP,TTRP,PTRP
      COMMON/3/DPDT,D2PDT2,DPSDT,DPMDT,DPDD,DTSDR,DTHDR
      COMMON/4/ XB1,XB2, XE1,XE2, DXBDR,DXEDR
      COMMON/6/ TSAT, THETA, PSAT
    1 S = D/DCRT  $  DSDR = DTRP/DCRT  $  R = D/DTRP
    2 R2=R*R $ R3=R*R2 $ R4=R2*R2    $    RG = R*GK
    3 TC = TCRT  $  TS = TSAT = TSATF(D)  $  THETA = THETAF(D)
    4 PS = PSATF(TS)  $  XB = XBF(T,D)  $  XE = XEF(T,D)
    5 BN = 1+BE*R2  $  B = B1*R2 + B2*R3 + B3*R4/BN
    6 EM = E1*R2 + E2*R3  $  SX = (S-1)*(S-ER)  $  E = SX*EM
    7 F = B*XB + E*XE  $  F1 = B*XB1 + E*XE1  $  F2 = B*XB2 + E*XE2
    8 PVTF = PS + (T-TS)*RG + GK*TC*F
    9 DPDT = RG + GK*F1  $  D2PDT2 = GK*F2/TC  $  IF(M.EQ.1) 10,20
   10 BD = 2*B1*R + 3*B2*R2 + (2-BE*R2/BN)*2*B3*R3/BN
   11 ED = SX*(2*E1*R + 3*E2*R2) + (2*S-1-ER)*EM*DSDR
   12 F1 = B*DXBDR + BD*XE  +  E*DXEDR + ED*XE
   13 DPDR = DPSDT*DTSDR + GK*(T-TS-R*DTSDR) + GK*TC*F1
   14 DPDD = DPDR/DTRP
   20 RETURN    $    END
```

06/06/74

```
      FUNCTION THETAF(DEN)
C     THETA = TSAT*EXP(U(S)).
C     LET Q = (S-1)/(ST-1),  WHERE ST = DTRP/DCRT,  THEN -
C     IF S < 1, U = AL*Q**3,    IF S > 1,  U = -AL*Q**3,
C     YIELDS ALSO THE FIRST DERIVATIVE RSP. TO RHO ≡ DEN/DTRP.
      COMMON/1/AL,BE,EP,GK, DCRT,TCRT,PCRT, DTRP,TTRP,PTRP
      COMMON/3/DPDT,D2PDT2,DPSDT,DPMDT,DPDD,DTSDR,DTHDR
      COMMON/6/ TSAT, THETA, PSAT
    1 S = DEN/DCRT  $  DSDR = DTRP/DCRT  $  C = DSDR-1
    2 Q = (S-1)/C  $  Q2 = Q*Q  $  U = AL*Q*Q2
    3 U1 = 3*AL*Q2*DSDR/C  $   IF(Q) 5,9,4
    4 U = -U   $   U1 = -U1
    5 XP = EXPF(U)   $   THETAF = TSAT*XP
    6 DTHDR = (TSAT*U1 + DTSDR)*XP    $    RETURN
    9 THETAF = TCRT  $  DTHDR = 0    $    RETURN   $   END
```

06/06/74

```
      FUNCTION XBF(T,D)
C     XBF = SQRT(T/TC)*LN(T/TS) = Q(T)*Z(R,T),
C     Z(R,T) = LN(U),  U(R,T) = T/TS(R).
C     COMMON/1/AL,BE,EP,GK, DCRT,TCRT,PCRT, DTRP,TTRP,PTRP
      COMMON/3/DPDT,D2PDT2,DPSDT,DPMDT,DPDD,DTSDR,DTHDR
      COMMON/4/ XB1,XB2, XE1,XE2, DXBDR,DXEDR
      COMMON/6/ TSAT, THETA, PSAT
    1 TC = TCRT  $  TS = TSAT  $  X = T/TC
    2 U = T/TS  $  U1X = TC/TS  $  U1R = -U*DTSDR/TS
    3 Z = LOGF(U)  $  Z1R=U1R/U  $  Z1X=U1X/U  $  Z2X=-Z1X*Z1X
    4 Q = SQRTF(X)  $  Q1 = 0.5/Q  $  Q2 = -Q1/2/X
    5 XBF = Q*Z  $  DXBDR = Q*Z1R  $  XB1 = Q*Z1X + Q1*Z
    6 XB2 = Q*Z2X + 2*Q1*Z1X + Q2*Z   $   RETURN  $  END
```

06/06/74

```
      FUNCTION XEF(T,D)
C     XEF = PSI-PSISAT,  PSI = (1-W*LN(1+1/W))/X,  W = EP*(T/TH-1).
C     XEF = F(R,T)/X - FS(R)/XS  . . . . .
C     F(R,T) = 1-W*P(R,T),  P(R,T) = LN(U),  U = 1+1/W(R,T),
C     FS(R) = 1-WS*PS(R),  PS(R) = LN(V),  V = 1+1/WS(R).
      COMMON/1/AL,BE,EP,GK, DCRT,TCRT,PCRT, DTRP,TTRP,PTRP
      COMMON/3/DPDT,D2PDT2,DPSDT,DPMDT,DPDD,DTSDR,DTHDR
      COMMON/4/ XB1,XB2, XE1,XE2, DXBDR,DXEDR
      COMMON/6/ TSAT, THETA, PSAT
    1 E=EP $ TC=TCRT $ TH=THETA $ TS=TSAT $ W=E*(T/TH-1) $ IF(W) 30,30,2
    2 WW = W*W  $  W1X = E*TC/TH  $  W1R = -E*T*DTHDR/TH/TH
    3 U=1+1/W $ U1R=-W1R/WW $ U1X=-W1X/WW  $  U2X = -2*U1X*W1X/W
    4 P=LOGF(U) $ P1R=U1R/U $ P1X=U1X/U  $  P2X = U2X/U - P1X*P1X
    5 F = 1 - W*P  $  F1R = -W*P1R - W1R*P
    6 F1X = -W*P1X - W1X*P  $  F2X = -W*P2X - 2*W1X*P1X
    7 WS = E*(TS/TH-1)   $   IF(WS) 8,8,9
    8 FS = 1  $  FS1 = 0  $  GO TO 12
    9 WS1 = E*(DTSDR - TS*DTHDR/TH)/TH   $   U = 1+1/WS
   10 PS = LOGF(U)  $  PS1 = -WS1/U/WS/WS
   11 FS = 1-WS*PS  $  FS1 = -WS*PS1 - WS1*PS
   12 X=T/TC $ X2=X*X $ XS=TS/TC $ XS1=DTSDR/TC
   13 XEF = F/X - FS/XS  $  XE1 = F1X/X - F/X2
   14 XE2 = F2X/X - 2*F1X/X2 + 2*F/X/X2
   15 DXEDR = F1R/X - FS1/XS + FS*XS1/XS/XS   $   RETURN
   30 XEF = XE1 = XE2 = DXEDR = 0     $     RETURN    $    END
```

06/06/74

```
      FUNCTION DENGASF(T)
C     Y = A1 + A2*Q2 + A3*Q3 + . . . ,   NF = AL,   YN = LN(DCRT/DTRP),
C     U = Z + (ZE-Z)*Y,    DEN = DCRT*EXP(-YN*U).
      DIMENSION A(5)
      DATA  (TTRP=89.899),(DTRP=1.35114E-6)
      DATA  (TCRT=305.37),(DCRT=6.74),(E=0.39)
      DATA(A = 0.21587515, -0.08522342, -0.61523457,
     1 0.25452490, 0.15177230)
    1 FORMAT(1H0 9X *DENGASF = 0, T EXCEEDS TCRT. * / )
    2 IF(TCRT-T) 3,4,5
    3 PRINT 1  $  STOP
    4 DENGASF = DCRT   $   RETURN
    5 ZN=TCRT/TTRP-1  $  YN=LOGF(DCRT/DTRP) $  Z=(TCRT/T-1)/ZN
    6 Q = CUBERTF(Z)  $  X = Z**E - Z  $  Y = A(1)  $  DO 8 K=2,5
    8 Y = Y + A(K)*Q**K   $   U = Z + X*Y
    9 DENGASF = DCRT*EXPF(-YN*U)    $    RETURN   $   END
```

06/06/74

```
      FUNCTION DENLIQF(T)
C     ETHANE SATD. LIQUID DENSITIES, MOL/L, VIA LAB. NOTE 73-5.
C     Y = A1 + A2*Q2 + A3*Q3 + . . . ,   YN = DTRP-DCRT,
C     DEN = DCRT + YN*(X + (XE-X)*Y).
      DATA  (TTRP=89.899),(DTRP=21.68)
      DATA  (TCRT=305.37),(DCRT=6.74),(E=0.33)
      DATA  (A=0.721909438),(B=0.296577899),(C=-0.300365476)
    1 FORMAT(1H0 9X *DENLIQF = 0, T EXCEEDS TCRT. * / )
    2 IF(TCRT-T)  3,4,5
    3 PRINT 1   $   STOP
    4 DENLIQF = DCRT   $   RETURN
    5 XN = TCRT-TTRP  $  YN = DTRP-DCRT  $  X = (TCRT-T)/XN
    6 W = CUBERTF(X)  $  G = X**E - X  $  Y = A + B*W*W + C*X
    8 DENLIQF = DCRT + (X + G*Y)*YN   $   RETURN  $  END
```

06/06/74

```
      FUNCTION PMELTF(T)
C     ETHANE MELT P TO 42 ATM., CLUSIUS/WEIGAND, 1940.
C     SIMON EQN.,  P = PTRP + A*(X**2 - 1),   X = T/TTRP.
      COMMON/3/DPDT,D2PDT2,DPSDT,DPMDT,DPDD,DTSDP,DTHDP
      DATA  (TTRP=89.899),(PTRP=9.967E-6),(A=2840.0),(Q=1.01325)
    1 X = T/TTRP  $  PMELTF = Q*(PTRP + A*(X*X-1))
    2 DPMDT = Q*A*2*X/TTRP    $    RETURN   $   END
```

06/06/74

```
        FUNCTION PSATF(T)
      C    ETHANE V.P., BAR, VIA LAB. NOTE 73-3.
        COMMON/3/DPDT,D2PDT2,DPSDT,DPMDT,DPDD,DTSDR,DTHDR
        DATA (TTRP=89.899),(TCRT=305.37),(PTRP=9.967E-6)
        DATA (P1=10.79549166),(P2=8.35899001),(P3=-3.11490770),
       1 (P4=-0.64969799),(P5=6.07349549)
      1 FORMAT(1H0 9X *PSATF = 0, T EXCEEDS TCRT. * / )
C     2 XN = 1-TTRP/TCRT   $   DXDT = TTRP/XN/T/T
C     3 X=(1-TTRP/T)/XN $ X2=X*X $ X3=X*X2 $ X4=X2*X2
      4 V = 1-X    $    IF(V) 5,6,7
      5 PSATF = DPSDT = 0   $   PRINT 1   $   RETURN
      6 Z = Z1 = 0   $   GO TO 9
      7 Q = SQRTF(V)   $   W = V*Q   $   W1 = -3*Q/2
      8 Z = X*W   $   Z1 = W + X*W1
      9 F = P1*X + P2*X2 + P3*X3 + P4*X4 + P5*Z
     10 F1 = P1 + 2*P2*X + 3*P3*X2 + 4*P4*X3 + P5*Z1
     11 PSATF = 1.01325*PTRF*EXPF(F)
     12 DPSDT = F1*DXDT*PSATF     $     RETURN    $    END
```

06/06/74

```
        FUNCTION TSATF(DEN)
      C    THIS NEW TSATF VIA TSATFIT, 4/19/74 AT 09.00.
        COMMON/3/DPDT,D2PDT2,DPSDT,DPMCT,DPDD,DTSDR,DTHDP
        DIMENSION AV(8), AW(5)
        DATA (ALS=0.5),(BES=0.5),(E=0.25),(DTRP=21.68),(DGAT=1.35114E-6)
C       DATA (TTRP=89.899),(TCRT=305.37),(DCRT=6.74)
C       DATA(AV = 0.868105174, 0.015169784, -0.729604322, 1.009654932,
C      1 -8.734027096, 21.107128228, -31.449940867, 17.863703965)
C       DATA(AW = 23.724518399, -14.886051613, 5.431774425,
       1 -1.071505659, 0.091351825)
      C    SATD. VAPOR TEMPS. CONSTRAINED AT T.P.
      C    DEFINE  X = ABS(S-1),   XT = ABS(ST-1),   WHEN THE EQN. IS -
      C    LN(YY) = AL*(1/XT-1/X) + A1*LOG(LN(1+E/S)/LN(1+E/ST)) + W(S),
      C    W(S) = A2*(Q-QT) + A3*(Q2-QT2) + A4*(S-ST) + A5*(S2-ST2) + . . .
      1 S = DEN/DCRT   $   DSDR = DTRP/DCRT   $   QS = S-1   $   IF(QS) 2,30
      2 X = ABSF(QS)   $   X1 = DSDR*QS/X   $   YN = TCRT/TTRP - 1
      3 V=1/X $ V1=-DSDR/X/CS $ ST=DGAT/DCRT   $   IF(QS) 4,30,15
      4 XT=1-ST $ VT=1/XT $ U=ALS*(VT-V) $ U1=-ALS*V1 $ EK=LOGF(1+ E/ST)
      5 P = 1 +  E/S   $   P1 =  -E*DSDR/S/S   $   PG = LOGF(P)/EK
      6 G = LOGF(PG)    $    G1 = P1/P/PG/EK
      7 Q = CUBERTF(S)   $   QT = CUBERTF(ST)   $   Q1 = Q*DSDR/3/S
      8 W = U + AV(1)*G + AV(2)*(Q-QT) + AV(3)*(Q*Q-QT*QT)
      9 W1 = U1 + AV(1)*G1 + AV(2)*Q1 + AV(3)*2*Q*Q1
     10 DO 11 K=4,8   $   N = K-3   $   W = W + AV(K)*(S**N-ST**N)
     11 W1 = W1 + N*DSDR*AV(K)*S**(N-1)    $    GO TO 18
      C    SATD. LIQUID TEMPS. CONSTRAINED AT THE T.P.
      C    EQN.,   LN(YY) = W(S),   WHERE   X=ABS(S-1),   XT=ABS(ST-1), AND -
      C    W(S) = BE*(1/XT - 1/X) + B1*(S-ST) + B2*(S2-ST2) + . . .
     15 ST = DSDR   $   XT = ST-1   $   W = BES*(1/XT-V)   $   W1 = -BES*V1
     16 DO 17 K=1,5   $   W = W + AW(K)*(S**K - ST**K)
     17 W1 = W1 + AW(K)*K*DSDR*S**(K-1)
     18 F = EXPF(W)   $   F1 = W1*F   $   G = 1 + YN*F
     19 TSATF = TCRT/Q   $   DTSDR = -YN*F1*TSATF/Q    $    RETURN
     30 TSATF = TCRT   $   DTSDR = 0   $   RETURN    $    END
```

APPENDIX I. (Continued)

06/06/74

```
      FUNCTION FINDTMF(P)
C     GIVEN MELTING PRESSURE P, ITERATE T TO MINIMIZE (P-PC).
      COMMON/3/DPDT,D2PDT2,DPSDT,DPMDT,DPDD,DTSDR,DTHDR
    1 FORMAT(1H0 9X *FINDTMF = 0,  FAILS TO CONVERGE) * / )
    2 T = 100   $  DO 6 J=1,50   $   DP = P-PMELTF(T)   $   ADP = ABSF(DP)
    3 IF(ADP/P-1.0E-6) 7,7,4
    4 IF(ADP/DPMDT/T-1.0E-6) 7,7,5
    5 T = T + DP/DPMDT
    6 CONTINUE   $   FINDTMF = 0   $   PRINT 1   $   RETURN
    7 FINDTMF = T     $     RETURN    $    END
```

06/06/74

```
      FUNCTION FINDTSF(P)
C     GIVEN VAPOR PRESSURE P, ITERATE T TO MINIMIZE (P-PC).
      COMMON/1/AL,BE,EP,GK, DCRT,TCRT,PCRT, DTRP,TTRP,PTRP
      COMMON/3/DPDT,D2PDT2,DPSDT,DPMDT,DPDD,DTSDP,DTHDP
    1 FORMAT(1H0 9X *FINDTSF = 0,  FAILS TO CONVERGE. * / )
    2 FORMAT(1H0 9X *FINDTSF = 0,  P EXCEEDS PCRT. * / )
    3 IF(P-PCRT) 4,11,12
    4 T = 200   $  DO 9 J=1,50   $   DP = P - PSATF(T)   $   ADP = ABSF(DP)
    5 IF(ADP/P-1.0E-6) 10,10,6
    6 IF(ADP/DPSDT/T-1.0E-6) 10,10,7
    7 T = T + DP/DPSDT   $   IF(T-TCRT) 9,9,8
    8 T = TCRT
    9 CONTINUE   $   FINDTSF = 0   $   PRINT 1   $   RETURN
   10 FINDTSF = T    $    RETURN
   11 FINDTSF = TCRT    $    RETURN
   12 FINDTSF = 0  $  PRINT 2    $    RETURN   $   END
```

06/06/74

```
      FUNCTION FINDENF(T,P)
C     ON ISOTHERM T, FIND DEN, MOL/L, TO MINIMIZE (P-PC) VIA EQNSTATE.
      COMMON/1/AL,BE,EP,GK, DCRT,TCRT,FCRT, DTRP,TTRP,PTRP
      COMMON/3/DPDT,D2PDT2,DPSDT,DPMDT,DPDD,DTSDR,DTHDR
      DATA (DM=23.0),(DGAT=1.35114E-6)
   41 FORMAT(1H0 9X *FINDENF = 0,  FAILS TO CONVERGE. * / )
   42 FORMAT(1H0 9X *FINDENF = DCRT, DP/DR ZERO OR NEG. * / )
   43 FORMAT(1H0 9X *FINDENF = 0, DOUBLE-VALUED AT P = PSAT. * / )
    1 IF(T-TCRT) 2,5,8
    2 DG=FINDSATF(T,0) $ DL=FINDSATF(T,1) $ PS=PSATF(T)$ IF(P-PS) 3,32,4
    3 D = DG/2  $  GO TO 11
    4 D = (DL+DM)/2  $  GO TO 11
    5 DG=DL=DCRT  $  PS=PCRT  $  IF(P-PS) 6,33,7
    6 D = DCRT/2  $  GO TO 11
    7 D = 2*DCRT  $  GO TO 11
    8 IF(T.LT.400.0) 9,10
    9 PC = PVTF(T,DCRT,0)  $  IF(P-PC) 6,33,7
   10 D = DCRT
   11 DO 30 J=1,50 $ DP=P-PVTF(T,D,1) $ IF(ABSF(DP/P)-1.0E-6) 31,31,12
   12 IF(DPDD) 34,34,13
   13 DD = DP/DPDD  $  IF(ABSF(DD/D)-1.0E-6) 31,31,14
   14 C = D + DD   $   IF(D.GT.DGAT) 16,15
   15 D = DGAT   $   GO TO 30
   16 IF(D.GT.DM) 17,18
   17 D = DTRP  $  GO TO 30
   18 IF(T-TCRT) 19,24,30
   19 IF(P.LT.PS) 20,22
   20 IF(D.GT.DG) 21,30
   21 D = DG  $  GO TO 30
   22 IF(D.LT.DL) 23,30
   23 D = DL  $  GO TO 30
   24 IF(P.LT.PCRT) 25,27
   25 IF(D.LT.DCRT) 30,26
   26 D = DCRT - 0.02  $  GO TO 30
   27 IF(D.GT.DCRT) 30,28
   28 D = DCRT + 0.02
   30 CONTINUE  $  FINDENF = 0  $  PRINT 41  $  RETURN
   31 FINDENF = D   $   RETURN
   32 FINDENF = 0  $  PRINT 43  $  RETURN
   33 FINDENF = DCRT  $  RETURN
   34 FINDENF = DCRT  $  PRINT 42  $  RETURN  $  END
```

*    SINGLE-BANK COMPILATION.

06/06/74

```
      FUNCTION FINDSATF(T,M)
C     ITERATE DEN TO MINIMIZE (T-TS) VIA TSATF(DEN).
C     M = 0 FOR VAPOR,  M = 1 FOR LIQUIC.
      COMMON/1/AL,BE,EP,GK, DCRT,TCRT,PCRT, DTRP,TTRP,PTRP
      COMMON/3/DPDT,D2PDT2,DPSDT,DPMDT,DPDD,DTSDR,DTHDR
      DATA (DM=23.0),(DGAT=1.35114E-6)
    1 FORMAT(1H0 9X *FINDSATF = 0,  FAILS TO CONVERGE.* / )
    2 FORMAT(1H0 9X *FINDSATF = 0,  T EXCEEDS TCRT.* / )
    3 IF(T-TCRT) 4,22,23
    4 IF(M.EQ.0) 5,6
    5 D = DENGASF(T)   $  GO TO 7
    6 D = DENLIQF(T)
    7 DO 20 J=1,50   $  DT=T-TSATF(D)   $  IF(ABSF(DT/T)-1.0E-6) 21,21,8
    8 DTDD = DTSDR/DTRP   $  IF(DTDD.EQ.0.0) 22,9
    9 DD = DT/DTDD   $  IF(ABSF(DD/D)-1.0E-6) 21,21,10
   10 D = D + DD   $  IF(M.EQ.0) 11,15
   11 IF(D.GT.DGAT) 13,12
   12 D = DGAT   $  GO TO 20
   13 IF(D.LT.DCRT) 20,14
   14 D = DCRT - 0.02   $  GO TO 20
   15 IF(D.GT.DM) 16,17
   16 D = DM   $  GO TO 20
   17 IF(D.GT.DCRT) 20,18
   18 D = DCRT + 0.02
   20 CONTINUE   $  FINDSATF = 0   $  PRINT 1   $  RETURN
   21 FINDSATF = D   $   RETURN
   22 FINDSATF = DCRT   $  RETURN
   23 FINDSATF = 0   $  PRINT 2   $  RETURN   $  END
```

06/06/74

```
      SUBROUTINE IDEAL
C     ETHANE IDEAL GAS (1 ATM) THERMOFUNCTIONS (CHAO, 1973).
C     EQN.,  Y = (EZ-EZZ)/RT = 3 + F(X),  X = T/100,  Q = X**1/3,
C     F(X) = A1*Q4 + A2*Q5 + A3*Q6 + . . . + AN*Q**(N+3).
C     (HZ-HZZ)/RT = 1 + Y,  CVN = CVZ/R = D(EZ/R)/DT,  CPZ/R = 1 + CVZ/R,
C     SZ/R = AZ + INTEGRAL(CVZ/R/X + 1/X)*DX.
      COMMON/99/TI, EZZ, EZ,SZ,CVZ, HZ,CPZ
      DIMENSION A(9)
      DATA (R=8.3143),(AZ=21.705718)
      DATA(A = 65.498641, -362.0115914, 853.3408616, -1123.601622,
     1 906.2184427, -459.2302545, 143.0300226, -25.07495605,1.897540044)
    1 X = TI/100   $  Q = CUBERTF(X)   $  DQDX = Q/3/X   $  F = F1 = S = 0
    2 DO 4 J=1,9   $  K = J+3   $  L = J+6
    3 Y = A(J)*Q**K   $  F = F + Y   $  F1 = F1 + K*Y/Q
    4 S = S + L*Y/K    $   S = AZ + S + 4*LOGF(X)
    5 Y = 3 + F    $   CV = Y + X*F1*DQDX
C     CONVERT TO DIMENSIONED RESULTS, JOULES, MOLES, KELVINS.
    6 EZ = R*TI*Y   $  HZ = R*TI*(1+Y)   $  CPZ = R*(1+CV)
    9 SZ = R*S   $  CVZ = R*CV       $      RETURN    $    END
```

06/06/74

```
      SUBROUTINE HOMOTHRM
C     GIVEN P,T, GET DEN AND FUNCTIONS FOR HOMOGENEOUS DOMAIN.
C     USE MEMORIZED IDEAL GAS FUNCTIONS EVERY 10 K.
      COMMON/1/AL,BE,EP,GK, DCRT,TCRT,PCRT, DTRP,TTRP,PTRP
      COMMON/3/DPDT,D2PDT2,DPSDT,DPMDT,DPDD,DTSDR,DTHDR
      COMMON/8/ P,T,DEN, E,H,S, CV,CP,CSAT, W,WK
      COMMON/9/ EI(60),SI(60),CVI(60)
      COMMON/39/TI,EZZ, EZ,SZ,CVZ,HZ,CPZ
      DATA (DA=0.0),(Q=1.01325),(G=0.0831434)
    1 K = T/10  $  EZ = EI(K)  $  SZ = SI(K)  $  CVZ = CVI(K)
    2 DEN = DB = FINDENF(T,P)  $  N = 5*(1+DB)
    3 E = EZZ + EZ + ESUMF(N,T,DA,DB)  $  H = E + 100*P/DB
    4 S = SZ + SSUMF(1,N,T,DA,DB) - 100*G*LOGF(G*T*DB/Q)
    5 X = 10.0*ABSF(T/TCRT-1)  $  IF(X.LT.3.0) 6,7
    6 N = N + DB*DB*EXPF(-X)
    7 CV = CVZ + CSUMF(N,T,DA,DB)   $   PX = PVTF(T,DB,1)
    8 CP = CV + 100*T/DPDD*(DPDT/DB)**2
    9 W = SQRTF(WK*CP*DPDD/CV)   $   RETURN  $  END
```

06/06/74

```
      SUBROUTINE LIQTHERM
C     FOR DEN ABOVE DCRT, AND T UNDER TB = 340 K.
C     GIVEN P,T, GET DEN ETC.   FIRST USE CPSUMIT TO GET FUNCTIONS
C     AT POINT (T,PB,DB),  THEN INTEGRATE ALONG ISOTHERM T.
C     USE MEMORIZED FUNCTIONS FROM CPSUMIT ON ISOBAR PB(FURTADO).
      COMMON/3/DPDT,D2PDT2,DPSDT,DPMDT,DPDD,DTSDR,DTHDR
      COMMON/8/ P,T,DEN, E,H,S, CV,CP,CSAT, W,WK
      COMMON/10/ DF(34),EF(34),SF(34),CVF(34)
    1 K = T/10  $  DB = DF(K)  $  DEN = DN = FINDENF(T,P)
    2 E = EF(K)  $  S = SF(K)  $  CV = CVF(K)
C     INTEGRATE ALONG ISOTHERM T FROM DB TO DN.
    3 DX = ABSF(DN-DB)  $  N = 5*(1+DX)
    4 E = E + ESUMF(N,T,DB,DN)  $  H = E + 100*P/DN
    5 S = S + SSUMF(0,N,T,DB,DN)  $  N = N + DX*DX
    6 CV = CV + CSUMF(N,T,DB,DN)  $  PX = PVTF(T,DN,1)
    7 CP = CV + 100*T/DPDD*(DPDT/DN)**2
    9 W = SQRTF(WK*CP*DPDD/CV)    $    RETURN   $   END
```

06/06/74

```
      SUBROUTINE SATGSTRM
C     GIVEN P,T AT SATURATION, GET DEN ETC. -
      COMMON/1/AL,BE,EP,GK, DCRT,TCRT,PCRT, DTRP,TTRP,PTRP
      COMMON/3/DPDT,D2PDT2,DPSDT,DPMDT,DPDD,DTSDR,DTHDR
      COMMON/8/ P,T,DEN, E,H,S, CV,CP,CSAT, W,WK
      COMMON/99/ TI,EZZ, EZ,SZ,CVZ, HZ,CPZ
      DATA (A=0.0),(Q=1.01325),(G=0.0831434)
    1 TI = T  $   CALL IDEAL
    2 DEN = DG = FINDSATF(T,0)  $  N = 5*(1+DG)
    3 E = EZZ + EZ + ESUMF(N,T,A,DG)  $  H = E + 100*P/DG
    4 S = SZ + SSUMF(1,N,T,A,DG) - 100*G*LOGF(G*T*DG/Q)
    5 IF(T.EQ.TCRT) 6,7
    6 CP = CV = W = 0   $   RETURN
    7 N = N + DG*DG  $  CV = CVZ + CSUMF(N,T,A,DG)
    8 PX = PVTF(T,DG,1)  $  CP = CV + 100*T/DPDD*(DPDT/DG)**2
    9 W = SQRTF(WK*CP*DPDD/CV)     $     RETURN   $   END
```

06/06/74

```
      SUBROUTINE SATLQTRM
C     GIVEN P,T AT SATURATION, GET DEN ETC. -
C     AT TEMP. T, GET FUNCTIONS AT P = PB VIA CPSUMIT,
C     THEN INTEGRATE ON ISOTHERM T FROM DB DOWN TO DL OF THE SATLIQ.
      COMMON/1/AL,BE,EP,GK, DCRT,TCRT,PCRT, DTRP,TTRP,PTRP
      COMMON/3/DPDT,D2PDT2,DPSDT,DPMDT,DPDD,DTSDR,DTHDR
      COMMON/8/ P,T,DEN, E,H,S, CV,CP,CSAT, W,WK
    1 CALL CPSUMIT  $  DB = DEN  $  DEN = DL = FINDSATF(T,1)
    2 DX = ABSF(DB-DL)  $  N = 5*(1+DX)
    3 S = S + SSUMF(0,N,T,DB,DL)  $  E = E + ESUMF(N,T,DB,DL)
    4 H = E + 100*P/DL  $  IF(T.EQ.TCRT) 5,6
    5 CSAT = CV = CP = W = 0   $   RETURN
    6 N = N + DX*DX  $  CV = CV + CSUMF(N,T,DB,DL)
    7 PX = PVTF(T,DL,1)  $  DDLDT = DTFP/DTSDR
    8 CSAT = CV-100*T*DPDT*DDLDT/DL/DL $ CP = CV+100*T/DPDD*(DPDT/DL)**2
    9 W = SQRTF(WK*CP*DPDD/CV)     $    RETURN   $   END
```

06/06/74

```
      SUBROUTINE MELTHERM
C     GIVEN P, GET T,DEN, ETC. FOR FREEZING LIQUID.
      COMMON/3/DPDT,D2PDT2,DPSDT,DPMDT,DPDD,DTSDR,DTHDR
      COMMON/8/ P,T,DEN, E,H,S, CV,CP,CSAT, W,WK
    1 T = FINDTMF(P)  $  CALL CPSUMIT  $  DB = DEN
    2 DEN = DM = FINDENF(T,P)
C     NOW INTEGRATE ON ISOTHERM T FROM DB TO DM
    3 N = 5 + 5*ABSF(DM-DB)  $  E = E + ESUMF(N,T,DB,DM)
    4 H = E + 100*P/DM  $  S = S + SSUMF(0,N,T,DB,DM)
    5 CV = CV + CSUMF(N,T,DB,DM)  $  PX = PVTF(T,DM,1)
    6 CP = CV + 100*T/DPDD*(DPDT/DM)**2
    9 W = SQRTF(WK*CP*DPDD/CV)     $    RETURN  $  END
```

06/06/74

```
      SUBROUTINE CPSUMIT
C     USE FURTADO CP(T) ALONG ISOBAR PB = 137.895 BAR.
C     START AT TB = 340 K WITH VALUES HB, SB, THEN -
C     INTEGRATE DOWN TO ANY T, YIELDS DEN, E, H, S, CP, CV, AT (T,PB).
      COMMON/3/DPDT,D2PDT2,DPSDT,DPMDT,DPDD,DTSDR,DTHDR
      COMMON/7/ TB,PB, HB,SB
      COMMON/8/ P,T,DEN, E,H,S, CV,CP,CSAT, W,WK
      DATA (TX = 250.0)
    1 H = HB  $  S = SB  $  IF(T.LT.TX) 6,2
    2 TR = T-TB  $  N = 2+ABSF(TR)  $  DT = TR/N
    3 DO 5 J=1,N  $  TJ = TB + (J-0.5)*DT  $  CP = CPXF(TJ)
    4 H = H + CP*DT  $  S = S + CP*DT/TJ
    5 CONTINUE   $   GO TO 15
    6 TR= TX-TB  $  N = 2+ABSF(TR)  $  DT = TR/N
    7 DO 9 J=1,N  $  TJ = TB + (J-0.5)*DT  $  CP = CPXF(TJ)
    8 H = H + CP*DT  $  S = S + CP*DT/TJ
    9 CONTINUE
   10 TR = T-TX  $  N = 2+ABSF(TR)/2  $  DT = TR/N
   11 DO 13 J=1,N  $  TJ = TX + (J-0.5)*DT  $  CP = CPXF(TJ)
   12 H = H + CP*DT  $  S = S + CP*DT/TJ
   13 CONTINUE
   15 DEN = FINDENF(T,PB)  $  CP = CPXF(T)
   16 E = H - 100*PB/DEN  $  PX = PVTF(T,DEN,1)
   20 CV = CP - 100*T/DPDD*(DPDT/DEN)**2  $   RETURN  $  END
```

06/06/74

```
      FUNCTION CSUMF(N,T,DA,DB)
C     DELTA CV = -T*INTEGRAL((D2P/DT2)/D**2)*DD.
      COMMON/3/DPDT,D2PDT2,DPSDT,DPMDT,DPDD,DTSDR,DTHDR
    2 DX = (DB-DA)/N  $  CSUMF = 0  $  DO 5 J=1,N
    3 DN = DA + (J-0.5)*DX   $   P = PVTF(T,DN,0)
    5 CSUMF = CSUMF - D2PDT2*DX/DN/DN
    9 CSUMF = 100*T*CSUMF    $    RETURN   $   END
```

06/06/74

```
      FUNCTION ESUMF(N,T,DA,DB)
C     GET DELTA E OVER DENSITY RANGE FROM DA TO DB.
C     DELTA E  =  INTEGRAL(P-T*(DP/DT))*DX/DN**2.
      COMMON/3/DPDT,D2PDT2,DPSDT,DPMDT,DPDD,DTSDR,DTHDR
    2 DX = (DB-DA)/N   $   ESUMF = 0.0
    3 DO 5 J=1,N  $  DN = DA + (J-0.5)*DX  $  P = PVTF(T,DN,0)
    5 ESUMF = ESUMF + (P-T*DPDT)*DX/DN/DN
    9 ESUMF = 100*ESUMF   $   RETURN  $  END
```

06/06/74

```
      FUNCTION SSUMF(L,N,T,DA,DB)
C     DENSITY-DEPENDENT CHANGE OF S FROM DA TO DB.
C     DELTA S  =  INTEGRAL(GK-(DP/DT)/DN)*DX/DN.
      COMMON/3/DPDT,D2PDT2,DPSDT,DPMDT,DPDD,DTSDR,DTHDR
      DATA (GC = 0.0831434)
    1 SSUMF = 0  $  DX = (DB-DA)/N  $  IF(L.EQ.0) 4,2
    2 DO 3 J=1,N  $  DN = DA + (J-0.5)*DX  $  P = PVTF(T,DN,0)
    3 SSUMF = SSUMF + (GC-DPDT/DN)*DX/DN  $  GO TO 9
    4 DO 5 J=1,N  $  DN = DA + (J-0.5)*DX  $  P = PVTF(T,DN,0)
    5 SSUMF = SSUMF - DPDT*DX/DN/DN
    9 SSUMF = 100*SSUMF   $   RETURN  $  END
```

06/06/74

```
      FUNCTION CPXF(T)
C     ETHANE CP, J/MOL/K, OF ANDRE FURTADO AT P = 137.895 BAR.
C     DEFINE X = (T-TTRP)/(TMAX-TTRP),  WHEN THE EQN. IS -
C     LN(CM-CP) = A1 + A2*X2/(1-X) + A3*X2 + A4*X3 + A5*X4.
C     NOTE THIS FORMULA VALID ONLY UP TO 345 K.
C     NOTE FACTOR 1.874 FOR ETHANE VS. METHANE CONVERSION.
      DIMENSION A(5)
      DATA (TTRP=89.899),(TM=354.0),(CM=62.60)
      DATA(A = 3.2632884, -0.1544225, -0.1414889, -0.5064375, 0.2769915)
    1 X = (T-TTRP)/(TM-TTRP)   $   X2 = X*X
    2 Y = A(1) + A(2)*X2/(1-X) + A(3)*X2 + A(4)*X*X2 + A(5)*X2*X2
    3 CPXF = 1.874335*(CM - EXPF(Y))   $   RETURN  $  END
```

10/15/74

```
      FUNCTION CSATXF(T)
C     FORMULATION OF ETHANE DATA OF AUTHORS -
C     WIEBE/HUBBARD/BREVOORT,  AND  WITT/KEMP,   J/MOL/K.
C     VIA PROGRAM CSAT-2, 3/27/74.
C     FOR 59 POINTS, THE RMS IS 0.50 PCT.
C     CS = A + B*X + C*X/(1-X)**E,    X = T/TCRT.
C     REVISED FOR TCRT = 305.37,   10/7/74.
      DATA (E=0.5),(TC=305.37)
      DATA (A=67.3153),(B=-16.5876),(C=16.3526)
    1 X = T/TC  $  U = 1-X  $  IF(U) 2,2,3
    2 CSATXF = 0   $   RETURN
    3 CSATXF = A + B*X + C*X/U**E    $    RETURN   $   END
```

10/15/74

```
      FUNCTION QVAPXF(T)
C     VIA PROGRAM QVAP-2, 3/27/74.  USING DATA OF -
C     DOUSLIN, RIEDEL, FURTADO.  FOR 49 POINTS, RMS = 0.56 PCT.
C     DEFINE X = (TC-T)/(TC-TT),   U = X**1/3,  WHEN EQN. IS -
C     QV = A1*U + A2*U2 + . . . + A6*U6.
C     REVISED FOR TCRT = 305.37,  10/7/74.
      DIMENSION A(6)
      DATA (TT=89.899),(TC=305.37)
      DATA (A = 12.102730, 11.165588, 16.539265,
     1 -71.854695, 82.166239, -32.610514)
    1 U = CUBERTF((TC-T)/(TC-TT))  $  Q = 0  $  DO 2 K=1,6
    2 Q = Q + A(K)*U**K   $   QVAPXF = 1000*Q   $   RETURN  $  END
```

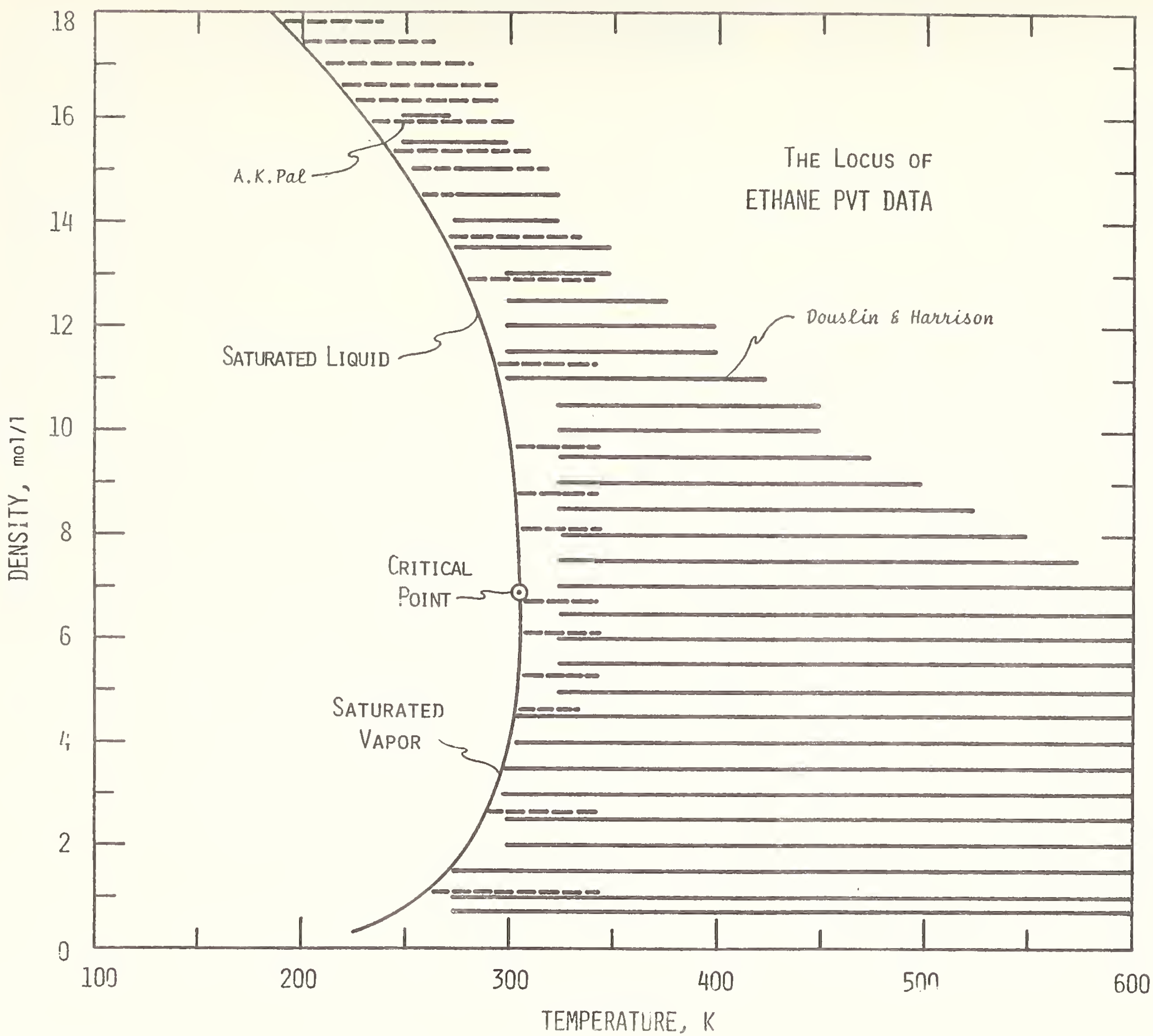


Figure 1. The locus of recent P-ρ-T data.

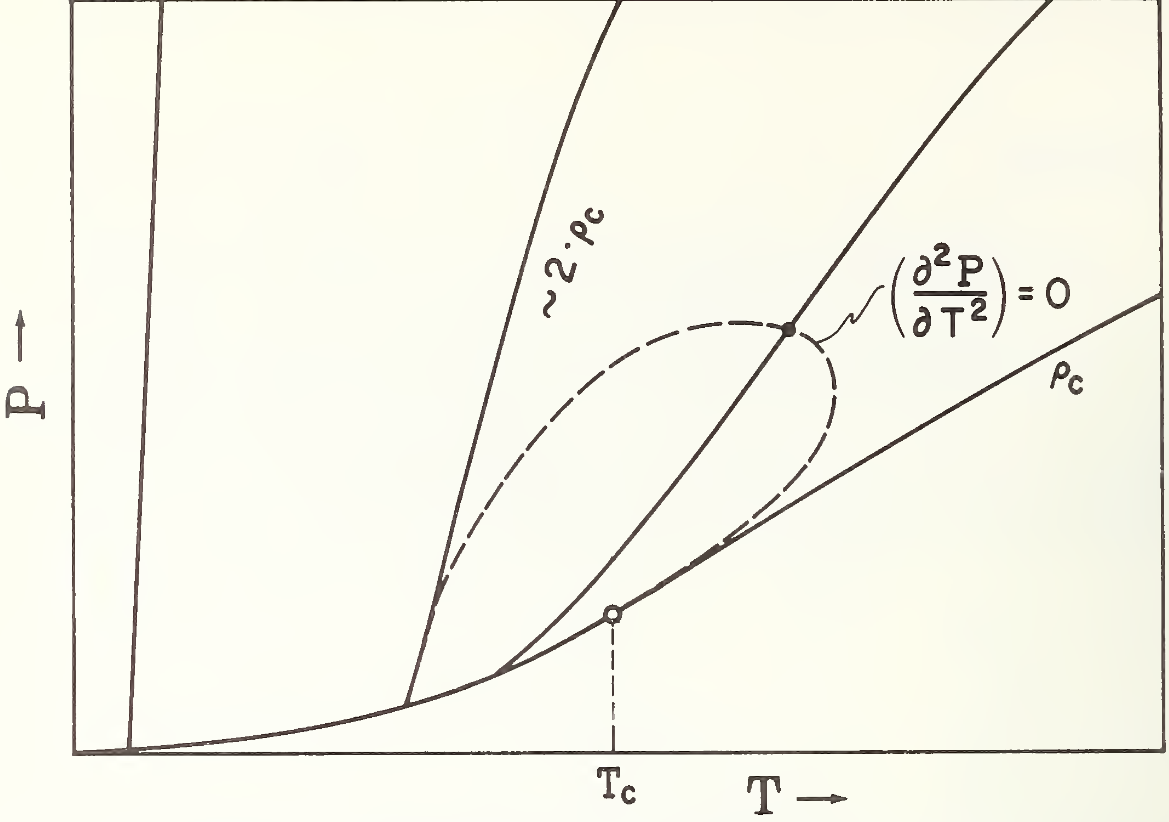


Figure 2. Generalized locus of isochore inflection points.

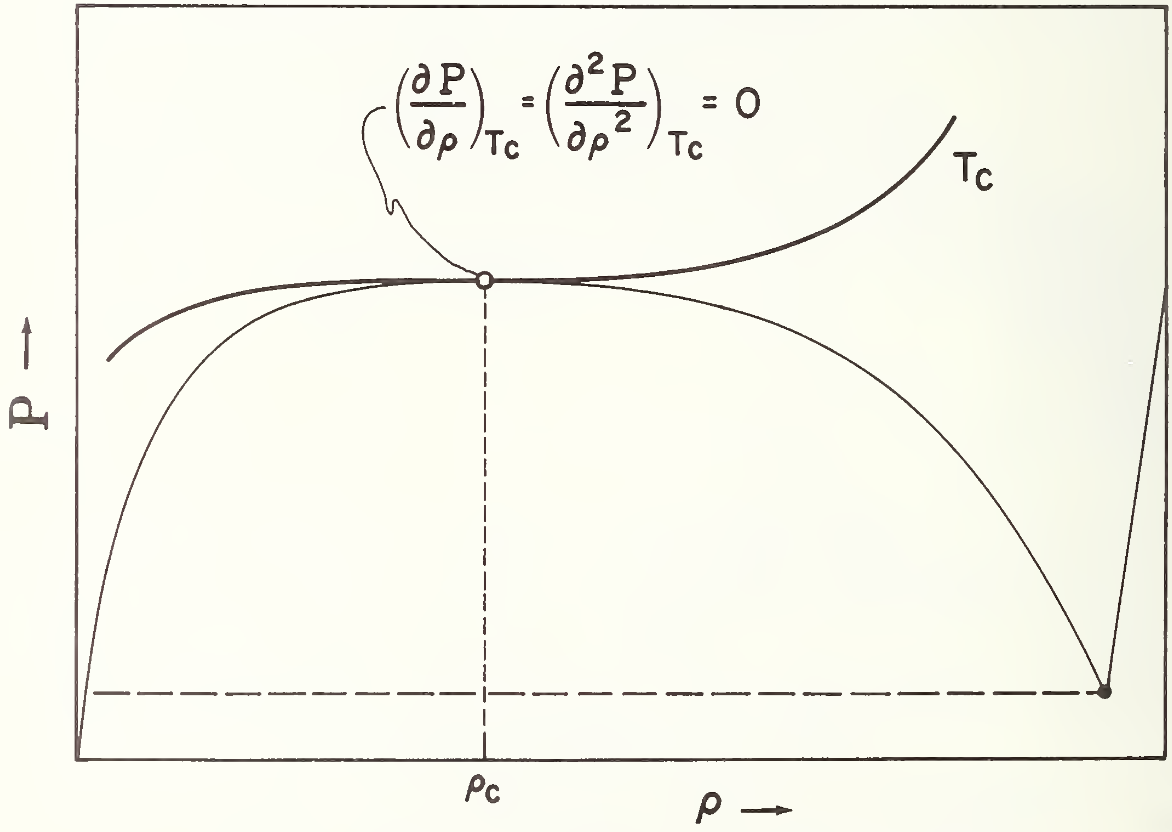


Figure 3. Generalized behavior of the critical isotherm.

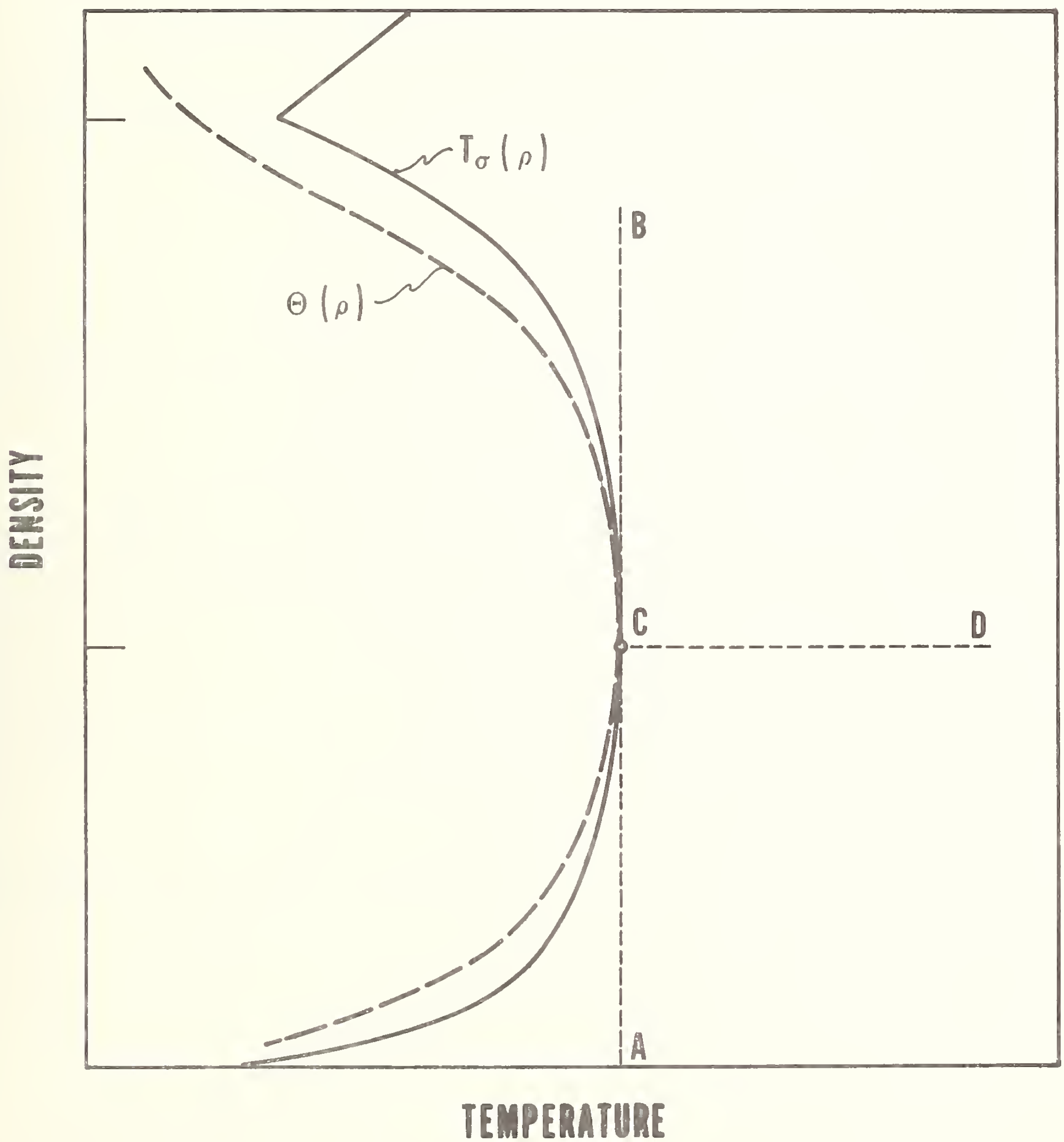


Figure 4. Generalized behavior of the locus $\theta(\rho)$.

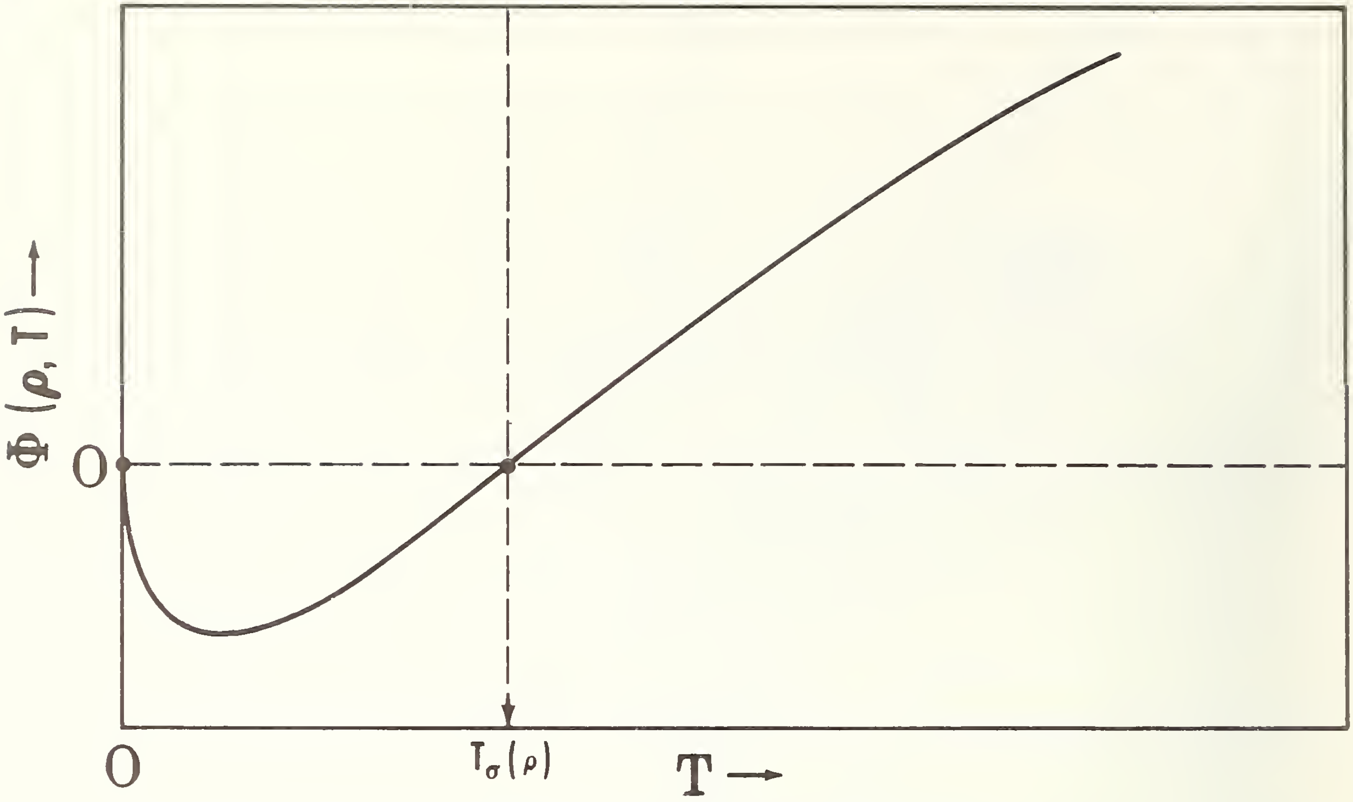


Figure 5. Generalized behavior of the function $\Phi(\rho, T)$.

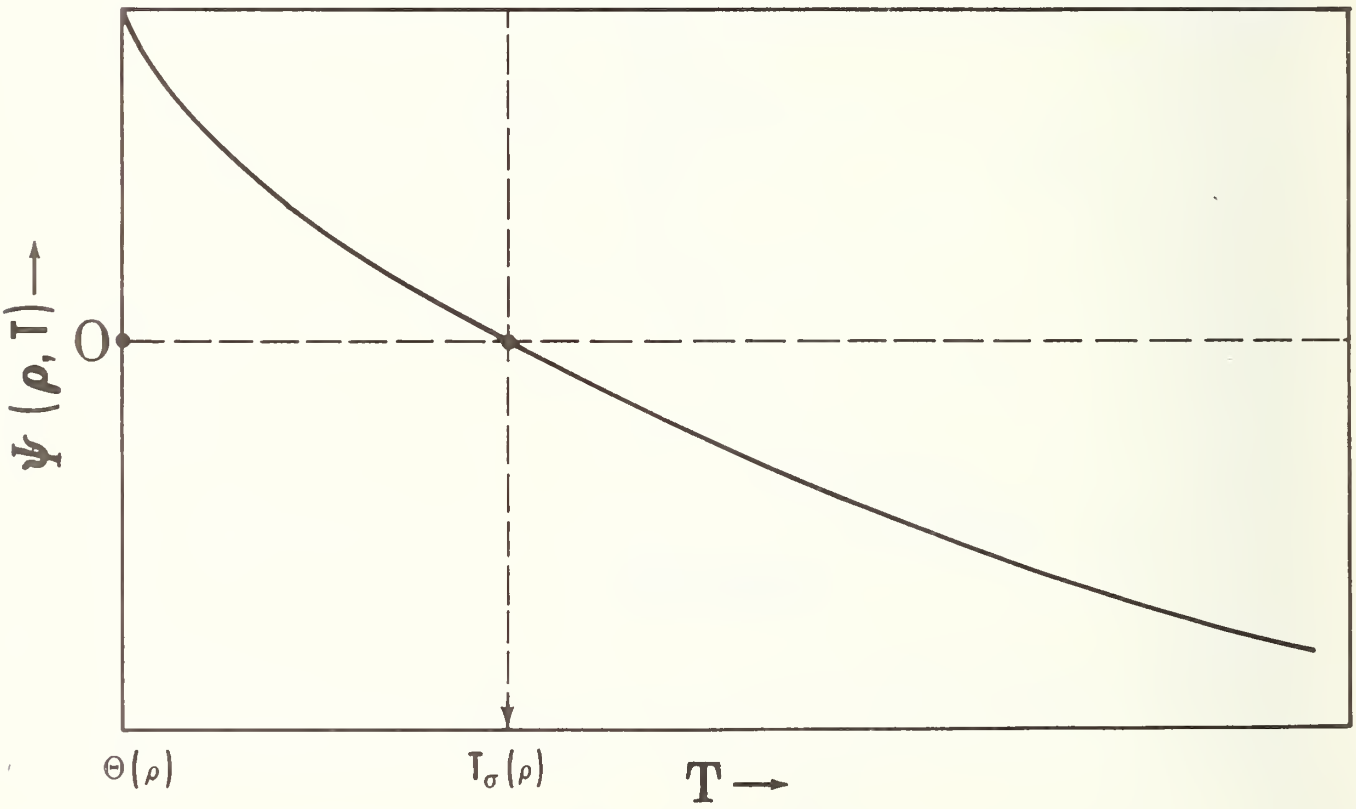


Figure 6. Generalized behavior of the function $\Psi(\rho, T)$.

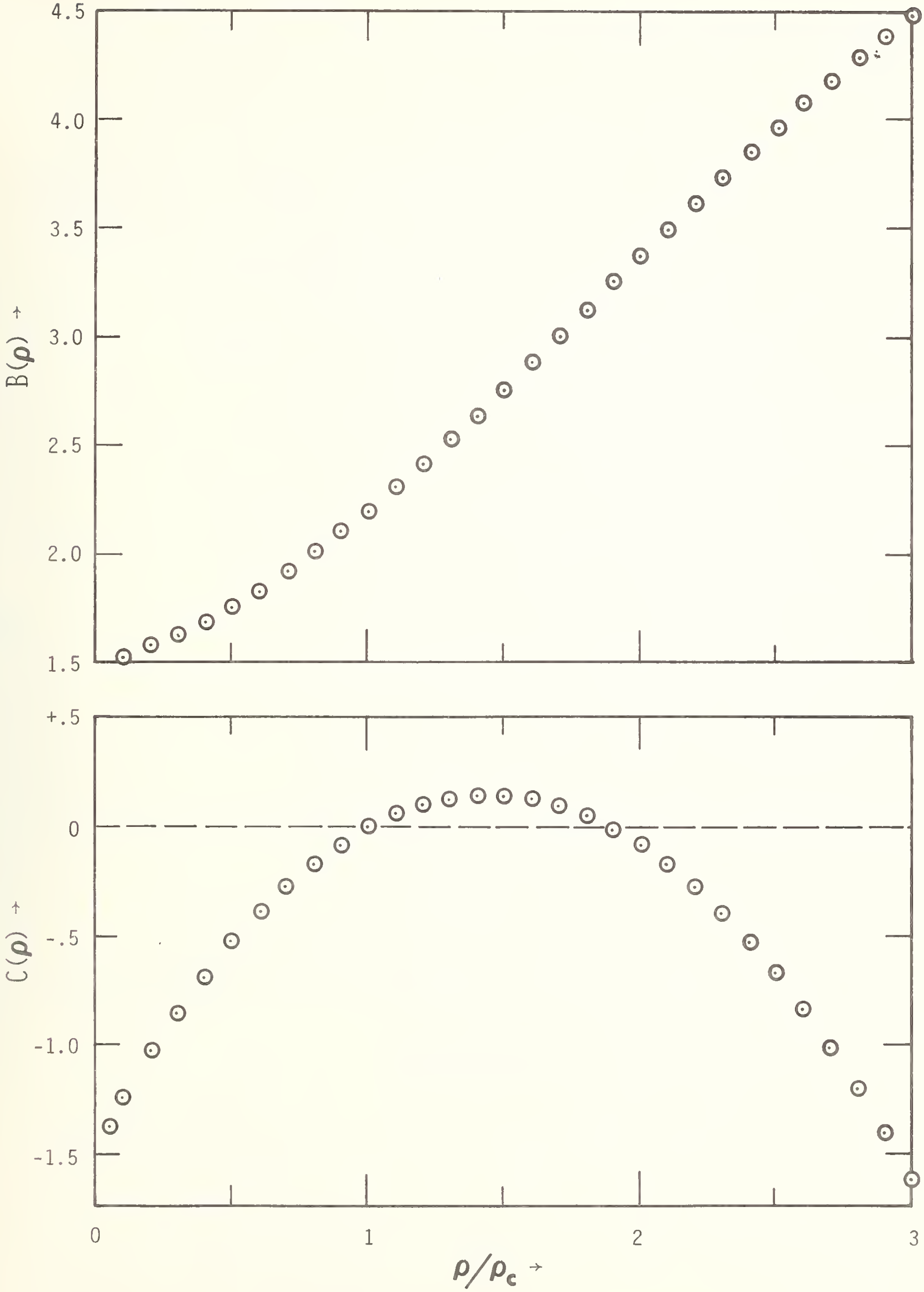


Figure 7. Behavior of coefficients B(ρ), C(ρ) for methane.

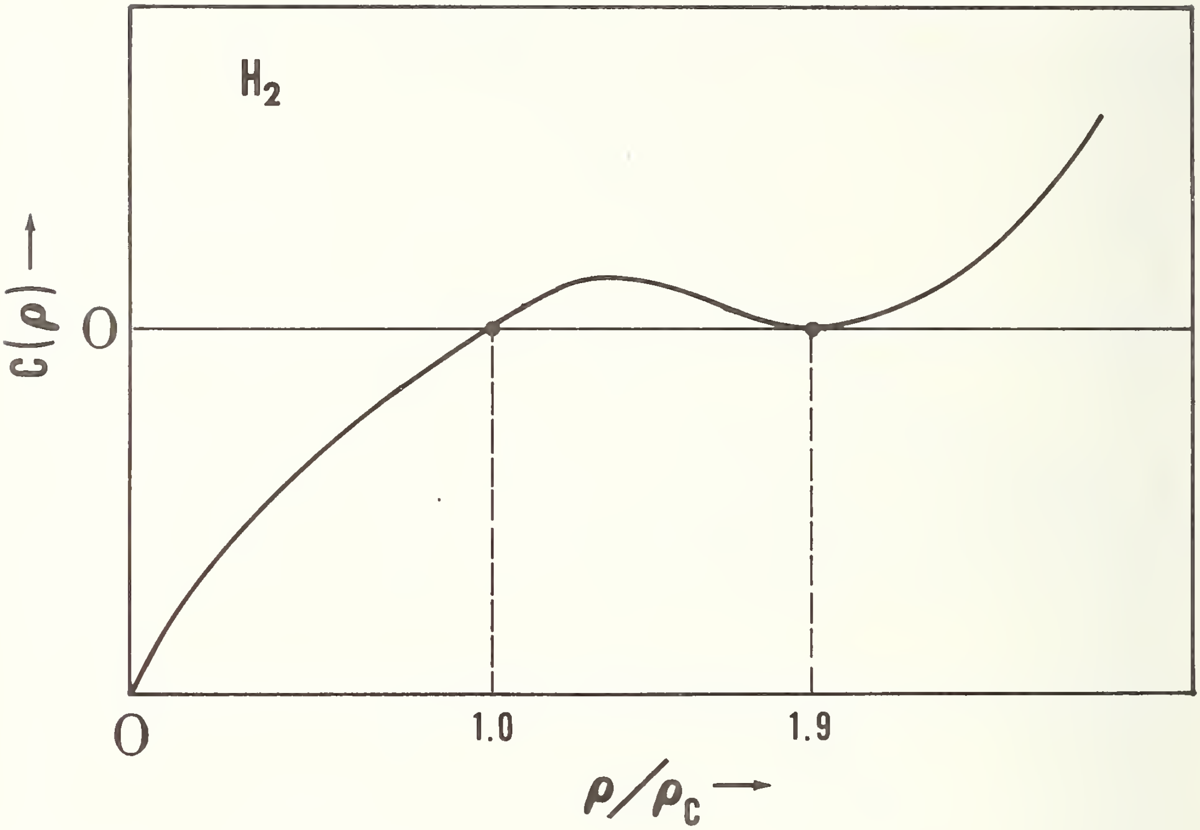


Figure 8. Presumed behavior of $C(\rho)$ for hydrogen.

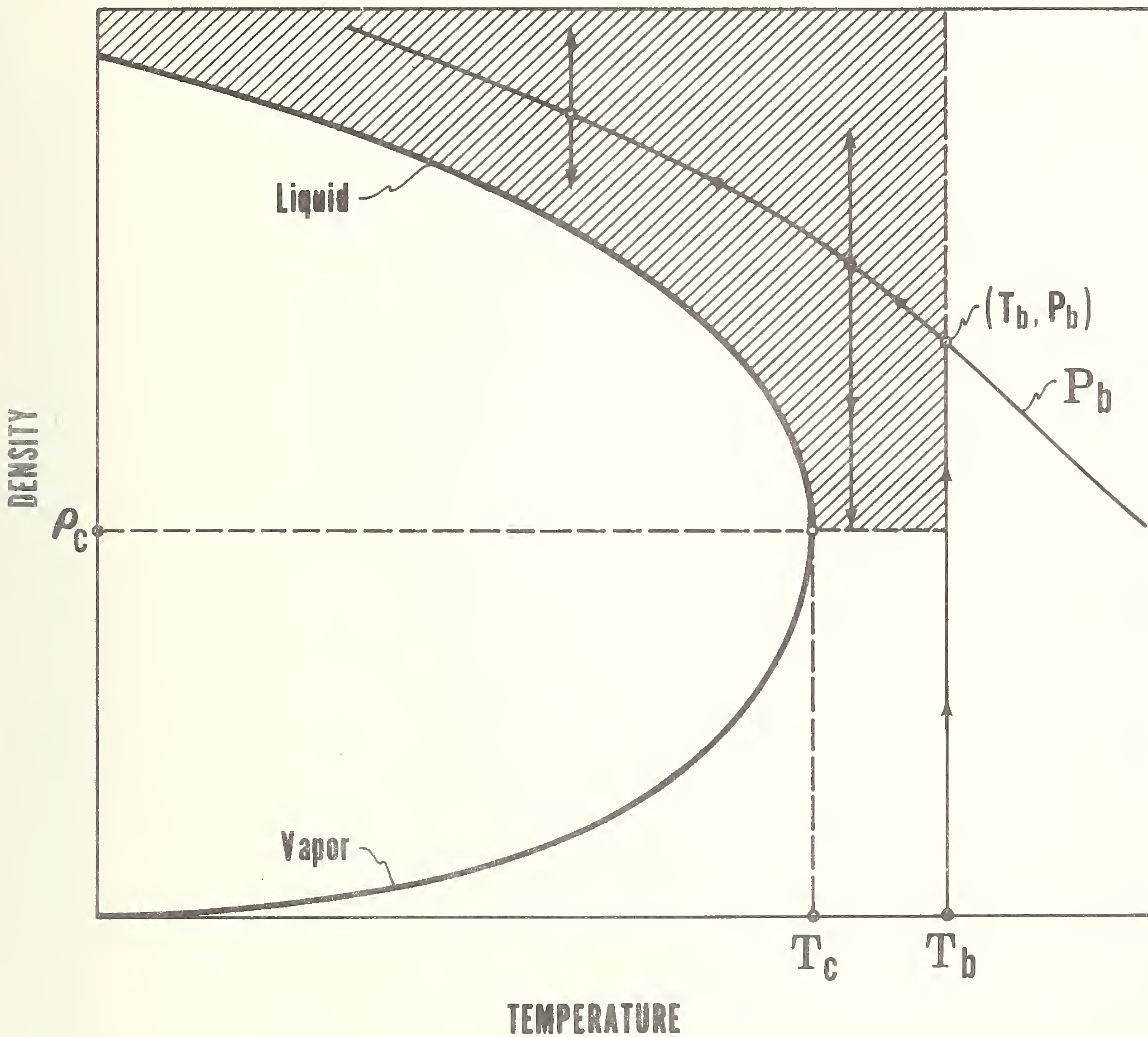


Figure 9. Generalized density-temperature phase diagram.

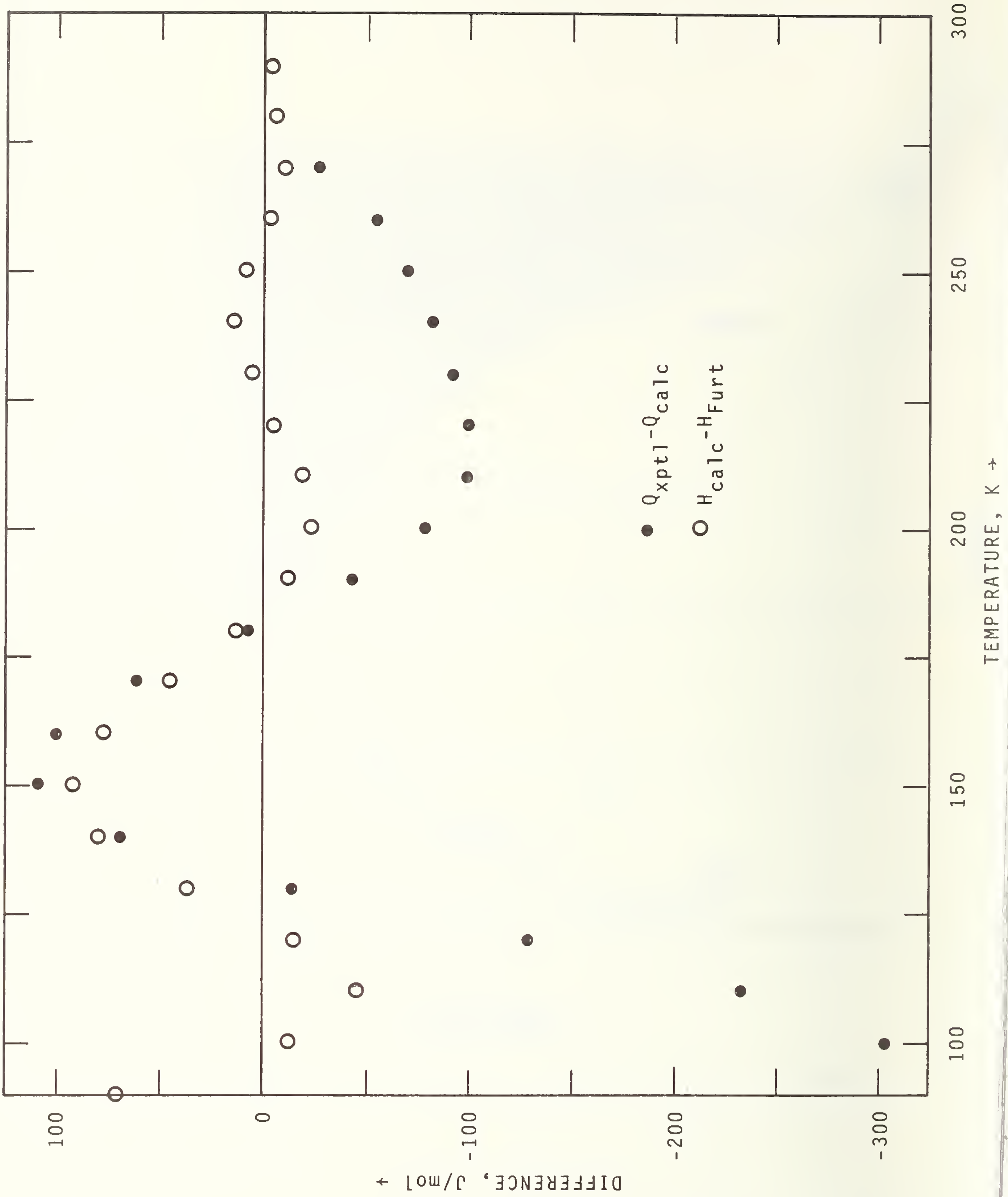


Figure 10. Comparisons for saturated liquid ethane. Q is heat of vaporization, and H is enthalpy. Calculated values are via the Clapeyron equation. See section 4.3 of the text.

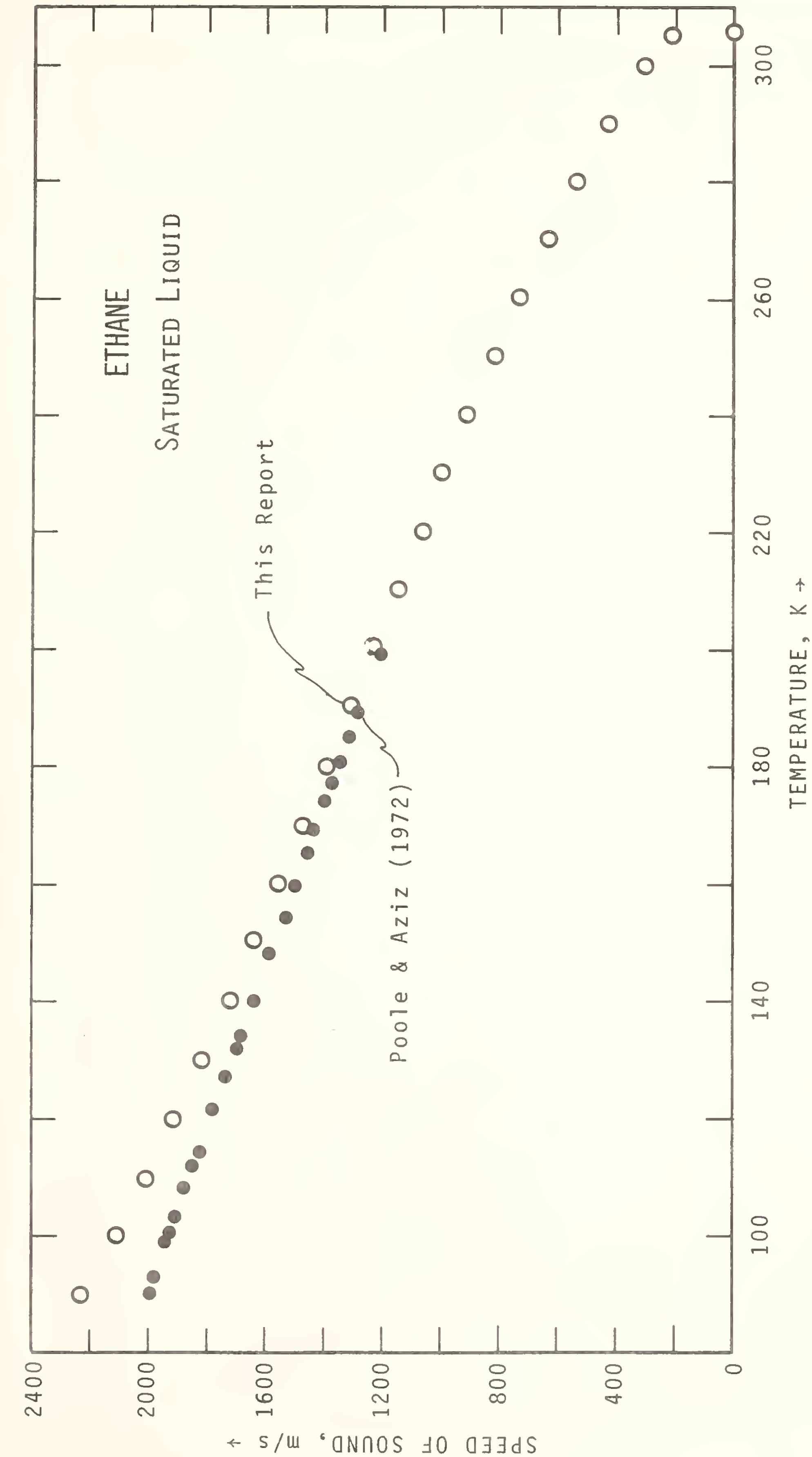


Figure 11. Speeds of sound for saturated liquid ethane

Table 1. Experimental and calculated vapor pressures.

ID: (4) Pal; (7) Ziegler; (9) Pope; (10) Douslin

VAPOR PRESSURES, TTRP = 89.899, TCRT = 305.370

10.79549166 8.35899001 -3.11490770 -0.64969799 6.07349549

| ID | T,K | P,BAR | CALCD | PCNT |
|---|---|---|---|---|
| 7 | 90.010 | 1.03991-005 | 1.04012-005 | -0.020 |
| 7 | 100.010 | 1.11231-004 | 1.11214-004 | 0.015 |
| 7 | 109.998 | 7.46205-004 | 7.46084-004 | 0.016 |
| 7 | 119.989 | 3.53971-003 | 3.54004-003 | -0.009 |
| 7 | 129.987 | 1.28963-002 | 1.29009-002 | -0.035 |
| 7 | 139.992 | 3.82929-002 | 3.83041-002 | -0.029 |
| 7 | 150.000 | 9.67387-002 | 9.67415-002 | -0.003 |
| 7 | 160.010 | 2.14770-001 | 2.14725-001 | 0.021 |
| 7 | 170.019 | 4.29490-001 | 4.29303-001 | 0.044 |
| 7 | 180.027 | 7.88547-001 | 7.88122-001 | 0.054 |
| 7 | 184.550 | 1.01325+000 | 1.01269+000 | 0.055 |
| 9 | 198.216 | 1.99985+000 | 2.00235+000 | -0.125 |
| 4 | 214.334 | 3.97283+000 | 3.96786+000 | 0.125 |
| 4 | 224.130 | 5.71141+000 | 5.71485+000 | -0.060 |
| 4 | 229.782 | 6.94778+000 | 6.95075+000 | -0.043 |
| 4 | 234.581 | 8.13995+000 | 8.14562+000 | -0.070 |
| 9 | 234.715 | 8.18108+000 | 8.18100+000 | 0.001 |
| 10 | 238.150 | 9.12908+000 | 9.12702+000 | 0.023 |
| 9 | 238.792 | 9.30599+000 | 9.31232+000 | -0.068 |
| 4 | 239.864 | 9.62177+000 | 9.62783+000 | -0.063 |
| 4 | 240.534 | 9.82448+000 | 9.82894+000 | -0.045 |
| 10 | 243.150 | 1.06455+001 | 1.06436+001 | 0.018 |
| 4 | 243.377 | 1.07162+001 | 1.07165+001 | -0.003 |
| 4 | 246.830 | 1.18689+001 | 1.18715+001 | -0.022 |
| 4 | 247.831 | 1.22099+001 | 1.22225+001 | -0.103 |
| 10 | 248.150 | 1.23369+001 | 1.23360+001 | 0.007 |
| 4 | 249.755 | 1.29310+001 | 1.29184+001 | 0.097 |
| 4 | 250.160 | 1.30694+001 | 1.30685+001 | 0.007 |
| 4 | 251.600 | 1.36207+001 | 1.36124+001 | 0.061 |
| 4 | 252.556 | 1.39895+001 | 1.39824+001 | 0.051 |
| 10 | 253.150 | 1.42169+001 | 1.42160+001 | 0.007 |
| 4 | 254.301 | 1.46818+001 | 1.46766+001 | 0.036 |
| 4 | 257.552 | 1.60349+001 | 1.60361+001 | -0.007 |
| 10 | 258.150 | 1.62966+001 | 1.62958+001 | 0.005 |
| 10 | 263.150 | 1.85895+001 | 1.85882+001 | 0.007 |
| 4 | 263.386 | 1.86989+001 | 1.87019+001 | -0.016 |
| 4 | 267.539 | 2.07916+001 | 2.07864+001 | 0.025 |
| 10 | 268.150 | 2.11078+001 | 2.11067+001 | 0.005 |
| 4 | 271.750 | 2.30678+001 | 2.30680+001 | -0.001 |
| 9 | 272.949 | 2.37622+001 | 2.37499+001 | 0.052 |
| 10 | 273.150 | 2.38670+001 | 2.38656+001 | 0.006 |
| 4 | 275.921 | 2.54917+001 | 2.55038+001 | -0.047 |
| 4 | 276.362 | 2.57931+001 | 2.57719+001 | 0.082 |
| 4 | 276.384 | 2.57863+001 | 2.57854+001 | 0.004 |

Table 1. Experimental and calculated vapor pressures, (continued).

| ID | T,K | P,BAR | CALCD | PCNT |
|---|---|---|---|---|
| 4 | 276.513 | 2.58857+001 | 2.58642+001 | 0.083 |
| 4 | 277.811 | 2.66672+001 | 2.66676+001 | -0.002 |
| 10 | 278.150 | 2.68824+001 | 2.68805+001 | 0.007 |
| 4 | 280.038 | 2.80710+001 | 2.80889+001 | -0.064 |
| 4 | 282.243 | 2.95400+001 | 2.95509+001 | -0.037 |
| 10 | 283.150 | 3.01708+001 | 3.01685+001 | 0.008 |
| 4 | 284.630 | 3.11740+001 | 3.11970+001 | -0.074 |
| 9 | 284.840 | 3.13657+001 | 3.13450+001 | 0.066 |
| 4 | 287.648 | 3.33652+001 | 3.33761+001 | -0.033 |
| 10 | 288.150 | 3.37524+001 | 3.37495+001 | 0.009 |
| 4 | 288.257 | 3.38323+001 | 3.38295+001 | 0.008 |
| 4 | 290.034 | 3.51469+001 | 3.51795+001 | -0.093 |
| 9 | 290.208 | 3.53369+001 | 3.53139+001 | 0.065 |
| 4 | 292.229 | 3.69269+001 | 3.69041+001 | 0.062 |
| 4 | 293.091 | 3.75729+001 | 3.75992+001 | -0.070 |
| 10 | 293.150 | 3.76506+001 | 3.76472+001 | 0.009 |
| 9 | 293.259 | 3.77610+001 | 3.77359+001 | 0.067 |
| 4 | 296.339 | 4.02866+001 | 4.03123+001 | -0.064 |
| 10 | 298.150 | 4.18973+001 | 4.18927+001 | 0.011 |
| 4 | 299.657 | 4.32194+001 | 4.32470+001 | -0.064 |
| 9 | 299.855 | 4.34545+001 | 4.34277+001 | 0.062 |
| 4 | 300.196 | 4.37369+001 | 4.37404+001 | -0.008 |
| 4 | 301.242 | 4.46929+001 | 4.47120+001 | -0.043 |
| 10 | 302.150 | 4.55769+001 | 4.55712+001 | 0.013 |
| 10 | 303.150 | 4.65413+001 | 4.65354+001 | 0.013 |
| 4 | 303.462 | 4.68154+001 | 4.68403+001 | -0.053 |
| 4 | 303.468 | 4.68930+001 | 4.68462+001 | 0.100 |
| 9 | 304.002 | 4.73934+001 | 4.73730+001 | 0.043 |
| 4 | 304.039 | 4.73895+001 | 4.74097+001 | -0.043 |
| 10 | 304.150 | 4.75255+001 | 4.75201+001 | 0.011 |
| 4 | 304.350 | 4.77171+001 | 4.77197+001 | -0.005 |
| 4 | 304.435 | 4.78455+001 | 4.78048+001 | 0.085 |
| 4 | 304.508 | 4.78280+001 | 4.78781+001 | -0.105 |
| 4 | 304.723 | 4.80594+001 | 4.80947+001 | -0.073 |
| 4 | 304.785 | 4.81482+001 | 4.81574+001 | -0.019 |
| 4 | 304.913 | 4.83164+001 | 4.82871+001 | 0.061 |
| 4 | 304.969 | 4.83453+001 | 4.83440+001 | 0.003 |
| 4 | 305.110 | 4.84837+001 | 4.84878+001 | -0.008 |
| 4 | 305.142 | 4.85152+001 | 4.85205+001 | -0.011 |
| 10 | 305.150 | 4.85339+001 | 4.85287+001 | 0.011 |
| 10 | 305.250 | 4.86354+001 | 4.86313+001 | 0.008 |

NP = 85, RMSPCT = 0.050

Table 3. Experimental and calculated saturated liquid densities

ID: (5) via isochores of Pal; (10) Douslin; (12) Chui;
(13) Klosek; (14) Miller; (16) Tomlinson

SATD. LIQUID DENSITIES, E = 0.330

TTRP = 89.899, TCRT = 305.370, DCRT = 6.740, DTRP = 21.680

0.721909438 0.296577899 -0.300365476

| ID | T,K | MOL/L | CALCD | PRCNT |
|---|---|---|---|---|
| 10 | 304.150 | 8.737 | 8.740 | -0.03 |
| 10 | 303.150 | 9.201 | 9.200 | 0.01 |
| 10 | 302.150 | 9.544 | 9.544 | 0.00 |
| 10 | 298.150 | 10.499 | 10.487 | 0.12 |
| 10 | 293.150 | 11.297 | 11.292 | 0.05 |
| 10 | 283.150 | 12.458 | 12.454 | 0.04 |
| 10 | 273.150 | 13.342 | 13.344 | -0.02 |
| 10 | 263.150 | 14.089 | 14.091 | -0.02 |
| 5 | 255.963 | 14.554 | 14.570 | -0.11 |
| 10 | 253.150 | 14.753 | 14.747 | 0.04 |
| 5 | 247.962 | 15.050 | 15.060 | -0.07 |
| 5 | 240.700 | 15.455 | 15.475 | -0.13 |
| 5 | 229.917 | 16.037 | 16.048 | -0.07 |
| 5 | 222.618 | 16.423 | 16.413 | 0.06 |
| 5 | 214.942 | 16.754 | 16.781 | -0.16 |
| 5 | 207.941 | 17.125 | 17.103 | 0.13 |
| 5 | 197.888 | 17.529 | 17.548 | -0.11 |
| 5 | 188.451 | 17.941 | 17.950 | -0.05 |
| 5 | 176.512 | 18.446 | 18.440 | 0.03 |
| 5 | 167.366 | 18.823 | 18.805 | 0.10 |
| 12 | 161.360 | 19.027 | 19.040 | -0.06 |
| 5 | 156.875 | 19.226 | 19.213 | 0.07 |
| 13 | 133.150 | 20.126 | 20.107 | 0.10 |
| 13 | 127.594 | 20.323 | 20.312 | 0.05 |
| 13 | 122.039 | 20.521 | 20.516 | 0.02 |
| 13 | 116.483 | 20.717 | 20.719 | -0.01 |
| 12 | 115.770 | 20.747 | 20.745 | 0.01 |
| 14 | 115.050 | 20.771 | 20.771 | 0.00 |
| 13 | 110.928 | 20.915 | 20.921 | -0.03 |
| 14 | 108.110 | 21.025 | 21.023 | 0.01 |
| 12 | 108.150 | 21.027 | 21.022 | 0.02 |
| 14 | 100.020 | 21.313 | 21.315 | -0.01 |
| 14 | 91.010 | 21.639 | 21.640 | -0.00 |

NP = 33, RMSPCT = 0.068

Table 4. Vapor densities via vapor-pressure and virial equations

ETHANE SATD. VAPOR DENSITIES VIA V.P. AND VIRIAL EQNS.

| ID | T,K | P,ATM | PLANK/KAMB | MOL/L | PCT |
|---|---|---|---|---|---|
| 1 | 89.899 | 9.9670-006 | 1.3511-006 | 1.3511-006 | 0.00 |
| 1 | 90.000 | 1.0238-005 | 1.3863-006 | 1.3863-006 | 0.00 |
| 1 | 95.000 | 3.5808-005 | 4.5936-006 | 4.5936-006 | 0.00 |
| 1 | 100.000 | 1.0952-004 | 1.3347-005 | 1.3347-005 | 0.00 |
| 1 | 105.000 | 2.9851-004 | 3.4649-005 | 3.4648-005 | 0.00 |
| 1 | 110.000 | 7.3654-004 | 8.1615-005 | 8.1612-005 | 0.00 |
| 1 | 115.000 | 1.6670-003 | 1.7671-004 | 1.7670-004 | 0.01 |
| 1 | 120.000 | 3.4991-003 | 3.5558-004 | 3.5552-004 | 0.01 |
| 1 | 125.000 | 6.8762-003 | 6.7110-004 | 6.7093-004 | 0.02 |
| 1 | 130.000 | 1.2752-002 | 1.1974-003 | 1.1970-003 | 0.04 |
| 1 | 135.000 | 2.2468-002 | 2.0336-003 | 2.0323-003 | 0.06 |
| 1 | 140.000 | 3.7834-002 | 3.3064-003 | 3.3033-003 | 0.09 |
| 1 | 145.000 | 6.1192-002 | 5.1721-003 | 5.1653-003 | 0.13 |
| 1 | 150.000 | 9.5478-002 | 7.8184-003 | 7.8043-003 | 0.18 |
| 1 | 155.000 | 1.4426-001 | 1.1464-002 | 1.1436-002 | 0.24 |
| 1 | 160.000 | 2.1176-001 | 1.6358-002 | 1.6308-002 | 0.31 |
| 1 | 165.000 | 3.0288-001 | 2.2781-002 | 2.2694-002 | 0.38 |
| 1 | 170.000 | 4.2317-001 | 3.1042-002 | 3.0899-002 | 0.46 |
| 1 | 175.000 | 5.7882-001 | 4.1479-002 | 4.1252-002 | 0.55 |
| 1 | 180.000 | 7.7662-001 | 5.4457-002 | 5.4111-002 | 0.64 |
| 1 | 185.000 | 1.0239+000 | 7.0359-002 | 6.9860-002 | 0.73 |
| 1 | 190.000 | 1.3287+000 | 8.9635-002 | 8.8911-002 | 0.81 |
| 1 | 195.000 | 1.6991+000 | 1.1271-001 | 1.1171-001 | 0.89 |
| 1 | 200.000 | 2.1440+000 | 1.4006-001 | 1.3872-001 | 0.97 |
| 1 | 205.000 | 2.6726+000 | 1.7222-001 | 1.7047-001 | 1.03 |
| 1 | 210.000 | 3.2943+000 | 2.0973-001 | 2.0750-001 | 1.08 |
| 1 | 215.000 | 4.0186+000 | 2.5321-001 | 2.5043-001 | 1.11 |
| 1 | 220.000 | 4.8561+000 | 3.0331-001 | 2.9993-001 | 1.13 |
| 1 | 225.000 | 5.8165+000 | 3.6077-001 | 3.5674-001 | 1.13 |
| 1 | 230.000 | 6.9105+000 | 4.2642-001 | 4.2173-001 | 1.11 |
| 1 | 235.000 | 8.1487+000 | 5.0120-001 | 4.9585-001 | 1.08 |
| 1 | 240.000 | 9.5420+000 | 5.8618-001 | 5.8025-001 | 1.02 |
| 1 | 245.000 | 1.1102+001 | 6.8262-001 | 6.7626-001 | 0.94 |
| 1 | 250.000 | 1.2839+001 | 7.9203-001 | 7.8551-001 | 0.83 |
| 1 | 255.000 | 1.4766+001 | 9.1618-001 | 9.0997-001 | 0.68 |
| 1 | 260.000 | 1.6895+001 | 1.0572+000 | 1.0522+000 | 0.48 |
| 1 | 265.000 | 1.9238+001 | 1.2179+000 | 1.2154+000 | 0.21 |
| 1 | 270.000 | 2.1810+001 | 1.4016+000 | 1.4041+000 | -0.18 |
| 1 | 275.000 | 2.4624+001 | 1.6125+000 | 1.6245+000 | -0.74 |
| 1 | 280.000 | 2.7697+001 | 1.8563+000 | 1.8861+000 | -1.58 |
| 1 | 285.000 | 3.1047+001 | 2.1404+000 | 2.2047+000 | -2.91 |
| 1 | 290.000 | 3.4693+001 | 2.4754+000 | 2.6108+000 | -5.19 |

Table 5. Experimental and calculated saturated vapor densities

ID: (1) from Table 4; (10) Douslin

SATURATED VAPOR DENSITIES, E = 0.390

TTRP = 89.899, TCRT = 305.370, DCRT = 6.740, DGAT = 1.35114-006

0.21587515 -0.08522342 -0.61523457 0.25452490 0.15177230

| ID | T,K | MOL/L | CALCD | PCNT |
|---|---|---|---|---|
| 1 | 90.000 | 1.3863-006 | 1.3863-006 | 0.00 |
| 1 | 100.000 | 1.3347-005 | 1.3356-005 | -0.06 |
| 1 | 110.000 | 8.1612-005 | 8.1689-005 | -0.09 |
| 1 | 120.000 | 3.5552-004 | 3.5564-004 | -0.03 |
| 1 | 130.000 | 1.1970-003 | 1.1962-003 | 0.06 |
| 1 | 140.000 | 3.3033-003 | 3.2989-003 | 0.13 |
| 1 | 150.000 | 7.8043-003 | 7.7922-003 | 0.16 |
| 1 | 160.000 | 1.6308-002 | 1.6286-002 | 0.13 |
| 1 | 170.000 | 3.0899-002 | 3.0875-002 | 0.08 |
| 1 | 180.000 | 5.4111-002 | 5.4107-002 | 0.01 |
| 1 | 190.000 | 8.8911-002 | 8.8968-002 | -0.06 |
| 1 | 200.000 | 1.3872-001 | 1.3888-001 | -0.12 |
| 1 | 210.000 | 2.0750-001 | 2.0781-001 | -0.15 |
| 1 | 220.000 | 2.9992-001 | 3.0040-001 | -0.16 |
| 1 | 230.000 | 4.2172-001 | 4.2231-001 | -0.14 |
| 1 | 240.000 | 5.8025-001 | 5.8083-001 | -0.10 |
| 1 | 245.000 | 6.7626-001 | 6.7677-001 | -0.07 |
| 10 | 248.150 | 7.4490-001 | 7.4384-001 | 0.14 |
| 1 | 250.000 | 7.8551-001 | 7.8586-001 | -0.04 |
| 10 | 253.150 | 8.6310-001 | 8.6220-001 | 0.10 |
| 10 | 263.150 | 1.1530+000 | 1.1516+000 | 0.12 |
| 10 | 273.150 | 1.5370+000 | 1.5357+000 | 0.09 |
| 10 | 283.150 | 2.0670+000 | 2.0669+000 | 0.00 |
| 10 | 293.150 | 2.8800+000 | 2.8748+000 | 0.18 |
| 10 | 298.150 | 3.5020+000 | 3.5051+000 | -0.09 |
| 10 | 302.150 | 4.3070+000 | 4.3068+000 | 0.01 |
| 10 | 303.150 | 4.6040+000 | 4.6122+000 | -0.18 |
| 10 | 304.150 | 5.0350+000 | 5.0298+000 | 0.10 |

NP = 28, RMSPCT = 0.107

Table 6. Experimental and calculated liquid saturation temperatures

ID: (5) via isochores of Pal; (10) Douslin; (12) Chui;
(13) Klosek; (14) Miller

TTRP = 89.899, TCRT = 305.370, DTRP = 21.680, DCRT = 6.740

23.724518399 -14.886051613 5.431774425 -1.071505659
0.091351825

| ID | MOL/L | CALC | PCNT | T,K | CALC | PCNT | DTS/DD |
|---|---|---|---|---|---|---|---|
| 10 | 8.73700+000 | 8.74092+000 | -0.04 | 304.150 | 304.157 | -0.00 | -1.821+000 |
| 10 | 9.20100+000 | 9.19581+000 | 0.06 | 303.150 | 303.137 | 0.00 | -2.593+000 |
| 10 | 9.54400+000 | 9.54113+000 | 0.03 | 302.150 | 302.141 | 0.00 | -3.222+000 |
| 10 | 1.04990+001 | 1.04963+001 | 0.03 | 298.150 | 298.136 | 0.00 | -5.224+000 |
| 10 | 1.12970+001 | 1.13066+001 | -0.08 | 293.150 | 293.218 | -0.02 | -7.131+000 |
| 10 | 1.24580+001 | 1.24637+001 | -0.05 | 283.150 | 283.207 | -0.02 | -1.015+001 |
| 10 | 1.33420+001 | 1.33450+001 | -0.02 | 273.150 | 273.188 | -0.01 | -1.253+001 |
| 10 | 1.40890+001 | 1.40844+001 | 0.03 | 263.150 | 263.083 | 0.03 | -1.452+001 |
| 5 | 1.45540+001 | 1.45591+001 | -0.04 | 255.963 | 256.043 | -0.03 | -1.575+001 |
| 10 | 1.47530+001 | 1.47350+001 | 0.12 | 253.150 | 252.858 | 0.12 | -1.626+001 |
| 5 | 1.50500+001 | 1.50472+001 | 0.02 | 247.962 | 247.915 | 0.02 | -1.702+001 |
| 5 | 1.54550+001 | 1.54613+001 | -0.04 | 240.700 | 240.814 | -0.05 | -1.804+001 |
| 5 | 1.60370+001 | 1.60362+001 | 0.00 | 229.917 | 229.901 | 0.01 | -1.945+001 |
| 5 | 1.64230+001 | 1.64033+001 | 0.12 | 222.618 | 222.218 | 0.18 | -2.036+001 |
| 5 | 1.67540+001 | 1.67735+001 | -0.12 | 214.942 | 215.354 | -0.19 | -2.111+001 |
| 5 | 1.71250+001 | 1.70989+001 | 0.15 | 207.941 | 207.369 | 0.28 | -2.193+001 |
| 5 | 1.75290+001 | 1.75485+001 | -0.11 | 197.888 | 198.332 | -0.22 | -2.280+001 |
| 5 | 1.79410+001 | 1.79542+001 | -0.07 | 188.451 | 188.763 | -0.17 | -2.365+001 |
| 5 | 1.84460+001 | 1.84483+001 | -0.01 | 176.512 | 176.569 | -0.03 | -2.463+001 |
| 5 | 1.88230+001 | 1.88145+001 | 0.05 | 167.366 | 167.150 | 0.13 | -2.533+001 |
| 12 | 1.90273+001 | 1.90499+001 | -0.12 | 161.360 | 161.940 | -0.36 | -2.568+001 |
| 5 | 1.92260+001 | 1.92233+001 | 0.01 | 156.875 | 156.804 | 0.05 | -2.601+001 |
| 13 | 2.01262+001 | 2.01134+001 | 0.06 | 133.150 | 132.802 | 0.26 | -2.723+001 |
| 13 | 2.03228+001 | 2.03168+001 | 0.03 | 127.594 | 127.428 | 0.13 | -2.742+001 |
| 13 | 2.05207+001 | 2.05188+001 | 0.01 | 122.039 | 121.985 | 0.04 | -2.758+001 |
| 13 | 2.07171+001 | 2.07198+001 | -0.01 | 116.483 | 116.558 | -0.06 | -2.769+001 |
| 12 | 2.07466+001 | 2.07456+001 | 0.01 | 115.770 | 115.741 | 0.02 | -2.770+001 |
| 14 | 2.07715+001 | 2.07715+001 | -0.00 | 115.050 | 115.051 | -0.00 | -2.771+001 |
| 13 | 2.09146+001 | 2.09202+001 | -0.03 | 110.928 | 111.083 | -0.14 | -2.775+001 |
| 14 | 2.10247+001 | 2.10217+001 | 0.01 | 108.110 | 108.027 | 0.08 | -2.776+001 |
| 12 | 2.10266+001 | 2.10203+001 | 0.03 | 108.150 | 107.974 | 0.16 | -2.776+001 |
| 14 | 2.13129+001 | 2.13133+001 | -0.00 | 100.020 | 100.030 | -0.01 | -2.771+001 |
| 14 | 2.16394+001 | 2.16395+001 | -0.00 | 91.010 | 91.014 | -0.00 | -2.749+001 |

NP = 33, DNRMSPCT = 0.062, TSRMSPCT = 0.127

Table 7. Experimental and calculated vapor saturation temperatures.

TTRP = 89.899, TCRT = 305.370, DTRP = 21.680, DCRT = 6.740

| | | | |
|---|---|---|---|
| 0.868105174 | 0.015169784 | -0.729604322 | 1.009654932 |
| -8.734027096 | 21.107128228 | -31.449940867 | 17.863703965 |

| ID | MOL/L | CALC | PCNT | T,K | CALC | PCNT | DTS/DD |
|---|---|---|---|---|---|---|---|
| 1 | 1.38632-006 | 1.38631-006 | 0.00 | 90.000 | 90.000 | 0.00 | 2.836+006 |
| 1 | 1.33473-005 | 1.33231-005 | 0.18 | 100.000 | 100.009 | -0.01 | 3.725+005 |
| 1 | 8.16117-005 | 8.12917-005 | 0.39 | 110.000 | 110.024 | -0.02 | 7.547+004 |
| 1 | 3.55524-004 | 3.54355-004 | 0.33 | 120.000 | 120.025 | -0.02 | 2.111+004 |
| 1 | 1.19696-003 | 1.19589-003 | 0.09 | 130.000 | 130.008 | -0.01 | 7.535+003 |
| 1 | 3.30328-003 | 3.30835-003 | -0.15 | 140.000 | 139.984 | 0.01 | 3.243+003 |
| 1 | 7.80430-003 | 7.82616-003 | -0.28 | 150.000 | 149.965 | 0.02 | 1.613+003 |
| 1 | 1.63081-002 | 1.63504-002 | -0.26 | 160.000 | 159.962 | 0.02 | 8.966+002 |
| 1 | 3.08987-002 | 3.09388-002 | -0.13 | 170.000 | 169.978 | 0.01 | 5.435+002 |
| 1 | 5.41110-002 | 5.40912-002 | 0.04 | 180.000 | 180.007 | -0.00 | 3.523+002 |
| 1 | 8.89114-002 | 8.87651-002 | 0.16 | 190.000 | 190.035 | -0.02 | 2.404+002 |
| 1 | 1.38721-001 | 1.38434-001 | 0.21 | 200.000 | 200.049 | -0.02 | 1.708+002 |
| 1 | 2.07500-001 | 2.07182-001 | 0.15 | 210.000 | 210.040 | -0.02 | 1.251+002 |
| 1 | 2.99925-001 | 2.99825-001 | 0.03 | 220.000 | 220.009 | -0.00 | 9.395+001 |
| 1 | 4.21725-001 | 4.22114-001 | -0.09 | 230.000 | 229.972 | 0.01 | 7.182+001 |
| 1 | 5.80249-001 | 5.81153-001 | -0.16 | 240.000 | 239.950 | 0.02 | 5.554+001 |
| 1 | 6.76262-001 | 6.77273-001 | -0.15 | 245.000 | 244.951 | 0.02 | 4.891+001 |
| 10 | 7.44900-001 | 7.44404-001 | 0.07 | 248.150 | 248.172 | -0.01 | 4.507+001 |
| 1 | 7.85506-001 | 7.86416-001 | -0.12 | 250.000 | 249.961 | 0.02 | 4.305+001 |
| 10 | 8.63100-001 | 8.62708-001 | 0.05 | 253.150 | 253.166 | -0.01 | 3.964+001 |
| 10 | 1.15300+000 | 1.15155+000 | 0.13 | 263.150 | 263.194 | -0.02 | 3.026+001 |
| 10 | 1.53700+000 | 1.53526+000 | 0.11 | 273.150 | 273.189 | -0.01 | 2.239+001 |
| 10 | 2.06700+000 | 2.06882+000 | -0.09 | 283.150 | 283.122 | 0.01 | 1.565+001 |
| 10 | 2.88000+000 | 2.87935+000 | 0.02 | 293.150 | 293.156 | -0.00 | 9.602+000 |
| 10 | 3.50200+000 | 3.50420+000 | -0.06 | 298.150 | 298.136 | 0.00 | 6.553+000 |
| 10 | 4.30700+000 | 4.30072+000 | 0.15 | 302.150 | 302.173 | -0.01 | 3.652+000 |
| 10 | 4.60400+000 | 4.60953+000 | -0.12 | 303.150 | 303.134 | 0.01 | 2.846+000 |
| 10 | 5.03500+000 | 5.03402+000 | 0.02 | 304.150 | 304.152 | -0.00 | 1.923+000 |

NP = 28, DNRMSPCT = 0.162, TSRMSPCT = 0.014

Table 8. Experimental and calculated second virial coefficients

ID: (3) Michels; (6) McGlashan; (10) Douslin

0.552671 -1.106244 -0.592947 -0.041944 0.000000

| ID | T,K | T/TC | B* | CALC | DIFF | PCNT |
|---|---|---|---|---|---|---|
| 6 | 150.000 | 0.4912 | -5.183 | -5.185 | 0.002 | 0.03 |
| 6 | 160.000 | 0.5240 | -4.489 | -4.487 | -0.001 | -0.03 |
| 6 | 170.000 | 0.5567 | -3.935 | -3.933 | -0.002 | -0.04 |
| 6 | 180.000 | 0.5894 | -3.485 | -3.483 | -0.001 | -0.04 |
| 6 | 190.000 | 0.6222 | -3.112 | -3.112 | -0.001 | -0.02 |
| 6 | 200.000 | 0.6549 | -2.800 | -2.800 | 0.000 | 0.01 |
| 6 | 210.000 | 0.6877 | -2.535 | -2.536 | 0.001 | 0.04 |
| 6 | 220.000 | 0.7204 | -2.307 | -2.309 | 0.002 | 0.07 |
| 6 | 230.000 | 0.7532 | -2.110 | -2.111 | 0.002 | 0.09 |
| 6 | 240.000 | 0.7859 | -1.937 | -1.939 | 0.002 | 0.10 |
| 6 | 250.000 | 0.8187 | -1.785 | -1.786 | 0.002 | 0.10 |
| 6 | 260.000 | 0.8514 | -1.650 | -1.651 | 0.001 | 0.08 |
| 6 | 270.000 | 0.8842 | -1.529 | -1.530 | 0.001 | 0.05 |
| 6 | 280.000 | 0.9169 | -1.421 | -1.421 | 0.000 | 0.00 |
| 6 | 290.000 | 0.9497 | -1.323 | -1.323 | -0.001 | -0.06 |
| 6 | 300.000 | 0.9824 | -1.235 | -1.233 | -0.002 | -0.14 |
| 3 | 273.150 | 0.8945 | -1.493 | -1.494 | 0.002 | 0.12 |
| 10 | 273.150 | 0.8945 | -1.498 | -1.494 | -0.003 | -0.21 |
| 3 | 298.138 | 0.9763 | -1.251 | -1.249 | -0.002 | -0.14 |
| 10 | 298.150 | 0.9764 | -1.252 | -1.249 | -0.003 | -0.26 |
| 10 | 303.150 | 0.9927 | -1.209 | -1.207 | -0.002 | -0.21 |
| 3 | 322.748 | 1.0569 | -1.058 | -1.058 | -0.000 | -0.01 |
| 10 | 323.150 | 1.0582 | -1.056 | -1.055 | -0.001 | -0.14 |
| 3 | 347.652 | 1.1385 | -0.898 | -0.900 | 0.002 | 0.18 |
| 10 | 348.150 | 1.1401 | -0.896 | -0.897 | 0.001 | 0.07 |
| 3 | 372.522 | 1.2199 | -0.769 | -0.770 | 0.001 | 0.13 |
| 10 | 373.150 | 1.2220 | -0.766 | -0.767 | 0.001 | 0.14 |
| 3 | 397.844 | 1.3028 | -0.659 | -0.659 | -0.000 | -0.02 |
| 10 | 398.150 | 1.3038 | -0.656 | -0.657 | 0.001 | 0.23 |
| 3 | 422.700 | 1.3842 | -0.566 | -0.566 | 0.000 | 0.02 |
| 10 | 423.150 | 1.3857 | -0.563 | -0.564 | 0.001 | 0.12 |
| 10 | 448.150 | 1.4676 | -0.483 | -0.484 | 0.001 | 0.13 |
| 10 | 473.150 | 1.5494 | -0.415 | -0.414 | -0.000 | -0.09 |
| 10 | 498.150 | 1.6313 | -0.353 | -0.353 | -0.000 | -0.07 |
| 10 | 523.150 | 1.7132 | -0.300 | -0.299 | -0.001 | -0.37 |
| 10 | 548.150 | 1.7950 | -0.251 | -0.251 | -0.001 | -0.30 |
| 10 | 573.150 | 1.8769 | -0.208 | -0.208 | -0.001 | -0.36 |
| 10 | 598.150 | 1.9588 | -0.168 | -0.169 | 0.000 | 0.10 |
| 10 | 623.150 | 2.0406 | -0.132 | -0.134 | 0.001 | 1.06 |

NP = 39, MEANPCT = 0.139

Table 8. Experimental and calculated second virial coefficients (Continued)

ID: (1) Eucken; (2) Lambert; (4) Hoover; (5) Pope; (8) Gunn; (9) Hamann via Dymond/Smith.

| ID | T,K | T/TC | B* | CALC | DIFF | PCNT |
|---|---|---|---|---|---|---|
| 1 | 200.000 | 0.6549 | -3.053 | -2.800 | -0.253 | -9.03 |
| 2 | 200.000 | 0.6549 | -3.060 | -2.800 | -0.260 | -9.27 |
| 5 | 209.534 | 0.6862 | -2.485 | -2.547 | 0.063 | 2.46 |
| 1 | 210.000 | 0.6877 | -2.763 | -2.536 | -0.227 | -8.97 |
| 2 | 210.000 | 0.6877 | -2.763 | -2.536 | -0.227 | -8.97 |
| 4 | 215.000 | 0.7041 | -2.296 | -2.418 | 0.123 | 5.07 |
| 1 | 220.000 | 0.7204 | -2.494 | -2.309 | -0.185 | -8.02 |
| 2 | 220.000 | 0.7204 | -2.528 | -2.309 | -0.219 | -9.48 |
| 1 | 230.000 | 0.7532 | -2.244 | -2.111 | -0.133 | -6.30 |
| 2 | 230.000 | 0.7532 | -2.298 | -2.111 | -0.187 | -8.85 |
| 5 | 238.769 | 0.7819 | -1.935 | -1.959 | 0.024 | 1.24 |
| 1 | 240.000 | 0.7859 | -2.056 | -1.939 | -0.117 | -6.03 |
| 2 | 240.000 | 0.7859 | -2.076 | -1.939 | -0.137 | -7.07 |
| 4 | 240.000 | 0.7859 | -1.864 | -1.939 | 0.075 | 3.88 |
| 1 | 250.000 | 0.8187 | -1.887 | -1.786 | -0.101 | -5.64 |
| 2 | 250.000 | 0.8187 | -1.907 | -1.786 | -0.121 | -6.77 |
| 5 | 254.807 | 0.8344 | -1.700 | -1.719 | 0.019 | 1.11 |
| 1 | 260.000 | 0.8514 | -1.725 | -1.651 | -0.074 | -4.51 |
| 2 | 260.000 | 0.8514 | -1.752 | -1.651 | -0.101 | -6.14 |
| 1 | 270.000 | 0.8842 | -1.584 | -1.530 | -0.054 | -3.53 |
| 2 | 270.000 | 0.8842 | -1.618 | -1.530 | -0.088 | -5.73 |
| 4 | 273.150 | 0.8945 | -1.506 | -1.494 | -0.011 | -0.76 |
| 5 | 273.150 | 0.8945 | -1.479 | -1.494 | 0.016 | 1.06 |
| 8 | 273.200 | 0.8947 | -1.498 | -1.494 | -0.004 | -0.25 |
| 1 | 280.000 | 0.9169 | -1.442 | -1.421 | -0.021 | -1.50 |
| 2 | 280.000 | 0.9169 | -1.483 | -1.421 | -0.062 | -4.35 |
| 2 | 290.000 | 0.9497 | -1.382 | -1.323 | -0.059 | -4.47 |
| 8 | 298.200 | 0.9765 | -1.260 | -1.249 | -0.011 | -0.89 |
| 2 | 300.000 | 0.9824 | -1.281 | -1.233 | -0.047 | -3.85 |
| 5 | 306.062 | 1.0023 | -1.181 | -1.183 | 0.002 | 0.13 |
| 9 | 310.940 | 1.0182 | -1.111 | -1.144 | 0.033 | 2.87 |
| 8 | 323.200 | 1.0584 | -1.062 | -1.054 | -0.007 | -0.68 |
| 9 | 344.270 | 1.1274 | -0.913 | -0.920 | 0.006 | 0.68 |
| 9 | 377.600 | 1.2365 | -0.741 | -0.746 | 0.004 | 0.60 |
| 8 | 377.600 | 1.2365 | -0.737 | -0.746 | 0.009 | 1.14 |
| 8 | 410.900 | 1.3456 | -0.604 | -0.608 | 0.004 | 0.67 |
| 9 | 410.940 | 1.3457 | -0.609 | -0.608 | -0.001 | -0.24 |
| 9 | 444.270 | 1.4549 | -0.500 | -0.496 | -0.004 | -0.91 |
| 8 | 444.300 | 1.4550 | -0.499 | -0.496 | -0.003 | -0.65 |
| 9 | 477.600 | 1.5640 | -0.404 | -0.403 | -0.001 | -0.27 |
| 8 | 477.600 | 1.5640 | -0.415 | -0.403 | -0.013 | -3.11 |
| 8 | 510.910 | 1.6731 | -0.344 | -0.325 | -0.019 | -5.92 |
| 9 | 510.940 | 1.6732 | -0.319 | -0.324 | 0.005 | 1.53 |

Table 9. Experimental and calculated third virial coefficients

ID: (7) Chueh; (10) Douslin; (4) Hoover; (5) Pope

217.800 0.244226 0.832529 0.534875 0.000000

| ID | T,K | T/TCRT | C* | CALCD | DIFF |
|---|---|---|---|---|---|
| 7 | 210.000 | 0.6877 | -0.241 | -0.237 | -0.004 |
| 7 | 220.000 | 0.7204 | 0.053 | 0.053 | 0.000 |
| 7 | 230.000 | 0.7532 | 0.239 | 0.238 | 0.002 |
| 7 | 240.000 | 0.7859 | 0.353 | 0.352 | 0.001 |
| 7 | 250.000 | 0.8187 | 0.419 | 0.421 | -0.002 |
| 7 | 260.000 | 0.8514 | 0.454 | 0.460 | -0.005 |
| 10 | 273.150 | 0.8945 | 0.471 | 0.480 | -0.010 |
| 10 | 298.150 | 0.9764 | 0.482 | 0.471 | 0.011 |
| 10 | 303.150 | 0.9927 | 0.472 | 0.465 | 0.007 |
| 10 | 323.150 | 1.0582 | 0.438 | 0.436 | 0.003 |
| 10 | 348.150 | 1.1401 | 0.393 | 0.395 | -0.001 |
| 10 | 373.150 | 1.2220 | 0.351 | 0.355 | -0.004 |
| 10 | 398.150 | 1.3038 | 0.316 | 0.319 | -0.003 |
| 10 | 423.150 | 1.3857 | 0.284 | 0.288 | -0.004 |
| 10 | 448.150 | 1.4676 | 0.258 | 0.261 | -0.003 |
| 10 | 473.150 | 1.5494 | 0.240 | 0.238 | 0.002 |
| 10 | 498.150 | 1.6313 | 0.220 | 0.218 | 0.002 |
| 10 | 523.150 | 1.7132 | 0.204 | 0.201 | 0.003 |
| 10 | 548.150 | 1.7950 | 0.188 | 0.186 | 0.002 |
| 10 | 573.150 | 1.8769 | 0.175 | 0.173 | 0.002 |
| 10 | 598.150 | 1.9588 | 0.161 | 0.162 | -0.001 |
| 10 | 623.150 | 2.0406 | 0.149 | 0.151 | -0.003 |

NP = 22, MEANDIFF = 0.003

| ID | T,K | T/TCRT | C* | CALCD | DIFF |
|---|---|---|---|---|---|
| 5 | 209.534 | 0.6862 | -2.667 | -0.254 | -2.412 |
| 4 | 215.000 | 0.7041 | -3.230 | -0.076 | -3.154 |
| 5 | 238.769 | 0.7819 | 0.168 | 0.341 | -0.173 |
| 4 | 240.000 | 0.7859 | -0.117 | 0.352 | -0.469 |
| 5 | 254.307 | 0.8344 | 0.386 | 0.443 | -0.056 |
| 5 | 273.150 | 0.8945 | 0.471 | 0.480 | -0.010 |
| 4 | 273.150 | 0.8945 | 0.482 | 0.480 | 0.002 |
| 4 | 273.150 | 0.8945 | 0.517 | 0.480 | 0.036 |
| 4 | 298.138 | 0.9763 | 0.488 | 0.471 | 0.017 |
| 5 | 306.062 | 1.0023 | 0.456 | 0.461 | -0.006 |
| 4 | 322.748 | 1.0569 | 0.439 | 0.436 | 0.003 |
| 4 | 347.652 | 1.1385 | 0.390 | 0.395 | -0.006 |
| 4 | 372.522 | 1.2199 | 0.350 | 0.356 | -0.006 |
| 4 | 397.844 | 1.3028 | 0.318 | 0.320 | -0.002 |
| 4 | 422.700 | 1.3842 | 0.290 | 0.289 | 0.001 |

Table 11. Coefficients of the equation of state

DTRP = 21.6800, TTRP = 89.899, PTRP = 0.000010099
DCRT = 6.7400, TCRT = 305.370, PCRT = 48.755014373

AL = 2.00, BE = 1.00, EP = 0.50

| | | |
|---|---|---|
| 1.848167996 | 1.569704511 | 5.560186452 |
| -1.042842462 | 0.224978299 | |

| MOL/L | TSAT | THETA | PSAT | B | C |
|---|---|---|---|---|---|
| 0.5 | 235.219 | 203.322 | 8.315 | 1.887 | -1.754 |
| 1.0 | 258.239 | 230.548 | 16.335 | 1.932 | -1.540 |
| 1.5 | 272.349 | 249.833 | 23.407 | 1.983 | -1.340 |
| 2.0 | 282.050 | 264.599 | 29.421 | 2.040 | -1.152 |
| 2.5 | 289.067 | 276.149 | 34.440 | 2.102 | -0.978 |
| 3.0 | 294.268 | 285.179 | 38.565 | 2.170 | -0.817 |
| 3.5 | 298.122 | 292.103 | 41.868 | 2.243 | -0.668 |
| 4.0 | 300.905 | 297.215 | 44.397 | 2.321 | -0.532 |
| 4.5 | 302.825 | 300.790 | 46.220 | 2.404 | -0.408 |
| 5.0 | 304.083 | 303.124 | 47.454 | 2.491 | -0.296 |
| 5.5 | 304.868 | 304.520 | 48.242 | 2.583 | -0.197 |
| 6.0 | 305.290 | 305.215 | 48.672 | 2.678 | -0.109 |
| 6.5 | 305.370 | 305.367 | 48.755 | 2.777 | -0.032 |
| 7.0 | 305.370 | 305.367 | 48.755 | 2.880 | 0.032 |
| 7.5 | 305.339 | 305.258 | 48.723 | 2.985 | 0.086 |
| 8.0 | 305.101 | 304.735 | 48.478 | 3.094 | 0.128 |
| 8.5 | 304.546 | 303.552 | 47.916 | 3.204 | 0.159 |
| 9.0 | 303.623 | 301.528 | 46.998 | 3.317 | 0.180 |
| 9.5 | 302.281 | 298.493 | 45.696 | 3.432 | 0.190 |
| 10.0 | 300.467 | 294.288 | 43.990 | 3.548 | 0.189 |
| 10.5 | 298.130 | 288.775 | 41.875 | 3.665 | 0.178 |
| 11.0 | 295.227 | 281.851 | 39.366 | 3.783 | 0.157 |
| 11.5 | 291.719 | 273.446 | 36.497 | 3.902 | 0.126 |
| 12.0 | 287.576 | 263.540 | 33.323 | 4.021 | 0.086 |
| 12.5 | 282.779 | 252.156 | 29.915 | 4.140 | 0.035 |
| 13.0 | 277.314 | 239.372 | 26.358 | 4.260 | -0.024 |
| 13.5 | 271.175 | 225.313 | 22.746 | 4.379 | -0.093 |
| 14.0 | 264.365 | 210.151 | 19.179 | 4.498 | -0.171 |
| 14.5 | 256.890 | 194.102 | 15.752 | 4.616 | -0.258 |
| 15.0 | 248.763 | 177.416 | 12.556 | 4.734 | -0.354 |
| 15.5 | 240.000 | 160.367 | 9.668 | 4.851 | -0.458 |
| 16.0 | 230.619 | 143.243 | 7.149 | 4.967 | -0.571 |
| 16.5 | 220.643 | 126.336 | 5.038 | 5.082 | -0.692 |
| 17.0 | 210.093 | 109.923 | 3.351 | 5.196 | -0.821 |
| 17.5 | 198.992 | 94.264 | 2.075 | 5.309 | -0.958 |
| 18.0 | 187.364 | 79.584 | 1.176 | 5.420 | -1.102 |
| 18.5 | 175.236 | 66.069 | 0.595 | 5.530 | -1.254 |
| 19.0 | 162.640 | 53.856 | 0.260 | 5.639 | -1.414 |
| 19.5 | 149.619 | 43.037 | 0.094 | 5.747 | -1.580 |
| 20.0 | 136.230 | 33.650 | 0.026 | 5.853 | -1.754 |
| 20.5 | 122.556 | 25.688 | 0.005 | 5.957 | -1.935 |
| 21.0 | 108.713 | 19.098 | 0.001 | 6.060 | -2.122 |
| 21.5 | 94.854 | 13.788 | 0.000 | 6.162 | -2.316 |
| 22.0 | 81.182 | 9.635 | 0.000 | 6.262 | -2.516 |
| 22.5 | 67.940 | 6.494 | 0.000 | 6.361 | -2.722 |
| 23.0 | 55.403 | 4.205 | 0.000 | 6.458 | -2.934 |

Table 12. Experimental and calculated P-ρ-T data

The following pages compare experimental P-ρ-T (compressibility) data with densities and pressures computed by the equation of state (5). The first column identifies sources of the data (as in Table 10):

| ID | Authors |
|---|---|
| 2 | Virial equation (4). |
| 8 | Reamer et al [57]. |
| 9 | Michels et al [47]. |
| 10 | Douslin and Harrison [14]. |
| $100^+$ | A. K. Pal, via Pope [54]. |

The equation of state was adjusted only to data of ID = 2, 9, 10, and $1300^+$. Remaining data validate our extrapolation to higher pressures. Density deviations should be ignored near the critical point, and pressure deviations should be ignored for compressed liquid at low temperatures for reasons given in the text.

Table 12. Experimental and calculated P-ρ-T data

EQUATION OF STATE VS. PVT DATA

| ID | T,K | MOL/L | CALCD | D,PCT | P,BAR | CALCD | P,PCT |
|---|---|---|---|---|---|---|---|
| 2 | 230.000 | 0.4000 | 0.4003 | -0.07 | 6.693 | 6.689 | 0.06 |
| 2 | 240.000 | 0.4000 | 0.4003 | -0.07 | 7.070 | 7.066 | 0.06 |
| 2 | 250.000 | 0.4000 | 0.4002 | -0.06 | 7.442 | 7.438 | 0.05 |
| 2 | 260.000 | 0.4000 | 0.4002 | -0.06 | 7.811 | 7.807 | 0.05 |
| 2 | 270.000 | 0.4000 | 0.4002 | -0.06 | 8.177 | 8.173 | 0.05 |
| 2 | 280.000 | 0.4000 | 0.4002 | -0.05 | 8.541 | 8.537 | 0.05 |
| 2 | 290.000 | 0.4000 | 0.4002 | -0.05 | 8.902 | 8.898 | 0.05 |
| 2 | 300.000 | 0.4000 | 0.4002 | -0.05 | 9.262 | 9.258 | 0.04 |
| 2 | 310.000 | 0.4000 | 0.4002 | -0.04 | 9.621 | 9.617 | 0.04 |
| 2 | 320.000 | 0.4000 | 0.4002 | -0.04 | 9.978 | 9.974 | 0.04 |
| 2 | 330.000 | 0.4000 | 0.4002 | -0.04 | 10.334 | 10.330 | 0.04 |
| 2 | 340.000 | 0.4000 | 0.4002 | -0.04 | 10.689 | 10.686 | 0.04 |
| 2 | 350.000 | 0.4000 | 0.4001 | -0.04 | 11.044 | 11.040 | 0.03 |
| 2 | 360.000 | 0.4000 | 0.4001 | -0.03 | 11.397 | 11.393 | 0.03 |
| 2 | 370.000 | 0.4000 | 0.4001 | -0.03 | 11.750 | 11.746 | 0.03 |
| 2 | 380.000 | 0.4000 | 0.4001 | -0.03 | 12.102 | 12.099 | 0.03 |
| 2 | 390.000 | 0.4000 | 0.4001 | -0.03 | 12.454 | 12.451 | 0.03 |
| 2 | 400.000 | 0.4000 | 0.4001 | -0.03 | 12.805 | 12.802 | 0.03 |
| 2 | 410.000 | 0.4000 | 0.4001 | -0.02 | 13.156 | 13.153 | 0.02 |
| 2 | 420.000 | 0.4000 | 0.4001 | -0.02 | 13.506 | 13.503 | 0.02 |
| 2 | 430.000 | 0.4000 | 0.4001 | -0.02 | 13.856 | 13.853 | 0.02 |
| 2 | 440.000 | 0.4000 | 0.4001 | -0.02 | 14.205 | 14.203 | 0.02 |
| 2 | 450.000 | 0.4000 | 0.4001 | -0.02 | 14.555 | 14.552 | 0.02 |
| 2 | 460.000 | 0.4000 | 0.4001 | -0.02 | 14.904 | 14.901 | 0.02 |
| 2 | 470.000 | 0.4000 | 0.4001 | -0.02 | 15.252 | 15.250 | 0.02 |
| 2 | 480.000 | 0.4000 | 0.4001 | -0.02 | 15.601 | 15.598 | 0.02 |
| 2 | 490.000 | 0.4000 | 0.4001 | -0.01 | 15.949 | 15.947 | 0.01 |
| 2 | 500.000 | 0.4000 | 0.4001 | -0.01 | 16.297 | 16.295 | 0.01 |
| 2 | 510.000 | 0.4000 | 0.4001 | -0.01 | 16.645 | 16.643 | 0.01 |
| 2 | 520.000 | 0.4000 | 0.4001 | -0.01 | 16.993 | 16.990 | 0.01 |
| 2 | 530.000 | 0.4000 | 0.4001 | -0.01 | 17.340 | 17.338 | 0.01 |
| 2 | 540.000 | 0.4000 | 0.4001 | -0.01 | 17.687 | 17.685 | 0.01 |
| 2 | 550.000 | 0.4000 | 0.4001 | -0.01 | 18.035 | 18.032 | 0.01 |
| 2 | 560.000 | 0.4000 | 0.4001 | -0.01 | 18.382 | 18.379 | 0.01 |
| 2 | 570.000 | 0.4000 | 0.4001 | -0.01 | 18.729 | 18.726 | 0.01 |
| 2 | 580.000 | 0.4000 | 0.4001 | -0.01 | 19.076 | 19.073 | 0.01 |
| 2 | 590.000 | 0.4000 | 0.4001 | -0.02 | 19.423 | 19.420 | 0.02 |
| 2 | 600.000 | 0.4000 | 0.4001 | -0.02 | 19.769 | 19.766 | 0.02 |

NP = 38, DNRMSPCT = 0.035, PMEANPCT = 0.028

Table 12. Experimental and calculated P-ρ-T data- - - (Continued)

EQUATION OF STATE VS. PVT DATA

| ID | T,K | MOL/L | CALCD | D,PCT | P,BAR | CALCD | P,PCT |
|---|---|---|---|---|---|---|---|
| 8 | 310.928 | 3.5245 | 3.5650 | -1.15 | 48.263 | 48.071 | 0.40 |
| 8 | 310.928 | 4.5021 | 4.5925 | -2.01 | 51.711 | 51.498 | 0.41 |
| 8 | 310.928 | 5.5178 | 5.6358 | -2.14 | 53.434 | 53.287 | 0.28 |
| 8 | 310.928 | 7.2697 | 7.2407 | 0.40 | 55.158 | 55.192 | -0.06 |
| 8 | 310.928 | 8.3632 | 8.1814 | 2.17 | 56.537 | 56.923 | -0.68 |
| 8 | 310.928 | 8.8480 | 8.7333 | 1.30 | 57.916 | 58.294 | -0.65 |
| 8 | 310.928 | 9.1894 | 9.1054 | 0.91 | 59.295 | 59.673 | -0.64 |
| 8 | 310.928 | 9.4447 | 9.3856 | 0.63 | 60.674 | 61.010 | -0.55 |
| 8 | 310.928 | 9.6593 | 9.6110 | 0.50 | 62.053 | 62.385 | -0.54 |
| 8 | 310.928 | 9.8423 | 9.8000 | 0.43 | 63.432 | 63.771 | -0.54 |
| 8 | 310.928 | 9.9921 | 9.9633 | 0.29 | 64.811 | 65.074 | -0.41 |
| 8 | 310.928 | 10.1321 | 10.1072 | 0.25 | 66.190 | 66.444 | -0.38 |
| 8 | 310.928 | 10.2579 | 10.2362 | 0.21 | 67.569 | 67.815 | -0.36 |
| 8 | 344.261 | 4.9251 | 4.9626 | -0.76 | 75.842 | 75.550 | 0.39 |
| 8 | 344.261 | 5.8407 | 5.8663 | -0.44 | 82.737 | 82.542 | 0.24 |
| 8 | 344.261 | 6.7517 | 6.7335 | 0.27 | 89.632 | 89.785 | -0.17 |
| 8 | 344.261 | 7.5579 | 7.5011 | 0.75 | 96.527 | 97.080 | -0.57 |
| 8 | 344.261 | 8.2287 | 8.1557 | 0.89 | 103.421 | 104.275 | -0.83 |
| 8 | 344.261 | 8.7434 | 8.6989 | 0.51 | 110.316 | 110.943 | -0.57 |
| 8 | 344.261 | 9.1754 | 9.1501 | 0.28 | 117.211 | 117.636 | -0.36 |
| 8 | 344.261 | 9.5504 | 9.5302 | 0.21 | 124.106 | 124.503 | -0.32 |
| 8 | 344.261 | 9.8679 | 9.8559 | 0.12 | 131.000 | 131.275 | -0.21 |
| 8 | 310.928 | 0.5889 | 0.5911 | -0.36 | 13.790 | 13.745 | 0.32 |
| 8 | 344.261 | 0.5165 | 0.5173 | -0.16 | 13.790 | 13.769 | 0.15 |
| 8 | 377.594 | 0.4620 | 0.4623 | -0.07 | 13.790 | 13.780 | 0.07 |
| 8 | 410.928 | 0.4189 | 0.4190 | -0.04 | 13.790 | 13.785 | 0.04 |
| 8 | 444.261 | 0.3838 | 0.3839 | -0.03 | 13.790 | 13.785 | 0.03 |
| 8 | 477.594 | 0.3544 | 0.3546 | -0.04 | 13.790 | 13.784 | 0.04 |
| 8 | 510.928 | 0.3295 | 0.3297 | -0.07 | 13.790 | 13.780 | 0.07 |
| 8 | 310.928 | 1.3468 | 1.3519 | -0.38 | 27.579 | 27.500 | 0.29 |
| 8 | 344.261 | 1.1212 | 1.1222 | -0.09 | 27.579 | 27.558 | 0.08 |
| 8 | 377.594 | 0.9762 | 0.9762 | -0.00 | 27.579 | 27.578 | 0.00 |
| 8 | 410.928 | 0.8711 | 0.8708 | 0.03 | 27.579 | 27.587 | -0.03 |
| 8 | 444.261 | 0.7892 | 0.7893 | -0.02 | 27.579 | 27.574 | 0.02 |
| 8 | 477.594 | 0.7233 | 0.7238 | -0.06 | 27.579 | 27.563 | 0.06 |
| 8 | 510.928 | 0.6684 | 0.6694 | -0.15 | 27.579 | 27.540 | 0.14 |
| 8 | 310.928 | 2.4961 | 2.5158 | -0.79 | 41.369 | 41.196 | 0.42 |
| 8 | 344.261 | 1.8567 | 1.8601 | -0.18 | 41.369 | 41.312 | 0.14 |
| 8 | 377.594 | 1.5546 | 1.5549 | -0.02 | 41.369 | 41.363 | 0.01 |
| 8 | 410.928 | 1.3605 | 1.3589 | 0.12 | 41.369 | 41.411 | -0.10 |
| 8 | 444.261 | 1.2172 | 1.2168 | 0.03 | 41.369 | 41.382 | -0.03 |
| 8 | 477.594 | 1.1066 | 1.1068 | -0.01 | 41.369 | 41.364 | 0.01 |
| 8 | 510.928 | 1.0165 | 1.0180 | -0.14 | 41.369 | 41.312 | 0.14 |
| 8 | 310.928 | 7.2697 | 7.2407 | 0.40 | 55.158 | 55.192 | -0.06 |
| 8 | 344.261 | 2.8018 | 2.8142 | -0.44 | 55.158 | 55.002 | 0.28 |
| 8 | 377.594 | 2.2130 | 2.2174 | -0.20 | 55.158 | 55.074 | 0.15 |
| 8 | 410.928 | 1.8902 | 1.8895 | 0.04 | 55.158 | 55.175 | -0.03 |
| 8 | 444.261 | 1.6685 | 1.6684 | 0.00 | 55.158 | 55.159 | -0.00 |
| 8 | 477.594 | 1.5040 | 1.5043 | -0.03 | 55.158 | 55.145 | 0.02 |
| 8 | 510.928 | 1.3733 | 1.3755 | -0.16 | 55.158 | 55.073 | 0.15 |
| 8 | 310.928 | 10.3736 | 10.3532 | 0.20 | 68.948 | 69.201 | -0.37 |
| 8 | 344.261 | 4.0959 | 4.1261 | -0.74 | 68.948 | 68.679 | 0.39 |

EQUATION OF STATE VS. PVT DATA

| ID | T,K | MOL/L | CALCD | D,PCT | P,BAR | CALCD | P,PCT |
|---|---|---|---|---|---|---|---|
| 8 | 377.594 | 2.9702 | 2.9796 | -0.32 | 68.948 | 68.789 | 0.23 |
| 8 | 410.928 | 2.4628 | 2.4656 | -0.12 | 68.948 | 68.882 | 0.09 |
| 8 | 444.261 | 2.1426 | 2.1447 | -0.10 | 68.948 | 68.887 | 0.09 |
| 8 | 477.594 | 1.9142 | 1.9163 | -0.11 | 68.948 | 68.876 | 0.10 |
| 8 | 510.928 | 1.7377 | 1.7417 | -0.23 | 68.948 | 68.798 | 0.22 |
| 8 | 310.928 | 11.2820 | 11.3103 | -0.25 | 86.184 | 85.486 | 0.81 |
| 8 | 344.261 | 6.3137 | 6.3109 | 0.05 | 86.184 | 86.207 | -0.03 |
| 8 | 377.594 | 4.0652 | 4.0858 | -0.51 | 86.184 | 85.885 | 0.35 |
| 8 | 410.928 | 3.2373 | 3.2474 | -0.31 | 86.184 | 85.970 | 0.25 |
| 8 | 444.261 | 2.7645 | 2.7714 | -0.25 | 86.184 | 86.001 | 0.21 |
| 8 | 477.594 | 2.4431 | 2.4490 | -0.24 | 86.184 | 85.996 | 0.22 |
| 8 | 510.928 | 2.2028 | 2.2099 | -0.32 | 86.184 | 85.925 | 0.30 |
| 8 | 310.928 | 11.8116 | 11.8807 | -0.59 | 103.421 | 100.977 | 2.36 |
| 8 | 344.261 | 8.2287 | 8.1557 | 0.89 | 103.421 | 104.275 | -0.83 |
| 8 | 377.594 | 5.2776 | 5.3106 | -0.63 | 103.421 | 102.959 | 0.45 |
| 8 | 410.928 | 4.0686 | 4.0863 | -0.43 | 103.421 | 103.067 | 0.34 |
| 8 | 444.261 | 3.4145 | 3.4256 | -0.33 | 103.421 | 103.133 | 0.28 |
| 8 | 477.594 | 2.9861 | 2.9963 | -0.34 | 103.421 | 103.105 | 0.31 |
| 8 | 510.928 | 2.6754 | 2.6862 | -0.41 | 103.421 | 103.031 | 0.38 |
| 8 | 310.928 | 12.2182 | 12.2988 | -0.66 | 120.658 | 116.984 | 3.05 |
| 8 | 344.261 | 9.3676 | 9.3479 | 0.21 | 120.658 | 121.018 | -0.30 |
| 8 | 377.594 | 6.4713 | 6.4858 | -0.22 | 120.658 | 120.431 | 0.19 |
| 8 | 410.928 | 4.9220 | 4.9488 | -0.54 | 120.658 | 120.119 | 0.45 |
| 8 | 444.261 | 4.0781 | 4.0962 | -0.44 | 120.658 | 120.194 | 0.38 |
| 8 | 477.594 | 3.5369 | 3.5520 | -0.43 | 120.658 | 120.193 | 0.39 |
| 8 | 510.928 | 3.1538 | 3.1664 | -0.40 | 120.658 | 120.207 | 0.37 |
| 8 | 310.928 | 12.5479 | 12.6333 | -0.68 | 137.895 | 133.171 | 3.43 |
| 8 | 344.261 | 10.1360 | 10.1396 | -0.04 | 137.895 | 137.802 | 0.07 |
| 8 | 377.594 | 7.5147 | 7.4975 | 0.23 | 137.895 | 138.216 | -0.23 |
| 8 | 410.928 | 5.7575 | 5.7831 | -0.44 | 137.895 | 137.349 | 0.40 |
| 8 | 444.261 | 4.7394 | 4.7654 | -0.55 | 137.895 | 137.217 | 0.49 |
| 8 | 477.594 | 4.0884 | 4.1085 | -0.49 | 137.895 | 137.268 | 0.45 |
| 8 | 510.928 | 3.6322 | 3.6462 | -0.39 | 137.895 | 137.389 | 0.37 |
| 8 | 310.928 | 12.8333 | 12.9143 | -0.63 | 155.132 | 149.886 | 3.38 |
| 8 | 344.261 | 10.6669 | 10.7182 | -0.48 | 155.132 | 153.407 | 1.11 |
| 8 | 377.594 | 8.3540 | 8.3367 | 0.21 | 155.132 | 155.527 | -0.25 |
| 8 | 410.928 | 6.5294 | 6.5505 | -0.32 | 155.132 | 154.632 | 0.32 |
| 8 | 444.261 | 5.3796 | 5.4124 | -0.61 | 155.132 | 154.236 | 0.58 |
| 8 | 477.594 | 4.6299 | 4.6564 | -0.57 | 155.132 | 154.288 | 0.54 |
| 8 | 510.928 | 4.1041 | 4.1210 | -0.41 | 155.132 | 154.516 | 0.40 |
| 8 | 310.928 | 13.0738 | 13.1579 | -0.64 | 172.369 | 166.162 | 3.60 |
| 8 | 344.261 | 11.0985 | 11.1720 | -0.66 | 172.369 | 169.320 | 1.77 |
| 8 | 377.594 | 9.0258 | 9.0201 | 0.06 | 172.369 | 172.531 | -0.09 |
| 8 | 410.928 | 7.2289 | 7.2381 | -0.13 | 172.369 | 172.124 | 0.14 |
| 8 | 444.261 | 5.9919 | 6.0219 | -0.50 | 172.369 | 171.493 | 0.51 |
| 8 | 477.594 | 5.1560 | 5.1860 | -0.58 | 172.369 | 171.370 | 0.58 |
| 8 | 510.928 | 4.5658 | 4.5853 | -0.43 | 172.369 | 171.633 | 0.43 |
| 8 | 310.928 | 13.2869 | 13.3736 | -0.65 | 189.606 | 182.447 | 3.78 |
| 8 | 344.261 | 11.4646 | 11.5453 | -0.70 | 189.606 | 185.617 | 2.10 |
| 8 | 377.594 | 9.5652 | 9.5810 | -0.17 | 189.606 | 189.074 | 0.28 |
| 8 | 410.928 | 7.8461 | 7.8502 | -0.05 | 189.606 | 189.482 | 0.07 |
| 8 | 444.261 | 6.5583 | 6.5860 | -0.42 | 189.606 | 188.723 | 0.47 |
| 8 | 477.594 | 5.6568 | 5.6902 | -0.59 | 189.606 | 188.432 | 0.62 |

Table 12. Experimental and calculated P-ρ-T data- - - (Continued)

EQUATICN OF STATE VS. PVT DATA

| ID | T,K | MOL/L | CALCD | D,PCT | P,BAR | CALCD | P,PCT |
|---|---|---|---|---|---|---|---|
| 8 | 510.928 | 5.0133 | 5.0344 | -0.42 | 189.606 | 188.781 | 0.43 |
| 8 | 310.928 | 13.4768 | 13.5679 | -0.68 | 206.843 | 198.548 | 4.01 |
| 8 | 344.261 | 11.7810 | 11.8628 | -0.70 | 206.843 | 202.151 | 2.27 |
| 8 | 377.594 | 10.0144 | 10.0500 | -0.35 | 206.843 | 205.433 | 0.68 |
| 8 | 410.928 | 8.3875 | 8.3906 | -0.04 | 206.843 | 206.735 | 0.05 |
| 8 | 444.261 | 7.0812 | 7.1044 | -0.33 | 206.843 | 206.039 | 0.39 |
| 8 | 477.594 | 6.1325 | 6.1653 | -0.53 | 206.843 | 205.617 | 0.59 |
| 8 | 510.928 | 5.4446 | 5.4646 | -0.37 | 206.843 | 206.024 | 0.40 |
| 8 | 310.928 | 13.8169 | 13.9077 | -0.66 | 241.316 | 231.536 | 4.05 |
| 8 | 344.261 | 12.3150 | 12.3850 | -0.57 | 241.316 | 236.205 | 2.12 |
| 8 | 377.594 | 10.7385 | 10.7972 | -0.55 | 241.316 | 238.239 | 1.28 |
| 8 | 410.928 | 9.2546 | 9.2879 | -0.36 | 241.316 | 239.874 | 0.60 |
| 8 | 444.261 | 8.0043 | 8.0164 | -0.15 | 241.316 | 240.816 | 0.21 |
| 8 | 477.594 | 6.9989 | 7.0249 | -0.37 | 241.316 | 240.204 | 0.46 |
| 8 | 510.928 | 6.2432 | 6.2616 | -0.29 | 241.316 | 240.475 | 0.35 |
| 8 | 310.928 | 14.1021 | 14.1998 | -0.69 | 275.790 | 263.723 | 4.38 |
| 8 | 344.261 | 12.7400 | 12.8070 | -0.53 | 275.790 | 269.878 | 2.14 |
| 8 | 377.594 | 11.3044 | 11.3770 | -0.64 | 275.790 | 271.038 | 1.72 |
| 8 | 410.928 | 9.9483 | 9.9983 | -0.50 | 275.790 | 273.107 | 0.97 |
| 8 | 444.261 | 8.7521 | 8.7793 | -0.31 | 275.790 | 274.453 | 0.49 |
| 8 | 477.594 | 7.7541 | 7.7753 | -0.27 | 275.790 | 274.748 | 0.38 |
| 8 | 510.928 | 6.9554 | 6.9734 | -0.26 | 275.790 | 274.871 | 0.33 |
| 8 | 310.928 | 14.3527 | 14.4571 | -0.73 | 310.264 | 295.792 | 4.66 |
| 8 | 344.261 | 13.0835 | 13.1626 | -0.60 | 310.264 | 302.128 | 2.62 |
| 8 | 377.594 | 11.7680 | 11.8495 | -0.69 | 310.264 | 303.853 | 2.07 |
| 8 | 410.928 | 10.5117 | 10.5772 | -0.62 | 310.264 | 306.030 | 1.36 |
| 8 | 444.261 | 9.3799 | 9.4201 | -0.43 | 310.264 | 307.927 | 0.75 |
| 8 | 477.594 | 8.4052 | 8.4289 | -0.28 | 310.264 | 308.925 | 0.43 |
| 8 | 510.928 | 7.5930 | 7.6094 | -0.22 | 310.264 | 309.327 | 0.30 |
| 8 | 310.928 | 14.5677 | 14.6877 | -0.82 | 344.738 | 326.363 | 5.33 |
| 8 | 344.261 | 13.3764 | 13.4709 | -0.71 | 344.738 | 333.679 | 3.21 |
| 8 | 377.594 | 12.1604 | 12.2483 | -0.72 | 344.738 | 336.676 | 2.34 |
| 8 | 410.928 | 10.9866 | 11.0620 | -0.69 | 344.738 | 338.997 | 1.67 |
| 8 | 444.261 | 9.9098 | 9.9651 | -0.56 | 344.738 | 340.987 | 1.09 |
| 8 | 477.594 | 8.9742 | 8.9992 | -0.28 | 344.738 | 343.124 | 0.47 |
| 8 | 510.928 | 8.1552 | 8.1777 | -0.28 | 344.738 | 343.297 | 0.42 |
| 8 | 310.928 | 14.9359 | 15.0894 | -1.03 | 413.685 | 385.936 | 6.71 |
| 8 | 344.261 | 13.8663 | 13.9892 | -0.89 | 413.685 | 395.994 | 4.28 |
| 8 | 377.594 | 12.8094 | 12.8982 | -0.69 | 413.685 | 403.217 | 2.53 |
| 8 | 410.928 | 11.7577 | 11.8412 | -0.71 | 413.685 | 405.383 | 2.01 |
| 8 | 444.261 | 10.7824 | 10.8474 | -0.60 | 413.685 | 407.951 | 1.39 |
| 8 | 477.594 | 9.9049 | 9.9429 | -0.38 | 413.685 | 410.568 | 0.75 |
| 8 | 510.928 | 9.1371 | 9.1425 | -0.06 | 413.685 | 413.258 | 0.10 |
| 8 | 310.928 | 15.2790 | 15.4333 | -1.01 | 482.633 | 450.484 | 6.66 |
| 8 | 344.261 | 14.2981 | 14.4173 | -0.83 | 482.633 | 462.241 | 4.23 |
| 8 | 377.594 | 13.3124 | 13.4189 | -0.80 | 482.633 | 467.419 | 3.15 |
| 8 | 410.928 | 12.3491 | 12.4538 | -0.85 | 482.633 | 469.784 | 2.66 |
| 8 | 444.261 | 11.4576 | 11.5401 | -0.72 | 482.633 | 473.608 | 1.87 |
| 8 | 477.594 | 10.6337 | 10.6943 | -0.57 | 482.633 | 476.512 | 1.27 |
| 8 | 510.928 | 9.8992 | 9.9277 | -0.29 | 482.633 | 479.885 | 0.57 |
| 8 | 310.928 | 15.5877 | 15.7353 | -0.95 | 551.581 | 516.844 | 6.30 |
| 8 | 344.261 | 14.6722 | 14.7839 | -0.76 | 551.581 | 529.535 | 4.00 |
| 8 | 377.594 | 13.7271 | 13.8549 | -0.93 | 551.581 | 530.226 | 3.87 |

Table 12. Experimental and calculated P-ρ-T data- - - (Continued)

EQUATION OF STATE VS. PVT DATA

| ID | T,K | MOL/L | CALCD | D,PCT | P,BAR | CALCD | P,PCT |
|---|---|---|---|---|---|---|---|
| 8 | 410.928 | 12.8373 | 12.9589 | -0.95 | 551.581 | 533.862 | 3.21 |
| 8 | 444.261 | 12.0126 | 12.1079 | -0.79 | 551.581 | 539.119 | 2.26 |
| 8 | 477.594 | 11.2338 | 11.3126 | -0.70 | 551.581 | 542.088 | 1.72 |
| 8 | 510.928 | 10.5290 | 10.5812 | -0.50 | 551.581 | 545.625 | 1.08 |
| 8 | 310.928 | 15.8659 | 16.0055 | -0.88 | 620.528 | 584.001 | 5.89 |
| 8 | 344.261 | 14.9988 | 15.1058 | -0.71 | 620.528 | 596.696 | 3.84 |
| 8 | 377.594 | 14.1021 | 14.2311 | -0.91 | 620.528 | 595.836 | 3.98 |
| 8 | 410.928 | 13.2590 | 13.3892 | -0.98 | 620.528 | 598.584 | 3.54 |
| 8 | 444.261 | 12.4801 | 12.5883 | -0.87 | 620.528 | 604.063 | 2.65 |
| 8 | 477.594 | 11.7416 | 11.8356 | -0.80 | 620.528 | 607.339 | 2.13 |
| 8 | 510.928 | 11.0763 | 11.1369 | -0.55 | 620.528 | 612.496 | 1.29 |
| 8 | 310.928 | 16.1346 | 16.2505 | -0.72 | 689.476 | 656.075 | 4.84 |
| 8 | 344.261 | 15.2747 | 15.3933 | -0.78 | 689.476 | 660.150 | 4.25 |
| 8 | 377.594 | 14.4380 | 14.5628 | -0.86 | 689.476 | 662.597 | 3.90 |
| 8 | 410.928 | 13.6362 | 13.7647 | -0.94 | 689.476 | 664.891 | 3.57 |
| 8 | 444.261 | 12.8838 | 13.0047 | -0.94 | 689.476 | 668.504 | 3.04 |
| 8 | 477.594 | 12.1848 | 12.2880 | -0.85 | 689.476 | 672.912 | 2.40 |
| 8 | 510.928 | 11.5520 | 11.6184 | -0.58 | 689.476 | 679.400 | 1.46 |

NP = 176, DNRMSPCT = 0.605, PMEANPCT = 1.222

Table 12. Experimental and calculated P-ρ-T data- - - (Continued)

EQUATION OF STATE VS. PVT DATA

| ID | T,K | MOL/L | CALCD | D,PCT | P,BAR | CALCD | P,PCT |
|---|---|---|---|---|---|---|---|
| 9 | 273.150 | 0.8538 | 0.8552 | -0.16 | 15.874 | 15.854 | 0.13 |
| 9 | 298.142 | 0.8538 | 0.8545 | -0.08 | 17.978 | 17.967 | 0.06 |
| 9 | 323.140 | 0.8538 | 0.8540 | -0.02 | 20.036 | 20.032 | 0.02 |
| 9 | 348.143 | 0.8538 | 0.8538 | 0.00 | 22.065 | 22.065 | -0.00 |
| 9 | 373.150 | 0.8538 | 0.8535 | 0.04 | 24.066 | 24.075 | -0.04 |
| 9 | 398.160 | 0.8538 | 0.8533 | 0.06 | 26.053 | 26.067 | -0.06 |
| 9 | 423.170 | 0.8538 | 0.8533 | 0.06 | 28.031 | 28.046 | -0.06 |
| 9 | 273.150 | 1.0672 | 1.0686 | -0.13 | 18.802 | 18.784 | 0.10 |
| 9 | 298.142 | 1.0672 | 1.0675 | -0.03 | 21.539 | 21.534 | 0.02 |
| 9 | 323.140 | 1.0672 | 1.0669 | 0.03 | 24.201 | 24.206 | -0.02 |
| 9 | 348.143 | 1.0672 | 1.0665 | 0.06 | 26.812 | 26.826 | -0.05 |
| 9 | 373.150 | 1.0672 | 1.0662 | 0.10 | 29.385 | 29.410 | -0.08 |
| 9 | 398.160 | 1.0672 | 1.0660 | 0.12 | 31.933 | 31.967 | -0.11 |
| 9 | 423.170 | 1.0672 | 1.0661 | 0.11 | 34.468 | 34.502 | -0.10 |
| 9 | 273.150 | 1.2812 | 1.2828 | -0.13 | 21.349 | 21.331 | 0.08 |
| 9 | 298.142 | 1.2812 | 1.2815 | -0.03 | 24.769 | 24.764 | 0.02 |
| 9 | 323.140 | 1.2812 | 1.2805 | 0.05 | 28.067 | 28.079 | -0.04 |
| 9 | 348.143 | 1.2812 | 1.2800 | 0.09 | 31.294 | 31.318 | -0.08 |
| 9 | 373.150 | 1.2812 | 1.2794 | 0.13 | 34.465 | 34.504 | -0.12 |
| 9 | 398.160 | 1.2812 | 1.2791 | 0.16 | 37.599 | 37.652 | -0.14 |
| 9 | 423.170 | 1.2812 | 1.2792 | 0.15 | 40.713 | 40.770 | -0.14 |
| 9 | 273.150 | 1.4870 | 1.4888 | -0.12 | 23.441 | 23.424 | 0.07 |
| 9 | 298.142 | 1.4870 | 1.4876 | -0.04 | 27.563 | 27.555 | 0.03 |
| 9 | 323.140 | 1.4870 | 1.4862 | 0.05 | 31.508 | 31.520 | -0.04 |
| 9 | 348.143 | 1.4870 | 1.4856 | 0.09 | 35.354 | 35.381 | -0.08 |
| 9 | 373.150 | 1.4870 | 1.4848 | 0.14 | 39.125 | 39.173 | -0.12 |
| 9 | 398.160 | 1.4870 | 1.4844 | 0.17 | 42.848 | 42.912 | -0.15 |
| 9 | 423.170 | 1.4870 | 1.4845 | 0.17 | 46.543 | 46.612 | -0.15 |
| 9 | 298.142 | 1.6354 | 1.6366 | -0.07 | 29.397 | 29.384 | 0.05 |
| 9 | 323.140 | 1.6354 | 1.6351 | 0.02 | 33.830 | 33.836 | -0.02 |
| 9 | 348.143 | 1.6354 | 1.6343 | 0.07 | 38.142 | 38.163 | -0.06 |
| 9 | 373.150 | 1.6354 | 1.6333 | 0.13 | 42.360 | 42.405 | -0.11 |
| 9 | 398.160 | 1.6354 | 1.6328 | 0.16 | 46.520 | 46.585 | -0.14 |
| 9 | 423.170 | 1.6354 | 1.6328 | 0.16 | 50.647 | 50.719 | -0.14 |
| 9 | 298.142 | 1.7032 | 1.7050 | -0.11 | 30.189 | 30.169 | 0.07 |
| 9 | 323.140 | 1.7032 | 1.7031 | 0.01 | 34.846 | 34.848 | -0.01 |
| 9 | 348.143 | 1.7032 | 1.7021 | 0.07 | 39.371 | 39.392 | -0.05 |
| 9 | 373.150 | 1.7032 | 1.7010 | 0.13 | 43.798 | 43.844 | -0.10 |
| 9 | 398.160 | 1.7032 | 1.7004 | 0.17 | 48.161 | 48.229 | -0.14 |
| 9 | 423.170 | 1.7032 | 1.7005 | 0.16 | 52.490 | 52.564 | -0.14 |
| 9 | 298.142 | 1.9165 | 1.9202 | -0.19 | 32.483 | 32.446 | 0.11 |
| 9 | 323.140 | 1.9165 | 1.9174 | -0.05 | 37.873 | 37.861 | 0.03 |
| 9 | 348.143 | 1.9165 | 1.9159 | 0.03 | 43.093 | 43.104 | -0.02 |
| 9 | 373.150 | 1.9165 | 1.9145 | 0.10 | 48.192 | 48.232 | -0.08 |
| 9 | 398.160 | 1.9165 | 1.9137 | 0.14 | 53.214 | 53.278 | -0.12 |
| 9 | 423.170 | 1.9165 | 1.9138 | 0.14 | 58.192 | 58.262 | -0.12 |
| 9 | 298.142 | 1.9754 | 1.9793 | -0.20 | 33.063 | 33.025 | 0.11 |
| 9 | 323.140 | 1.9754 | 1.9767 | -0.06 | 38.665 | 38.648 | 0.04 |
| 9 | 348.143 | 1.9754 | 1.9751 | 0.01 | 44.084 | 44.088 | -0.01 |
| 9 | 373.150 | 1.9754 | 1.9739 | 0.08 | 49.378 | 49.407 | -0.06 |
| 9 | 398.160 | 1.9754 | 1.9728 | 0.13 | 54.581 | 54.640 | -0.11 |
| 9 | 423.170 | 1.9754 | 1.9728 | 0.13 | 59.738 | 59.807 | -0.12 |

EQUATION OF STATE VS. PVT DATA

| ID | T,K | MOL/L | CALCD | D,PCT | P,BAR | CALCD | P,PCT |
|---|---|---|---|---|---|---|---|
| 9 | 298.142 | 2.1218 | 2.1279 | -0.29 | 34.428 | 34.374 | 0.16 |
| 9 | 323.140 | 2.1218 | 2.1243 | -0.12 | 40.556 | 40.524 | 0.08 |
| 9 | 348.143 | 2.1218 | 2.1222 | -0.02 | 46.470 | 46.463 | 0.02 |
| 9 | 373.150 | 2.1218 | 2.1204 | 0.06 | 52.238 | 52.264 | -0.05 |
| 9 | 398.160 | 2.1218 | 2.1194 | 0.11 | 57.913 | 57.967 | -0.09 |
| 9 | 423.170 | 2.1218 | 2.1195 | 0.11 | 63.538 | 63.596 | -0.09 |
| 9 | 298.142 | 2.3339 | 2.3428 | -0.38 | 36.183 | 36.115 | 0.19 |
| 9 | 323.140 | 2.3339 | 2.3383 | -0.19 | 43.101 | 43.052 | 0.12 |
| 9 | 348.143 | 2.3339 | 2.3356 | -0.07 | 49.758 | 49.732 | 0.05 |
| 9 | 373.150 | 2.3339 | 2.3334 | 0.02 | 56.240 | 56.251 | -0.02 |
| 9 | 398.160 | 2.3339 | 2.3321 | 0.08 | 62.614 | 62.655 | -0.06 |
| 9 | 423.170 | 2.3339 | 2.3319 | 0.09 | 68.922 | 68.972 | -0.07 |
| 9 | 298.142 | 2.4084 | 2.4175 | -0.38 | 36.734 | 36.668 | 0.18 |
| 9 | 323.140 | 2.4084 | 2.4130 | -0.19 | 43.938 | 43.887 | 0.12 |
| 9 | 348.143 | 2.4084 | 2.4103 | -0.08 | 50.862 | 50.834 | 0.06 |
| 9 | 373.150 | 2.4084 | 2.4081 | 0.01 | 57.603 | 57.609 | -0.01 |
| 9 | 398.160 | 2.4084 | 2.4066 | 0.08 | 64.224 | 64.263 | -0.06 |
| 9 | 423.170 | 2.4084 | 2.4063 | 0.09 | 70.776 | 70.828 | -0.07 |
| 9 | 298.142 | 2.9393 | 2.9535 | -0.48 | 39.901 | 39.833 | 0.17 |
| 9 | 323.140 | 2.9393 | 2.9485 | -0.31 | 49.228 | 49.148 | 0.16 |
| 9 | 348.143 | 2.9393 | 2.9443 | -0.17 | 58.126 | 58.062 | 0.11 |
| 9 | 373.150 | 2.9393 | 2.9410 | -0.06 | 66.768 | 66.742 | 0.04 |
| 9 | 398.160 | 2.9393 | 2.9390 | 0.01 | 75.253 | 75.260 | -0.01 |
| 9 | 423.170 | 2.9393 | 2.9385 | 0.03 | 83.640 | 83.659 | -0.02 |
| 9 | 323.140 | 3.5820 | 3.5966 | -0.41 | 54.204 | 54.107 | 0.18 |
| 9 | 348.143 | 3.5820 | 3.5907 | -0.24 | 65.647 | 65.553 | 0.14 |
| 9 | 373.150 | 3.5820 | 3.5867 | -0.13 | 76.769 | 76.700 | 0.09 |
| 9 | 398.160 | 3.5820 | 3.5841 | -0.06 | 87.686 | 87.646 | 0.04 |
| 9 | 423.170 | 3.5820 | 3.5836 | -0.04 | 98.481 | 98.446 | 0.04 |
| 9 | 323.140 | 4.4288 | 4.4544 | -0.58 | 58.974 | 58.854 | 0.20 |
| 9 | 348.143 | 4.4288 | 4.4450 | -0.37 | 74.001 | 73.854 | 0.20 |
| 9 | 373.150 | 4.4288 | 4.4392 | -0.24 | 88.656 | 88.516 | 0.16 |
| 9 | 398.160 | 4.4288 | 4.4367 | -0.18 | 103.099 | 102.959 | 0.14 |
| 9 | 423.170 | 4.4288 | 4.4361 | -0.17 | 117.402 | 117.240 | 0.14 |
| 9 | 323.140 | 5.4403 | 5.4572 | -0.31 | 62.995 | 62.935 | 0.10 |
| 9 | 348.143 | 5.4403 | 5.4494 | -0.17 | 82.596 | 82.521 | 0.09 |
| 9 | 373.150 | 5.4403 | 5.4478 | -0.14 | 101.932 | 101.833 | 0.10 |
| 9 | 398.160 | 5.4403 | 5.4476 | -0.13 | 121.098 | 120.966 | 0.11 |
| 9 | 423.170 | 5.4403 | 5.4492 | -0.16 | 140.168 | 139.962 | 0.15 |
| 9 | 323.140 | 6.6818 | 6.5878 | 1.41 | 66.912 | 67.250 | -0.51 |
| 9 | 348.143 | 6.6818 | 6.6341 | 0.71 | 92.790 | 93.230 | -0.47 |
| 9 | 373.150 | 6.6818 | 6.6551 | 0.40 | 118.770 | 119.173 | -0.34 |
| 9 | 398.160 | 6.6818 | 6.6654 | 0.25 | 144.726 | 145.073 | -0.24 |
| 9 | 423.170 | 6.6818 | 6.6739 | 0.12 | 170.709 | 170.924 | -0.13 |
| 9 | 323.140 | 8.2024 | 8.0128 | 2.31 | 72.785 | 73.780 | -1.37 |
| 9 | 348.143 | 8.2024 | 8.1079 | 1.15 | 108.346 | 109.548 | -1.11 |
| 9 | 373.150 | 8.2024 | 8.1498 | 0.64 | 144.605 | 145.681 | -0.74 |
| 9 | 398.160 | 8.2024 | 8.1707 | 0.39 | 181.105 | 182.004 | -0.50 |
| 9 | 423.170 | 8.2024 | 8.1813 | 0.26 | 217.659 | 218.423 | -0.35 |

NP = 101, DNRMSPCT = 0.353, PMEANPCT = 0.135

EQUATION OF STATE VS. PVT DATA

| ID | T,K | MOL/L | CALCD | D,PCT | P,BAR | CALCD | P,PCT |
|---|---|---|---|---|---|---|---|
| 10 | 248.150 | 0.7000 | 0.6999 | 0.02 | 11.763 | 11.764 | -0.01 |
| 10 | 273.150 | 0.7500 | 0.7508 | -0.11 | 14.298 | 14.285 | 0.09 |
| 10 | 298.150 | 0.7500 | 0.7506 | -0.08 | 16.116 | 16.105 | 0.07 |
| 10 | 303.150 | 0.7500 | 0.7506 | -0.08 | 16.475 | 16.464 | 0.07 |
| 10 | 323.150 | 0.7500 | 0.7504 | -0.06 | 17.897 | 17.888 | 0.05 |
| 10 | 348.150 | 0.7500 | 0.7503 | -0.03 | 19.652 | 19.646 | 0.03 |
| 10 | 373.150 | 0.7500 | 0.7502 | -0.02 | 21.391 | 21.386 | 0.02 |
| 10 | 398.150 | 0.7500 | 0.7501 | -0.01 | 23.116 | 23.113 | 0.01 |
| 10 | 423.150 | 0.7500 | 0.7500 | -0.00 | 24.830 | 24.829 | 0.00 |
| 10 | 448.150 | 0.7500 | 0.7500 | -0.00 | 26.538 | 26.537 | 0.00 |
| 10 | 473.150 | 0.7500 | 0.7500 | -0.00 | 28.239 | 28.238 | 0.00 |
| 10 | 498.150 | 0.7500 | 0.7500 | 0.00 | 29.934 | 29.934 | -0.00 |
| 10 | 523.150 | 0.7500 | 0.7500 | -0.00 | 31.627 | 31.626 | 0.00 |
| 10 | 548.150 | 0.7500 | 0.7501 | -0.01 | 33.315 | 33.313 | 0.01 |
| 10 | 573.150 | 0.7500 | 0.7501 | -0.02 | 35.003 | 34.997 | 0.02 |
| 10 | 598.150 | 0.7500 | 0.7502 | -0.03 | 36.689 | 36.678 | 0.03 |
| 10 | 623.150 | 0.7500 | 0.7504 | -0.05 | 38.375 | 38.357 | 0.05 |
| 10 | 273.150 | 1.0000 | 1.0003 | -0.03 | 17.908 | 17.903 | 0.02 |
| 10 | 298.150 | 1.0000 | 1.0000 | -0.00 | 20.450 | 20.449 | 0.00 |
| 10 | 303.150 | 1.0000 | 0.9999 | 0.01 | 20.948 | 20.949 | -0.01 |
| 10 | 323.150 | 1.0000 | 0.9996 | 0.04 | 22.919 | 22.926 | -0.03 |
| 10 | 348.150 | 1.0000 | 0.9994 | 0.06 | 25.344 | 25.358 | -0.05 |
| 10 | 373.150 | 1.0000 | 0.9992 | 0.08 | 27.738 | 27.757 | -0.07 |
| 10 | 398.150 | 1.0000 | 0.9991 | 0.09 | 30.109 | 30.133 | -0.08 |
| 10 | 423.150 | 1.0000 | 0.9991 | 0.09 | 32.462 | 32.489 | -0.09 |
| 10 | 448.150 | 1.0000 | 0.9991 | 0.09 | 34.802 | 34.832 | -0.09 |
| 10 | 473.150 | 1.0000 | 0.9991 | 0.09 | 37.130 | 37.162 | -0.09 |
| 10 | 498.150 | 1.0000 | 0.9991 | 0.09 | 39.450 | 39.483 | -0.08 |
| 10 | 523.150 | 1.0000 | 0.9992 | 0.08 | 41.763 | 41.796 | -0.08 |
| 10 | 548.150 | 1.0000 | 0.9993 | 0.07 | 44.071 | 44.102 | -0.07 |
| 10 | 573.150 | 1.0000 | 0.9994 | 0.06 | 46.375 | 46.402 | -0.06 |
| 10 | 598.150 | 1.0000 | 0.9995 | 0.05 | 48.675 | 48.697 | -0.05 |
| 10 | 623.150 | 1.0000 | 0.9999 | 0.01 | 50.982 | 50.988 | -0.01 |
| 10 | 273.150 | 1.5000 | 1.4984 | 0.11 | 23.530 | 23.545 | -0.06 |
| 10 | 298.150 | 1.5000 | 1.4997 | 0.02 | 27.719 | 27.723 | -0.01 |
| 10 | 303.150 | 1.5000 | 1.4994 | 0.04 | 28.528 | 28.535 | -0.03 |
| 10 | 323.150 | 1.5000 | 1.4987 | 0.09 | 31.709 | 31.730 | -0.07 |
| 10 | 348.150 | 1.5000 | 1.4979 | 0.14 | 35.592 | 35.632 | -0.11 |
| 10 | 373.150 | 1.5000 | 1.4975 | 0.16 | 39.407 | 39.461 | -0.14 |
| 10 | 398.150 | 1.5000 | 1.4974 | 0.17 | 43.172 | 43.237 | -0.15 |
| 10 | 423.150 | 1.5000 | 1.4973 | 0.18 | 46.899 | 46.973 | -0.16 |
| 10 | 448.150 | 1.5000 | 1.4975 | 0.17 | 50.600 | 50.678 | -0.15 |
| 10 | 473.150 | 1.5000 | 1.4975 | 0.16 | 54.276 | 54.358 | -0.15 |
| 10 | 498.150 | 1.5000 | 1.4977 | 0.15 | 57.934 | 58.017 | -0.14 |
| 10 | 523.150 | 1.5000 | 1.4979 | 0.14 | 61.578 | 61.659 | -0.13 |
| 10 | 548.150 | 1.5000 | 1.4983 | 0.11 | 65.215 | 65.287 | -0.11 |
| 10 | 573.150 | 1.5000 | 1.4983 | 0.11 | 68.827 | 68.902 | -0.11 |
| 10 | 598.150 | 1.5000 | 1.4987 | 0.09 | 72.443 | 72.506 | -0.09 |
| 10 | 623.150 | 1.5000 | 1.4993 | 0.05 | 76.067 | 76.101 | -0.05 |
| 10 | 298.150 | 2.0000 | 2.0027 | -0.14 | 33.289 | 33.263 | 0.08 |
| 10 | 303.150 | 2.0000 | 2.0023 | -0.12 | 34.448 | 34.425 | 0.07 |
| 10 | 323.150 | 2.0000 | 2.0003 | -0.02 | 38.978 | 38.974 | 0.01 |

EQUATION OF STATE VS. PVT DATA

| ID | T,K | MOL/L | CALCD | D,PCT | P,BAR | CALCD | P,PCT |
|---|---|---|---|---|---|---|---|
| 10 | 348.150 | 2.0000 | 1.9986 | 0.07 | 44.474 | 44.496 | -0.05 |
| 10 | 373.150 | 2.0000 | 1.9978 | 0.11 | 49.850 | 49.894 | -0.09 |
| 10 | 398.150 | 2.0000 | 1.9972 | 0.14 | 55.139 | 55.203 | -0.12 |
| 10 | 423.150 | 2.0000 | 1.9969 | 0.15 | 60.365 | 60.445 | -0.13 |
| 10 | 448.150 | 2.0000 | 1.9971 | 0.15 | 65.550 | 65.635 | -0.13 |
| 10 | 473.150 | 2.0000 | 1.9973 | 0.13 | 70.697 | 70.783 | -0.12 |
| 10 | 498.150 | 2.0000 | 1.9975 | 0.13 | 75.809 | 75.898 | -0.12 |
| 10 | 523.150 | 2.0000 | 1.9977 | 0.11 | 80.898 | 80.984 | -0.11 |
| 10 | 548.150 | 2.0000 | 1.9979 | 0.11 | 85.959 | 86.047 | -0.10 |
| 10 | 573.150 | 2.0000 | 1.9982 | 0.09 | 91.008 | 91.089 | -0.09 |
| 10 | 598.150 | 2.0000 | 1.9987 | 0.06 | 96.054 | 96.114 | -0.06 |
| 10 | 623.150 | 2.0000 | 1.9997 | 0.02 | 101.105 | 101.123 | -0.02 |
| 10 | 298.150 | 2.5000 | 2.5084 | -0.33 | 37.369 | 37.313 | 0.15 |
| 10 | 303.150 | 2.5000 | 2.5077 | -0.31 | 38.918 | 38.860 | 0.15 |
| 10 | 323.150 | 2.5000 | 2.5042 | -0.17 | 44.928 | 44.883 | 0.10 |
| 10 | 348.150 | 2.5000 | 2.5007 | -0.03 | 52.169 | 52.159 | 0.02 |
| 10 | 373.150 | 2.5000 | 2.4989 | 0.04 | 59.233 | 59.252 | -0.03 |
| 10 | 398.150 | 2.5000 | 2.4981 | 0.07 | 66.177 | 66.216 | -0.06 |
| 10 | 423.150 | 2.5000 | 2.4977 | 0.09 | 73.029 | 73.085 | -0.08 |
| 10 | 448.150 | 2.5000 | 2.4978 | 0.09 | 79.818 | 79.880 | -0.08 |
| 10 | 473.150 | 2.5000 | 2.4977 | 0.09 | 86.544 | 86.616 | -0.08 |
| 10 | 498.150 | 2.5000 | 2.4979 | 0.09 | 93.231 | 93.305 | -0.08 |
| 10 | 523.150 | 2.5000 | 2.4984 | 0.06 | 99.892 | 99.953 | -0.06 |
| 10 | 548.150 | 2.5000 | 2.4989 | 0.04 | 106.522 | 106.568 | -0.04 |
| 10 | 573.150 | 2.5000 | 2.4993 | 0.03 | 113.120 | 113.153 | -0.03 |
| 10 | 598.150 | 2.5000 | 2.4998 | 0.01 | 119.704 | 119.713 | -0.01 |
| 10 | 623.150 | 2.5000 | 2.5013 | -0.05 | 126.314 | 126.251 | 0.05 |
| 10 | 298.150 | 3.0000 | 3.0121 | -0.40 | 40.172 | 40.118 | 0.13 |
| 10 | 303.150 | 3.0000 | 3.0125 | -0.42 | 42.149 | 42.082 | 0.16 |
| 10 | 323.150 | 3.0000 | 3.0080 | -0.27 | 49.750 | 49.681 | 0.14 |
| 10 | 348.150 | 3.0000 | 3.0029 | -0.10 | 58.862 | 58.826 | 0.06 |
| 10 | 373.150 | 3.0000 | 3.0002 | -0.01 | 67.732 | 67.729 | 0.00 |
| 10 | 398.150 | 3.0000 | 2.9992 | 0.03 | 76.450 | 76.465 | -0.02 |
| 10 | 423.150 | 3.0000 | 2.9983 | 0.06 | 85.039 | 85.079 | -0.05 |
| 10 | 448.150 | 3.0000 | 2.9986 | 0.05 | 93.560 | 93.599 | -0.04 |
| 10 | 473.150 | 3.0000 | 2.9988 | 0.04 | 102.007 | 102.044 | -0.04 |
| 10 | 498.150 | 3.0000 | 2.9990 | 0.03 | 110.392 | 110.427 | -0.03 |
| 10 | 523.150 | 3.0000 | 2.9995 | 0.02 | 118.741 | 118.759 | -0.02 |
| 10 | 548.150 | 3.0000 | 3.0002 | -0.01 | 127.056 | 127.048 | 0.01 |
| 10 | 573.150 | 3.0000 | 3.0007 | -0.02 | 135.329 | 135.299 | 0.02 |
| 10 | 598.150 | 3.0000 | 3.0016 | -0.05 | 143.594 | 143.517 | 0.05 |
| 10 | 623.150 | 3.0000 | 3.0034 | -0.11 | 151.881 | 151.705 | 0.12 |
| 10 | 303.150 | 3.5000 | 3.5146 | -0.42 | 44.346 | 44.294 | 0.12 |
| 10 | 323.150 | 3.5000 | 3.5119 | -0.34 | 53.635 | 53.553 | 0.15 |
| 10 | 348.150 | 3.5000 | 3.5051 | -0.15 | 64.723 | 64.667 | 0.09 |
| 10 | 373.150 | 3.5000 | 3.5017 | -0.05 | 75.512 | 75.486 | 0.03 |
| 10 | 398.150 | 3.5000 | 3.5007 | -0.02 | 86.122 | 86.108 | 0.02 |
| 10 | 423.150 | 3.5000 | 3.5000 | 0.00 | 96.586 | 96.586 | -0.00 |
| 10 | 448.150 | 3.5000 | 3.5003 | -0.01 | 106.961 | 106.953 | 0.01 |
| 10 | 473.150 | 3.5000 | 3.5008 | -0.02 | 117.256 | 117.232 | 0.02 |
| 10 | 498.150 | 3.5000 | 3.5010 | -0.03 | 127.471 | 127.438 | 0.03 |
| 10 | 523.150 | 3.5000 | 3.5015 | -0.04 | 137.642 | 137.583 | 0.04 |
| 10 | 548.150 | 3.5000 | 3.5021 | -0.06 | 147.765 | 147.676 | 0.06 |

Table 12. Experimental and calculated P-ρ-T data- - - (Continued)

EQUATION OF STATE VS. PVT DATA

| ID | T,K | MOL/L | CALCD | C,PCT | P,BAR | CALCD | P,PCT |
|---|---|---|---|---|---|---|---|
| 10 | 573.150 | 3.5000 | 3.5029 | -0.08 | 157.853 | 157.724 | 0.08 |
| 10 | 598.150 | 3.5000 | 3.5039 | -0.11 | 167.924 | 167.731 | 0.11 |
| 10 | 623.150 | 3.5000 | 3.5061 | -0.17 | 178.025 | 177.702 | 0.18 |
| 10 | 303.150 | 4.0000 | 4.0149 | -0.37 | 45.714 | 45.684 | 0.07 |
| 10 | 323.150 | 4.0000 | 4.0182 | -0.45 | 56.768 | 56.667 | 0.18 |
| 10 | 348.150 | 4.0000 | 4.0086 | -0.21 | 69.920 | 69.836 | 0.12 |
| 10 | 373.150 | 4.0000 | 4.0044 | -0.11 | 82.737 | 82.675 | 0.07 |
| 10 | 398.150 | 4.0000 | 4.0030 | -0.07 | 95.353 | 95.299 | 0.06 |
| 10 | 423.150 | 4.0000 | 4.0025 | -0.06 | 107.820 | 107.764 | 0.05 |
| 10 | 448.150 | 4.0000 | 4.0031 | -0.08 | 120.189 | 120.108 | 0.07 |
| 10 | 473.150 | 4.0000 | 4.0035 | -0.09 | 132.460 | 132.355 | 0.08 |
| 10 | 498.150 | 4.0000 | 4.0038 | -0.10 | 144.652 | 144.521 | 0.09 |
| 10 | 523.150 | 4.0000 | 4.0046 | -0.11 | 156.793 | 156.618 | 0.11 |
| 10 | 548.150 | 4.0000 | 4.0048 | -0.12 | 168.860 | 168.656 | 0.12 |
| 10 | 573.150 | 4.0000 | 4.0055 | -0.14 | 180.897 | 180.643 | 0.14 |
| 10 | 598.150 | 4.0000 | 4.0067 | -0.17 | 192.920 | 192.583 | 0.17 |
| 10 | 623.150 | 4.0000 | 4.0093 | -0.23 | 204.991 | 204.481 | 0.25 |
| 10 | 303.150 | 4.5000 | 4.5112 | -0.25 | 46.448 | 46.437 | 0.02 |
| 10 | 323.150 | 4.5000 | 4.5245 | -0.54 | 59.302 | 59.191 | 0.19 |
| 10 | 348.150 | 4.5000 | 4.5115 | -0.25 | 74.601 | 74.498 | 0.14 |
| 10 | 373.150 | 4.5000 | 4.5068 | -0.15 | 89.556 | 89.466 | 0.10 |
| 10 | 398.150 | 4.5000 | 4.5058 | -0.13 | 104.316 | 104.213 | 0.10 |
| 10 | 423.150 | 4.5000 | 4.5055 | -0.12 | 118.922 | 118.800 | 0.10 |
| 10 | 448.150 | 4.5000 | 4.5065 | -0.15 | 133.434 | 133.261 | 0.13 |
| 10 | 473.150 | 4.5000 | 4.5065 | -0.15 | 147.823 | 147.621 | 0.14 |
| 10 | 498.150 | 4.5000 | 4.5072 | -0.16 | 162.148 | 161.896 | 0.16 |
| 10 | 523.150 | 4.5000 | 4.5076 | -0.17 | 176.399 | 176.098 | 0.17 |
| 10 | 548.150 | 4.5000 | 4.5076 | -0.17 | 190.571 | 190.236 | 0.18 |
| 10 | 573.150 | 4.5000 | 4.5080 | -0.18 | 204.706 | 204.318 | 0.19 |
| 10 | 598.150 | 4.5000 | 4.5093 | -0.21 | 218.837 | 218.348 | 0.22 |
| 10 | 623.150 | 4.5000 | 4.5123 | -0.27 | 233.031 | 232.331 | 0.30 |
| 10 | 323.150 | 5.0000 | 5.0242 | -0.48 | 61.395 | 61.300 | 0.15 |
| 10 | 348.150 | 5.0000 | 5.0099 | -0.20 | 78.919 | 78.835 | 0.11 |
| 10 | 373.150 | 5.0000 | 5.0065 | -0.13 | 96.135 | 96.050 | 0.09 |
| 10 | 398.150 | 5.0000 | 5.0068 | -0.14 | 113.178 | 113.057 | 0.11 |
| 10 | 423.150 | 5.0000 | 5.0073 | -0.15 | 130.076 | 129.912 | 0.13 |
| 10 | 448.150 | 5.0000 | 5.0083 | -0.17 | 146.871 | 146.646 | 0.15 |
| 10 | 473.150 | 5.0000 | 5.0086 | -0.17 | 163.555 | 163.281 | 0.17 |
| 10 | 498.150 | 5.0000 | 5.0089 | -0.18 | 180.155 | 179.830 | 0.18 |
| 10 | 523.150 | 5.0000 | 5.0087 | -0.17 | 196.667 | 196.306 | 0.18 |
| 10 | 548.150 | 5.0000 | 5.0088 | -0.18 | 213.119 | 212.715 | 0.19 |
| 10 | 573.150 | 5.0000 | 5.0094 | -0.19 | 229.543 | 229.063 | 0.21 |
| 10 | 598.150 | 5.0000 | 5.0107 | -0.21 | 245.951 | 245.357 | 0.24 |
| 10 | 623.150 | 5.0000 | 5.0140 | -0.28 | 262.444 | 261.600 | 0.32 |
| 10 | 323.150 | 5.5000 | 5.5078 | -0.14 | 63.184 | 63.156 | 0.04 |
| 10 | 348.150 | 5.5000 | 5.4995 | 0.01 | 83.020 | 83.024 | -0.01 |
| 10 | 373.150 | 5.5000 | 5.5009 | -0.02 | 102.635 | 102.623 | 0.01 |
| 10 | 398.150 | 5.5000 | 5.5036 | -0.06 | 122.111 | 122.046 | 0.05 |
| 10 | 423.150 | 5.5000 | 5.5056 | -0.10 | 141.466 | 141.335 | 0.09 |
| 10 | 448.150 | 5.5000 | 5.5070 | -0.13 | 160.716 | 160.516 | 0.12 |
| 10 | 473.150 | 5.5000 | 5.5075 | -0.14 | 179.857 | 179.604 | 0.14 |
| 10 | 498.150 | 5.5000 | 5.5083 | -0.15 | 198.931 | 198.612 | 0.16 |
| 10 | 523.150 | 5.5000 | 5.5081 | -0.15 | 217.901 | 217.547 | 0.16 |

Table 12. Experimental and calculated P-ρ-T data- - - (Continued)

EQUATION OF STATE VS. PVT DATA

| ID | T,K | MOL/L | CALCD | D,PCT | P,BAR | CALCD | P,PCT |
|---|---|---|---|---|---|---|---|
| 10 | 548.150 | 5.5000 | 5.5080 | -0.15 | 236.807 | 236.415 | 0.17 |
| 10 | 573.150 | 5.5000 | 5.5087 | -0.16 | 255.693 | 255.221 | 0.18 |
| 10 | 598.150 | 5.5000 | 5.5099 | -0.18 | 274.554 | 273.970 | 0.21 |
| 10 | 623.150 | 5.5000 | 5.5135 | -0.25 | 293.532 | 292.665 | 0.30 |
| 10 | 323.150 | 6.0000 | 5.9723 | 0.46 | 64.792 | 64.887 | -0.15 |
| 10 | 348.150 | 6.0000 | 5.9798 | 0.34 | 87.049 | 87.221 | -0.20 |
| 10 | 373.150 | 6.0000 | 5.9890 | 0.18 | 109.215 | 109.367 | -0.14 |
| 10 | 398.150 | 6.0000 | 5.9962 | 0.06 | 131.309 | 131.383 | -0.06 |
| 10 | 423.150 | 6.0000 | 5.9999 | 0.00 | 153.294 | 153.295 | -0.00 |
| 10 | 448.150 | 6.0000 | 6.0026 | -0.04 | 175.196 | 175.118 | 0.04 |
| 10 | 473.150 | 6.0000 | 6.0042 | -0.07 | 197.010 | 196.861 | 0.08 |
| 10 | 498.150 | 6.0000 | 6.0053 | -0.09 | 218.751 | 218.531 | 0.10 |
| 10 | 523.150 | 6.0000 | 6.0049 | -0.08 | 240.359 | 240.132 | 0.09 |
| 10 | 548.150 | 6.0000 | 6.0051 | -0.09 | 261.935 | 261.668 | 0.10 |
| 10 | 573.150 | 6.0000 | 6.0056 | -0.09 | 283.465 | 283.143 | 0.11 |
| 10 | 598.150 | 6.0000 | 6.0070 | -0.12 | 304.998 | 304.557 | 0.14 |
| 10 | 623.150 | 6.0000 | 6.0109 | -0.18 | 326.668 | 325.914 | 0.23 |
| 10 | 323.150 | 6.5000 | 6.4217 | 1.20 | 66.335 | 66.610 | -0.41 |
| 10 | 348.150 | 6.5000 | 6.4533 | 0.72 | 91.161 | 91.579 | -0.46 |
| 10 | 373.150 | 6.5000 | 6.4720 | 0.43 | 116.055 | 116.465 | -0.35 |
| 10 | 398.150 | 6.5000 | 6.4843 | 0.24 | 140.958 | 141.281 | -0.23 |
| 10 | 423.150 | 6.5000 | 6.4913 | 0.13 | 165.800 | 166.031 | -0.14 |
| 10 | 448.150 | 6.5000 | 6.4957 | 0.07 | 190.579 | 190.717 | -0.07 |
| 10 | 473.150 | 6.5000 | 6.4981 | 0.03 | 215.266 | 215.340 | -0.03 |
| 10 | 498.150 | 6.5000 | 6.4997 | 0.00 | 239.886 | 239.900 | -0.01 |
| 10 | 523.150 | 6.5000 | 6.4995 | 0.01 | 264.373 | 264.398 | -0.01 |
| 10 | 548.150 | 6.5000 | 6.5003 | -0.00 | 288.851 | 288.833 | 0.01 |
| 10 | 573.150 | 6.5000 | 6.5005 | -0.01 | 313.236 | 313.207 | 0.01 |
| 10 | 598.150 | 6.5000 | 6.5023 | -0.04 | 337.677 | 337.520 | 0.05 |
| 10 | 623.150 | 6.5000 | 6.5059 | -0.09 | 362.215 | 361.772 | 0.12 |
| 10 | 323.150 | 7.0000 | 6.8616 | 1.98 | 67.920 | 68.441 | -0.77 |
| 10 | 348.150 | 7.0000 | 6.9238 | 1.09 | 95.515 | 96.251 | -0.77 |
| 10 | 373.150 | 7.0000 | 6.9537 | 0.66 | 123.367 | 124.100 | -0.59 |
| 10 | 398.150 | 7.0000 | 6.9727 | 0.39 | 151.344 | 151.950 | -0.40 |
| 10 | 423.150 | 7.0000 | 6.9822 | 0.25 | 179.269 | 179.778 | -0.28 |
| 10 | 448.150 | 7.0000 | 6.9890 | 0.16 | 207.185 | 207.572 | -0.19 |
| 10 | 473.150 | 7.0000 | 6.9918 | 0.12 | 234.982 | 235.323 | -0.15 |
| 10 | 498.150 | 7.0000 | 6.9933 | 0.10 | 262.698 | 263.022 | -0.12 |
| 10 | 523.150 | 7.0000 | 6.9939 | 0.09 | 290.334 | 290.667 | -0.11 |
| 10 | 548.150 | 7.0000 | 6.9943 | 0.08 | 317.906 | 318.253 | -0.11 |
| 10 | 573.150 | 7.0000 | 6.9948 | 0.07 | 345.424 | 345.778 | -0.10 |
| 10 | 598.150 | 7.0000 | 6.9967 | 0.05 | 372.994 | 373.241 | -0.07 |
| 10 | 623.150 | 7.0000 | 7.0011 | -0.02 | 400.729 | 400.640 | 0.02 |
| 10 | 323.150 | 7.5000 | 7.3181 | 2.43 | 69.687 | 70.439 | -1.08 |
| 10 | 348.150 | 7.5000 | 7.4020 | 1.31 | 100.302 | 101.338 | -1.03 |
| 10 | 373.150 | 7.5000 | 7.4407 | 0.79 | 131.381 | 132.409 | -0.78 |
| 10 | 398.150 | 7.5000 | 7.4644 | 0.48 | 162.693 | 163.557 | -0.53 |
| 10 | 423.150 | 7.5000 | 7.4762 | 0.32 | 193.990 | 194.733 | -0.38 |
| 10 | 448.150 | 7.5000 | 7.4843 | 0.21 | 225.305 | 225.906 | -0.27 |
| 10 | 473.150 | 7.5000 | 7.4879 | 0.16 | 256.509 | 257.056 | -0.21 |
| 10 | 498.150 | 7.5000 | 7.4900 | 0.13 | 287.646 | 288.170 | -0.18 |
| 10 | 523.150 | 7.5000 | 7.4901 | 0.13 | 318.646 | 319.235 | -0.18 |
| 10 | 548.150 | 7.5000 | 7.4899 | 0.14 | 349.569 | 350.246 | -0.19 |

EQUATION OF STATE VS. PVT DATA

| ID | T,K | MOL/L | CALCD | D,PCT | P,BAR | CALCD | P,PCT |
|---|---|---|---|---|---|---|---|
| 10 | 573.150 | 7.5000 | 7.4900 | 0.13 | 380.454 | 381.196 | -0.20 |
| 10 | 323.150 | 8.0000 | 7.8017 | 2.48 | 71.775 | 72.734 | -1.34 |
| 10 | 348.150 | 8.0000 | 7.8935 | 1.33 | 105.750 | 107.024 | -1.20 |
| 10 | 373.150 | 8.0000 | 7.9379 | 0.78 | 140.417 | 141.621 | -0.86 |
| 10 | 398.150 | 8.0000 | 7.9617 | 0.48 | 175.341 | 176.373 | -0.59 |
| 10 | 423.150 | 8.0000 | 7.9749 | 0.31 | 210.334 | 211.202 | -0.41 |
| 10 | 448.150 | 8.0000 | 7.9832 | 0.21 | 245.348 | 246.061 | -0.29 |
| 10 | 473.150 | 8.0000 | 7.9884 | 0.14 | 280.338 | 280.917 | -0.21 |
| 10 | 498.150 | 8.0000 | 7.9888 | 0.14 | 315.099 | 315.748 | -0.21 |
| 10 | 523.150 | 8.0000 | 7.9884 | 0.14 | 349.779 | 350.538 | -0.22 |
| 10 | 548.150 | 8.0000 | 7.9882 | 0.15 | 384.407 | 385.276 | -0.23 |
| 10 | 323.150 | 8.5000 | 8.3116 | 2.22 | 74.407 | 75.542 | -1.52 |
| 10 | 348.150 | 8.5000 | 8.3967 | 1.22 | 112.147 | 113.592 | -1.29 |
| 10 | 373.150 | 8.5000 | 8.4411 | 0.69 | 150.763 | 152.072 | -0.87 |
| 10 | 398.150 | 8.5000 | 8.4648 | 0.41 | 189.705 | 190.779 | -0.57 |
| 10 | 423.150 | 8.5000 | 8.4774 | 0.27 | 228.728 | 229.609 | -0.39 |
| 10 | 448.150 | 8.5000 | 8.4858 | 0.17 | 267.823 | 268.497 | -0.25 |
| 10 | 473.150 | 8.5000 | 8.4903 | 0.11 | 306.859 | 307.399 | -0.18 |
| 10 | 498.150 | 8.5000 | 8.4898 | 0.12 | 345.630 | 346.287 | -0.19 |
| 10 | 523.150 | 8.5000 | 8.4886 | 0.13 | 384.306 | 385.139 | -0.22 |
| 10 | 323.150 | 9.0000 | 8.8361 | 1.82 | 77.856 | 79.144 | -1.65 |
| 10 | 348.150 | 9.0000 | 8.9087 | 1.01 | 119.857 | 121.393 | -1.28 |
| 10 | 373.150 | 9.0000 | 8.9493 | 0.56 | 162.857 | 164.171 | -0.81 |
| 10 | 398.150 | 9.0000 | 8.9723 | 0.31 | 206.258 | 207.234 | -0.47 |
| 10 | 423.150 | 9.0000 | 8.9836 | 0.18 | 249.728 | 250.455 | -0.29 |
| 10 | 448.150 | 9.0000 | 8.9901 | 0.11 | 293.226 | 293.756 | -0.18 |
| 10 | 473.150 | 9.0000 | 8.9943 | 0.06 | 336.726 | 337.085 | -0.11 |
| 10 | 498.150 | 9.0000 | 8.9924 | 0.08 | 379.850 | 380.403 | -0.15 |
| 10 | 323.150 | 9.5000 | 9.3667 | 1.40 | 82.499 | 83.907 | -1.71 |
| 10 | 348.150 | 9.5000 | 9.4253 | 0.79 | 129.325 | 130.868 | -1.19 |
| 10 | 373.150 | 9.5000 | 9.4606 | 0.41 | 177.203 | 178.418 | -0.69 |
| 10 | 398.150 | 9.5000 | 9.4811 | 0.20 | 225.515 | 226.290 | -0.34 |
| 10 | 423.150 | 9.5000 | 9.4913 | 0.09 | 273.897 | 274.343 | -0.16 |
| 10 | 448.150 | 9.5000 | 9.4975 | 0.03 | 322.334 | 322.486 | -0.05 |
| 10 | 473.150 | 9.5000 | 9.4993 | 0.01 | 370.609 | 370.659 | -0.01 |
| 10 | 323.150 | 10.0000 | 9.8976 | 1.02 | 88.838 | 90.311 | -1.66 |
| 10 | 348.150 | 10.0000 | 9.9423 | 0.58 | 141.085 | 142.568 | -1.05 |
| 10 | 373.150 | 10.0000 | 9.9730 | 0.27 | 194.424 | 195.427 | -0.52 |
| 10 | 398.150 | 10.0000 | 9.9915 | 0.08 | 248.207 | 248.618 | -0.17 |
| 10 | 423.150 | 10.0000 | 9.9998 | 0.00 | 301.977 | 301.991 | -0.00 |
| 10 | 448.150 | 10.0000 | 10.0037 | -0.04 | 355.715 | 355.450 | 0.07 |
| 10 | 323.150 | 10.5000 | 10.4239 | 0.73 | 97.478 | 98.972 | -1.53 |
| 10 | 348.150 | 10.5000 | 10.4587 | 0.39 | 155.840 | 157.176 | -0.86 |
| 10 | 373.150 | 10.5000 | 10.4843 | 0.15 | 215.238 | 215.943 | -0.33 |
| 10 | 398.150 | 10.5000 | 10.4999 | 0.00 | 275.014 | 275.018 | -0.00 |
| 10 | 423.150 | 10.5000 | 10.5069 | -0.07 | 334.734 | 334.252 | 0.14 |
| 10 | 448.150 | 10.5000 | 10.5097 | -0.09 | 394.346 | 393.551 | 0.20 |
| 10 | 298.150 | 11.0000 | 10.9727 | 0.25 | 46.397 | 46.734 | -0.73 |
| 10 | 323.150 | 11.0000 | 10.9450 | 0.50 | 109.201 | 110.664 | -1.34 |
| 10 | 348.150 | 11.0000 | 10.9729 | 0.25 | 174.420 | 175.525 | -0.63 |
| 10 | 373.150 | 11.0000 | 10.9952 | 0.04 | 240.596 | 240.858 | -0.11 |
| 10 | 398.150 | 11.0000 | 11.0079 | -0.07 | 306.980 | 306.438 | 0.18 |
| 10 | 423.150 | 11.0000 | 11.0133 | -0.12 | 373.226 | 372.128 | 0.29 |

Table 12. Experimental and calculated P-ρ-T data- - - (Continued)

EQUATION OF STATE VS. PVT DATA

| ID | T,K | MOL/L | CALCD | D,PCT | P,BAR | CALCD | P,PCT |
|---|---|---|---|---|---|---|---|
| 10 | 298.150 | 11.5000 | 11.4689 | 0.27 | 54.120 | 54.730 | -1.13 |
| 10 | 323.150 | 11.5000 | 11.4619 | 0.33 | 124.979 | 126.340 | -1.09 |
| 10 | 348.150 | 11.5000 | 11.4841 | 0.14 | 197.803 | 198.620 | -0.41 |
| 10 | 373.150 | 11.5000 | 11.5036 | -0.03 | 271.474 | 271.232 | 0.09 |
| 10 | 398.150 | 11.5000 | 11.5151 | -0.13 | 345.236 | 343.992 | 0.36 |
| 10 | 298.150 | 12.0000 | 11.9705 | 0.25 | 66.139 | 67.006 | -1.31 |
| 10 | 323.150 | 12.0000 | 11.9763 | 0.20 | 146.022 | 147.141 | -0.77 |
| 10 | 348.150 | 12.0000 | 11.9934 | 0.05 | 227.224 | 227.651 | -0.19 |
| 10 | 373.150 | 12.0000 | 12.0104 | -0.09 | 309.160 | 308.307 | 0.28 |
| 10 | 398.150 | 12.0000 | 12.0220 | -0.18 | 391.141 | 388.973 | 0.55 |
| 10 | 298.150 | 12.5000 | 12.4738 | 0.21 | 83.768 | 84.868 | -1.31 |
| 10 | 323.150 | 12.5000 | 12.4854 | 0.12 | 173.516 | 174.419 | -0.52 |
| 10 | 348.150 | 12.5000 | 12.5006 | -0.01 | 264.063 | 264.011 | 0.02 |
| 10 | 373.150 | 12.5000 | 12.5155 | -0.12 | 355.074 | 353.521 | 0.44 |
| 10 | 298.150 | 13.0000 | 12.9782 | 0.17 | 108.587 | 109.845 | -1.16 |
| 10 | 323.150 | 13.0000 | 12.9890 | 0.08 | 208.863 | 209.738 | -0.42 |
| 10 | 348.150 | 13.0000 | 13.0057 | -0.04 | 309.878 | 309.305 | 0.18 |
| 10 | 273.150 | 13.5000 | 13.4989 | 0.01 | 31.583 | 31.642 | -0.19 |
| 10 | 298.150 | 13.5000 | 13.4821 | 0.13 | 142.310 | 143.698 | -0.98 |
| 10 | 323.150 | 13.5000 | 13.4926 | 0.05 | 254.146 | 254.893 | -0.29 |
| 10 | 348.150 | 13.5000 | 13.5083 | -0.06 | 366.398 | 365.364 | 0.28 |
| 10 | 273.150 | 14.0000 | 13.9904 | 0.07 | 62.783 | 63.504 | -1.15 |
| 10 | 298.150 | 14.0000 | 13.9863 | 0.10 | 187.036 | 188.425 | -0.74 |
| 10 | 323.150 | 14.0000 | 13.9986 | 0.01 | 311.735 | 311.915 | -0.06 |
| 10 | 273.150 | 14.5000 | 14.4880 | 0.08 | 106.237 | 107.449 | -1.14 |
| 10 | 298.150 | 14.5000 | 14.4911 | 0.06 | 245.114 | 246.273 | -0.47 |
| 10 | 323.150 | 14.5000 | 14.5033 | -0.02 | 383.607 | 383.080 | 0.14 |
| 10 | 273.150 | 15.0000 | 14.9872 | 0.09 | 164.251 | 165.958 | -1.04 |
| 10 | 298.150 | 15.0000 | 14.9928 | 0.05 | 318.560 | 319.750 | -0.37 |
| 10 | 248.150 | 15.5000 | 15.4982 | 0.01 | 67.393 | 67.644 | -0.37 |
| 10 | 273.150 | 15.5000 | 15.4916 | 0.05 | 240.347 | 241.786 | -0.60 |
| 10 | 298.150 | 15.5000 | 15.4932 | 0.04 | 410.257 | 411.635 | -0.34 |
| 10 | 248.150 | 16.0000 | 15.9930 | 0.04 | 144.656 | 145.900 | -0.86 |
| 10 | 273.150 | 16.0000 | 15.9950 | 0.03 | 336.908 | 337.977 | -0.32 |

NP = 298, DNRMSPCT = 0.401, PMEANPCT = 0.256

Table 12. Experimental and calculated P-ρ-T data- - - (Continued)

EQUATION OF STATE VS. PVT DATA

| ID | T,K | MOL/L | CALCD | D,PCT | P,BAR | CALCD | P,PCT |
|---|---|---|---|---|---|---|---|
| 101 | 263.847 | 1.1061 | 1.0901 | 1.45 | 17.993 | 18.174 | -1.01 |
| 102 | 267.267 | 1.1058 | 1.0955 | 0.92 | 18.458 | 18.578 | -0.65 |
| 103 | 270.457 | 1.1054 | 1.0970 | 0.76 | 18.849 | 18.951 | -0.54 |
| 104 | 273.094 | 1.1054 | 1.0977 | 0.69 | 19.165 | 19.261 | -0.50 |
| 105 | 276.946 | 1.1051 | 1.0987 | 0.58 | 19.623 | 19.706 | -0.42 |
| 106 | 281.362 | 1.1048 | 1.0995 | 0.48 | 20.142 | 20.213 | -0.35 |
| 107 | 288.868 | 1.1044 | 1.1000 | 0.40 | 21.006 | 21.069 | -0.30 |
| 108 | 298.954 | 1.1038 | 1.0998 | 0.36 | 22.139 | 22.202 | -0.28 |
| 109 | 306.232 | 1.1034 | 1.0999 | 0.32 | 22.953 | 23.012 | -0.25 |
| 110 | 315.928 | 1.1026 | 1.0994 | 0.31 | 24.016 | 24.077 | -0.25 |
| 111 | 326.185 | 1.1021 | 1.0990 | 0.28 | 25.135 | 25.192 | -0.23 |
| 112 | 332.655 | 1.1018 | 1.0989 | 0.26 | 25.836 | 25.892 | -0.22 |
| 113 | 343.612 | 1.1011 | 1.0984 | 0.25 | 27.010 | 27.067 | -0.21 |
| 201 | 290.936 | 2.5966 | 2.5821 | 0.56 | 35.479 | 35.553 | -0.21 |
| 202 | 292.700 | 2.5963 | 2.5957 | 0.02 | 36.139 | 36.142 | -0.01 |
| 203 | 294.967 | 2.5959 | 2.5983 | -0.09 | 36.907 | 36.894 | 0.04 |
| 204 | 297.293 | 2.5956 | 2.5988 | -0.12 | 37.678 | 37.658 | 0.05 |
| 205 | 299.402 | 2.5953 | 2.6006 | -0.20 | 38.380 | 38.346 | 0.09 |
| 206 | 300.717 | 2.5953 | 2.5987 | -0.13 | 38.797 | 38.773 | 0.06 |
| 207 | 306.169 | 2.5943 | 2.5983 | -0.16 | 40.554 | 40.524 | 0.08 |
| 208 | 311.528 | 2.5936 | 2.5974 | -0.14 | 42.255 | 42.223 | 0.07 |
| 209 | 317.621 | 2.5926 | 2.5957 | -0.12 | 44.159 | 44.130 | 0.07 |
| 210 | 325.244 | 2.5916 | 2.5935 | -0.07 | 46.507 | 46.487 | 0.04 |
| 211 | 333.156 | 2.5903 | 2.5911 | -0.03 | 48.909 | 48.900 | 0.02 |
| 212 | 343.446 | 2.5890 | 2.5883 | 0.03 | 51.991 | 52.000 | -0.02 |
| 301 | 305.270 | 4.5943 | 4.5190 | 1.64 | 47.863 | 47.962 | -0.21 |
| 302 | 306.575 | 4.5939 | 4.5368 | 1.24 | 48.748 | 48.836 | -0.18 |
| 303 | 306.998 | 4.5939 | 4.5454 | 1.06 | 49.040 | 49.118 | -0.16 |
| 304 | 308.355 | 4.5936 | 4.5483 | 0.99 | 49.934 | 50.018 | -0.17 |
| 305 | 309.475 | 4.5933 | 4.5514 | 0.91 | 50.671 | 50.757 | -0.17 |
| 306 | 310.226 | 4.5929 | 4.5547 | 0.83 | 51.168 | 51.251 | -0.16 |
| 307 | 311.461 | 4.5926 | 4.5562 | 0.79 | 51.973 | 52.060 | -0.17 |
| 308 | 314.528 | 4.5920 | 4.5585 | 0.73 | 53.959 | 54.058 | -0.18 |
| 309 | 316.957 | 4.5913 | 4.5587 | 0.71 | 55.518 | 55.628 | -0.20 |
| 310 | 326.208 | 4.5890 | 4.5558 | 0.72 | 61.371 | 61.537 | -0.27 |
| 311 | 329.914 | 4.5880 | 4.5471 | 0.89 | 63.647 | 63.878 | -0.36 |
| 312 | 333.690 | 4.5870 | 4.5821 | 0.11 | 66.220 | 66.251 | -0.05 |
| 401 | 305.232 | 5.3595 | 4.9727 | 7.22 | 48.302 | 48.507 | -0.42 |
| 402 | 306.165 | 5.3595 | 5.1961 | 3.05 | 49.168 | 49.266 | -0.20 |
| 403 | 307.343 | 5.3588 | 5.2688 | 1.68 | 50.145 | 50.216 | -0.14 |
| 404 | 308.378 | 5.3585 | 5.2844 | 1.38 | 50.973 | 51.045 | -0.14 |
| 405 | 310.753 | 5.3578 | 5.3268 | 0.58 | 52.892 | 52.935 | -0.08 |
| 406 | 315.523 | 5.3565 | 5.3429 | 0.25 | 56.662 | 56.693 | -0.05 |
| 407 | 320.133 | 5.3552 | 5.3418 | 0.25 | 60.250 | 60.291 | -0.07 |
| 408 | 324.789 | 5.3535 | 5.3397 | 0.26 | 63.845 | 63.900 | -0.09 |
| 409 | 329.529 | 5.3522 | 5.3387 | 0.25 | 67.488 | 67.553 | -0.10 |
| 410 | 334.774 | 5.3505 | 5.3379 | 0.24 | 71.501 | 71.574 | -0.10 |
| 411 | 342.584 | 5.3482 | 5.3379 | 0.19 | 77.450 | 77.525 | -0.10 |

Table 12. Experimental and calculated P-ρ-T data- - - (Continued)

EQUATION OF STATE VS. PVT DATA

| ID | T,K | MOL/L | CALCD | D,PCT | P,BAR | CALCD | P,PCT |
|---|---|---|---|---|---|---|---|
| 501 | 304.721 | 6.1373 | 5.2442 | 14.55 | 48.051 | 48.166 | -0.24 |
| 502 | 305.360 | 6.1370 | 5.5227 | 10.01 | 48.682 | 48.763 | -0.17 |
| 503 | 305.932 | 6.1367 | 5.6833 | 7.39 | 49.202 | 49.289 | -0.18 |
| 504 | 306.528 | 6.1367 | 5.7928 | 5.60 | 49.760 | 49.854 | -0.19 |
| 505 | 307.927 | 6.1360 | 5.9612 | 2.85 | 51.087 | 51.173 | -0.17 |
| 506 | 309.803 | 6.1354 | 6.0301 | 1.71 | 52.846 | 52.933 | -0.16 |
| 507 | 314.618 | 6.1337 | 6.0789 | 0.89 | 57.330 | 57.425 | -0.17 |
| 508 | 320.295 | 6.1317 | 6.0814 | 0.82 | 62.550 | 62.692 | -0.23 |
| 509 | 325.427 | 6.1300 | 6.0801 | 0.82 | 67.241 | 67.434 | -0.29 |
| 510 | 330.799 | 6.1280 | 6.0821 | 0.75 | 72.153 | 72.381 | -0.32 |
| 511 | 336.699 | 6.1260 | 6.0860 | 0.65 | 77.549 | 77.797 | -0.32 |
| 512 | 343.543 | 6.1237 | 6.0873 | 0.59 | 83.782 | 84.059 | -0.33 |
| 601 | 305.423 | 6.7892 | 5.9149 | 12.88 | 48.790 | 48.811 | -0.04 |
| 602 | 305.743 | 6.7888 | 5.6716 | 16.46 | 49.034 | 49.151 | -0.24 |
| 603 | 306.184 | 6.7888 | 5.8169 | 14.32 | 49.461 | 49.619 | -0.32 |
| 604 | 306.693 | 6.7885 | 6.0142 | 11.41 | 49.978 | 50.159 | -0.36 |
| 605 | 307.188 | 6.7885 | 6.2012 | 8.65 | 50.499 | 50.685 | -0.37 |
| 606 | 309.162 | 6.7875 | 6.4936 | 4.33 | 52.576 | 52.781 | -0.39 |
| 607 | 312.231 | 6.7865 | 6.5013 | 4.20 | 55.667 | 56.040 | -0.67 |
| 608 | 317.552 | 6.7845 | 6.5778 | 3.05 | 61.188 | 61.688 | -0.82 |
| 609 | 322.347 | 6.7825 | 6.6161 | 2.45 | 66.200 | 66.775 | -0.87 |
| 610 | 327.148 | 6.7805 | 6.6398 | 2.08 | 71.229 | 71.864 | -0.89 |
| 611 | 333.270 | 6.7782 | 6.6639 | 1.69 | 77.676 | 78.349 | -0.87 |
| 612 | 343.351 | 6.7745 | 6.6836 | 1.34 | 88.268 | 89.013 | -0.84 |
| 701 | 305.633 | 8.1021 | 5.9810 | 26.18 | 48.991 | 49.211 | -0.45 |
| 702 | 306.319 | 8.1018 | 7.1329 | 11.96 | 49.819 | 50.129 | -0.62 |
| 703 | 307.031 | 8.1014 | 7.6433 | 5.65 | 50.808 | 51.087 | -0.55 |
| 704 | 308.123 | 8.1008 | 7.6411 | 5.67 | 52.160 | 52.564 | -0.77 |
| 705 | 311.913 | 8.0991 | 7.6884 | 5.07 | 56.966 | 57.728 | -1.34 |
| 706 | 316.998 | 8.0968 | 7.7679 | 4.06 | 63.649 | 64.713 | -1.67 |
| 707 | 322.404 | 8.0941 | 7.8239 | 3.34 | 70.899 | 72.181 | -1.81 |
| 708 | 327.708 | 8.0918 | 7.8583 | 2.89 | 78.080 | 79.537 | -1.87 |
| 709 | 333.451 | 8.0891 | 7.8875 | 2.49 | 85.935 | 87.525 | -1.85 |
| 710 | 339.014 | 8.0865 | 7.9157 | 2.11 | 93.653 | 95.278 | -1.73 |
| 711 | 343.093 | 8.0845 | 7.9315 | 1.89 | 99.332 | 100.969 | -1.65 |
| 801 | 305.015 | 8.8104 | 8.2090 | 6.83 | 48.426 | 48.920 | -1.02 |
| 802 | 306.220 | 8.8096 | 8.2922 | 5.87 | 50.132 | 50.785 | -1.30 |
| 803 | 307.783 | 8.8088 | 8.3015 | 5.76 | 52.332 | 53.219 | -1.70 |
| 804 | 309.310 | 8.8081 | 8.4607 | 3.94 | 54.784 | 55.611 | -1.51 |
| 805 | 310.839 | 8.8074 | 8.4754 | 3.77 | 57.061 | 58.016 | -1.67 |
| 806 | 314.681 | 8.8055 | 8.4776 | 3.72 | 62.751 | 64.091 | -2.14 |
| 807 | 319.840 | 8.8028 | 8.5218 | 3.19 | 70.675 | 72.302 | -2.30 |
| 808 | 325.591 | 8.7998 | 8.5685 | 2.63 | 79.720 | 81.507 | -2.24 |
| 809 | 331.302 | 8.7971 | 8.6010 | 2.23 | 88.794 | 90.690 | -2.13 |
| 810 | 337.309 | 8.7938 | 8.6277 | 1.89 | 98.429 | 100.374 | -1.98 |
| 811 | 342.720 | 8.7912 | 8.6448 | 1.67 | 107.138 | 109.122 | -1.85 |
| 901 | 303.430 | 9.6887 | 9.5875 | 1.04 | 48.035 | 48.413 | -0.79 |
| 902 | 303.752 | 9.6887 | 9.5850 | 1.07 | 48.615 | 49.016 | -0.82 |
| 903 | 303.962 | 9.6887 | 9.5803 | 1.12 | 48.982 | 49.410 | -0.87 |

EQUATION OF STATE VS. PVT DATA

| ID | T,K | MOL/L | CALCD | D,PCT | P,BAR | CALCD | P,PCT |
|---|---|---|---|---|---|---|---|
| 904 | 304.336 | 9.6884 | 9.5310 | 1.62 | 49.484 | 50.110 | -1.27 |
| 905 | 305.899 | 9.6874 | 9.5180 | 1.75 | 52.267 | 53.046 | -1.49 |
| 906 | 308.437 | 9.6861 | 9.5031 | 1.89 | 56.812 | 57.839 | -1.81 |
| 907 | 313.081 | 9.6834 | 9.5096 | 1.80 | 65.354 | 66.663 | -2.00 |
| 908 | 318.048 | 9.6807 | 9.5318 | 1.54 | 74.730 | 76.163 | -1.92 |
| 909 | 322.924 | 9.6781 | 9.5421 | 1.40 | 83.951 | 85.534 | -1.89 |
| 910 | 327.991 | 9.6751 | 9.5515 | 1.28 | 93.608 | 95.306 | -1.81 |
| 911 | 334.413 | 9.6714 | 9.5540 | 1.21 | 105.811 | 107.733 | -1.82 |
| 912 | 342.647 | 9.6668 | 9.5814 | 0.88 | 122.022 | 123.717 | -1.39 |
| 1001 | 293.336 | 11.3761 | 11.3655 | 0.09 | 38.979 | 39.135 | -0.40 |
| 1002 | 293.674 | 11.3761 | 11.3634 | 0.11 | 39.876 | 40.064 | -0.47 |
| 1003 | 294.103 | 11.3758 | 11.3587 | 0.15 | 40.981 | 41.238 | -0.63 |
| 1004 | 294.883 | 11.3751 | 11.3534 | 0.19 | 43.036 | 43.374 | -0.78 |
| 1005 | 295.416 | 11.3748 | 11.3495 | 0.22 | 44.436 | 44.835 | -0.90 |
| 1006 | 295.792 | 11.3745 | 11.3470 | 0.24 | 45.424 | 45.865 | -0.97 |
| 1007 | 296.034 | 11.3745 | 11.3452 | 0.26 | 46.058 | 46.532 | -1.03 |
| 1008 | 298.624 | 11.3728 | 11.3334 | 0.35 | 52.946 | 53.646 | -1.32 |
| 1009 | 301.993 | 11.3705 | 11.3220 | 0.43 | 61.951 | 62.912 | -1.55 |
| 1010 | 304.995 | 11.3685 | 11.3180 | 0.44 | 70.089 | 71.183 | -1.56 |
| 1011 | 309.657 | 11.3651 | 11.3151 | 0.44 | 82.812 | 84.041 | -1.48 |
| 1012 | 314.468 | 11.3622 | 11.3130 | 0.43 | 95.989 | 97.341 | -1.41 |
| 1013 | 319.264 | 11.3588 | 11.3170 | 0.37 | 109.329 | 110.604 | -1.17 |
| 1014 | 324.667 | 11.3552 | 11.3213 | 0.30 | 124.415 | 125.561 | -0.92 |
| 1015 | 328.588 | 11.3525 | 11.3216 | 0.27 | 135.300 | 136.420 | -0.83 |
| 1016 | 335.200 | 11.3482 | 11.3225 | 0.23 | 153.711 | 154.743 | -0.67 |
| 1017 | 341.335 | 11.3442 | 11.3099 | 0.30 | 170.251 | 171.747 | -0.88 |
| 1101 | 277.504 | 12.9867 | 13.0057 | -0.13 | 27.349 | 26.677 | 2.46 |
| 1102 | 277.925 | 12.9884 | 13.0037 | -0.12 | 28.958 | 28.348 | 2.11 |
| 1103 | 273.136 | 12.9884 | 13.0006 | -0.09 | 29.682 | 29.192 | 1.65 |
| 1104 | 278.777 | 12.9877 | 12.9994 | -0.09 | 32.203 | 31.730 | 1.47 |
| 1105 | 279.387 | 12.9874 | 12.9966 | -0.07 | 34.536 | 34.156 | 1.10 |
| 1106 | 279.902 | 12.9870 | 12.9955 | -0.07 | 36.554 | 36.202 | 0.96 |
| 1107 | 282.317 | 12.9850 | 12.9838 | 0.01 | 45.716 | 45.770 | -0.12 |
| 1108 | 284.543 | 12.9834 | 12.9823 | 0.01 | 54.539 | 54.588 | -0.09 |
| 1109 | 286.727 | 12.9814 | 12.9784 | 0.02 | 63.074 | 63.214 | -0.22 |
| 1110 | 290.618 | 12.9784 | 12.9727 | 0.04 | 78.298 | 78.585 | -0.37 |
| 1111 | 297.190 | 12.9734 | 12.9664 | 0.05 | 104.097 | 104.490 | -0.38 |
| 1112 | 304.683 | 12.9674 | 12.9640 | 0.03 | 133.702 | 133.914 | -0.16 |
| 1113 | 312.625 | 12.9614 | 12.9601 | 0.01 | 164.925 | 165.016 | -0.06 |
| 1114 | 320.632 | 12.9548 | 12.9581 | -0.03 | 197.261 | 197.007 | 0.13 |
| 1115 | 329.753 | 12.9478 | 12.9589 | -0.09 | 232.594 | 231.663 | 0.40 |
| 1116 | 339.989 | 12.9401 | 12.9531 | -0.10 | 272.480 | 271.290 | 0.44 |
| 1201 | 268.389 | 13.7157 | 13.7212 | -0.04 | 21.840 | 21.525 | 1.44 |
| 1202 | 268.613 | 13.7153 | 13.7206 | -0.04 | 22.869 | 22.567 | 1.32 |
| 1203 | 268.944 | 13.7150 | 13.7198 | -0.04 | 24.394 | 24.115 | 1.14 |
| 1204 | 269.313 | 13.7150 | 13.7180 | -0.02 | 26.037 | 25.862 | 0.67 |
| 1205 | 269.861 | 13.7143 | 13.7169 | -0.02 | 28.565 | 28.418 | 0.52 |
| 1206 | 270.539 | 13.7137 | 13.7146 | -0.01 | 31.644 | 31.586 | 0.18 |
| 1207 | 271.359 | 13.7130 | 13.7128 | 0.00 | 35.412 | 35.424 | -0.03 |
| 1208 | 272.788 | 13.7120 | 13.7094 | 0.02 | 41.957 | 42.115 | -0.38 |

Table 12. Experimental and calculated P-ρ-T data- - - (Continued)

EQUATION OF STATE VS. PVT DATA

| ID | T,K | MOL/L | CALCD | D,PCT | P,BAR | CALCD | P,PCT |
|---|---|---|---|---|---|---|---|
| 1209 | 277.605 | 13.7080 | 13.7001 | 0.06 | 64.048 | 64.572 | -0.82 |
| 1210 | 281.789 | 13.7044 | 13.6957 | 0.06 | 83.378 | 83.991 | -0.74 |
| 1211 | 286.317 | 13.7007 | 13.6911 | 0.07 | 104.232 | 104.953 | -0.69 |
| 1212 | 290.328 | 13.6974 | 13.6879 | 0.07 | 122.712 | 123.454 | -0.61 |
| 1213 | 296.212 | 13.6924 | 13.6851 | 0.05 | 149.868 | 150.484 | -0.41 |
| 1214 | 302.145 | 13.6874 | 13.6819 | 0.04 | 177.132 | 177.624 | -0.28 |
| 1215 | 310.715 | 13.6804 | 13.6790 | 0.01 | 216.504 | 216.647 | -0.07 |
| 1216 | 318.093 | 13.6734 | 13.6783 | -0.04 | 255.083 | 254.561 | 0.20 |
| 1217 | 334.225 | 13.6608 | 13.6723 | -0.08 | 323.892 | 322.512 | 0.43 |
| | | | | | | | |
| 1301 | 256.613 | 14.5544 | 14.5584 | -0.03 | 19.044 | 18.702 | 1.80 |
| 1302 | 257.326 | 14.5537 | 14.5556 | -0.01 | 22.901 | 22.743 | 0.69 |
| 1303 | 257.911 | 14.5534 | 14.5538 | -0.00 | 26.113 | 26.073 | 0.15 |
| 1304 | 259.065 | 14.5524 | 14.5519 | 0.00 | 32.560 | 32.607 | -0.15 |
| 1305 | 263.450 | 14.5484 | 14.5440 | 0.03 | 56.915 | 57.324 | -0.72 |
| 1306 | 268.631 | 14.5437 | 14.5353 | 0.06 | 85.525 | 86.354 | -0.97 |
| 1307 | 273.496 | 14.5391 | 14.5321 | 0.05 | 112.695 | 113.417 | -0.64 |
| 1308 | 283.116 | 14.5304 | 14.5247 | 0.04 | 165.879 | 166.542 | -0.40 |
| 1309 | 291.287 | 14.5231 | 14.5194 | 0.03 | 210.784 | 211.238 | -0.22 |
| 1310 | 298.372 | 14.5168 | 14.5160 | 0.01 | 249.591 | 249.700 | -0.04 |
| 1311 | 307.254 | 14.5088 | 14.5117 | -0.02 | 297.945 | 297.542 | 0.14 |
| 1312 | 319.529 | 14.4978 | 14.5045 | -0.05 | 364.059 | 363.039 | 0.28 |
| | | | | | | | |
| 1401 | 248.290 | 15.0496 | 15.0457 | 0.03 | 14.224 | 14.625 | -2.82 |
| 1402 | 249.192 | 15.0486 | 15.0456 | 0.02 | 20.022 | 20.331 | -1.54 |
| 1403 | 250.248 | 15.0476 | 15.0433 | 0.03 | 26.564 | 27.018 | -1.71 |
| 1404 | 253.374 | 15.0446 | 15.0378 | 0.05 | 45.992 | 46.742 | -1.63 |
| 1405 | 259.654 | 15.0396 | 15.0300 | 0.06 | 78.728 | 79.845 | -1.42 |
| 1406 | 265.858 | 15.0329 | 15.0229 | 0.07 | 123.345 | 124.612 | -1.03 |
| 1407 | 272.972 | 15.0263 | 15.0163 | 0.07 | 167.038 | 168.374 | -0.80 |
| 1408 | 279.035 | 15.0206 | 15.0116 | 0.06 | 204.080 | 205.354 | -0.62 |
| 1409 | 285.189 | 15.0146 | 15.0074 | 0.05 | 241.489 | 242.571 | -0.45 |
| 1410 | 294.840 | 15.0057 | 15.0025 | 0.02 | 299.962 | 300.461 | -0.17 |
| 1411 | 304.470 | 14.9967 | 14.9963 | 0.00 | 357.549 | 357.617 | -0.02 |
| 1412 | 316.744 | 14.9850 | 14.9999 | -0.10 | 432.383 | 429.618 | 0.64 |
| | | | | | | | |
| 1501 | 240.739 | 15.4546 | 15.4609 | -0.04 | 10.100 | 9.335 | 7.57 |
| 1502 | 240.885 | 15.4546 | 15.4603 | -0.04 | 11.065 | 10.369 | 6.28 |
| 1503 | 241.249 | 15.4543 | 15.4602 | -0.04 | 13.638 | 12.905 | 5.37 |
| 1504 | 241.891 | 15.4536 | 15.4590 | -0.03 | 18.027 | 17.364 | 3.68 |
| 1505 | 243.148 | 15.4523 | 15.4565 | -0.03 | 26.600 | 26.074 | 1.98 |
| 1506 | 246.601 | 15.4490 | 15.4481 | 0.01 | 49.822 | 49.938 | -0.23 |
| 1507 | 251.930 | 15.4436 | 15.4423 | 0.01 | 86.273 | 86.453 | -0.21 |
| 1508 | 257.186 | 15.4386 | 15.4375 | 0.01 | 122.011 | 122.182 | -0.14 |
| 1509 | 261.745 | 15.4343 | 15.4335 | 0.01 | 152.813 | 152.930 | -0.08 |
| 1510 | 267.242 | 15.4287 | 15.4300 | -0.01 | 189.860 | 189.655 | 0.11 |
| 1511 | 273.834 | 15.4223 | 15.4245 | -0.01 | 233.738 | 233.380 | 0.15 |
| 1512 | 282.799 | 15.4137 | 15.4187 | -0.03 | 293.088 | 292.212 | 0.30 |
| 1513 | 290.022 | 15.4067 | 15.4131 | -0.04 | 340.314 | 339.120 | 0.35 |
| 1514 | 298.219 | 15.3987 | 15.4081 | -0.06 | 393.682 | 391.850 | 0.47 |
| 1515 | 309.559 | 15.3878 | 15.4010 | -0.09 | 466.789 | 464.006 | 0.60 |
| | | | | | | | |
| 1601 | 230.051 | 16.0366 | 16.0361 | 0.00 | 8.060 | 8.126 | -0.82 |

EQUATION OF STATE VS. PVT DATA

| ID | T,K | MOL/L | CALCD | D,PCT | P,BAR | CALCD | P,PCT |
|---|---|---|---|---|---|---|---|
| 1602 | 230.294 | 16.0362 | 16.0357 | 0.00 | 9.965 | 10.043 | -0.78 |
| 1603 | 230.807 | 16.0359 | 16.0348 | 0.01 | 13.973 | 14.142 | -1.21 |
| 1604 | 232.572 | 16.0339 | 16.0324 | 0.01 | 27.840 | 28.078 | -0.85 |
| 1605 | 234.160 | 16.0323 | 16.0286 | 0.02 | 40.005 | 40.590 | -1.46 |
| 1606 | 235.255 | 16.0313 | 16.0268 | 0.03 | 48.499 | 49.217 | -1.48 |
| 1607 | 242.791 | 16.0236 | 16.0158 | 0.05 | 106.582 | 107.928 | -1.26 |
| 1608 | 249.107 | 16.0170 | 16.0093 | 0.05 | 155.042 | 156.422 | -0.89 |
| 1609 | 254.888 | 16.0110 | 16.0029 | 0.05 | 198.800 | 200.331 | -0.77 |
| 1610 | 262.164 | 16.0037 | 15.9976 | 0.04 | 253.808 | 255.017 | -0.48 |
| 1611 | 271.236 | 15.9943 | 15.9880 | 0.04 | 320.920 | 322.271 | -0.42 |
| 1612 | 279.282 | 15.9860 | 15.9829 | 0.02 | 380.442 | 381.144 | -0.18 |
| 1613 | 286.940 | 15.9781 | 15.9779 | 0.00 | 436.516 | 436.544 | -0.01 |
| 1614 | 294.543 | 15.9704 | 15.9734 | -0.02 | 491.788 | 491.055 | 0.15 |
| 1615 | 301.025 | 15.9638 | 15.9651 | -0.01 | 537.420 | 537.087 | 0.06 |
| | | | | | | | |
| 1701 | 222.875 | 16.4230 | 16.4030 | 0.12 | 7.625 | 11.158 | -46.34 |
| 1702 | 223.264 | 16.4227 | 16.4017 | 0.13 | 10.831 | 14.539 | -34.24 |
| 1703 | 223.573 | 16.4223 | 16.4012 | 0.13 | 13.464 | 17.210 | -27.83 |
| 1704 | 225.014 | 16.4210 | 16.3994 | 0.13 | 25.785 | 29.680 | -15.10 |
| 1705 | 230.291 | 16.4154 | 16.3902 | 0.15 | 70.101 | 74.832 | -6.75 |
| 1706 | 237.396 | 16.4077 | 16.3812 | 0.16 | 129.495 | 134.758 | -4.06 |
| 1707 | 252.785 | 16.3911 | 16.3647 | 0.16 | 255.712 | 261.545 | -2.28 |
| 1708 | 259.848 | 16.3838 | 16.3580 | 0.16 | 312.610 | 318.592 | -1.91 |
| 1709 | 267.602 | 16.3755 | 16.3512 | 0.15 | 374.481 | 380.373 | -1.57 |
| 1710 | 275.649 | 16.3668 | 16.3480 | 0.11 | 438.898 | 443.679 | -1.09 |
| 1711 | 282.466 | 16.3598 | 16.3429 | 0.10 | 492.335 | 496.803 | -0.91 |
| 1712 | 293.185 | 16.3485 | 16.3360 | 0.08 | 575.740 | 579.231 | -0.61 |
| | | | | | | | |
| 1801 | 215.247 | 16.7539 | 16.7727 | -0.11 | 6.823 | 3.084 | 54.80 |
| 1802 | 215.504 | 16.7536 | 16.7728 | -0.11 | 9.325 | 5.477 | 41.27 |
| 1803 | 215.892 | 16.7532 | 16.7715 | -0.11 | 12.777 | 9.119 | 28.62 |
| 1804 | 215.369 | 16.7526 | 16.7710 | -0.11 | 17.256 | 13.541 | 21.53 |
| 1805 | 216.632 | 16.7522 | 16.7702 | -0.11 | 21.511 | 17.890 | 16.83 |
| 1806 | 217.058 | 16.7519 | 16.7692 | -0.10 | 23.470 | 19.977 | 14.88 |
| 1807 | 220.809 | 16.7476 | 16.7629 | -0.09 | 57.842 | 54.663 | 5.50 |
| 1808 | 226.802 | 16.7409 | 16.7551 | -0.08 | 112.523 | 109.438 | 2.74 |
| 1809 | 234.917 | 16.7323 | 16.7458 | -0.08 | 185.542 | 182.440 | 1.67 |
| 1810 | 243.045 | 16.7233 | 16.7365 | -0.08 | 257.383 | 254.185 | 1.24 |
| 1811 | 250.885 | 16.7147 | 16.7300 | -0.09 | 326.185 | 322.276 | 1.20 |
| 1812 | 260.378 | 16.7044 | 16.7226 | -0.11 | 408.368 | 403.438 | 1.21 |
| 1813 | 269.927 | 16.6937 | 16.7176 | -0.14 | 490.451 | 483.674 | 1.38 |
| 1814 | 278.130 | 16.6847 | 16.7118 | -0.16 | 559.695 | 551.671 | 1.43 |
| 1815 | 284.744 | 16.6778 | 16.7078 | -0.18 | 615.144 | 605.967 | 1.49 |
| 1816 | 293.608 | 16.6681 | 16.7025 | -0.21 | 688.810 | 677.857 | 1.59 |
| | | | | | | | |
| 1901 | 208.453 | 17.1250 | 17.0977 | 0.16 | 8.116 | 14.300 | -76.19 |
| 1902 | 209.053 | 17.1244 | 17.0967 | 0.16 | 14.087 | 20.385 | -44.71 |
| 1903 | 213.403 | 17.1194 | 17.0891 | 0.18 | 57.037 | 64.142 | -12.46 |
| 1904 | 218.566 | 17.1134 | 17.0812 | 0.19 | 107.538 | 115.363 | -7.28 |
| 1905 | 227.034 | 17.1038 | 17.0713 | 0.19 | 189.571 | 197.916 | -4.40 |
| 1906 | 233.700 | 17.0961 | 17.0636 | 0.19 | 252.998 | 261.697 | -3.44 |
| 1907 | 241.770 | 17.0871 | 17.0560 | 0.18 | 328.989 | 337.725 | -2.66 |
| 1908 | 251.549 | 17.0762 | 17.0496 | 0.16 | 420.278 | 428.155 | -1.87 |

EQUATION OF STATE VS. PVT DATA

| ID | T,K | MOL/L | CALCD | D,PCT | P,BAR | CALCD | P,PCT |
|---|---|---|---|---|---|---|---|
| 1909 | 260.957 | 17.0655 | 17.0446 | 0.12 | 507.048 | 513.568 | -1.29 |
| 1910 | 268.486 | 17.0569 | 17.0368 | 0.12 | 574.398 | 580.876 | -1.13 |
| 1911 | 280.494 | 17.0436 | 17.0328 | 0.06 | 683.038 | 686.701 | -0.54 |
| | | | | | | | |
| 2001 | 198.356 | 17.5291 | 17.5476 | -0.11 | 7.130 | 2.315 | 67.53 |
| 2002 | 199.230 | 17.5281 | 17.5454 | -0.10 | 16.592 | 12.067 | 27.27 |
| 2003 | 200.946 | 17.5261 | 17.5424 | -0.09 | 35.439 | 31.123 | 12.18 |
| 2004 | 204.756 | 17.5214 | 17.5355 | -0.08 | 76.814 | 72.991 | 4.98 |
| 2005 | 210.931 | 17.5141 | 17.5267 | -0.07 | 143.419 | 139.863 | 2.48 |
| 2006 | 220.998 | 17.5022 | 17.5152 | -0.07 | 250.280 | 246.369 | 1.56 |
| 2007 | 227.537 | 17.4945 | 17.5071 | -0.07 | 318.013 | 314.102 | 1.23 |
| 2008 | 235.067 | 17.4859 | 17.5015 | -0.09 | 395.918 | 390.856 | 1.28 |
| 2009 | 242.758 | 17.4769 | 17.4948 | -0.10 | 473.940 | 467.901 | 1.27 |
| 2010 | 249.071 | 17.4692 | 17.4903 | -0.12 | 537.459 | 530.140 | 1.36 |
| 2011 | 256.389 | 17.4609 | 17.4875 | -0.15 | 611.081 | 601.535 | 1.56 |
| 2012 | 263.603 | 17.4523 | 17.4829 | -0.18 | 682.214 | 670.834 | 1.67 |
| | | | | | | | |
| 2101 | 183.907 | 17.9415 | 17.9532 | -0.07 | 6.728 | 3.226 | 52.05 |
| 2102 | 189.331 | 17.9411 | 17.9521 | -0.06 | 11.762 | 8.484 | 27.87 |
| 2103 | 189.746 | 17.9405 | 17.9515 | -0.06 | 16.843 | 13.521 | 19.72 |
| 2104 | 192.590 | 17.9368 | 17.9459 | -0.05 | 50.874 | 48.097 | 5.46 |
| 2105 | 198.660 | 17.9295 | 17.9362 | -0.04 | 123.000 | 120.883 | 1.72 |
| 2106 | 205.509 | 17.9209 | 17.9254 | -0.03 | 202.640 | 201.149 | 0.74 |
| 2107 | 213.217 | 17.9115 | 17.9159 | -0.02 | 291.132 | 289.643 | 0.51 |
| 2108 | 220.733 | 17.9022 | 17.9096 | -0.04 | 376.667 | 374.052 | 0.69 |
| 2109 | 228.543 | 17.8929 | 17.9040 | -0.06 | 464.311 | 460.202 | 0.89 |
| 2110 | 238.949 | 17.8799 | 17.9001 | -0.11 | 580.193 | 572.381 | 1.35 |
| | | | | | | | |
| 2201 | 176.719 | 18.4456 | 18.4480 | -0.01 | 3.471 | 2.652 | 23.59 |
| 2202 | 177.382 | 18.4450 | 18.4462 | -0.01 | 12.310 | 11.869 | 3.58 |
| 2203 | 178.429 | 18.4433 | 18.4445 | -0.01 | 26.585 | 26.156 | 1.61 |
| 2204 | 179.691 | 18.4416 | 18.4416 | -0.00 | 43.417 | 43.413 | 0.01 |
| 2205 | 182.793 | 18.4376 | 18.4358 | 0.01 | 84.808 | 85.485 | -0.80 |
| 2206 | 188.263 | 18.4307 | 18.4260 | 0.03 | 156.732 | 158.461 | -1.10 |
| 2207 | 195.148 | 18.4217 | 18.4155 | 0.03 | 245.802 | 248.198 | -0.97 |
| 2208 | 201.949 | 18.4130 | 18.4077 | 0.03 | 332.786 | 334.917 | -0.64 |
| 2209 | 208.686 | 18.4044 | 18.4024 | 0.01 | 418.212 | 419.023 | -0.19 |
| 2210 | 215.452 | 18.3957 | 18.3979 | -0.01 | 502.825 | 501.907 | 0.18 |
| 2211 | 222.008 | 18.3871 | 18.3956 | -0.05 | 584.427 | 580.711 | 0.64 |
| 2212 | 227.030 | 18.3808 | 18.3942 | -0.07 | 646.312 | 640.353 | 0.92 |
| 2213 | 229.121 | 18.3781 | 18.3946 | -0.09 | 672.368 | 664.967 | 1.10 |
| | | | | | | | |
| 2301 | 168.032 | 18.8234 | 18.8126 | 0.06 | 10.003 | 14.303 | -42.99 |
| 2302 | 168.479 | 18.8227 | 18.8117 | 0.06 | 16.593 | 21.008 | -26.61 |
| 2303 | 169.437 | 18.8214 | 18.8093 | 0.06 | 30.514 | 35.366 | -15.90 |
| 2304 | 171.067 | 18.8194 | 18.8057 | 0.07 | 54.233 | 59.759 | -10.19 |
| 2305 | 173.679 | 18.8158 | 18.8008 | 0.08 | 92.210 | 98.292 | -6.60 |
| 2306 | 177.673 | 18.8104 | 18.7931 | 0.09 | 149.285 | 156.488 | -4.83 |
| 2307 | 183.136 | 18.8031 | 18.7831 | 0.11 | 226.036 | 234.559 | -3.77 |
| 2308 | 188.844 | 18.7955 | 18.7749 | 0.11 | 305.443 | 314.423 | -2.94 |
| 2309 | 195.448 | 18.7865 | 18.7688 | 0.09 | 396.836 | 404.799 | -2.01 |
| 2310 | 201.251 | 18.7788 | 18.7661 | 0.07 | 476.851 | 482.746 | -1.24 |
| 2311 | 206.784 | 18.7715 | 18.7606 | 0.06 | 550.626 | 555.805 | -0.94 |

Table 12. Experimental and calculated P-ρ-T data- - - (Continued

EQUATION OF STATE VS. PVT DATA

| ID | T,K | MOL/L | CALCD | D,PCT | P,BAR | CALCD | P,PCT |
|---|---|---|---|---|---|---|---|
| 2312 | 212.460 | 18.7639 | 18.7618 | 0.01 | 628.513 | 629.515 | -0.16 |
| 2313 | 217.337 | 18.7576 | 18.7591 | -0.01 | 692.835 | 692.094 | 0.11 |
| 2401 | 157.201 | 19.2261 | 19.2220 | 0.02 | 5.219 | 7.098 | -36.01 |
| 2402 | 158.496 | 19.2241 | 19.2189 | 0.03 | 26.162 | 28.516 | -9.00 |
| 2403 | 159.577 | 19.2225 | 19.2149 | 0.04 | 42.827 | 46.284 | -8.07 |
| 2404 | 160.786 | 19.2208 | 19.2138 | 0.04 | 62.930 | 66.128 | -5.08 |
| 2405 | 163.656 | 19.2168 | 19.2080 | 0.05 | 108.664 | 112.741 | -3.75 |
| 2406 | 167.103 | 19.2122 | 19.1981 | 0.07 | 161.353 | 167.949 | -4.09 |
| 2407 | 172.270 | 19.2049 | 19.1897 | 0.08 | 241.688 | 248.958 | -3.01 |
| 2408 | 177.321 | 19.1979 | 19.1815 | 0.09 | 318.533 | 326.541 | -2.51 |
| 2409 | 183.160 | 19.1896 | 19.1764 | 0.07 | 407.622 | 414.225 | -1.62 |
| 2410 | 188.652 | 19.1819 | 19.1726 | 0.05 | 490.353 | 495.107 | -0.97 |
| 2411 | 194.552 | 19.1739 | 19.1703 | 0.02 | 578.543 | 580.480 | -0.33 |
| 2412 | 199.115 | 19.1673 | 19.1720 | -0.02 | 647.704 | 645.181 | 0.39 |
| 2413 | 202.417 | 19.1630 | 19.1682 | -0.03 | 694.537 | 691.718 | 0.41 |
| 2501 | 134.069 | 20.4300 | 20.1037 | 1.60 | 14.291 | 221.481 | -1449.79 |
| 2502 | 134.656 | 20.4293 | 20.1019 | 1.60 | 25.882 | 234.170 | -804.77 |
| 2503 | 136.071 | 20.4270 | 20.0975 | 1.61 | 53.739 | 264.078 | -391.41 |
| 2504 | 137.536 | 20.4247 | 20.0931 | 1.62 | 82.345 | 294.824 | -258.04 |
| 2505 | 140.791 | 20.4194 | 20.0842 | 1.64 | 145.396 | 362.087 | -149.04 |
| 2506 | 144.763 | 20.4134 | 20.0753 | 1.66 | 221.796 | 442.862 | -99.67 |
| 2507 | 149.679 | 20.4054 | 20.0673 | 1.66 | 315.714 | 540.141 | -71.09 |
| 2508 | 154.382 | 20.3981 | 20.0628 | 1.64 | 405.313 | 631.278 | -55.75 |
| 2509 | 159.399 | 20.3904 | 20.0607 | 1.62 | 500.568 | 726.521 | -45.14 |
| 2510 | 164.174 | 20.3828 | 20.0598 | 1.58 | 590.104 | 815.074 | -38.12 |
| 2511 | 168.954 | 20.3755 | 20.0614 | 1.54 | 679.933 | 902.343 | -32.71 |

NP = 321, DNRMSPCT = 2.853, PMEANPCT =14.092

Table 13. Experimental and calculated ideal gas functions

IDEAL GAS FUNCTIONS FOR ETHANE, IN JOULES, MOLES, KELVINS

| T,K | HZ | CALC | PCNT | SZ | CALC | PCNT | CPZ | CALC | PCNT |
|---|---|---|---|---|---|---|---|---|---|
| 50.00 | 1663.77 | 1663.77 | 0.00 | 160.12 | 160.18 | 0.04 | 33.39 | 33.09 | -0.90 |
| 100.00 | 3381.51 | 3381.50 | -0.00 | 183.84 | 183.88 | 0.02 | 35.65 | 35.73 | 0.24 |
| 150.00 | 5239.20 | 5239.29 | 0.00 | 198.87 | 198.91 | 0.02 | 38.66 | 38.64 | -0.06 |
| 200.00 | 7257.57 | 7257.41 | -0.00 | 210.50 | 210.50 | 0.00 | 42.26 | 42.26 | 0.00 |
| 273.15 | 10601.17 | 10600.97 | -0.00 | 224.68 | 224.69 | 0.00 | 49.54 | 49.53 | -0.01 |
| 298.15 | 11875.82 | 11875.64 | -0.00 | 229.12 | 229.15 | 0.01 | 52.47 | 52.47 | 0.01 |
| 300.00 | 11972.10 | 11972.91 | 0.01 | 229.45 | 229.47 | 0.01 | 52.72 | 52.69 | -0.04 |
| 400.00 | 17875.72 | 17875.11 | -0.00 | 246.35 | 246.37 | 0.00 | 65.48 | 65.48 | 0.00 |
| 500.00 | 25057.96 | 25058.40 | 0.00 | 262.34 | 262.34 | 0.00 | 77.99 | 78.00 | 0.02 |
| 600.00 | 33431.00 | 33431.55 | 0.00 | 277.57 | 277.58 | 0.00 | 89.24 | 89.23 | -0.02 |
| 700.00 | 42862.99 | 42862.23 | -0.00 | 292.09 | 292.10 | 0.00 | 99.20 | 99.19 | -0.01 |
| 800.00 | 53230.52 | 53231.87 | 0.00 | 305.89 | 305.93 | 0.01 | 107.99 | 108.01 | 0.02 |
| 900.00 | 64425.65 | 64426.01 | 0.00 | 319.07 | 319.10 | 0.01 | 115.77 | 115.70 | -0.06 |
| 1000.00 | 76353.82 | 76354.94 | 0.00 | 331.62 | 331.67 | 0.01 | 122.59 | 122.97 | 0.31 |

Table 14. Interpolated ideal gas functions

ETHANE IDEAL GAS FUNCTIONS, JOULES,MOLES,KELVINS

| T,K | EZ | HZ | SZ | CVZ | CPZ |
|---|---|---|---|---|---|
| 90 | 2278.7 | 3027.0 | 180.150 | 26.86 | 35.17 |
| 100 | 2550.1 | 3381.5 | 183.884 | 27.42 | 35.73 |
| 110 | 2827.0 | 3741.6 | 187.316 | 27.98 | 36.29 |
| 120 | 3109.6 | 4107.4 | 190.498 | 28.54 | 36.86 |
| 130 | 3397.9 | 4478.8 | 193.471 | 29.12 | 37.43 |
| 140 | 3692.0 | 4856.0 | 196.266 | 29.71 | 38.02 |
| 150 | 3992.1 | 5239.3 | 198.910 | 30.32 | 38.64 |
| 160 | 4298.6 | 5628.9 | 201.424 | 30.97 | 39.28 |
| 170 | 4611.6 | 6025.1 | 203.826 | 31.65 | 39.96 |
| 180 | 4931.7 | 6428.3 | 206.131 | 32.37 | 40.69 |
| 190 | 5259.2 | 6838.9 | 208.351 | 33.14 | 41.45 |
| 200 | 5594.6 | 7257.4 | 210.497 | 33.95 | 42.25 |
| 210 | 5938.2 | 7684.3 | 212.579 | 34.80 | 43.12 |
| 220 | 6290.7 | 8119.9 | 214.606 | 35.70 | 44.02 |
| 230 | 6652.3 | 8564.5 | 216.583 | 36.65 | 44.97 |
| 240 | 7023.9 | 9019.4 | 218.518 | 37.64 | 45.96 |
| 250 | 7405.5 | 9484.1 | 220.415 | 38.68 | 46.99 |
| 260 | 7797.6 | 9959.3 | 222.279 | 39.75 | 48.07 |
| 270 | 8200.6 | 10445.5 | 224.113 | 40.86 | 49.18 |
| 280 | 8614.9 | 10943.0 | 225.922 | 42.01 | 50.32 |
| 290 | 9040.9 | 11452.0 | 227.708 | 43.18 | 51.49 |
| 300 | 9478.6 | 11972.9 | 229.474 | 44.38 | 52.69 |
| 310 | 9928.7 | 12506.0 | 231.222 | 45.61 | 53.92 |
| 320 | 10390.8 | 13051.4 | 232.954 | 46.85 | 55.17 |
| 330 | 10865.6 | 13609.3 | 234.670 | 48.11 | 56.43 |
| 340 | 11353.1 | 14180.0 | 236.374 | 49.39 | 57.70 |
| 350 | 11853.4 | 14763.4 | 238.065 | 50.68 | 58.99 |
| 360 | 12366.6 | 15359.6 | 239.745 | 51.97 | 60.28 |
| 370 | 12892.9 | 15969.1 | 241.414 | 53.27 | 61.58 |
| 380 | 13432.0 | 16591.4 | 243.074 | 54.57 | 62.88 |
| 390 | 13984.2 | 17225.8 | 244.724 | 55.87 | 64.18 |
| 400 | 14549.4 | 17875.1 | 246.366 | 57.17 | 65.48 |
| 410 | 15127.5 | 18536.4 | 247.998 | 58.46 | 66.78 |
| 420 | 15718.6 | 19210.7 | 249.623 | 59.75 | 68.07 |
| 430 | 16322.5 | 19897.7 | 251.240 | 61.03 | 69.35 |
| 440 | 16939.2 | 20597.5 | 252.849 | 62.30 | 70.62 |
| 450 | 17568.5 | 21310.0 | 254.450 | 63.56 | 71.88 |
| 460 | 18210.3 | 22035.0 | 256.043 | 64.81 | 73.13 |
| 470 | 18864.7 | 22772.5 | 257.629 | 66.05 | 74.37 |
| 480 | 19531.3 | 23522.3 | 259.208 | 67.28 | 75.59 |
| 490 | 20210.3 | 24284.4 | 260.779 | 68.49 | 76.81 |
| 500 | 20901.3 | 25058.4 | 262.343 | 69.69 | 78.00 |
| 510 | 21604.1 | 25844.4 | 263.899 | 70.87 | 79.19 |
| 520 | 22318.7 | 26642.1 | 265.448 | 72.05 | 80.36 |
| 530 | 23045.0 | 27451.5 | 266.990 | 73.20 | 81.52 |
| 540 | 23782.7 | 28272.4 | 268.524 | 74.35 | 82.66 |
| 550 | 24531.8 | 29104.7 | 270.051 | 75.47 | 83.79 |
| 560 | 25292.2 | 29946.2 | 271.571 | 76.59 | 84.99 |
| 570 | 26063.6 | 30802.7 | 273.084 | 77.69 | 86.01 |
| 580 | 26845.9 | 31668.2 | 274.589 | 78.78 | 87.09 |
| 590 | 27639.1 | 32544.5 | 276.087 | 79.85 | 88.17 |
| 600 | 28443.0 | 33431.5 | 277.578 | 80.92 | 89.23 |

Table 15. Experimental and calculated heats of vaporization

ID: (10) Douslin; (11) Wiebe; (13) Riedel via Furtado; (20) Furtado

| | | |
|---|---|---|
| 1.21027302+001 | 1.11655879+001 | 1.65392652+001 |
| -7.18546945+001 | 8.21662387+001 | -3.26105136+001 |

| ID | T,K | KJ/MOL | CALCD | PCNT |
|---|---|---|---|---|
| 10 | 248.15 | 11.239 | 11.235 | 0.57 |
| 10 | 253.15 | 10.925 | 10.862 | 0.58 |
| 10 | 263.15 | 10.072 | 10.039 | 0.33 |
| 10 | 273.15 | 9.073 | 9.072 | 0.01 |
| 10 | 283.15 | 7.844 | 7.878 | -0.44 |
| 10 | 293.15 | 6.170 | 6.253 | -1.34 |
| 10 | 298.15 | 5.034 | 5.090 | -1.09 |
| 10 | 302.15 | 3.677 | 3.708 | -0.85 |
| 10 | 303.15 | 3.207 | 3.208 | -0.02 |
| 10 | 304.15 | 2.548 | 2.547 | 0.04 |
| 13 | 100.00 | 17.154 | 17.312 | -0.91 |
| 13 | 111.11 | 16.928 | 17.068 | -0.82 |
| 13 | 133.33 | 16.455 | 16.492 | -0.22 |
| 13 | 155.56 | 15.853 | 15.797 | 0.35 |
| 13 | 166.67 | 15.430 | 15.403 | 0.50 |
| 13 | 180.00 | 14.957 | 14.886 | 0.48 |
| 12 | 184.10 | 14.706 | 14.717 | -0.07 |
| 13 | 184.11 | 14.802 | 14.716 | 0.58 |
| 13 | 190.00 | 14.528 | 14.465 | 0.43 |
| 13 | 200.00 | 14.049 | 14.012 | 0.26 |
| 13 | 210.00 | 13.530 | 13.525 | 0.04 |
| 13 | 220.00 | 12.999 | 12.998 | 0.01 |
| 13 | 230.00 | 12.388 | 12.425 | -0.30 |
| 13 | 240.00 | 11.743 | 11.797 | -0.46 |
| 13 | 250.00 | 11.044 | 11.099 | -0.50 |
| 13 | 260.00 | 10.287 | 10.311 | -0.24 |
| 13 | 270.00 | 9.416 | 9.396 | 0.22 |
| 13 | 280.00 | 8.353 | 8.287 | 0.80 |
| 13 | 290.00 | 6.863 | 6.836 | 0.40 |
| 13 | 300.00 | 4.557 | 4.531 | 0.57 |
| 20 | 100.00 | 17.544 | 17.312 | 1.34 |
| 20 | 111.11 | 17.117 | 17.068 | 0.28 |
| 20 | 133.33 | 16.497 | 16.492 | 0.03 |
| 20 | 155.56 | 15.761 | 15.797 | -0.23 |
| 20 | 166.67 | 15.351 | 15.403 | -0.34 |
| 20 | 180.00 | 14.832 | 14.886 | -0.36 |
| 20 | 184.11 | 14.677 | 14.716 | -0.27 |
| 20 | 190.00 | 14.422 | 14.465 | -0.30 |
| 20 | 200.00 | 13.953 | 14.012 | -0.42 |
| 20 | 210.00 | 13.438 | 13.525 | -0.27 |
| 20 | 220.00 | 12.999 | 12.998 | 0.01 |
| 20 | 230.00 | 12.434 | 12.425 | 0.07 |
| 20 | 240.00 | 11.814 | 11.797 | 0.15 |
| 20 | 250.00 | 11.065 | 11.099 | -0.31 |
| 20 | 260.00 | 10.287 | 10.311 | -0.24 |
| 20 | 270.00 | 9.416 | 9.396 | 0.22 |
| 20 | 280.00 | 8.249 | 8.287 | -0.46 |
| 20 | 290.00 | 6.863 | 6.836 | 0.40 |
| 20 | 300.00 | 4.612 | 4.531 | 1.78 |
| 11 | 190.00 | 13.777 | 14.465 | -4.75 |
| 11 | 195.00 | 13.635 | 14.242 | -4.27 |
| 11 | 200.00 | 13.501 | 14.012 | -3.65 |
| 11 | 205.00 | 13.338 | 13.773 | -3.16 |
| 11 | 210.00 | 13.179 | 13.525 | -2.56 |
| 11 | 215.00 | 12.999 | 13.266 | -2.02 |
| 11 | 220.00 | 12.806 | 12.998 | -1.47 |
| 11 | 225.00 | 12.584 | 12.718 | -1.05 |
| 11 | 230.00 | 12.362 | 12.425 | -0.50 |
| 11 | 235.00 | 12.111 | 12.119 | -0.06 |
| 11 | 240.00 | 11.844 | 11.797 | 0.40 |
| 11 | 245.00 | 11.551 | 11.458 | 0.81 |
| 11 | 250.00 | 11.233 | 11.099 | 1.20 |
| 11 | 255.00 | 10.881 | 10.718 | 1.52 |
| 11 | 260.00 | 10.492 | 10.311 | 1.75 |
| 11 | 265.00 | 10.036 | 9.872 | 1.65 |
| 11 | 270.00 | 9.584 | 9.396 | 2.00 |
| 11 | 275.00 | 9.002 | 8.872 | 1.47 |
| 11 | 280.00 | 8.429 | 8.287 | 1.71 |
| 11 | 285.00 | 7.700 | 7.620 | 1.05 |
| 11 | 290.00 | 6.834 | 6.836 | -0.03 |
| 11 | 295.00 | 5.779 | 5.865 | -1.46 |
| 11 | 300.00 | 4.294 | 4.531 | -5.24 |

NP = 43, RMSPCT = 0.56

Table 16. Experimental and calculated specific heats for saturated liquid

ID: (11) Wiebe; (12) Witt $T_c = 305.37$ K

6.73153+001 -1.65876+001 1.63526+001 $\epsilon = 0.5$

| ID | T,K | J/MOL/K | CALCD | PCNT |
|---|---|---|---|---|
| 12 | 90.00 | 68.22 | 68.17 | 0.07 |
| 11 | 96.77 | 68.42 | 68.33 | 0.14 |
| 11 | 96.82 | 68.72 | 68.33 | 0.57 |
| 11 | 98.06 | 68.51 | 68.36 | 0.21 |
| 12 | 100.00 | 68.55 | 68.41 | 0.20 |
| 11 | 101.54 | 68.68 | 68.46 | 0.32 |
| 11 | 107.08 | 68.59 | 68.61 | -0.03 |
| 11 | 108.65 | 68.51 | 68.66 | -0.22 |
| 12 | 110.00 | 68.93 | 68.70 | 0.32 |
| 11 | 115.74 | 68.63 | 68.89 | -0.38 |
| 11 | 116.19 | 68.42 | 68.91 | -0.70 |
| 12 | 120.00 | 69.26 | 69.04 | 0.31 |
| 11 | 122.70 | 69.51 | 69.15 | 0.53 |
| 11 | 123.60 | 69.14 | 69.18 | -0.06 |
| 11 | 128.08 | 69.51 | 69.36 | 0.22 |
| 11 | 128.49 | 69.47 | 69.38 | 0.14 |
| 12 | 130.00 | 69.51 | 69.44 | 0.10 |
| 11 | 132.65 | 69.81 | 69.55 | 0.36 |
| 11 | 138.05 | 69.85 | 69.80 | 0.06 |
| 11 | 138.18 | 69.97 | 69.81 | 0.23 |
| 11 | 138.31 | 69.81 | 69.82 | -0.01 |
| 12 | 140.00 | 69.85 | 69.90 | -0.07 |
| 11 | 142.43 | 70.06 | 70.02 | 0.05 |
| 11 | 143.36 | 70.02 | 70.07 | -0.08 |
| 12 | 150.00 | 70.27 | 70.43 | -0.23 |
| 11 | 151.75 | 69.93 | 70.53 | -0.85 |
| 11 | 152.60 | 70.10 | 70.58 | -0.68 |
| 11 | 154.99 | 70.22 | 70.72 | -0.71 |
| 11 | 156.98 | 70.22 | 70.85 | -0.88 |
| 11 | 157.42 | 70.06 | 70.88 | -1.15 |
| 12 | 160.00 | 70.85 | 71.04 | -0.27 |
| 11 | 160.10 | 71.06 | 71.05 | 0.02 |
| 11 | 162.65 | 71.14 | 71.22 | -0.11 |
| 11 | 164.49 | 71.69 | 71.35 | 0.48 |
| 11 | 168.09 | 71.56 | 71.61 | -0.06 |
| 12 | 170.00 | 71.48 | 71.75 | -0.38 |
| 11 | 170.18 | 71.73 | 71.77 | -0.05 |
| 11 | 172.05 | 71.73 | 71.91 | -0.25 |
| 11 | 172.69 | 72.11 | 71.96 | 0.20 |
| 11 | 178.17 | 72.78 | 72.42 | 0.49 |
| 12 | 180.00 | 72.23 | 72.58 | -0.48 |
| 11 | 181.50 | 73.03 | 72.72 | 0.43 |
| 11 | 182.03 | 73.28 | 72.77 | 0.71 |
| 11 | 190.00 | 73.49 | 73.55 | -0.08 |
| 11 | 199.86 | 74.33 | 74.67 | -0.46 |
| 11 | 208.88 | 75.62 | 75.87 | -0.32 |
| 11 | 212.80 | 75.92 | 76.45 | -0.70 |
| 11 | 220.48 | 77.76 | 77.73 | 0.03 |
| 11 | 228.76 | 80.56 | 79.35 | 1.53 |
| 11 | 236.21 | 82.28 | 81.06 | 1.50 |
| 11 | 244.61 | 83.91 | 83.39 | 0.62 |
| 11 | 252.53 | 87.09 | 86.11 | 1.14 |
| 11 | 258.22 | 88.39 | 88.48 | -0.10 |
| 11 | 265.25 | 92.28 | 92.09 | 0.20 |
| 11 | 273.06 | 98.05 | 97.44 | 0.63 |
| 11 | 278.07 | 101.28 | 102.01 | -0.72 |
| 11 | 284.07 | 109.06 | 109.48 | -0.39 |
| 11 | 291.27 | 122.62 | 124.08 | -1.18 |
| 11 | 294.85 | 135.72 | 136.37 | -0.47 |

NP = 59, RMSPCT = 0.54

Table 17. Experimental and calculated specific heats $C_p(T)$ on isobar $P_b$

TM = 354.0, CM = 117.333

3.89154 -0.15442 -0.14149 -0.50644 0.27699

| T,K | J/MOL/K | CALC | PCT |
|---|---|---|---|
| 110.928 | 68.19 | 68.45 | -0.39 |
| 118.372 | 68.45 | 68.55 | -0.15 |
| 122.039 | 68.56 | 68.62 | -0.08 |
| 133.150 | 68.94 | 68.87 | 0.10 |
| 144.261 | 69.44 | 69.23 | 0.31 |
| 155.372 | 70.08 | 69.70 | 0.55 |
| 166.483 | 70.59 | 70.29 | 0.42 |
| 177.594 | 71.09 | 71.03 | 0.09 |
| 186.872 | 71.58 | 71.75 | -0.24 |
| 188.706 | 71.71 | 71.91 | -0.27 |
| 199.817 | 72.72 | 72.94 | -0.30 |
| 210.928 | 73.98 | 74.15 | -0.23 |
| 222.039 | 75.37 | 75.54 | -0.23 |
| 233.150 | 77.13 | 77.14 | -0.01 |
| 241.761 | 78.63 | 78.53 | 0.13 |
| 244.261 | 79.00 | 78.96 | 0.06 |
| 255.372 | 81.14 | 81.03 | 0.13 |
| 266.483 | 83.41 | 83.42 | -0.01 |
| 277.594 | 86.31 | 86.17 | 0.17 |
| 282.706 | 87.70 | 87.58 | 0.13 |
| 288.706 | 89.71 | 89.39 | 0.36 |
| 299.817 | 92.97 | 93.22 | -0.27 |
| 305.261 | 94.86 | 95.38 | -0.55 |
| 310.928 | 97.88 | 97.88 | 0.00 |
| 322.039 | 103.80 | 103.63 | 0.17 |
| 324.817 | 105.43 | 105.26 | 0.16 |
| 333.150 | 110.45 | 110.54 | -0.08 |
| 344.261 | 116.62 | 116.62 | 0.00 |

NP = 28, RMS = 0.25

Table 18. Calculated $P(\rho)$ critical isotherm

The following page gives a high-resolution examination of the critical isotherm of ethane as computed by equation of state (5). Column headings have the following interpretations--

D/DC $\equiv d/d_c$, density reduced at the critical point.

P/PC $\equiv P/P_c$, pressure reduced at the critical point.

DP/DD $\equiv \partial P/\partial d$, slope of the critical isotherm, bar/(mol/$\ell$).

The last five columns give the density-dependence of functions used in the equation of state, where $R \equiv \rho \equiv d/d_t$ is density reduced at the liquid triple point--

DTS/DR $\equiv dT_\sigma(\rho)/d\rho$, K.

DTH/DR $\equiv d\theta(\rho)/d\rho$, K.

DPS/DR $\equiv dP_\sigma(\rho)/d\rho$, bar.

DXB/DR $\equiv \partial\Phi(\rho, T)/\partial\rho$.

DXC/DR $\equiv \partial\Psi(\rho, T)/\partial\rho$.

Table 18. Calculated $P(\rho)$ critical isotherm.

TC = 305.370, DC = 6.740, PC = 48.7550

| D/DC | P/PC | DP/DD | DTS/DR | DTH/DR | DPS/DR | DXB/DR | DXC/DR |
|---|---|---|---|---|---|---|---|
| 0.75 | 0.993995341 | 0.658819307 | 40.90712 | 74.38357 | 40.77208 | -0.13448 | 0.40412 |
| 0.76 | 0.994858823 | 0.591217592 | 38.34226 | 69.22775 | 38.32854 | -0.12600 | 0.38616 |
| 0.77 | 0.995632133 | 0.528321099 | 35.89818 | 64.29211 | 35.98713 | -0.11792 | 0.36888 |
| 0.78 | 0.996321595 | 0.469866251 | 33.56442 | 59.56723 | 33.73933 | -0.11021 | 0.35219 |
| 0.79 | 0.996933166 | 0.415589108 | 31.32866 | 55.04173 | 31.57456 | -0.10284 | 0.33599 |
| 0.80 | 0.997472439 | 0.365229997 | 29.17651 | 50.70206 | 29.47982 | -0.09575 | 0.32014 |
| 0.81 | 0.997944660 | 0.318539129 | 27.09132 | 46.53235 | 27.43963 | -0.08888 | 0.30447 |
| 0.82 | 0.998354733 | 0.275283463 | 25.05409 | 42.51428 | 25.43582 | -0.08217 | 0.28875 |
| 0.83 | 0.998707261 | 0.235255248 | 23.04356 | 38.62722 | 23.44768 | -0.07556 | 0.27271 |
| 0.84 | 0.999006584 | 0.198282488 | 21.03666 | 34.84865 | 21.45237 | -0.06896 | 0.25603 |
| 0.85 | 0.999256832 | 0.164241474 | 19.00951 | 31.15516 | 19.42597 | -0.06230 | 0.23833 |
| 0.86 | 0.999462008 | 0.133071105 | 16.93942 | 27.52453 | 17.34554 | -0.05551 | 0.21919 |
| 0.87 | 0.999626082 | 0.104787529 | 14.80834 | 23.93907 | 15.19272 | -0.04852 | 0.19819 |
| 0.88 | 0.999753105 | 0.079495860 | 12.60834 | 20.39122 | 12.95942 | -0.04130 | 0.17498 |
| 0.89 | 0.999847343 | 0.057392249 | 10.34968 | 16.89154 | 10.65629 | -0.03390 | 0.14936 |
| 0.90 | 0.999913379 | 0.038744754 | 8.07130 | 13.47924 | 8.32377 | -0.02644 | 0.12153 |
| 0.91 | 0.999956191 | 0.023836181 | 5.85191 | 10.23329 | 6.04377 | -0.01917 | 0.09228 |
| 0.92 | 0.999981094 | 0.012851315 | 3.81596 | 7.27835 | 3.94613 | -0.01250 | 0.06328 |
| 0.93 | 0.999993499 | 0.005707396 | 2.12263 | 4.77383 | 2.19740 | -0.00695 | 0.03716 |
| 0.94 | 0.999998411 | 0.001881248 | 0.92089 | 2.86884 | 0.95413 | -0.00302 | 0.01707 |
| 0.95 | 0.999999775 | 0.000380131 | 0.26456 | 1.61736 | 0.27427 | -0.00087 | 0.00521 |
| 0.96 | 0.999999987 | 0.000031585 | 0.03611 | 0.90191 | 0.03745 | -0.00012 | 0.00076 |
| 0.97 | 0.999999999 | 0.000000382 | 0.00107 | 0.48808 | 0.00111 | -0.00000 | 0.00002 |
| 0.98 | 1.000000000 | 0.000000001 | 0.00000 | 0.21645 | 0.00000 | -0.00000 | 0.00000 |
| 0.99 | 1.000000000 | 0.000000000 | 0.00000 | 0.05411 | 0.00000 | -0.00000 | 0.00000 |
| 1.00 | 1.000000000 | 0.000000001 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 |
| 1.01 | 1.000000000 | 0.000000001 | -0.00000 | -0.05411 | -0.00000 | 0.00000 | -0.00000 |
| 1.02 | 1.000000000 | 0.000000000 | -0.00000 | -0.21645 | -0.00000 | 0.00000 | -0.00000 |
| 1.03 | 0.999999999 | 0.000000307 | -0.00017 | -0.48719 | -0.00018 | 0.00000 | -0.00000 |
| 1.04 | 1.000000006 | 0.000015499 | -0.00658 | -0.87239 | -0.00683 | 0.00002 | -0.00014 |
| 1.05 | 1.000000099 | 0.000163143 | -0.05510 | -1.40790 | -0.05714 | 0.00018 | -0.00109 |
| 1.06 | 1.000000673 | 0.000790788 | -0.21774 | -2.16574 | -0.22573 | 0.00071 | -0.00408 |
| 1.07 | 1.000002769 | 0.002471622 | -0.56601 | -3.21735 | -0.58651 | 0.00185 | -0.01010 |
| 1.08 | 1.000008306 | 0.005884685 | -1.13956 | -4.60234 | -1.18018 | 0.00373 | -0.01943 |
| 1.09 | 1.000020147 | 0.011698168 | -1.94303 | -6.32524 | -2.01086 | 0.00636 | -0.03171 |
| 1.10 | 1.000042032 | 0.020506538 | -2.95766 | -8.36717 | -3.05834 | 0.00969 | -0.04633 |
| 1.11 | 1.000078458 | 0.032814787 | -4.15409 | -10.69861 | -4.29137 | 0.01360 | -0.06259 |
| 1.12 | 1.000134569 | 0.049048904 | -5.50116 | -13.28819 | -5.67682 | 0.01802 | -0.07991 |
| 1.13 | 1.000216050 | 0.069575997 | -6.97053 | -16.10734 | -7.18454 | 0.02283 | -0.09782 |
| 1.14 | 1.000329066 | 0.094724915 | -8.53860 | -19.13220 | -8.78935 | 0.02797 | -0.11598 |
| 1.15 | 1.000480221 | 0.124803633 | -10.18679 | -22.34387 | -10.47126 | 0.03337 | -0.13414 |
| 1.16 | 1.000676539 | 0.160112464 | -11.90101 | -25.72791 | -12.21500 | 0.03899 | -0.15216 |
| 1.17 | 1.000925457 | 0.200953526 | -13.67097 | -29.27363 | -14.00923 | 0.04480 | -0.16995 |
| 1.18 | 1.001234836 | 0.247637223 | -15.48936 | -32.97332 | -15.84571 | 0.05076 | -0.18744 |
| 1.19 | 1.001612976 | 0.300486478 | -17.35121 | -36.82149 | -17.71862 | 0.05687 | -0.20463 |
| 1.20 | 1.002068631 | 0.359839428 | -19.25328 | -40.81437 | -19.62388 | 0.06312 | -0.22150 |
| 1.21 | 1.002611035 | 0.426051033 | -21.19357 | -44.94941 | -21.55873 | 0.06950 | -0.23807 |
| 1.22 | 1.003249928 | 0.499493948 | -23.17105 | -49.22492 | -23.52133 | 0.07600 | -0.25436 |
| 1.23 | 1.003995570 | 0.580558929 | -25.18528 | -53.63980 | -25.51048 | 0.08262 | -0.27039 |
| 1.24 | 1.004858783 | 0.669654959 | -27.23630 | -58.19332 | -27.52539 | 0.08938 | -0.28618 |
| 1.25 | 1.005850959 | 0.767209159 | -29.32441 | -62.88500 | -29.56554 | 0.09626 | -0.30175 |

Table 19. Loop closure computations for saturated liquid.

ENTHALPY, H, VIA FURTADO CP(T). HC VIA CLAPEYRON EQN.

| T,K | H | HC | PCT | S | SC | PCT |
|---|---|---|---|---|---|---|
| 90 | 5306 | 5382 | 1.45 | 76.57 | 77.16 | 0.77 |
| 95 | 5648 | 5677 | 0.51 | 80.28 | 80.44 | 0.21 |
| 100 | 5991 | 5978 | -0.22 | 83.80 | 83.55 | -0.29 |
| 105 | 6335 | 6296 | -0.61 | 87.15 | 86.65 | -0.57 |
| 110 | 6678 | 6633 | -0.68 | 90.35 | 89.79 | -0.62 |
| 115 | 7023 | 6987 | -0.52 | 93.41 | 92.93 | -0.51 |
| 120 | 7368 | 7352 | -0.21 | 96.35 | 96.05 | -0.31 |
| 125 | 7714 | 7724 | 0.13 | 99.17 | 99.09 | -0.08 |
| 130 | 8061 | 8098 | 0.46 | 101.89 | 102.04 | 0.14 |
| 135 | 8409 | 8470 | 0.73 | 104.52 | 104.86 | 0.32 |
| 140 | 8758 | 8837 | 0.90 | 107.06 | 107.54 | 0.45 |
| 145 | 9108 | 9197 | 0.98 | 109.51 | 110.08 | 0.52 |
| 150 | 9460 | 9552 | 0.97 | 111.90 | 112.50 | 0.54 |
| 155 | 9814 | 9901 | 0.89 | 114.22 | 114.80 | 0.51 |
| 160 | 10169 | 10246 | 0.76 | 116.47 | 117.00 | 0.45 |
| 165 | 10527 | 10589 | 0.60 | 118.67 | 119.11 | 0.38 |
| 170 | 10886 | 10932 | 0.42 | 120.81 | 121.16 | 0.29 |
| 175 | 11248 | 11277 | 0.26 | 122.91 | 123.16 | 0.20 |
| 180 | 11613 | 11626 | 0.11 | 124.96 | 125.11 | 0.13 |
| 185 | 11981 | 11979 | -0.02 | 126.96 | 127.04 | 0.06 |
| 190 | 12352 | 12340 | -0.10 | 128.93 | 128.95 | 0.02 |
| 195 | 12727 | 12707 | -0.15 | 130.87 | 130.85 | -0.01 |
| 200 | 13106 | 13083 | -0.17 | 132.77 | 132.73 | -0.03 |
| 205 | 13488 | 13466 | -0.16 | 134.65 | 134.61 | -0.03 |
| 210 | 13876 | 13857 | -0.14 | 136.50 | 136.47 | -0.02 |
| 215 | 14268 | 14255 | -0.09 | 138.32 | 138.32 | -0.00 |
| 220 | 14666 | 14660 | -0.04 | 140.13 | 140.15 | 0.02 |
| 225 | 15070 | 15071 | 0.00 | 141.92 | 141.97 | 0.04 |
| 230 | 15480 | 15486 | 0.04 | 143.69 | 143.77 | 0.05 |
| 235 | 15898 | 15908 | 0.06 | 145.45 | 145.54 | 0.06 |
| 240 | 16323 | 16336 | 0.08 | 147.21 | 147.30 | 0.06 |
| 245 | 16758 | 16768 | 0.07 | 148.96 | 149.04 | 0.06 |
| 250 | 17202 | 17210 | 0.05 | 150.70 | 150.77 | 0.05 |
| 255 | 17657 | 17660 | 0.02 | 152.45 | 152.50 | 0.03 |
| 260 | 18125 | 18123 | -0.01 | 154.21 | 154.24 | 0.02 |
| 265 | 18607 | 18601 | -0.03 | 155.99 | 156.00 | 0.01 |
| 270 | 19107 | 19098 | -0.05 | 157.78 | 157.78 | 0.00 |
| 275 | 19628 | 19619 | -0.04 | 159.62 | 159.62 | 0.00 |
| 280 | 20175 | 20169 | -0.03 | 161.50 | 161.51 | 0.01 |
| 285 | 20756 | 20754 | -0.01 | 163.46 | 163.48 | 0.01 |
| 290 | 21386 | 21383 | -0.02 | 165.55 | 165.56 | 0.01 |
| 295 | 22093 | 22080 | -0.06 | 167.84 | 167.82 | -0.01 |
| 300 | 22950 | 22915 | -0.16 | 170.58 | 170.49 | -0.06 |

Table 20. Experimental and calculated specific heats, $C_p(\rho, T)$.

| T,K | MOL/L | J/MOL/K | CALCD | PCNT |
|---|---|---|---|---|
| | THE CP ISOBAR AT P = | | 0.000 BAR | |
| 99.817 | 0.000 | 35.86 | 35.72 | 0.37 |
| 110.928 | 0.000 | 36.49 | 36.34 | 0.41 |
| 118.372 | 0.000 | 36.98 | 36.76 | 0.59 |
| 122.039 | 0.000 | 37.24 | 36.97 | 0.73 |
| 133.150 | 0.000 | 37.99 | 37.61 | 1.00 |
| 144.261 | 0.000 | 38.74 | 38.28 | 1.19 |
| 155.372 | 0.000 | 39.25 | 38.98 | 0.69 |
| 166.483 | 0.000 | 40.02 | 39.72 | 0.74 |
| 177.594 | 0.000 | 40.77 | 40.51 | 0.64 |
| 186.872 | 0.000 | 41.39 | 41.21 | 0.43 |
| 188.706 | 0.000 | 41.65 | 41.35 | 0.72 |
| 199.817 | 0.000 | 42.53 | 42.24 | 0.67 |
| 210.928 | 0.000 | 43.52 | 43.20 | 0.74 |
| 222.039 | 0.000 | 44.53 | 44.21 | 0.73 |
| 233.150 | 0.000 | 45.55 | 45.27 | 0.60 |
| 241.761 | 0.000 | 46.43 | 46.14 | 0.62 |
| 244.261 | 0.000 | 46.67 | 46.39 | 0.59 |
| 255.372 | 0.000 | 47.93 | 47.56 | 0.76 |
| 266.483 | 0.000 | 49.20 | 48.78 | 0.85 |
| 277.594 | 0.000 | 50.46 | 50.04 | 0.82 |
| 282.706 | 0.000 | 50.96 | 50.63 | 0.65 |
| 288.706 | 0.000 | 51.71 | 51.34 | 0.72 |
| 299.817 | 0.000 | 52.84 | 52.67 | 0.31 |
| 305.261 | 0.000 | 53.21 | 53.34 | -0.23 |
| 310.928 | 0.000 | 53.85 | 54.03 | -0.34 |
| 322.039 | 0.000 | 55.24 | 55.42 | -0.33 |
| 324.817 | 0.000 | 55.61 | 55.77 | -0.29 |
| 333.150 | 0.000 | 56.62 | 56.83 | -0.36 |
| 344.261 | 0.000 | 58.12 | 58.25 | -0.22 |
| 355.372 | 0.000 | 60.15 | 59.68 | 0.77 |
| 366.483 | 0.000 | 61.65 | 61.12 | 0.85 |
| 366.817 | 0.000 | 61.78 | 61.17 | 0.99 |
| 377.594 | 0.000 | 63.17 | 62.57 | 0.94 |
| 388.706 | 0.000 | 64.53 | 64.02 | 0.80 |
| 399.817 | 0.000 | 65.81 | 65.46 | 0.53 |
| 410.928 | 0.000 | 66.56 | 66.90 | -0.51 |
| 422.039 | 0.000 | 67.81 | 68.33 | -0.76 |

| T,K | MOL/L | J/MOL/K | CALCD | PCNT |
|---|---|---|---|---|
| | THE CP ISOBAR AT P = | | 17.237 BAR | |
| 99.817 | 21.340 | 68.45 | 68.59 | -0.21 |
| 110.928 | 20.943 | 68.69 | 68.80 | -0.15 |
| 118.372 | 20.676 | 68.83 | 68.98 | -0.23 |
| 122.039 | 20.544 | 68.94 | 69.09 | -0.22 |
| 133.150 | 20.142 | 69.20 | 69.50 | -0.43 |
| 144.261 | 19.734 | 69.82 | 70.03 | -0.30 |
| 155.372 | 19.318 | 70.70 | 70.70 | -0.00 |
| 166.483 | 18.891 | 71.47 | 71.55 | -0.11 |
| 177.594 | 18.452 | 72.46 | 72.59 | -0.18 |
| 186.872 | 18.073 | 73.34 | 73.63 | -0.39 |
| 188.706 | 17.936 | 73.47 | 73.86 | -0.53 |
| 199.817 | 17.522 | 74.99 | 75.41 | -0.55 |
| 210.928 | 17.025 | 76.75 | 77.31 | -0.72 |
| 222.039 | 16.498 | 78.89 | 79.66 | -0.98 |
| 233.150 | 15.933 | 82.02 | 82.67 | -0.80 |
| 241.761 | 15.460 | 85.30 | 85.68 | -0.44 |
| 244.261 | 15.315 | 85.94 | 86.70 | -0.89 |
| 249.817 | 14.980 | 89.33 | 89.31 | 0.02 |
| 252.594 | 14.804 | 91.34 | 90.84 | 0.55 |
| 255.372 | 14.621 | 94.11 | 92.54 | 1.67 |
| 258.150 | 14.431 | 98.76 | 94.48 | 4.33 |
| 260.928 | 1.053 | 74.35 | 71.68 | 3.59 |
| 262.594 | 1.037 | 72.72 | 70.51 | 3.04 |
| 265.372 | 1.012 | 70.21 | 68.88 | 1.90 |
| 266.483 | 1.002 | 69.44 | 68.32 | 1.62 |
| 277.594 | 0.921 | 65.17 | 64.56 | 0.94 |
| 282.706 | 0.890 | 64.05 | 63.57 | 0.75 |
| 288.706 | 0.858 | 63.28 | 62.77 | 0.80 |
| 299.817 | 0.805 | 62.40 | 62.01 | 0.62 |
| 305.261 | 0.783 | 62.15 | 61.87 | 0.45 |
| 310.928 | 0.761 | 62.02 | 61.86 | 0.27 |
| 322.039 | 0.723 | 62.28 | 62.10 | 0.30 |
| 324.817 | 0.714 | 62.40 | 62.20 | 0.31 |
| 333.150 | 0.689 | 62.77 | 62.61 | 0.26 |
| 344.261 | 0.659 | 63.65 | 63.31 | 0.53 |
| 355.372 | 0.632 | 64.53 | 64.17 | 0.57 |
| 366.483 | 0.608 | 65.30 | 65.12 | 0.27 |
| 366.817 | 0.607 | 65.41 | 65.15 | 0.40 |
| 377.594 | 0.586 | 66.18 | 66.17 | 0.03 |

Table 20. Experimental and calculated specific heats, $C_p(\rho, T)$, (continued).

THE CP ISOBAR AT P = 28.269 BAR

| T,K | MOL/L | J/MOL/K | CALCD | PCNT |
|---|---|---|---|---|
| 277.594 | 13.020 | 115.37 | 113.73 | 1.42 |
| 278.706 | 12.906 | 116.13 | 116.21 | -0.07 |
| 279.817 | 12.788 | 118.65 | 119.01 | -0.31 |

THE CP ISOBAR AT P = 34.474 BAR

| T,K | MOL/L | J/MOL/K | CALCD | PCNT |
|---|---|---|---|---|
| 233.150 | 16.045 | 81.78 | 81.55 | 0.28 |
| 241.761 | 15.594 | 84.42 | 84.13 | 0.35 |
| 244.261 | 15.457 | 85.30 | 84.99 | 0.37 |
| 255.372 | 14.807 | 89.20 | 89.67 | -0.53 |
| 266.483 | 14.066 | 96.88 | 96.69 | 0.20 |
| 277.594 | 13.165 | 109.70 | 109.28 | 0.39 |
| 282.706 | 12.652 | 119.26 | 119.93 | -0.56 |
| 285.928 | 12.272 | 128.82 | 130.62 | -1.40 |
| 287.594 | 12.049 | 136.88 | 138.50 | -1.18 |
| 288.706 | 11.886 | 142.81 | 145.26 | -1.72 |
| 290.372 | 2.432 | 131.60 | 132.60 | -0.77 |
| 291.483 | 2.377 | 122.28 | 124.59 | -1.89 |
| 292.594 | 2.327 | 115.63 | 118.25 | -2.27 |
| 294.261 | 2.261 | 107.19 | 110.84 | -3.40 |
| 297.039 | 2.166 | 98.52 | 101.99 | -3.53 |
| 299.817 | 2.087 | 98.38 | 95.77 | 2.66 |
| 305.261 | 1.959 | 87.06 | 87.69 | -0.72 |
| 310.928 | 1.853 | 82.28 | 82.43 | -0.18 |
| 322.039 | 1.691 | 76.25 | 76.54 | -0.39 |
| 324.817 | 1.658 | 75.61 | 75.60 | 0.02 |
| 333.150 | 1.569 | 73.72 | 73.53 | 0.26 |
| 344.261 | 1.470 | 72.22 | 71.96 | 0.36 |
| 355.372 | 1.388 | 71.47 | 71.23 | 0.33 |
| 366.483 | 1.318 | 71.47 | 71.04 | 0.60 |
| 366.817 | 1.316 | 71.47 | 71.04 | 0.60 |

THE CP ISOBAR AT P = 41.369 BAR

| T,K | MOL/L | J/MOL/K | CALCD | PCNT |
|---|---|---|---|---|
| 282.706 | 12.642 | 111.60 | 113.45 | -1.66 |
| 288.706 | 12.131 | 129.59 | 129.39 | 0.16 |
| 294.261 | 11.356 | 161.66 | 163.98 | -1.43 |
| 295.928 | 11.021 | 179.28 | 187.10 | -4.36 |
| 297.039 | 10.752 | 195.01 | 212.72 | -9.08 |
| 298.706 | 3.252 | 220.80 | 208.18 | 5.71 |
| 299.817 | 3.131 | 189.98 | 179.61 | 5.46 |
| 299.817 | 3.131 | 189.85 | 179.61 | 5.39 |
| 300.650 | 3.055 | 168.60 | 165.17 | 2.03 |
| 301.206 | 3.009 | 157.76 | 157.51 | 0.16 |
| 302.594 | 2.909 | 137.89 | 142.85 | -3.59 |
| 305.261 | 2.754 | 122.41 | 124.78 | -1.94 |
| 310.928 | 2.516 | 104.68 | 104.74 | -0.06 |
| 322.039 | 2.214 | 89.20 | 88.19 | 1.13 |
| 324.817 | 2.157 | 86.93 | 85.89 | 1.20 |

THE CP ISOBAR AT P = 46.678 BAR

| T,K | MOL/L | J/MOL/K | CALCD | PCNT |
|---|---|---|---|---|
| 298.428 | 10.938 | 174.88 | 180.66 | -3.31 |
| 299.817 | 10.619 | 198.79 | 206.55 | -3.90 |
| 300.650 | 10.392 | 221.43 | 230.76 | -4.21 |
| 301.206 | 10.219 | 240.31 | 253.87 | -5.64 |
| 302.039 | 9.906 | 279.31 | 310.02 | -10.99 |
| 302.594 | 9.639 | 320.83 | 381.40 | -18.88 |
| 302.872 | 9.474 | 352.28 | 443.36 | -25.85 |
| 303.150 | 9.270 | 401.35 | 549.78 | -36.98 |
| 303.983 | 4.273 | 425.25 | 457.03 | -7.47 |
| 304.261 | 4.176 | 352.28 | 394.11 | -11.87 |
| 305.261 | 3.922 | 299.44 | 281.47 | 6.00 |
| 305.372 | 3.900 | 293.15 | 274.01 | 6.53 |
| 305.928 | 3.799 | 261.69 | 243.90 | 6.80 |
| 306.761 | 3.673 | 223.95 | 213.18 | 4.81 |
| 308.150 | 3.505 | 184.94 | 181.23 | 2.00 |
| 309.539 | 3.371 | 162.30 | 161.11 | 0.73 |
| 310.928 | 3.259 | 148.47 | 147.11 | 0.92 |
| 310.928 | 3.259 | 148.84 | 147.11 | 1.17 |
| 313.706 | 3.078 | 130.85 | 128.66 | 1.67 |
| 316.483 | 2.934 | 120.28 | 116.93 | 2.78 |
| 322.039 | 2.712 | 119.02 | 102.71 | 13.71 |
| 324.817 | 2.623 | 97.88 | 98.06 | -0.18 |

Table 20. Experimental and calculated specific heats, $C_p(\rho, T)$, (continued).

| THE CP ISOBAR AT P = 49.160 BAR | | | | |
|---|---|---|---|---|
| T,K | MOL/L | J/MOL/K | CALCD | PCNT |
| 282.706 | 13.026 | 106.07 | 108.18 | -1.99 |
| 283.150 | 12.986 | 106.69 | 108.82 | -2.00 |
| 288.706 | 12.443 | 119.15 | 119.03 | 0.10 |
| 294.261 | 11.778 | 135.50 | 136.93 | -1.06 |
| 297.039 | 11.366 | 149.08 | 152.75 | -2.46 |
| 298.261 | 11.158 | 156.64 | 162.78 | -3.92 |
| 299.817 | 10.858 | 177.89 | 180.52 | -1.47 |
| 300.928 | 10.610 | 193.13 | 199.02 | -3.05 |
| 302.039 | 10.320 | 217.40 | 226.77 | -4.31 |
| 302.594 | 10.152 | 231.24 | 246.82 | -6.74 |
| 303.150 | 9.963 | 246.48 | 274.21 | -11.25 |
| 303.706 | 9.743 | 274.40 | 314.24 | -14.52 |
| 304.261 | 9.476 | 566.16 | 379.44 | 32.98 |
| 304.817 | 9.125 | 691.97 | 510.24 | 26.26 |
| 305.261 | 8.707 | 1006.50 | 795.16 | 21.00 |
| 305.261 | 8.707 | 1132.32 | 795.16 | 29.78 |
| 306.483 | 4.904 | 553.58 | 709.02 | -28.08 |
| 307.039 | 4.603 | 488.15 | 474.72 | 2.75 |
| 307.594 | 4.401 | 375.56 | 371.78 | 1.01 |
| 308.150 | 4.247 | 332.39 | 312.59 | 5.96 |
| 309.261 | 4.016 | 261.83 | 246.21 | 5.97 |
| 310.928 | 3.769 | 200.05 | 196.12 | 1.96 |
| 313.706 | 3.485 | 158.14 | 155.87 | 1.44 |
| 316.483 | 3.281 | 135.50 | 134.78 | 0.53 |
| 322.039 | 2.987 | 108.82 | 112.55 | -3.42 |
| 324.817 | 2.875 | 101.91 | 105.91 | -3.92 |
| 327.594 | 2.777 | 102.54 | 100.83 | 1.67 |
| 333.150 | 2.613 | 95.37 | 93.61 | 1.84 |

| THE CP ISOBAR AT P = 51.711 BAR | | | | |
|---|---|---|---|---|
| T,K | MOL/L | J/MOL/K | CALCD | PCNT |
| 322.039 | 3.310 | 125.81 | 126.12 | -0.25 |
| 324.817 | 3.164 | 116.88 | 116.22 | 0.57 |
| 333.150 | 2.841 | 99.26 | 99.23 | 0.04 |
| 344.261 | 2.549 | 88.82 | 88.60 | 0.26 |
| 355.372 | 2.339 | 83.03 | 83.19 | -0.19 |
| 366.483 | 2.176 | 79.27 | 80.19 | -1.16 |
| 366.817 | 2.171 | 79.13 | 80.12 | -1.25 |
| 377.594 | 2.043 | 76.75 | 78.50 | -2.28 |

| THE CP ISOBAR AT P = 56.468 BAR | | | | |
|---|---|---|---|---|
| T,K | MOL/L | J/MOL/K | CALCD | PCNT |
| 310.372 | 8.515 | 408.89 | 442.02 | -8.10 |
| 310.650 | 8.338 | 444.12 | 479.25 | -7.91 |
| 310.928 | 8.146 | 483.13 | 519.80 | -7.59 |
| 311.206 | 7.938 | 530.92 | 560.87 | -5.64 |
| 311.483 | 7.718 | 577.48 | 596.74 | -3.33 |
| 311.761 | 7.488 | 626.55 | 619.71 | 1.09 |
| 312.039 | 7.256 | 666.81 | 623.91 | 6.43 |
| 312.150 | 7.165 | 680.65 | 620.86 | 8.78 |
| 312.261 | 7.076 | 689.46 | 616.16 | 10.63 |
| 312.428 | 6.944 | 693.22 | 607.65 | 12.34 |
| 312.594 | 6.817 | 694.48 | 598.49 | 13.82 |
| 312.706 | 6.733 | 693.22 | 598.20 | 13.71 |
| 312.817 | 6.652 | 691.97 | 591.75 | 14.48 |
| 312.928 | 6.572 | 679.39 | 585.18 | 13.87 |
| 313.150 | 6.418 | 644.15 | 571.49 | 11.28 |
| 313.428 | 6.235 | 595.10 | 549.95 | 7.59 |
| 313.706 | 6.064 | 552.31 | 520.95 | 5.68 |
| 313.983 | 5.909 | 514.58 | 489.20 | 4.93 |
| 314.261 | 5.766 | 485.64 | 458.39 | 5.61 |

Table 20. Experimental and calculated specific heats, $C_p(\rho, T)$, (continued).

THE CP ISOBAR AT P = 63.948 BAR

| T,K | MOL/L | J/MOL/K | CALCD | PCNT |
|---|---|---|---|---|
| 110.928 | 21.009 | 68.56 | 68.64 | -0.11 |
| 118.372 | 20.748 | 68.69 | 68.79 | -0.13 |
| 122.039 | 20.619 | 68.83 | 68.87 | -0.07 |
| 133.150 | 20.227 | 69.07 | 69.21 | -0.20 |
| 144.261 | 19.830 | 69.71 | 69.66 | 0.07 |
| 155.372 | 19.426 | 70.46 | 70.23 | 0.32 |
| 166.483 | 19.015 | 71.21 | 70.96 | 0.35 |
| 177.594 | 18.593 | 71.84 | 71.84 | -0.00 |
| 186.872 | 18.232 | 72.46 | 72.73 | -0.36 |
| 188.706 | 18.159 | 73.23 | 72.92 | 0.43 |
| 199.817 | 17.711 | 73.98 | 74.20 | -0.29 |
| 210.928 | 17.246 | 75.37 | 75.72 | -0.47 |
| 222.039 | 16.760 | 77.00 | 77.54 | -0.70 |
| 233.150 | 16.250 | 79.27 | 79.71 | -0.57 |
| 241.761 | 15.833 | 81.14 | 81.72 | -0.72 |
| 244.261 | 15.708 | 82.41 | 82.37 | 0.06 |
| 255.372 | 15.126 | 85.68 | 85.68 | -0.01 |
| 266.483 | 14.489 | 89.46 | 90.00 | -0.60 |
| 277.594 | 13.773 | 95.74 | 96.01 | -0.28 |
| 282.706 | 13.407 | 98.89 | 99.72 | -0.83 |
| 288.706 | 12.937 | 104.93 | 105.30 | -0.36 |
| 299.817 | 11.886 | 111.84 | 122.47 | -9.50 |
| 305.261 | 11.228 | 137.15 | 138.02 | -0.64 |
| 310.928 | 10.353 | 158.53 | 166.91 | -5.29 |
| 314.261 | 9.687 | 176.39 | 196.21 | -11.23 |
| 316.483 | 9.148 | 200.16 | 223.37 | -11.59 |
| 317.594 | 8.844 | 222.69 | 238.79 | -7.23 |
| 319.261 | 8.349 | 254.27 | 260.98 | -2.64 |
| 320.372 | 7.998 | 270.62 | 271.62 | -0.37 |
| 320.928 | 7.820 | 277.80 | 274.61 | 1.15 |
| 322.039 | 7.468 | 284.97 | 274.66 | 3.62 |
| 322.706 | 7.264 | 285.59 | 271.01 | 5.11 |
| 323.706 | 6.972 | 285.22 | 262.63 | 7.92 |
| 324.817 | 6.670 | 281.83 | 256.13 | 9.12 |
| 324.817 | 6.670 | 282.20 | 256.13 | 9.24 |
| 325.372 | 6.528 | 277.16 | 251.11 | 9.40 |
| 326.483 | 6.261 | 258.30 | 240.78 | 6.78 |
| 327.594 | 6.017 | 240.93 | 228.87 | 5.01 |
| 330.372 | 5.503 | 200.55 | 199.26 | 0.64 |
| 333.150 | 5.103 | 176.51 | 175.40 | 0.62 |
| 335.928 | 4.784 | 158.91 | 157.02 | 1.19 |
| 338.706 | 4.525 | 143.69 | 142.97 | 0.50 |
| 344.261 | 4.126 | 123.29 | 123.74 | -0.36 |
| 355.372 | 3.594 | 104.42 | 103.65 | 0.73 |
| 366.483 | 3.241 | 94.49 | 93.94 | 0.58 |
| 366.817 | 3.232 | 94.24 | 93.73 | 0.55 |

THE CP ISOBAR AT P = 86.184 BAR

| T,K | MOL/L | J/MOL/K | CALCD | PCNT |
|---|---|---|---|---|
| 282.706 | 13.675 | 94.86 | 95.17 | -0.33 |
| 288.706 | 13.260 | 98.89 | 98.94 | -0.05 |
| 299.817 | 12.389 | 108.21 | 108.67 | -0.42 |
| 305.261 | 11.894 | 114.62 | 115.53 | -0.80 |
| 310.928 | 11.310 | 123.42 | 125.07 | -1.33 |
| 316.483 | 10.647 | 134.61 | 137.82 | -2.38 |
| 322.039 | 9.867 | 149.97 | 154.63 | -3.11 |
| 324.817 | 9.428 | 160.16 | 164.03 | -2.41 |
| 327.594 | 8.957 | 168.20 | 172.82 | -2.75 |
| 330.372 | 8.467 | 176.13 | 179.23 | -1.76 |
| 333.150 | 7.973 | 180.54 | 181.35 | -0.45 |
| 334.817 | 7.684 | 181.17 | 180.18 | 0.55 |
| 337.039 | 7.317 | 180.29 | 176.04 | 2.36 |
| 338.706 | 7.060 | 177.65 | 171.68 | 3.36 |
| 341.483 | 6.665 | 170.23 | 165.13 | 2.99 |
| 344.261 | 6.311 | 161.79 | 157.81 | 2.46 |
| 349.817 | 5.713 | 148.47 | 142.89 | 3.75 |
| 355.372 | 5.241 | 134.00 | 130.08 | 2.92 |
| 366.483 | 4.557 | 114.24 | 112.09 | 1.88 |
| 366.817 | 4.540 | 113.98 | 111.68 | 2.01 |
| 377.594 | 4.086 | 101.66 | 101.36 | 0.30 |

Table 20. Experimental and calculated specific heats, $C_p(\rho, T)$, (continued).

THE CP ISOBAR AT P = 103.421 BAR

| T,K | MOL/L | J/MOL/K | CALCD | PCNT |
|---|---|---|---|---|
| 241.761 | 16.045 | 79.64 | 79.93 | -0.36 |
| 244.261 | 15.929 | 80.15 | 80.44 | -0.37 |
| 255.372 | 15.394 | 82.79 | 82.99 | -0.25 |
| 266.483 | 14.824 | 85.94 | 86.07 | -0.15 |
| 277.594 | 14.207 | 89.84 | 89.86 | -0.03 |
| 282.706 | 13.903 | 91.84 | 91.94 | -0.11 |
| 288.706 | 13.528 | 94.73 | 94.74 | -0.01 |
| 299.817 | 12.765 | 101.66 | 101.29 | 0.37 |
| 305.261 | 12.349 | 105.68 | 105.41 | 0.25 |
| 310.928 | 11.881 | 110.34 | 110.57 | -0.21 |
| 316.483 | 11.378 | 115.63 | 116.70 | -0.92 |
| 322.039 | 10.825 | 122.17 | 124.00 | -1.50 |
| 324.817 | 10.528 | 126.44 | 128.06 | -1.28 |
| 327.594 | 10.217 | 129.97 | 132.29 | -1.79 |
| 333.150 | 9.555 | 137.89 | 140.60 | -1.96 |
| 338.706 | 8.855 | 144.81 | 146.68 | -1.29 |
| 344.261 | 8.156 | 150.85 | 148.60 | 1.49 |
| 344.928 | 8.074 | 151.73 | 148.33 | 2.24 |
| 345.928 | 7.953 | 151.48 | 147.78 | 2.44 |
| 348.150 | 7.691 | 151.11 | 146.01 | 3.37 |
| 349.817 | 7.501 | 149.22 | 144.25 | 3.33 |
| 352.594 | 7.202 | 144.81 | 140.73 | 2.82 |
| 355.372 | 6.923 | 140.91 | 136.97 | 2.80 |
| 360.928 | 6.425 | 132.35 | 130.00 | 1.77 |
| 366.483 | 5.996 | 126.82 | 123.53 | 2.60 |
| 366.817 | 5.972 | 126.44 | 123.14 | 2.61 |
| 377.594 | 5.311 | 116.75 | 112.23 | 3.87 |

THE CP ISOBAR AT P = 120.658 BAR

| T,K | MOL/L | J/MOL/K | CALCD | PCNT |
|---|---|---|---|---|
| 324.817 | 11.192 | 113.73 | 113.36 | 0.33 |
| 333.150 | 10.439 | 120.28 | 120.95 | -0.56 |
| 338.706 | 9.903 | 124.68 | 125.75 | -0.86 |
| 344.261 | 9.348 | 129.70 | 130.03 | -0.25 |
| 347.039 | 9.068 | 131.60 | 130.98 | 0.47 |
| 349.817 | 8.790 | 132.74 | 131.44 | 0.98 |
| 351.761 | 8.598 | 133.12 | 131.44 | 1.26 |
| 352.317 | 8.543 | 133.23 | 131.39 | 1.38 |
| 355.372 | 8.248 | 132.35 | 130.74 | 1.21 |
| 358.150 | 7.938 | 130.34 | 129.64 | 0.54 |
| 360.928 | 7.738 | 128.34 | 128.13 | 0.16 |
| 366.483 | 7.274 | 124.04 | 124.21 | -0.13 |
| 366.817 | 7.247 | 123.80 | 123.95 | -0.12 |
| 377.594 | 6.486 | 117.26 | 116.09 | 1.00 |

THE CP ISOBAR AT P = 137.895 BAR

| T,K | MOL/L | J/MOL/K | CALCD | PCNT |
|---|---|---|---|---|
| 110.928 | 21.095 | 68.19 | 68.45 | -0.39 |
| 118.372 | 20.841 | 68.45 | 68.55 | -0.15 |
| 122.039 | 20.716 | 68.56 | 68.62 | -0.08 |
| 133.150 | 20.335 | 68.94 | 68.87 | 0.10 |
| 144.261 | 19.952 | 69.44 | 69.23 | 0.31 |
| 155.372 | 19.564 | 70.08 | 69.70 | 0.55 |
| 166.483 | 19.170 | 70.59 | 70.29 | 0.41 |
| 177.594 | 18.768 | 71.09 | 71.03 | 0.09 |
| 186.872 | 18.427 | 71.58 | 71.75 | -0.24 |
| 188.706 | 18.358 | 71.71 | 71.91 | -0.27 |
| 199.817 | 17.938 | 72.72 | 72.94 | -0.30 |
| 210.928 | 17.507 | 73.98 | 74.15 | -0.23 |
| 222.039 | 17.063 | 75.37 | 75.54 | -0.23 |
| 233.150 | 16.603 | 77.13 | 77.14 | -0.01 |
| 241.761 | 16.235 | 78.63 | 78.53 | 0.13 |
| 244.261 | 16.126 | 79.00 | 78.96 | 0.06 |
| 255.372 | 15.628 | 81.14 | 81.03 | 0.13 |
| 266.483 | 15.105 | 83.41 | 83.42 | -0.01 |
| 277.594 | 14.552 | 86.31 | 86.17 | 0.17 |
| 282.706 | 14.285 | 87.70 | 87.58 | 0.13 |
| 288.706 | 13.961 | 89.71 | 89.39 | 0.36 |
| 299.817 | 13.325 | 92.97 | 93.22 | -0.27 |
| 305.261 | 12.994 | 94.86 | 95.38 | -0.55 |
| 310.928 | 12.633 | 97.88 | 97.88 | 0.00 |
| 322.039 | 11.875 | 103.80 | 103.63 | 0.17 |
| 324.817 | 11.673 | 105.43 | 105.26 | 0.16 |
| 333.150 | 11.041 | 110.45 | 110.54 | -0.08 |
| 344.261 | 10.140 | 116.62 | 117.70 | -0.93 |
| 355.372 | 9.204 | 120.28 | 120.81 | -0.44 |
| 366.483 | 8.302 | 120.65 | 120.01 | 0.53 |
| 366.817 | 8.276 | 118.38 | 119.93 | -1.30 |
| 377.594 | 7.497 | 112.61 | 115.84 | -2.87 |

Table 21. Comparison of Enthalpies for Saturated Liquid, J/mol

| T, K | Tester [70] | This Report | Difference |
|---|---|---|---|
| 100 | 6 075 | 5 991 | 84 |
| 120 | 7 447 | 7 368 | 79 |
| 140 | 8 833 | 8 758 | 75 |
| 160 | 10 243 | 10 169 | 74 |
| 180 | 11 682 | 11 613 | 69 |
| 200 | 13 156 | 13 106 | 50 |
| 220 | 14 678 | 14 666 | 12 |
| 240 | 16 281 | 16 323 | -42 |
| 260 | 18 006 | 18 125 | -119 |
| 280 | 19 940 | 20 175 | -235 |
| 300 | 22 720 | 22 950 | -230 |

Table 22. Comparison of Enthalpies, J/mol†

| | | P = 20 atm | | | P = 100 atm | | |
|---|---|---|---|---|---|---|---|
| T, K | $H^o$ | HT | TE | RG* | HT | TE | RG** |
| 280 | 31 228 | 29 493 | 29 457 | 29 535 | -- | -- | -- |
| 320 | 33 348 | 32 169 | 32 169 | 32 137 | 24 122 | 23 774 | 24 019 |
| 360 | 35 666 | 34 781 | 34 799 | 34 708 | 29 715 | 29 733 | 29 720 |
| 400 | 38 188 | 37 493 | 37 515 | 37 391 | 34 185 | 34 270 | 34 134 |
| 460 | 42 353 | 41 837 | 41 862 | 41 718 | 39 680 | 39 771 | 39 564 |

† HT = Tester [70], TE = Eubank et al. [18], RG = This Report,

* Pressure of 20 bar; ** Pressure of 100 bar.

Table 23. Calculated P(T) isochores

The following pages give P(T) along isochores, as computed by the equation of state. The third column DP/DD is the isotherm slope $(\partial P/\partial \rho)$ in units of the bar and mol/$\ell$. The last two columns give the isochore slopes and curvatures $\partial P/\partial T$, $\partial^2 P/\partial T^2$, in units of the bar and K.

These tables show that the isochore curvatures are qualitatively consistent with a maximum in the specific heat $C_v(\rho, T)$ at the critical point.

Table 23. Calculated P(T) isochores.

THE ISOCHORE AT 1.00 MOL/L

| T,K | P,BAR | DP/DD | DP/DT | D2P/DT2 |
|---|---|---|---|---|
| 266.0 | 17.157 | 12.481 | 0.1051 | -0.00021 |
| 274.0 | 17.992 | 13.495 | 0.1035 | -0.00017 |
| 282.0 | 18.815 | 14.482 | 0.1023 | -0.00015 |
| 290.0 | 19.628 | 15.448 | 0.1012 | -0.00012 |
| 298.0 | 20.434 | 16.395 | 0.1003 | -0.00011 |
| 306.0 | 21.233 | 17.328 | 0.0995 | -0.00009 |
| 314.0 | 22.026 | 18.248 | 0.0988 | -0.00008 |
| 322.0 | 22.814 | 19.156 | 0.0982 | -0.00007 |
| 330.0 | 23.597 | 20.055 | 0.0976 | -0.00007 |
| 338.0 | 24.375 | 20.946 | 0.0971 | -0.00006 |
| 346.0 | 25.150 | 21.828 | 0.0967 | -0.00005 |
| 354.0 | 25.922 | 22.704 | 0.0963 | -0.00005 |
| 362.0 | 26.691 | 23.574 | 0.0959 | -0.00004 |
| 370.0 | 27.457 | 24.438 | 0.0956 | -0.00004 |
| 378.0 | 28.220 | 25.298 | 0.0953 | -0.00004 |
| 386.0 | 28.981 | 26.152 | 0.0950 | -0.00003 |
| 394.0 | 29.740 | 27.003 | 0.0947 | -0.00003 |
| 402.0 | 30.497 | 27.849 | 0.0945 | -0.00003 |
| 410.0 | 31.252 | 28.692 | 0.0943 | -0.00003 |
| 418.0 | 32.005 | 29.532 | 0.0941 | -0.00002 |
| 426.0 | 32.757 | 30.369 | 0.0939 | -0.00002 |
| 434.0 | 33.508 | 31.203 | 0.0937 | -0.00002 |
| 442.0 | 34.257 | 32.034 | 0.0936 | -0.00002 |
| 450.0 | 35.004 | 32.863 | 0.0934 | -0.00002 |
| 458.0 | 35.751 | 33.690 | 0.0933 | -0.00002 |
| 466.0 | 36.497 | 34.514 | 0.0931 | -0.00002 |
| 474.0 | 37.241 | 35.337 | 0.0930 | -0.00002 |
| 482.0 | 37.985 | 36.157 | 0.0929 | -0.00001 |
| 490.0 | 38.727 | 36.976 | 0.0928 | -0.00001 |
| 498.0 | 39.469 | 37.793 | 0.0927 | -0.00001 |
| 506.0 | 40.210 | 38.609 | 0.0926 | -0.00001 |
| 514.0 | 40.950 | 39.423 | 0.0925 | -0.00001 |
| 522.0 | 41.690 | 40.235 | 0.0924 | -0.00001 |
| 530.0 | 42.428 | 41.047 | 0.0923 | -0.00001 |
| 538.0 | 43.166 | 41.857 | 0.0922 | -0.00001 |
| 546.0 | 43.904 | 42.666 | 0.0921 | -0.00001 |
| 554.0 | 44.641 | 43.473 | 0.0921 | -0.00001 |
| 562.0 | 45.377 | 44.280 | 0.0920 | -0.00001 |
| 570.0 | 46.113 | 45.085 | 0.0919 | -0.00001 |
| 578.0 | 46.848 | 45.890 | 0.0919 | -0.00001 |
| 586.0 | 47.583 | 46.694 | 0.0918 | -0.00001 |
| 594.0 | 48.317 | 47.496 | 0.0917 | -0.00001 |

Table 23. Calculated P(T) isochores- - - (Continued)

THE ISOCHORE AT 2.00 MOL/L

| T,K | P,BAR | DP/DD | DP/DT | D2P/DT2 |
|---|---|---|---|---|
| 290.0 | 31.339 | 8.269 | 0.2384 | -0.00066 |
| 298.0 | 33.227 | 9.482 | 0.2338 | -0.00051 |
| 306.0 | 35.082 | 10.654 | 0.2301 | -0.00042 |
| 314.0 | 36.910 | 11.796 | 0.2270 | -0.00035 |
| 322.0 | 38.716 | 12.915 | 0.2244 | -0.00030 |
| 330.0 | 40.502 | 14.015 | 0.2222 | -0.00026 |
| 338.0 | 42.272 | 15.099 | 0.2202 | -0.00023 |
| 346.0 | 44.027 | 16.169 | 0.2185 | -0.00020 |
| 354.0 | 45.769 | 17.228 | 0.2170 | -0.00018 |
| 362.0 | 47.499 | 18.276 | 0.2156 | -0.00016 |
| 370.0 | 49.219 | 19.315 | 0.2144 | -0.00015 |
| 378.0 | 50.930 | 20.346 | 0.2133 | -0.00013 |
| 386.0 | 52.632 | 21.370 | 0.2123 | -0.00012 |
| 394.0 | 54.327 | 22.387 | 0.2113 | -0.00011 |
| 402.0 | 56.014 | 23.399 | 0.2105 | -0.00010 |
| 410.0 | 57.695 | 24.404 | 0.2097 | -0.00009 |
| 418.0 | 59.369 | 25.405 | 0.2090 | -0.00009 |
| 426.0 | 61.039 | 26.401 | 0.2083 | -0.00008 |
| 434.0 | 62.703 | 27.393 | 0.2077 | -0.00007 |
| 442.0 | 64.362 | 28.380 | 0.2071 | -0.00007 |
| 450.0 | 66.017 | 29.365 | 0.2066 | -0.00006 |
| 458.0 | 67.668 | 30.345 | 0.2061 | -0.00006 |
| 466.0 | 69.314 | 31.323 | 0.2056 | -0.00006 |
| 474.0 | 70.958 | 32.297 | 0.2052 | -0.00005 |
| 482.0 | 72.597 | 33.269 | 0.2048 | -0.00005 |
| 490.0 | 74.234 | 34.238 | 0.2044 | -0.00005 |
| 498.0 | 75.867 | 35.204 | 0.2040 | -0.00004 |
| 506.0 | 77.498 | 36.168 | 0.2036 | -0.00004 |
| 514.0 | 79.126 | 37.130 | 0.2033 | -0.00004 |
| 522.0 | 80.751 | 38.090 | 0.2030 | -0.00004 |
| 530.0 | 82.374 | 39.047 | 0.2027 | -0.00004 |
| 538.0 | 83.994 | 40.003 | 0.2024 | -0.00003 |
| 546.0 | 85.613 | 40.957 | 0.2021 | -0.00003 |
| 554.0 | 87.229 | 41.909 | 0.2019 | -0.00003 |
| 562.0 | 88.843 | 42.860 | 0.2016 | -0.00003 |
| 570.0 | 90.455 | 43.808 | 0.2014 | -0.00003 |
| 578.0 | 92.065 | 44.756 | 0.2012 | -0.00003 |
| 586.0 | 93.674 | 45.701 | 0.2010 | -0.00003 |
| 594.0 | 95.281 | 46.646 | 0.2008 | -0.00003 |

Table 23. Calculated P(T) isochores- - - (Continued)

THE ISOCHORE AT 3.00 MOL/L

| T,K | P,BAR | DP/DD | DP/DT | D2P/DT2 |
|---|---|---|---|---|
| 298.0 | 40.058 | 4.480 | 0.3967 | -0.00163 |
| 306.0 | 43.187 | 5.849 | 0.3862 | -0.00107 |
| 314.0 | 46.246 | 7.159 | 0.3788 | -0.00080 |
| 322.0 | 49.252 | 8.432 | 0.3731 | -0.00064 |
| 330.0 | 52.218 | 9.682 | 0.3684 | -0.00053 |
| 338.0 | 55.149 | 10.913 | 0.3645 | -0.00045 |
| 346.0 | 58.051 | 12.131 | 0.3611 | -0.00039 |
| 354.0 | 60.928 | 13.336 | 0.3582 | -0.00034 |
| 362.0 | 63.782 | 14.532 | 0.3556 | -0.00031 |
| 370.0 | 66.617 | 15.719 | 0.3532 | -0.00027 |
| 378.0 | 69.435 | 16.898 | 0.3512 | -0.00025 |
| 386.0 | 72.237 | 18.071 | 0.3493 | -0.00022 |
| 394.0 | 75.024 | 19.239 | 0.3476 | -0.00020 |
| 402.0 | 77.799 | 20.401 | 0.3460 | -0.00019 |
| 410.0 | 80.561 | 21.558 | 0.3446 | -0.00017 |
| 418.0 | 83.313 | 22.710 | 0.3433 | -0.00016 |
| 426.0 | 86.054 | 23.859 | 0.3421 | -0.00015 |
| 434.0 | 88.787 | 25.004 | 0.3410 | -0.00014 |
| 442.0 | 91.510 | 26.146 | 0.3399 | -0.00013 |
| 450.0 | 94.226 | 27.284 | 0.3390 | -0.00012 |
| 458.0 | 96.934 | 28.419 | 0.3381 | -0.00011 |
| 466.0 | 99.635 | 29.552 | 0.3372 | -0.00010 |
| 474.0 | 102.330 | 30.681 | 0.3364 | -0.00010 |
| 482.0 | 105.018 | 31.808 | 0.3357 | -0.00009 |
| 490.0 | 107.700 | 32.933 | 0.3349 | -0.00009 |
| 498.0 | 110.377 | 34.056 | 0.3343 | -0.00008 |
| 506.0 | 113.049 | 35.176 | 0.3336 | -0.00008 |
| 514.0 | 115.715 | 36.294 | 0.3330 | -0.00007 |
| 522.0 | 118.377 | 37.410 | 0.3325 | -0.00007 |
| 530.0 | 121.034 | 38.524 | 0.3319 | -0.00007 |
| 538.0 | 123.688 | 39.637 | 0.3314 | -0.00006 |
| 546.0 | 126.337 | 40.748 | 0.3309 | -0.00006 |
| 554.0 | 128.982 | 41.856 | 0.3304 | -0.00006 |
| 562.0 | 131.623 | 42.964 | 0.3300 | -0.00006 |
| 570.0 | 134.261 | 44.070 | 0.3295 | -0.00005 |
| 578.0 | 136.895 | 45.174 | 0.3291 | -0.00005 |
| 586.0 | 139.527 | 46.276 | 0.3287 | -0.00005 |
| 594.0 | 142.155 | 47.378 | 0.3283 | -0.00005 |

Table 23. Calculated P(T) isochores- - - (Continued)

THE ISOCHORE AT 4.00 MOL/L

| T,K | P,BAR | DP/DD | DP/DT | D2P/DT2 |
|---|---|---|---|---|
| 306.0 | 47.293 | 2.606 | 0.5608 | -0.00241 |
| 314.0 | 51.716 | 4.014 | 0.5465 | -0.00137 |
| 322.0 | 56.049 | 5.384 | 0.5373 | -0.00098 |
| 330.0 | 60.319 | 6.736 | 0.5304 | -0.00076 |
| 338.0 | 64.539 | 8.079 | 0.5248 | -0.00063 |
| 346.0 | 68.719 | 9.415 | 0.5202 | -0.00053 |
| 354.0 | 72.864 | 10.746 | 0.5163 | -0.00046 |
| 362.0 | 76.981 | 12.074 | 0.5129 | -0.00040 |
| 370.0 | 81.071 | 13.398 | 0.5098 | -0.00036 |
| 378.0 | 85.139 | 14.720 | 0.5072 | -0.00032 |
| 386.0 | 89.186 | 16.040 | 0.5047 | -0.00029 |
| 394.0 | 93.215 | 17.358 | 0.5025 | -0.00026 |
| 402.0 | 97.228 | 18.674 | 0.5005 | -0.00024 |
| 410.0 | 101.224 | 19.988 | 0.4987 | -0.00022 |
| 418.0 | 105.207 | 21.301 | 0.4970 | -0.00020 |
| 426.0 | 109.177 | 22.612 | 0.4955 | -0.00019 |
| 434.0 | 113.135 | 23.922 | 0.4940 | -0.00017 |
| 442.0 | 117.082 | 25.230 | 0.4927 | -0.00016 |
| 450.0 | 121.018 | 26.537 | 0.4914 | -0.00015 |
| 458.0 | 124.944 | 27.843 | 0.4902 | -0.00014 |
| 466.0 | 128.861 | 29.147 | 0.4891 | -0.00014 |
| 474.0 | 132.770 | 30.450 | 0.4880 | -0.00013 |
| 482.0 | 136.670 | 31.752 | 0.4870 | -0.00012 |
| 490.0 | 140.563 | 33.052 | 0.4861 | -0.00011 |
| 498.0 | 144.448 | 34.351 | 0.4852 | -0.00011 |
| 506.0 | 148.326 | 35.649 | 0.4844 | -0.00010 |
| 514.0 | 152.198 | 36.946 | 0.4835 | -0.00010 |
| 522.0 | 156.063 | 38.242 | 0.4828 | -0.00009 |
| 530.0 | 159.922 | 39.536 | 0.4820 | -0.00009 |
| 538.0 | 163.775 | 40.829 | 0.4813 | -0.00009 |
| 546.0 | 167.623 | 42.121 | 0.4806 | -0.00008 |
| 554.0 | 171.466 | 43.412 | 0.4800 | -0.00008 |
| 562.0 | 175.303 | 44.702 | 0.4793 | -0.00008 |
| 570.0 | 179.135 | 45.990 | 0.4787 | -0.00007 |
| 578.0 | 182.962 | 47.278 | 0.4781 | -0.00007 |
| 586.0 | 186.785 | 48.564 | 0.4776 | -0.00007 |
| 594.0 | 190.604 | 49.849 | 0.4770 | -0.00007 |

Table 23. Calculated P(T) isochores- - - (Continued)

THE ISOCHORE AT 5.00 MOL/L

| T,K | P,BAR | DP/DD | DP/DT | D2P/DT2 |
|---|---|---|---|---|
| 306.0 | 48.895 | 0.835 | 0.7449 | -0.00551 |
| 314.0 | 54.747 | 2.274 | 0.7225 | -0.00167 |
| 322.0 | 60.482 | 3.709 | 0.7120 | -0.00104 |
| 330.0 | 66.148 | 5.155 | 0.7049 | -0.00077 |
| 338.0 | 71.765 | 6.610 | 0.6994 | -0.00061 |
| 346.0 | 77.342 | 8.074 | 0.6950 | -0.00051 |
| 354.0 | 82.886 | 9.546 | 0.6912 | -0.00044 |
| 362.0 | 88.402 | 11.024 | 0.6879 | -0.00038 |
| 370.0 | 93.894 | 12.508 | 0.6850 | -0.00034 |
| 378.0 | 99.363 | 13.996 | 0.6824 | -0.00031 |
| 386.0 | 104.813 | 15.489 | 0.6801 | -0.00028 |
| 394.0 | 110.246 | 16.985 | 0.6780 | -0.00025 |
| 402.0 | 115.662 | 18.484 | 0.6761 | -0.00023 |
| 410.0 | 121.063 | 19.985 | 0.6743 | -0.00022 |
| 418.0 | 126.451 | 21.489 | 0.6726 | -0.00020 |
| 426.0 | 131.826 | 22.994 | 0.6711 | -0.00019 |
| 434.0 | 137.188 | 24.502 | 0.6696 | -0.00018 |
| 442.0 | 142.540 | 26.010 | 0.6683 | -0.00017 |
| 450.0 | 147.881 | 27.520 | 0.6670 | -0.00016 |
| 458.0 | 153.211 | 29.030 | 0.6657 | -0.00015 |
| 466.0 | 158.533 | 30.542 | 0.6646 | -0.00014 |
| 474.0 | 163.845 | 32.053 | 0.6635 | -0.00013 |
| 482.0 | 169.149 | 33.565 | 0.6624 | -0.00013 |
| 490.0 | 174.444 | 35.078 | 0.6614 | -0.00012 |
| 498.0 | 179.731 | 36.590 | 0.6605 | -0.00012 |
| 506.0 | 185.011 | 38.103 | 0.6595 | -0.00011 |
| 514.0 | 190.284 | 39.615 | 0.6586 | -0.00011 |
| 522.0 | 195.549 | 41.128 | 0.6578 | -0.00011 |
| 530.0 | 200.808 | 42.640 | 0.6569 | -0.00010 |
| 538.0 | 206.060 | 44.151 | 0.6561 | -0.00010 |
| 546.0 | 211.306 | 45.663 | 0.6553 | -0.00010 |
| 554.0 | 216.545 | 47.173 | 0.6546 | -0.00009 |
| 562.0 | 221.779 | 48.684 | 0.6538 | -0.00009 |
| 570.0 | 227.007 | 50.193 | 0.6531 | -0.00009 |
| 578.0 | 232.229 | 51.702 | 0.6524 | -0.00009 |
| 586.0 | 237.445 | 53.211 | 0.6517 | -0.00008 |
| 594.0 | 242.656 | 54.718 | 0.6510 | -0.00008 |

Table 23. Calculated P(T) isochores- - - (Continued)

THE ISOCHORE AT 6.00 MOL/L

| T,K | P,BAR | DP/DD | DP/DT | D2P/DT2 |
|---|---|---|---|---|
| 306.0 | 49.334 | 0.167 | 0.9259 | -0.00990 |
| 314.0 | 56.633 | 1.634 | 0.9058 | -0.00105 |
| 322.0 | 63.853 | 3.183 | 0.8995 | -0.00061 |
| 330.0 | 71.031 | 4.777 | 0.8954 | -0.00044 |
| 338.0 | 78.182 | 6.402 | 0.8922 | -0.00036 |
| 346.0 | 85.309 | 8.052 | 0.8896 | -0.00030 |
| 354.0 | 92.417 | 9.720 | 0.8874 | -0.00026 |
| 362.0 | 99.508 | 11.404 | 0.8854 | -0.00023 |
| 370.0 | 106.584 | 13.102 | 0.8837 | -0.00021 |
| 378.0 | 113.647 | 14.811 | 0.8820 | -0.00019 |
| 386.0 | 120.697 | 16.530 | 0.8805 | -0.00018 |
| 394.0 | 127.736 | 18.257 | 0.8791 | -0.00017 |
| 402.0 | 134.763 | 19.992 | 0.8778 | -0.00016 |
| 410.0 | 141.781 | 21.734 | 0.8766 | -0.00015 |
| 418.0 | 148.789 | 23.481 | 0.8754 | -0.00015 |
| 426.0 | 155.787 | 25.233 | 0.8742 | -0.00014 |
| 434.0 | 162.776 | 26.989 | 0.8731 | -0.00013 |
| 442.0 | 169.757 | 28.750 | 0.8721 | -0.00013 |
| 450.0 | 176.729 | 30.513 | 0.8710 | -0.00013 |
| 458.0 | 183.694 | 32.280 | 0.8700 | -0.00012 |
| 466.0 | 190.650 | 34.048 | 0.8691 | -0.00012 |
| 474.0 | 197.599 | 35.819 | 0.8681 | -0.00012 |
| 482.0 | 204.540 | 37.592 | 0.8672 | -0.00011 |
| 490.0 | 211.474 | 39.367 | 0.8663 | -0.00011 |
| 498.0 | 218.401 | 41.142 | 0.8654 | -0.00011 |
| 506.0 | 225.321 | 42.919 | 0.8645 | -0.00011 |
| 514.0 | 232.234 | 44.697 | 0.8637 | -0.00011 |
| 522.0 | 239.140 | 46.475 | 0.8628 | -0.00010 |
| 530.0 | 246.039 | 48.254 | 0.8620 | -0.00010 |
| 538.0 | 252.932 | 50.033 | 0.8612 | -0.00010 |
| 546.0 | 259.819 | 51.812 | 0.8604 | -0.00010 |
| 554.0 | 266.699 | 53.591 | 0.8596 | -0.00010 |
| 562.0 | 273.573 | 55.371 | 0.8588 | -0.00010 |
| 570.0 | 280.440 | 57.150 | 0.8581 | -0.00010 |
| 578.0 | 287.302 | 58.928 | 0.8573 | -0.00009 |
| 586.0 | 294.157 | 60.707 | 0.8565 | -0.00009 |
| 594.0 | 301.006 | 62.485 | 0.8558 | -0.00009 |

Table 23. Calculated P(T) isochores- - - (Continued)

THE ISOCHORE AT 6.74 MOL/L

| T,K | P,BAR | DP/DD | DP/DT | D2P/DT2 |
|---|---|---|---|---|
| 306.0 | 49.418 | 0.104 | 1.0528 | -0.00000 |
| 314.0 | 57.840 | 1.691 | 1.0527 | -0.00001 |
| 322.0 | 66.261 | 3.401 | 1.0526 | -0.00002 |
| 330.0 | 74.681 | 5.171 | 1.0524 | -0.00003 |
| 338.0 | 83.100 | 6.981 | 1.0521 | -0.00004 |
| 346.0 | 91.515 | 8.823 | 1.0518 | -0.00004 |
| 354.0 | 99.929 | 10.690 | 1.0515 | -0.00005 |
| 362.0 | 108.339 | 12.578 | 1.0511 | -0.00005 |
| 370.0 | 116.746 | 14.483 | 1.0506 | -0.00006 |
| 378.0 | 125.149 | 16.403 | 1.0501 | -0.00006 |
| 386.0 | 133.548 | 18.336 | 1.0496 | -0.00007 |
| 394.0 | 141.943 | 20.279 | 1.0491 | -0.00007 |
| 402.0 | 150.333 | 22.233 | 1.0485 | -0.00007 |
| 410.0 | 158.719 | 24.195 | 1.0479 | -0.00008 |
| 418.0 | 167.100 | 26.165 | 1.0473 | -0.00008 |
| 426.0 | 175.476 | 28.141 | 1.0466 | -0.00008 |
| 434.0 | 183.846 | 30.122 | 1.0460 | -0.00008 |
| 442.0 | 192.211 | 32.109 | 1.0453 | -0.00009 |
| 450.0 | 200.571 | 34.100 | 1.0446 | -0.00009 |
| 458.0 | 208.925 | 36.095 | 1.0439 | -0.00009 |
| 466.0 | 217.273 | 38.093 | 1.0432 | -0.00009 |
| 474.0 | 225.616 | 40.094 | 1.0425 | -0.00009 |
| 482.0 | 233.953 | 42.098 | 1.0417 | -0.00009 |
| 490.0 | 242.284 | 44.103 | 1.0410 | -0.00009 |
| 498.0 | 250.609 | 46.111 | 1.0402 | -0.00009 |
| 506.0 | 258.927 | 48.119 | 1.0395 | -0.00010 |
| 514.0 | 267.240 | 50.130 | 1.0387 | -0.00010 |
| 522.0 | 275.547 | 52.141 | 1.0379 | -0.00010 |
| 530.0 | 283.847 | 54.152 | 1.0372 | -0.00010 |
| 538.0 | 292.141 | 56.165 | 1.0364 | -0.00010 |
| 546.0 | 300.429 | 58.178 | 1.0356 | -0.00010 |
| 554.0 | 308.710 | 60.191 | 1.0348 | -0.00010 |
| 562.0 | 316.986 | 62.204 | 1.0340 | -0.00010 |
| 570.0 | 325.255 | 64.216 | 1.0332 | -0.00010 |
| 578.0 | 333.517 | 66.229 | 1.0324 | -0.00010 |
| 586.0 | 341.774 | 68.241 | 1.0317 | -0.00010 |
| 594.0 | 350.024 | 70.253 | 1.0309 | -0.00010 |

Table 23. Calculated P(T) isochores- - - (Continued)

THE ISOCHORE AT 8.00 MOL/L

| T,K | P,BAR | DP/DD | DP/DT | D2P/DT2 |
|---|---|---|---|---|
| 306.0 | 49.651 | 0.447 | 1.3126 | 0.01309 |
| 314.0 | 60.333 | 2.529 | 1.3477 | 0.00208 |
| 322.0 | 71.169 | 4.704 | 1.3601 | 0.00119 |
| 330.0 | 82.083 | 6.937 | 1.3680 | 0.00083 |
| 338.0 | 93.051 | 9.214 | 1.3738 | 0.00063 |
| 346.0 | 104.060 | 11.524 | 1.3782 | 0.00049 |
| 354.0 | 115.100 | 13.861 | 1.3817 | 0.00039 |
| 362.0 | 126.165 | 16.221 | 1.3846 | 0.00032 |
| 370.0 | 137.251 | 18.600 | 1.3869 | 0.00026 |
| 378.0 | 148.354 | 20.994 | 1.3887 | 0.00021 |
| 386.0 | 159.470 | 23.403 | 1.3903 | 0.00017 |
| 394.0 | 170.597 | 25.824 | 1.3915 | 0.00014 |
| 402.0 | 181.733 | 28.255 | 1.3924 | 0.00011 |
| 410.0 | 192.876 | 30.696 | 1.3932 | 0.00008 |
| 418.0 | 204.024 | 33.144 | 1.3937 | 0.00006 |
| 426.0 | 215.175 | 35.599 | 1.3941 | 0.00004 |
| 434.0 | 226.329 | 38.060 | 1.3944 | 0.00002 |
| 442.0 | 237.485 | 40.526 | 1.3945 | 0.00001 |
| 450.0 | 248.640 | 42.997 | 1.3945 | -0.00001 |
| 458.0 | 259.796 | 45.471 | 1.3943 | -0.00002 |
| 466.0 | 270.950 | 47.949 | 1.3941 | -0.00003 |
| 474.0 | 282.101 | 50.429 | 1.3938 | -0.00004 |
| 482.0 | 293.251 | 52.911 | 1.3935 | -0.00005 |
| 490.0 | 304.397 | 55.396 | 1.3930 | -0.00006 |
| 498.0 | 315.539 | 57.882 | 1.3925 | -0.00007 |
| 506.0 | 326.677 | 60.369 | 1.3920 | -0.00007 |
| 514.0 | 337.811 | 62.857 | 1.3914 | -0.00008 |
| 522.0 | 348.939 | 65.345 | 1.3907 | -0.00008 |
| 530.0 | 360.062 | 67.834 | 1.3900 | -0.00009 |
| 538.0 | 371.180 | 70.323 | 1.3893 | -0.00009 |
| 546.0 | 382.291 | 72.812 | 1.3886 | -0.00010 |
| 554.0 | 393.397 | 75.301 | 1.3878 | -0.00010 |
| 562.0 | 404.495 | 77.789 | 1.3869 | -0.00010 |
| 570.0 | 415.588 | 80.276 | 1.3861 | -0.00011 |
| 578.0 | 426.673 | 82.763 | 1.3852 | -0.00011 |
| 586.0 | 437.751 | 85.249 | 1.3843 | -0.00011 |
| 594.0 | 448.823 | 87.733 | 1.3834 | -0.00011 |

Table 23. Calculated P(T) isochores- - - (Continued)

THE ISOCHORE AT 9.00 MOL/L

| T,K | P,BAR | DP/DD | DP/DT | C2P/DT2 |
|---|---|---|---|---|
| 306.0 | 50.818 | 2.236 | 1.6175 | 0.00728 |
| 314.0 | 63.920 | 5.028 | 1.6527 | 0.00291 |
| 322.0 | 77.221 | 7.822 | 1.6712 | 0.00186 |
| 330.0 | 90.644 | 10.640 | 1.6839 | 0.00136 |
| 338.0 | 104.155 | 13.480 | 1.6935 | 0.00106 |
| 346.0 | 117.734 | 16.341 | 1.7011 | 0.00085 |
| 354.0 | 131.368 | 19.218 | 1.7072 | 0.00069 |
| 362.0 | 145.046 | 22.110 | 1.7123 | 0.00057 |
| 370.0 | 158.762 | 25.014 | 1.7164 | 0.00048 |
| 378.0 | 172.508 | 27.929 | 1.7199 | 0.00040 |
| 386.0 | 186.279 | 30.853 | 1.7228 | 0.00033 |
| 394.0 | 200.072 | 33.784 | 1.7252 | 0.00027 |
| 402.0 | 213.882 | 36.723 | 1.7272 | 0.00023 |
| 410.0 | 227.707 | 39.666 | 1.7289 | 0.00018 |
| 418.0 | 241.543 | 42.614 | 1.7302 | 0.00015 |
| 426.0 | 255.389 | 45.566 | 1.7312 | 0.00011 |
| 434.0 | 269.242 | 48.522 | 1.7320 | 0.00008 |
| 442.0 | 283.100 | 51.479 | 1.7326 | 0.00006 |
| 450.0 | 296.962 | 54.439 | 1.7330 | 0.00004 |
| 458.0 | 310.827 | 57.400 | 1.7332 | 0.00002 |
| 466.0 | 324.692 | 60.363 | 1.7332 | -0.00000 |
| 474.0 | 338.558 | 63.326 | 1.7331 | -0.00002 |
| 482.0 | 352.422 | 66.289 | 1.7329 | -0.00003 |
| 490.0 | 366.284 | 69.252 | 1.7326 | -0.00005 |
| 498.0 | 380.143 | 72.215 | 1.7322 | -0.00006 |
| 506.0 | 393.998 | 75.178 | 1.7316 | -0.00007 |
| 514.0 | 407.849 | 78.139 | 1.7310 | -0.00008 |
| 522.0 | 421.695 | 81.100 | 1.7304 | -0.00009 |
| 530.0 | 435.535 | 84.059 | 1.7296 | -0.00010 |
| 538.0 | 449.369 | 87.017 | 1.7288 | -0.00010 |
| 546.0 | 463.196 | 89.973 | 1.7279 | -0.00011 |
| 554.0 | 477.015 | 92.928 | 1.7270 | -0.00012 |
| 562.0 | 490.828 | 95.880 | 1.7261 | -0.00012 |
| 570.0 | 504.632 | 98.831 | 1.7250 | -0.00013 |
| 578.0 | 518.428 | 101.779 | 1.7240 | -0.00013 |
| 586.0 | 532.216 | 104.725 | 1.7229 | -0.00014 |
| 594.0 | 545.995 | 107.669 | 1.7218 | -0.00014 |

Table 23. Calculated P(T) isochores- - - (Continued)

THE ISOCHORE AT 10.00 MOL/L

| T,K | P,BAR | DP/DD | DP/DT | D2P/DT2 |
|---|---|---|---|---|
| 306.0 | 55.121 | 7.041 | 2.0254 | 0.00422 |
| 314.0 | 71.438 | 10.701 | 2.0519 | 0.00265 |
| 322.0 | 87.929 | 14.316 | 2.0699 | 0.00192 |
| 330.0 | 104.545 | 17.915 | 2.0834 | 0.00149 |
| 338.0 | 121.257 | 21.505 | 2.0941 | 0.00119 |
| 346.0 | 138.045 | 25.092 | 2.1027 | 0.00097 |
| 354.0 | 154.896 | 28.677 | 2.1098 | 0.00080 |
| 362.0 | 171.799 | 32.261 | 2.1157 | 0.00067 |
| 370.0 | 188.745 | 35.843 | 2.1206 | 0.00056 |
| 378.0 | 205.726 | 39.424 | 2.1246 | 0.00046 |
| 386.0 | 222.737 | 43.004 | 2.1280 | 0.00038 |
| 394.0 | 239.772 | 46.582 | 2.1308 | 0.00032 |
| 402.0 | 256.828 | 50.158 | 2.1331 | 0.00026 |
| 410.0 | 273.901 | 53.732 | 2.1349 | 0.00021 |
| 418.0 | 290.986 | 57.304 | 2.1364 | 0.00016 |
| 426.0 | 308.082 | 60.873 | 2.1375 | 0.00012 |
| 434.0 | 325.186 | 64.440 | 2.1383 | 0.00009 |
| 442.0 | 342.295 | 68.004 | 2.1389 | 0.00005 |
| 450.0 | 359.407 | 71.564 | 2.1392 | 0.00003 |
| 458.0 | 376.522 | 75.122 | 2.1393 | 0.00000 |
| 466.0 | 393.636 | 78.676 | 2.1392 | -0.00002 |
| 474.0 | 410.749 | 82.226 | 2.1390 | -0.00004 |
| 482.0 | 427.859 | 85.773 | 2.1386 | -0.00006 |
| 490.0 | 444.966 | 89.316 | 2.1380 | -0.00008 |
| 498.0 | 462.067 | 92.856 | 2.1373 | -0.00009 |
| 506.0 | 479.162 | 96.391 | 2.1365 | -0.00011 |
| 514.0 | 496.251 | 99.922 | 2.1356 | -0.00012 |
| 522.0 | 513.332 | 103.449 | 2.1346 | -0.00013 |
| 530.0 | 530.405 | 106.972 | 2.1335 | -0.00014 |
| 538.0 | 547.469 | 110.491 | 2.1324 | -0.00015 |
| 546.0 | 564.523 | 114.005 | 2.1312 | -0.00016 |
| 554.0 | 581.567 | 117.515 | 2.1299 | -0.00017 |
| 562.0 | 598.600 | 121.021 | 2.1285 | -0.00017 |
| 570.0 | 615.623 | 124.522 | 2.1271 | -0.00018 |
| 578.0 | 632.634 | 128.018 | 2.1256 | -0.00018 |
| 586.0 | 649.633 | 131.510 | 2.1241 | -0.00019 |
| 594.0 | 666.620 | 134.998 | 2.1226 | -0.00020 |

Table 23. Calculated P(T) isochores- - - (Continued)

THE ISOCHORE AT 11.00 MOL/L

| T,K | P,BAR | DP/DD | DP/DT | D2P/DT2 |
|---|---|---|---|---|
| 298.0 | 46.355 | 12.389 | 2.5254 | 0.00353 |
| 306.0 | 66.658 | 17.137 | 2.5488 | 0.00244 |
| 314.0 | 87.118 | 21.783 | 2.5657 | 0.00184 |
| 322.0 | 107.698 | 26.365 | 2.5787 | 0.00144 |
| 330.0 | 128.370 | 30.903 | 2.5890 | 0.00116 |
| 338.0 | 149.117 | 35.406 | 2.5974 | 0.00094 |
| 346.0 | 169.924 | 39.881 | 2.6042 | 0.00077 |
| 354.0 | 190.781 | 44.332 | 2.6098 | 0.00063 |
| 362.0 | 211.678 | 48.763 | 2.6144 | 0.00052 |
| 370.0 | 232.609 | 53.175 | 2.6181 | 0.00042 |
| 378.0 | 253.567 | 57.570 | 2.6211 | 0.00033 |
| 386.0 | 274.546 | 61.950 | 2.6235 | 0.00026 |
| 394.0 | 295.541 | 66.316 | 2.6254 | 0.00020 |
| 402.0 | 316.550 | 70.668 | 2.6267 | 0.00014 |
| 410.0 | 337.568 | 75.007 | 2.6277 | 0.00010 |
| 418.0 | 358.592 | 79.334 | 2.6283 | 0.00005 |
| 426.0 | 379.620 | 83.650 | 2.6286 | 0.00002 |
| 434.0 | 400.648 | 87.954 | 2.6285 | -0.00002 |
| 442.0 | 421.675 | 92.248 | 2.6283 | -0.00005 |
| 450.0 | 442.700 | 96.531 | 2.6278 | -0.00008 |
| 458.0 | 463.719 | 100.804 | 2.6270 | -0.00010 |
| 466.0 | 484.732 | 105.067 | 2.6261 | -0.00012 |
| 474.0 | 505.737 | 109.320 | 2.6251 | -0.00014 |
| 482.0 | 526.733 | 113.564 | 2.6239 | -0.00016 |
| 490.0 | 547.718 | 117.798 | 2.6225 | -0.00018 |
| 498.0 | 568.693 | 122.024 | 2.6210 | -0.00019 |
| 506.0 | 589.655 | 126.240 | 2.6194 | -0.00020 |
| 514.0 | 610.603 | 130.448 | 2.6178 | -0.00022 |
| 522.0 | 631.538 | 134.647 | 2.6160 | -0.00023 |
| 530.0 | 652.459 | 138.838 | 2.6141 | -0.00024 |
| 538.0 | 673.364 | 143.020 | 2.6122 | -0.00025 |
| 546.0 | 694.254 | 147.194 | 2.6102 | -0.00025 |

Table 23. Calculated P(T) isochores- - - (Continued)

THE ISOCHORE AT 12.00 MOL/L

| T,K | P,BAR | DP/DD | DP/DT | D2P/DT2 |
|---|---|---|---|---|
| 290.0 | 41.028 | 23.606 | 3.1812 | 0.00170 |
| 294.0 | 53.766 | 26.598 | 3.1875 | 0.00146 |
| 298.0 | 66.527 | 29.555 | 3.1929 | 0.00127 |
| 302.0 | 79.308 | 32.483 | 3.1977 | 0.00112 |
| 306.0 | 92.108 | 35.385 | 3.2019 | 0.00098 |
| 310.0 | 104.923 | 38.264 | 3.2056 | 0.00087 |
| 314.0 | 117.751 | 41.123 | 3.2088 | 0.00076 |
| 318.0 | 130.593 | 43.963 | 3.2117 | 0.00067 |
| 322.0 | 143.445 | 46.785 | 3.2142 | 0.00059 |
| 326.0 | 156.306 | 49.592 | 3.2165 | 0.00052 |
| 330.0 | 169.176 | 52.384 | 3.2184 | 0.00046 |
| 334.0 | 182.053 | 55.162 | 3.2201 | 0.00040 |
| 338.0 | 194.937 | 57.928 | 3.2216 | 0.00034 |
| 342.0 | 207.826 | 60.681 | 3.2229 | 0.00029 |
| 346.0 | 220.719 | 63.423 | 3.2239 | 0.00025 |
| 350.0 | 233.617 | 66.154 | 3.2248 | 0.00020 |
| 354.0 | 246.518 | 68.875 | 3.2256 | 0.00016 |
| 358.0 | 259.421 | 71.587 | 3.2261 | 0.00013 |
| 362.0 | 272.327 | 74.289 | 3.2266 | 0.00009 |
| 366.0 | 285.234 | 76.982 | 3.2269 | 0.00006 |
| 370.0 | 298.142 | 79.666 | 3.2271 | 0.00003 |
| 374.0 | 311.050 | 82.342 | 3.2271 | 0.00000 |
| 378.0 | 323.959 | 85.011 | 3.2271 | -0.00002 |
| 382.0 | 336.867 | 87.672 | 3.2270 | -0.00005 |
| 386.0 | 349.774 | 90.325 | 3.2267 | -0.00007 |
| 390.0 | 362.681 | 92.972 | 3.2264 | -0.00009 |
| 394.0 | 375.586 | 95.612 | 3.2260 | -0.00011 |
| 398.0 | 388.489 | 98.245 | 3.2255 | -0.00013 |
| 402.0 | 401.390 | 100.872 | 3.2250 | -0.00015 |
| 406.0 | 414.288 | 103.492 | 3.2243 | -0.00017 |
| 410.0 | 427.184 | 106.107 | 3.2237 | -0.00018 |
| 414.0 | 440.077 | 108.715 | 3.2229 | -0.00020 |
| 418.0 | 452.967 | 111.318 | 3.2221 | -0.00021 |
| 422.0 | 465.854 | 113.915 | 3.2212 | -0.00022 |
| 426.0 | 478.737 | 116.507 | 3.2203 | -0.00024 |
| 430.0 | 491.616 | 119.094 | 3.2193 | -0.00025 |
| 434.0 | 504.492 | 121.676 | 3.2183 | -0.00026 |
| 438.0 | 517.363 | 124.252 | 3.2172 | -0.00027 |
| 442.0 | 530.229 | 126.823 | 3.2161 | -0.00028 |
| 446.0 | 543.092 | 129.390 | 3.2150 | -0.00029 |
| 450.0 | 555.949 | 131.952 | 3.2138 | -0.00030 |
| 454.0 | 568.802 | 134.509 | 3.2126 | -0.00031 |
| 458.0 | 581.650 | 137.062 | 3.2113 | -0.00032 |
| 462.0 | 594.493 | 139.610 | 3.2101 | -0.00032 |
| 466.0 | 607.331 | 142.154 | 3.2087 | -0.00033 |
| 470.0 | 620.163 | 144.694 | 3.2074 | -0.00034 |
| 474.0 | 632.990 | 147.229 | 3.2060 | -0.00035 |
| 478.0 | 645.811 | 149.761 | 3.2046 | -0.00035 |
| 482.0 | 658.627 | 152.288 | 3.2032 | -0.00036 |
| 486.0 | 671.437 | 154.811 | 3.2018 | -0.00036 |
| 490.0 | 684.241 | 157.330 | 3.2003 | -0.00037 |
| 494.0 | 697.039 | 159.846 | 3.1988 | -0.00037 |

Table 23. Calculated P(T) isochores- - - (Continued)

THE ISOCHORE AT 13.00 MOL/L

| T,K | P,BAR | DP/DD | DP/DT | D2P/DT2 |
|---|---|---|---|---|
| 278.0 | 29.111 | 39.986 | 4.0115 | -0.00049 |
| 282.0 | 45.153 | 43.672 | 4.0095 | -0.00048 |
| 286.0 | 61.188 | 47.321 | 4.0076 | -0.00048 |
| 290.0 | 77.215 | 50.936 | 4.0057 | -0.00048 |
| 294.0 | 93.234 | 54.518 | 4.0038 | -0.00048 |
| 298.0 | 109.245 | 58.072 | 4.0019 | -0.00048 |
| 302.0 | 125.249 | 61.597 | 4.0000 | -0.00048 |
| 306.0 | 141.245 | 65.096 | 3.9980 | -0.00049 |
| 310.0 | 157.233 | 68.571 | 3.9961 | -0.00050 |
| 314.0 | 173.213 | 72.022 | 3.9941 | -0.00050 |
| 318.0 | 189.186 | 75.452 | 3.9920 | -0.00051 |
| 322.0 | 205.150 | 78.861 | 3.9900 | -0.00052 |
| 326.0 | 221.105 | 82.251 | 3.9879 | -0.00052 |
| 330.0 | 237.053 | 85.621 | 3.9858 | -0.00053 |
| 334.0 | 252.992 | 88.974 | 3.9836 | -0.00054 |
| 338.0 | 268.922 | 92.310 | 3.9815 | -0.00055 |
| 342.0 | 284.843 | 95.630 | 3.9793 | -0.00055 |
| 346.0 | 300.756 | 98.935 | 3.9771 | -0.00056 |
| 350.0 | 316.660 | 102.224 | 3.9748 | -0.00057 |
| 354.0 | 332.554 | 105.499 | 3.9725 | -0.00057 |
| 358.0 | 348.440 | 108.761 | 3.9702 | -0.00058 |
| 362.0 | 364.316 | 112.009 | 3.9679 | -0.00058 |
| 366.0 | 380.183 | 115.245 | 3.9655 | -0.00059 |
| 370.0 | 396.041 | 118.468 | 3.9632 | -0.00060 |
| 374.0 | 411.889 | 121.680 | 3.9608 | -0.00060 |
| 378.0 | 427.727 | 124.880 | 3.9584 | -0.00061 |
| 382.0 | 443.556 | 128.070 | 3.9559 | -0.00061 |
| 386.0 | 459.374 | 131.248 | 3.9535 | -0.00061 |
| 390.0 | 475.183 | 134.417 | 3.9510 | -0.00062 |
| 394.0 | 490.983 | 137.575 | 3.9486 | -0.00062 |
| 398.0 | 506.772 | 140.724 | 3.9461 | -0.00063 |
| 402.0 | 522.551 | 143.863 | 3.9435 | -0.00063 |
| 406.0 | 538.320 | 146.993 | 3.9410 | -0.00063 |
| 410.0 | 554.079 | 150.114 | 3.9385 | -0.00064 |
| 414.0 | 569.828 | 153.227 | 3.9359 | -0.00064 |
| 418.0 | 585.567 | 156.331 | 3.9334 | -0.00064 |
| 422.0 | 601.295 | 159.427 | 3.9308 | -0.00064 |
| 426.0 | 617.013 | 162.514 | 3.9282 | -0.00065 |
| 430.0 | 632.721 | 165.594 | 3.9256 | -0.00065 |
| 434.0 | 648.418 | 168.667 | 3.9230 | -0.00065 |
| 438.0 | 664.105 | 171.732 | 3.9204 | -0.00065 |
| 442.0 | 679.781 | 174.790 | 3.9178 | -0.00065 |
| 446.0 | 695.447 | 177.840 | 3.9152 | -0.00066 |

Table 23. Calculated P(T) isochores- - - (Continued)

THE ISOCHORE AT 14.00 MOL/L

| T,K | P,BAR | DP/DD | DP/DT | D2P/DT2 |
|---|---|---|---|---|
| 266.0 | 27.449 | 67.107 | 5.0545 | -0.00345 |
| 270.0 | 47.640 | 71.553 | 5.0412 | -0.00323 |
| 274.0 | 67.779 | 75.957 | 5.0286 | -0.00304 |
| 278.0 | 87.870 | 80.323 | 5.0168 | -0.00287 |
| 282.0 | 107.915 | 84.651 | 5.0057 | -0.00272 |
| 286.0 | 127.916 | 88.944 | 4.9951 | -0.00258 |
| 290.0 | 147.876 | 93.204 | 4.9850 | -0.00246 |
| 294.0 | 167.797 | 97.431 | 4.9754 | -0.00236 |
| 298.0 | 187.680 | 101.627 | 4.9661 | -0.00226 |
| 302.0 | 207.526 | 105.794 | 4.9572 | -0.00217 |
| 306.0 | 227.338 | 109.932 | 4.9487 | -0.00210 |
| 310.0 | 247.116 | 114.044 | 4.9405 | -0.00202 |
| 314.0 | 266.862 | 118.130 | 4.9325 | -0.00196 |
| 318.0 | 286.577 | 122.191 | 4.9248 | -0.00190 |
| 322.0 | 306.261 | 126.229 | 4.9173 | -0.00184 |
| 326.0 | 325.916 | 130.244 | 4.9100 | -0.00179 |
| 330.0 | 345.541 | 134.238 | 4.9030 | -0.00175 |
| 334.0 | 365.139 | 138.210 | 4.8961 | -0.00170 |
| 338.0 | 384.710 | 142.162 | 4.8893 | -0.00166 |
| 342.0 | 404.254 | 146.095 | 4.8827 | -0.00163 |
| 346.0 | 423.772 | 150.009 | 4.8763 | -0.00159 |
| 350.0 | 443.265 | 153.905 | 4.8700 | -0.00156 |
| 354.0 | 462.733 | 157.783 | 4.8638 | -0.00153 |
| 358.0 | 482.176 | 161.645 | 4.8578 | -0.00150 |
| 362.0 | 501.595 | 165.491 | 4.8518 | -0.00148 |
| 366.0 | 520.990 | 169.320 | 4.8460 | -0.00145 |
| 370.0 | 540.362 | 173.135 | 4.8402 | -0.00143 |
| 374.0 | 559.712 | 176.935 | 4.8345 | -0.00141 |
| 378.0 | 579.039 | 180.720 | 4.8289 | -0.00139 |
| 382.0 | 598.343 | 184.492 | 4.8234 | -0.00137 |
| 386.0 | 617.626 | 188.250 | 4.8180 | -0.00135 |
| 390.0 | 636.888 | 191.995 | 4.8126 | -0.00133 |
| 394.0 | 656.128 | 195.727 | 4.8074 | -0.00131 |
| 398.0 | 675.347 | 199.448 | 4.8021 | -0.00130 |
| 402.0 | 694.545 | 203.156 | 4.7970 | -0.00128 |

Table 23. Calculated P(T) isochores- - - (Continued)

THE ISOCHORE AT 15.00 MOL/L

| T,K | P,BAR | DP/DD | DP/DT | D2P/DT2 |
|---|---|---|---|---|
| 250.0 | 20.439 | 103.276 | 6.3663 | -0.00782 |
| 254.0 | 45.843 | 108.584 | 6.3360 | -0.00732 |
| 258.0 | 71.129 | 113.846 | 6.3077 | -0.00687 |
| 262.0 | 96.306 | 119.061 | 6.2810 | -0.00647 |
| 266.0 | 121.379 | 124.232 | 6.2559 | -0.00610 |
| 270.0 | 146.355 | 129.361 | 6.2321 | -0.00578 |
| 274.0 | 171.238 | 134.449 | 6.2096 | -0.00548 |
| 278.0 | 196.034 | 139.498 | 6.1883 | -0.00520 |
| 282.0 | 220.746 | 144.509 | 6.1680 | -0.00496 |
| 286.0 | 245.379 | 149.484 | 6.1486 | -0.00473 |
| 290.0 | 269.936 | 154.425 | 6.1301 | -0.00452 |
| 294.0 | 294.421 | 159.331 | 6.1124 | -0.00433 |
| 298.0 | 318.836 | 164.206 | 6.0955 | -0.00415 |
| 302.0 | 343.185 | 169.050 | 6.0792 | -0.00399 |
| 306.0 | 367.471 | 173.865 | 6.0636 | -0.00384 |
| 310.0 | 391.694 | 178.650 | 6.0485 | -0.00369 |
| 314.0 | 415.859 | 183.408 | 6.0340 | -0.00356 |
| 318.0 | 439.967 | 188.140 | 6.0200 | -0.00344 |
| 322.0 | 464.020 | 192.846 | 6.0064 | -0.00333 |
| 326.0 | 488.019 | 197.528 | 5.9933 | -0.00323 |
| 330.0 | 511.967 | 202.185 | 5.9806 | -0.00313 |
| 334.0 | 535.865 | 206.820 | 5.9683 | -0.00304 |
| 338.0 | 559.714 | 211.432 | 5.9563 | -0.00295 |
| 342.0 | 583.516 | 216.023 | 5.9447 | -0.00287 |
| 346.0 | 607.272 | 220.593 | 5.9334 | -0.00279 |
| 350.0 | 630.983 | 225.143 | 5.9224 | -0.00272 |
| 354.0 | 654.651 | 229.674 | 5.9116 | -0.00265 |
| 358.0 | 678.276 | 234.185 | 5.9011 | -0.00259 |

Table 23. Calculated P(T) isochores- - - (Continued)

THE ISOCHORE AT 16.00 MOL/L

| T,K | P,BAR | DP/DD | DP/DT | D2P/DT2 |
|---|---|---|---|---|
| 232.0 | 18.224 | 153.066 | 8.0124 | -0.01443 |
| 234.0 | 34.221 | 156.194 | 7.9840 | -0.01395 |
| 236.0 | 50.161 | 159.307 | 7.9566 | -0.01349 |
| 238.0 | 66.048 | 162.407 | 7.9301 | -0.01306 |
| 240.0 | 81.882 | 165.494 | 7.9043 | -0.01265 |
| 242.0 | 97.666 | 168.568 | 7.8794 | -0.01226 |
| 244.0 | 113.400 | 171.629 | 7.8553 | -0.01188 |
| 246.0 | 129.087 | 174.677 | 7.8319 | -0.01153 |
| 248.0 | 144.728 | 177.713 | 7.8092 | -0.01119 |
| 250.0 | 160.325 | 180.737 | 7.7872 | -0.01086 |
| 252.0 | 175.877 | 183.750 | 7.7657 | -0.01055 |
| 254.0 | 191.388 | 186.750 | 7.7449 | -0.01025 |
| 255.0 | 206.858 | 189.739 | 7.7247 | -0.00997 |
| 258.0 | 222.287 | 192.717 | 7.7050 | -0.00970 |
| 260.0 | 237.678 | 195.683 | 7.6859 | -0.00944 |
| 262.0 | 253.031 | 198.639 | 7.6673 | -0.00919 |
| 264.0 | 268.348 | 201.585 | 7.6491 | -0.00895 |
| 266.0 | 283.628 | 204.519 | 7.6315 | -0.00873 |
| 268.0 | 298.874 | 207.444 | 7.6142 | -0.00851 |
| 270.0 | 314.085 | 210.359 | 7.5974 | -0.00830 |
| 272.0 | 329.264 | 213.263 | 7.5810 | -0.00810 |
| 274.0 | 344.410 | 216.158 | 7.5650 | -0.00790 |
| 276.0 | 359.524 | 219.044 | 7.5494 | -0.00772 |
| 278.0 | 374.608 | 221.920 | 7.5342 | -0.00754 |
| 280.0 | 389.661 | 224.787 | 7.5193 | -0.00737 |
| 282.0 | 404.685 | 227.645 | 7.5047 | -0.00720 |
| 284.0 | 419.680 | 230.494 | 7.4904 | -0.00704 |
| 286.0 | 434.647 | 233.335 | 7.4765 | -0.00689 |
| 288.0 | 449.586 | 236.167 | 7.4629 | -0.00674 |
| 290.0 | 464.499 | 238.991 | 7.4495 | -0.00660 |
| 292.0 | 479.385 | 241.806 | 7.4365 | -0.00646 |
| 294.0 | 494.245 | 244.614 | 7.4237 | -0.00633 |
| 296.0 | 509.080 | 247.413 | 7.4112 | -0.00620 |
| 298.0 | 523.890 | 250.205 | 7.3989 | -0.00608 |
| 300.0 | 538.675 | 252.989 | 7.3868 | -0.00596 |
| 302.0 | 553.437 | 255.766 | 7.3750 | -0.00585 |
| 304.0 | 568.175 | 258.535 | 7.3634 | -0.00574 |
| 306.0 | 582.891 | 261.298 | 7.3521 | -0.00563 |
| 308.0 | 597.584 | 264.052 | 7.3409 | -0.00553 |
| 310.0 | 612.255 | 266.800 | 7.3300 | -0.00543 |
| 312.0 | 626.904 | 269.541 | 7.3192 | -0.00533 |
| 314.0 | 641.532 | 272.276 | 7.3086 | -0.00524 |
| 316.0 | 656.139 | 275.003 | 7.2983 | -0.00515 |
| 318.0 | 670.725 | 277.724 | 7.2880 | -0.00506 |
| 320.0 | 685.291 | 280.439 | 7.2780 | -0.00498 |
| 322.0 | 699.837 | 283.147 | 7.2681 | -0.00489 |

Table 23. Calculated P(T) isochores- - - (Continued)

THE ISOCHORE AT 17.00 MOL/L

| T,K | P,BAR | DP/DD | DP/DT | D2P/DT2 |
|---|---|---|---|---|
| 212.0 | 22.625 | 219.957 | 10.0847 | -0.02469 |
| 214.0 | 42.745 | 223.563 | 10.0362 | -0.02383 |
| 216.0 | 62.771 | 227.155 | 9.9893 | -0.02301 |
| 218.0 | 82.704 | 230.735 | 9.9441 | -0.02223 |
| 220.0 | 102.548 | 234.300 | 9.9004 | -0.02148 |
| 222.0 | 122.307 | 237.853 | 9.8582 | -0.02077 |
| 224.0 | 141.982 | 241.393 | 9.8173 | -0.02010 |
| 226.0 | 161.577 | 244.920 | 9.7777 | -0.01946 |
| 228.0 | 181.094 | 248.434 | 9.7394 | -0.01884 |
| 230.0 | 200.535 | 251.936 | 9.7023 | -0.01826 |
| 232.0 | 219.904 | 255.426 | 9.6664 | -0.01770 |
| 234.0 | 239.202 | 258.904 | 9.6315 | -0.01717 |
| 236.0 | 258.431 | 262.370 | 9.5977 | -0.01666 |
| 238.0 | 277.593 | 265.825 | 9.5649 | -0.01617 |
| 240.0 | 296.691 | 269.268 | 9.5330 | -0.01571 |
| 242.0 | 315.726 | 272.700 | 9.5020 | -0.01526 |
| 244.0 | 334.699 | 276.121 | 9.4719 | -0.01483 |
| 246.0 | 353.614 | 279.532 | 9.4427 | -0.01442 |
| 248.0 | 372.471 | 282.931 | 9.4142 | -0.01403 |
| 250.0 | 391.271 | 286.321 | 9.3866 | -0.01366 |
| 252.0 | 410.017 | 289.700 | 9.3596 | -0.01330 |
| 254.0 | 428.710 | 293.069 | 9.3334 | -0.01295 |
| 256.0 | 447.351 | 296.428 | 9.3078 | -0.01262 |
| 258.0 | 465.942 | 299.777 | 9.2829 | -0.01230 |
| 260.0 | 484.483 | 303.117 | 9.2586 | -0.01199 |
| 262.0 | 502.977 | 306.448 | 9.2349 | -0.01170 |
| 264.0 | 521.423 | 309.769 | 9.2118 | -0.01142 |
| 266.0 | 539.824 | 313.081 | 9.1892 | -0.01114 |
| 268.0 | 558.181 | 316.384 | 9.1672 | -0.01088 |
| 270.0 | 576.493 | 319.679 | 9.1457 | -0.01063 |
| 272.0 | 594.764 | 322.964 | 9.1247 | -0.01039 |
| 274.0 | 612.992 | 326.242 | 9.1041 | -0.01015 |
| 276.0 | 631.181 | 329.510 | 9.0841 | -0.00993 |
| 278.0 | 649.329 | 332.771 | 9.0644 | -0.00971 |
| 280.0 | 667.438 | 336.024 | 9.0452 | -0.00950 |
| 282.0 | 685.510 | 339.268 | 9.0264 | -0.00930 |

Table 23. Calculated P(T) isochores- - - (Continued)

THE ISOCHORE AT 18.00 MOL/L

| T,K | P,BAR | DP/DD | DP/DT | D2P/DT2 |
|---|---|---|---|---|
| 188.0 | 9.323 | 304.719 | 12.8014 | -0.04276 |
| 190.0 | 34.841 | 308.783 | 12.7175 | -0.04110 |
| 192.0 | 60.195 | 312.839 | 12.6369 | -0.03953 |
| 194.0 | 85.391 | 316.885 | 12.5594 | -0.03804 |
| 196.0 | 110.435 | 320.923 | 12.4847 | -0.03662 |
| 198.0 | 135.332 | 324.952 | 12.4128 | -0.03528 |
| 200.0 | 160.088 | 328.972 | 12.3436 | -0.03401 |
| 202.0 | 184.708 | 332.983 | 12.2768 | -0.03280 |
| 204.0 | 209.196 | 336.985 | 12.2123 | -0.03165 |
| 206.0 | 233.558 | 340.977 | 12.1501 | -0.03056 |
| 208.0 | 257.798 | 344.961 | 12.0900 | -0.02952 |
| 210.0 | 281.920 | 348.936 | 12.0320 | -0.02853 |
| 212.0 | 305.928 | 352.903 | 11.9759 | -0.02759 |
| 214.0 | 329.825 | 356.860 | 11.9216 | -0.02669 |
| 216.0 | 353.615 | 360.809 | 11.8691 | -0.02584 |
| 218.0 | 377.302 | 364.749 | 11.8182 | -0.02502 |
| 220.0 | 400.889 | 368.680 | 11.7690 | -0.02424 |
| 222.0 | 424.379 | 372.603 | 11.7213 | -0.02349 |
| 224.0 | 447.775 | 376.517 | 11.6750 | -0.02278 |
| 226.0 | 471.080 | 380.423 | 11.6301 | -0.02210 |
| 228.0 | 494.297 | 384.321 | 11.5866 | -0.02145 |
| 230.0 | 517.427 | 388.211 | 11.5443 | -0.02083 |
| 232.0 | 540.474 | 392.092 | 11.5032 | -0.02024 |
| 234.0 | 563.441 | 395.965 | 11.4633 | -0.01967 |
| 236.0 | 586.328 | 399.831 | 11.4245 | -0.01912 |
| 238.0 | 609.140 | 403.688 | 11.3868 | -0.01860 |
| 240.0 | 631.876 | 407.537 | 11.3501 | -0.01810 |
| 242.0 | 654.541 | 411.379 | 11.3144 | -0.01762 |
| 244.0 | 677.135 | 415.213 | 11.2797 | -0.01715 |
| 246.0 | 699.660 | 419.040 | 11.2458 | -0.01671 |

Table 23. Calculated P(T) isochores- - - (Continued)

THE ISOCHORE AT 19.00 MOL/L

| T,K | P,BAR | DP/CD | DP/DT | D2P/DT2 |
|---|---|---|---|---|
| 163.0 | 6.143 | 419.883 | 16.3415 | -0.07340 |
| 164.0 | 22.448 | 422.072 | 16.2689 | -0.07174 |
| 165.0 | 38.681 | 424.264 | 16.1980 | -0.07014 |
| 166.0 | 54.844 | 426.458 | 16.1286 | -0.06858 |
| 167.0 | 70.939 | 428.655 | 16.0608 | -0.06707 |
| 168.0 | 86.966 | 430.854 | 15.9945 | -0.06560 |
| 169.0 | 102.928 | 433.056 | 15.9296 | -0.06418 |
| 170.0 | 118.826 | 435.259 | 15.8661 | -0.06280 |
| 171.0 | 134.661 | 437.465 | 15.8040 | -0.06146 |
| 172.0 | 150.434 | 439.672 | 15.7432 | -0.06016 |
| 173.0 | 166.148 | 441.881 | 15.6836 | -0.05889 |
| 174.0 | 181.802 | 444.092 | 15.6254 | -0.05767 |
| 175.0 | 197.399 | 446.304 | 15.5683 | -0.05647 |
| 176.0 | 212.939 | 448.517 | 15.5124 | -0.05531 |
| 177.0 | 228.424 | 450.732 | 15.4576 | -0.05419 |
| 178.0 | 243.855 | 452.949 | 15.4040 | -0.05309 |
| 179.0 | 259.232 | 455.166 | 15.3515 | -0.05203 |
| 180.0 | 274.558 | 457.385 | 15.2999 | -0.05099 |
| 181.0 | 289.833 | 459.604 | 15.2495 | -0.04999 |
| 182.0 | 305.057 | 461.825 | 15.2000 | -0.04901 |
| 183.0 | 320.233 | 464.046 | 15.1514 | -0.04806 |
| 184.0 | 335.360 | 466.268 | 15.1038 | -0.04713 |
| 185.0 | 350.441 | 468.491 | 15.0572 | -0.04623 |
| 186.0 | 365.475 | 470.715 | 15.0114 | -0.04535 |
| 187.0 | 380.464 | 472.939 | 14.9665 | -0.04450 |
| 188.0 | 395.408 | 475.164 | 14.9224 | -0.04367 |
| 189.0 | 410.309 | 477.389 | 14.8791 | -0.04286 |
| 190.0 | 425.167 | 479.615 | 14.8367 | -0.04207 |
| 191.0 | 439.982 | 481.840 | 14.7950 | -0.04130 |
| 192.0 | 454.757 | 484.067 | 14.7541 | -0.04055 |
| 193.0 | 469.491 | 486.293 | 14.7139 | -0.03982 |
| 194.0 | 484.185 | 488.520 | 14.6744 | -0.03911 |
| 195.0 | 498.840 | 490.747 | 14.6356 | -0.03842 |
| 196.0 | 513.456 | 492.974 | 14.5976 | -0.03774 |
| 197.0 | 528.035 | 495.201 | 14.5602 | -0.03708 |
| 198.0 | 542.577 | 497.428 | 14.5234 | -0.03644 |
| 199.0 | 557.082 | 499.655 | 14.4873 | -0.03582 |
| 200.0 | 571.552 | 501.882 | 14.4518 | -0.03521 |
| 201.0 | 585.986 | 504.109 | 14.4168 | -0.03461 |
| 202.0 | 600.385 | 506.336 | 14.3825 | -0.03403 |
| 203.0 | 614.751 | 508.562 | 14.3488 | -0.03346 |
| 204.0 | 629.083 | 510.789 | 14.3156 | -0.03291 |
| 205.0 | 643.382 | 513.015 | 14.2830 | -0.03237 |
| 206.0 | 657.649 | 515.241 | 14.2508 | -0.03184 |
| 207.0 | 671.884 | 517.466 | 14.2193 | -0.03133 |
| 208.0 | 686.088 | 519.692 | 14.1882 | -0.03083 |

Table 23. Calculated P(T) isochores- - - (Continued)

THE ISOCHORE AT 20.00 MOL/L

| T,K | P,BAR | DP/DD | DP/DT | D2P/DT2 |
|---|---|---|---|---|
| 137.0 | 16.308 | 575.795 | 21.0926 | -0.12851 |
| 138.0 | 37.337 | 577.966 | 20.9658 | -0.12506 |
| 139.0 | 58.241 | 580.153 | 20.8424 | -0.12174 |
| 140.0 | 79.023 | 582.358 | 20.7223 | -0.11853 |
| 141.0 | 99.687 | 584.579 | 20.6053 | -0.11543 |
| 142.0 | 120.235 | 586.816 | 20.4914 | -0.11245 |
| 143.0 | 140.670 | 589.068 | 20.3804 | -0.10956 |
| 144.0 | 160.997 | 591.335 | 20.2722 | -0.10678 |
| 145.0 | 181.216 | 593.616 | 20.1668 | -0.10408 |
| 146.0 | 201.331 | 595.911 | 20.0640 | -0.10148 |
| 147.0 | 221.345 | 598.219 | 19.9638 | -0.09897 |
| 148.0 | 241.260 | 600.540 | 19.8661 | -0.09654 |
| 149.0 | 261.078 | 602.873 | 19.7707 | -0.09419 |
| 150.0 | 280.802 | 605.219 | 19.6777 | -0.09192 |
| 151.0 | 300.434 | 607.575 | 19.5869 | -0.08972 |
| 152.0 | 319.976 | 609.943 | 19.4982 | -0.08760 |
| 153.0 | 339.431 | 612.322 | 19.4116 | -0.08554 |
| 154.0 | 358.800 | 614.711 | 19.3271 | -0.08354 |
| 155.0 | 378.086 | 617.110 | 19.2445 | -0.08162 |
| 156.0 | 397.290 | 619.519 | 19.1639 | -0.07975 |
| 157.0 | 416.414 | 621.937 | 19.0850 | -0.07794 |
| 158.0 | 435.460 | 624.364 | 19.0080 | -0.07618 |
| 159.0 | 454.431 | 626.800 | 18.9326 | -0.07448 |
| 160.0 | 473.326 | 629.245 | 18.8590 | -0.07284 |
| 161.0 | 492.149 | 631.697 | 18.7869 | -0.07124 |
| 162.0 | 510.901 | 634.158 | 18.7165 | -0.06969 |
| 163.0 | 529.583 | 636.626 | 18.6475 | -0.06819 |
| 164.0 | 548.196 | 639.101 | 18.5801 | -0.06673 |
| 165.0 | 566.743 | 641.584 | 18.5141 | -0.06532 |
| 166.0 | 585.225 | 644.073 | 18.4494 | -0.06395 |
| 167.0 | 603.643 | 646.569 | 18.3862 | -0.06262 |
| 168.0 | 621.998 | 649.072 | 18.3242 | -0.06132 |
| 169.0 | 640.291 | 651.581 | 18.2635 | -0.06007 |
| 170.0 | 658.525 | 654.095 | 18.2040 | -0.05885 |
| 171.0 | 676.700 | 656.615 | 18.1458 | -0.05767 |
| 172.0 | 694.817 | 659.141 | 18.0887 | -0.05652 |

Table 23. Calculated P(T) isochores- - - (Continued)

THE ISOCHORE AT 21.00 MOL/L

| T,K | P,BAR | DP/DD | DP/DT | D2P/DT2 |
|---|---|---|---|---|
| 109.0 | 8.092 | 782.786 | 28.1089 | -0.24813 |
| 110.0 | 36.078 | 784.450 | 27.8650 | -0.23973 |
| 111.0 | 63.825 | 786.177 | 27.6294 | -0.23170 |
| 112.0 | 91.340 | 787.964 | 27.4015 | -0.22402 |
| 113.0 | 118.631 | 789.810 | 27.1812 | -0.21668 |
| 114.0 | 145.705 | 791.713 | 26.9681 | -0.20965 |
| 115.0 | 172.569 | 793.669 | 26.7618 | -0.20292 |
| 116.0 | 199.230 | 795.677 | 26.5621 | -0.19647 |
| 117.0 | 225.695 | 797.735 | 26.3688 | -0.19030 |
| 118.0 | 251.970 | 799.841 | 26.1814 | -0.18438 |
| 119.0 | 278.060 | 801.994 | 25.9999 | -0.17871 |
| 120.0 | 303.972 | 804.191 | 25.8240 | -0.17326 |
| 121.0 | 329.710 | 806.431 | 25.6533 | -0.16804 |
| 122.0 | 355.280 | 808.712 | 25.4878 | -0.16303 |
| 123.0 | 380.687 | 811.034 | 25.3272 | -0.15822 |
| 124.0 | 405.936 | 813.394 | 25.1713 | -0.15359 |
| 125.0 | 431.031 | 815.790 | 25.0200 | -0.14915 |
| 126.0 | 455.977 | 818.223 | 24.8730 | -0.14488 |
| 127.0 | 480.779 | 820.690 | 24.7301 | -0.14078 |
| 128.0 | 505.439 | 823.190 | 24.5913 | -0.13683 |
| 129.0 | 529.962 | 825.722 | 24.4564 | -0.13303 |
| 130.0 | 554.353 | 828.285 | 24.3252 | -0.12938 |
| 131.0 | 578.614 | 830.878 | 24.1976 | -0.12586 |
| 132.0 | 602.749 | 833.500 | 24.0735 | -0.12247 |
| 133.0 | 626.762 | 836.149 | 23.9526 | -0.11921 |
| 134.0 | 650.656 | 838.825 | 23.8350 | -0.11606 |
| 135.0 | 674.433 | 841.526 | 23.7205 | -0.11303 |
| 136.0 | 698.098 | 844.253 | 23.6089 | -0.11011 |

THE ISOCHORE AT 22.00 MOL/L

| T,K | P,BAR | DP/DD | DP/DT | D2P/DT2 |
|---|---|---|---|---|
| 96.0 | 533.498 | 1074.777 | 33.3642 | -0.28865 |
| 97.0 | 566.720 | 1076.862 | 33.0810 | -0.27785 |
| 98.0 | 599.663 | 1079.053 | 32.8083 | -0.26758 |
| 99.0 | 632.339 | 1081.344 | 32.5456 | -0.25782 |
| 100.0 | 664.758 | 1083.732 | 32.2925 | -0.24854 |
| 101.0 | 696.927 | 1086.211 | 32.0484 | -0.23971 |

Table 24. Calculated $P(\rho)$ isotherms

The following pages give $P(\rho)$ isotherms, as computed by the equation of state (5). The third column DP/DD is the isotherm slope $(\partial P/\partial \rho)$ in units of the bar and mol/$\ell$. The last two columns give the isochore slopes and curvatures, DP/DT $\equiv (\partial P/\partial T)$, D2P/DT2 $\equiv (\partial^2 P/\partial T^2)$ in units of the bar and Kelvins.

These tables show that $\partial P/\partial \rho$ is non-negative, and that it increases monotonically with density to pressures about twice those for adjusting the equation of state.

Table 24. Calculated P(ρ) isotherms.

THE ISOTHERM AT 95.00 DEG. K

| MOL/L | P,BAR | DP/DD | DP/DT | D2P/DT2 |
|---|---|---|---|---|
| 21.50 | 4.806 | 911.484 | 32.9615 | -0.359363 |
| 21.55 | 50.760 | 926.705 | 33.0105 | -0.353331 |
| 21.60 | 97.480 | 942.107 | 33.0636 | -0.347309 |
| 21.65 | 144.974 | 957.697 | 33.1208 | -0.341302 |
| 21.70 | 193.253 | 973.484 | 33.1826 | -0.335313 |
| 21.75 | 242.326 | 989.475 | 33.2489 | -0.329348 |
| 21.80 | 292.204 | 1005.679 | 33.3202 | -0.323411 |
| 21.85 | 342.897 | 1022.104 | 33.3966 | -0.317505 |
| 21.90 | 394.418 | 1038.760 | 33.4782 | -0.311636 |
| 21.95 | 446.777 | 1055.656 | 33.5655 | -0.305809 |

THE ISOTHERM AT 100.00 DEG. K

| MOL/L | P,BAR | DP/DD | DP/DT | D2P/DT2 |
|---|---|---|---|---|
| 21.35 | 31.210 | 871.909 | 31.1230 | -0.310639 |
| 21.40 | 75.180 | 886.956 | 31.1884 | -0.305784 |
| 21.45 | 119.908 | 902.184 | 31.2572 | -0.300928 |
| 21.50 | 165.402 | 917.599 | 31.3296 | -0.296076 |
| 21.55 | 211.671 | 933.208 | 31.4057 | -0.291231 |
| 21.60 | 258.726 | 949.019 | 31.4858 | -0.286396 |
| 21.65 | 306.577 | 965.038 | 31.5700 | -0.281575 |
| 21.70 | 355.234 | 981.274 | 31.6586 | -0.276773 |
| 21.75 | 404.708 | 997.736 | 31.7517 | -0.271991 |
| 21.80 | 455.011 | 1014.432 | 31.8495 | -0.267236 |
| 21.85 | 506.155 | 1031.370 | 31.9523 | -0.262509 |
| 21.90 | 558.152 | 1048.559 | 32.0603 | -0.257815 |
| 21.95 | 611.015 | 1066.010 | 32.1736 | -0.253157 |
| 22.00 | 664.758 | 1083.732 | 32.2925 | -0.248540 |
| 22.05 | 719.393 | 1101.735 | 32.4171 | -0.243968 |

THE ISOTHERM AT 110.00 DEG. K

| MOL/L | P,BAR | DP/DD | DP/DT | D2P/DT2 |
|---|---|---|---|---|
| 21.00 | 36.078 | 784.450 | 27.8650 | -0.239728 |
| 21.05 | 75.660 | 798.827 | 27.9509 | -0.236564 |
| 21.10 | 115.964 | 813.376 | 28.0391 | -0.233386 |
| 21.15 | 157.000 | 828.104 | 28.1297 | -0.230198 |
| 21.20 | 198.777 | 843.014 | 28.2230 | -0.227000 |
| 21.25 | 241.305 | 858.114 | 28.3189 | -0.223795 |
| 21.30 | 284.592 | 873.409 | 28.4177 | -0.220586 |
| 21.35 | 328.649 | 888.906 | 28.5196 | -0.217375 |
| 21.40 | 373.486 | 904.610 | 28.6247 | -0.214164 |
| 21.45 | 419.114 | 920.530 | 28.7332 | -0.210957 |
| 21.50 | 465.543 | 936.672 | 28.8451 | -0.207755 |
| 21.55 | 512.785 | 953.043 | 28.9608 | -0.204561 |
| 21.60 | 560.851 | 969.652 | 29.0803 | -0.201377 |
| 21.65 | 609.754 | 986.506 | 29.2038 | -0.198208 |
| 21.70 | 659.506 | 1003.613 | 29.3315 | -0.195054 |
| 21.75 | 710.120 | 1020.982 | 29.4635 | -0.191920 |

Table 24. Calculated P(ρ) isotherms (Continued)

THE ISOTHERM AT 120.00 DEG. K

| MOL/L | P,BAR | DP/DD | DP/DT | D2P/DT2 |
|---|---|---|---|---|
| 20.60 | 5.090 | 692.070 | 24.9991 | -0.190010 |
| 20.65 | 40.029 | 705.492 | 25.0963 | -0.187977 |
| 20.70 | 75.642 | 719.075 | 25.1949 | -0.185923 |
| 20.75 | 111.939 | 732.823 | 25.2952 | -0.183852 |
| 20.80 | 148.927 | 746.739 | 25.3971 | -0.181763 |
| 20.85 | 186.616 | 760.830 | 25.5008 | -0.179658 |
| 20.90 | 225.013 | 775.099 | 25.6065 | -0.177539 |
| 20.95 | 264.129 | 789.550 | 25.7141 | -0.175407 |
| 21.00 | 303.972 | 804.191 | 25.8240 | -0.173264 |
| 21.05 | 344.551 | 819.025 | 25.9361 | -0.171111 |
| 21.10 | 385.877 | 834.058 | 26.0506 | -0.168951 |
| 21.15 | 427.960 | 849.296 | 26.1676 | -0.166784 |
| 21.20 | 470.811 | 864.746 | 26.2873 | -0.164612 |
| 21.25 | 514.439 | 880.413 | 26.4097 | -0.162438 |
| 21.30 | 558.856 | 896.303 | 26.5351 | -0.160263 |
| 21.35 | 604.073 | 912.424 | 26.6636 | -0.158089 |
| 21.40 | 650.102 | 928.783 | 26.7952 | -0.155918 |
| 21.45 | 696.955 | 945.386 | 26.9301 | -0.153751 |
| 21.50 | 744.645 | 962.241 | 27.0685 | -0.151592 |

THE ISOTHERM AT 140.00 DEG. K

| MOL/L | P,BAR | DP/DD | DP/DT | D2P/DT2 |
|---|---|---|---|---|
| 19.90 | 21.970 | 558.809 | 20.5026 | -0.120130 |
| 19.95 | 50.202 | 570.510 | 20.6121 | -0.119339 |
| 20.00 | 79.023 | 582.358 | 20.7223 | -0.118529 |
| 20.05 | 108.440 | 594.355 | 20.8334 | -0.117703 |
| 20.10 | 138.461 | 606.504 | 20.9453 | -0.116859 |
| 20.15 | 169.093 | 618.808 | 21.0582 | -0.115998 |
| 20.20 | 200.345 | 631.271 | 21.1721 | -0.115121 |
| 20.25 | 232.223 | 643.894 | 21.2870 | -0.114229 |
| 20.30 | 264.737 | 656.683 | 21.4031 | -0.113321 |
| 20.35 | 297.894 | 669.641 | 21.5204 | -0.112399 |
| 20.40 | 331.704 | 682.771 | 21.6390 | -0.111463 |
| 20.45 | 366.174 | 696.078 | 21.7589 | -0.110514 |
| 20.50 | 401.315 | 709.565 | 21.8802 | -0.109552 |
| 20.55 | 437.134 | 723.237 | 22.0031 | -0.108579 |
| 20.60 | 473.641 | 737.098 | 22.1275 | -0.107594 |
| 20.65 | 510.847 | 751.153 | 22.2536 | -0.106600 |
| 20.70 | 548.760 | 765.407 | 22.3815 | -0.105595 |
| 20.75 | 587.391 | 779.864 | 22.5112 | -0.104583 |
| 20.80 | 626.750 | 794.530 | 22.6428 | -0.103563 |
| 20.85 | 666.848 | 809.410 | 22.7764 | -0.102536 |
| 20.90 | 707.695 | 824.510 | 22.9122 | -0.101504 |
| 20.95 | 749.302 | 839.835 | 23.0501 | -0.100466 |

Table 24. Calculated P(ρ) isotherms (Continued)

THE ISOTHERM AT 160.00 DEG. K

| MOL/L | P,BAR | DP/DD | DP/DT | D2P/DT2 |
|---|---|---|---|---|
| 19.15 | 20.934 | 442.231 | 16.8979 | -0.078123 |
| 19.20 | 43.292 | 452.114 | 17.0083 | -0.077910 |
| 19.25 | 66.148 | 462.126 | 17.1191 | -0.077685 |
| 19.30 | 89.507 | 472.268 | 17.2304 | -0.077447 |
| 19.35 | 113.377 | 482.543 | 17.3422 | -0.077196 |
| 19.40 | 137.763 | 492.952 | 17.4545 | -0.076933 |
| 19.45 | 162.674 | 503.498 | 17.5675 | -0.076657 |
| 19.50 | 188.115 | 514.182 | 17.6810 | -0.076369 |
| 19.55 | 214.095 | 525.008 | 17.7953 | -0.076068 |
| 19.60 | 240.619 | 535.978 | 17.9102 | -0.075755 |
| 19.65 | 267.695 | 547.094 | 18.0258 | -0.075431 |
| 19.70 | 295.331 | 558.359 | 18.1422 | -0.075094 |
| 19.75 | 323.533 | 569.776 | 18.2594 | -0.074746 |
| 19.80 | 352.311 | 581.348 | 18.3774 | -0.074386 |
| 19.85 | 381.671 | 593.078 | 18.4963 | -0.074015 |
| 19.90 | 411.621 | 604.968 | 18.6162 | -0.073633 |
| 19.95 | 442.170 | 617.023 | 18.7371 | -0.073240 |
| 20.00 | 473.326 | 629.245 | 18.8590 | -0.072837 |
| 20.05 | 505.098 | 641.638 | 18.9820 | -0.072424 |
| 20.10 | 537.493 | 654.205 | 19.1061 | -0.072001 |
| 20.15 | 570.521 | 666.952 | 19.2314 | -0.071568 |
| 20.20 | 604.191 | 679.880 | 19.3579 | -0.071127 |
| 20.25 | 638.512 | 692.995 | 19.4858 | -0.070677 |
| 20.30 | 673.494 | 706.301 | 19.6150 | -0.070219 |
| 20.35 | 709.146 | 719.801 | 19.7456 | -0.069753 |
| 20.40 | 745.477 | 733.501 | 19.8778 | -0.069281 |

Table 24. Calculated P(ρ) isotherms (Continued)

THE ISOTHERM AT 180.00 DEG. K

| MOL/L | P,BAR | DP/DD | DP/DT | D2P/DT2 |
|---|---|---|---|---|
| 0.05 | 0.729 | 14.231 | 0.0043 | -0.000002 |
| 18.35 | 15.706 | 342.424 | 13.8992 | -0.050964 |
| 18.40 | 33.031 | 350.573 | 14.0043 | -0.051014 |
| 18.45 | 50.765 | 358.831 | 14.1099 | -0.051056 |
| 18.50 | 68.916 | 367.202 | 14.2158 | -0.051090 |
| 18.55 | 87.487 | 375.685 | 14.3222 | -0.051117 |
| 18.60 | 106.486 | 384.283 | 14.4290 | -0.051136 |
| 18.65 | 125.918 | 392.998 | 14.5362 | -0.051147 |
| 18.70 | 145.788 | 401.829 | 14.6438 | -0.051149 |
| 18.75 | 166.103 | 410.780 | 14.7519 | -0.051144 |
| 18.80 | 186.868 | 419.852 | 14.8605 | -0.051131 |
| 18.85 | 208.090 | 429.047 | 14.9696 | -0.051109 |
| 18.90 | 229.775 | 438.366 | 15.0792 | -0.051079 |
| 18.95 | 251.929 | 447.811 | 15.1893 | -0.051041 |
| 19.00 | 274.558 | 457.385 | 15.2999 | -0.050994 |
| 19.05 | 297.669 | 467.089 | 15.4112 | -0.050939 |
| 19.10 | 321.269 | 476.925 | 15.5230 | -0.050876 |
| 19.15 | 345.364 | 486.896 | 15.6355 | -0.050804 |
| 19.20 | 369.961 | 497.003 | 15.7486 | -0.050724 |
| 19.25 | 395.067 | 507.250 | 15.8624 | -0.050636 |
| 19.30 | 420.688 | 517.638 | 15.9768 | -0.050539 |
| 19.35 | 446.833 | 528.170 | 16.0920 | -0.050435 |
| 19.40 | 473.508 | 538.849 | 16.2080 | -0.050322 |
| 19.45 | 500.720 | 549.678 | 16.3247 | -0.050202 |
| 19.50 | 528.478 | 560.658 | 16.4422 | -0.050074 |
| 19.55 | 556.789 | 571.794 | 16.5606 | -0.049938 |
| 19.60 | 585.660 | 583.088 | 16.6799 | -0.049795 |
| 19.65 | 615.100 | 594.542 | 16.8001 | -0.049644 |
| 19.70 | 645.117 | 606.162 | 16.9212 | -0.049486 |
| 19.75 | 675.719 | 617.949 | 17.0434 | -0.049321 |
| 19.80 | 706.915 | 629.907 | 17.1665 | -0.049149 |
| 19.85 | 738.713 | 642.041 | 17.2908 | -0.048971 |

Table 24. Calculated P(ρ) isotherms (Continued)

THE ISOTHERM AT 200.00 DEG. K

| MOL/L | P,BAR | DP/DD | DP/DT | D2P/DT2 |
|---|---|---|---|---|
| 0.05 | 0.814 | 15.975 | 0.0042 | -0.000001 |
| 0.10 | 1.596 | 15.285 | 0.0087 | -0.000005 |
| 17.50 | 13.541 | 258.847 | 11.3605 | -0.032662 |
| 17.55 | 26.647 | 265.425 | 11.4570 | -0.032815 |
| 17.60 | 40.085 | 272.097 | 11.5539 | -0.032964 |
| 17.65 | 53.859 | 278.864 | 11.6512 | -0.033110 |
| 17.70 | 67.973 | 285.727 | 11.7489 | -0.033251 |
| 17.75 | 82.433 | 292.686 | 11.8469 | -0.033389 |
| 17.80 | 97.243 | 299.743 | 11.9454 | -0.033522 |
| 17.85 | 112.409 | 306.899 | 12.0443 | -0.033651 |
| 17.90 | 127.935 | 314.155 | 12.1437 | -0.033775 |
| 17.95 | 143.826 | 321.512 | 12.2434 | -0.033895 |
| 18.00 | 160.088 | 328.972 | 12.3436 | -0.034009 |
| 18.05 | 176.725 | 336.535 | 12.4442 | -0.034120 |
| 18.10 | 193.743 | 344.203 | 12.5452 | -0.034225 |
| 18.15 | 211.147 | 351.977 | 12.6467 | -0.034325 |
| 18.20 | 228.943 | 359.859 | 12.7486 | -0.034420 |
| 18.25 | 247.135 | 367.849 | 12.8511 | -0.034510 |
| 18.30 | 265.729 | 375.950 | 12.9540 | -0.034595 |
| 18.35 | 284.732 | 384.163 | 13.0573 | -0.034674 |
| 18.40 | 304.147 | 392.489 | 13.1612 | -0.034748 |
| 18.45 | 323.982 | 400.930 | 13.2656 | -0.034817 |
| 18.50 | 344.242 | 409.487 | 13.3705 | -0.034880 |
| 18.55 | 364.933 | 418.163 | 13.4760 | -0.034938 |
| 18.60 | 386.061 | 426.959 | 13.5820 | -0.034990 |
| 18.65 | 407.631 | 435.877 | 13.6886 | -0.035036 |
| 18.70 | 429.650 | 444.919 | 13.7957 | -0.035077 |
| 18.75 | 452.125 | 454.086 | 13.9035 | -0.035113 |
| 18.80 | 475.061 | 463.381 | 14.0118 | -0.035143 |
| 18.85 | 498.465 | 472.806 | 14.1208 | -0.035167 |
| 18.90 | 522.344 | 482.363 | 14.2304 | -0.035186 |
| 18.95 | 546.704 | 492.054 | 14.3408 | -0.035199 |
| 19.00 | 571.552 | 501.882 | 14.4518 | -0.035207 |
| 19.05 | 596.894 | 511.849 | 14.5635 | -0.035209 |
| 19.10 | 622.739 | 521.957 | 14.6759 | -0.035205 |
| 19.15 | 649.092 | 532.209 | 14.7891 | -0.035197 |
| 19.20 | 675.962 | 542.608 | 14.9031 | -0.035183 |
| 19.25 | 703.356 | 553.156 | 15.0178 | -0.035163 |
| 19.30 | 731.280 | 563.856 | 15.1334 | -0.035139 |

Table 24. Calculated P(ρ) isotherms (Continued)

THE ISOTHERM AT 220.00 DEG. K

| MOL/L | P,BAR | DP/DD | DP/DT | D2P/DT2 |
|---|---|---|---|---|
| 0.10 | 1.768 | 17.082 | 0.0086 | -0.000003 |
| 0.20 | 3.411 | 15.770 | 0.0178 | -0.000014 |
| 16.60 | 17.768 | 190.467 | 9.2021 | -0.020109 |
| 16.70 | 37.336 | 200.940 | 9.3742 | -0.020462 |
| 16.80 | 57.967 | 211.733 | 9.5479 | -0.020809 |
| 16.90 | 79.693 | 222.851 | 9.7233 | -0.021149 |
| 17.00 | 102.548 | 234.300 | 9.9004 | -0.021482 |
| 17.10 | 126.565 | 246.088 | 10.0792 | -0.021806 |
| 17.20 | 151.777 | 258.222 | 10.2598 | -0.022121 |
| 17.30 | 178.221 | 270.708 | 10.4420 | -0.022427 |
| 17.40 | 205.931 | 283.554 | 10.6260 | -0.022722 |
| 17.50 | 234.944 | 296.769 | 10.8119 | -0.023005 |
| 17.60 | 265.297 | 310.360 | 10.9995 | -0.023278 |
| 17.70 | 297.029 | 324.337 | 11.1890 | -0.023537 |
| 17.80 | 330.178 | 338.710 | 11.3803 | -0.023785 |
| 17.90 | 364.784 | 353.487 | 11.5737 | -0.024018 |
| 18.00 | 400.889 | 368.680 | 11.7690 | -0.024239 |
| 18.10 | 438.535 | 384.300 | 11.9664 | -0.024445 |
| 18.20 | 477.764 | 400.359 | 12.1659 | -0.024637 |
| 18.30 | 518.621 | 416.870 | 12.3677 | -0.024814 |
| 18.40 | 561.153 | 433.846 | 12.5718 | -0.024976 |
| 18.50 | 605.407 | 451.302 | 12.7783 | -0.025124 |
| 18.60 | 651.430 | 469.253 | 12.9873 | -0.025256 |
| 18.70 | 699.274 | 487.716 | 13.1989 | -0.025373 |
| 18.80 | 748.991 | 506.709 | 13.4133 | -0.025475 |

Table 24. Calculated P(ρ) isotherms (Continued)

THE ISOTHERM AT 240.00 DEG. K

| MOL/L | P,BAR | DP/DD | DP/DT | D2P/DT2 |
|---|---|---|---|---|
| 0.10 | 1.940 | 18.852 | 0.0085 | -0.000002 |
| 0.20 | 3.766 | 17.661 | 0.0176 | -0.000009 |
| 0.30 | 5.473 | 16.494 | 0.0272 | -0.000022 |
| 0.40 | 7.066 | 15.364 | 0.0374 | -0.000044 |
| 0.50 | 8.547 | 14.263 | 0.0483 | -0.000076 |
| 15.50 | 9.671 | 124.461 | 7.1561 | -0.011002 |
| 15.60 | 22.499 | 132.140 | 7.3023 | -0.011333 |
| 15.70 | 36.108 | 140.077 | 7.4502 | -0.011664 |
| 15.80 | 50.523 | 148.278 | 7.5998 | -0.011994 |
| 15.90 | 65.772 | 156.749 | 7.7512 | -0.012322 |
| 16.00 | 81.882 | 165.494 | 7.9043 | -0.012648 |
| 16.10 | 98.880 | 174.519 | 8.0592 | -0.012972 |
| 16.20 | 116.795 | 183.828 | 8.2159 | -0.013293 |
| 16.30 | 135.656 | 193.428 | 8.3743 | -0.013611 |
| 16.40 | 155.491 | 203.325 | 8.5345 | -0.013925 |
| 16.50 | 176.331 | 213.524 | 8.6964 | -0.014235 |
| 16.60 | 198.206 | 224.030 | 8.8601 | -0.014540 |
| 16.70 | 221.147 | 234.852 | 9.0256 | -0.014840 |
| 16.80 | 245.187 | 245.994 | 9.1929 | -0.015135 |
| 16.90 | 270.357 | 257.463 | 9.3620 | -0.015423 |
| 17.00 | 296.691 | 269.268 | 9.5330 | -0.015706 |
| 17.10 | 324.222 | 281.414 | 9.7058 | -0.015981 |
| 17.20 | 352.985 | 293.910 | 9.8805 | -0.016250 |
| 17.30 | 383.016 | 306.764 | 10.0571 | -0.016511 |
| 17.40 | 414.350 | 319.985 | 10.2357 | -0.016764 |
| 17.50 | 447.025 | 333.580 | 10.4162 | -0.017008 |
| 17.60 | 481.079 | 347.560 | 10.5987 | -0.017244 |
| 17.70 | 516.551 | 361.935 | 10.7834 | -0.017471 |
| 17.80 | 553.480 | 376.715 | 10.9701 | -0.017689 |
| 17.90 | 591.908 | 391.912 | 11.1590 | -0.017897 |
| 18.00 | 631.876 | 407.537 | 11.3501 | -0.018096 |
| 18.10 | 673.430 | 423.604 | 11.5436 | -0.018285 |
| 18.20 | 716.612 | 440.125 | 11.7394 | -0.018464 |

Table 24. Calculated P($\rho$) isotherms (Continued)

THE ISOTHERM AT 260.00 DEG. K

| MOL/L | P,BAR | DP/DD | DP/DT | D2P/DT2 |
|---|---|---|---|---|
| 0.10 | 2.110 | 20.604 | 0.0085 | -0.000001 |
| 0.20 | 4.116 | 19.511 | 0.0175 | -0.000006 |
| 0.30 | 6.014 | 18.446 | 0.0269 | -0.000015 |
| 0.40 | 7.807 | 17.423 | 0.0367 | -0.000028 |
| 0.50 | 9.499 | 16.433 | 0.0471 | -0.000047 |
| 0.60 | 11.094 | 15.465 | 0.0579 | -0.000071 |
| 0.70 | 12.593 | 14.511 | 0.0693 | -0.000103 |
| 0.80 | 13.997 | 13.566 | 0.0811 | -0.000143 |
| 0.90 | 15.306 | 12.629 | 0.0935 | -0.000193 |
| 1.00 | 16.523 | 11.698 | 0.1065 | -0.000255 |
| 14.30 | 17.323 | 75.033 | 5.4238 | -0.004694 |
| 14.40 | 25.089 | 80.318 | 5.5430 | -0.004975 |
| 14.50 | 33.393 | 85.806 | 5.6639 | -0.005257 |
| 14.60 | 42.257 | 91.502 | 5.7865 | -0.005538 |
| 14.70 | 51.701 | 97.411 | 5.9108 | -0.005819 |
| 14.80 | 61.747 | 103.537 | 6.0368 | -0.006101 |
| 14.90 | 72.416 | 109.885 | 6.1646 | -0.006382 |
| 15.00 | 83.731 | 116.459 | 6.2941 | -0.006663 |
| 15.10 | 95.715 | 123.264 | 6.4254 | -0.006944 |
| 15.20 | 108.392 | 130.304 | 6.5584 | -0.007225 |
| 15.30 | 121.784 | 137.585 | 6.6932 | -0.007506 |
| 15.40 | 135.917 | 145.110 | 6.8297 | -0.007786 |
| 15.50 | 150.814 | 152.885 | 6.9679 | -0.008065 |
| 15.60 | 166.502 | 160.915 | 7.1080 | -0.008343 |
| 15.70 | 183.006 | 169.205 | 7.2498 | -0.008620 |
| 15.80 | 200.352 | 177.759 | 7.3934 | -0.008895 |
| 15.90 | 218.567 | 186.584 | 7.5387 | -0.009169 |
| 16.00 | 237.678 | 195.683 | 7.6859 | -0.009441 |
| 16.10 | 257.713 | 205.064 | 7.8349 | -0.009710 |
| 16.20 | 278.700 | 214.731 | 7.9856 | -0.009978 |
| 16.30 | 300.669 | 224.690 | 8.1382 | -0.010242 |
| 16.40 | 323.648 | 234.947 | 8.2927 | -0.010504 |
| 16.50 | 347.669 | 245.509 | 8.4489 | -0.010762 |
| 16.60 | 372.761 | 256.381 | 8.6071 | -0.011016 |
| 16.70 | 398.956 | 267.571 | 8.7671 | -0.011267 |
| 16.80 | 426.286 | 279.086 | 8.9290 | -0.011514 |
| 16.90 | 454.784 | 290.932 | 9.0928 | -0.011756 |
| 17.00 | 484.483 | 303.117 | 9.2586 | -0.011993 |
| 17.10 | 515.419 | 315.650 | 9.4263 | -0.012226 |
| 17.20 | 547.625 | 328.538 | 9.5961 | -0.012453 |
| 17.30 | 581.139 | 341.791 | 9.7679 | -0.012675 |
| 17.40 | 615.996 | 355.418 | 9.9418 | -0.012891 |
| 17.50 | 652.235 | 369.428 | 10.1177 | -0.013101 |
| 17.60 | 689.895 | 383.833 | 10.2959 | -0.013305 |
| 17.70 | 729.015 | 398.642 | 10.4763 | -0.013503 |

Table 24. Calculated P(ρ) isotherms (Continued)

THE ISOTHERM AT 280.00 DEG. K

| MOL/L | P,BAR | DP/DD | DP/DT | D2P/DT2 |
|---|---|---|---|---|
| 0.20 | 4.464 | 21.334 | 0.0174 | -0.000004 |
| 0.40 | 8.537 | 19.416 | 0.0363 | -0.000020 |
| 0.60 | 12.240 | 17.635 | 0.0568 | -0.000048 |
| 0.80 | 15.595 | 15.918 | 0.0789 | -0.000091 |
| 1.00 | 18.610 | 14.238 | 0.1026 | -0.000152 |
| 1.20 | 21.292 | 12.596 | 0.1279 | -0.000235 |
| 1.40 | 23.651 | 11.005 | 0.1549 | -0.000346 |
| 1.60 | 25.699 | 9.482 | 0.1836 | -0.000496 |
| 1.80 | 27.449 | 8.034 | 0.2141 | -0.000706 |
| 12.80 | 29.399 | 35.601 | 3.8292 | 0.000011 |
| 13.00 | 37.133 | 41.834 | 4.0105 | -0.000486 |
| 13.20 | 46.172 | 48.656 | 4.1979 | -0.000961 |
| 13.40 | 56.637 | 56.100 | 4.3915 | -0.001425 |
| 13.60 | 68.656 | 64.199 | 4.5916 | -0.001882 |
| 13.80 | 82.363 | 72.985 | 4.7981 | -0.002336 |
| 14.00 | 97.898 | 82.492 | 5.0112 | -0.002789 |
| 14.20 | 115.410 | 92.751 | 5.2310 | -0.003244 |
| 14.40 | 135.051 | 103.798 | 5.4575 | -0.003700 |
| 14.60 | 156.984 | 115.667 | 5.6908 | -0.004157 |
| 14.80 | 181.375 | 128.392 | 5.9309 | -0.004617 |
| 15.00 | 208.400 | 142.008 | 6.1780 | -0.005078 |
| 15.20 | 238.240 | 156.553 | 6.4320 | -0.005539 |
| 15.40 | 271.085 | 172.064 | 6.6931 | -0.006000 |
| 15.60 | 307.133 | 188.579 | 6.9613 | -0.006459 |
| 15.80 | 346.587 | 206.139 | 7.2367 | -0.006915 |
| 16.00 | 389.661 | 224.787 | 7.5193 | -0.007366 |
| 16.20 | 436.577 | 244.567 | 7.8092 | -0.007812 |
| 16.40 | 487.566 | 265.527 | 8.1066 | -0.008250 |
| 16.60 | 542.870 | 287.718 | 8.4116 | -0.008679 |
| 16.80 | 602.739 | 311.197 | 8.7244 | -0.009097 |
| 17.00 | 667.438 | 336.024 | 9.0452 | -0.009502 |
| 17.20 | 737.243 | 362.265 | 9.3742 | -0.009894 |

Table 24. Calculated P(ρ) isotherms (Continued)

THE ISOTHERM AT 290.00 DEG. K

| MOL/L | P,BAR | DP/DD | DP/DT | D2P/DT2 |
|---|---|---|---|---|
| 0.20 | 4.638 | 22.237 | 0.0173 | -0.000004 |
| 0.40 | 8.898 | 20.396 | 0.0361 | -0.000017 |
| 0.60 | 12.805 | 18.691 | 0.0563 | -0.000040 |
| 0.80 | 16.379 | 17.052 | 0.0780 | -0.000076 |
| 1.00 | 19.628 | 15.448 | 0.1012 | -0.000124 |
| 1.20 | 22.561 | 13.882 | 0.1258 | -0.000187 |
| 1.40 | 25.185 | 12.368 | 0.1519 | -0.000268 |
| 1.60 | 27.512 | 10.922 | 0.1793 | -0.000369 |
| 1.80 | 29.559 | 9.554 | 0.2082 | -0.000496 |
| 2.00 | 31.339 | 8.269 | 0.2384 | -0.000659 |
| 2.20 | 32.872 | 7.068 | 0.2701 | -0.000872 |
| 2.40 | 34.172 | 5.945 | 0.3033 | -0.001165 |
| 11.80 | 36.715 | 19.597 | 3.0333 | 0.002241 |
| 12.00 | 41.028 | 23.606 | 3.1812 | 0.001695 |
| 12.20 | 46.187 | 28.061 | 3.3345 | 0.001209 |
| 12.40 | 52.284 | 32.991 | 3.4934 | 0.000760 |
| 12.60 | 59.417 | 38.427 | 3.6582 | 0.000336 |
| 12.80 | 67.691 | 44.398 | 3.8289 | -0.000074 |
| 13.00 | 77.215 | 50.936 | 4.0057 | -0.000476 |
| 13.20 | 88.105 | 58.070 | 4.1888 | -0.000873 |
| 13.40 | 100.484 | 65.832 | 4.3781 | -0.001268 |
| 13.60 | 114.482 | 74.253 | 4.5739 | -0.001665 |
| 13.80 | 130.232 | 83.366 | 4.7762 | -0.002063 |
| 14.00 | 147.876 | 93.204 | 4.9850 | -0.002465 |
| 14.20 | 167.564 | 103.798 | 5.2005 | -0.002869 |
| 14.40 | 189.448 | 115.183 | 5.4227 | -0.003278 |
| 14.60 | 213.692 | 127.392 | 5.6516 | -0.003689 |
| 14.80 | 240.462 | 140.461 | 5.8874 | -0.004103 |
| 15.00 | 269.936 | 154.425 | 6.1301 | -0.004520 |
| 15.20 | 302.294 | 169.319 | 6.3798 | -0.004937 |
| 15.40 | 337.728 | 185.183 | 6.6365 | -0.005355 |
| 15.60 | 376.435 | 202.056 | 6.9003 | -0.005772 |
| 15.80 | 418.620 | 219.977 | 7.1713 | -0.006187 |
| 16.00 | 464.499 | 238.991 | 7.4495 | -0.006599 |
| 16.20 | 514.293 | 259.142 | 7.7352 | -0.007007 |
| 16.40 | 568.235 | 280.481 | 8.0285 | -0.007408 |
| 16.60 | 626.567 | 303.059 | 8.3294 | -0.007802 |
| 16.80 | 689.545 | 326.934 | 8.6381 | -0.008187 |

Table 24. Calculated P(ρ) isotherms (Continued)

THE ISOTHERM AT 300.00 DEG. K

| MOL/L | P,BAR | DP/DD | DP/DT | D2P/DT2 |
|---|---|---|---|---|
| 0.20 | 4.811 | 23.137 | 0.0173 | -0.000003 |
| 0.40 | 9.258 | 21.366 | 0.0359 | -0.000014 |
| 0.60 | 13.367 | 19.733 | 0.0559 | -0.000034 |
| 0.80 | 17.156 | 18.164 | 0.0773 | -0.000064 |
| 1.00 | 20.634 | 16.630 | 0.1001 | -0.000103 |
| 1.20 | 23.810 | 15.132 | 0.1241 | -0.000154 |
| 1.40 | 26.691 | 13.685 | 0.1495 | -0.000216 |
| 1.60 | 29.289 | 12.304 | 0.1760 | -0.000291 |
| 1.80 | 31.618 | 11.000 | 0.2038 | -0.000380 |
| 2.00 | 33.694 | 9.778 | 0.2328 | -0.000486 |
| 2.20 | 35.534 | 8.639 | 0.2628 | -0.000611 |
| 2.40 | 37.155 | 7.580 | 0.2940 | -0.000760 |
| 2.60 | 38.572 | 6.596 | 0.3262 | -0.000940 |
| 2.80 | 39.798 | 5.681 | 0.3594 | -0.001160 |
| 3.00 | 40.848 | 4.830 | 0.3936 | -0.001439 |
| 3.20 | 41.734 | 4.040 | 0.4289 | -0.001803 |
| 3.40 | 42.463 | 3.308 | 0.4653 | -0.002303 |
| 3.60 | 43.062 | 2.633 | 0.5028 | -0.003045 |
| 3.80 | 43.525 | 2.015 | 0.5420 | -0.004278 |
| 10.20 | 44.034 | 5.581 | 2.0913 | 0.006320 |
| 10.40 | 45.307 | 7.188 | 2.1950 | 0.005196 |
| 10.60 | 46.926 | 9.043 | 2.3028 | 0.004369 |
| 10.80 | 48.942 | 11.169 | 2.4150 | 0.003717 |
| 11.00 | 51.413 | 13.590 | 2.5321 | 0.003176 |
| 11.20 | 54.399 | 16.331 | 2.6541 | 0.002708 |
| 11.40 | 57.968 | 19.419 | 2.7813 | 0.002289 |
| 11.60 | 62.192 | 22.879 | 2.9139 | 0.001903 |
| 11.80 | 67.147 | 26.737 | 3.0518 | 0.001540 |
| 12.00 | 72.915 | 31.022 | 3.1954 | 0.001191 |
| 12.20 | 79.586 | 35.762 | 3.3446 | 0.000852 |
| 12.40 | 87.252 | 40.983 | 3.4997 | 0.000517 |
| 12.60 | 96.013 | 46.717 | 3.6607 | 0.000185 |
| 12.80 | 105.975 | 52.992 | 3.8278 | -0.000148 |
| 13.00 | 117.248 | 59.838 | 4.0010 | -0.000482 |
| 13.20 | 129.950 | 67.285 | 4.1803 | -0.000820 |
| 13.40 | 144.204 | 75.365 | 4.3660 | -0.001162 |
| 13.60 | 160.140 | 84.108 | 4.5581 | -0.001509 |
| 13.80 | 177.894 | 93.547 | 4.7566 | -0.001860 |
| 14.00 | 197.607 | 103.714 | 4.9616 | -0.002217 |
| 14.20 | 219.430 | 114.641 | 5.1733 | -0.002579 |
| 14.40 | 243.517 | 126.362 | 5.3916 | -0.002945 |
| 14.60 | 270.030 | 138.911 | 5.6167 | -0.003316 |
| 14.80 | 299.139 | 152.322 | 5.8485 | -0.003690 |
| 15.00 | 331.019 | 166.632 | 6.0873 | -0.004067 |
| 15.20 | 365.854 | 181.877 | 6.3329 | -0.004446 |
| 15.40 | 403.834 | 198.094 | 6.5856 | -0.004826 |
| 15.60 | 445.159 | 215.324 | 6.8455 | -0.005206 |
| 15.80 | 490.034 | 233.608 | 7.1125 | -0.005585 |
| 16.00 | 538.675 | 252.989 | 7.3868 | -0.005962 |
| 16.20 | 591.306 | 273.515 | 7.6686 | -0.006335 |
| 16.40 | 648.161 | 295.236 | 7.9580 | -0.006704 |
| 16.60 | 709.484 | 318.205 | 8.2551 | -0.007067 |

Table 24. Calculated P(ρ) isotherms (Continued)

THE ISOTHERM AT 305.37 DEG. K

| MOL/L | P,BAR | DP/DD | DP/DT | D2P/DT2 |
|---|---|---|---|---|
| 0.40 | 9.451 | 21.884 | 0.0358 | -0.000013 |
| 0.80 | 17.570 | 18.754 | 0.0770 | -0.000059 |
| 1.20 | 24.474 | 15.792 | 0.1233 | -0.000140 |
| 1.60 | 30.230 | 13.029 | 0.1746 | -0.000260 |
| 2.00 | 34.937 | 10.563 | 0.2303 | -0.000424 |
| 2.40 | 38.723 | 8.420 | 0.2902 | -0.000641 |
| 2.80 | 41.713 | 6.571 | 0.3539 | -0.000925 |
| 3.20 | 44.014 | 4.977 | 0.4207 | -0.001304 |
| 3.60 | 45.725 | 3.616 | 0.4904 | -0.001823 |
| 4.00 | 46.939 | 2.491 | 0.5623 | -0.002567 |
| 4.40 | 47.751 | 1.609 | 0.6361 | -0.003696 |
| 4.80 | 48.257 | 0.962 | 0.7110 | -0.005536 |
| 5.20 | 48.547 | 0.519 | 0.7866 | -0.008912 |
| 5.60 | 48.693 | 0.232 | 0.8625 | -0.016770 |
| 6.00 | 48.748 | 0.057 | 0.9383 | -0.049009 |
| 6.40 | 48.755 | 0.000 | 1.0104 | -0.480413 |
| 6.80 | 48.755 | -0.000 | 1.0567 | 17.287460 |
| 7.20 | 48.755 | 0.002 | 1.1174 | 0.285379 |
| 7.60 | 48.764 | 0.064 | 1.2016 | 0.061370 |
| 8.00 | 48.828 | 0.284 | 1.3013 | 0.025533 |
| 8.40 | 49.022 | 0.730 | 1.4149 | 0.014647 |
| 8.80 | 49.453 | 1.486 | 1.5429 | 0.009849 |
| 9.20 | 50.265 | 2.655 | 1.6862 | 0.007230 |
| 9.60 | 51.649 | 4.362 | 1.8458 | 0.005584 |
| 10.00 | 53.846 | 6.749 | 2.0227 | 0.004434 |
| 10.40 | 57.159 | 9.974 | 2.2179 | 0.003554 |
| 10.80 | 61.960 | 14.212 | 2.4324 | 0.002828 |
| 11.20 | 68.688 | 19.649 | 2.6672 | 0.002185 |
| 11.60 | 77.865 | 26.485 | 2.9232 | 0.001586 |
| 12.00 | 90.091 | 34.930 | 3.2012 | 0.001002 |
| 12.40 | 106.052 | 45.204 | 3.5022 | 0.000416 |
| 12.80 | 126.528 | 57.535 | 3.8269 | -0.000183 |
| 13.20 | 152.387 | 72.162 | 4.1760 | -0.000801 |
| 13.60 | 184.596 | 89.327 | 4.5502 | -0.001443 |
| 14.00 | 224.220 | 109.282 | 4.9500 | -0.002108 |
| 14.40 | 272.428 | 132.288 | 5.3762 | -0.002795 |
| 14.80 | 330.493 | 158.613 | 5.8292 | -0.003500 |
| 15.20 | 399.799 | 188.540 | 6.3097 | -0.004219 |
| 15.60 | 481.845 | 222.370 | 6.8182 | -0.004942 |
| 16.00 | 578.258 | 260.428 | 7.3556 | -0.005664 |
| 16.40 | 690.800 | 303.083 | 7.9229 | -0.006373 |

Table 24. Calculated P(ρ) isotherms (Continued)

THE ISOTHERM AT 310.00 DEG. K

| MOL/L | P,BAR | DP/DD | DP/DT | D2P/DT2 |
|---|---|---|---|---|
| 0.40 | 9.617 | 22.329 | 0.0358 | -0.000013 |
| 0.80 | 17.926 | 19.259 | 0.0767 | -0.000055 |
| 1.20 | 25.044 | 16.354 | 0.1227 | -0.000129 |
| 1.60 | 31.035 | 13.645 | 0.1734 | -0.000237 |
| 2.00 | 35.999 | 11.228 | 0.2285 | -0.000382 |
| 2.40 | 40.061 | 9.130 | 0.2875 | -0.000564 |
| 2.80 | 43.342 | 7.320 | 0.3499 | -0.000789 |
| 3.20 | 45.949 | 5.758 | 0.4153 | -0.001059 |
| 3.60 | 47.978 | 4.424 | 0.4831 | -0.001378 |
| 4.00 | 49.519 | 3.318 | 0.5526 | -0.001736 |
| 4.40 | 50.664 | 2.447 | 0.6234 | -0.002101 |
| 4.80 | 51.507 | 1.804 | 0.6948 | -0.002402 |
| 5.20 | 52.133 | 1.359 | 0.7664 | -0.002528 |
| 5.60 | 52.614 | 1.066 | 0.8384 | -0.002353 |
| 6.00 | 53.000 | 0.885 | 0.9112 | -0.001801 |
| 6.40 | 53.339 | 0.837 | 0.9862 | -0.000910 |
| 6.80 | 53.682 | 0.879 | 1.0648 | 0.000162 |
| 7.20 | 54.045 | 0.945 | 1.1483 | 0.001334 |
| 7.60 | 54.451 | 1.113 | 1.2383 | 0.002503 |
| 8.00 | 54.961 | 1.474 | 1.3372 | 0.003449 |
| 8.40 | 55.664 | 2.084 | 1.4474 | 0.004001 |
| 8.80 | 56.672 | 3.018 | 1.5713 | 0.004148 |
| 9.20 | 58.134 | 4.377 | 1.7106 | 0.003995 |
| 9.60 | 60.246 | 6.283 | 1.8665 | 0.003667 |
| 10.00 | 63.253 | 8.880 | 2.0402 | 0.003253 |
| 10.40 | 67.463 | 12.326 | 2.2325 | 0.002803 |
| 10.80 | 73.250 | 16.794 | 2.4443 | 0.002337 |
| 11.20 | 81.060 | 22.472 | 2.6765 | 0.001860 |
| 11.60 | 91.416 | 29.559 | 2.9300 | 0.001371 |
| 12.00 | 104.923 | 38.264 | 3.2056 | 0.000866 |
| 12.40 | 122.272 | 48.808 | 3.5040 | 0.000340 |
| 12.80 | 144.244 | 61.417 | 3.8260 | -0.000211 |
| 13.20 | 171.713 | 76.330 | 4.1723 | -0.000789 |
| 13.60 | 205.647 | 93.788 | 4.5436 | -0.001393 |
| 14.00 | 247.116 | 114.044 | 4.9405 | -0.002024 |
| 14.40 | 297.290 | 137.357 | 5.3635 | -0.002679 |
| 14.80 | 357.445 | 163.996 | 5.8134 | -0.003352 |
| 15.20 | 428.968 | 194.244 | 6.2906 | -0.004040 |
| 15.60 | 513.361 | 228.402 | 6.7958 | -0.004734 |
| 16.00 | 612.255 | 266.800 | 7.3300 | -0.005427 |
| 16.40 | 727.416 | 309.808 | 7.8940 | -0.006111 |

Table 24. Calculated P(ρ) isotherms (Continued)

THE ISOTHERM AT 320.00 DEG. K

| MOL/L | P,BAR | DP/DD | DP/DT | D2P/DT2 |
|---|---|---|---|---|
| 0.40 | 9.974 | 23.285 | 0.0357 | -0.000011 |
| 0.80 | 18.691 | 20.340 | 0.0762 | -0.000047 |
| 1.20 | 26.265 | 17.554 | 0.1215 | -0.000110 |
| 1.60 | 32.758 | 14.954 | 0.1712 | -0.000198 |
| 2.00 | 38.266 | 12.637 | 0.2250 | -0.000311 |
| 2.40 | 42.909 | 10.627 | 0.2825 | -0.000445 |
| 2.80 | 46.805 | 8.893 | 0.3431 | -0.000597 |
| 3.20 | 50.055 | 7.395 | 0.4064 | -0.000758 |
| 3.60 | 52.749 | 6.111 | 0.4719 | -0.000916 |
| 4.00 | 54.973 | 5.043 | 0.5393 | -0.001054 |
| 4.40 | 56.814 | 4.201 | 0.6082 | -0.001146 |
| 4.80 | 58.363 | 3.581 | 0.6785 | -0.001168 |
| 5.20 | 59.706 | 3.164 | 0.7504 | -0.001100 |
| 5.60 | 60.916 | 2.911 | 0.8243 | -0.000934 |
| 6.00 | 62.052 | 2.791 | 0.9008 | -0.000677 |
| 6.40 | 63.171 | 2.834 | 0.9810 | -0.000343 |
| 6.80 | 64.335 | 2.994 | 1.0657 | 0.000043 |
| 7.20 | 65.572 | 3.205 | 1.1558 | 0.000466 |
| 7.60 | 66.918 | 3.557 | 1.2526 | 0.000906 |
| 8.00 | 68.451 | 4.153 | 1.3576 | 0.001327 |
| 8.40 | 70.281 | 5.050 | 1.4725 | 0.001689 |
| 8.80 | 72.541 | 6.319 | 1.5990 | 0.001956 |
| 9.20 | 75.398 | 8.055 | 1.7391 | 0.002108 |
| 9.60 | 79.062 | 10.374 | 1.8942 | 0.002142 |
| 10.00 | 83.793 | 13.415 | 2.0659 | 0.002069 |
| 10.40 | 89.910 | 17.330 | 2.2555 | 0.001906 |
| 10.80 | 97.797 | 22.293 | 2.4640 | 0.001669 |
| 11.20 | 107.909 | 28.488 | 2.6925 | 0.001372 |
| 11.60 | 120.778 | 36.112 | 2.9419 | 0.001025 |
| 12.00 | 137.017 | 45.376 | 3.2130 | 0.000633 |
| 12.40 | 157.326 | 56.497 | 3.5067 | 0.000202 |
| 12.80 | 182.493 | 69.702 | 3.8236 | -0.000266 |
| 13.20 | 213.397 | 85.226 | 4.1645 | -0.000770 |
| 13.60 | 251.015 | 103.313 | 4.5301 | -0.001305 |
| 14.00 | 296.423 | 124.213 | 4.9210 | -0.001871 |
| 14.40 | 350.795 | 148.185 | 5.3379 | -0.002462 |
| 14.80 | 415.416 | 175.499 | 5.7813 | -0.003074 |
| 15.20 | 491.678 | 206.438 | 6.2519 | -0.003701 |
| 15.60 | 581.090 | 241.306 | 6.7505 | -0.004338 |
| 16.00 | 685.291 | 280.439 | 7.2780 | -0.004976 |

Table 24. Calculated P(ρ) isotherms (Continued)

THE ISOTHERM AT 330.00 DEG. K

| MOL/L | P,BAR | DP/DD | DP/DT | D2P/DT2 |
|---|---|---|---|---|
| 0.40 | 10.330 | 24.236 | 0.0356 | -0.000010 |
| 0.80 | 19.451 | 21.408 | 0.0758 | -0.000041 |
| 1.20 | 27.475 | 18.734 | 0.1205 | -0.000094 |
| 1.60 | 34.461 | 16.238 | 0.1694 | -0.000168 |
| 2.00 | 40.502 | 14.015 | 0.2222 | -0.000260 |
| 2.40 | 45.713 | 12.088 | 0.2784 | -0.000365 |
| 2.80 | 50.208 | 10.426 | 0.3377 | -0.000477 |
| 3.20 | 54.084 | 8.990 | 0.3997 | -0.000589 |
| 3.60 | 57.427 | 7.759 | 0.4640 | -0.000689 |
| 4.00 | 60.319 | 6.736 | 0.5304 | -0.000765 |
| 4.40 | 62.846 | 5.936 | 0.5987 | -0.000804 |
| 4.80 | 65.097 | 5.361 | 0.6690 | -0.000794 |
| 5.20 | 67.163 | 4.997 | 0.7415 | -0.000731 |
| 5.60 | 69.119 | 4.811 | 0.8168 | -0.000612 |
| 6.00 | 71.031 | 4.777 | 0.8954 | -0.000444 |
| 6.40 | 72.966 | 4.929 | 0.9782 | -0.000232 |
| 6.80 | 74.993 | 5.218 | 1.0659 | 0.000010 |
| 7.20 | 77.150 | 5.583 | 1.1594 | 0.000276 |
| 7.60 | 79.482 | 6.119 | 1.2597 | 0.000555 |
| 8.00 | 82.083 | 6.937 | 1.3680 | 0.000829 |
| 8.40 | 85.077 | 8.096 | 1.4859 | 0.001078 |
| 8.80 | 88.615 | 9.669 | 1.6148 | 0.001283 |
| 9.20 | 92.880 | 11.751 | 1.7563 | 0.001426 |
| 9.60 | 98.099 | 14.455 | 1.9121 | 0.001496 |
| 10.00 | 104.545 | 17.915 | 2.0834 | 0.001489 |
| 10.40 | 112.551 | 22.281 | 2.2719 | 0.001408 |
| 10.80 | 122.513 | 27.722 | 2.4785 | 0.001258 |
| 11.20 | 134.897 | 34.421 | 2.7045 | 0.001045 |
| 11.60 | 150.244 | 42.572 | 2.9508 | 0.000776 |
| 12.00 | 169.176 | 52.384 | 3.2184 | 0.000456 |
| 12.40 | 192.401 | 64.073 | 3.5081 | 0.000092 |
| 12.80 | 220.714 | 77.864 | 3.8207 | -0.000314 |
| 13.20 | 255.004 | 93.993 | 4.1569 | -0.000758 |
| 13.60 | 296.252 | 112.701 | 4.5174 | -0.001237 |
| 14.00 | 345.541 | 134.238 | 4.9030 | -0.001747 |
| 14.40 | 404.054 | 158.863 | 5.3142 | -0.002283 |
| 14.80 | 473.079 | 186.846 | 5.7517 | -0.002841 |
| 15.20 | 554.017 | 218.473 | 6.2164 | -0.003416 |
| 15.60 | 648.384 | 254.051 | 6.7089 | -0.004002 |

Table 24. Calculated P(ρ) isotherms (Continued)

THE ISOTHERM AT 340.00 DEG. K

| MOL/L | P,BAR | DP/DD | DP/DT | D2P/DT2 |
|---|---|---|---|---|
| 0.40 | 10.686 | 25.181 | 0.0355 | -0.000009 |
| 0.80 | 20.207 | 22.465 | 0.0754 | -0.000036 |
| 1.20 | 28.675 | 19.898 | 0.1196 | -0.000082 |
| 1.60 | 36.148 | 17.501 | 0.1679 | -0.000145 |
| 2.00 | 42.712 | 15.368 | 0.2198 | -0.000221 |
| 2.40 | 48.480 | 13.521 | 0.2751 | -0.000306 |
| 2.80 | 53.563 | 11.931 | 0.3334 | -0.000394 |
| 3,20 | 58.054 | 10.558 | 0.3944 | -0.000478 |
| 3.60 | 62.035 | 9.383 | 0.4579 | -0.000550 |
| 4.00 | 65.587 | 8.413 | 0.5236 | -0.000600 |
| 4.40 | 68.795 | 7.666 | 0.5916 | -0.000621 |
| 4.80 | 71.751 | 7.150 | 0.6620 | -0.000606 |
| 5.20 | 74.545 | 6.853 | 0.7352 | -0.000553 |
| 5.60 | 77.259 | 6.748 | 0.8115 | -0.000463 |
| 6.00 | 79.965 | 6.813 | 0.8915 | -0.000339 |
| 6.40 | 82.737 | 7.083 | 0.9761 | -0.000185 |
| 6.80 | 85.652 | 7.508 | 1.0659 | -0.000009 |
| 7.20 | 88.756 | 8.030 | 1.1616 | 0.000184 |
| 7.60 | 92.103 | 8.752 | 1.2643 | 0.000386 |
| 8.00 | 95.800 | 9.788 | 1.3750 | 0.000588 |
| 8.40 | 99.984 | 11.201 | 1.4950 | 0.000775 |
| 8.80 | 104.820 | 13.064 | 1.6257 | 0.000934 |
| 9.20 | 110.508 | 15.473 | 1.7686 | 0.001053 |
| 9.60 | 117.287 | 18.543 | 1.9250 | 0.001121 |
| 10.00 | 125.447 | 22.402 | 2.0964 | 0.001132 |
| 10.40 | 135.334 | 27.202 | 2.2842 | 0.001082 |
| 10.80 | 147.356 | 33.105 | 2.4896 | 0.000973 |
| 11.20 | 161.990 | 40.293 | 2.7137 | 0.000806 |
| 11.60 | 179.787 | 48.958 | 2.9576 | 0.000586 |
| 12.00 | 201.380 | 59.306 | 3.2223 | 0.000317 |
| 12.40 | 227.485 | 71.552 | 3.5086 | 0.000001 |
| 12.80 | 258.905 | 85.920 | 3.8173 | -0.000356 |
| 13.20 | 296.535 | 102.643 | 4.1493 | -0.000752 |
| 13.60 | 341.366 | 121.964 | 4.5053 | -0.001183 |
| 14.00 | 394.485 | 144.131 | 4.8860 | -0.001645 |
| 14.40 | 457.084 | 169.403 | 5.2921 | -0.002134 |
| 14.80 | 530.458 | 198.051 | 5.7243 | -0.002645 |
| 15.20 | 616.014 | 230.363 | 6.1834 | -0.003174 |
| 15.60 | 715.278 | 266.648 | 6.6703 | -0.003715 |

Table 24. Calculated P(ρ) isotherms (Continued)

THE ISOTHERM AT 360.00 DEG. K

| MOL/L | P,BAR | DP/DD | DP/DT | D2P/DT2 |
|---|---|---|---|---|
| 0.40 | 11.393 | 27.058 | 0.0353 | -0.000007 |
| 0.80 | 21.708 | 24.554 | 0.0748 | -0.000028 |
| 1.20 | 31.053 | 22.187 | 0.1182 | -0.000064 |
| 1.60 | 39.478 | 19.977 | 0.1653 | -0.000111 |
| 2.00 | 47.068 | 18.015 | 0.2160 | -0.000166 |
| 2.40 | 53.927 | 16.325 | 0.2698 | -0.000226 |
| 2.80 | 60.160 | 14.878 | 0.3267 | -0.000286 |
| 3.20 | 65.857 | 13.637 | 0.3863 | -0.000341 |
| 3.60 | 71.095 | 12.588 | 0.4487 | -0.000385 |
| 4.00 | 75.954 | 11.742 | 0.5137 | -0.000414 |
| 4.40 | 80.519 | 11.124 | 0.5814 | -0.000423 |
| 4.80 | 84.866 | 10.750 | 0.6521 | -0.000410 |
| 5.20 | 89.152 | 10.616 | 0.7261 | -0.000375 |
| 5.60 | 93.408 | 10.698 | 0.8039 | -0.000317 |
| 6.00 | 97.737 | 10.982 | 0.8859 | -0.000239 |
| 6.40 | 102.226 | 11.507 | 0.9729 | -0.000144 |
| 6.80 | 106.966 | 12.219 | 1.0654 | -0.000035 |
| 7.20 | 112.018 | 13.065 | 1.1642 | 0.000085 |
| 7.60 | 117.452 | 14.162 | 1.2700 | 0.000211 |
| 8.00 | 123.397 | 15.629 | 1.3839 | 0.000336 |
| 8.40 | 130.013 | 17.533 | 1.5069 | 0.000455 |
| 8.80 | 137.492 | 19.953 | 1.6402 | 0.000558 |
| 9.20 | 146.057 | 22.986 | 1.7850 | 0.000638 |
| 9.60 | 155.978 | 26.747 | 1.9426 | 0.000687 |
| 10.00 | 167.569 | 31.365 | 2.1143 | 0.000699 |
| 10.40 | 181.203 | 36.987 | 2.3013 | 0.000670 |
| 10.80 | 197.314 | 43.773 | 2.5050 | 0.000597 |
| 11.20 | 216.400 | 51.899 | 2.7263 | 0.000479 |
| 11.60 | 239.036 | 61.554 | 2.9664 | 0.000316 |
| 12.00 | 265.874 | 72.939 | 3.2264 | 0.000110 |
| 12.40 | 297.646 | 86.266 | 3.5071 | -0.000138 |
| 12.80 | 335.175 | 101.758 | 3.8095 | -0.000424 |
| 13.20 | 379.372 | 119.644 | 4.1344 | -0.000747 |
| 13.60 | 431.242 | 140.165 | 4.4825 | -0.001103 |
| 14.00 | 491.888 | 163.570 | 4.8548 | -0.001489 |
| 14.40 | 562.516 | 190.118 | 5.2519 | -0.001901 |
| 14.80 | 644.438 | 220.081 | 5.6747 | -0.002336 |
| 15.20 | 739.075 | 253.751 | 6.1240 | -0.002788 |

Table 24. Calculated P(ρ) isotherms (Continued)

THE ISOTHERM AT 380.00 DEG. K

| MOL/L | P,BAR | DP/DD | DP/DT | D2P/DT2 |
|---|---|---|---|---|
| 0.40 | 12.099 | 28.922 | 0.0352 | -0.000006 |
| 0.80 | 23.198 | 26.613 | 0.0743 | -0.000023 |
| 1.20 | 33.404 | 24.434 | 0.1170 | -0.000051 |
| 1.60 | 42.764 | 22.400 | 0.1634 | -0.000087 |
| 2.00 | 51.356 | 20.603 | 0.2130 | -0.000130 |
| 2.40 | 59.282 | 19.068 | 0.2659 | -0.000175 |
| 2.80 | 66.642 | 17.766 | 0.3217 | -0.000219 |
| 3.20 | 73.522 | 16.665 | 0.3804 | -0.000259 |
| 3.60 | 79.999 | 15.754 | 0.4420 | -0.000290 |
| 4.00 | 86.153 | 15.051 | 0.5065 | -0.000310 |
| 4.40 | 92.071 | 14.584 | 0.5741 | -0.000317 |
| 4.80 | 97.854 | 14.375 | 0.6450 | -0.000308 |
| 5.20 | 103.606 | 14.426 | 0.7196 | -0.000283 |
| 5.60 | 109.427 | 14.718 | 0.7983 | -0.000244 |
| 6.00 | 115.411 | 15.240 | 0.8817 | -0.000191 |
| 6.40 | 121.656 | 16.035 | 0.9702 | -0.000126 |
| 6.80 | 128.267 | 17.046 | 1.0646 | -0.000052 |
| 7.20 | 135.315 | 18.227 | 1.1653 | 0.000030 |
| 7.60 | 142.888 | 19.701 | 1.2732 | 0.000115 |
| 8.00 | 151.132 | 21.595 | 1.3892 | 0.000200 |
| 8.40 | 160.229 | 23.980 | 1.5141 | 0.000280 |
| 8.80 | 170.392 | 26.936 | 1.6491 | 0.000350 |
| 9.20 | 181.868 | 30.565 | 1.7952 | 0.000404 |
| 9.60 | 194.949 | 34.982 | 1.9537 | 0.000436 |
| 10.00 | 209.976 | 40.319 | 2.1255 | 0.000442 |
| 10.40 | 227.346 | 46.719 | 2.3120 | 0.000417 |
| 10.80 | 247.515 | 54.343 | 2.5144 | 0.000359 |
| 11.20 | 271.006 | 63.362 | 2.7336 | 0.000264 |
| 11.60 | 298.415 | 73.962 | 2.9708 | 0.000133 |
| 12.00 | 330.413 | 86.342 | 3.2271 | -0.000035 |
| 12.40 | 367.754 | 100.711 | 3.5033 | -0.000238 |
| 12.80 | 411.276 | 117.289 | 3.8005 | -0.000476 |
| 13.20 | 461.909 | 136.303 | 4.1194 | -0.000747 |
| 13.60 | 520.675 | 157.993 | 4.4610 | -0.001048 |
| 14.00 | 588.694 | 182.608 | 4.8262 | -0.001376 |
| 14.40 | 667.186 | 210.407 | 5.2157 | -0.001730 |

Table 24. Calculated P(ρ) isotherms (Continued)

THE ISOTHERM AT 400.00 DEG. K

| MOL/L | P,BAR | DP/DD | DP/DT | D2P/DT2 |
|---|---|---|---|---|
| 0.40 | 12.802 | 30.774 | 0.0351 | -0.000005 |
| 0.80 | 24.679 | 28.650 | 0.0738 | -0.000019 |
| 1.20 | 35.736 | 26.648 | 0.1161 | -0.000041 |
| 1.60 | 46.015 | 24.783 | 0.1618 | -0.000070 |
| 2.00 | 55.593 | 23.146 | 0.2107 | -0.000104 |
| 2.40 | 64.567 | 21.764 | 0.2627 | -0.000139 |
| 2.80 | 73.035 | 20.611 | 0.3178 | -0.000174 |
| 3.20 | 81.082 | 19.657 | 0.3758 | -0.000204 |
| 3.60 | 88.786 | 18.894 | 0.4369 | -0.000229 |
| 4.00 | 96.226 | 18.345 | 0.5010 | -0.000244 |
| 4.40 | 103.495 | 18.044 | 0.5685 | -0.000250 |
| 4.80 | 110.698 | 18.017 | 0.6396 | -0.000244 |
| 5.20 | 117.946 | 18.269 | 0.7146 | -0.000228 |
| 5.60 | 125.348 | 18.784 | 0.7939 | -0.000200 |
| 6.00 | 133.008 | 19.558 | 0.8781 | -0.000163 |
| 6.40 | 141.036 | 20.635 | 0.9678 | -0.000117 |
| 6.80 | 149.547 | 21.954 | 1.0634 | -0.000064 |
| 7.20 | 158.625 | 23.473 | 1.1655 | -0.000007 |
| 7.60 | 168.370 | 25.327 | 1.2749 | 0.000053 |
| 8.00 | 178.948 | 27.647 | 1.3922 | 0.000113 |
| 8.40 | 190.559 | 30.503 | 1.5185 | 0.000169 |
| 8.80 | 203.434 | 33.983 | 1.6547 | 0.000217 |
| 9.20 | 217.842 | 38.188 | 1.8017 | 0.000253 |
| 9.60 | 234.097 | 43.238 | 1.9606 | 0.000272 |
| 10.00 | 252.563 | 49.264 | 2.1326 | 0.000271 |
| 10.40 | 273.658 | 56.410 | 2.3186 | 0.000246 |
| 10.80 | 297.861 | 64.836 | 2.5198 | 0.000194 |
| 11.20 | 325.719 | 74.711 | 2.7373 | 0.000114 |
| 11.60 | 357.848 | 86.220 | 2.9721 | 0.000003 |
| 12.00 | 394.939 | 99.559 | 3.2253 | -0.000140 |
| 12.40 | 437.767 | 114.934 | 3.4978 | -0.000312 |
| 12.80 | 487.187 | 132.564 | 3.7905 | -0.000515 |
| 13.20 | 544.149 | 152.675 | 4.1045 | -0.000747 |
| 13.60 | 609.690 | 175.505 | 4.4405 | -0.001007 |
| 14.00 | 684.948 | 201.303 | 4.7995 | -0.001291 |

Table 24. Calculated P(ρ) isotherms (Continued)

THE ISOTHERM AT 420.00 DEG. K

| MOL/L | P,BAR | DP/DD | DP/DT | D2P/DT2 |
|---|---|---|---|---|
| 0.40 | 13.503 | 32.616 | 0.0350 | -0.000004 |
| 0.80 | 26.153 | 30.668 | 0.0735 | -0.000015 |
| 1.20 | 38.051 | 28.835 | 0.1154 | -0.000034 |
| 1.60 | 49.238 | 27.133 | 0.1605 | -0.000058 |
| 2.00 | 59.787 | 25.654 | 0.2088 | -0.000085 |
| 2.40 | 69.795 | 24.425 | 0.2602 | -0.000114 |
| 2.80 | 79.358 | 23.423 | 0.3146 | -0.000141 |
| 3.20 | 88.560 | 22.621 | 0.3721 | -0.000166 |
| 3.60 | 97.480 | 22.014 | 0.4327 | -0.000186 |
| 4.00 | 106.201 | 21.629 | 0.4966 | -0.000199 |
| 4.40 | 114.818 | 21.505 | 0.5640 | -0.000204 |
| 4.80 | 123.443 | 21.670 | 0.6351 | -0.000201 |
| 5.20 | 132.194 | 22.134 | 0.7104 | -0.000190 |
| 5.60 | 141.189 | 22.884 | 0.7902 | -0.000171 |
| 6.00 | 150.539 | 23.919 | 0.8751 | -0.000144 |
| 6.40 | 160.368 | 25.285 | 0.9655 | -0.000111 |
| 6.80 | 170.801 | 26.917 | 1.0620 | -0.000074 |
| 7.20 | 181.932 | 28.780 | 1.1651 | -0.000032 |
| 7.60 | 193.875 | 31.014 | 1.2755 | 0.000011 |
| 8.00 | 206.811 | 33.757 | 1.3939 | 0.000053 |
| 8.40 | 220.958 | 37.080 | 1.5211 | 0.000092 |
| 8.80 | 236.564 | 41.072 | 1.6580 | 0.000124 |
| 9.20 | 253.919 | 45.840 | 1.8057 | 0.000147 |
| 9.60 | 273.356 | 51.504 | 1.9649 | 0.000157 |
| 10.00 | 295.259 | 58.196 | 2.1367 | 0.000150 |
| 10.40 | 320.070 | 66.063 | 2.3222 | 0.000124 |
| 10.80 | 348.287 | 75.262 | 2.5224 | 0.000076 |
| 11.20 | 380.480 | 85.964 | 2.7384 | 0.000004 |
| 11.60 | 417.283 | 98.351 | 2.9711 | -0.000093 |
| 12.00 | 459.411 | 112.618 | 3.2217 | -0.000217 |
| 12.40 | 507.655 | 128.969 | 3.4909 | -0.000368 |
| 12.80 | 562.893 | 147.620 | 3.7799 | -0.000545 |
| 13.20 | 626.089 | 168.800 | 4.0895 | -0.000747 |
| 13.60 | 698.301 | 192.744 | 4.4207 | -0.000975 |

Table 24. Calculated P(ρ) isotherms (Continued)

THE ISOTHERM AT 450.00 DEG. K

| MOL/L | P,BAR | DP/DD | DP/DT | D2P/DT2 |
|---|---|---|---|---|
| 0.40 | 14.552 | 35.366 | 0.0349 | -0.000003 |
| 0.80 | 28.352 | 33.667 | 0.0731 | -0.000012 |
| 1.20 | 41.498 | 32.077 | 0.1145 | -0.000026 |
| 1.60 | 54.030 | 30.612 | 0.1590 | -0.000044 |
| 2.00 | 66.017 | 29.365 | 0.2066 | -0.000065 |
| 2.40 | 77.555 | 28.365 | 0.2572 | -0.000087 |
| 2.80 | 88.739 | 27.593 | 0.3109 | -0.000108 |
| 3.20 | 99.656 | 27.025 | 0.3678 | -0.000127 |
| 3.60 | 110.386 | 26.663 | 0.4279 | -0.000142 |
| 4.00 | 121.018 | 26.537 | 0.4914 | -0.000153 |
| 4.40 | 131.654 | 26.692 | 0.5586 | -0.000159 |
| 4.80 | 142.414 | 27.162 | 0.6298 | -0.000159 |
| 5.20 | 153.427 | 27.959 | 0.7053 | -0.000153 |
| 5.60 | 164.823 | 29.075 | 0.7856 | -0.000142 |
| 6.00 | 176.729 | 30.513 | 0.8710 | -0.000126 |
| 6.40 | 189.284 | 32.323 | 0.9622 | -0.000107 |
| 6.80 | 202.627 | 34.433 | 1.0596 | -0.000084 |
| 7.20 | 216.866 | 36.816 | 1.1637 | -0.000059 |
| 7.60 | 232.136 | 39.623 | 1.2751 | -0.000033 |
| 8.00 | 248.640 | 42.997 | 1.3945 | -0.000008 |
| 8.40 | 266.619 | 47.010 | 1.5226 | 0.000014 |
| 8.80 | 286.346 | 51.757 | 1.6603 | 0.000030 |
| 9.20 | 308.137 | 57.347 | 1.8083 | 0.000040 |
| 9.60 | 332.353 | 63.904 | 1.9677 | 0.000039 |
| 10.00 | 359.407 | 71.564 | 2.1392 | 0.000026 |
| 10.40 | 389.771 | 80.474 | 2.3239 | -0.000002 |
| 10.80 | 423.974 | 90.791 | 2.5227 | -0.000047 |
| 11.20 | 462.614 | 102.687 | 2.7367 | -0.000111 |
| 11.60 | 506.359 | 116.343 | 2.9667 | -0.000195 |
| 12.00 | 555.949 | 131.952 | 3.2138 | -0.000300 |
| 12.40 | 612.208 | 149.718 | 3.4789 | -0.000427 |
| 12.80 | 676.040 | 169.855 | 3.7631 | -0.000575 |
| 13.20 | 748.439 | 192.591 | 4.0671 | -0.000745 |

Table 24. Calculated P(ρ) isotherms (Continued)

THE ISOTHERM AT 500.00 DEG. K

| MOL/L | P,BAR | DP/DD | DP/DT | D2P/DT2 |
|---|---|---|---|---|
| 0.40 | 16.295 | 39.920 | 0.0348 | -0.000002 |
| 0.80 | 31.994 | 38.610 | 0.0726 | -0.000008 |
| 1.20 | 47.194 | 37.402 | 0.1134 | -0.000018 |
| 1.60 | 61.931 | 36.315 | 0.1572 | -0.000030 |
| 2.00 | 76.275 | 35.445 | 0.2039 | -0.000044 |
| 2.40 | 90.321 | 34.827 | 0.2537 | -0.000059 |
| 2.80 | 104.168 | 34.445 | 0.3065 | -0.000074 |
| 3.20 | 117.906 | 34.281 | 0.3625 | -0.000087 |
| 3.60 | 131.623 | 34.346 | 0.4220 | -0.000099 |
| 4.00 | 145.418 | 34.676 | 0.4850 | -0.000108 |
| 4.40 | 159.407 | 35.323 | 0.5519 | -0.000114 |
| 4.80 | 173.724 | 36.327 | 0.6230 | -0.000117 |
| 5.20 | 188.518 | 37.704 | 0.6986 | -0.000117 |
| 5.60 | 203.937 | 39.454 | 0.7792 | -0.000114 |
| 6.00 | 220.132 | 41.586 | 0.8652 | -0.000109 |
| 6.40 | 237.265 | 44.153 | 0.9570 | -0.000102 |
| 6.80 | 255.499 | 47.071 | 1.0552 | -0.000094 |
| 7.20 | 274.966 | 50.327 | 1.1601 | -0.000084 |
| 7.60 | 295.829 | 54.088 | 1.2723 | -0.000075 |
| 8.00 | 318.324 | 58.503 | 1.3924 | -0.000067 |
| 8.40 | 342.729 | 63.649 | 1.5212 | -0.000062 |
| 8.80 | 369.354 | 69.623 | 1.6593 | -0.000061 |
| 9.20 | 398.553 | 76.541 | 1.8074 | -0.000065 |
| 9.60 | 430.730 | 84.534 | 1.9664 | -0.000076 |
| 10.00 | 466.341 | 93.740 | 2.1371 | -0.000096 |
| 10.40 | 505.903 | 104.310 | 2.3204 | -0.000127 |
| 10.80 | 549.993 | 116.406 | 2.5170 | -0.000169 |
| 11.20 | 599.254 | 130.198 | 2.7280 | -0.000225 |
| 11.60 | 654.402 | 145.869 | 2.9542 | -0.000295 |
| 12.00 | 716.226 | 163.612 | 3.1966 | -0.000380 |

Table 24. Calculated P(ρ) isotherms (Continued)

THE ISOTHERM AT 550.00 DEG. K

| MOL/L | P,BAR | DP/DD | DP/DT | D2P/DT2 |
|---|---|---|---|---|
| 0.40 | 18.032 | 44.448 | 0.0347 | -0.000002 |
| 0.80 | 35.616 | 43.501 | 0.0723 | -0.000006 |
| 1.20 | 52.844 | 42.655 | 0.1127 | -0.000013 |
| 1.60 | 69.756 | 41.933 | 0.1559 | -0.000022 |
| 2.00 | 86.421 | 41.433 | 0.2020 | -0.000032 |
| 2.40 | 102.938 | 41.194 | 0.2511 | -0.000043 |
| 2.80 | 119.410 | 41.207 | 0.3033 | -0.000054 |
| 3.20 | 135.935 | 41.458 | 0.3588 | -0.000065 |
| 3.60 | 152.610 | 41.963 | 0.4177 | -0.000074 |
| 4.00 | 169.545 | 42.767 | 0.4803 | -0.000082 |
| 4.40 | 186.871 | 43.925 | 0.5469 | -0.000089 |
| 4.80 | 204.738 | 45.482 | 0.6178 | -0.000093 |
| 5.20 | 223.312 | 47.460 | 0.6933 | -0.000097 |
| 5.60 | 242.763 | 49.861 | 0.7739 | -0.000098 |
| 6.00 | 263.260 | 52.702 | 0.8600 | -0.000099 |
| 6.40 | 284.991 | 56.035 | 0.9520 | -0.000099 |
| 6.80 | 308.139 | 59.768 | 1.0504 | -0.000098 |
| 7.20 | 332.858 | 63.900 | 1.1555 | -0.000097 |
| 7.60 | 359.337 | 68.611 | 1.2679 | -0.000097 |
| 8.00 | 387.845 | 74.057 | 1.3882 | -0.000099 |
| 8.40 | 418.690 | 80.313 | 1.5169 | -0.000103 |
| 8.80 | 452.217 | 87.485 | 1.6549 | -0.000110 |
| 9.20 | 488.816 | 95.692 | 1.8026 | -0.000121 |
| 9.60 | 528.927 | 105.069 | 1.9609 | -0.000138 |
| 10.00 | 573.046 | 115.761 | 2.1305 | -0.000162 |
| 10.40 | 621.731 | 127.921 | 2.3122 | -0.000194 |
| 10.80 | 675.601 | 141.715 | 2.5068 | -0.000234 |
| 11.20 | 735.343 | 157.315 | 2.7151 | -0.000285 |

Table 24. Calculated P(ρ) isotherms (Continued)

THE ISOTHERM AT 600.00 DEG. K

| MOL/L | P,BAR | DP/DD | DP/DT | D2P/DT2 |
|---|---|---|---|---|
| 0.40 | 19.766 | 48.957 | 0.0346 | -0.000001 |
| 0.80 | 39.222 | 48.356 | 0.0720 | -0.000005 |
| 1.20 | 58.462 | 47.858 | 0.1121 | -0.000010 |
| 1.60 | 77.525 | 47.489 | 0.1549 | -0.000017 |
| 2.00 | 96.485 | 47.353 | 0.2006 | -0.000025 |
| 2.40 | 115.445 | 47.492 | 0.2492 | -0.000033 |
| 2.80 | 134.514 | 47.900 | 0.3009 | -0.000042 |
| 3.20 | 153.800 | 48.572 | 0.3559 | -0.000051 |
| 3.60 | 173.409 | 49.526 | 0.4144 | -0.000059 |
| 4.00 | 193.465 | 50.812 | 0.4766 | -0.000066 |
| 4.40 | 214.111 | 52.491 | 0.5429 | -0.000073 |
| 4.80 | 235.517 | 54.613 | 0.6135 | -0.000079 |
| 5.20 | 257.864 | 57.202 | 0.6888 | -0.000084 |
| 5.60 | 281.341 | 60.262 | 0.7693 | -0.000088 |
| 6.00 | 306.139 | 63.818 | 0.8552 | -0.000092 |
| 6.40 | 332.470 | 67.922 | 0.9472 | -0.000096 |
| 6.80 | 360.534 | 72.472 | 1.0454 | -0.000099 |
| 7.20 | 390.507 | 77.477 | 1.1504 | -0.000104 |
| 7.60 | 422.604 | 83.132 | 1.2627 | -0.000109 |
| 8.00 | 457.121 | 89.596 | 1.3827 | -0.000116 |
| 8.40 | 494.398 | 96.947 | 1.5112 | -0.000125 |
| 8.80 | 534.811 | 105.291 | 1.6486 | -0.000137 |
| 9.20 | 578.781 | 114.756 | 1.7957 | -0.000153 |
| 9.60 | 626.783 | 125.479 | 1.9531 | -0.000173 |
| 10.00 | 679.352 | 137.610 | 2.1214 | -0.000198 |
| 10.40 | 737.081 | 151.308 | 2.3015 | -0.000230 |

Table 25. The Joule-Thomson inversion locus.

| T,K | P,BAR | MOL/L | T,K | P,BAR | MOL/L |
|---|---|---|---|---|---|
| | | | 425 | 467.3 | 11.93 |
| 250 | 26.3 | 15.06 | 430 | 474.2 | 11.85 |
| 255 | 47.2 | 14.95 | 435 | 481.0 | 11.77 |
| 260 | 67.3 | 14.85 | 440 | 487.6 | 11.70 |
| 265 | 86.7 | 14.75 | 445 | 493.9 | 11.62 |
| 270 | 105.3 | 14.65 | 450 | 500.1 | 11.55 |
| 275 | 123.4 | 14.55 | 455 | 506.0 | 11.47 |
| 280 | 140.8 | 14.45 | 460 | 511.7 | 11.40 |
| 285 | 157.6 | 14.36 | 465 | 517.3 | 11.32 |
| 290 | 173.8 | 14.26 | 470 | 522.6 | 11.25 |
| 295 | 189.5 | 14.16 | 475 | 527.8 | 11.17 |
| 300 | 204.7 | 14.07 | 480 | 532.7 | 11.10 |
| 305 | 219.5 | 13.97 | 485 | 537.5 | 11.03 |
| 310 | 233.7 | 13.88 | 490 | 542.1 | 10.95 |
| 315 | 247.5 | 13.79 | 495 | 546.5 | 10.88 |
| 320 | 260.9 | 13.69 | 500 | 550.7 | 10.81 |
| 325 | 273.9 | 13.60 | 505 | 554.8 | 10.73 |
| 330 | 286.5 | 13.51 | 510 | 558.6 | 10.66 |
| 335 | 298.7 | 13.42 | 515 | 562.3 | 10.59 |
| 340 | 310.6 | 13.33 | 520 | 565.8 | 10.52 |
| 345 | 322.1 | 13.24 | 525 | 569.1 | 10.44 |
| 350 | 333.3 | 13.16 | 530 | 572.3 | 10.37 |
| 355 | 344.1 | 13.07 | 535 | 575.2 | 10.30 |
| 360 | 354.7 | 12.98 | 540 | 578.0 | 10.23 |
| 365 | 364.9 | 12.90 | 545 | 580.7 | 10.16 |
| 370 | 374.9 | 12.81 | 550 | 583.2 | 10.09 |
| 375 | 384.6 | 12.73 | 555 | 585.5 | 10.01 |
| 380 | 393.9 | 12.65 | 560 | 587.6 | 9.94 |
| 385 | 403.1 | 12.57 | 565 | 589.6 | 9.87 |
| 390 | 411.9 | 12.48 | 570 | 591.4 | 9.80 |
| 395 | 420.6 | 12.40 | 575 | 593.0 | 9.73 |
| 400 | 428.9 | 12.32 | 580 | 594.5 | 9.66 |
| 405 | 437.1 | 12.24 | 585 | 595.9 | 9.59 |
| 410 | 445.0 | 12.16 | 590 | 597.1 | 9.52 |
| 415 | 452.6 | 12.08 | 595 | 598.1 | 9.44 |
| 420 | 460.0 | 12.01 | 600 | 599.0 | 9.37 |

Table 26. Thermophysical properties of the saturated liquid

This table was computed by integrating first along isotherm $T_b$ of Figure 9, then along isobar $P_b$, and finally along each isotherm down to the saturated liquid boundary.

Column headings have the following interpretations--

| | | |
|---|---|---|
| DPS/DT | ≡ | $dP_\sigma/dT$, vapor pressure, |
| DDL/DT | ≡ | $d\rho_\ell/dT$, saturated liquid, |
| DP/DT | ≡ | $(\partial P/\partial T)$, single phase, |
| DP/DD | ≡ | $(\partial P/\partial \rho)$, single phase, |
| Q,VAP | ≡ | $\Delta H_{vap}$, heat of vaporization, |
| CV | ≡ | $C_v(\rho, T)$ |
| CS | ≡ | $C_\sigma(T)$ |
| CP | ≡ | $C_p(\rho, T)$ |
| W | ≡ | speed of sound |

Table 26. Thermophysical properties of the saturated liquid.

PROPERTIES OF SATURATED LIQUID ETHANE

| T | P | DEN | V,LIQ | V,GAS | DPS/DT | DDL/DT | DP/DT | DP/DD | Q,VAP | Q,XPT |
|---|---|---|---|---|---|---|---|---|---|---|
| DEG K | BAR | MOL/L | L/MOL | L/MOL | BAR/K | MOL/L/K | BAR/K | BAR-L/MOL | J/MOL | J/MOL |
| 89.899 | 1.010-005 | 21.680 | 0.04613 | 7.401+005 | 2.686-006 | -0.0364 | 3.507+001 | 9.625+002 | 17869 | 17509 |
| 90.000 | 1.037-005 | 21.676 | 0.04613 | 7.213+005 | 2.752-006 | -0.0364 | 3.503+001 | 9.614+002 | 17867 | 17507 |
| 95.000 | 3.628-005 | 21.495 | 0.04652 | 2.178+005 | 8.575-006 | -0.0362 | 3.296+001 | 9.099+002 | 17740 | 17412 |
| 100.000 | 1.110-004 | 21.314 | 0.04692 | 7.506+004 | 2.347-005 | -0.0361 | 3.108+001 | 8.612+002 | 17617 | 17312 |
| 105.000 | 3.025-004 | 21.134 | 0.04732 | 2.895+004 | 5.750-005 | -0.0360 | 2.936+001 | 8.150+002 | 17482 | 17206 |
| 110.000 | 7.463-004 | 20.954 | 0.04772 | 1.230+004 | 1.281-004 | -0.0360 | 2.779+001 | 7.713+002 | 17329 | 17094 |
| 115.000 | 1.689-003 | 20.773 | 0.04814 | 5.682+003 | 2.626-004 | -0.0361 | 2.633+001 | 7.297+002 | 17161 | 16976 |
| 120.000 | 3.546-003 | 20.593 | 0.04856 | 2.822+003 | 5.014-004 | -0.0362 | 2.498+001 | 6.901+002 | 16979 | 16852 |
| 125.000 | 6.967-003 | 20.411 | 0.04899 | 1.494+003 | 8.993-004 | -0.0364 | 2.373+001 | 6.524+002 | 16791 | 16722 |
| 130.000 | 1.292-002 | 20.229 | 0.04943 | 8.362+002 | 1.527-003 | -0.0366 | 2.256+001 | 6.165+002 | 16600 | 16586 |
| 135.000 | 2.277-002 | 20.045 | 0.04989 | 4.918+002 | 2.472-003 | -0.0368 | 2.145+001 | 5.823+002 | 16410 | 16444 |
| 140.000 | 3.833-002 | 19.860 | 0.05035 | 3.023+002 | 3.835-003 | -0.0371 | 2.042+001 | 5.497+002 | 16225 | 16296 |
| 145.000 | 6.200-002 | 19.674 | 0.05083 | 1.931+002 | 5.731-003 | -0.0375 | 1.944+001 | 5.185+002 | 16046 | 16142 |
| 150.000 | 9.674-002 | 19.486 | 0.05132 | 1.278+002 | 8.285-003 | -0.0379 | 1.851+001 | 4.887+002 | 15873 | 15982 |
| 155.000 | 1.462-001 | 19.295 | 0.05183 | 8.719+001 | 1.163-002 | -0.0383 | 1.763+001 | 4.602+002 | 15706 | 15816 |
| 160.000 | 2.146-001 | 19.103 | 0.05235 | 6.116+001 | 1.590-002 | -0.0387 | 1.679+001 | 4.330+002 | 15542 | 15643 |
| 165.000 | 3.069-001 | 18.908 | 0.05289 | 4.397+001 | 2.122-002 | -0.0393 | 1.600+001 | 4.070+002 | 15380 | 15464 |
| 170.000 | 4.288-001 | 18.710 | 0.05345 | 3.232+001 | 2.774-002 | -0.0398 | 1.523+001 | 3.820+002 | 15217 | 15278 |
| 175.000 | 5.865-001 | 18.510 | 0.05403 | 2.423+001 | 3.557-002 | -0.0404 | 1.451+001 | 3.582+002 | 15051 | 15085 |
| 180.000 | 7.869-001 | 18.306 | 0.05463 | 1.849+001 | 4.484-002 | -0.0410 | 1.381+001 | 3.353+002 | 14879 | 14886 |
| 185.000 | 1.038+000 | 18.099 | 0.05525 | 1.433+001 | 5.566-002 | -0.0417 | 1.314+001 | 3.135+002 | 14699 | 14679 |
| 190.000 | 1.346+000 | 17.889 | 0.05590 | 1.127+001 | 6.812-002 | -0.0425 | 1.249+001 | 2.925+002 | 14509 | 14465 |
| 195.000 | 1.722+000 | 17.674 | 0.05658 | 8.970+000 | 8.232-002 | -0.0433 | 1.187+001 | 2.724+002 | 14307 | 14242 |
| 200.000 | 2.172+000 | 17.456 | 0.05729 | 7.224+000 | 9.833-002 | -0.0442 | 1.128+001 | 2.531+002 | 14093 | 14012 |
| 205.000 | 2.708+000 | 17.232 | 0.05803 | 5.877+000 | 1.162-001 | -0.0451 | 1.070+001 | 2.346+002 | 13865 | 13773 |
| 210.000 | 3.338+000 | 17.004 | 0.05881 | 4.827+000 | 1.361-001 | -0.0462 | 1.014+001 | 2.168+002 | 13624 | 13525 |
| 215.000 | 4.072+000 | 16.771 | 0.05963 | 3.997+000 | 1.579-001 | -0.0473 | 9.605+000 | 1.998+002 | 13368 | 13266 |
| 220.000 | 4.920+000 | 16.531 | 0.06049 | 3.335+000 | 1.818-001 | -0.0485 | 9.085+000 | 1.835+002 | 13098 | 12998 |
| 225.000 | 5.894+000 | 16.285 | 0.06141 | 2.802+000 | 2.078-001 | -0.0499 | 8.581+000 | 1.678+002 | 12815 | 12718 |
| 230.000 | 7.002+000 | 16.032 | 0.06238 | 2.369+000 | 2.359-001 | -0.0514 | 8.092+000 | 1.527+002 | 12517 | 12425 |
| 235.000 | 8.257+000 | 15.771 | 0.06341 | 2.014+000 | 2.663-001 | -0.0532 | 7.618+000 | 1.383+002 | 12205 | 12119 |
| 240.000 | 9.668+000 | 15.500 | 0.06452 | 1.721+000 | 2.988-001 | -0.0551 | 7.156+000 | 1.245+002 | 11878 | 11797 |
| 245.000 | 1.125+001 | 15.219 | 0.06571 | 1.477+000 | 3.337-001 | -0.0573 | 6.707+000 | 1.112+002 | 11533 | 11458 |
| 250.000 | 1.301+001 | 14.926 | 0.06700 | 1.272+000 | 3.709-001 | -0.0599 | 6.269+000 | 9.854+001 | 11169 | 11099 |
| 255.000 | 1.496+001 | 14.620 | 0.06840 | 1.098+000 | 4.105-001 | -0.0628 | 5.840+000 | 8.644+001 | 10781 | 10718 |
| 260.000 | 1.712+001 | 14.297 | 0.06994 | 9.506-001 | 4.527-001 | -0.0663 | 5.421+000 | 7.489+001 | 10365 | 10311 |
| 265.000 | 1.949+001 | 13.955 | 0.07166 | 8.236-001 | 4.975-001 | -0.0706 | 5.008+000 | 6.391+001 | 9914 | 9872 |
| 270.000 | 2.210+001 | 13.590 | 0.07358 | 7.135-001 | 5.452-001 | -0.0758 | 4.601+000 | 5.351+001 | 9420 | 9396 |
| 275.000 | 2.495+001 | 13.195 | 0.07579 | 6.172-001 | 5.960-001 | -0.0824 | 4.198+000 | 4.369+001 | 8873 | 8872 |
| 280.000 | 2.806+001 | 12.762 | 0.07836 | 5.321-001 | 6.501-001 | -0.0912 | 3.735+000 | 3.448+001 | 8260 | 8287 |
| 285.000 | 3.146+001 | 12.277 | 0.08145 | 4.562-001 | 7.081-001 | -0.1035 | 3.389+000 | 2.592+001 | 7564 | 7620 |
| 290.000 | 3.515+001 | 11.717 | 0.08535 | 3.877-001 | 7.707-001 | -0.1220 | 2.973+000 | 1.806+001 | 6758 | 6836 |
| 295.000 | 3.918+001 | 11.035 | 0.09062 | 3.243-001 | 8.393-001 | -0.1542 | 2.536+000 | 1.100+001 | 5785 | 5865 |
| 300.000 | 4.356+001 | 10.110 | 0.09891 | 2.619-001 | 9.166-001 | -0.2290 | 2.046+000 | 4.930+000 | 4483 | 4531 |
| 305.000 | 4.638+001 | 8.118 | 0.12318 | 1.780-001 | 1.018+000 | -1.0772 | 1.323+000 | 2.831-001 | 1702 | 1625 |
| 305.370 | 4.876+001 | 6.740 | 0.14837 | 1.484-001 | 1.037+000 | 0.0000 | 1.053+000 | | | |

Table 26. Thermophysical properties of the saturated liquid (continued).

PROPERTIES OF SATURATED LIQUID ETHANE

| T DEG K | P BAR | E J/MOL | H J/MOL | S J/MOL/K | CV J/MOL/K | CS J/MOL/K | CP J/MOL/K | W M/SEC | CS,XPT J/MOL/K |
|---|---|---|---|---|---|---|---|---|---|
| 89.899 | 1.010-005 | 5298.6 | 5298.6 | 76.497 | 44.06 | 68.50 | 68.50 | 2231 | 68.16 |
| 90.000 | 1.037-005 | 5305.5 | 5305.5 | 76.574 | 44.06 | 68.50 | 68.50 | 2230 | 68.17 |
| 95.000 | 3.628-005 | 5648.2 | 5648.2 | 80.279 | 44.02 | 68.56 | 68.56 | 2171 | 68.28 |
| 100.000 | 1.110-004 | 5991.2 | 5991.2 | 83.797 | 43.95 | 68.64 | 68.64 | 2115 | 68.41 |
| 105.000 | 3.025-004 | 6334.6 | 6334.6 | 87.148 | 43.86 | 68.73 | 68.73 | 2061 | 68.55 |
| 110.000 | 7.463-004 | 6678.4 | 6678.4 | 90.347 | 43.75 | 68.83 | 68.83 | 2009 | 68.70 |
| 115.000 | 1.689-003 | 7022.9 | 7022.9 | 93.410 | 43.63 | 68.96 | 68.96 | 1958 | 68.87 |
| 120.000 | 3.546-003 | 7368.1 | 7368.1 | 96.347 | 43.51 | 69.10 | 69.10 | 1909 | 69.04 |
| 125.000 | 6.967-003 | 7714.0 | 7714.0 | 99.172 | 43.38 | 69.27 | 69.27 | 1861 | 69.24 |
| 130.000 | 1.292-002 | 8060.8 | 8060.9 | 101.892 | 43.25 | 69.46 | 69.47 | 1815 | 69.44 |
| 135.000 | 2.277-002 | 8408.7 | 8408.8 | 104.518 | 43.13 | 69.68 | 69.68 | 1769 | 69.66 |
| 140.000 | 3.833-002 | 8757.6 | 8757.8 | 107.056 | 43.01 | 69.92 | 69.93 | 1724 | 69.90 |
| 145.000 | 6.200-002 | 9107.9 | 9108.2 | 109.514 | 42.90 | 70.19 | 70.20 | 1680 | 70.15 |
| 150.000 | 9.674-002 | 9459.6 | 9460.1 | 111.899 | 42.81 | 70.50 | 70.51 | 1636 | 70.43 |
| 155.000 | 1.462-001 | 9812.9 | 9813.7 | 114.216 | 42.73 | 70.83 | 70.85 | 1593 | 70.72 |
| 160.000 | 2.146-001 | 10168.0 | 10169.1 | 116.470 | 42.66 | 71.19 | 71.22 | 1550 | 71.04 |
| 165.000 | 3.069-001 | 10524.9 | 10526.5 | 118.667 | 42.61 | 71.59 | 71.63 | 1508 | 71.38 |
| 170.000 | 4.288-001 | 10883.9 | 10886.2 | 120.811 | 42.58 | 72.03 | 72.09 | 1467 | 71.75 |
| 175.000 | 5.865-001 | 11245.2 | 11248.4 | 122.905 | 42.58 | 72.51 | 72.58 | 1425 | 72.15 |
| 180.000 | 7.869-001 | 11609.0 | 11613.3 | 124.955 | 42.59 | 73.03 | 73.12 | 1384 | 72.58 |
| 185.000 | 1.038+000 | 11975.5 | 11981.2 | 126.963 | 42.63 | 73.59 | 73.72 | 1343 | 73.05 |
| 190.000 | 1.346+000 | 12344.8 | 12352.3 | 128.934 | 42.69 | 74.19 | 74.37 | 1302 | 73.55 |
| 195.000 | 1.722+000 | 12717.3 | 12727.0 | 130.869 | 42.77 | 74.85 | 75.08 | 1261 | 74.09 |
| 200.000 | 2.172+000 | 13093.2 | 13105.6 | 132.773 | 42.88 | 75.56 | 75.85 | 1220 | 74.68 |
| 205.000 | 2.708+000 | 13472.7 | 13488.4 | 134.648 | 43.01 | 76.33 | 76.70 | 1179 | 75.33 |
| 210.000 | 3.338+000 | 13856.2 | 13875.8 | 136.498 | 43.17 | 77.17 | 77.63 | 1139 | 76.03 |
| 215.000 | 4.072+000 | 14244.0 | 14268.2 | 138.324 | 43.35 | 78.07 | 78.65 | 1098 | 76.80 |
| 220.000 | 4.920+000 | 14636.3 | 14666.1 | 140.130 | 43.56 | 79.05 | 79.78 | 1057 | 77.65 |
| 225.000 | 5.894+000 | 15033.7 | 15069.9 | 141.918 | 43.79 | 80.12 | 81.03 | 1016 | 78.58 |
| 230.000 | 7.002+000 | 15436.6 | 15480.3 | 143.692 | 44.05 | 81.30 | 82.41 | 975 | 79.61 |
| 235.000 | 8.257+000 | 15845.5 | 15897.8 | 145.454 | 44.32 | 82.59 | 83.97 | 933 | 80.77 |
| 240.000 | 9.668+000 | 16260.9 | 16323.3 | 147.207 | 44.62 | 84.01 | 85.73 | 892 | 82.06 |
| 245.000 | 1.125+001 | 16683.6 | 16757.5 | 148.955 | 44.95 | 85.60 | 87.73 | 850 | 83.51 |
| 250.000 | 1.301+001 | 17114.5 | 17201.6 | 150.702 | 45.29 | 87.39 | 90.04 | 807 | 85.17 |
| 255.000 | 1.496+001 | 17554.4 | 17656.8 | 152.453 | 45.66 | 89.43 | 92.74 | 764 | 87.09 |
| 260.000 | 1.712+001 | 18004.8 | 18124.6 | 154.211 | 46.05 | 91.78 | 95.95 | 720 | 89.31 |
| 265.000 | 1.949+001 | 18467.3 | 18607.0 | 155.985 | 46.46 | 94.56 | 99.86 | 676 | 91.95 |
| 270.000 | 2.210+001 | 18944.2 | 19106.8 | 157.783 | 46.91 | 97.90 | 104.75 | 630 | 95.13 |
| 275.000 | 2.495+001 | 19438.5 | 19627.6 | 159.616 | 47.38 | 102.05 | 111.10 | 584 | 99.07 |
| 280.000 | 2.806+001 | 19954.7 | 20174.6 | 161.501 | 47.90 | 107.43 | 119.73 | 535 | 104.13 |
| 285.000 | 3.146+001 | 20500.0 | 20756.2 | 163.463 | 48.49 | 114.80 | 132.31 | 485 | 110.93 |
| 290.000 | 3.515+001 | 21086.5 | 21386.5 | 165.548 | 49.20 | 125.81 | 152.62 | 432 | 120.78 |
| 295.000 | 3.918+001 | 21738.3 | 22093.3 | 167.843 | 50.12 | 144.82 | 191.67 | 374 | 137.02 |
| 300.000 | 4.356+001 | 22519.4 | 22950.3 | 170.584 | 51.67 | 189.20 | 300.84 | 309 | 172.17 |
| 305.000 | 4.836+001 | 23370.6 | 24466.4 | 175.417 | 60.59 | 720.24 | 2923.16 | 213 | 519.96 |
| 305.370 | 4.876+001 | 24004.3 | 25308.2 | 178.420 | | | | 0 | |

Table 27. Thermophysical properties along isobars*

The following pages give physical and thermodynamic properties along selected isobars, as computed by methods of section 3 of the text.

The first line of each table refers to freezing liquid on the P(T) melting line.

Each table $P<P_c$ contains a blank line for the transition from saturated liquid to vapor, as seen by the abrupt decrease of density.

Table headings for partial derivatives have the following interpretations--

$$DP/DT \equiv \partial P/\partial T,$$

$$DP/DD \equiv \partial P/\partial \rho.$$

The specific heat interpretations are -

$$CV \equiv C_v(\rho, T),$$

$$CP \equiv C_p(\rho, T).$$

*These tables are extrapolated beyond the range of P-ρ-T data used for adjusting the equation of state (P~350 bar).

Table 27. Thermophysical properties along isobars.

ETHANE ISOBAR AT P = 0.1 BAR

| T | DEN | VOL | DP/DT | DP/DD | E | H | S | CV | CP | W |
|---|---|---|---|---|---|---|---|---|---|---|
| DEG K | MOL/L | L/MOL | BAR/K | BAR-L/MOL | J/MOL | J/MOL | J/MOL/K | J/MOL/K | J/MOL/K | M/SEC |
| 89.901 | 21.680 | 0.04613 | 35.0703 | 962.504 | 5298.6 | 5299.1 | 76.497 | 44.06 | 68.50 | 2231 |
| 90.000 | 21.676 | 0.04613 | 35.0269 | 961.449 | 5305.5 | 5305.9 | 76.573 | 44.06 | 68.50 | 2230 |
| 100.000 | 21.314 | 0.04692 | 31.0780 | 861.212 | 5991.1 | 5991.5 | 83.796 | 43.95 | 68.64 | 2115 |
| 110.000 | 20.954 | 0.04772 | 27.7875 | 771.300 | 6678.3 | 6678.8 | 90.346 | 43.75 | 68.83 | 2009 |
| 120.000 | 20.593 | 0.04856 | 24.9852 | 690.149 | 7367.9 | 7368.4 | 96.346 | 43.51 | 69.10 | 1909 |
| 130.000 | 20.229 | 0.04943 | 22.5553 | 616.578 | 8060.7 | 8061.2 | 101.891 | 43.25 | 69.47 | 1815 |
| 140.000 | 19.861 | 0.05035 | 20.4166 | 549.676 | 8757.6 | 8758.1 | 107.055 | 43.01 | 69.93 | 1724 |
| 150.000 | 19.486 | 0.05132 | 18.5104 | 488.678 | 9459.6 | 9460.1 | 111.899 | 42.81 | 70.51 | 1636 |
| 150.388 | 19.471 | 0.05136 | 18.4405 | 486.423 | 9487.0 | 9487.5 | 112.081 | 42.80 | 70.53 | 1633 |
| | | | | | | | | | | |
| 150.388 | 0.00807 | 123.911 | 0.000675 | 12.305 | 24200.1 | 25439.3 | 218.143 | 30.48 | 39.03 | 229 |
| 160.000 | 0.00758 | 131.996 | 0.000633 | 13.121 | 24497.3 | 25817.2 | 220.577 | 31.06 | 39.57 | 236 |
| 170.000 | 0.00712 | 140.391 | 0.000594 | 13.967 | 24812.4 | 26216.3 | 222.995 | 31.72 | 40.20 | 243 |
| 180.000 | 0.00672 | 148.774 | 0.000561 | 14.810 | 25134.1 | 26621.9 | 225.311 | 32.42 | 40.88 | 249 |
| 190.000 | 0.00636 | 157.147 | 0.000530 | 15.651 | 25463.1 | 27034.5 | 227.541 | 33.18 | 41.61 | 255 |
| 200.000 | 0.00604 | 165.513 | 0.000503 | 16.491 | 25799.6 | 27454.8 | 229.695 | 33.98 | 42.40 | 262 |
| 210.000 | 0.00575 | 173.873 | 0.000479 | 17.329 | 26144.4 | 27883.1 | 231.784 | 34.83 | 43.24 | 267 |
| 220.000 | 0.00549 | 182.228 | 0.000457 | 18.167 | 26497.8 | 28320.1 | 233.815 | 35.73 | 44.12 | 273 |
| 230.000 | 0.00525 | 190.579 | 0.000437 | 19.004 | 26860.4 | 28766.2 | 235.797 | 36.67 | 45.06 | 279 |
| 240.000 | 0.00503 | 198.927 | 0.000418 | 19.841 | 27232.6 | 29221.9 | 237.736 | 37.66 | 46.04 | 284 |
| 250.000 | 0.00482 | 207.273 | 0.000402 | 20.677 | 27614.9 | 29687.6 | 239.636 | 38.69 | 47.07 | 289 |
| 260.000 | 0.00464 | 215.616 | 0.000386 | 21.512 | 28007.6 | 30163.8 | 241.503 | 39.76 | 48.13 | 294 |
| 270.000 | 0.00447 | 223.957 | 0.000372 | 22.348 | 28411.2 | 30650.8 | 243.340 | 40.87 | 49.24 | 299 |
| 280.000 | 0.00430 | 232.296 | 0.000358 | 23.183 | 28826.0 | 31149.0 | 245.151 | 42.01 | 50.38 | 304 |
| 290.000 | 0.00416 | 240.633 | 0.000346 | 24.017 | 29252.4 | 31658.8 | 246.939 | 43.19 | 51.55 | 309 |
| 300.000 | 0.00402 | 248.969 | 0.000334 | 24.852 | 29690.7 | 32180.4 | 248.707 | 44.39 | 52.74 | 313 |
| 310.000 | 0.00389 | 257.304 | 0.000323 | 25.686 | 30141.0 | 32714.0 | 250.456 | 45.61 | 53.97 | 318 |
| 320.000 | 0.00376 | 265.638 | 0.000313 | 26.520 | 30603.6 | 33260.0 | 252.189 | 46.86 | 55.21 | 322 |
| 330.000 | 0.00365 | 273.971 | 0.000304 | 27.354 | 31078.8 | 33818.5 | 253.907 | 48.12 | 56.47 | 327 |
| 340.000 | 0.00354 | 282.303 | 0.000295 | 28.188 | 31566.7 | 34389.7 | 255.612 | 49.39 | 57.74 | 331 |
| 350.000 | 0.00344 | 290.634 | 0.000286 | 29.022 | 32067.3 | 34973.6 | 257.304 | 50.68 | 59.02 | 335 |
| 360.000 | 0.00334 | 298.965 | 0.000278 | 29.856 | 32580.8 | 35570.5 | 258.985 | 51.97 | 60.32 | 339 |
| 370.000 | 0.00325 | 307.294 | 0.000271 | 30.689 | 33107.3 | 36180.2 | 260.655 | 53.27 | 61.61 | 344 |
| 380.000 | 0.00317 | 315.623 | 0.000264 | 31.523 | 33646.8 | 36803.0 | 262.316 | 54.57 | 62.91 | 348 |
| 390.000 | 0.00309 | 323.952 | 0.000257 | 32.356 | 34199.2 | 37438.7 | 263.967 | 55.87 | 64.21 | 352 |
| 400.000 | 0.00301 | 332.279 | 0.000250 | 33.189 | 34764.7 | 38087.5 | 265.609 | 57.17 | 65.51 | 356 |
| 410.000 | 0.00294 | 340.607 | 0.000244 | 34.022 | 35343.1 | 38749.1 | 267.242 | 58.46 | 66.80 | 360 |
| 420.000 | 0.00287 | 348.934 | 0.000238 | 34.855 | 35934.4 | 39423.7 | 268.867 | 59.75 | 68.09 | 363 |
| 430.000 | 0.00280 | 357.260 | 0.000233 | 35.689 | 36538.5 | 40111.1 | 270.484 | 61.03 | 69.37 | 367 |
| 440.000 | 0.00274 | 365.586 | 0.000228 | 36.522 | 37155.4 | 40811.2 | 272.094 | 62.30 | 70.64 | 371 |
| 450.000 | 0.00267 | 373.912 | 0.000222 | 37.354 | 37784.9 | 41524.0 | 273.695 | 63.57 | 71.90 | 375 |
| 460.000 | 0.00262 | 382.237 | 0.000218 | 38.187 | 38427.0 | 42249.4 | 275.289 | 64.82 | 73.15 | 379 |
| 470.000 | 0.00256 | 390.562 | 0.000213 | 39.020 | 39081.5 | 42987.2 | 276.876 | 66.05 | 74.39 | 382 |
| 480.000 | 0.00251 | 398.887 | 0.000209 | 39.853 | 39748.4 | 43737.2 | 278.455 | 67.28 | 75.61 | 386 |
| 490.000 | 0.00246 | 407.211 | 0.000204 | 40.686 | 40427.4 | 44499.5 | 280.026 | 68.49 | 76.82 | 390 |
| 500.000 | 0.00241 | 415.535 | 0.000200 | 41.518 | 41118.5 | 45273.8 | 281.590 | 69.69 | 78.02 | 393 |
| 520.000 | 0.00231 | 432.182 | 0.000192 | 43.184 | 42536.2 | 46858.0 | 284.697 | 72.05 | 80.38 | 400 |
| 540.000 | 0.00223 | 448.828 | 0.000185 | 44.849 | 44000.5 | 48488.8 | 287.773 | 74.35 | 82.67 | 407 |
| 560.000 | 0.00215 | 465.473 | 0.000179 | 46.514 | 45510.2 | 50165.0 | 290.821 | 76.59 | 84.92 | 414 |
| 580.000 | 0.00207 | 482.118 | 0.000172 | 48.179 | 47064.2 | 51885.4 | 293.839 | 78.78 | 87.11 | 421 |
| 600.000 | 0.00200 | 498.761 | 0.000167 | 49.844 | 48661.5 | 53649.1 | 296.828 | 80.92 | 89.24 | 428 |

Table 27. Thermophysical properties along isobars (Continued)

ETHANE ISOBAR AT P = 0.5 BAR

| T DEG K | DEN MOL/L | VOL L/MOL | DP/DT BAR/K | DP/DD BAR-L/MOL | E J/MOL | H J/MOL | S J/MOL/K | CV J/MOL/K | CP J/MOL/K | W M/SEC |
|---|---|---|---|---|---|---|---|---|---|---|
| 89.907 | 21.680 | 0.04612 | 35.0678 | 962.565 | 5298.8 | 5301.1 | 76.499 | 44.06 | 68.50 | 2231 |
| 90.000 | 21.677 | 0.04613 | 35.0272 | 961.576 | 5305.2 | 5307.5 | 76.570 | 44.06 | 68.50 | 2230 |
| 100.000 | 21.315 | 0.04692 | 31.0786 | 861.350 | 5990.8 | 5993.1 | 83.793 | 43.95 | 68.63 | 2115 |
| 110.000 | 20.954 | 0.04772 | 27.7884 | 771.447 | 6678.0 | 6680.4 | 90.343 | 43.75 | 68.83 | 2009 |
| 120.000 | 20.593 | 0.04856 | 24.9863 | 690.304 | 7367.5 | 7370.0 | 96.343 | 43.51 | 69.10 | 1909 |
| 130.000 | 20.230 | 0.04943 | 22.5567 | 616.739 | 8060.3 | 8062.7 | 101.888 | 43.26 | 69.46 | 1815 |
| 140.000 | 19.861 | 0.05035 | 20.4182 | 549.843 | 8757.0 | 8759.6 | 107.052 | 43.02 | 69.93 | 1724 |
| 150.000 | 19.486 | 0.05132 | 18.5122 | 488.852 | 9459.0 | 9461.6 | 111.895 | 42.81 | 70.50 | 1636 |
| 160.000 | 19.103 | 0.05235 | 16.7953 | 433.117 | 10167.5 | 10170.1 | 116.467 | 42.66 | 71.22 | 1551 |
| 170.000 | 18.710 | 0.05345 | 15.2347 | 382.070 | 10883.8 | 10886.5 | 120.810 | 42.58 | 72.08 | 1467 |
| 172.413 | 18.614 | 0.05372 | 14.8786 | 370.397 | 11058.0 | 11060.7 | 121.827 | 42.58 | 72.32 | 1446 |
| 172.413 | 0.03564 | 28.061 | 0.003025 | 13.780 | 24832.7 | 26235.7 | 209.926 | 32.25 | 41.27 | 242 |
| 180.000 | 0.03405 | 29.368 | 0.002881 | 14.459 | 25081.8 | 26550.2 | 211.710 | 32.71 | 41.62 | 247 |
| 190.000 | 0.03217 | 31.081 | 0.002713 | 15.342 | 25415.3 | 26969.3 | 213.976 | 33.40 | 42.20 | 254 |
| 200.000 | 0.03050 | 32.785 | 0.002566 | 16.217 | 25755.5 | 27394.7 | 216.157 | 34.15 | 42.88 | 260 |
| 210.000 | 0.02900 | 34.483 | 0.002435 | 17.084 | 26103.2 | 27827.3 | 218.267 | 34.96 | 43.63 | 266 |
| 220.000 | 0.02764 | 36.176 | 0.002318 | 17.946 | 26459.0 | 28267.8 | 220.316 | 35.84 | 44.46 | 272 |
| 230.000 | 0.02641 | 37.865 | 0.002212 | 18.803 | 26823.7 | 28716.9 | 222.312 | 36.76 | 45.35 | 278 |
| 240.000 | 0.02528 | 39.550 | 0.002116 | 19.657 | 27197.6 | 29175.1 | 224.261 | 37.74 | 46.29 | 283 |
| 250.000 | 0.02425 | 41.233 | 0.002028 | 20.508 | 27581.4 | 29643.1 | 226.171 | 38.75 | 47.28 | 288 |
| 260.000 | 0.02330 | 42.914 | 0.001948 | 21.357 | 27975.5 | 30121.2 | 228.045 | 39.82 | 48.32 | 294 |
| 270.000 | 0.02243 | 44.592 | 0.001874 | 22.204 | 28380.3 | 30609.9 | 229.889 | 40.92 | 49.41 | 299 |
| 280.000 | 0.02161 | 46.269 | 0.001805 | 23.049 | 28796.1 | 31109.6 | 231.706 | 42.05 | 50.53 | 303 |
| 290.000 | 0.02086 | 47.945 | 0.001741 | 23.893 | 29223.5 | 31620.7 | 233.499 | 43.22 | 51.68 | 308 |
| 300.000 | 0.02015 | 49.620 | 0.001682 | 24.736 | 29662.5 | 32143.5 | 235.271 | 44.42 | 52.87 | 313 |
| 310.000 | 0.01950 | 51.294 | 0.001627 | 25.577 | 30113.6 | 32678.3 | 237.024 | 45.64 | 54.08 | 317 |
| 320.000 | 0.01888 | 52.966 | 0.001575 | 26.418 | 30577.0 | 33225.3 | 238.761 | 46.88 | 55.31 | 322 |
| 330.000 | 0.01830 | 54.639 | 0.001526 | 27.258 | 31052.8 | 33784.8 | 240.482 | 48.14 | 56.56 | 326 |
| 340.000 | 0.01776 | 56.310 | 0.001481 | 28.097 | 31541.3 | 34356.8 | 242.189 | 49.41 | 57.83 | 331 |
| 350.000 | 0.01725 | 57.981 | 0.001438 | 28.936 | 32042.5 | 34941.5 | 243.884 | 50.70 | 59.10 | 335 |
| 360.000 | 0.01676 | 59.651 | 0.001397 | 29.774 | 32556.5 | 35539.1 | 245.567 | 51.99 | 60.39 | 339 |
| 370.000 | 0.01631 | 61.321 | 0.001359 | 30.612 | 33083.5 | 36149.5 | 247.239 | 53.29 | 61.68 | 343 |
| 380.000 | 0.01588 | 62.990 | 0.001323 | 31.449 | 33623.4 | 36772.9 | 248.901 | 54.58 | 62.98 | 347 |
| 390.000 | 0.01547 | 64.659 | 0.001289 | 32.286 | 34176.3 | 37409.2 | 250.553 | 55.88 | 64.27 | 351 |
| 400.000 | 0.01508 | 66.328 | 0.001256 | 33.122 | 34742.1 | 38058.5 | 252.197 | 57.18 | 65.57 | 355 |
| 410.000 | 0.01471 | 67.996 | 0.001225 | 33.958 | 35320.9 | 38720.7 | 253.832 | 58.47 | 66.85 | 359 |
| 420.000 | 0.01435 | 69.664 | 0.001196 | 34.794 | 35912.6 | 39395.8 | 255.458 | 59.76 | 68.14 | 363 |
| 430.000 | 0.01402 | 71.332 | 0.001168 | 35.630 | 36517.0 | 40083.6 | 257.077 | 61.04 | 69.42 | 367 |
| 440.000 | 0.01370 | 73.000 | 0.001141 | 36.465 | 37134.2 | 40784.2 | 258.687 | 62.31 | 70.68 | 371 |
| 450.000 | 0.01339 | 74.667 | 0.001115 | 37.300 | 37764.1 | 41497.4 | 260.290 | 63.57 | 71.94 | 375 |
| 460.000 | 0.01310 | 76.334 | 0.001091 | 38.135 | 38406.5 | 42223.2 | 261.884 | 64.82 | 73.19 | 378 |
| 470.000 | 0.01282 | 78.001 | 0.001068 | 38.970 | 39061.3 | 42961.4 | 263.472 | 66.06 | 74.42 | 382 |
| 480.000 | 0.01255 | 79.668 | 0.001045 | 39.805 | 39728.4 | 43711.8 | 265.051 | 67.29 | 75.65 | 386 |
| 490.000 | 0.01229 | 81.334 | 0.001024 | 40.639 | 40407.7 | 44474.4 | 266.624 | 68.50 | 76.86 | 389 |
| 500.000 | 0.01205 | 83.001 | 0.001003 | 41.473 | 41099.1 | 45249.1 | 268.189 | 69.70 | 78.05 | 393 |
| 520.000 | 0.01158 | 86.333 | 0.000964 | 43.142 | 42517.3 | 46834.0 | 271.296 | 72.05 | 80.41 | 400 |
| 540.000 | 0.01115 | 89.665 | 0.000928 | 44.809 | 43982.0 | 48465.3 | 274.374 | 74.35 | 82.70 | 407 |
| 560.000 | 0.01075 | 92.997 | 0.000895 | 46.477 | 45492.2 | 50142.0 | 277.422 | 76.59 | 84.94 | 414 |
| 580.000 | 0.01038 | 96.328 | 0.000864 | 48.144 | 47046.6 | 51863.0 | 280.441 | 78.78 | 87.13 | 421 |
| 600.000 | 0.01003 | 99.659 | 0.000835 | 49.810 | 48644.3 | 53627.2 | 283.431 | 80.92 | 89.27 | 427 |

Table 27. Thermophysical properties along isobars (Continued)

ETHANE ISOBAR AT P = 1.0 BAR

| T | DEN | VOL | DP/DT | DP/DD | E | H | S | CV | CP | W |
|---|---|---|---|---|---|---|---|---|---|---|
| DEG K | MOL/L | L/MOL | BAR/K | BAR-L/MOL | J/MOL | J/MOL | J/MOL/K | J/MOL/K | J/MOL/K | M/SEC |
| 89.915 | 21.680 | 0.04612 | 35.0647 | 962.641 | 5299.0 | 5303.6 | 76.501 | 44.07 | 68.50 | 2231 |
| 90.000 | 21.677 | 0.04613 | 35.0275 | 961.736 | 5304.8 | 5309.4 | 76.566 | 44.07 | 68.50 | 2230 |
| 100.000 | 21.315 | 0.04691 | 31.0793 | 861.522 | 5990.4 | 5995.1 | 83.789 | 43.96 | 68.63 | 2115 |
| 110.000 | 20.955 | 0.04772 | 27.7894 | 771.630 | 6677.5 | 6682.3 | 90.339 | 43.76 | 68.83 | 2009 |
| 120.000 | 20.594 | 0.04856 | 24.9877 | 690.497 | 7367.0 | 7371.9 | 96.339 | 43.52 | 69.10 | 1910 |
| 130.000 | 20.230 | 0.04943 | 22.5584 | 616.941 | 8059.7 | 8064.6 | 101.883 | 43.26 | 69.46 | 1815 |
| 140.000 | 19.862 | 0.05035 | 20.4202 | 550.053 | 8756.4 | 8761.4 | 107.047 | 43.02 | 69.92 | 1724 |
| 150.000 | 19.487 | 0.05132 | 18.5145 | 489.069 | 9458.3 | 9463.4 | 111.890 | 42.82 | 70.50 | 1636 |
| 160.000 | 19.104 | 0.05234 | 16.7978 | 433.341 | 10166.6 | 10171.9 | 116.462 | 42.67 | 71.21 | 1551 |
| 170.000 | 18.712 | 0.05344 | 15.2375 | 382.301 | 10882.8 | 10888.2 | 120.804 | 42.59 | 72.08 | 1467 |
| 180.000 | 18.307 | 0.05463 | 13.8082 | 335.442 | 11608.5 | 11614.0 | 124.952 | 42.59 | 73.12 | 1384 |
| 184.316 | 18.128 | 0.05516 | 13.2266 | 316.391 | 11925.2 | 11930.7 | 126.691 | 42.62 | 73.63 | 1348 |
| | | | | | | | | | | |
| 184.316 | 0.06745 | 14.825 | 0.005806 | 14.352 | 25172.1 | 26654.6 | 206.666 | 33.41 | 42.92 | 248 |
| 190.000 | 0.06524 | 15.328 | 0.005592 | 14.891 | 25366.2 | 26899.0 | 207.972 | 33.73 | 43.11 | 252 |
| 200.000 | 0.06171 | 16.206 | 0.005261 | 15.821 | 25711.8 | 27332.4 | 210.195 | 34.40 | 43.59 | 258 |
| 210.000 | 0.05856 | 17.076 | 0.004973 | 16.734 | 26063.7 | 27771.3 | 212.336 | 35.16 | 44.21 | 265 |
| 220.000 | 0.05574 | 17.939 | 0.004719 | 17.633 | 26423.0 | 28216.9 | 214.409 | 35.99 | 44.94 | 271 |
| 230.000 | 0.05320 | 18.799 | 0.004493 | 18.523 | 26790.4 | 28670.2 | 216.424 | 36.89 | 45.75 | 276 |
| 240.000 | 0.05088 | 19.654 | 0.004289 | 19.405 | 27166.7 | 29132.1 | 218.390 | 37.84 | 46.63 | 282 |
| 250.000 | 0.04877 | 20.506 | 0.004105 | 20.281 | 27552.4 | 29603.1 | 220.312 | 38.84 | 47.58 | 287 |
| 260.000 | 0.04682 | 21.356 | 0.003936 | 21.151 | 27948.2 | 30083.8 | 222.198 | 39.89 | 48.58 | 293 |
| 270.000 | 0.04504 | 22.204 | 0.003782 | 22.016 | 28354.4 | 30574.8 | 224.050 | 40.98 | 49.63 | 298 |
| 280.000 | 0.04338 | 23.050 | 0.003640 | 22.878 | 28771.6 | 31076.6 | 225.875 | 42.11 | 50.72 | 303 |
| 290.000 | 0.04185 | 23.895 | 0.003509 | 23.737 | 29200.0 | 31589.5 | 227.675 | 43.27 | 51.86 | 308 |
| 300.000 | 0.04042 | 24.738 | 0.003387 | 24.593 | 29640.1 | 32113.9 | 229.452 | 44.46 | 53.02 | 312 |
| 310.000 | 0.03909 | 25.580 | 0.003273 | 25.447 | 30092.1 | 32650.1 | 231.210 | 45.68 | 54.22 | 317 |
| 320.000 | 0.03785 | 26.422 | 0.003168 | 26.299 | 30556.2 | 33198.4 | 232.951 | 46.91 | 55.44 | 321 |
| 330.000 | 0.03668 | 27.262 | 0.003069 | 27.149 | 31032.7 | 33758.9 | 234.675 | 48.17 | 56.67 | 326 |
| 340.000 | 0.03558 | 28.102 | 0.002976 | 27.997 | 31521.8 | 34332.0 | 236.386 | 49.44 | 57.93 | 330 |
| 350.000 | 0.03455 | 28.941 | 0.002889 | 28.844 | 32023.6 | 34917.7 | 238.084 | 50.72 | 59.20 | 335 |
| 360.000 | 0.03358 | 29.779 | 0.002806 | 29.690 | 32538.2 | 35516.1 | 239.769 | 52.01 | 60.48 | 339 |
| 370.000 | 0.03266 | 30.617 | 0.002729 | 30.535 | 33065.6 | 36127.3 | 241.444 | 53.30 | 61.76 | 343 |
| 380.000 | 0.03179 | 31.455 | 0.002656 | 31.378 | 33606.0 | 36751.5 | 243.108 | 54.60 | 63.05 | 347 |
| 390.000 | 0.03097 | 32.292 | 0.002586 | 32.221 | 34159.2 | 37388.5 | 244.762 | 55.90 | 64.34 | 351 |
| 400.000 | 0.03019 | 33.129 | 0.002520 | 33.063 | 34725.5 | 38038.4 | 246.408 | 57.20 | 65.63 | 355 |
| 410.000 | 0.02944 | 33.965 | 0.002458 | 33.905 | 35304.6 | 38701.1 | 248.044 | 58.49 | 66.91 | 359 |
| 420.000 | 0.02873 | 34.801 | 0.002398 | 34.746 | 35896.6 | 39376.7 | 249.672 | 59.77 | 68.19 | 363 |
| 430.000 | 0.02806 | 35.637 | 0.002342 | 35.586 | 36501.4 | 40065.1 | 251.291 | 61.05 | 69.47 | 367 |
| 440.000 | 0.02742 | 36.473 | 0.002288 | 36.425 | 37118.9 | 40766.2 | 252.903 | 62.32 | 70.73 | 371 |
| 450.000 | 0.02680 | 37.308 | 0.002236 | 37.265 | 37749.0 | 41479.8 | 254.507 | 63.58 | 71.99 | 375 |
| 460.000 | 0.02622 | 38.143 | 0.002187 | 38.103 | 38391.6 | 42206.0 | 256.102 | 64.83 | 73.23 | 378 |
| 470.000 | 0.02566 | 38.978 | 0.002140 | 38.942 | 39046.7 | 42944.6 | 257.691 | 66.07 | 74.47 | 382 |
| 480.000 | 0.02512 | 39.813 | 0.002095 | 39.780 | 39714.0 | 43695.4 | 259.271 | 67.29 | 75.69 | 386 |
| 490.000 | 0.02460 | 40.648 | 0.002052 | 40.617 | 40393.6 | 44458.3 | 260.844 | 68.50 | 76.89 | 389 |
| 500.000 | 0.02411 | 41.482 | 0.002010 | 41.454 | 41085.1 | 45233.3 | 262.410 | 69.70 | 78.09 | 393 |
| 520.000 | 0.02317 | 43.151 | 0.001932 | 43.128 | 42503.7 | 46818.8 | 265.518 | 72.06 | 80.44 | 400 |
| 540.000 | 0.02231 | 44.819 | 0.001860 | 44.801 | 43968.8 | 48450.7 | 268.597 | 74.36 | 82.73 | 407 |
| 560.000 | 0.02151 | 46.487 | 0.001793 | 46.473 | 45479.2 | 50127.9 | 271.647 | 76.60 | 84.97 | 414 |
| 580.000 | 0.02077 | 48.154 | 0.001731 | 48.144 | 47033.9 | 51849.3 | 274.667 | 78.79 | 87.15 | 421 |
| 600.000 | 0.02007 | 49.821 | 0.001673 | 49.814 | 48631.9 | 53613.9 | 277.657 | 80.92 | 89.29 | 428 |

Table 27. Thermophysical properties along isobars (Continued)

ETHANE ISOBAR AT P = 1.5 BAR

| T DEG K | DEN MOL/L | VOL L/MOL | DP/DT BAR/K | DP/DD BAR-L/MOL | E J/MOL | H J/MOL | S J/MOL/K | CV J/MOL/K | CP J/MOL/K | W M/SEC |
|---|---|---|---|---|---|---|---|---|---|---|
| 89.922 | 21.681 | 0.04612 | 35.0616 | 962.716 | 5299.2 | 5306.1 | 76.503 | 44.07 | 68.50 | 2231 |
| 90.000 | 21.678 | 0.04613 | 35.0278 | 961.895 | 5304.5 | 5311.4 | 76.562 | 44.07 | 68.50 | 2230 |
| 100.000 | 21.316 | 0.04691 | 31.0800 | 861.694 | 5990.0 | 5997.0 | 83.785 | 43.96 | 68.63 | 2115 |
| 110.000 | 20.956 | 0.04772 | 27.7905 | 771.813 | 6677.1 | 6684.2 | 90.335 | 43.76 | 68.83 | 2009 |
| 120.000 | 20.595 | 0.04856 | 24.9891 | 690.690 | 7366.5 | 7373.8 | 96.334 | 43.52 | 69.10 | 1910 |
| 130.000 | 20.231 | 0.04943 | 22.5601 | 617.143 | 8059.1 | 8066.5 | 101.879 | 43.26 | 69.46 | 1815 |
| 140.000 | 19.863 | 0.05034 | 20.4222 | 550.262 | 8755.7 | 8763.3 | 107.042 | 43.02 | 69.92 | 1724 |
| 150.000 | 19.488 | 0.05131 | 18.5167 | 489.286 | 9457.5 | 9465.2 | 111.885 | 42.82 | 70.50 | 1637 |
| 160.000 | 19.106 | 0.05234 | 16.8004 | 433.565 | 10165.8 | 10173.6 | 116.456 | 42.67 | 71.21 | 1551 |
| 170.000 | 18.713 | 0.05344 | 15.2403 | 382.532 | 10881.9 | 10889.9 | 120.798 | 42.59 | 72.07 | 1467 |
| 180.000 | 18.308 | 0.05462 | 13.8113 | 335.681 | 11607.4 | 11615.6 | 124.946 | 42.60 | 73.11 | 1384 |
| 190.000 | 17.889 | 0.05590 | 12.4933 | 292.555 | 12344.4 | 12352.8 | 128.932 | 42.69 | 74.36 | 1302 |
| 192.164 | 17.796 | 0.05619 | 12.2211 | 283.671 | 12505.6 | 12514.0 | 129.776 | 42.72 | 74.67 | 1284 |
| | | | | | | | | | | |
| 192.164 | 0.09811 | 10.193 | 0.008546 | 14.598 | 25392.0 | 26920.9 | 204.833 | 34.25 | 44.24 | 250 |
| 200.000 | 0.09376 | 10.666 | 0.008110 | 15.375 | 25668.2 | 27268.1 | 206.604 | 34.70 | 44.43 | 256 |
| 210.000 | 0.08880 | 11.262 | 0.007630 | 16.339 | 26025.1 | 27714.4 | 208.782 | 35.39 | 44.88 | 263 |
| 220.000 | 0.08438 | 11.851 | 0.007215 | 17.282 | 26388.3 | 28165.9 | 210.883 | 36.17 | 45.48 | 269 |
| 230.000 | 0.08042 | 12.435 | 0.006850 | 18.207 | 26758.9 | 28624.1 | 212.920 | 37.03 | 46.20 | 275 |
| 240.000 | 0.07684 | 13.015 | 0.006525 | 19.120 | 27137.8 | 29090.0 | 214.903 | 37.96 | 47.01 | 281 |
| 250.000 | 0.07358 | 13.591 | 0.006233 | 20.022 | 27525.7 | 29564.4 | 216.840 | 38.94 | 47.90 | 286 |
| 260.000 | 0.07060 | 14.165 | 0.005969 | 20.915 | 27923.4 | 30048.1 | 218.737 | 39.97 | 48.86 | 292 |
| 270.000 | 0.06786 | 14.737 | 0.005728 | 21.801 | 28331.2 | 30541.7 | 220.600 | 41.05 | 49.87 | 297 |
| 280.000 | 0.06533 | 15.307 | 0.005507 | 22.681 | 28749.7 | 31045.7 | 222.433 | 42.17 | 50.94 | 302 |
| 290.000 | 0.06299 | 15.875 | 0.005304 | 23.556 | 29179.4 | 31560.6 | 224.239 | 43.32 | 52.05 | 307 |
| 300.000 | 0.06082 | 16.441 | 0.005116 | 24.427 | 29620.5 | 32086.7 | 226.023 | 44.50 | 53.19 | 312 |
| 310.000 | 0.05880 | 17.007 | 0.004941 | 25.294 | 30073.4 | 32624.5 | 227.786 | 45.71 | 54.37 | 316 |
| 320.000 | 0.05691 | 17.572 | 0.004779 | 26.158 | 30538.4 | 33174.2 | 229.532 | 46.95 | 55.57 | 321 |
| 330.000 | 0.05514 | 18.135 | 0.004627 | 27.019 | 31015.7 | 33736.0 | 231.260 | 48.20 | 56.80 | 325 |
| 340.000 | 0.05348 | 18.698 | 0.004486 | 27.878 | 31505.5 | 34310.2 | 232.974 | 49.46 | 58.04 | 330 |
| 350.000 | 0.05192 | 19.260 | 0.004352 | 28.734 | 32007.9 | 34896.9 | 234.675 | 50.74 | 59.30 | 334 |
| 360.000 | 0.05045 | 19.822 | 0.004227 | 29.589 | 32523.0 | 35496.3 | 236.363 | 52.03 | 60.57 | 338 |
| 370.000 | 0.04906 | 20.383 | 0.004109 | 30.441 | 33050.9 | 36108.4 | 238.040 | 53.32 | 61.85 | 343 |
| 380.000 | 0.04775 | 20.944 | 0.003998 | 31.292 | 33591.7 | 36733.3 | 239.707 | 54.62 | 63.13 | 347 |
| 390.000 | 0.04650 | 21.504 | 0.003892 | 32.142 | 34145.5 | 37371.0 | 241.363 | 55.92 | 64.42 | 351 |
| 400.000 | 0.04532 | 22.063 | 0.003792 | 32.991 | 34712.1 | 38021.6 | 243.010 | 57.21 | 65.70 | 355 |
| 410.000 | 0.04420 | 22.623 | 0.003697 | 33.838 | 35291.6 | 38685.0 | 244.648 | 58.50 | 66.98 | 359 |
| 420.000 | 0.04314 | 23.182 | 0.003607 | 34.684 | 35883.9 | 39361.2 | 246.278 | 59.79 | 68.25 | 363 |
| 430.000 | 0.04212 | 23.741 | 0.003522 | 35.530 | 36489.0 | 40050.1 | 247.899 | 61.06 | 69.52 | 367 |
| 440.000 | 0.04115 | 24.299 | 0.003440 | 36.374 | 37106.8 | 40751.7 | 249.511 | 62.33 | 70.78 | 371 |
| 450.000 | 0.04023 | 24.858 | 0.003362 | 37.218 | 37737.2 | 41465.8 | 251.116 | 63.59 | 72.04 | 374 |
| 460.000 | 0.03935 | 25.416 | 0.003288 | 38.061 | 38380.1 | 42192.4 | 252.713 | 64.84 | 73.28 | 378 |
| 470.000 | 0.03850 | 25.973 | 0.003216 | 38.904 | 39035.4 | 42931.4 | 254.302 | 66.08 | 74.51 | 382 |
| 480.000 | 0.03769 | 26.531 | 0.003148 | 39.746 | 39702.9 | 43682.6 | 255.884 | 67.30 | 75.73 | 386 |
| 490.000 | 0.03692 | 27.089 | 0.003083 | 40.587 | 40382.7 | 44445.9 | 257.458 | 68.51 | 76.93 | 389 |
| 500.000 | 0.03617 | 27.646 | 0.003020 | 41.428 | 41074.4 | 45221.3 | 259.024 | 69.71 | 78.13 | 393 |
| 520.000 | 0.03477 | 28.760 | 0.002903 | 43.108 | 42493.4 | 46807.4 | 262.134 | 72.06 | 80.47 | 400 |
| 540.000 | 0.03347 | 29.874 | 0.002794 | 44.786 | 43958.8 | 48439.8 | 265.214 | 74.36 | 82.76 | 407 |
| 560.000 | 0.03227 | 30.987 | 0.002693 | 46.463 | 45469.5 | 50117.6 | 268.264 | 76.60 | 85.00 | 414 |
| 580.000 | 0.03115 | 32.100 | 0.002599 | 48.139 | 47024.5 | 51839.5 | 271.285 | 78.79 | 87.18 | 421 |
| 600.000 | 0.03011 | 33.212 | 0.002512 | 49.813 | 48622.7 | 53604.5 | 274.277 | 80.93 | 89.31 | 428 |

Table 27. Thermophysical properties along isobars (Continued)

ETHANE ISOBAR AT P = 2.0 BAR

| T<br>DEG K | DEN<br>MOL/L | VOL<br>L/MOL | DP/DT<br>BAR/K | DP/DD<br>BAR-L/MOL | E<br>J/MOL | H<br>J/MOL | S<br>J/MOL/K | CV<br>J/MOL/K | CP<br>J/MOL/K | W<br>M/SEC |
|---|---|---|---|---|---|---|---|---|---|---|
| 89.930 | 21.681 | 0.04612 | 35.0584 | 962.794 | 5299.3 | 5308.6 | 76.505 | 44.07 | 68.50 | 2231 |
| 90.000 | 21.678 | 0.04613 | 35.0281 | 962.054 | 5304.1 | 5313.4 | 76.558 | 44.07 | 68.50 | 2230 |
| 100.000 | 21.316 | 0.04691 | 31.0808 | 861.867 | 5989.6 | 5998.9 | 83.781 | 43.96 | 68.63 | 2115 |
| 110.000 | 20.956 | 0.04772 | 27.7916 | 771.997 | 6676.6 | 6686.2 | 90.331 | 43.77 | 68.83 | 2009 |
| 120.000 | 20.596 | 0.04855 | 24.9905 | 690.883 | 7366.0 | 7375.7 | 96.330 | 43.52 | 69.10 | 1910 |
| 130.000 | 20.232 | 0.04943 | 22.5618 | 617.344 | 8058.5 | 8068.4 | 101.874 | 43.27 | 69.45 | 1815 |
| 140.000 | 19.864 | 0.05034 | 20.4241 | 550.472 | 8755.1 | 8765.1 | 107.037 | 43.03 | 69.91 | 1725 |
| 150.000 | 19.489 | 0.05131 | 18.5190 | 489.502 | 9456.8 | 9467.1 | 111.880 | 42.82 | 70.49 | 1637 |
| 160.000 | 19.107 | 0.05234 | 16.8029 | 433.789 | 10164.9 | 10175.4 | 116.451 | 42.68 | 71.20 | 1551 |
| 170.000 | 18.714 | 0.05344 | 15.2432 | 382.763 | 10880.9 | 10891.6 | 120.793 | 42.60 | 72.06 | 1467 |
| 180.000 | 18.310 | 0.05462 | 13.8145 | 335.919 | 11606.3 | 11617.3 | 124.940 | 42.60 | 73.10 | 1385 |
| 190.000 | 17.891 | 0.05589 | 12.4968 | 292.801 | 12343.2 | 12354.3 | 128.925 | 42.69 | 74.35 | 1302 |
| 198.191 | 17.535 | 0.05703 | 11.4887 | 259.968 | 12956.8 | 12968.2 | 132.088 | 42.84 | 75.56 | 1235 |
| | | | | | | | | | | |
| 198.191 | 0.12816 | 7.803 | 0.011284 | 14.706 | 25557.6 | 27118.1 | 203.561 | 34.95 | 45.39 | 252 |
| 200.000 | 0.12679 | 7.887 | 0.011140 | 14.896 | 25622.8 | 27200.2 | 203.974 | 35.04 | 45.40 | 253 |
| 210.000 | 0.11980 | 8.348 | 0.010424 | 15.917 | 25985.4 | 27654.9 | 206.193 | 35.64 | 45.63 | 260 |
| 220.000 | 0.11363 | 8.800 | 0.009818 | 16.906 | 26353.0 | 28113.1 | 208.325 | 36.36 | 46.08 | 267 |
| 230.000 | 0.10814 | 9.248 | 0.009293 | 17.869 | 26727.1 | 28576.6 | 210.387 | 37.18 | 46.69 | 273 |
| 240.000 | 0.10320 | 9.690 | 0.008831 | 18.814 | 27108.9 | 29047.0 | 212.389 | 38.08 | 47.42 | 279 |
| 250.000 | 0.09872 | 10.129 | 0.008420 | 19.744 | 27499.3 | 29525.1 | 214.341 | 39.04 | 48.25 | 285 |
| 260.000 | 0.09465 | 10.566 | 0.008050 | 20.662 | 27898.9 | 30012.0 | 216.251 | 40.06 | 49.16 | 290 |
| 270.000 | 0.09091 | 10.999 | 0.007715 | 21.569 | 28308.5 | 30508.4 | 218.124 | 41.12 | 50.14 | 296 |
| 280.000 | 0.08748 | 11.431 | 0.007409 | 22.468 | 28728.5 | 31014.8 | 219.966 | 42.23 | 51.17 | 301 |
| 290.000 | 0.08431 | 11.861 | 0.007129 | 23.360 | 29159.5 | 31531.7 | 221.781 | 43.37 | 52.25 | 306 |
| 300.000 | 0.08137 | 12.290 | 0.006871 | 24.246 | 29601.7 | 32059.8 | 223.571 | 44.55 | 53.37 | 311 |
| 310.000 | 0.07863 | 12.718 | 0.006632 | 25.127 | 30055.7 | 32599.2 | 225.340 | 45.75 | 54.53 | 316 |
| 320.000 | 0.07608 | 13.144 | 0.006411 | 26.004 | 30521.6 | 33150.3 | 227.090 | 46.98 | 55.72 | 320 |
| 330.000 | 0.07370 | 13.569 | 0.006204 | 26.876 | 30999.6 | 33713.5 | 228.823 | 48.23 | 56.93 | 325 |
| 340.000 | 0.07146 | 13.994 | 0.006011 | 27.745 | 31490.1 | 34288.9 | 230.540 | 49.49 | 58.16 | 329 |
| 350.000 | 0.06936 | 14.418 | 0.005830 | 28.611 | 31993.2 | 34876.8 | 232.244 | 50.77 | 59.41 | 334 |
| 360.000 | 0.06738 | 14.841 | 0.005660 | 29.475 | 32508.9 | 35477.1 | 233.936 | 52.05 | 60.67 | 338 |
| 370.000 | 0.06551 | 15.264 | 0.005501 | 30.336 | 33037.4 | 36090.2 | 235.615 | 53.34 | 61.94 | 342 |
| 380.000 | 0.06375 | 15.686 | 0.005350 | 31.195 | 33578.7 | 36715.9 | 237.284 | 54.64 | 63.22 | 346 |
| 390.000 | 0.06208 | 16.108 | 0.005207 | 32.052 | 34132.8 | 37354.4 | 238.943 | 55.93 | 64.49 | 351 |
| 400.000 | 0.06050 | 16.529 | 0.005073 | 32.907 | 34699.9 | 38005.7 | 240.592 | 57.23 | 65.77 | 355 |
| 410.000 | 0.05900 | 16.950 | 0.004945 | 33.760 | 35279.7 | 38669.8 | 242.231 | 58.51 | 67.05 | 359 |
| 420.000 | 0.05757 | 17.371 | 0.004823 | 34.613 | 35872.4 | 39346.6 | 243.862 | 59.80 | 68.32 | 363 |
| 430.000 | 0.05621 | 17.791 | 0.004708 | 35.464 | 36477.9 | 40036.1 | 245.485 | 61.08 | 69.58 | 367 |
| 440.000 | 0.05491 | 18.211 | 0.004598 | 36.313 | 37095.9 | 40738.2 | 247.099 | 62.34 | 70.84 | 370 |
| 450.000 | 0.05367 | 18.631 | 0.004493 | 37.162 | 37726.6 | 41452.9 | 248.705 | 63.60 | 72.09 | 374 |
| 460.000 | 0.05249 | 19.051 | 0.004393 | 38.010 | 38369.8 | 42179.9 | 250.303 | 64.85 | 73.33 | 378 |
| 470.000 | 0.05136 | 19.470 | 0.004297 | 38.856 | 39025.3 | 42919.4 | 251.893 | 66.09 | 74.55 | 382 |
| 480.000 | 0.05028 | 19.889 | 0.004206 | 39.702 | 39693.1 | 43671.0 | 253.475 | 67.31 | 75.77 | 386 |
| 490.000 | 0.04924 | 20.308 | 0.004118 | 40.548 | 40373.1 | 44434.7 | 255.050 | 68.52 | 76.97 | 389 |
| 500.000 | 0.04825 | 20.727 | 0.004034 | 41.392 | 41065.0 | 45210.4 | 256.617 | 69.72 | 78.16 | 393 |
| 520.000 | 0.04637 | 21.564 | 0.003876 | 43.079 | 42484.3 | 46797.2 | 259.728 | 72.07 | 80.50 | 400 |
| 540.000 | 0.04464 | 22.401 | 0.003731 | 44.764 | 43950.1 | 48430.3 | 262.810 | 74.37 | 82.79 | 407 |
| 560.000 | 0.04303 | 23.237 | 0.003595 | 46.446 | 45461.1 | 50108.6 | 265.861 | 76.61 | 85.02 | 414 |
| 580.000 | 0.04154 | 24.073 | 0.003470 | 48.127 | 47016.4 | 51830.9 | 268.883 | 78.80 | 87.20 | 421 |
| 600.000 | 0.04015 | 24.908 | 0.003353 | 49.806 | 48614.8 | 53596.5 | 271.875 | 80.93 | 89.33 | 428 |

Table 27. Thermophysical properties along isobars (Continued)

ETHANE ISOBAR AT P = 3.0 BAR

| T DEG K | DEN MOL/L | VOL L/MOL | DP/DT BAR/K | DP/DD BAR-L/MOL | E J/MOL | H J/MOL | S J/MOL/K | CV J/MOL/K | CP J/MOL/K | W M/SEC |
|---|---|---|---|---|---|---|---|---|---|---|
| 89.946 | 21.681 | 0.04612 | 35.0522 | 962.947 | 5299.7 | 5313.6 | 76.509 | 44.08 | 68.50 | 2231 |
| 90.000 | 21.679 | 0.04613 | 35.0286 | 962.373 | 5303.4 | 5317.3 | 76.550 | 44.08 | 68.50 | 2230 |
| 100.000 | 21.317 | 0.04691 | 31.0822 | 862.211 | 5988.8 | 6002.8 | 83.773 | 43.97 | 68.63 | 2115 |
| 110.000 | 20.958 | 0.04772 | 27.7937 | 772.363 | 6675.7 | 6690.0 | 90.323 | 43.77 | 68.82 | 2010 |
| 120.000 | 20.597 | 0.04855 | 24.9933 | 691.268 | 7365.0 | 7379.5 | 96.322 | 43.53 | 69.09 | 1910 |
| 130.000 | 20.234 | 0.04942 | 22.5651 | 617.747 | 8057.4 | 8072.2 | 101.865 | 43.28 | 69.45 | 1816 |
| 140.000 | 19.866 | 0.05034 | 20.4281 | 550.890 | 8753.8 | 8768.9 | 107.028 | 43.03 | 69.91 | 1725 |
| 150.000 | 19.492 | 0.05130 | 18.5235 | 489.936 | 9455.3 | 9470.7 | 111.870 | 42.83 | 70.48 | 1637 |
| 160.000 | 19.109 | 0.05233 | 16.8080 | 434.236 | 10163.2 | 10178.9 | 116.441 | 42.68 | 71.19 | 1552 |
| 170.000 | 18.717 | 0.05343 | 15.2488 | 383.225 | 10879.0 | 10895.0 | 120.781 | 42.60 | 72.05 | 1468 |
| 180.000 | 18.313 | 0.05461 | 13.8207 | 336.396 | 11604.1 | 11620.5 | 124.928 | 42.61 | 73.09 | 1385 |
| 190.000 | 17.894 | 0.05588 | 12.5037 | 293.293 | 12340.6 | 12357.4 | 128.912 | 42.70 | 74.33 | 1303 |
| 200.000 | 17.459 | 0.05728 | 11.2814 | 253.503 | 13090.8 | 13107.9 | 132.761 | 42.89 | 75.83 | 1221 |
| 207.416 | 17.123 | 0.05840 | 10.4279 | 225.912 | 13657.5 | 13675.0 | 135.545 | 43.09 | 77.14 | 1160 |
| | | | | | | | | | | |
| 207.416 | 0.18734 | 5.338 | 0.016817 | 14.727 | 25803.2 | 27404.6 | 201.803 | 36.10 | 47.45 | 254 |
| 210.000 | 0.18444 | 5.422 | 0.016494 | 15.019 | 25900.5 | 27527.0 | 202.390 | 36.22 | 47.40 | 256 |
| 220.000 | 0.17421 | 5.740 | 0.015391 | 16.110 | 26278.6 | 28000.7 | 204.595 | 36.80 | 47.45 | 263 |
| 230.000 | 0.16523 | 6.052 | 0.014468 | 17.157 | 26660.9 | 28476.5 | 206.711 | 37.52 | 47.80 | 270 |
| 240.000 | 0.15727 | 6.359 | 0.013675 | 18.171 | 27049.3 | 28956.8 | 208.756 | 38.35 | 48.34 | 276 |
| 250.000 | 0.15013 | 6.661 | 0.012983 | 19.159 | 27445.0 | 29443.3 | 210.743 | 39.26 | 49.02 | 282 |
| 260.000 | 0.14368 | 6.960 | 0.012370 | 20.127 | 27849.2 | 29937.2 | 212.680 | 40.24 | 49.81 | 288 |
| 270.000 | 0.13781 | 7.257 | 0.011822 | 21.079 | 28262.6 | 30439.5 | 214.577 | 41.27 | 50.70 | 293 |
| 280.000 | 0.13244 | 7.551 | 0.011327 | 22.017 | 28685.9 | 30951.1 | 216.438 | 42.36 | 51.66 | 299 |
| 290.000 | 0.12750 | 7.843 | 0.010877 | 22.944 | 29119.7 | 31472.7 | 218.268 | 43.48 | 52.68 | 304 |
| 300.000 | 0.12294 | 8.134 | 0.010466 | 23.862 | 29564.4 | 32004.7 | 220.072 | 44.65 | 53.76 | 309 |
| 310.000 | 0.11871 | 8.424 | 0.010087 | 24.771 | 30020.6 | 32547.7 | 221.853 | 45.84 | 54.87 | 314 |
| 320.000 | 0.11478 | 8.712 | 0.009738 | 25.673 | 30488.4 | 33102.1 | 223.613 | 47.05 | 56.03 | 319 |
| 330.000 | 0.11112 | 9.000 | 0.009414 | 26.568 | 30968.2 | 33668.1 | 225.356 | 48.29 | 57.21 | 324 |
| 340.000 | 0.10769 | 9.286 | 0.009112 | 27.459 | 31460.3 | 34246.1 | 227.081 | 49.55 | 58.42 | 328 |
| 350.000 | 0.10447 | 9.572 | 0.008831 | 28.345 | 31964.7 | 34836.3 | 228.792 | 50.82 | 59.64 | 333 |
| 360.000 | 0.10145 | 9.857 | 0.008567 | 29.226 | 32481.7 | 35438.8 | 230.490 | 52.10 | 60.88 | 337 |
| 370.000 | 0.09860 | 10.142 | 0.008319 | 30.104 | 33011.3 | 36053.8 | 232.175 | 53.38 | 62.13 | 341 |
| 380.000 | 0.09592 | 10.426 | 0.008087 | 30.978 | 33553.7 | 36681.4 | 233.849 | 54.67 | 63.39 | 346 |
| 390.000 | 0.09338 | 10.709 | 0.007867 | 31.850 | 34108.8 | 37321.6 | 235.512 | 55.97 | 64.66 | 350 |
| 400.000 | 0.09097 | 10.992 | 0.007660 | 32.719 | 34676.7 | 37974.4 | 237.165 | 57.26 | 65.92 | 354 |
| 410.000 | 0.08869 | 11.275 | 0.007463 | 33.585 | 35257.4 | 38639.9 | 238.808 | 58.54 | 67.19 | 358 |
| 420.000 | 0.08653 | 11.557 | 0.007277 | 34.449 | 35850.8 | 39318.0 | 240.442 | 59.82 | 68.45 | 362 |
| 430.000 | 0.08446 | 11.839 | 0.007101 | 35.311 | 36457.0 | 40008.8 | 242.067 | 61.10 | 69.71 | 366 |
| 440.000 | 0.08250 | 12.121 | 0.006932 | 36.172 | 37075.7 | 40712.0 | 243.684 | 62.37 | 70.95 | 370 |
| 450.000 | 0.08063 | 12.402 | 0.006772 | 37.030 | 37707.0 | 41427.7 | 245.293 | 63.62 | 72.20 | 374 |
| 460.000 | 0.07884 | 12.684 | 0.006620 | 37.888 | 38350.7 | 42155.8 | 246.893 | 64.87 | 73.43 | 378 |
| 470.000 | 0.07713 | 12.965 | 0.006474 | 38.743 | 39006.8 | 42896.2 | 248.485 | 66.10 | 74.65 | 381 |
| 480.000 | 0.07550 | 13.245 | 0.006335 | 39.598 | 39675.1 | 43648.7 | 250.070 | 67.33 | 75.86 | 385 |
| 490.000 | 0.07393 | 13.526 | 0.006202 | 40.451 | 40355.5 | 44413.3 | 251.646 | 68.54 | 77.06 | 389 |
| 500.000 | 0.07243 | 13.806 | 0.006074 | 41.303 | 41047.9 | 45189.8 | 253.215 | 69.73 | 78.24 | 393 |
| 520.000 | 0.06961 | 14.367 | 0.005834 | 43.004 | 42468.0 | 46778.0 | 256.329 | 72.08 | 80.58 | 400 |
| 540.000 | 0.06700 | 14.926 | 0.005613 | 44.702 | 43934.5 | 48412.4 | 259.413 | 74.38 | 82.86 | 407 |
| 560.000 | 0.06458 | 15.486 | 0.005408 | 46.396 | 45446.2 | 50091.9 | 262.467 | 76.62 | 85.08 | 414 |
| 580.000 | 0.06233 | 16.044 | 0.005218 | 48.088 | 47002.0 | 51815.3 | 265.491 | 78.81 | 87.26 | 421 |
| 600.000 | 0.06023 | 16.603 | 0.005040 | 49.777 | 48600.9 | 53581.8 | 268.485 | 80.94 | 89.38 | 428 |

Table 27. Thermophysical properties along isobars (Continued)

ETHANE ISOBAR AT P = 4.0 BAR

| T | DEN | VOL | DP/DT | DP/DD | E | H | S | CV | CP | W |
|---|---|---|---|---|---|---|---|---|---|---|
| DEG K | MOL/L | L/MOL | BAR/K | BAR-L/MOL | J/MOL | J/MOL | J/MOL/K | J/MOL/K | J/MOL/K | M/SEC |
| 89.961 | 21.682 | 0.04612 | 35.0460 | 963.101 | 5300.1 | 5318.5 | 76.513 | 44.09 | 68.49 | 2231 |
| 90.000 | 21.680 | 0.04612 | 35.0292 | 962.692 | 5302.7 | 5321.2 | 76.543 | 44.09 | 68.50 | 2230 |
| 100.000 | 21.319 | 0.04691 | 31.0836 | 862.555 | 5988.0 | 6006.7 | 83.765 | 43.98 | 68.63 | 2116 |
| 110.000 | 20.959 | 0.04771 | 27.7959 | 772.730 | 6674.8 | 6693.9 | 90.314 | 43.78 | 68.82 | 2010 |
| 120.000 | 20.598 | 0.04855 | 24.9961 | 691.654 | 7364.0 | 7383.4 | 96.313 | 43.54 | 69.09 | 1910 |
| 130.000 | 20.235 | 0.04942 | 22.5685 | 618.150 | 8056.2 | 8076.0 | 101.857 | 43.28 | 69.44 | 1816 |
| 140.000 | 19.868 | 0.05033 | 20.4320 | 551.309 | 8752.4 | 8772.6 | 107.019 | 43.04 | 69.90 | 1726 |
| 150.000 | 19.494 | 0.05130 | 18.5280 | 490.369 | 9453.8 | 9474.3 | 111.860 | 42.84 | 70.47 | 1638 |
| 160.000 | 19.111 | 0.05232 | 16.8130 | 434.684 | 10161.5 | 10182.5 | 116.430 | 42.69 | 71.18 | 1552 |
| 170.000 | 18.719 | 0.05342 | 15.2544 | 383.686 | 10877.0 | 10898.4 | 120.770 | 42.61 | 72.04 | 1469 |
| 180.000 | 18.316 | 0.05460 | 13.8269 | 336.872 | 11601.9 | 11623.8 | 124.916 | 42.62 | 73.07 | 1386 |
| 190.000 | 17.898 | 0.05587 | 12.5105 | 293.785 | 12338.1 | 12360.4 | 128.898 | 42.71 | 74.31 | 1304 |
| 200.000 | 17.463 | 0.05726 | 11.2889 | 254.012 | 13087.9 | 13110.8 | 132.747 | 42.89 | 75.80 | 1222 |
| 210.000 | 17.007 | 0.05880 | 10.1483 | 217.180 | 13854.0 | 13877.5 | 136.487 | 43.18 | 77.60 | 1139 |
| 214.541 | 16.792 | 0.05955 | 9.6538 | 201.332 | 14208.2 | 14232.0 | 138.157 | 43.34 | 78.55 | 1102 |
| 214.541 | 0.24597 | 4.066 | 0.022469 | 14.623 | 25983.7 | 27610.0 | 200.573 | 37.06 | 49.31 | 254 |
| 220.000 | 0.23794 | 4.203 | 0.021535 | 15.274 | 26197.2 | 27878.3 | 201.809 | 37.30 | 49.10 | 259 |
| 230.000 | 0.22481 | 4.448 | 0.020079 | 16.414 | 26589.3 | 28368.6 | 203.989 | 37.90 | 49.08 | 266 |
| 240.000 | 0.21333 | 4.687 | 0.018865 | 17.503 | 26985.4 | 28860.4 | 206.083 | 38.65 | 49.37 | 273 |
| 250.000 | 0.20316 | 4.922 | 0.017826 | 18.555 | 27387.3 | 29356.2 | 208.108 | 39.50 | 49.87 | 279 |
| 260.000 | 0.19405 | 5.153 | 0.016920 | 19.576 | 27797.5 | 29858.8 | 210.077 | 40.44 | 50.53 | 285 |
| 270.000 | 0.18582 | 5.381 | 0.016121 | 20.574 | 28215.1 | 30367.7 | 211.998 | 41.44 | 51.32 | 291 |
| 280.000 | 0.17834 | 5.607 | 0.015407 | 21.552 | 28642.1 | 30885.0 | 213.880 | 42.50 | 52.19 | 297 |
| 290.000 | 0.17149 | 5.831 | 0.014764 | 22.514 | 29079.0 | 31411.5 | 215.728 | 43.60 | 53.15 | 302 |
| 300.000 | 0.16520 | 6.053 | 0.014180 | 23.463 | 29526.5 | 31947.8 | 217.547 | 44.75 | 54.17 | 307 |
| 310.000 | 0.15939 | 6.274 | 0.013646 | 24.400 | 29985.0 | 32494.6 | 219.341 | 45.93 | 55.24 | 312 |
| 320.000 | 0.15400 | 6.494 | 0.013156 | 25.328 | 30454.9 | 33052.4 | 221.112 | 47.13 | 56.35 | 317 |
| 330.000 | 0.14898 | 6.712 | 0.012703 | 26.247 | 30936.6 | 33621.5 | 222.863 | 48.36 | 57.50 | 322 |
| 340.000 | 0.14430 | 6.930 | 0.012284 | 27.159 | 31430.3 | 34202.3 | 224.597 | 49.61 | 58.68 | 327 |
| 350.000 | 0.13993 | 7.147 | 0.011894 | 28.064 | 31936.3 | 34794.9 | 226.316 | 50.87 | 59.88 | 331 |
| 360.000 | 0.13582 | 7.363 | 0.011530 | 28.964 | 32454.6 | 35399.7 | 228.020 | 52.15 | 61.10 | 336 |
| 370.000 | 0.13196 | 7.578 | 0.011189 | 29.859 | 32985.5 | 36016.8 | 229.711 | 53.43 | 62.34 | 340 |
| 380.000 | 0.12832 | 7.793 | 0.010869 | 30.749 | 33529.0 | 36646.3 | 231.390 | 54.71 | 63.58 | 345 |
| 390.000 | 0.12488 | 8.008 | 0.010568 | 31.635 | 34085.1 | 37288.2 | 233.057 | 56.00 | 64.83 | 349 |
| 400.000 | 0.12163 | 8.222 | 0.010284 | 32.517 | 34654.0 | 37942.7 | 234.714 | 57.29 | 66.08 | 353 |
| 410.000 | 0.11855 | 8.435 | 0.010016 | 33.396 | 35235.6 | 38609.7 | 236.362 | 58.57 | 67.34 | 357 |
| 420.000 | 0.11563 | 8.648 | 0.009762 | 34.272 | 35829.8 | 39289.2 | 237.999 | 59.85 | 68.59 | 361 |
| 430.000 | 0.11285 | 8.861 | 0.009522 | 35.146 | 36436.7 | 39981.2 | 239.628 | 61.12 | 69.83 | 365 |
| 440.000 | 0.11021 | 9.074 | 0.009293 | 36.016 | 37056.1 | 40685.7 | 241.247 | 62.39 | 71.07 | 369 |
| 450.000 | 0.10769 | 9.286 | 0.009076 | 36.885 | 37688.0 | 41402.5 | 242.858 | 63.64 | 72.31 | 373 |
| 460.000 | 0.10528 | 9.498 | 0.008868 | 37.752 | 38332.4 | 42131.7 | 244.461 | 64.89 | 73.53 | 377 |
| 470.000 | 0.10299 | 9.710 | 0.008671 | 38.616 | 38989.0 | 42873.0 | 246.056 | 66.12 | 74.75 | 381 |
| 480.000 | 0.10079 | 9.922 | 0.008482 | 39.479 | 39657.8 | 43626.5 | 247.642 | 67.34 | 75.95 | 385 |
| 490.000 | 0.09869 | 10.133 | 0.008302 | 40.340 | 40338.7 | 44392.0 | 249.220 | 68.55 | 77.15 | 389 |
| 500.000 | 0.09667 | 10.344 | 0.008129 | 41.200 | 41031.5 | 45169.3 | 250.791 | 69.75 | 78.33 | 392 |
| 520.000 | 0.09288 | 10.766 | 0.007805 | 42.915 | 42452.5 | 46759.0 | 253.908 | 72.10 | 80.65 | 400 |
| 540.000 | 0.08938 | 11.188 | 0.007507 | 44.626 | 43919.8 | 48394.8 | 256.995 | 74.39 | 82.92 | 407 |
| 560.000 | 0.08614 | 11.608 | 0.007231 | 46.332 | 45432.1 | 50075.5 | 260.051 | 76.63 | 85.15 | 414 |
| 580.000 | 0.08313 | 12.029 | 0.006975 | 48.035 | 46988.6 | 51800.1 | 263.077 | 78.82 | 87.31 | 421 |
| 600.000 | 0.08033 | 12.449 | 0.006736 | 49.734 | 48588.1 | 53567.6 | 266.073 | 80.95 | 89.43 | 427 |

Table 27. Thermophysical properties along isobars (Continued)

ETHANE ISOBAR AT P = 5.0 BAR

| T DEG K | DEN MOL/L | VOL L/MOL | DP/DT BAR/K | DP/DD BAR-L/MOL | E J/MOL | H J/MOL | S J/MOL/K | CV J/MOL/K | CP J/MOL/K | W M/SEC |
|---|---|---|---|---|---|---|---|---|---|---|
| 89.977 | 21.682 | 0.04612 | 35.0398 | 963.254 | 5300.5 | 5323.5 | 76.517 | 44.10 | 68.49 | 2231 |
| 90.000 | 21.682 | 0.04612 | 35.0298 | 963.011 | 5302.0 | 5325.1 | 76.535 | 44.10 | 68.49 | 2230 |
| 100.000 | 21.320 | 0.04690 | 31.0851 | 862.900 | 5987.2 | 6010.6 | 83.757 | 43.99 | 68.62 | 2116 |
| 110.000 | 20.960 | 0.04771 | 27.7980 | 773.096 | 6673.9 | 6697.8 | 90.306 | 43.79 | 68.82 | 2010 |
| 120.000 | 20.600 | 0.04854 | 24.9989 | 692.040 | 7362.9 | 7387.2 | 96.305 | 43.55 | 69.08 | 1911 |
| 130.000 | 20.237 | 0.04941 | 22.5719 | 618.553 | 8055.0 | 8079.7 | 101.848 | 43.29 | 69.44 | 1816 |
| 140.000 | 19.869 | 0.05033 | 20.4360 | 551.727 | 8751.1 | 8776.3 | 107.009 | 43.05 | 69.89 | 1726 |
| 150.000 | 19.496 | 0.05129 | 18.5325 | 490.802 | 9452.3 | 9478.0 | 111.850 | 42.85 | 70.46 | 1638 |
| 160.000 | 19.114 | 0.05232 | 16.8181 | 435.131 | 10159.9 | 10186.0 | 116.419 | 42.70 | 71.17 | 1553 |
| 170.000 | 18.722 | 0.05341 | 15.2600 | 384.148 | 10875.1 | 10901.8 | 120.759 | 42.62 | 72.02 | 1469 |
| 180.000 | 18.319 | 0.05459 | 13.8331 | 337.348 | 11599.7 | 11627.0 | 124.903 | 42.62 | 73.05 | 1387 |
| 190.000 | 17.901 | 0.05586 | 12.5174 | 294.277 | 12335.6 | 12363.5 | 128.885 | 42.72 | 74.29 | 1305 |
| 200.000 | 17.467 | 0.05725 | 11.2965 | 254.520 | 13084.9 | 13113.6 | 132.732 | 42.90 | 75.77 | 1223 |
| 210.000 | 17.012 | 0.05878 | 10.1567 | 217.708 | 13850.6 | 13880.0 | 136.471 | 43.18 | 77.57 | 1140 |
| 220.000 | 16.532 | 0.06049 | 9.0856 | 183.495 | 14636.0 | 14666.3 | 140.128 | 43.56 | 79.77 | 1057 |
| 220.435 | 16.510 | 0.06057 | 9.0404 | 182.062 | 14670.7 | 14701.0 | 140.286 | 43.58 | 79.88 | 1053 |
| 220.435 | 0.30448 | 3.284 | 0.028265 | 14.458 | 26127.3 | 27769.5 | 199.623 | 37.91 | 51.05 | 254 |
| 230.000 | 0.28719 | 3.482 | 0.026199 | 15.649 | 26513.7 | 28254.7 | 201.780 | 38.33 | 50.57 | 262 |
| 240.000 | 0.27161 | 3.682 | 0.024444 | 16.821 | 26918.6 | 28759.5 | 203.930 | 38.98 | 50.54 | 269 |
| 250.000 | 0.25797 | 3.876 | 0.022977 | 17.939 | 27327.6 | 29265.8 | 205.998 | 39.76 | 50.82 | 276 |
| 260.000 | 0.24588 | 4.067 | 0.021721 | 19.017 | 27742.5 | 29776.1 | 208.000 | 40.65 | 51.32 | 283 |
| 270.000 | 0.23504 | 4.255 | 0.020627 | 20.062 | 28164.9 | 30292.2 | 209.949 | 41.61 | 51.98 | 289 |
| 280.000 | 0.22525 | 4.439 | 0.019661 | 21.082 | 28595.8 | 30815.6 | 211.853 | 42.64 | 52.76 | 295 |
| 290.000 | 0.21634 | 4.622 | 0.018797 | 22.080 | 29036.2 | 31347.3 | 213.719 | 43.73 | 53.64 | 300 |
| 300.000 | 0.20819 | 4.803 | 0.018020 | 23.061 | 29486.6 | 31888.3 | 215.554 | 44.85 | 54.60 | 306 |
| 310.000 | 0.20068 | 4.983 | 0.017314 | 24.027 | 29947.7 | 32439.1 | 217.361 | 46.02 | 55.62 | 311 |
| 320.000 | 0.19375 | 5.161 | 0.016669 | 24.980 | 30420.8 | 33001.4 | 219.143 | 47.21 | 56.69 | 316 |
| 330.000 | 0.18732 | 5.338 | 0.016076 | 25.923 | 30904.5 | 33573.7 | 220.905 | 48.43 | 57.81 | 321 |
| 340.000 | 0.18133 | 5.515 | 0.015529 | 26.856 | 31400.0 | 34157.3 | 222.647 | 49.67 | 58.96 | 326 |
| 350.000 | 0.17574 | 5.690 | 0.015022 | 27.781 | 31907.5 | 34752.6 | 224.373 | 50.93 | 60.13 | 330 |
| 360.000 | 0.17050 | 5.865 | 0.014551 | 28.698 | 32427.3 | 35359.8 | 226.084 | 52.20 | 61.33 | 335 |
| 370.000 | 0.16559 | 6.039 | 0.014110 | 29.609 | 32959.4 | 35979.0 | 227.781 | 53.47 | 62.55 | 339 |
| 380.000 | 0.16096 | 6.213 | 0.013698 | 30.515 | 33504.1 | 36610.4 | 229.465 | 54.75 | 63.77 | 344 |
| 390.000 | 0.15660 | 6.386 | 0.013311 | 31.415 | 34061.4 | 37254.2 | 231.138 | 56.04 | 65.01 | 348 |
| 400.000 | 0.15248 | 6.558 | 0.012947 | 32.311 | 34631.2 | 37910.3 | 232.799 | 57.32 | 66.25 | 352 |
| 410.000 | 0.14858 | 6.730 | 0.012603 | 33.202 | 35213.7 | 38578.9 | 234.450 | 58.60 | 67.49 | 357 |
| 420.000 | 0.14488 | 6.902 | 0.012279 | 34.090 | 35808.8 | 39259.8 | 236.091 | 59.88 | 68.73 | 361 |
| 430.000 | 0.14137 | 7.074 | 0.011972 | 34.974 | 36416.4 | 39953.2 | 237.723 | 61.15 | 69.97 | 365 |
| 440.000 | 0.13803 | 7.245 | 0.011680 | 35.855 | 37036.6 | 40658.9 | 239.346 | 62.41 | 71.20 | 369 |
| 450.000 | 0.13485 | 7.415 | 0.011403 | 36.734 | 37669.2 | 41376.9 | 240.959 | 63.66 | 72.42 | 373 |
| 460.000 | 0.13182 | 7.586 | 0.011140 | 37.610 | 38314.2 | 42107.2 | 242.565 | 64.91 | 73.64 | 377 |
| 470.000 | 0.12893 | 7.756 | 0.010889 | 38.483 | 38971.4 | 42849.6 | 244.161 | 66.14 | 74.85 | 381 |
| 480.000 | 0.12616 | 7.926 | 0.010649 | 39.354 | 39640.7 | 43604.0 | 245.750 | 67.36 | 76.05 | 384 |
| 490.000 | 0.12351 | 8.096 | 0.010420 | 40.223 | 40322.2 | 44370.4 | 247.330 | 68.57 | 77.24 | 388 |
| 500.000 | 0.12098 | 8.266 | 0.010202 | 41.090 | 41015.5 | 45148.5 | 248.902 | 69.76 | 78.41 | 392 |
| 520.000 | 0.11621 | 8.605 | 0.009791 | 42.820 | 42437.4 | 46739.9 | 252.023 | 72.11 | 80.73 | 399 |
| 540.000 | 0.11181 | 8.943 | 0.009414 | 44.543 | 43905.4 | 48377.1 | 255.112 | 74.40 | 82.99 | 406 |
| 560.000 | 0.10774 | 9.281 | 0.009065 | 46.261 | 45418.5 | 50059.1 | 258.171 | 76.64 | 85.21 | 414 |
| 580.000 | 0.10396 | 9.619 | 0.008742 | 47.974 | 46975.5 | 51784.9 | 261.199 | 78.82 | 87.37 | 421 |
| 600.000 | 0.10045 | 9.956 | 0.008441 | 49.683 | 48575.6 | 53553.5 | 264.197 | 80.96 | 89.49 | 427 |

Table 27. Thermophysical properties along isobars (Continued)

ETHANE ISOBAR AT P = 6.0 BAR

| T | DEN | VOL | DP/DT | DP/DD | E | H | S | CV | CP | W |
|---|---|---|---|---|---|---|---|---|---|---|
| DEG K | MOL/L | L/MOL | BAR/K | BAR-L/MOL | J/MOL | J/MOL | J/MCL/K | J/MOL/K | J/MOL/K | M/SEC |
| 89.993 | 21.683 | 0.04612 | 35.0336 | 963.407 | 5300.8 | 5328.5 | 76.522 | 44.11 | 68.49 | 2231 |
| 90.000 | 21.683 | 0.04612 | 35.0304 | 963.330 | 5301.3 | 5329.0 | 76.527 | 44.11 | 68.49 | 2230 |
| 100.000 | 21.321 | 0.04690 | 31.0865 | 863.244 | 5986.4 | 6014.5 | 83.749 | 44.00 | 68.62 | 2116 |
| 110.000 | 20.961 | 0.04771 | 27.8002 | 773.462 | 6673.0 | 6701.7 | 90.298 | 43.80 | 68.81 | 2010 |
| 120.000 | 20.601 | 0.04854 | 25.0017 | 692.425 | 7361.9 | 7391.0 | 96.296 | 43.55 | 69.08 | 1911 |
| 130.000 | 20.239 | 0.04941 | 22.5753 | 618.956 | 8053.9 | 8083.5 | 101.839 | 43.30 | 69.43 | 1817 |
| 140.000 | 19.871 | 0.05032 | 20.4399 | 552.146 | 8749.8 | 8780.0 | 107.000 | 43.06 | 69.89 | 1726 |
| 150.000 | 19.498 | 0.05129 | 18.5370 | 491.235 | 9450.8 | 9481.6 | 111.840 | 42.85 | 70.46 | 1639 |
| 160.000 | 19.116 | 0.05231 | 16.8231 | 435.578 | 10158.2 | 10189.5 | 116.409 | 42.71 | 71.16 | 1554 |
| 170.000 | 18.725 | 0.05341 | 15.2656 | 384.609 | 10873.2 | 10905.2 | 120.747 | 42.63 | 72.01 | 1470 |
| 180.000 | 18.321 | 0.05458 | 13.8393 | 337.823 | 11597.5 | 11630.3 | 124.891 | 42.63 | 73.03 | 1387 |
| 190.000 | 17.904 | 0.05585 | 12.5242 | 294.768 | 12333.1 | 12366.6 | 128.872 | 42.72 | 74.26 | 1305 |
| 200.000 | 17.471 | 0.05724 | 11.3040 | 255.029 | 13082.0 | 13116.4 | 132.718 | 42.91 | 75.74 | 1224 |
| 210.000 | 17.017 | 0.05877 | 10.1650 | 218.235 | 13847.2 | 13882.5 | 136.455 | 43.19 | 77.53 | 1141 |
| 220.000 | 16.537 | 0.06047 | 9.0949 | 184.045 | 14632.1 | 14668.3 | 140.110 | 43.57 | 79.72 | 1058 |
| 225.509 | 16.260 | 0.06150 | 8.5305 | 166.208 | 15074.5 | 15111.4 | 142.099 | 43.82 | 81.16 | 1012 |
| | | | | | | | | | | |
| 225.509 | 0.36311 | 2.754 | 0.034221 | 14.259 | 26245.6 | 27898.0 | 198.848 | 38.68 | 52.73 | 254 |
| 230.000 | 0.35275 | 2.835 | 0.032915 | 14.859 | 26432.7 | 28133.6 | 199.883 | 38.83 | 52.30 | 258 |
| 240.000 | 0.33232 | 3.009 | 0.030467 | 16.125 | 26848.1 | 28653.6 | 202.098 | 39.34 | 51.85 | 266 |
| 250.000 | 0.31470 | 3.178 | 0.028472 | 17.316 | 27265.0 | 29171.5 | 204.213 | 40.05 | 51.86 | 273 |
| 260.000 | 0.29926 | 3.342 | 0.026796 | 18.454 | 27686.2 | 29691.2 | 206.253 | 40.87 | 52.17 | 280 |
| 270.000 | 0.28554 | 3.502 | 0.025356 | 19.549 | 28113.8 | 30215.1 | 208.231 | 41.80 | 52.69 | 286 |
| 280.000 | 0.27322 | 3.660 | 0.024099 | 20.611 | 28549.0 | 30745.0 | 210.159 | 42.80 | 53.37 | 292 |
| 290.000 | 0.26208 | 3.816 | 0.022986 | 21.647 | 28993.0 | 31282.3 | 212.045 | 43.86 | 54.16 | 298 |
| 300.000 | 0.25193 | 3.969 | 0.021992 | 22.660 | 29446.5 | 31828.1 | 213.896 | 44.96 | 55.05 | 304 |
| 310.000 | 0.24263 | 4.121 | 0.021095 | 23.655 | 29910.3 | 32383.2 | 215.717 | 46.11 | 56.02 | 309 |
| 320.000 | 0.23406 | 4.272 | 0.020280 | 24.634 | 30384.9 | 32948.3 | 217.511 | 47.29 | 57.05 | 314 |
| 330.000 | 0.22614 | 4.422 | 0.019535 | 25.600 | 30870.7 | 33523.9 | 219.283 | 48.50 | 58.12 | 319 |
| 340.000 | 0.21878 | 4.571 | 0.018850 | 26.554 | 31368.0 | 34110.5 | 221.035 | 49.74 | 59.24 | 324 |
| 350.000 | 0.21192 | 4.719 | 0.018218 | 27.498 | 31877.3 | 34708.5 | 222.769 | 50.98 | 60.39 | 329 |
| 360.000 | 0.20551 | 4.866 | 0.017631 | 28.433 | 32398.6 | 35318.1 | 224.486 | 52.25 | 61.56 | 334 |
| 370.000 | 0.19950 | 5.012 | 0.017085 | 29.360 | 32933.1 | 35940.5 | 226.189 | 53.52 | 62.76 | 338 |
| 380.000 | 0.19386 | 5.158 | 0.016575 | 30.281 | 33479.0 | 36574.0 | 227.879 | 54.79 | 63.97 | 343 |
| 390.000 | 0.18855 | 5.304 | 0.016098 | 31.195 | 34037.3 | 37219.6 | 229.556 | 56.07 | 65.19 | 347 |
| 400.000 | 0.18353 | 5.449 | 0.015649 | 32.104 | 34608.2 | 37877.4 | 231.222 | 57.35 | 66.41 | 352 |
| 410.000 | 0.17879 | 5.593 | 0.015227 | 33.007 | 35191.7 | 38547.6 | 232.877 | 58.63 | 67.64 | 356 |
| 420.000 | 0.17430 | 5.737 | 0.014828 | 33.907 | 35787.6 | 39230.0 | 234.522 | 59.91 | 68.87 | 360 |
| 430.000 | 0.17004 | 5.881 | 0.014451 | 34.802 | 36396.1 | 39924.7 | 236.157 | 61.17 | 70.10 | 364 |
| 440.000 | 0.16599 | 6.025 | 0.014095 | 35.693 | 37017.0 | 40631.7 | 237.783 | 62.43 | 71.32 | 368 |
| 450.000 | 0.16213 | 6.168 | 0.013756 | 36.581 | 37650.3 | 41351.0 | 239.399 | 63.69 | 72.54 | 372 |
| 460.000 | 0.15846 | 6.311 | 0.013434 | 37.466 | 38295.9 | 42082.3 | 241.007 | 64.93 | 73.75 | 376 |
| 470.000 | 0.15496 | 6.453 | 0.013128 | 38.348 | 38953.7 | 42825.8 | 242.606 | 66.16 | 74.95 | 380 |
| 480.000 | 0.15161 | 6.596 | 0.012836 | 39.227 | 39623.7 | 43581.2 | 244.196 | 67.38 | 76.15 | 384 |
| 490.000 | 0.14841 | 6.738 | 0.012557 | 40.104 | 40305.6 | 44348.5 | 245.779 | 68.58 | 77.33 | 388 |
| 500.000 | 0.14535 | 6.880 | 0.012291 | 40.978 | 40999.4 | 45127.5 | 247.353 | 69.78 | 78.50 | 392 |
| 520.000 | 0.13959 | 7.164 | 0.011792 | 42.721 | 42422.2 | 46720.5 | 250.477 | 72.12 | 80.81 | 399 |
| 540.000 | 0.13429 | 7.447 | 0.011333 | 44.457 | 43891.1 | 48359.2 | 253.569 | 74.41 | 83.07 | 406 |
| 560.000 | 0.12938 | 7.729 | 0.010910 | 46.186 | 45404.9 | 50042.5 | 256.630 | 76.65 | 85.27 | 413 |
| 580.000 | 0.12482 | 8.011 | 0.010519 | 47.910 | 46962.6 | 51769.4 | 259.660 | 78.83 | 87.43 | 420 |
| 600.000 | 0.12058 | 8.293 | 0.010155 | 49.629 | 48563.3 | 53539.1 | 262.659 | 80.97 | 89.54 | 427 |

Table 27. Thermophysical properties along isobars (Continued)

ETHANE ISOBAR AT P = 7.0 BAR

| T DEG K | DEN MOL/L | VOL L/MOL | DF/DT BAR/K | DF/DD BAR-L/MOL | E J/MOL | H J/MOL | S J/MOL/K | CV J/MOL/K | CP J/MOL/K | W M/SEC |
|---|---|---|---|---|---|---|---|---|---|---|
| 90.008 | 21.683 | 0.04612 | 35.0274 | 963.561 | 5301.2 | 5333.5 | 76.526 | 44.12 | 68.49 | 2230 |
| 100.000 | 21.322 | 0.04690 | 31.0879 | 863.588 | 5985.6 | 6018.4 | 83.742 | 44.00 | 68.62 | 2116 |
| 110.000 | 20.963 | 0.04770 | 27.8023 | 773.829 | 6672.1 | 6705.5 | 90.290 | 43.81 | 68.81 | 2011 |
| 120.000 | 20.603 | 0.04854 | 25.0045 | 692.811 | 7360.9 | 7394.9 | 96.288 | 43.56 | 69.07 | 1911 |
| 130.000 | 20.240 | 0.04941 | 22.5787 | 619.358 | 8052.7 | 8087.3 | 101.830 | 43.31 | 69.43 | 1817 |
| 140.000 | 19.873 | 0.05032 | 20.4439 | 552.564 | 8748.5 | 8783.7 | 106.991 | 43.07 | 69.88 | 1727 |
| 150.000 | 19.500 | 0.05128 | 18.5415 | 491.668 | 9449.4 | 9485.3 | 111.830 | 42.86 | 70.45 | 1639 |
| 160.000 | 19.118 | 0.05231 | 16.8281 | 436.025 | 10156.5 | 10193.1 | 116.398 | 42.71 | 71.15 | 1554 |
| 170.000 | 18.727 | 0.05340 | 15.2712 | 385.070 | 10871.3 | 10908.7 | 120.736 | 42.64 | 71.99 | 1470 |
| 180.000 | 18.324 | 0.05457 | 13.8455 | 338.299 | 11595.3 | 11633.5 | 124.879 | 42.64 | 73.02 | 1388 |
| 190.000 | 17.908 | 0.05584 | 12.5310 | 295.259 | 12330.6 | 12369.6 | 128.859 | 42.73 | 74.24 | 1306 |
| 200.000 | 17.475 | 0.05723 | 11.3115 | 255.536 | 13079.2 | 13119.2 | 132.703 | 42.92 | 75.71 | 1224 |
| 210.000 | 17.021 | 0.05875 | 10.1733 | 218.762 | 13843.8 | 13885.0 | 136.439 | 43.20 | 77.49 | 1142 |
| 220.000 | 16.543 | 0.06045 | 9.1041 | 184.595 | 14628.1 | 14670.4 | 140.092 | 43.58 | 79.68 | 1059 |
| 229.991 | 16.032 | 0.06237 | 8.0930 | 152.747 | 15435.9 | 15479.6 | 143.689 | 44.05 | 82.41 | 975 |
| | | | | | | | | | | |
| 229.991 | 0.42199 | 2.370 | 0.040343 | 14.038 | 26344.5 | 28003.3 | 198.189 | 39.39 | 54.36 | 254 |
| 230.000 | 0.42197 | 2.370 | 0.040340 | 14.039 | 26344.9 | 28003.8 | 198.191 | 39.39 | 54.36 | 254 |
| 240.000 | 0.39574 | 2.527 | 0.036995 | 15.411 | 26773.4 | 28542.2 | 200.481 | 39.75 | 53.36 | 262 |
| 250.000 | 0.37353 | 2.677 | 0.034347 | 16.684 | 27199.3 | 29073.4 | 202.650 | 40.35 | 53.02 | 270 |
| 260.000 | 0.35430 | 2.823 | 0.032167 | 17.886 | 27627.6 | 29603.4 | 204.731 | 41.12 | 53.10 | 277 |
| 270.000 | 0.33738 | 2.964 | 0.030323 | 19.034 | 28060.8 | 30135.7 | 206.741 | 42.00 | 53.46 | 284 |
| 280.000 | 0.32230 | 3.103 | 0.028733 | 20.141 | 28500.7 | 30672.6 | 208.694 | 42.96 | 54.01 | 290 |
| 290.000 | 0.30875 | 3.239 | 0.027339 | 21.214 | 28948.6 | 31215.8 | 210.601 | 43.99 | 54.71 | 296 |
| 300.000 | 0.29646 | 3.373 | 0.026102 | 22.261 | 29405.4 | 31766.7 | 212.469 | 45.08 | 55.53 | 302 |
| 310.000 | 0.28524 | 3.506 | 0.024994 | 23.285 | 29872.1 | 32326.2 | 214.305 | 46.21 | 56.43 | 308 |
| 320.000 | 0.27494 | 3.637 | 0.023994 | 24.290 | 30349.2 | 32895.1 | 216.112 | 47.38 | 57.41 | 313 |
| 330.000 | 0.26545 | 3.767 | 0.023083 | 25.279 | 30837.2 | 33474.2 | 217.894 | 48.58 | 58.45 | 318 |
| 340.000 | 0.25665 | 3.896 | 0.022249 | 26.254 | 31336.5 | 34063.9 | 219.655 | 49.80 | 59.53 | 323 |
| 350.000 | 0.24847 | 4.025 | 0.021482 | 27.218 | 31847.4 | 34664.6 | 221.397 | 51.04 | 60.65 | 328 |
| 360.000 | 0.24085 | 4.152 | 0.020773 | 28.170 | 32370.3 | 35276.7 | 223.122 | 52.30 | 61.80 | 333 |
| 370.000 | 0.23371 | 4.279 | 0.020115 | 29.114 | 32905.3 | 35900.5 | 224.831 | 53.56 | 62.98 | 337 |
| 380.000 | 0.22701 | 4.405 | 0.019501 | 30.049 | 33452.5 | 36536.0 | 226.526 | 54.83 | 64.17 | 342 |
| 390.000 | 0.22072 | 4.531 | 0.018928 | 30.977 | 34012.0 | 37183.5 | 228.209 | 56.11 | 65.37 | 346 |
| 400.000 | 0.21478 | 4.656 | 0.018391 | 31.899 | 34584.0 | 37843.1 | 229.879 | 57.39 | 66.58 | 351 |
| 410.000 | 0.20917 | 4.781 | 0.017886 | 32.814 | 35168.4 | 38514.9 | 231.538 | 58.66 | 67.80 | 355 |
| 420.000 | 0.20387 | 4.905 | 0.017410 | 33.725 | 35765.3 | 39198.9 | 233.186 | 59.93 | 69.02 | 359 |
| 430.000 | 0.19884 | 5.029 | 0.016961 | 34.630 | 36375.5 | 39895.9 | 234.825 | 61.20 | 70.23 | 364 |
| 440.000 | 0.19407 | 5.153 | 0.016537 | 35.532 | 36997.2 | 40604.2 | 236.453 | 62.46 | 71.45 | 368 |
| 450.000 | 0.18953 | 5.276 | 0.016134 | 36.429 | 37631.2 | 41324.7 | 238.072 | 63.71 | 72.66 | 372 |
| 460.000 | 0.18520 | 5.399 | 0.015752 | 37.322 | 38277.5 | 42057.2 | 239.683 | 64.95 | 73.86 | 376 |
| 470.000 | 0.18108 | 5.522 | 0.015388 | 38.213 | 38936.0 | 42801.7 | 241.284 | 66.18 | 75.06 | 380 |
| 480.000 | 0.17714 | 5.645 | 0.015042 | 39.100 | 39606.5 | 43558.1 | 242.877 | 67.39 | 76.25 | 384 |
| 490.000 | 0.17338 | 5.768 | 0.014712 | 39.984 | 40289.0 | 44326.3 | 244.461 | 68.60 | 77.42 | 387 |
| 500.000 | 0.16978 | 5.890 | 0.014397 | 40.866 | 40983.3 | 45106.3 | 246.037 | 69.79 | 78.59 | 391 |
| 520.000 | 0.16303 | 6.134 | 0.013807 | 42.622 | 42407.1 | 46700.9 | 249.164 | 72.13 | 80.89 | 399 |
| 540.000 | 0.15680 | 6.377 | 0.013266 | 44.370 | 43876.8 | 48341.0 | 252.259 | 74.42 | 83.14 | 406 |
| 560.000 | 0.15105 | 6.620 | 0.012767 | 46.110 | 45391.4 | 50025.7 | 255.322 | 76.66 | 85.34 | 413 |
| 580.000 | 0.14571 | 6.863 | 0.012306 | 47.844 | 46949.8 | 51753.8 | 258.355 | 78.84 | 87.49 | 420 |
| 600.000 | 0.14075 | 7.105 | 0.011877 | 49.572 | 48551.1 | 53524.6 | 261.356 | 80.97 | 89.59 | 427 |

Table 27. Thermophysical properties along isobars (Continued)

ETHANE ISOBAR AT P = 8.0 BAR

| T DEG K | DEN MOL/L | VOL L/MOL | DF/DT BAR/K | DF/DD BAR-L/MOL | E J/MOL | H J/MOL | S J/MOL/K | CV J/MOL/K | CP J/MOL/K | W M/SEC |
|---|---|---|---|---|---|---|---|---|---|---|
| 90.024 | 21.684 | 0.04612 | 35.0213 | 963.714 | 5301.6 | 5338.5 | 76.530 | 44.12 | 68.49 | 2230 |
| 100.000 | 21.323 | 0.04690 | 31.0894 | 863.933 | 5984.8 | 6022.3 | 83.734 | 44.01 | 68.62 | 2116 |
| 110.000 | 20.964 | 0.04770 | 27.8045 | 774.195 | 6671.2 | 6709.4 | 90.282 | 43.81 | 68.81 | 2011 |
| 120.000 | 20.604 | 0.04853 | 25.0072 | 693.196 | 7359.9 | 7398.7 | 96.279 | 43.57 | 69.07 | 1912 |
| 130.000 | 20.242 | 0.04940 | 22.5820 | 619.761 | 8051.6 | 8091.1 | 101.821 | 43.31 | 69.42 | 1818 |
| 140.000 | 19.875 | 0.05031 | 20.4478 | 552.982 | 8747.2 | 8787.5 | 106.981 | 43.07 | 69.87 | 1727 |
| 150.000 | 19.502 | 0.05128 | 18.5459 | 492.101 | 9447.9 | 9488.9 | 111.820 | 42.87 | 70.44 | 1640 |
| 160.000 | 19.121 | 0.05230 | 16.8332 | 436.472 | 10154.8 | 10196.6 | 116.388 | 42.72 | 71.13 | 1555 |
| 170.000 | 18.730 | 0.05339 | 15.2768 | 385.530 | 10869.4 | 10912.1 | 120.725 | 42.64 | 71.98 | 1471 |
| 180.000 | 18.327 | 0.05456 | 13.8517 | 338.774 | 11593.2 | 11636.8 | 124.867 | 42.65 | 73.00 | 1389 |
| 190.000 | 17.911 | 0.05583 | 12.5379 | 295.749 | 12328.1 | 12372.7 | 128.845 | 42.74 | 74.22 | 1307 |
| 200.000 | 17.478 | 0.05721 | 11.3191 | 256.044 | 13076.3 | 13122.0 | 132.689 | 42.93 | 75.69 | 1225 |
| 210.000 | 17.026 | 0.05873 | 10.1816 | 219.289 | 13840.5 | 13887.5 | 136.423 | 43.21 | 77.46 | 1143 |
| 220.000 | 16.548 | 0.06043 | 9.1133 | 185.144 | 14624.2 | 14672.5 | 140.074 | 43.59 | 79.63 | 1061 |
| 230.000 | 16.038 | 0.06235 | 8.1024 | 153.295 | 15431.9 | 15481.8 | 143.671 | 44.05 | 82.35 | 976 |
| 234.025 | 15.822 | 0.06320 | 7.7090 | 141.058 | 15765.3 | 15815.8 | 145.111 | 44.27 | 83.65 | 942 |
| | | | | | | | | | | |
| 234.025 | 0.48124 | 2.078 | 0.046641 | 13.802 | 26430.4 | 28092.7 | 197.615 | 40.05 | 55.98 | 253 |
| 240.000 | 0.46221 | 2.163 | 0.044105 | 14.676 | 26693.3 | 28424.1 | 199.014 | 40.20 | 55.09 | 259 |
| 250.000 | 0.43465 | 2.301 | 0.040647 | 16.040 | 27129.6 | 28970.2 | 201.245 | 40.69 | 54.32 | 267 |
| 260.000 | 0.41112 | 2.432 | 0.037864 | 17.311 | 27565.7 | 29511.6 | 203.370 | 41.38 | 54.12 | 274 |
| 270.000 | 0.39064 | 2.560 | 0.035548 | 18.516 | 28006.1 | 30054.0 | 205.415 | 42.20 | 54.28 | 281 |
| 280.000 | 0.37254 | 2.684 | 0.033575 | 19.670 | 28451.0 | 30598.4 | 207.396 | 43.13 | 54.69 | 288 |
| 290.000 | 0.35637 | 2.806 | 0.031863 | 20.783 | 28903.0 | 31147.9 | 209.325 | 44.13 | 55.29 | 294 |
| 300.000 | 0.34179 | 2.926 | 0.030357 | 21.864 | 29363.4 | 31704.1 | 211.211 | 45.20 | 56.02 | 300 |
| 310.000 | 0.32853 | 3.044 | 0.029016 | 22.918 | 29833.1 | 32268.2 | 213.062 | 46.31 | 56.87 | 306 |
| 320.000 | 0.31641 | 3.161 | 0.027812 | 23.950 | 30312.8 | 32841.2 | 214.882 | 47.47 | 57.79 | 311 |
| 330.000 | 0.30526 | 3.276 | 0.026722 | 24.962 | 30803.1 | 33423.8 | 216.675 | 48.66 | 58.79 | 317 |
| 340.000 | 0.29496 | 3.390 | 0.025728 | 25.959 | 31304.4 | 34016.7 | 218.446 | 49.87 | 59.83 | 322 |
| 350.000 | 0.28540 | 3.504 | 0.024817 | 26.941 | 31817.2 | 34620.2 | 220.196 | 51.10 | 60.92 | 327 |
| 360.000 | 0.27651 | 3.617 | 0.023977 | 27.911 | 32341.7 | 35234.9 | 221.928 | 52.35 | 62.05 | 332 |
| 370.000 | 0.26820 | 3.729 | 0.023199 | 28.871 | 32878.1 | 35860.9 | 223.643 | 53.61 | 63.20 | 336 |
| 380.000 | 0.26042 | 3.840 | 0.022477 | 29.821 | 33426.6 | 36498.6 | 225.344 | 54.88 | 64.37 | 341 |
| 390.000 | 0.25311 | 3.951 | 0.021803 | 30.763 | 33987.3 | 37148.0 | 227.032 | 56.15 | 65.56 | 346 |
| 400.000 | 0.24623 | 4.061 | 0.021173 | 31.697 | 34560.4 | 37809.4 | 228.706 | 57.42 | 66.75 | 350 |
| 410.000 | 0.23974 | 4.171 | 0.020582 | 32.624 | 35145.8 | 38482.8 | 230.369 | 58.69 | 67.96 | 354 |
| 420.000 | 0.23360 | 4.281 | 0.020026 | 33.546 | 35743.6 | 39168.3 | 232.022 | 59.96 | 69.16 | 359 |
| 430.000 | 0.22779 | 4.390 | 0.019502 | 34.461 | 36353.8 | 39865.8 | 233.663 | 61.23 | 70.37 | 363 |
| 440.000 | 0.22227 | 4.499 | 0.019006 | 35.372 | 36976.3 | 40575.4 | 235.295 | 62.48 | 71.58 | 367 |
| 450.000 | 0.21703 | 4.608 | 0.018538 | 36.279 | 37611.0 | 41297.1 | 236.917 | 63.73 | 72.78 | 371 |
| 460.000 | 0.21205 | 4.716 | 0.018093 | 37.181 | 38258.0 | 42030.8 | 238.529 | 64.97 | 73.98 | 375 |
| 470.000 | 0.20730 | 4.824 | 0.017671 | 38.079 | 38917.1 | 42776.3 | 240.133 | 66.20 | 75.16 | 379 |
| 480.000 | 0.20276 | 4.932 | 0.017269 | 38.974 | 39588.3 | 43533.8 | 241.728 | 67.41 | 76.34 | 383 |
| 490.000 | 0.19843 | 5.040 | 0.016886 | 39.866 | 40272.3 | 44303.9 | 243.314 | 68.61 | 77.52 | 387 |
| 500.000 | 0.19429 | 5.147 | 0.016521 | 40.754 | 40967.2 | 45084.8 | 244.892 | 69.81 | 78.68 | 391 |
| 520.000 | 0.18651 | 5.362 | 0.015838 | 42.523 | 42391.9 | 46681.1 | 248.023 | 72.15 | 80.97 | 398 |
| 540.000 | 0.17936 | 5.575 | 0.015212 | 44.283 | 43862.4 | 48322.7 | 251.120 | 74.44 | 83.21 | 406 |
| 560.000 | 0.17275 | 5.789 | 0.014635 | 46.034 | 45377.8 | 50008.7 | 254.186 | 76.67 | 85.40 | 413 |
| 580.000 | 0.16663 | 6.001 | 0.014103 | 47.778 | 46936.9 | 51738.1 | 257.221 | 78.85 | 87.55 | 420 |
| 600.000 | 0.16093 | 6.214 | 0.013609 | 49.516 | 48538.8 | 53510.0 | 260.224 | 80.98 | 89.65 | 427 |

Table 27. Thermophysical properties along isobars (Continued)

ETHANE ISOBAR AT P = 9.0 BAR

| T | DEN | VOL | DP/DT | DP/DD | E | H | S | CV | CP | W |
|---|---|---|---|---|---|---|---|---|---|---|
| DEG K | MOL/L | L/MOL | BAR/K | BAR-L/MOL | J/MOL | J/MOL | J/MOL/K | J/MOL/K | J/MOL/K | M/SEC |
| 90.039 | 21.684 | 0.04612 | 35.0151 | 963.868 | 5302.0 | 5343.5 | 76.534 | 44.13 | 68.49 | 2230 |
| 100.000 | 21.324 | 0.04689 | 31.0908 | 864.277 | 5984.0 | 6026.2 | 83.726 | 44.02 | 68.62 | 2117 |
| 110.000 | 20.965 | 0.04770 | 27.8066 | 774.561 | 6670.3 | 6713.3 | 90.274 | 43.82 | 68.80 | 2011 |
| 120.000 | 20.606 | 0.04853 | 25.0100 | 693.581 | 7358.9 | 7402.5 | 96.271 | 43.58 | 69.07 | 1912 |
| 130.000 | 20.243 | 0.04940 | 22.5854 | 620.163 | 8050.4 | 8094.9 | 101.812 | 43.32 | 69.41 | 1818 |
| 140.000 | 19.877 | 0.05031 | 20.4517 | 553.400 | 8745.9 | 8791.2 | 106.972 | 43.08 | 69.86 | 1728 |
| 150.000 | 19.504 | 0.05127 | 18.5504 | 492.533 | 9446.4 | 9492.5 | 111.810 | 42.88 | 70.43 | 1640 |
| 160.000 | 19.123 | 0.05229 | 16.8382 | 436.918 | 10153.1 | 10200.2 | 116.377 | 42.73 | 71.12 | 1555 |
| 170.000 | 18.732 | 0.05338 | 15.2824 | 385.991 | 10867.4 | 10915.5 | 120.713 | 42.65 | 71.97 | 1472 |
| 180.000 | 18.330 | 0.05455 | 13.8579 | 339.248 | 11591.0 | 11640.1 | 124.855 | 42.66 | 72.98 | 1389 |
| 190.000 | 17.915 | 0.05582 | 12.5447 | 296.239 | 12325.6 | 12375.8 | 128.832 | 42.75 | 74.20 | 1308 |
| 200.000 | 17.482 | 0.05720 | 11.3266 | 256.551 | 13073.4 | 13124.9 | 132.674 | 42.94 | 75.66 | 1226 |
| 210.000 | 17.030 | 0.05872 | 10.1899 | 219.815 | 13837.1 | 13890.0 | 136.407 | 43.22 | 77.42 | 1144 |
| 220.000 | 16.553 | 0.06041 | 9.1225 | 185.692 | 14620.2 | 14674.6 | 140.056 | 43.60 | 79.58 | 1062 |
| 230.000 | 16.045 | 0.06232 | 8.1127 | 153.870 | 15427.2 | 15483.3 | 143.651 | 44.06 | 82.28 | 977 |
| 237.704 | 15.625 | 0.06400 | 7.3664 | 130.737 | 16069.3 | 16126.9 | 146.403 | 44.48 | 84.89 | 911 |
| | | | | | | | | | | |
| 237.704 | 0.54095 | 1.849 | 0.053120 | 13.554 | 26505.1 | 28168.8 | 197.104 | 40.68 | 57.59 | 253 |
| 240.000 | 0.53218 | 1.879 | 0.051900 | 13.913 | 26609.2 | 28300.3 | 197.655 | 40.71 | 57.11 | 255 |
| 250.000 | 0.49831 | 2.007 | 0.047427 | 15.379 | 27057.4 | 28863.5 | 199.956 | 41.05 | 55.78 | 264 |
| 260.000 | 0.46988 | 2.128 | 0.043918 | 16.728 | 27502.3 | 29417.7 | 202.131 | 41.65 | 55.23 | 272 |
| 270.000 | 0.44542 | 2.245 | 0.041050 | 17.994 | 27948.5 | 29969.0 | 204.213 | 42.42 | 55.17 | 279 |
| 280.000 | 0.42400 | 2.358 | 0.038638 | 19.197 | 28398.8 | 30521.4 | 206.223 | 43.31 | 55.42 | 286 |
| 290.000 | 0.40499 | 2.469 | 0.036568 | 20.352 | 28855.3 | 31077.6 | 208.176 | 44.28 | 55.90 | 292 |
| 300.000 | 0.38794 | 2.578 | 0.034761 | 21.468 | 29320.5 | 31640.4 | 210.081 | 45.32 | 56.54 | 298 |
| 310.000 | 0.37251 | 2.684 | 0.033165 | 22.553 | 29793.3 | 32209.3 | 211.948 | 46.42 | 57.32 | 304 |
| 320.000 | 0.35846 | 2.790 | 0.031739 | 23.612 | 30275.7 | 32786.5 | 213.781 | 47.56 | 58.19 | 310 |
| 330.000 | 0.34557 | 2.894 | 0.030454 | 24.649 | 30768.4 | 33372.8 | 215.586 | 48.73 | 59.13 | 315 |
| 340.000 | 0.33370 | 2.997 | 0.029288 | 25.666 | 31271.9 | 33968.9 | 217.366 | 49.94 | 60.14 | 321 |
| 350.000 | 0.32271 | 3.099 | 0.028222 | 26.668 | 31786.5 | 34575.4 | 219.124 | 51.16 | 61.20 | 326 |
| 360.000 | 0.31250 | 3.200 | 0.027244 | 27.656 | 32312.6 | 35192.6 | 220.864 | 52.40 | 62.30 | 331 |
| 370.000 | 0.30298 | 3.301 | 0.026340 | 28.632 | 32850.6 | 35821.0 | 222.586 | 53.66 | 63.42 | 335 |
| 380.000 | 0.29408 | 3.400 | 0.025503 | 29.596 | 33400.4 | 36460.8 | 224.293 | 54.92 | 64.58 | 340 |
| 390.000 | 0.28573 | 3.500 | 0.024723 | 30.551 | 33962.4 | 37112.2 | 225.985 | 56.19 | 65.75 | 345 |
| 400.000 | 0.27788 | 3.599 | 0.023996 | 31.498 | 34536.6 | 37775.4 | 227.664 | 57.46 | 66.93 | 349 |
| 410.000 | 0.27048 | 3.697 | 0.023315 | 32.437 | 35123.0 | 38450.5 | 229.332 | 58.73 | 68.12 | 354 |
| 420.000 | 0.26349 | 3.795 | 0.022675 | 33.370 | 35721.8 | 39137.5 | 230.987 | 59.99 | 69.31 | 358 |
| 430.000 | 0.25688 | 3.893 | 0.022072 | 34.296 | 36332.8 | 39836.4 | 232.632 | 61.25 | 70.51 | 362 |
| 440.000 | 0.25061 | 3.990 | 0.021504 | 35.216 | 36956.1 | 40547.4 | 234.267 | 62.51 | 71.71 | 367 |
| 450.000 | 0.24466 | 4.087 | 0.020967 | 36.131 | 37591.6 | 41270.3 | 235.892 | 63.75 | 72.90 | 371 |
| 460.000 | 0.23899 | 4.184 | 0.020458 | 37.042 | 38239.3 | 42005.1 | 237.507 | 64.99 | 74.09 | 375 |
| 470.000 | 0.23360 | 4.281 | 0.019975 | 37.948 | 38899.1 | 42751.8 | 239.113 | 66.21 | 75.27 | 379 |
| 480.000 | 0.22846 | 4.377 | 0.019516 | 38.851 | 39570.8 | 43510.2 | 240.710 | 67.43 | 76.44 | 383 |
| 490.000 | 0.22355 | 4.473 | 0.019078 | 39.749 | 40254.4 | 44280.4 | 242.298 | 68.63 | 77.61 | 387 |
| 500.000 | 0.21886 | 4.569 | 0.018662 | 40.645 | 40949.9 | 45062.1 | 243.878 | 69.82 | 78.77 | 390 |
| 520.000 | 0.21006 | 4.761 | 0.017883 | 42.427 | 42375.6 | 46660.1 | 247.012 | 72.16 | 81.04 | 398 |
| 540.000 | 0.20197 | 4.951 | 0.017171 | 44.198 | 43847.0 | 48303.2 | 250.112 | 74.45 | 83.28 | 405 |
| 560.000 | 0.19449 | 5.142 | 0.016515 | 45.960 | 45364.1 | 49991.5 | 253.181 | 76.68 | 85.47 | 413 |
| 580.000 | 0.18757 | 5.331 | 0.015910 | 47.713 | 46923.9 | 51722.2 | 256.217 | 78.86 | 87.61 | 420 |
| 600.000 | 0.18114 | 5.521 | 0.015349 | 49.459 | 48526.5 | 53495.2 | 259.223 | 80.99 | 89.70 | 427 |

Table 27. Thermophysical properties along isobars (Continued)

ETHANE ISOBAR AT P = 10.0 BAR

| T | DEN | VOL | DP/DT | DP/DD | E | H | S | CV | CP | W |
|---|---|---|---|---|---|---|---|---|---|---|
| DEG K | MOL/L | L/MOL | BAR/K | BAR-L/MOL | J/MOL | J/MOL | J/MOL/K | J/MOL/K | J/MOL/K | M/SEC |
| 90.055 | 21.685 | 0.04612 | 35.0089 | 964.022 | 5302.3 | 5348.5 | 76.538 | 44.14 | 68.49 | 2230 |
| 100.000 | 21.326 | 0.04689 | 31.0922 | 864.621 | 5983.2 | 6030.1 | 83.718 | 44.03 | 68.61 | 2117 |
| 110.000 | 20.967 | 0.04770 | 27.8088 | 774.927 | 6669.4 | 6717.1 | 90.265 | 43.83 | 68.80 | 2011 |
| 120.000 | 20.607 | 0.04853 | 25.0128 | 693.966 | 7357.8 | 7406.4 | 96.262 | 43.58 | 69.06 | 1912 |
| 130.000 | 20.245 | 0.04939 | 22.5888 | 620.565 | 8049.3 | 8098.7 | 101.803 | 43.33 | 69.41 | 1818 |
| 140.000 | 19.878 | 0.05031 | 20.4557 | 553.818 | 8744.6 | 8794.9 | 106.962 | 43.09 | 69.86 | 1728 |
| 150.000 | 19.506 | 0.05127 | 18.5549 | 492.965 | 9444.9 | 9496.2 | 111.801 | 42.89 | 70.42 | 1641 |
| 160.000 | 19.125 | 0.05229 | 16.8432 | 437.364 | 10151.4 | 10203.7 | 116.367 | 42.74 | 71.11 | 1556 |
| 170.000 | 18.735 | 0.05338 | 15.2880 | 386.451 | 10865.5 | 10918.9 | 120.702 | 42.66 | 71.95 | 1472 |
| 180.000 | 18.333 | 0.05455 | 13.8641 | 339.723 | 11588.8 | 11643.3 | 124.843 | 42.66 | 72.96 | 1390 |
| 190.000 | 17.918 | 0.05581 | 12.5515 | 296.729 | 12323.1 | 12378.9 | 128.819 | 42.76 | 74.18 | 1308 |
| 200.000 | 17.486 | 0.05719 | 11.3341 | 257.057 | 13070.5 | 13127.7 | 132.660 | 42.94 | 75.63 | 1227 |
| 210.000 | 17.035 | 0.05870 | 10.1982 | 220.340 | 13833.8 | 13892.5 | 136.391 | 43.23 | 77.39 | 1145 |
| 220.000 | 16.559 | 0.06039 | 9.1317 | 186.239 | 14616.3 | 14676.7 | 140.038 | 43.60 | 79.53 | 1063 |
| 230.000 | 16.051 | 0.06230 | 8.1230 | 154.444 | 15422.6 | 15484.9 | 143.630 | 44.07 | 82.21 | 979 |
| 240.000 | 15.503 | 0.06451 | 7.1600 | 124.661 | 16259.0 | 16323.5 | 147.199 | 44.63 | 85.69 | 892 |
| 241.096 | 15.439 | 0.06477 | 7.0566 | 121.507 | 16352.9 | 16417.7 | 147.591 | 44.69 | 86.14 | 883 |
| | | | | | | | | | | |
| 241.096 | 0.60119 | 1.663 | 0.059787 | 13.295 | 26569.8 | 28233.1 | 196.641 | 41.28 | 59.21 | 252 |
| 250.000 | 0.56481 | 1.771 | 0.054751 | 14.698 | 26981.5 | 28752.0 | 198.753 | 41.45 | 57.43 | 260 |
| 260.000 | 0.53074 | 1.884 | 0.050366 | 16.133 | 27436.3 | 29320.4 | 200.984 | 41.95 | 56.47 | 269 |
| 270.000 | 0.50183 | 1.993 | 0.046851 | 17.465 | 27889.9 | 29882.7 | 203.107 | 42.66 | 56.13 | 276 |
| 280.000 | 0.47675 | 2.098 | 0.043938 | 18.721 | 28346.2 | 30443.7 | 205.149 | 43.50 | 56.20 | 284 |
| 290.000 | 0.45466 | 2.199 | 0.041463 | 19.920 | 28807.4 | 31006.9 | 207.126 | 44.44 | 56.54 | 290 |
| 300.000 | 0.43496 | 2.299 | 0.039323 | 21.074 | 29275.5 | 31574.6 | 209.052 | 45.45 | 57.09 | 297 |
| 310.000 | 0.41721 | 2.397 | 0.037445 | 22.190 | 29751.8 | 32148.6 | 210.935 | 46.53 | 57.78 | 303 |
| 320.000 | 0.40111 | 2.493 | 0.035778 | 23.277 | 30237.1 | 32730.1 | 212.782 | 47.65 | 58.59 | 309 |
| 330.000 | 0.38640 | 2.588 | 0.034283 | 24.338 | 30733.2 | 33321.2 | 214.598 | 48.82 | 59.49 | 314 |
| 340.000 | 0.37288 | 2.682 | 0.032931 | 25.377 | 31238.9 | 33920.7 | 216.388 | 50.01 | 60.46 | 319 |
| 350.000 | 0.36040 | 2.775 | 0.031701 | 26.399 | 31755.4 | 34530.1 | 218.156 | 51.22 | 61.48 | 325 |
| 360.000 | 0.34883 | 2.867 | 0.030575 | 27.404 | 32283.3 | 35150.0 | 219.902 | 52.46 | 62.55 | 330 |
| 370.000 | 0.33805 | 2.958 | 0.029538 | 28.396 | 32822.7 | 35780.8 | 221.631 | 53.71 | 63.65 | 335 |
| 380.000 | 0.32799 | 3.049 | 0.028579 | 29.375 | 33374.0 | 36422.8 | 223.344 | 54.96 | 64.79 | 339 |
| 390.000 | 0.31857 | 3.139 | 0.027689 | 30.344 | 33937.2 | 37076.2 | 225.041 | 56.23 | 65.94 | 344 |
| 400.000 | 0.30972 | 3.229 | 0.026860 | 31.303 | 34512.6 | 37741.2 | 226.726 | 57.49 | 67.10 | 349 |
| 410.000 | 0.30139 | 3.318 | 0.026084 | 32.254 | 35100.1 | 38418.0 | 228.397 | 58.76 | 68.28 | 353 |
| 420.000 | 0.29354 | 3.407 | 0.025357 | 33.197 | 35699.8 | 39106.5 | 230.056 | 60.02 | 69.46 | 357 |
| 430.000 | 0.28610 | 3.495 | 0.024674 | 34.133 | 36311.7 | 39806.9 | 231.705 | 61.28 | 70.65 | 362 |
| 440.000 | 0.27907 | 3.583 | 0.024030 | 35.063 | 36935.8 | 40519.2 | 233.343 | 62.53 | 71.84 | 366 |
| 450.000 | 0.27239 | 3.671 | 0.023422 | 35.987 | 37572.1 | 41243.3 | 234.970 | 63.77 | 73.02 | 370 |
| 460.000 | 0.26604 | 3.759 | 0.022846 | 36.906 | 38220.5 | 41979.3 | 236.588 | 65.01 | 74.20 | 374 |
| 470.000 | 0.26000 | 3.846 | 0.022300 | 37.820 | 38880.9 | 42727.1 | 238.196 | 66.23 | 75.38 | 378 |
| 480.000 | 0.25424 | 3.933 | 0.021782 | 38.730 | 39553.2 | 43486.5 | 239.796 | 67.45 | 76.54 | 382 |
| 490.000 | 0.24874 | 4.020 | 0.021289 | 39.636 | 40237.5 | 44257.7 | 241.386 | 68.65 | 77.70 | 386 |
| 500.000 | 0.24349 | 4.107 | 0.020820 | 40.538 | 40933.4 | 45040.3 | 242.967 | 69.84 | 78.85 | 390 |
| 520.000 | 0.23365 | 4.280 | 0.019944 | 42.332 | 42360.1 | 46639.9 | 246.104 | 72.18 | 81.12 | 398 |
| 540.000 | 0.22461 | 4.452 | 0.019142 | 44.114 | 43832.5 | 48284.6 | 249.208 | 74.46 | 83.35 | 405 |
| 560.000 | 0.21627 | 4.624 | 0.018406 | 45.886 | 45349.4 | 49973.3 | 252.279 | 76.69 | 85.53 | 413 |
| 580.000 | 0.20854 | 4.795 | 0.017727 | 47.649 | 46910.0 | 51705.2 | 255.317 | 78.87 | 87.67 | 420 |
| 600.000 | 0.20137 | 4.966 | 0.017098 | 49.405 | 48513.2 | 53479.3 | 258.325 | 81.00 | 89.76 | 427 |

Table 27. Thermophysical properties along isobars (Continued)

ETHANE ISOBAR AT P = 12.0 BAR

| T | DEN | VOL | DP/DT | DP/DD | E | H | S | CV | CP | W |
|---|---|---|---|---|---|---|---|---|---|---|
| DEG K | MOL/L | L/MOL | BAR/K | BAR-L/MOL | J/MOL | J/MOL | J/MOL/K | J/MOL/K | J/MOL/K | M/SEC |
| 90.086 | 21.686 | 0.04611 | 34.9966 | 964.330 | 5303.1 | 5358.4 | 76.546 | 44.16 | 68.49 | 2230 |
| 100.000 | 21.328 | 0.04689 | 31.0951 | 865.309 | 5981.7 | 6037.9 | 83.702 | 44.04 | 68.61 | 2117 |
| 110.000 | 20.969 | 0.04769 | 27.8131 | 775.659 | 6667.7 | 6724.9 | 90.249 | 43.84 | 68.79 | 2012 |
| 120.000 | 20.610 | 0.04852 | 25.0184 | 694.737 | 7355.8 | 7414.0 | 96.245 | 43.60 | 69.05 | 1913 |
| 130.000 | 20.248 | 0.04939 | 22.5955 | 621.370 | 8047.0 | 8106.2 | 101.785 | 43.34 | 69.40 | 1819 |
| 140.000 | 19.882 | 0.05030 | 20.4635 | 554.653 | 8742.0 | 8802.3 | 106.944 | 43.10 | 69.84 | 1729 |
| 150.000 | 19.510 | 0.05126 | 18.5638 | 493.829 | 9442.0 | 9503.5 | 111.781 | 42.90 | 70.40 | 1642 |
| 160.000 | 19.130 | 0.05227 | 16.8533 | 438.256 | 10148.1 | 10210.8 | 116.346 | 42.75 | 71.09 | 1557 |
| 170.000 | 18.740 | 0.05336 | 15.2992 | 387.370 | 10861.7 | 10925.8 | 120.680 | 42.68 | 71.93 | 1473 |
| 180.000 | 18.339 | 0.05453 | 13.8764 | 340.671 | 11584.4 | 11649.9 | 124.818 | 42.68 | 72.93 | 1391 |
| 190.000 | 17.925 | 0.05579 | 12.5651 | 297.707 | 12318.1 | 12385.0 | 128.793 | 42.77 | 74.13 | 1310 |
| 200.000 | 17.494 | 0.05716 | 11.3490 | 258.069 | 13064.8 | 13133.4 | 132.631 | 42.96 | 75.58 | 1229 |
| 210.000 | 17.044 | 0.05867 | 10.2146 | 221.389 | 13827.1 | 13897.6 | 136.359 | 43.24 | 77.31 | 1147 |
| 220.000 | 16.569 | 0.06035 | 9.1499 | 187.332 | 14608.5 | 14680.9 | 140.003 | 43.62 | 79.43 | 1065 |
| 230.000 | 16.064 | 0.06225 | 8.1434 | 155.588 | 15413.2 | 15487.9 | 143.590 | 44.09 | 82.08 | 981 |
| 240.000 | 15.519 | 0.06444 | 7.1832 | 125.871 | 16247.7 | 16325.0 | 147.152 | 44.64 | 85.50 | 895 |
| 247.199 | 15.092 | 0.06626 | 6.5128 | 105.571 | 16872.1 | 16951.6 | 149.724 | 45.10 | 88.70 | 831 |
| 247.199 | 0.72357 | 1.382 | 0.073717 | 12.752 | 26678.8 | 28337.3 | 195.822 | 42.40 | 62.52 | 250 |
| 250.000 | 0.70794 | 1.413 | 0.071397 | 13.251 | 26815.8 | 28510.9 | 196.521 | 42.38 | 61.57 | 253 |
| 260.000 | 0.65968 | 1.516 | 0.064634 | 14.894 | 27294.8 | 29113.9 | 198.888 | 42.62 | 59.37 | 263 |
| 270.000 | 0.62003 | 1.613 | 0.059464 | 16.378 | 27765.9 | 29701.3 | 201.106 | 43.16 | 58.32 | 271 |
| 280.000 | 0.58643 | 1.705 | 0.055313 | 17.753 | 28236.3 | 30282.6 | 203.219 | 43.90 | 57.93 | 279 |
| 290.000 | 0.55732 | 1.794 | 0.051872 | 19.048 | 28708.2 | 30861.4 | 205.251 | 44.76 | 57.95 | 286 |
| 300.000 | 0.53169 | 1.881 | 0.048949 | 20.281 | 29185.0 | 31441.9 | 207.220 | 45.72 | 58.26 | 293 |
| 310.000 | 0.50885 | 1.965 | 0.046422 | 21.465 | 29668.4 | 32026.7 | 209.138 | 46.76 | 58.78 | 300 |
| 320.000 | 0.48829 | 2.048 | 0.044206 | 22.610 | 30159.9 | 32617.4 | 211.015 | 47.85 | 59.45 | 306 |
| 330.000 | 0.46964 | 2.129 | 0.042239 | 23.722 | 30660.3 | 33215.5 | 212.856 | 48.98 | 60.24 | 311 |
| 340.000 | 0.45259 | 2.209 | 0.040476 | 24.806 | 31170.5 | 33821.9 | 214.667 | 50.15 | 61.12 | 317 |
| 350.000 | 0.43694 | 2.289 | 0.038883 | 25.868 | 31691.1 | 34437.5 | 216.452 | 51.35 | 62.07 | 322 |
| 360.000 | 0.42248 | 2.367 | 0.037434 | 26.909 | 32222.6 | 35063.0 | 218.215 | 52.57 | 63.07 | 328 |
| 370.000 | 0.40907 | 2.445 | 0.036107 | 27.934 | 32765.2 | 35698.7 | 219.957 | 53.81 | 64.13 | 333 |
| 380.000 | 0.39659 | 2.522 | 0.034886 | 28.943 | 33320.4 | 36346.2 | 221.682 | 55.05 | 65.21 | 338 |
| 390.000 | 0.38493 | 2.598 | 0.033758 | 29.939 | 33886.2 | 37003.7 | 223.390 | 56.31 | 66.33 | 342 |
| 400.000 | 0.37401 | 2.674 | 0.032711 | 30.923 | 34463.9 | 37672.4 | 225.083 | 57.56 | 67.46 | 347 |
| 410.000 | 0.36375 | 2.749 | 0.031735 | 31.897 | 35053.6 | 38352.6 | 226.763 | 58.82 | 68.61 | 352 |
| 420.000 | 0.35409 | 2.824 | 0.030823 | 32.861 | 35655.3 | 39044.2 | 228.430 | 60.08 | 69.77 | 356 |
| 430.000 | 0.34497 | 2.899 | 0.029969 | 33.817 | 36269.0 | 39747.5 | 230.085 | 61.33 | 70.93 | 361 |
| 440.000 | 0.33635 | 2.973 | 0.029165 | 34.766 | 36894.8 | 40462.5 | 231.729 | 62.58 | 72.10 | 365 |
| 450.000 | 0.32818 | 3.047 | 0.028408 | 35.707 | 37532.6 | 41189.1 | 233.363 | 63.82 | 73.26 | 369 |
| 460.000 | 0.32043 | 3.121 | 0.027693 | 36.643 | 38182.5 | 41927.5 | 234.986 | 65.05 | 74.43 | 373 |
| 470.000 | 0.31306 | 3.194 | 0.027017 | 37.572 | 38844.2 | 42677.4 | 236.599 | 66.27 | 75.59 | 378 |
| 480.000 | 0.30604 | 3.268 | 0.026376 | 38.497 | 39517.8 | 43438.9 | 238.202 | 67.48 | 76.74 | 382 |
| 490.000 | 0.29935 | 3.341 | 0.025767 | 39.416 | 40203.2 | 44212.0 | 239.797 | 68.68 | 77.89 | 386 |
| 500.000 | 0.29296 | 3.413 | 0.025187 | 40.331 | 40900.3 | 44996.5 | 241.382 | 69.87 | 79.03 | 390 |
| 520.000 | 0.28100 | 3.559 | 0.024109 | 42.150 | 42329.0 | 46599.4 | 244.525 | 72.20 | 81.28 | 397 |
| 540.000 | 0.27003 | 3.703 | 0.023125 | 43.954 | 43803.2 | 48247.1 | 247.635 | 74.48 | 83.49 | 405 |
| 560.000 | 0.25992 | 3.847 | 0.022223 | 45.746 | 45321.7 | 49938.5 | 250.711 | 76.71 | 85.66 | 412 |
| 580.000 | 0.25057 | 3.991 | 0.021392 | 47.527 | 46883.7 | 51672.8 | 253.754 | 78.89 | 87.79 | 419 |
| 600.000 | 0.24189 | 4.134 | 0.020624 | 49.299 | 48488.3 | 53449.2 | 256.765 | 81.02 | 89.86 | 426 |

Table 27. Thermophysical properties along isobars (Continued)

ETHANE ISOBAR AT P = 14.0 BAR

| T | DEN | VCL | DF/DT | DF/DD | E | H | S | CV | CP | W |
|---|---|---|---|---|---|---|---|---|---|---|
| DEG K | MOL/L | L/MOL | BAR/K | BAR-L/MOL | J/MOL | J/MOL | J/MOL/K | J/MOL/K | J/MOL/K | M/SEC |
| 90.117 | 21.687 | 0.04611 | 34.9843 | 964.639 | 5303.8 | 5368.4 | 76.555 | 44.17 | 68.48 | 2230 |
| 100.000 | 21.330 | 0.04688 | 31.0980 | 865.997 | 5980.1 | 6045.7 | 83.686 | 44.06 | 68.60 | 2118 |
| 110.000 | 20.972 | 0.04768 | 27.8174 | 776.390 | 6665.9 | 6732.6 | 90.233 | 43.86 | 68.79 | 2012 |
| 120.000 | 20.613 | 0.04851 | 25.0240 | 695.506 | 7353.8 | 7421.7 | 96.228 | 43.62 | 69.04 | 1913 |
| 130.000 | 20.251 | 0.04938 | 22.6023 | 622.173 | 8044.7 | 8113.8 | 101.768 | 43.36 | 69.39 | 1820 |
| 140.000 | 19.886 | 0.05029 | 20.4714 | 555.488 | 8739.4 | 8809.8 | 106.925 | 43.12 | 69.83 | 1730 |
| 150.000 | 19.514 | 0.05125 | 18.5728 | 494.693 | 9439.0 | 9510.8 | 111.761 | 42.92 | 70.38 | 1643 |
| 160.000 | 19.134 | 0.05226 | 16.8633 | 439.147 | 10144.7 | 10217.9 | 116.325 | 42.77 | 71.07 | 1558 |
| 170.000 | 18.745 | 0.05335 | 15.3103 | 388.289 | 10857.9 | 10932.6 | 120.657 | 42.69 | 71.90 | 1475 |
| 180.000 | 18.345 | 0.05451 | 13.8887 | 341.618 | 11580.1 | 11656.4 | 124.794 | 42.70 | 72.90 | 1393 |
| 190.000 | 17.931 | 0.05577 | 12.5786 | 298.684 | 12313.1 | 12391.2 | 128.766 | 42.79 | 74.09 | 1311 |
| 200.000 | 17.502 | 0.05714 | 11.3639 | 259.078 | 13059.1 | 13139.1 | 132.602 | 42.98 | 75.52 | 1230 |
| 210.000 | 17.053 | 0.05864 | 10.2311 | 222.436 | 13820.5 | 13902.6 | 136.327 | 43.26 | 77.24 | 1149 |
| 220.000 | 16.580 | 0.06031 | 9.1681 | 188.421 | 14600.7 | 14685.2 | 139.967 | 43.64 | 79.34 | 1067 |
| 230.000 | 16.077 | 0.06220 | 8.1637 | 156.729 | 15404.0 | 15491.1 | 143.549 | 44.11 | 81.95 | 984 |
| 240.000 | 15.534 | 0.06437 | 7.2063 | 127.075 | 16236.4 | 16326.6 | 147.104 | 44.66 | 85.30 | 898 |
| 250.000 | 14.936 | 0.06695 | 6.2818 | 99.179 | 17107.5 | 17201.2 | 150.674 | 45.30 | 89.89 | 809 |
| 252.601 | 14.769 | 0.06771 | 6.0446 | 92.173 | 17342.1 | 17436.9 | 151.612 | 45.48 | 91.39 | 785 |
| 252.601 | 0.84896 | 1.178 | 0.088500 | 12.175 | 26763.8 | 28412.8 | 195.103 | 43.45 | 66.00 | 248 |
| 260.000 | 0.80025 | 1.250 | 0.081161 | 13.564 | 27139.7 | 28889.2 | 196.963 | 43.40 | 63.12 | 256 |
| 270.000 | 0.74657 | 1.339 | 0.073656 | 15.236 | 27633.5 | 29508.8 | 199.300 | 43.73 | 60.98 | 266 |
| 280.000 | 0.70237 | 1.424 | 0.067864 | 16.751 | 28119.0 | 30112.3 | 201.497 | 44.34 | 59.94 | 274 |
| 290.000 | 0.66484 | 1.504 | 0.063191 | 18.155 | 28603.2 | 30709.0 | 203.592 | 45.11 | 59.54 | 282 |
| 300.000 | 0.63231 | 1.582 | 0.059303 | 19.477 | 29089.7 | 31303.9 | 205.610 | 46.01 | 59.56 | 290 |
| 310.000 | 0.60364 | 1.657 | 0.055994 | 20.735 | 29581.2 | 31900.5 | 207.567 | 47.00 | 59.86 | 296 |
| 320.000 | 0.57808 | 1.730 | 0.053129 | 21.942 | 30080.2 | 32502.1 | 209.475 | 48.05 | 60.37 | 303 |
| 330.000 | 0.55506 | 1.802 | 0.050613 | 23.108 | 30586.4 | 33108.7 | 211.343 | 49.16 | 61.03 | 309 |
| 340.000 | 0.53415 | 1.872 | 0.048378 | 24.240 | 31101.6 | 33722.5 | 213.176 | 50.30 | 61.81 | 315 |
| 350.000 | 0.51505 | 1.942 | 0.046374 | 25.344 | 31626.5 | 34344.7 | 214.980 | 51.48 | 62.68 | 320 |
| 360.000 | 0.49748 | 2.010 | 0.044562 | 26.423 | 32161.7 | 34975.9 | 216.759 | 52.69 | 63.62 | 326 |
| 370.000 | 0.48126 | 2.078 | 0.042913 | 27.481 | 32707.7 | 35616.8 | 218.515 | 53.91 | 64.61 | 331 |
| 380.000 | 0.46620 | 2.145 | 0.041404 | 28.520 | 33264.9 | 36267.9 | 220.252 | 55.14 | 65.65 | 336 |
| 390.000 | 0.45218 | 2.212 | 0.040014 | 29.544 | 33833.4 | 36929.5 | 221.971 | 56.39 | 66.73 | 341 |
| 400.000 | 0.43908 | 2.278 | 0.038729 | 30.553 | 34413.6 | 37602.1 | 223.675 | 57.64 | 67.82 | 346 |
| 410.000 | 0.42680 | 2.343 | 0.037537 | 31.550 | 35005.5 | 38285.7 | 225.363 | 58.89 | 68.94 | 350 |
| 420.000 | 0.41526 | 2.408 | 0.036426 | 32.536 | 35609.2 | 38980.6 | 227.038 | 60.14 | 70.07 | 355 |
| 430.000 | 0.40438 | 2.473 | 0.035387 | 33.513 | 36224.8 | 39686.9 | 228.700 | 61.39 | 71.21 | 360 |
| 440.000 | 0.39412 | 2.537 | 0.034413 | 34.480 | 36853.4 | 40405.6 | 230.351 | 62.63 | 72.36 | 364 |
| 450.000 | 0.38441 | 2.601 | 0.033498 | 35.439 | 37492.8 | 41134.8 | 231.989 | 63.87 | 73.51 | 368 |
| 460.000 | 0.37520 | 2.665 | 0.032635 | 36.390 | 38144.1 | 41875.4 | 233.618 | 65.09 | 74.66 | 373 |
| 470.000 | 0.36646 | 2.729 | 0.031820 | 37.335 | 38807.2 | 42627.6 | 235.236 | 66.31 | 75.80 | 377 |
| 480.000 | 0.35814 | 2.792 | 0.031049 | 38.274 | 39482.1 | 43391.2 | 236.844 | 67.52 | 76.95 | 381 |
| 490.000 | 0.35022 | 2.855 | 0.030318 | 39.207 | 40168.7 | 44166.2 | 238.442 | 68.72 | 78.08 | 385 |
| 500.000 | 0.34267 | 2.918 | 0.029624 | 40.135 | 40866.9 | 44952.5 | 240.031 | 69.90 | 79.21 | 389 |
| 520.000 | 0.32855 | 3.044 | 0.028333 | 41.977 | 42297.7 | 46558.8 | 243.181 | 72.23 | 81.44 | 397 |
| 540.000 | 0.31561 | 3.168 | 0.027159 | 43.802 | 43773.6 | 48209.4 | 246.296 | 74.51 | 83.64 | 404 |
| 560.000 | 0.30371 | 3.293 | 0.026084 | 45.614 | 45293.8 | 49903.6 | 249.377 | 76.74 | 85.79 | 412 |
| 580.000 | 0.29270 | 3.416 | 0.025096 | 47.413 | 46857.3 | 51640.3 | 252.424 | 78.91 | 87.90 | 419 |
| 600.000 | 0.28250 | 3.540 | 0.024184 | 49.201 | 48463.2 | 53419.0 | 255.439 | 81.03 | 89.97 | 426 |

Table 27. Thermophysical properties along isobars (Continued)

ETHANE ISOBAR AT P = 16.0 BAR

| T DEG K | DEN MOL/L | VCL L/MOL | DP/DT BAR/K | DP/DD BAR-L/MOL | E J/MOL | H J/MOL | S J/MOL/K | CV J/MOL/K | CP J/MOL/K | W M/SEC |
|---|---|---|---|---|---|---|---|---|---|---|
| 90.149 | 21.688 | 0.04611 | 34.9721 | 964.948 | 5304.6 | 5378.4 | 76.563 | 44.19 | 68.48 | 2230 |
| 100.000 | 21.333 | 0.04688 | 31.1009 | 866.685 | 5978.5 | 6053.5 | 83.670 | 44.08 | 68.60 | 2118 |
| 110.000 | 20.974 | 0.04768 | 27.8217 | 777.122 | 6664.1 | 6740.4 | 90.216 | 43.88 | 68.78 | 2013 |
| 120.000 | 20.616 | 0.04851 | 25.0295 | 696.276 | 7351.8 | 7429.4 | 96.211 | 43.63 | 69.04 | 1914 |
| 130.000 | 20.255 | 0.04937 | 22.6090 | 622.977 | 8042.4 | 8121.4 | 101.750 | 43.38 | 69.38 | 1820 |
| 140.000 | 19.889 | 0.05028 | 20.4792 | 556.322 | 8736.8 | 8817.2 | 106.907 | 43.14 | 69.82 | 1730 |
| 150.000 | 19.518 | 0.05124 | 18.5817 | 495.556 | 9436.1 | 9518.0 | 111.741 | 42.93 | 70.37 | 1644 |
| 160.000 | 19.139 | 0.05225 | 16.8733 | 440.038 | 10141.4 | 10225.0 | 116.304 | 42.78 | 71.05 | 1559 |
| 170.000 | 18.750 | 0.05333 | 15.3214 | 389.207 | 10854.1 | 10939.5 | 120.635 | 42.71 | 71.87 | 1476 |
| 180.000 | 18.351 | 0.05449 | 13.9010 | 342.564 | 11575.8 | 11663.0 | 124.770 | 42.71 | 72.86 | 1394 |
| 190.000 | 17.938 | 0.05575 | 12.5921 | 299.660 | 12308.2 | 12397.4 | 128.740 | 42.81 | 74.05 | 1313 |
| 200.000 | 17.509 | 0.05711 | 11.3787 | 260.087 | 13053.4 | 13144.8 | 132.574 | 42.99 | 75.47 | 1232 |
| 210.000 | 17.062 | 0.05861 | 10.2474 | 223.481 | 13813.9 | 13907.7 | 136.296 | 43.28 | 77.17 | 1151 |
| 220.000 | 16.591 | 0.06027 | 9.1862 | 189.508 | 14593.0 | 14689.5 | 139.932 | 43.66 | 79.25 | 1070 |
| 230.000 | 16.090 | 0.06215 | 8.1839 | 157.867 | 15394.8 | 15494.3 | 143.509 | 44.12 | 81.82 | 987 |
| 240.000 | 15.550 | 0.06431 | 7.2291 | 128.275 | 16225.3 | 16328.2 | 147.058 | 44.68 | 85.12 | 901 |
| 250.000 | 14.956 | 0.06686 | 6.3083 | 100.459 | 17093.5 | 17200.5 | 150.618 | 45.32 | 89.59 | 813 |
| 257.468 | 14.463 | 0.06914 | 5.6321 | 80.667 | 17775.4 | 17886.0 | 153.319 | 45.85 | 94.25 | 743 |
| | | | | | | | | | | |
| 257.468 | 0.97801 | 1.022 | 0.104224 | 11.567 | 26830.7 | 28466.7 | 194.450 | 44.45 | 69.73 | 246 |
| 260.000 | 0.95609 | 1.046 | 0.100728 | 12.106 | 26967.6 | 28641.0 | 195.124 | 44.35 | 68.19 | 249 |
| 270.000 | 0.88331 | 1.132 | 0.089809 | 14.019 | 27489.3 | 29300.7 | 197.616 | 44.39 | 64.29 | 260 |
| 280.000 | 0.82563 | 1.211 | 0.081803 | 15.701 | 27994.4 | 29932.3 | 199.915 | 44.82 | 62.33 | 269 |
| 290.000 | 0.77789 | 1.286 | 0.075550 | 17.231 | 28493.7 | 30550.5 | 202.083 | 45.49 | 61.37 | 278 |
| 300.000 | 0.73722 | 1.356 | 0.070467 | 18.652 | 28991.4 | 31161.7 | 204.157 | 46.32 | 61.01 | 286 |
| 310.000 | 0.70186 | 1.425 | 0.066216 | 19.992 | 29491.8 | 31771.4 | 206.157 | 47.25 | 61.05 | 293 |
| 320.000 | 0.67066 | 1.491 | 0.062585 | 21.267 | 29997.3 | 32383.0 | 208.100 | 48.26 | 61.37 | 300 |
| 330.000 | 0.64278 | 1.556 | 0.059432 | 22.492 | 30509.7 | 32998.9 | 209.996 | 49.34 | 61.88 | 306 |
| 340.000 | 0.61764 | 1.619 | 0.056657 | 23.674 | 31030.1 | 33620.6 | 211.853 | 50.46 | 62.55 | 312 |
| 350.000 | 0.59479 | 1.681 | 0.054188 | 24.822 | 31560.5 | 34250.5 | 213.677 | 51.62 | 63.32 | 318 |
| 360.000 | 0.57388 | 1.743 | 0.051971 | 25.940 | 32099.7 | 34887.8 | 215.472 | 52.81 | 64.19 | 324 |
| 370.000 | 0.55463 | 1.803 | 0.049964 | 27.033 | 32649.3 | 35534.1 | 217.244 | 54.01 | 65.12 | 329 |
| 380.000 | 0.53684 | 1.863 | 0.048136 | 28.104 | 33209.6 | 36190.0 | 218.993 | 55.24 | 66.11 | 334 |
| 390.000 | 0.52032 | 1.922 | 0.046461 | 29.156 | 33780.9 | 36855.9 | 220.724 | 56.47 | 67.14 | 340 |
| 400.000 | 0.50493 | 1.980 | 0.044919 | 30.192 | 34363.6 | 37532.4 | 222.437 | 57.71 | 68.20 | 344 |
| 410.000 | 0.49053 | 2.039 | 0.043491 | 31.213 | 34957.8 | 38219.6 | 224.134 | 58.96 | 69.28 | 349 |
| 420.000 | 0.47703 | 2.096 | 0.042166 | 32.220 | 35563.7 | 38917.8 | 225.817 | 60.20 | 70.39 | 354 |
| 430.000 | 0.46433 | 2.154 | 0.040930 | 33.217 | 36181.2 | 39627.0 | 227.486 | 61.44 | 71.50 | 359 |
| 440.000 | 0.45236 | 2.211 | 0.039774 | 34.202 | 36810.5 | 40347.5 | 229.143 | 62.68 | 72.63 | 363 |
| 450.000 | 0.44105 | 2.267 | 0.038690 | 35.179 | 37451.6 | 41079.3 | 230.788 | 63.91 | 73.76 | 367 |
| 460.000 | 0.43035 | 2.324 | 0.037671 | 36.147 | 38104.4 | 41822.3 | 232.421 | 65.14 | 74.89 | 372 |
| 470.000 | 0.42019 | 2.380 | 0.036710 | 37.107 | 38768.9 | 42576.7 | 234.044 | 66.35 | 76.02 | 376 |
| 480.000 | 0.41054 | 2.436 | 0.035803 | 38.060 | 39445.1 | 43342.4 | 235.656 | 67.56 | 77.15 | 380 |
| 490.000 | 0.40137 | 2.491 | 0.034943 | 39.007 | 40133.0 | 44119.4 | 237.259 | 68.75 | 78.27 | 384 |
| 500.000 | 0.39262 | 2.547 | 0.034128 | 39.947 | 40833.3 | 44908.5 | 238.851 | 69.93 | 79.39 | 388 |
| 520.000 | 0.37629 | 2.658 | 0.032617 | 41.813 | 42266.2 | 46518.2 | 242.008 | 72.26 | 81.60 | 396 |
| 540.000 | 0.36135 | 2.767 | 0.031244 | 43.659 | 43744.0 | 48171.8 | 245.129 | 74.53 | 83.78 | 404 |
| 560.000 | 0.34761 | 2.877 | 0.029990 | 45.490 | 45265.8 | 49868.7 | 248.214 | 76.76 | 85.92 | 412 |
| 580.000 | 0.33493 | 2.986 | 0.028840 | 47.306 | 46830.8 | 51607.9 | 251.266 | 78.93 | 88.02 | 419 |
| 600.000 | 0.32319 | 3.094 | 0.027780 | 49.110 | 48438.0 | 53388.7 | 254.285 | 81.05 | 90.08 | 426 |

Table 27. Thermophysical properties along isobars (Continued)

ETHANE ISOBAR AT P = 18.0 BAR

| T DEG K | DEN MOL/L | VOL L/MOL | DP/DT BAR/K | DP/DD BAR-L/MOL | E J/MOL | H J/MOL | S J/MOL/K | CV J/MOL/K | CP J/MOL/K | W M/SEC |
|---|---|---|---|---|---|---|---|---|---|---|
| 90.180 | 21.688 | 0.04611 | 34.9599 | 965.257 | 5305.3 | 5388.3 | 76.571 | 44.20 | 68.48 | 2230 |
| 100.000 | 21.335 | 0.04687 | 31.1038 | 867.372 | 5977.0 | 6061.3 | 83.655 | 44.09 | 68.60 | 2118 |
| 110.000 | 20.977 | 0.04767 | 27.8260 | 777.853 | 6662.3 | 6748.1 | 90.200 | 43.89 | 68.77 | 2013 |
| 120.000 | 20.619 | 0.04850 | 25.0351 | 697.045 | 7349.8 | 7437.1 | 96.194 | 43.65 | 69.03 | 1915 |
| 130.000 | 20.258 | 0.04936 | 22.6157 | 623.780 | 8040.1 | 8129.0 | 101.732 | 43.39 | 69.37 | 1821 |
| 140.000 | 19.893 | 0.05027 | 20.4870 | 557.156 | 8734.2 | 8824.7 | 106.888 | 43.15 | 69.80 | 1731 |
| 150.000 | 19.522 | 0.05122 | 18.5906 | 496.418 | 9433.1 | 9525.3 | 111.722 | 42.95 | 70.35 | 1644 |
| 160.000 | 19.143 | 0.05224 | 16.8833 | 440.927 | 10138.1 | 10232.1 | 116.283 | 42.80 | 71.03 | 1560 |
| 170.000 | 18.756 | 0.05332 | 15.3325 | 390.124 | 10850.4 | 10946.3 | 120.612 | 42.72 | 71.85 | 1477 |
| 180.000 | 18.357 | 0.05448 | 13.9132 | 343.508 | 11571.5 | 11669.6 | 124.746 | 42.73 | 72.83 | 1395 |
| 190.000 | 17.945 | 0.05573 | 12.6056 | 300.634 | 12303.3 | 12403.6 | 128.714 | 42.82 | 74.01 | 1314 |
| 200.000 | 17.517 | 0.05709 | 11.3935 | 261.093 | 13047.7 | 13150.5 | 132.545 | 43.01 | 75.42 | 1234 |
| 210.000 | 17.071 | 0.05858 | 10.2637 | 224.523 | 13807.4 | 13912.8 | 136.264 | 43.29 | 77.11 | 1153 |
| 220.000 | 16.601 | 0.06024 | 9.2042 | 190.593 | 14585.4 | 14693.8 | 139.897 | 43.67 | 79.15 | 1072 |
| 230.000 | 16.102 | 0.06210 | 8.2040 | 159.001 | 15385.7 | 15497.5 | 143.469 | 44.14 | 81.69 | 989 |
| 240.000 | 15.566 | 0.06424 | 7.2518 | 129.470 | 16214.3 | 16329.9 | 147.011 | 44.70 | 84.93 | 905 |
| 250.000 | 14.976 | 0.06677 | 6.3346 | 101.733 | 17079.7 | 17199.9 | 150.562 | 45.33 | 89.30 | 816 |
| 260.000 | 14.309 | 0.06989 | 5.4345 | 75.501 | 17996.9 | 18122.6 | 154.180 | 46.06 | 95.73 | 722 |
| 261.912 | 14.169 | 0.07058 | 5.2621 | 70.628 | 18180.1 | 18307.2 | 154.887 | 46.20 | 97.35 | 703 |
| | | | | | | | | | | |
| 261.912 | 1.11138 | 0.900 | 0.120953 | 10.933 | 26881.0 | 28500.6 | 193.842 | 45.41 | 73.80 | 243 |
| 270.000 | 1.03301 | 0.968 | 0.108487 | 12.703 | 27331.3 | 29073.8 | 195.999 | 45.15 | 68.59 | 253 |
| 280.000 | 0.95769 | 1.044 | 0.097417 | 14.590 | 27861.6 | 29741.2 | 198.426 | 45.37 | 65.22 | 264 |
| 290.000 | 0.89731 | 1.114 | 0.089114 | 16.267 | 28377.4 | 30383.4 | 200.681 | 45.91 | 63.49 | 274 |
| 300.000 | 0.84695 | 1.181 | 0.082544 | 17.801 | 28887.9 | 31013.2 | 202.818 | 46.65 | 62.65 | 282 |
| 310.000 | 0.80385 | 1.244 | 0.077155 | 19.230 | 29398.3 | 31637.6 | 204.866 | 47.52 | 62.37 | 290 |
| 320.000 | 0.76624 | 1.305 | 0.072620 | 20.580 | 29912.8 | 32261.9 | 206.847 | 48.49 | 62.45 | 297 |
| 330.000 | 0.73295 | 1.364 | 0.068728 | 21.867 | 30431.8 | 32887.7 | 208.773 | 49.53 | 62.80 | 304 |
| 340.000 | 0.70315 | 1.422 | 0.065335 | 23.104 | 30958.0 | 33517.9 | 210.656 | 50.62 | 63.33 | 310 |
| 350.000 | 0.67622 | 1.479 | 0.062341 | 24.298 | 31492.3 | 34154.2 | 212.501 | 51.76 | 64.00 | 316 |
| 360.000 | 0.65170 | 1.534 | 0.059671 | 25.457 | 32035.8 | 34797.8 | 214.314 | 52.93 | 64.78 | 322 |
| 370.000 | 0.62924 | 1.589 | 0.057268 | 26.587 | 32589.0 | 35449.6 | 216.101 | 54.12 | 65.65 | 327 |
| 380.000 | 0.60854 | 1.643 | 0.055091 | 27.691 | 33152.6 | 36110.5 | 217.864 | 55.33 | 66.58 | 333 |
| 390.000 | 0.58938 | 1.697 | 0.053104 | 28.772 | 33727.8 | 36781.9 | 219.606 | 56.56 | 67.56 | 338 |
| 400.000 | 0.57157 | 1.750 | 0.051282 | 29.835 | 34313.1 | 37462.4 | 221.329 | 57.79 | 68.58 | 343 |
| 410.000 | 0.55495 | 1.802 | 0.049601 | 30.880 | 34909.7 | 38153.2 | 223.036 | 59.03 | 69.63 | 348 |
| 420.000 | 0.53940 | 1.854 | 0.048046 | 31.910 | 35517.7 | 38854.7 | 224.727 | 60.27 | 70.71 | 353 |
| 430.000 | 0.52481 | 1.905 | 0.046599 | 32.927 | 36137.2 | 39567.1 | 226.403 | 61.50 | 71.80 | 358 |
| 440.000 | 0.51107 | 1.957 | 0.045250 | 33.932 | 36768.3 | 40290.4 | 228.066 | 62.73 | 72.90 | 362 |
| 450.000 | 0.49811 | 2.008 | 0.043987 | 34.926 | 37411.1 | 41024.7 | 229.717 | 63.96 | 74.01 | 367 |
| 460.000 | 0.48586 | 2.058 | 0.042802 | 35.911 | 38065.4 | 41770.2 | 231.356 | 65.18 | 75.12 | 371 |
| 470.000 | 0.47425 | 2.109 | 0.041687 | 36.886 | 38731.4 | 42526.9 | 232.983 | 66.39 | 76.24 | 375 |
| 480.000 | 0.46324 | 2.159 | 0.040636 | 37.854 | 39408.9 | 43294.6 | 234.600 | 67.59 | 77.35 | 380 |
| 490.000 | 0.45277 | 2.209 | 0.039642 | 38.814 | 40098.0 | 44073.6 | 236.207 | 68.78 | 78.46 | 384 |
| 500.000 | 0.44280 | 2.258 | 0.038701 | 39.767 | 40798.5 | 44863.6 | 237.803 | 69.96 | 79.57 | 388 |
| 520.000 | 0.42421 | 2.357 | 0.036959 | 41.656 | 42233.5 | 46476.6 | 240.966 | 72.29 | 81.76 | 396 |
| 540.000 | 0.40723 | 2.456 | 0.035380 | 43.523 | 43713.1 | 48133.2 | 244.093 | 74.56 | 83.92 | 404 |
| 560.000 | 0.39164 | 2.553 | 0.033941 | 45.373 | 45237.7 | 49833.8 | 247.183 | 76.78 | 86.05 | 411 |
| 580.000 | 0.37726 | 2.651 | 0.032623 | 47.206 | 46804.2 | 51575.5 | 250.239 | 78.95 | 88.14 | 419 |
| 600.000 | 0.36395 | 2.748 | 0.031410 | 49.026 | 48412.8 | 53358.5 | 253.262 | 81.07 | 90.19 | 426 |

Table 27. Thermophysical properties along isobars (Continued)

ETHANE ISOBAR AT P = 20.0 BAR

| T | DEN | VOL | DF/DT | DF/DD | E | H | S | CV | CP | W |
|---|---|---|---|---|---|---|---|---|---|---|
| DEG K | MOL/L | L/MOL | BAR/K | BAR-L/MOL | J/MOL | J/MOL | J/MOL/K | J/MOL/K | J/MOL/K | M/SEC |
| 90.211 | 21.689 | 0.04611 | 34.9477 | 965.567 | 5306.1 | 5398.3 | 76.579 | 44.22 | 68.48 | 2230 |
| 100.000 | 21.337 | 0.04687 | 31.1067 | 868.059 | 5975.4 | 6069.1 | 83.639 | 44.11 | 68.59 | 2119 |
| 110.000 | 20.979 | 0.04767 | 27.8303 | 778.584 | 6660.5 | 6755.9 | 90.184 | 43.91 | 68.77 | 2014 |
| 120.000 | 20.621 | 0.04849 | 25.0407 | 697.814 | 7347.7 | 7444.7 | 96.178 | 43.66 | 69.02 | 1915 |
| 130.000 | 20.261 | 0.04936 | 22.6224 | 624.582 | 8037.8 | 8136.5 | 101.715 | 43.41 | 69.35 | 1822 |
| 140.000 | 19.896 | 0.05026 | 20.4949 | 557.989 | 8731.6 | 8832.1 | 106.869 | 43.17 | 69.79 | 1732 |
| 150.000 | 19.526 | 0.05121 | 18.5995 | 497.280 | 9430.2 | 9532.6 | 111.702 | 42.96 | 70.33 | 1645 |
| 160.000 | 19.148 | 0.05223 | 16.8933 | 441.816 | 10134.8 | 10239.2 | 116.262 | 42.82 | 71.00 | 1561 |
| 170.000 | 18.761 | 0.05330 | 15.3436 | 391.040 | 10846.6 | 10953.2 | 120.590 | 42.74 | 71.82 | 1478 |
| 180.000 | 18.363 | 0.05446 | 13.9254 | 344.452 | 11567.2 | 11676.1 | 124.722 | 42.74 | 72.80 | 1397 |
| 190.000 | 17.951 | 0.05571 | 12.6190 | 301.607 | 12298.4 | 12409.8 | 128.688 | 42.84 | 73.97 | 1316 |
| 200.000 | 17.525 | 0.05706 | 11.4083 | 262.098 | 13042.1 | 13156.2 | 132.517 | 43.03 | 75.36 | 1236 |
| 210.000 | 17.080 | 0.05855 | 10.2799 | 225.564 | 13800.9 | 13918.0 | 136.233 | 43.31 | 77.04 | 1155 |
| 220.000 | 16.612 | 0.06020 | 9.2221 | 191.674 | 14577.8 | 14698.1 | 139.862 | 43.69 | 79.06 | 1074 |
| 230.000 | 16.115 | 0.06205 | 8.2240 | 160.131 | 15376.7 | 15500.8 | 143.429 | 44.16 | 81.57 | 992 |
| 240.000 | 15.581 | 0.06418 | 7.2744 | 130.660 | 16203.3 | 16331.7 | 146.965 | 44.71 | 84.75 | 908 |
| 250.000 | 14.996 | 0.06669 | 6.3606 | 102.999 | 17066.0 | 17199.4 | 150.507 | 45.35 | 89.02 | 820 |
| 260.000 | 14.335 | 0.06976 | 5.4656 | 76.873 | 17979.0 | 18118.5 | 154.111 | 46.07 | 95.24 | 727 |
| 266.010 | 13.884 | 0.07203 | 4.9257 | 61.767 | 18562.4 | 18706.4 | 156.346 | 46.55 | 100.76 | 667 |
| | | | | | | | | | | |
| 266.010 | 1.250 | 0.80009 | 0.1389 | 10.275 | 26917.3 | 28517.4 | 193.262 | 46.34 | 78.34 | 240 |
| 270.000 | 1.200 | 0.83336 | 0.1306 | 11.261 | 27155.4 | 28822.1 | 194.398 | 46.07 | 74.47 | 246 |
| 280.000 | 1.101 | 0.90861 | 0.1151 | 13.406 | 27717.4 | 29534.7 | 196.992 | 45.98 | 68.83 | 258 |
| 290.000 | 1.024 | 0.97637 | 0.1041 | 15.256 | 28254.1 | 30206.8 | 199.352 | 46.36 | 66.00 | 269 |
| 300.000 | 0.962 | 1.03931 | 0.0957 | 16.917 | 28780.3 | 30858.9 | 201.562 | 47.00 | 64.53 | 278 |
| 310.000 | 0.910 | 1.09888 | 0.0889 | 18.447 | 29302.1 | 31499.9 | 203.665 | 47.80 | 63.84 | 286 |
| 320.000 | 0.865 | 1.15592 | 0.0833 | 19.878 | 29824.7 | 32136.6 | 205.688 | 48.72 | 63.64 | 294 |
| 330.000 | 0.826 | 1.21100 | 0.0785 | 21.232 | 30351.2 | 32773.2 | 207.648 | 49.72 | 63.78 | 301 |
| 340.000 | 0.791 | 1.26452 | 0.0744 | 22.526 | 30884.2 | 33413.2 | 209.557 | 50.79 | 64.16 | 308 |
| 350.000 | 0.759 | 1.31676 | 0.0709 | 23.770 | 31423.7 | 34057.2 | 211.424 | 51.90 | 64.72 | 314 |
| 360.000 | 0.731 | 1.36795 | 0.0677 | 24.972 | 31971.6 | 34707.5 | 213.257 | 53.05 | 65.41 | 320 |
| 370.000 | 0.705 | 1.41824 | 0.0648 | 26.140 | 32528.8 | 35365.3 | 215.060 | 54.23 | 66.20 | 326 |
| 380.000 | 0.681 | 1.46777 | 0.0623 | 27.278 | 33095.8 | 36031.3 | 216.837 | 55.43 | 67.07 | 331 |
| 390.000 | 0.659 | 1.51664 | 0.0599 | 28.390 | 33673.2 | 36706.4 | 218.591 | 56.64 | 68.00 | 337 |
| 400.000 | 0.639 | 1.56493 | 0.0578 | 29.480 | 34261.2 | 37391.1 | 220.325 | 57.87 | 68.98 | 342 |
| 410.000 | 0.620 | 1.61273 | 0.0559 | 30.551 | 34860.2 | 38085.7 | 222.040 | 59.10 | 69.99 | 347 |
| 420.000 | 0.602 | 1.66008 | 0.0541 | 31.604 | 35470.5 | 38790.6 | 223.739 | 60.33 | 71.03 | 352 |
| 430.000 | 0.586 | 1.70704 | 0.0524 | 32.642 | 36092.9 | 39507.0 | 225.423 | 61.56 | 72.10 | 357 |
| 440.000 | 0.570 | 1.75364 | 0.0508 | 33.666 | 36725.9 | 40233.2 | 227.093 | 62.79 | 73.18 | 361 |
| 450.000 | 0.556 | 1.79993 | 0.0494 | 34.679 | 37370.3 | 40970.2 | 228.750 | 64.01 | 74.26 | 366 |
| 460.000 | 0.542 | 1.84593 | 0.0480 | 35.680 | 38026.2 | 41718.1 | 230.394 | 65.23 | 75.36 | 370 |
| 470.000 | 0.529 | 1.89167 | 0.0468 | 36.671 | 38693.7 | 42477.0 | 232.026 | 66.43 | 76.46 | 375 |
| 480.000 | 0.516 | 1.93718 | 0.0455 | 37.653 | 39372.6 | 43246.9 | 233.648 | 67.63 | 77.56 | 379 |
| 490.000 | 0.504 | 1.98247 | 0.0444 | 38.627 | 40062.9 | 44027.8 | 235.258 | 68.82 | 78.65 | 383 |
| 500.000 | 0.493 | 2.02757 | 0.0433 | 39.593 | 40764.6 | 44819.7 | 236.858 | 70.00 | 79.75 | 387 |
| 520.000 | 0.472 | 2.11723 | 0.0414 | 41.505 | 42201.7 | 46436.1 | 240.028 | 72.31 | 81.92 | 395 |
| 540.000 | 0.453 | 2.20628 | 0.0396 | 43.394 | 43683.2 | 48095.8 | 243.160 | 74.58 | 84.07 | 403 |
| 560.000 | 0.436 | 2.29479 | 0.0379 | 45.262 | 45208.4 | 49798.0 | 246.256 | 76.80 | 86.18 | 411 |
| 580.000 | 0.420 | 2.38285 | 0.0364 | 47.113 | 46776.4 | 51542.1 | 249.316 | 78.97 | 88.25 | 418 |
| 600.000 | 0.405 | 2.47050 | 0.0351 | 48.948 | 48386.4 | 53327.4 | 252.343 | 81.09 | 90.29 | 426 |

Table 27. Thermophysical properties along isobars (Continued)

ETHANE ISOBAR AT P = 22.0 BAR

| T DEG K | DEN MOL/L | VOL L/MOL | DF/DT BAR/K | DF/DD BAR-L/MOL | E J/MOL | H J/MOL | S J/MOL/K | CV J/MOL/K | CP J/MOL/K | W M/SEC |
|---|---|---|---|---|---|---|---|---|---|---|
| 90.242 | 21.690 | 0.04610 | 34.9356 | 965.878 | 5306.8 | 5408.2 | 76.588 | 44.24 | 68.47 | 2230 |
| 100.000 | 21.339 | 0.04686 | 31.1096 | 868.747 | 5973.8 | 6076.9 | 83.623 | 44.12 | 68.59 | 2119 |
| 110.000 | 20.982 | 0.04766 | 27.8347 | 779.314 | 6658.8 | 6763.6 | 90.168 | 43.92 | 68.76 | 2014 |
| 120.000 | 20.624 | 0.04849 | 25.0462 | 698.582 | 7345.7 | 7452.4 | 96.161 | 43.68 | 69.01 | 1916 |
| 130.000 | 20.264 | 0.04935 | 22.6292 | 625.385 | 8035.5 | 8144.1 | 101.697 | 43.42 | 69.34 | 1822 |
| 140.000 | 19.900 | 0.05025 | 20.5027 | 558.821 | 8729.0 | 8839.6 | 106.851 | 43.18 | 69.77 | 1733 |
| 150.000 | 19.530 | 0.05120 | 18.6084 | 498.141 | 9427.3 | 9539.9 | 111.682 | 42.98 | 70.32 | 1646 |
| 160.000 | 19.152 | 0.05221 | 16.9032 | 442.704 | 10131.5 | 10246.3 | 116.241 | 42.83 | 70.98 | 1562 |
| 170.000 | 18.766 | 0.05329 | 15.3547 | 391.955 | 10842.8 | 10960.1 | 120.568 | 42.75 | 71.79 | 1479 |
| 180.000 | 18.368 | 0.05444 | 13.9376 | 345.394 | 11562.9 | 11682.7 | 124.698 | 42.76 | 72.77 | 1398 |
| 190.000 | 17.958 | 0.05569 | 12.6324 | 302.578 | 12293.5 | 12416.0 | 128.662 | 42.85 | 73.93 | 1318 |
| 200.000 | 17.532 | 0.05704 | 11.4230 | 263.101 | 13036.5 | 13162.0 | 132.488 | 43.04 | 75.31 | 1237 |
| 210.000 | 17.088 | 0.05852 | 10.2961 | 226.602 | 13794.4 | 13923.1 | 136.202 | 43.33 | 76.97 | 1157 |
| 220.000 | 16.622 | 0.06016 | 9.2400 | 192.753 | 14570.2 | 14702.5 | 139.827 | 43.71 | 78.97 | 1076 |
| 230.000 | 16.127 | 0.06201 | 8.2438 | 161.258 | 15367.7 | 15504.2 | 143.390 | 44.18 | 81.44 | 994 |
| 240.000 | 15.596 | 0.06412 | 7.2967 | 131.845 | 16192.5 | 16333.6 | 146.920 | 44.73 | 84.58 | 911 |
| 250.000 | 15.015 | 0.06660 | 6.3864 | 104.259 | 17052.6 | 17199.1 | 150.452 | 45.37 | 88.75 | 824 |
| 260.000 | 14.361 | 0.06963 | 5.4963 | 78.235 | 17961.4 | 18114.6 | 154.042 | 46.09 | 94.77 | 731 |
| 269.819 | 13.604 | 0.07351 | 4.6160 | 53.875 | 18926.6 | 19088.3 | 157.717 | 46.89 | 104.55 | 632 |
| | | | | | | | | | | |
| 269.819 | 1.394 | 0.71720 | 0.1582 | 9.597 | 26940.9 | 28518.8 | 192.699 | 47.27 | 83.46 | 237 |
| 270.000 | 1.391 | 0.71874 | 0.1577 | 9.649 | 26952.7 | 28533.9 | 192.755 | 47.24 | 83.18 | 238 |
| 280.000 | 1.257 | 0.79540 | 0.1355 | 12.135 | 27559.7 | 29309.5 | 195.579 | 46.69 | 73.48 | 252 |
| 290.000 | 1.160 | 0.86202 | 0.1208 | 14.191 | 28123.1 | 30019.6 | 198.071 | 46.86 | 69.01 | 264 |
| 300.000 | 1.084 | 0.92276 | 0.1100 | 15.998 | 28666.4 | 30696.5 | 200.368 | 47.38 | 66.69 | 274 |
| 310.000 | 1.021 | 0.97955 | 0.1015 | 17.638 | 29201.2 | 31356.2 | 202.532 | 48.10 | 65.48 | 283 |
| 320.000 | 0.968 | 1.03349 | 0.0946 | 19.157 | 29734.6 | 32008.3 | 204.601 | 48.97 | 64.95 | 291 |
| 330.000 | 0.921 | 1.08528 | 0.0889 | 20.583 | 30269.0 | 32656.6 | 206.598 | 49.93 | 64.85 | 298 |
| 340.000 | 0.881 | 1.13536 | 0.0840 | 21.938 | 30807.9 | 33305.7 | 208.536 | 50.96 | 65.06 | 305 |
| 350.000 | 0.845 | 1.18408 | 0.0797 | 23.234 | 31353.0 | 33958.0 | 210.428 | 52.05 | 65.48 | 312 |
| 360.000 | 0.812 | 1.23167 | 0.0760 | 24.482 | 31905.6 | 34615.3 | 212.280 | 53.18 | 66.07 | 318 |
| 370.000 | 0.782 | 1.27832 | 0.0727 | 25.690 | 32467.7 | 35280.0 | 214.100 | 54.35 | 66.78 | 324 |
| 380.000 | 0.755 | 1.32417 | 0.0697 | 26.863 | 33038.3 | 35951.5 | 215.891 | 55.53 | 67.58 | 330 |
| 390.000 | 0.730 | 1.36934 | 0.0670 | 28.007 | 33618.8 | 36631.4 | 217.658 | 56.73 | 68.45 | 335 |
| 400.000 | 0.707 | 1.41391 | 0.0645 | 29.126 | 34209.7 | 37320.3 | 219.402 | 57.95 | 69.39 | 341 |
| 410.000 | 0.686 | 1.45797 | 0.0623 | 30.223 | 34811.3 | 38016.8 | 221.128 | 59.17 | 70.36 | 346 |
| 420.000 | 0.666 | 1.50157 | 0.0602 | 31.300 | 35423.8 | 38727.2 | 222.835 | 60.39 | 71.37 | 351 |
| 430.000 | 0.647 | 1.54476 | 0.0583 | 32.359 | 36047.4 | 39445.9 | 224.527 | 61.62 | 72.40 | 356 |
| 440.000 | 0.630 | 1.58760 | 0.0565 | 33.404 | 36682.2 | 40175.0 | 226.203 | 62.84 | 73.46 | 360 |
| 450.000 | 0.613 | 1.63011 | 0.0549 | 34.434 | 37328.4 | 40914.7 | 227.866 | 64.06 | 74.52 | 365 |
| 460.000 | 0.598 | 1.67234 | 0.0534 | 35.452 | 37986.9 | 41666.0 | 229.516 | 65.27 | 75.60 | 370 |
| 470.000 | 0.583 | 1.71430 | 0.0519 | 36.460 | 38655.8 | 42427.3 | 231.153 | 66.47 | 76.68 | 374 |
| 480.000 | 0.569 | 1.75602 | 0.0505 | 37.456 | 39336.1 | 43199.3 | 232.779 | 67.67 | 77.76 | 378 |
| 490.000 | 0.556 | 1.79752 | 0.0493 | 38.444 | 40027.7 | 43982.2 | 234.393 | 68.85 | 78.85 | 383 |
| 500.000 | 0.544 | 1.83883 | 0.0481 | 39.423 | 40730.5 | 44775.9 | 235.997 | 70.03 | 79.93 | 387 |
| 520.000 | 0.521 | 1.92091 | 0.0458 | 41.359 | 42169.8 | 46395.8 | 239.174 | 72.34 | 82.08 | 395 |
| 540.000 | 0.499 | 2.00237 | 0.0438 | 43.269 | 43653.2 | 48058.4 | 242.312 | 74.61 | 84.21 | 403 |
| 560.000 | 0.480 | 2.08330 | 0.0420 | 45.156 | 45180.1 | 49763.4 | 245.412 | 76.82 | 86.31 | 411 |
| 580.000 | 0.462 | 2.16376 | 0.0403 | 47.024 | 46749.6 | 51509.9 | 248.477 | 78.99 | 88.37 | 418 |
| 600.000 | 0.446 | 2.24383 | 0.0388 | 48.875 | 48361.0 | 53297.4 | 251.507 | 81.11 | 90.40 | 426 |

Table 27. Thermophysical properties along isobars (Continued)

ETHANE ISOBAR AT P = 24.0 BAR

| T DEG K | DEN MOL/L | VOL L/MOL | DP/DT BAR/K | DP/DD BAR-L/MOL | E J/MOL | H J/MOL | S J/MOL/K | CV J/MOL/K | CP J/MOL/K | W M/SEC |
|---|---|---|---|---|---|---|---|---|---|---|
| 90.273 | 21.691 | 0.04610 | 34.9235 | 966.188 | 5307.6 | 5418.2 | 76.596 | 44.25 | 68.47 | 2230 |
| 100.000 | 21.342 | 0.04686 | 31.1125 | 869.434 | 5972.3 | 6084.7 | 83.607 | 44.14 | 68.58 | 2120 |
| 110.000 | 20.985 | 0.04765 | 27.8390 | 780.045 | 6657.0 | 6771.4 | 90.151 | 43.94 | 68.76 | 2015 |
| 120.000 | 20.627 | 0.04848 | 25.0518 | 699.350 | 7343.7 | 7460.1 | 96.144 | 43.69 | 69.00 | 1916 |
| 130.000 | 20.267 | 0.04934 | 22.6359 | 626.186 | 8033.3 | 8151.7 | 101.679 | 43.44 | 69.33 | 1823 |
| 140.000 | 19.904 | 0.05024 | 20.5105 | 559.654 | 8726.5 | 8847.1 | 106.832 | 43.20 | 69.76 | 1734 |
| 150.000 | 19.534 | 0.05119 | 18.6173 | 499.001 | 9424.4 | 9547.2 | 111.663 | 42.99 | 70.30 | 1647 |
| 160.000 | 19.157 | 0.05220 | 16.9132 | 443.592 | 10128.2 | 10253.4 | 116.220 | 42.85 | 70.96 | 1563 |
| 170.000 | 18.771 | 0.05327 | 15.3657 | 392.869 | 10839.1 | 10966.9 | 120.546 | 42.77 | 71.77 | 1481 |
| 180.000 | 18.374 | 0.05442 | 13.9498 | 346.336 | 11558.7 | 11689.3 | 124.674 | 42.78 | 72.73 | 1399 |
| 190.000 | 17.965 | 0.05567 | 12.6458 | 303.548 | 12288.6 | 12422.2 | 128.636 | 42.87 | 73.89 | 1319 |
| 200.000 | 17.540 | 0.05701 | 11.4377 | 264.102 | 13030.9 | 13167.7 | 132.460 | 43.06 | 75.26 | 1239 |
| 210.000 | 17.097 | 0.05849 | 10.3122 | 227.638 | 13787.9 | 13928.3 | 136.171 | 43.34 | 76.90 | 1159 |
| 220.000 | 16.632 | 0.06012 | 9.2577 | 193.829 | 14562.6 | 14706.9 | 139.792 | 43.72 | 78.89 | 1078 |
| 230.000 | 16.140 | 0.06196 | 8.2636 | 162.381 | 15358.8 | 15507.5 | 143.351 | 44.19 | 81.32 | 997 |
| 240.000 | 15.611 | 0.06406 | 7.3189 | 133.025 | 16181.8 | 16335.5 | 146.874 | 44.75 | 84.40 | 913 |
| 250.000 | 15.034 | 0.06652 | 6.4119 | 105.512 | 17039.2 | 17198.9 | 150.398 | 45.39 | 88.48 | 827 |
| 260.000 | 14.386 | 0.06951 | 5.5267 | 79.586 | 17944.1 | 18110.9 | 153.974 | 46.10 | 94.32 | 736 |
| 270.000 | 13.625 | 0.07339 | 4.6379 | 54.935 | 18921.0 | 19097.2 | 157.695 | 46.92 | 103.87 | 636 |
| 273.382 | 13.326 | 0.07504 | 4.3283 | 46.800 | 19276.4 | 19456.5 | 159.018 | 47.22 | 108.85 | 599 |
| | | | | | | | | | | |
| 273.382 | 1.546 | 0.64697 | 0.1790 | 8.907 | 26951.6 | 28504.4 | 192.144 | 48.18 | 89.33 | 234 |
| 280.000 | 1.432 | 0.69831 | 0.1594 | 10.757 | 27383.9 | 29059.9 | 194.154 | 47.54 | 79.78 | 245 |
| 290.000 | 1.307 | 0.76521 | 0.1396 | 13.066 | 27981.4 | 29817.9 | 196.815 | 47.42 | 72.73 | 258 |
| 300.000 | 1.213 | 0.82468 | 0.1257 | 15.039 | 28546.1 | 30525.3 | 199.215 | 47.79 | 69.21 | 269 |
| 310.000 | 1.137 | 0.87949 | 0.1151 | 16.802 | 29096.6 | 31207.3 | 201.451 | 48.42 | 67.34 | 279 |
| 320.000 | 1.074 | 0.93105 | 0.1068 | 18.416 | 29640.6 | 31875.1 | 203.572 | 49.22 | 66.39 | 287 |
| 330.000 | 1.020 | 0.98022 | 0.0999 | 19.920 | 30183.9 | 32536.4 | 205.608 | 50.14 | 66.01 | 295 |
| 340.000 | 0.973 | 1.02753 | 0.0940 | 21.340 | 30730.6 | 33196.6 | 207.578 | 51.14 | 66.02 | 303 |
| 350.000 | 0.932 | 1.07338 | 0.0890 | 22.691 | 31281.6 | 33857.7 | 209.495 | 52.20 | 66.29 | 310 |
| 360.000 | 0.894 | 1.11802 | 0.0847 | 23.986 | 31839.3 | 34522.6 | 211.369 | 53.31 | 66.76 | 316 |
| 370.000 | 0.861 | 1.16168 | 0.0808 | 25.235 | 32404.9 | 35192.9 | 213.206 | 54.46 | 67.38 | 322 |
| 380.000 | 0.830 | 1.20449 | 0.0774 | 26.446 | 32979.3 | 35870.0 | 215.013 | 55.63 | 68.11 | 328 |
| 390.000 | 0.802 | 1.24660 | 0.0743 | 27.623 | 33563.1 | 36554.9 | 216.792 | 56.82 | 68.92 | 334 |
| 400.000 | 0.776 | 1.28808 | 0.0715 | 28.771 | 34157.7 | 37249.1 | 218.548 | 58.03 | 69.81 | 339 |
| 410.000 | 0.752 | 1.32904 | 0.0689 | 29.894 | 34761.9 | 37951.6 | 220.283 | 59.24 | 70.74 | 345 |
| 420.000 | 0.730 | 1.36952 | 0.0665 | 30.996 | 35376.7 | 38663.6 | 222.000 | 60.46 | 71.71 | 350 |
| 430.000 | 0.709 | 1.40959 | 0.0644 | 32.078 | 36002.5 | 39385.5 | 223.699 | 61.68 | 72.72 | 355 |
| 440.000 | 0.690 | 1.44929 | 0.0624 | 33.143 | 36639.3 | 40117.6 | 225.382 | 62.89 | 73.74 | 359 |
| 450.000 | 0.672 | 1.48867 | 0.0605 | 34.192 | 37287.3 | 40860.1 | 227.051 | 64.11 | 74.79 | 364 |
| 460.000 | 0.655 | 1.52775 | 0.0588 | 35.228 | 37946.4 | 41613.0 | 228.706 | 65.31 | 75.84 | 369 |
| 470.000 | 0.638 | 1.56656 | 0.0571 | 36.251 | 38616.8 | 42376.6 | 230.349 | 66.52 | 76.91 | 373 |
| 480.000 | 0.623 | 1.60513 | 0.0556 | 37.263 | 39298.5 | 43150.8 | 231.979 | 67.71 | 77.97 | 378 |
| 490.000 | 0.608 | 1.64348 | 0.0542 | 38.265 | 39991.4 | 43935.7 | 233.598 | 68.89 | 79.04 | 382 |
| 500.000 | 0.595 | 1.68162 | 0.0528 | 39.257 | 40696.4 | 44732.3 | 235.205 | 70.06 | 80.11 | 386 |
| 520.000 | 0.569 | 1.75738 | 0.0503 | 41.217 | 42137.8 | 46355.5 | 238.389 | 72.37 | 82.24 | 395 |
| 540.000 | 0.546 | 1.83252 | 0.0481 | 43.148 | 43623.2 | 48021.3 | 241.533 | 74.63 | 84.35 | 403 |
| 560.000 | 0.524 | 1.90712 | 0.0461 | 45.054 | 45151.8 | 49728.9 | 244.638 | 76.85 | 86.43 | 411 |
| 580.000 | 0.505 | 1.98127 | 0.0442 | 46.939 | 46722.8 | 51477.9 | 247.707 | 79.01 | 88.49 | 418 |
| 600.000 | 0.487 | 2.05501 | 0.0425 | 48.806 | 48335.6 | 53267.6 | 250.741 | 81.12 | 90.50 | 426 |

Table 27. Thermophysical properties along isobars (Continued)

ETHANE ISOBAR AT P = 26.0 BAR

| T DEG K | DEN MOL/L | VOL L/MOL | DF/DT BAR/K | DF/DD BAR-L/MOL | E J/MOL | H J/MOL | S J/MOL/K | CV J/MOL/K | CP J/MOL/K | W M/SEC |
|---|---|---|---|---|---|---|---|---|---|---|
| 90.304 | 21.692 | 0.04610 | 34.9114 | 966.500 | 5308.3 | 5428.2 | 76.604 | 44.27 | 68.47 | 2230 |
| 100.000 | 21.344 | 0.04685 | 31.1154 | 870.121 | 5970.7 | 6092.5 | 83.592 | 44.15 | 68.58 | 2120 |
| 110.000 | 20.987 | 0.04765 | 27.8433 | 780.775 | 6655.2 | 6779.1 | 90.135 | 43.95 | 68.75 | 2015 |
| 120.000 | 20.630 | 0.04847 | 25.0573 | 700.118 | 7341.7 | 7467.8 | 96.127 | 43.71 | 68.99 | 1917 |
| 130.000 | 20.271 | 0.04933 | 22.6426 | 626.988 | 8031.0 | 8159.3 | 101.662 | 43.45 | 69.32 | 1824 |
| 140.000 | 19.907 | 0.05023 | 20.5183 | 560.485 | 8723.9 | 8854.5 | 106.814 | 43.21 | 69.75 | 1735 |
| 150.000 | 19.538 | 0.05118 | 18.6261 | 499.861 | 9421.5 | 9554.6 | 111.643 | 43.01 | 70.28 | 1648 |
| 160.000 | 19.161 | 0.05219 | 16.9231 | 444.479 | 10124.9 | 10260.5 | 116.199 | 42.86 | 70.94 | 1564 |
| 170.000 | 18.776 | 0.05326 | 15.3767 | 393.782 | 10835.4 | 10973.8 | 120.523 | 42.79 | 71.74 | 1482 |
| 180.000 | 18.380 | 0.05441 | 13.9619 | 347.276 | 11554.4 | 11695.9 | 124.650 | 42.79 | 72.70 | 1401 |
| 190.000 | 17.971 | 0.05564 | 12.6591 | 304.517 | 12283.8 | 12428.4 | 128.611 | 42.89 | 73.85 | 1321 |
| 200.000 | 17.548 | 0.05699 | 11.4523 | 265.102 | 13025.4 | 13173.5 | 132.432 | 43.08 | 75.21 | 1241 |
| 210.000 | 17.106 | 0.05846 | 10.3282 | 228.673 | 13781.5 | 13933.5 | 136.140 | 43.36 | 76.84 | 1161 |
| 220.000 | 16.643 | 0.06009 | 9.2754 | 194.903 | 14555.2 | 14711.4 | 139.758 | 43.74 | 78.80 | 1081 |
| 230.000 | 16.152 | 0.06191 | 8.2832 | 163.501 | 15350.0 | 15511.0 | 143.312 | 44.21 | 81.20 | 999 |
| 240.000 | 15.626 | 0.06399 | 7.3410 | 134.201 | 16171.1 | 16337.5 | 146.829 | 44.76 | 84.23 | 916 |
| 250.000 | 15.053 | 0.06643 | 6.4371 | 106.758 | 17026.1 | 17198.8 | 150.345 | 45.40 | 88.22 | 831 |
| 260.000 | 14.411 | 0.06939 | 5.5566 | 80.928 | 17927.1 | 18107.5 | 153.908 | 46.12 | 93.88 | 740 |
| 270.000 | 13.661 | 0.07320 | 4.6755 | 56.419 | 18897.2 | 19087.6 | 157.606 | 46.93 | 102.99 | 642 |
| 276.734 | 13.050 | 0.07663 | 4.0584 | 43.423 | 19614.8 | 19814.0 | 160.263 | 47.56 | 113.77 | 567 |
| | | | | | | | | | | |
| 276.734 | 1.705 | 0.58650 | 0.2014 | 8.207 | 26950.1 | 28475.0 | 191.589 | 49.10 | 96.16 | 231 |
| 280.000 | 1.632 | 0.61269 | 0.1884 | 9.244 | 27183.2 | 28776.1 | 192.672 | 48.59 | 88.92 | 237 |
| 290.000 | 1.467 | 0.68154 | 0.1609 | 11.873 | 27827.2 | 29599.2 | 195.562 | 48.05 | 77.44 | 252 |
| 300.000 | 1.350 | 0.74065 | 0.1430 | 14.040 | 28418.9 | 30344.5 | 198.089 | 48.23 | 72.21 | 264 |
| 310.000 | 1.259 | 0.79415 | 0.1299 | 15.938 | 28986.3 | 31051.1 | 200.408 | 48.76 | 69.47 | 275 |
| 320.000 | 1.185 | 0.84392 | 0.1197 | 17.656 | 29543.7 | 31737.9 | 202.587 | 49.49 | 68.00 | 284 |
| 330.000 | 1.122 | 0.89101 | 0.1115 | 19.243 | 30096.8 | 32413.4 | 204.667 | 50.36 | 67.28 | 292 |
| 340.000 | 1.068 | 0.93608 | 0.1046 | 20.730 | 30650.6 | 33084.4 | 206.672 | 51.33 | 67.05 | 300 |
| 350.000 | 1.021 | 0.97956 | 0.0987 | 22.139 | 31208.1 | 33754.9 | 208.616 | 52.36 | 67.15 | 307 |
| 360.000 | 0.979 | 1.02176 | 0.0937 | 23.484 | 31771.8 | 34428.4 | 210.512 | 53.45 | 67.49 | 314 |
| 370.000 | 0.941 | 1.06292 | 0.0892 | 24.776 | 32342.0 | 35105.5 | 212.368 | 54.58 | 68.01 | 320 |
| 380.000 | 0.906 | 1.10319 | 0.0853 | 26.025 | 32920.3 | 35788.6 | 214.190 | 55.73 | 68.66 | 327 |
| 390.000 | 0.875 | 1.14273 | 0.0818 | 27.235 | 33507.5 | 36478.6 | 215.983 | 56.91 | 69.41 | 332 |
| 400.000 | 0.846 | 1.18162 | 0.0786 | 28.414 | 34104.4 | 37176.6 | 217.751 | 58.11 | 70.24 | 338 |
| 410.000 | 0.820 | 1.21996 | 0.0757 | 29.565 | 34711.3 | 37883.2 | 219.496 | 59.31 | 71.13 | 343 |
| 420.000 | 0.795 | 1.25782 | 0.0730 | 30.691 | 35329.4 | 38599.7 | 221.221 | 60.52 | 72.06 | 349 |
| 430.000 | 0.772 | 1.29526 | 0.0706 | 31.796 | 35957.3 | 39325.0 | 222.928 | 61.74 | 73.04 | 354 |
| 440.000 | 0.751 | 1.33231 | 0.0683 | 32.882 | 36596.1 | 40060.1 | 224.619 | 62.95 | 74.04 | 359 |
| 450.000 | 0.730 | 1.36903 | 0.0662 | 33.951 | 37245.9 | 40805.4 | 226.294 | 64.16 | 75.05 | 363 |
| 460.000 | 0.712 | 1.40545 | 0.0643 | 35.004 | 37906.7 | 41560.9 | 227.955 | 65.36 | 76.09 | 368 |
| 470.000 | 0.694 | 1.44160 | 0.0625 | 36.044 | 38578.7 | 42326.8 | 229.602 | 66.56 | 77.13 | 373 |
| 480.000 | 0.677 | 1.47751 | 0.0608 | 37.071 | 39261.7 | 43103.3 | 231.237 | 67.75 | 78.19 | 377 |
| 490.000 | 0.661 | 1.51319 | 0.0592 | 38.087 | 39955.9 | 43890.2 | 232.860 | 68.92 | 79.24 | 382 |
| 500.000 | 0.646 | 1.54867 | 0.0577 | 39.093 | 40661.2 | 44687.8 | 234.472 | 70.09 | 80.30 | 386 |
| 520.000 | 0.618 | 1.61908 | 0.0549 | 41.077 | 42104.9 | 46314.5 | 237.662 | 72.40 | 82.40 | 394 |
| 540.000 | 0.592 | 1.68887 | 0.0524 | 43.030 | 43593.1 | 47984.2 | 240.811 | 74.66 | 84.50 | 402 |
| 560.000 | 0.569 | 1.75812 | 0.0502 | 44.956 | 45123.5 | 49694.6 | 243.922 | 76.87 | 86.56 | 410 |
| 580.000 | 0.547 | 1.82691 | 0.0481 | 46.858 | 46696.0 | 51446.0 | 246.995 | 79.03 | 88.60 | 418 |
| 600.000 | 0.528 | 1.89529 | 0.0463 | 48.740 | 48310.1 | 53237.9 | 250.033 | 81.14 | 90.61 | 425 |

Table 27. Thermophysical properties along isobars (Continued)

ETHANE ISOBAR AT P = 28.0 BAR

| T DEG K | DEN MOL/L | VOL L/MOL | DP/DT BAR/K | DP/DD BAR-L/MOL | E J/MOL | H J/MOL | S J/MOL/K | CV J/MOL/K | CP J/MOL/K | W M/SEC |
|---|---|---|---|---|---|---|---|---|---|---|
| 90.335 | 21.693 | 0.04610 | 34.8994 | 966.812 | 5309.1 | 5438.1 | 76.612 | 44.28 | 68.47 | 2230 |
| 100.000 | 21.346 | 0.04685 | 31.1183 | 870.807 | 5969.2 | 6100.3 | 83.576 | 44.17 | 68.57 | 2120 |
| 110.000 | 20.990 | 0.04764 | 27.8476 | 781.505 | 6653.5 | 6786.9 | 90.119 | 43.97 | 68.74 | 2016 |
| 120.000 | 20.633 | 0.04847 | 25.0629 | 700.886 | 7339.7 | 7475.4 | 96.110 | 43.72 | 68.99 | 1918 |
| 130.000 | 20.274 | 0.04932 | 22.6493 | 627.789 | 8028.7 | 8166.9 | 101.644 | 43.47 | 69.31 | 1825 |
| 140.000 | 19.911 | 0.05022 | 20.5261 | 561.316 | 8721.3 | 8862.0 | 106.795 | 43.23 | 69.73 | 1735 |
| 150.000 | 19.542 | 0.05117 | 18.6350 | 500.720 | 9418.6 | 9561.9 | 111.624 | 43.02 | 70.26 | 1649 |
| 160.000 | 19.166 | 0.05218 | 16.9330 | 445.365 | 10121.6 | 10267.7 | 116.179 | 42.88 | 70.92 | 1565 |
| 170.000 | 18.781 | 0.05325 | 15.3877 | 394.694 | 10831.6 | 10980.7 | 120.501 | 42.80 | 71.71 | 1483 |
| 180.000 | 18.386 | 0.05439 | 13.9740 | 348.215 | 11550.2 | 11702.5 | 124.626 | 42.81 | 72.67 | 1402 |
| 190.000 | 17.978 | 0.05562 | 12.6724 | 305.484 | 12278.9 | 12434.7 | 128.585 | 42.90 | 73.81 | 1322 |
| 200.000 | 17.555 | 0.05696 | 11.4668 | 266.100 | 13019.8 | 13179.3 | 132.404 | 43.09 | 75.16 | 1242 |
| 210.000 | 17.115 | 0.05843 | 10.3442 | 229.705 | 13775.1 | 13938.7 | 136.109 | 43.38 | 76.77 | 1163 |
| 220.000 | 16.653 | 0.06005 | 9.2930 | 195.974 | 14547.7 | 14715.9 | 139.724 | 43.76 | 78.71 | 1083 |
| 230.000 | 16.164 | 0.06186 | 8.3027 | 164.617 | 15341.2 | 15514.4 | 143.273 | 44.23 | 81.09 | 1002 |
| 240.000 | 15.641 | 0.06393 | 7.3629 | 135.372 | 16160.6 | 16339.6 | 146.785 | 44.78 | 84.07 | 919 |
| 250.000 | 15.072 | 0.06635 | 6.4622 | 107.999 | 17013.1 | 17198.8 | 150.292 | 45.42 | 87.97 | 834 |
| 260.000 | 14.436 | 0.06927 | 5.5861 | 82.260 | 17910.3 | 18104.3 | 153.842 | 46.13 | 93.46 | 744 |
| 270.000 | 13.696 | 0.07301 | 4.7124 | 57.886 | 18874.0 | 19078.5 | 157.518 | 46.94 | 102.16 | 647 |
| 279.901 | 12.771 | 0.07830 | 3.8033 | 34.654 | 19944.3 | 20163.5 | 161.463 | 47.89 | 119.53 | 536 |
| | | | | | | | | | | |
| 279.901 | 1.874 | 0.53370 | 0.2259 | 7.504 | 26936.3 | 28430.7 | 191.027 | 50.02 | 104.22 | 228 |
| 280.000 | 1.871 | 0.53455 | 0.2253 | 7.540 | 26944.2 | 28440.9 | 191.064 | 50.00 | 103.86 | 228 |
| 290.000 | 1.645 | 0.60779 | 0.1857 | 10.605 | 27656.9 | 29358.7 | 194.288 | 48.79 | 83.63 | 246 |
| 300.000 | 1.498 | 0.66749 | 0.1623 | 12.999 | 28282.1 | 30151.1 | 196.975 | 48.72 | 75.83 | 259 |
| 310.000 | 1.388 | 0.72029 | 0.1460 | 15.047 | 28871.0 | 30887.8 | 199.391 | 49.12 | 71.91 | 271 |
| 320.000 | 1.301 | 0.76876 | 0.1336 | 16.877 | 29442.3 | 31594.8 | 201.637 | 49.77 | 69.79 | 281 |
| 330.000 | 1.228 | 0.81422 | 0.1238 | 18.551 | 30006.3 | 32286.1 | 203.766 | 50.59 | 68.67 | 289 |
| 340.000 | 1.166 | 0.85746 | 0.1157 | 20.110 | 30569.3 | 32970.2 | 205.807 | 51.52 | 68.16 | 297 |
| 350.000 | 1.112 | 0.89898 | 0.1089 | 21.578 | 31133.6 | 33650.8 | 207.781 | 52.52 | 68.07 | 305 |
| 360.000 | 1.065 | 0.93914 | 0.1031 | 22.975 | 31702.4 | 34332.0 | 209.700 | 53.59 | 68.27 | 312 |
| 370.000 | 1.022 | 0.97819 | 0.0980 | 24.312 | 32277.3 | 35016.3 | 211.576 | 54.70 | 68.68 | 319 |
| 380.000 | 0.984 | 1.01632 | 0.0935 | 25.599 | 32860.5 | 35706.2 | 213.415 | 55.84 | 69.24 | 325 |
| 390.000 | 0.949 | 1.05367 | 0.0895 | 26.845 | 33451.4 | 36401.6 | 215.222 | 57.01 | 69.92 | 331 |
| 400.000 | 0.917 | 1.09036 | 0.0859 | 28.055 | 34051.4 | 37104.4 | 217.001 | 58.19 | 70.69 | 337 |
| 410.000 | 0.888 | 1.12647 | 0.0826 | 29.234 | 34661.1 | 37815.2 | 218.757 | 59.39 | 71.53 | 342 |
| 420.000 | 0.861 | 1.16209 | 0.0796 | 30.386 | 35280.9 | 38534.7 | 220.492 | 60.59 | 72.43 | 348 |
| 430.000 | 0.835 | 1.19728 | 0.0769 | 31.514 | 35911.1 | 39263.4 | 222.207 | 61.79 | 73.36 | 353 |
| 440.000 | 0.812 | 1.23207 | 0.0744 | 32.621 | 36551.9 | 40001.7 | 223.904 | 63.00 | 74.33 | 358 |
| 450.000 | 0.790 | 1.26653 | 0.0721 | 33.710 | 37204.3 | 40750.6 | 225.586 | 64.21 | 75.33 | 363 |
| 460.000 | 0.769 | 1.30067 | 0.0699 | 34.781 | 37866.9 | 41508.7 | 227.252 | 65.41 | 76.34 | 367 |
| 470.000 | 0.749 | 1.33454 | 0.0679 | 35.838 | 38540.4 | 42277.1 | 228.905 | 66.60 | 77.37 | 372 |
| 480.000 | 0.731 | 1.36817 | 0.0660 | 36.881 | 39224.9 | 43055.7 | 230.545 | 67.78 | 78.40 | 377 |
| 490.000 | 0.713 | 1.40156 | 0.0642 | 37.911 | 39920.4 | 43844.8 | 232.172 | 68.96 | 79.44 | 381 |
| 500.000 | 0.697 | 1.43476 | 0.0626 | 38.931 | 40626.9 | 44644.2 | 233.788 | 70.13 | 80.48 | 385 |
| 520.000 | 0.666 | 1.50059 | 0.0595 | 40.940 | 42072.8 | 46274.5 | 236.985 | 72.43 | 82.57 | 394 |
| 540.000 | 0.639 | 1.56579 | 0.0568 | 42.914 | 43562.1 | 47946.3 | 240.140 | 74.68 | 84.64 | 402 |
| 560.000 | 0.613 | 1.63046 | 0.0544 | 44.860 | 45094.1 | 49659.4 | 243.255 | 76.89 | 86.69 | 410 |
| 580.000 | 0.590 | 1.69465 | 0.0521 | 46.780 | 46669.2 | 51414.2 | 246.333 | 79.05 | 88.72 | 418 |
| 600.000 | 0.569 | 1.75845 | 0.0501 | 48.678 | 48284.7 | 53208.4 | 249.374 | 81.16 | 90.71 | 425 |

Table 27. Thermophysical properties along isobars (Continued)

ETHANE ISOBAR AT P = 30.0 BAR

| T DEG K | DEN MOL/L | VOL L/MOL | DP/DT BAR/K | DP/DD BAR-L/MOL | E J/MOL | H J/MOL | S J/MOL/K | CV J/MOL/K | CP J/MOL/K | W M/SEC |
|---|---|---|---|---|---|---|---|---|---|---|
| 90.366 | 21.694 | 0.04610 | 34.8873 | 967.124 | 5309.8 | 5448.1 | 76.621 | 44.30 | 68.46 | 2229 |
| 100.000 | 21.349 | 0.04684 | 31.1213 | 871.494 | 5967.6 | 6108.1 | 83.560 | 44.19 | 68.57 | 2121 |
| 110.000 | 20.992 | 0.04764 | 27.8519 | 782.234 | 6651.7 | 6794.6 | 90.103 | 43.98 | 68.74 | 2016 |
| 120.000 | 20.636 | 0.04846 | 25.0685 | 701.653 | 7337.7 | 7483.1 | 96.093 | 43.74 | 68.98 | 1918 |
| 130.000 | 20.277 | 0.04932 | 22.6560 | 628.589 | 8026.5 | 8174.4 | 101.627 | 43.48 | 69.30 | 1825 |
| 140.000 | 19.914 | 0.05022 | 20.5339 | 562.147 | 8718.8 | 8869.4 | 106.777 | 43.24 | 69.72 | 1736 |
| 150.000 | 19.546 | 0.05116 | 18.6438 | 501.579 | 9415.7 | 9569.2 | 111.604 | 43.04 | 70.25 | 1650 |
| 160.000 | 19.170 | 0.05216 | 16.9429 | 446.250 | 10118.3 | 10274.8 | 116.158 | 42.89 | 70.90 | 1566 |
| 170.000 | 18.786 | 0.05323 | 15.3987 | 395.606 | 10827.9 | 10987.6 | 120.479 | 42.82 | 71.69 | 1484 |
| 180.000 | 18.391 | 0.05437 | 13.9861 | 349.153 | 11546.0 | 11709.1 | 124.603 | 42.82 | 72.64 | 1403 |
| 190.000 | 17.984 | 0.05560 | 12.6856 | 306.451 | 12274.1 | 12440.9 | 128.559 | 42.92 | 73.77 | 1323 |
| 200.000 | 17.563 | 0.05694 | 11.4814 | 267.099 | 13014.3 | 13185.1 | 132.376 | 43.11 | 75.11 | 1244 |
| 210.000 | 17.123 | 0.05840 | 10.3601 | 230.735 | 13768.8 | 13944.0 | 136.078 | 43.39 | 76.71 | 1165 |
| 220.000 | 16.663 | 0.06001 | 9.3105 | 197.042 | 14540.3 | 14720.4 | 139.690 | 43.77 | 78.63 | 1085 |
| 230.000 | 16.176 | 0.06182 | 8.3221 | 165.730 | 15332.5 | 15518.0 | 143.235 | 44.24 | 80.97 | 1004 |
| 240.000 | 15.656 | 0.06387 | 7.3847 | 136.539 | 16150.1 | 16341.8 | 146.740 | 44.80 | 83.91 | 922 |
| 250.000 | 15.090 | 0.06627 | 6.4870 | 109.233 | 17000.2 | 17199.0 | 150.239 | 45.43 | 87.73 | 838 |
| 260.000 | 14.460 | 0.06916 | 5.6152 | 83.582 | 17893.8 | 18101.3 | 153.777 | 46.15 | 93.06 | 749 |
| 270.000 | 13.730 | 0.07283 | 4.7485 | 59.337 | 18851.4 | 19069.9 | 157.432 | 46.95 | 101.38 | 653 |
| 280.000 | 12.817 | 0.07802 | 3.8442 | 36.102 | 19919.8 | 20153.9 | 161.372 | 47.90 | 117.68 | 543 |
| 282.904 | 12.488 | 0.08008 | 3.5603 | 29.423 | 20267.3 | 20507.5 | 162.629 | 48.24 | 126.39 | 506 |
| 282.904 | 2.053 | 0.48705 | 0.2525 | 6.800 | 26909.8 | 28371.0 | 190.453 | 50.97 | 113.92 | 225 |
| 290.000 | 1.847 | 0.54143 | 0.2151 | 9.244 | 27465.1 | 29089.4 | 192.962 | 49.67 | 92.23 | 239 |
| 300.000 | 1.659 | 0.60286 | 0.1841 | 11.913 | 28134.5 | 29943.1 | 195.858 | 49.27 | 80.29 | 254 |
| 310.000 | 1.525 | 0.65555 | 0.1636 | 14.130 | 28748.5 | 30715.2 | 198.391 | 49.51 | 74.75 | 266 |
| 320.000 | 1.422 | 0.70314 | 0.1486 | 16.079 | 29336.7 | 31446.1 | 200.713 | 50.07 | 71.80 | 277 |
| 330.000 | 1.338 | 0.74734 | 0.1369 | 17.846 | 29913.4 | 32155.4 | 202.895 | 50.83 | 70.19 | 286 |
| 340.000 | 1.267 | 0.78909 | 0.1275 | 19.480 | 30485.1 | 32852.4 | 204.977 | 51.71 | 69.37 | 295 |
| 350.000 | 1.206 | 0.82899 | 0.1196 | 21.011 | 31056.9 | 33543.8 | 206.982 | 52.69 | 69.05 | 303 |
| 360.000 | 1.153 | 0.86742 | 0.1129 | 22.460 | 31632.3 | 34234.6 | 208.927 | 53.73 | 69.09 | 310 |
| 370.000 | 1.105 | 0.90468 | 0.1070 | 23.843 | 32212.4 | 34926.5 | 210.823 | 54.82 | 69.37 | 317 |
| 380.000 | 1.063 | 0.94097 | 0.1019 | 25.171 | 32799.2 | 35622.1 | 212.679 | 55.95 | 69.84 | 323 |
| 390.000 | 1.024 | 0.97645 | 0.0974 | 26.452 | 33393.8 | 36323.2 | 214.501 | 57.10 | 70.44 | 329 |
| 400.000 | 0.989 | 1.01124 | 0.0934 | 27.694 | 33997.8 | 37031.5 | 216.293 | 58.27 | 71.15 | 335 |
| 410.000 | 0.957 | 1.04544 | 0.0897 | 28.901 | 34610.4 | 37746.7 | 218.060 | 59.46 | 71.94 | 341 |
| 420.000 | 0.927 | 1.07913 | 0.0864 | 30.079 | 35232.8 | 38470.2 | 219.804 | 60.66 | 72.80 | 346 |
| 430.000 | 0.899 | 1.11237 | 0.0834 | 31.231 | 35865.3 | 39202.4 | 221.527 | 61.85 | 73.70 | 352 |
| 440.000 | 0.873 | 1.14522 | 0.0806 | 32.360 | 36508.2 | 39943.9 | 223.232 | 63.06 | 74.64 | 357 |
| 450.000 | 0.849 | 1.17771 | 0.0780 | 33.468 | 37161.8 | 40694.9 | 224.920 | 64.26 | 75.61 | 362 |
| 460.000 | 0.827 | 1.20989 | 0.0756 | 34.558 | 37826.0 | 41455.7 | 226.593 | 65.45 | 76.60 | 367 |
| 470.000 | 0.805 | 1.24179 | 0.0734 | 35.632 | 38501.1 | 42226.5 | 228.251 | 66.64 | 77.60 | 371 |
| 480.000 | 0.785 | 1.27344 | 0.0713 | 36.691 | 39187.9 | 43008.2 | 229.895 | 67.82 | 78.62 | 376 |
| 490.000 | 0.766 | 1.30486 | 0.0694 | 37.736 | 39884.8 | 43799.4 | 231.527 | 69.00 | 79.64 | 381 |
| 500.000 | 0.748 | 1.33607 | 0.0676 | 38.770 | 40592.6 | 44600.8 | 233.146 | 70.16 | 80.67 | 385 |
| 520.000 | 0.715 | 1.39794 | 0.0642 | 40.804 | 42040.7 | 46234.5 | 236.350 | 72.46 | 82.73 | 394 |
| 540.000 | 0.685 | 1.45917 | 0.0613 | 42.801 | 43532.0 | 47909.5 | 239.511 | 74.71 | 84.79 | 402 |
| 560.000 | 0.658 | 1.51986 | 0.0586 | 44.765 | 45065.8 | 49625.3 | 242.631 | 76.91 | 86.82 | 410 |
| 580.000 | 0.633 | 1.58008 | 0.0561 | 46.703 | 46641.4 | 51381.7 | 245.713 | 79.07 | 88.84 | 418 |
| 600.000 | 0.610 | 1.63989 | 0.0539 | 48.617 | 48258.3 | 53178.0 | 248.758 | 81.18 | 90.82 | 425 |

Table 27. Thermophysical properties along isobars (Continued)

ETHANE ISOBAR AT P = 32.0 BAR

| T DEG K | DEN MOL/L | VOL L/MOL | DP/DT BAR/K | DP/DD BAR-L/MOL | E J/MOL | H J/MOL | S J/MOL/K | CV J/MOL/K | CP J/MOL/K | W M/SEC |
|---|---|---|---|---|---|---|---|---|---|---|
| 90.397 | 21.695 | 0.04609 | 34.8754 | 967.436 | 5310.6 | 5458.1 | 76.629 | 44.32 | 68.46 | 2229 |
| 100.000 | 21.351 | 0.04684 | 31.1242 | 872.180 | 5966.1 | 6115.9 | 83.545 | 44.20 | 68.57 | 2121 |
| 110.000 | 20.995 | 0.04763 | 27.8562 | 782.964 | 6649.9 | 6802.4 | 90.087 | 44.00 | 68.73 | 2017 |
| 120.000 | 20.639 | 0.04845 | 25.0740 | 702.420 | 7335.7 | 7490.8 | 96.077 | 43.75 | 68.97 | 1919 |
| 130.000 | 20.280 | 0.04931 | 22.6627 | 629.390 | 8024.2 | 8182.0 | 101.609 | 43.50 | 69.29 | 1826 |
| 140.000 | 19.918 | 0.05021 | 20.5416 | 562.977 | 8716.2 | 8876.9 | 106.758 | 43.26 | 69.71 | 1737 |
| 150.000 | 19.550 | 0.05115 | 18.6527 | 502.437 | 9412.8 | 9576.5 | 111.585 | 43.05 | 70.23 | 1651 |
| 160.000 | 19.175 | 0.05215 | 16.9528 | 447.134 | 10115.0 | 10281.9 | 116.137 | 42.91 | 70.88 | 1567 |
| 170.000 | 18.791 | 0.05322 | 15.4096 | 396.516 | 10824.2 | 10994.5 | 120.457 | 42.83 | 71.66 | 1485 |
| 180.000 | 18.397 | 0.05436 | 13.9982 | 350.091 | 11541.8 | 11715.7 | 124.579 | 42.84 | 72.61 | 1405 |
| 190.000 | 17.991 | 0.05558 | 12.6988 | 307.415 | 12269.3 | 12447.2 | 128.534 | 42.93 | 73.73 | 1325 |
| 200.000 | 17.570 | 0.05691 | 11.4959 | 268.094 | 13008.8 | 13190.9 | 132.348 | 43.12 | 75.06 | 1246 |
| 210.000 | 17.132 | 0.05837 | 10.3760 | 231.763 | 13762.4 | 13949.2 | 136.048 | 43.41 | 76.64 | 1167 |
| 220.000 | 16.673 | 0.05998 | 9.3280 | 198.108 | 14533.0 | 14724.9 | 139.656 | 43.79 | 78.55 | 1087 |
| 230.000 | 16.188 | 0.06177 | 8.3414 | 166.841 | 15323.8 | 15521.5 | 143.196 | 44.26 | 80.86 | 1007 |
| 240.000 | 15.670 | 0.06381 | 7.4063 | 137.702 | 16139.8 | 16344.0 | 146.696 | 44.81 | 83.75 | 925 |
| 250.000 | 15.108 | 0.06619 | 6.5116 | 110.461 | 16987.5 | 17199.3 | 150.187 | 45.45 | 87.49 | 841 |
| 260.000 | 14.484 | 0.06904 | 5.6440 | 84.896 | 17877.6 | 18098.5 | 153.714 | 46.16 | 92.67 | 753 |
| 270.000 | 13.763 | 0.07266 | 4.7840 | 60.773 | 18829.2 | 19061.8 | 157.348 | 46.97 | 100.64 | 658 |
| 280.000 | 12.871 | 0.07769 | 3.8928 | 37.746 | 19885.3 | 20133.9 | 161.245 | 47.91 | 115.76 | 551 |
| 285.760 | 12.198 | 0.08198 | 3.3270 | 24.673 | 20586.1 | 20848.5 | 163.771 | 48.59 | 134.76 | 477 |
| 285.760 | 2.245 | 0.44539 | 0.2819 | 6.099 | 26870.1 | 28295.3 | 189.858 | 51.95 | 125.79 | 222 |
| 290.000 | 2.082 | 0.48021 | 0.2513 | 7.764 | 27242.6 | 28779.3 | 191.540 | 50.78 | 105.17 | 231 |
| 300.000 | 1.835 | 0.54492 | 0.2088 | 10.779 | 27973.5 | 29717.3 | 194.723 | 49.89 | 85.93 | 248 |
| 310.000 | 1.672 | 0.59812 | 0.1830 | 13.187 | 28618.6 | 30532.6 | 197.397 | 49.93 | 78.10 | 262 |
| 320.000 | 1.550 | 0.64524 | 0.1648 | 15.266 | 29226.7 | 31291.5 | 199.807 | 50.39 | 74.08 | 273 |
| 330.000 | 1.452 | 0.68850 | 0.1509 | 17.131 | 29816.6 | 32019.8 | 202.049 | 51.08 | 71.87 | 283 |
| 340.000 | 1.372 | 0.72904 | 0.1398 | 18.842 | 30399.1 | 32732.0 | 204.175 | 51.91 | 70.67 | 292 |
| 350.000 | 1.303 | 0.76757 | 0.1307 | 20.437 | 30978.9 | 33435.2 | 206.214 | 52.86 | 70.10 | 300 |
| 360.000 | 1.243 | 0.80455 | 0.1231 | 21.940 | 31560.3 | 34134.9 | 208.186 | 53.87 | 69.95 | 308 |
| 370.000 | 1.190 | 0.84027 | 0.1165 | 23.370 | 32146.4 | 34835.3 | 210.105 | 54.94 | 70.10 | 315 |
| 380.000 | 1.143 | 0.87498 | 0.1107 | 24.739 | 32737.8 | 35537.7 | 211.979 | 56.05 | 70.47 | 322 |
| 390.000 | 1.100 | 0.90885 | 0.1056 | 26.056 | 33336.3 | 36244.6 | 213.815 | 57.19 | 70.99 | 328 |
| 400.000 | 1.062 | 0.94199 | 0.1011 | 27.330 | 33943.0 | 36957.4 | 215.621 | 58.36 | 71.63 | 334 |
| 410.000 | 1.026 | 0.97453 | 0.0970 | 28.567 | 34558.6 | 37677.1 | 217.398 | 59.53 | 72.37 | 340 |
| 420.000 | 0.994 | 1.00654 | 0.0934 | 29.771 | 35184.4 | 38405.3 | 219.152 | 60.72 | 73.18 | 345 |
| 430.000 | 0.963 | 1.03809 | 0.0900 | 30.947 | 35819.3 | 39141.1 | 220.884 | 61.92 | 74.04 | 351 |
| 440.000 | 0.935 | 1.06923 | 0.0869 | 32.098 | 36464.3 | 39885.9 | 222.596 | 63.11 | 74.95 | 356 |
| 450.000 | 0.909 | 1.10001 | 0.0841 | 33.227 | 37119.8 | 40639.8 | 224.291 | 64.31 | 75.89 | 361 |
| 460.000 | 0.885 | 1.13048 | 0.0815 | 34.336 | 37785.8 | 41403.4 | 225.969 | 65.50 | 76.86 | 366 |
| 470.000 | 0.862 | 1.16066 | 0.0790 | 35.427 | 38462.6 | 42176.7 | 227.633 | 66.68 | 77.84 | 371 |
| 480.000 | 0.840 | 1.19058 | 0.0767 | 36.501 | 39150.0 | 42959.9 | 229.282 | 67.86 | 78.84 | 376 |
| 490.000 | 0.819 | 1.22027 | 0.0746 | 37.562 | 39848.3 | 43753.2 | 230.918 | 69.03 | 79.85 | 380 |
| 500.000 | 0.800 | 1.24976 | 0.0726 | 38.609 | 40557.3 | 44556.5 | 232.541 | 70.19 | 80.86 | 385 |
| 520.000 | 0.764 | 1.30816 | 0.0690 | 40.669 | 42008.6 | 46194.7 | 235.753 | 72.49 | 82.90 | 393 |
| 540.000 | 0.732 | 1.36591 | 0.0657 | 42.688 | 43501.8 | 47872.7 | 238.919 | 74.73 | 84.93 | 402 |
| 560.000 | 0.703 | 1.42312 | 0.0628 | 44.673 | 45037.4 | 49591.4 | 242.045 | 76.93 | 86.95 | 410 |
| 580.000 | 0.676 | 1.47986 | 0.0602 | 46.628 | 46614.6 | 51350.2 | 245.131 | 79.09 | 88.95 | 418 |
| 600.000 | 0.651 | 1.53620 | 0.0578 | 48.559 | 48232.9 | 53148.7 | 248.180 | 81.19 | 90.92 | 425 |

Table 27. Thermophysical properties along isobars (Continued)

ETHANE ISOBAR AT P = 34.0 BAR

| T DEG K | DEN MOL/L | VOL L/MOL | DF/DT BAR/K | DF/DD BAR-L/MOL | E J/MOL | H J/MOL | S J/MOL/K | CV J/MOL/K | CP J/MOL/K | W M/SEC |
|---|---|---|---|---|---|---|---|---|---|---|
| 90.429 | 21.696 | 0.04609 | 34.8634 | 967.750 | 5311.3 | 5468.0 | 76.637 | 44.33 | 68.46 | 2229 |
| 100.000 | 21.353 | 0.04683 | 31.1271 | 872.866 | 5964.5 | 6123.7 | 83.529 | 44.22 | 68.56 | 2122 |
| 110.000 | 20.997 | 0.04763 | 27.8606 | 783.693 | 6648.2 | 6810.1 | 90.071 | 44.01 | 68.73 | 2017 |
| 120.000 | 20.641 | 0.04845 | 25.0796 | 703.187 | 7333.8 | 7498.5 | 96.060 | 43.77 | 68.96 | 1920 |
| 130.000 | 20.283 | 0.04930 | 22.6694 | 630.189 | 8022.0 | 8189.6 | 101.592 | 43.51 | 69.28 | 1827 |
| 140.000 | 19.921 | 0.05020 | 20.5494 | 563.807 | 8713.7 | 8884.4 | 106.740 | 43.27 | 69.69 | 1738 |
| 150.000 | 19.554 | 0.05114 | 18.6615 | 503.294 | 9409.9 | 9583.8 | 111.565 | 43.07 | 70.21 | 1652 |
| 160.000 | 19.179 | 0.05214 | 16.9627 | 448.018 | 10111.8 | 10289.1 | 116.117 | 42.92 | 70.86 | 1568 |
| 170.000 | 18.796 | 0.05320 | 15.4205 | 397.426 | 10820.5 | 11001.4 | 120.435 | 42.85 | 71.64 | 1487 |
| 180.000 | 18.403 | 0.05434 | 14.0102 | 351.027 | 11537.6 | 11722.3 | 124.555 | 42.85 | 72.57 | 1406 |
| 190.000 | 17.997 | 0.05556 | 12.7120 | 308.379 | 12264.6 | 12453.5 | 128.508 | 42.95 | 73.69 | 1326 |
| 200.000 | 17.578 | 0.05689 | 11.5103 | 269.087 | 13003.3 | 13196.8 | 132.321 | 43.14 | 75.01 | 1247 |
| 210.000 | 17.141 | 0.05834 | 10.3918 | 232.789 | 13756.1 | 13954.5 | 136.017 | 43.42 | 76.58 | 1168 |
| 220.000 | 16.683 | 0.05994 | 9.3454 | 199.172 | 14525.6 | 14729.4 | 139.622 | 43.80 | 78.46 | 1089 |
| 230.000 | 16.200 | 0.06173 | 8.3607 | 167.947 | 15315.2 | 15525.1 | 143.158 | 44.27 | 80.75 | 1009 |
| 240.000 | 15.685 | 0.06376 | 7.4277 | 138.861 | 16129.5 | 16346.2 | 146.653 | 44.83 | 83.59 | 928 |
| 250.000 | 15.126 | 0.06611 | 6.5359 | 111.683 | 16974.9 | 17199.6 | 150.136 | 45.47 | 87.26 | 844 |
| 260.000 | 14.507 | 0.06893 | 5.6725 | 86.201 | 17861.6 | 18095.9 | 153.651 | 46.18 | 92.30 | 757 |
| 270.000 | 13.796 | 0.07249 | 4.8188 | 62.194 | 18807.6 | 19054.1 | 157.266 | 46.98 | 99.94 | 663 |
| 280.000 | 12.923 | 0.07738 | 3.9398 | 39.360 | 19852.1 | 20115.2 | 161.123 | 47.91 | 114.03 | 558 |
| 288.484 | 11.897 | 0.08406 | 3.1011 | 20.360 | 20903.3 | 21189.1 | 164.899 | 48.97 | 145.24 | 448 |
| 288.484 | 2.452 | 0.40780 | 0.3143 | 5.401 | 26816.0 | 28202.5 | 189.238 | 52.98 | 140.71 | 218 |
| 290.000 | 2.371 | 0.42168 | 0.2985 | 6.101 | 26971.6 | 28405.3 | 189.938 | 52.31 | 127.62 | 222 |
| 300.000 | 2.032 | 0.49222 | 0.2375 | 9.593 | 27795.7 | 29469.2 | 193.550 | 50.59 | 93.32 | 243 |
| 310.000 | 1.829 | 0.54663 | 0.2045 | 12.220 | 28479.8 | 30338.4 | 196.402 | 50.39 | 82.09 | 257 |
| 320.000 | 1.684 | 0.59365 | 0.1823 | 14.439 | 29110.9 | 31129.3 | 198.913 | 50.72 | 76.67 | 269 |
| 330.000 | 1.572 | 0.63624 | 0.1658 | 16.406 | 29716.7 | 31879.9 | 201.223 | 51.34 | 73.73 | 280 |
| 340.000 | 1.480 | 0.67583 | 0.1529 | 18.198 | 30310.0 | 32607.8 | 203.397 | 52.12 | 72.08 | 289 |
| 350.000 | 1.402 | 0.71323 | 0.1425 | 19.858 | 30898.6 | 33323.5 | 205.473 | 53.03 | 71.22 | 298 |
| 360.000 | 1.335 | 0.74895 | 0.1337 | 21.417 | 31487.5 | 34033.9 | 207.473 | 54.02 | 70.87 | 306 |
| 370.000 | 1.277 | 0.78336 | 0.1262 | 22.894 | 32078.7 | 34742.1 | 209.415 | 55.07 | 70.87 | 313 |
| 380.000 | 1.224 | 0.81670 | 0.1198 | 24.304 | 32674.9 | 35451.6 | 211.308 | 56.16 | 71.12 | 320 |
| 390.000 | 1.178 | 0.84915 | 0.1141 | 25.658 | 33278.1 | 36165.2 | 213.160 | 57.29 | 71.56 | 326 |
| 400.000 | 1.135 | 0.88086 | 0.1090 | 26.965 | 33888.4 | 36883.3 | 214.979 | 58.44 | 72.13 | 333 |
| 410.000 | 1.097 | 0.91194 | 0.1045 | 28.231 | 34507.1 | 37607.7 | 216.768 | 59.61 | 72.81 | 339 |
| 420.000 | 1.061 | 0.94248 | 0.1005 | 29.462 | 35134.9 | 38339.3 | 218.531 | 60.79 | 73.57 | 344 |
| 430.000 | 1.028 | 0.97254 | 0.0968 | 30.663 | 35772.2 | 39078.9 | 220.272 | 61.98 | 74.39 | 350 |
| 440.000 | 0.998 | 1.00219 | 0.0934 | 31.836 | 36420.2 | 39827.6 | 221.992 | 63.17 | 75.27 | 355 |
| 450.000 | 0.969 | 1.03147 | 0.0903 | 32.985 | 37077.6 | 40584.6 | 223.694 | 64.36 | 76.18 | 360 |
| 460.000 | 0.943 | 1.06042 | 0.0874 | 34.112 | 37745.5 | 41350.9 | 225.378 | 65.54 | 77.12 | 365 |
| 470.000 | 0.918 | 1.08909 | 0.0847 | 35.221 | 38423.9 | 42126.8 | 227.047 | 66.72 | 78.08 | 370 |
| 480.000 | 0.895 | 1.11749 | 0.0822 | 36.312 | 39112.8 | 42912.3 | 228.702 | 67.90 | 79.06 | 375 |
| 490.000 | 0.873 | 1.14566 | 0.0799 | 37.387 | 39812.5 | 43707.7 | 230.342 | 69.07 | 80.06 | 380 |
| 500.000 | 0.852 | 1.17362 | 0.0778 | 38.449 | 40522.8 | 44513.1 | 231.969 | 70.23 | 81.06 | 384 |
| 520.000 | 0.814 | 1.22896 | 0.0738 | 40.534 | 41975.6 | 46154.0 | 235.188 | 72.51 | 83.07 | 393 |
| 540.000 | 0.779 | 1.28366 | 0.0703 | 42.576 | 43471.6 | 47836.1 | 238.360 | 74.76 | 85.08 | 401 |
| 560.000 | 0.747 | 1.33780 | 0.0671 | 44.581 | 45009.0 | 49557.5 | 241.491 | 76.96 | 87.09 | 410 |
| 580.000 | 0.719 | 1.39147 | 0.0643 | 46.555 | 46587.8 | 51318.8 | 244.581 | 79.11 | 89.07 | 418 |
| 600.000 | 0.692 | 1.44473 | 0.0617 | 48.501 | 48207.5 | 53119.6 | 247.634 | 81.21 | 91.03 | 425 |

Table 27. Thermophysical properties along isobars (Continued)

ETHANE ISOBAR AT P = 36.0 BAR

| T DEG K | DEN MOL/L | VOL L/MOL | DP/DT BAR/K | DP/DD BAR-L/MOL | E J/MOL | H J/MOL | S J/MOL/K | CV J/MOL/K | CP J/MOL/K | W M/SEC |
|---|---|---|---|---|---|---|---|---|---|---|
| 90.460 | 21.697 | 0.04609 | 34.8515 | 968.063 | 5312.1 | 5478.0 | 76.645 | 44.35 | 68.46 | 2229 |
| 100.000 | 21.355 | 0.04683 | 31.1300 | 873.552 | 5963.0 | 6131.5 | 83.513 | 44.23 | 68.56 | 2122 |
| 110.000 | 21.000 | 0.04762 | 27.8649 | 784.422 | 6646.4 | 6817.9 | 90.055 | 44.03 | 68.72 | 2018 |
| 120.000 | 20.644 | 0.04844 | 25.0851 | 703.953 | 7331.8 | 7506.1 | 96.043 | 43.78 | 68.95 | 1920 |
| 130.000 | 20.287 | 0.04929 | 22.6761 | 630.989 | 8019.7 | 8197.2 | 101.574 | 43.53 | 69.27 | 1827 |
| 140.000 | 19.925 | 0.05019 | 20.5572 | 564.636 | 8711.2 | 8891.8 | 106.722 | 43.29 | 69.68 | 1739 |
| 150.000 | 19.558 | 0.05113 | 18.6703 | 504.151 | 9407.1 | 9591.1 | 111.546 | 43.08 | 70.20 | 1653 |
| 160.000 | 19.184 | 0.05213 | 16.9725 | 448.901 | 10103.5 | 10296.2 | 116.096 | 42.94 | 70.84 | 1569 |
| 170.000 | 18.801 | 0.05319 | 15.4314 | 398.335 | 10816.8 | 11008.3 | 120.413 | 42.86 | 71.61 | 1488 |
| 180.000 | 18.408 | 0.05432 | 14.0222 | 351.961 | 11533.4 | 11729.0 | 124.532 | 42.87 | 72.54 | 1407 |
| 190.000 | 18.004 | 0.05554 | 12.7252 | 309.341 | 12259.8 | 12459.8 | 128.483 | 42.96 | 73.65 | 1328 |
| 200.000 | 17.585 | 0.05687 | 11.5247 | 270.079 | 12997.9 | 13202.6 | 132.293 | 43.15 | 74.96 | 1249 |
| 210.000 | 17.149 | 0.05831 | 10.4076 | 233.814 | 13749.9 | 13959.8 | 135.987 | 43.44 | 76.52 | 1170 |
| 220.000 | 16.693 | 0.05990 | 9.3627 | 200.233 | 14519.4 | 14734.0 | 139.588 | 43.82 | 78.38 | 1091 |
| 230.000 | 16.212 | 0.06168 | 8.3798 | 169.051 | 15306.7 | 15528.7 | 143.121 | 44.29 | 80.64 | 1012 |
| 240.000 | 15.699 | 0.06370 | 7.4490 | 140.015 | 16119.3 | 16348.6 | 146.609 | 44.85 | 83.44 | 931 |
| 250.000 | 15.144 | 0.06603 | 6.5601 | 112.900 | 16962.4 | 17200.1 | 150.085 | 45.48 | 87.03 | 848 |
| 260.000 | 14.530 | 0.06882 | 5.7006 | 87.498 | 17845.8 | 18093.6 | 153.588 | 46.20 | 91.93 | 761 |
| 270.000 | 13.828 | 0.07232 | 4.8530 | 63.602 | 18786.4 | 19046.8 | 157.185 | 46.99 | 99.28 | 668 |
| 280.000 | 12.973 | 0.07709 | 3.9853 | 40.946 | 19820.2 | 20097.7 | 161.006 | 47.91 | 112.45 | 565 |
| 290.000 | 11.763 | 0.08501 | 3.0064 | 18.899 | 21059.8 | 21364.9 | 165.449 | 49.17 | 149.41 | 437 |
| 291.089 | 11.581 | 0.08635 | 2.8806 | 16.449 | 21221.6 | 21532.4 | 166.025 | 49.37 | 158.85 | 420 |
| | | | | | | | | | | |
| 291.089 | 2.677 | 0.37352 | 0.3504 | 4.703 | 26745.9 | 28090.6 | 188.581 | 54.08 | 160.10 | 215 |
| 300.000 | 2.255 | 0.44349 | 0.2713 | 8.341 | 27595.5 | 29192.1 | 192.314 | 51.43 | 103.49 | 236 |
| 310.000 | 2.000 | 0.49999 | 0.2285 | 11.228 | 28330.7 | 30130.7 | 195.394 | 50.89 | 86.92 | 253 |
| 320.000 | 1.827 | 0.54729 | 0.2013 | 13.600 | 28989.0 | 30959.2 | 198.025 | 51.08 | 79.64 | 266 |
| 330.000 | 1.696 | 0.58947 | 0.1818 | 15.675 | 29612.4 | 31734.5 | 200.411 | 51.61 | 75.79 | 277 |
| 340.000 | 1.592 | 0.62831 | 0.1668 | 17.549 | 30218.7 | 32480.6 | 202.638 | 52.34 | 73.62 | 287 |
| 350.000 | 1.504 | 0.66476 | 0.1548 | 19.277 | 30816.7 | 33209.9 | 204.753 | 53.21 | 72.43 | 295 |
| 360.000 | 1.430 | 0.69943 | 0.1448 | 20.891 | 31412.6 | 33930.5 | 206.784 | 54.17 | 71.85 | 304 |
| 370.000 | 1.365 | 0.73269 | 0.1364 | 22.416 | 32010.4 | 34648.1 | 208.750 | 55.19 | 71.68 | 311 |
| 380.000 | 1.307 | 0.76483 | 0.1291 | 23.868 | 32611.6 | 35365.0 | 210.663 | 56.27 | 71.80 | 318 |
| 390.000 | 1.256 | 0.79605 | 0.1228 | 25.259 | 33218.6 | 36084.4 | 212.532 | 57.39 | 72.14 | 325 |
| 400.000 | 1.210 | 0.82650 | 0.1172 | 26.599 | 33832.5 | 36807.9 | 214.364 | 58.53 | 72.64 | 331 |
| 410.000 | 1.168 | 0.85629 | 0.1122 | 27.895 | 34455.1 | 37537.7 | 216.165 | 59.69 | 73.26 | 337 |
| 420.000 | 1.129 | 0.88552 | 0.1077 | 29.153 | 35085.7 | 38273.6 | 217.939 | 60.86 | 73.97 | 343 |
| 430.000 | 1.094 | 0.91427 | 0.1037 | 30.377 | 35725.6 | 39017.0 | 219.689 | 62.04 | 74.75 | 349 |
| 440.000 | 1.061 | 0.94259 | 0.1000 | 31.573 | 36375.1 | 39768.4 | 221.417 | 63.22 | 75.59 | 354 |
| 450.000 | 1.030 | 0.97054 | 0.0966 | 32.742 | 37034.6 | 40528.5 | 223.125 | 64.41 | 76.47 | 360 |
| 460.000 | 1.002 | 0.99816 | 0.0934 | 33.889 | 37704.3 | 41297.6 | 224.816 | 65.59 | 77.39 | 365 |
| 470.000 | 0.975 | 1.02548 | 0.0905 | 35.015 | 38385.0 | 42076.8 | 226.491 | 66.77 | 78.33 | 370 |
| 480.000 | 0.950 | 1.05254 | 0.0878 | 36.122 | 39075.5 | 42864.7 | 228.150 | 67.94 | 79.29 | 374 |
| 490.000 | 0.926 | 1.07936 | 0.0853 | 37.213 | 39776.6 | 43662.3 | 229.795 | 69.10 | 80.27 | 379 |
| 500.000 | 0.904 | 1.10596 | 0.0830 | 38.289 | 40488.3 | 44469.7 | 231.426 | 70.26 | 81.25 | 384 |
| 520.000 | 0.863 | 1.15859 | 0.0787 | 40.400 | 41943.3 | 46114.3 | 234.651 | 72.54 | 83.24 | 393 |
| 540.000 | 0.826 | 1.21056 | 0.0749 | 42.464 | 43440.6 | 47798.7 | 237.830 | 74.78 | 85.23 | 401 |
| 560.000 | 0.792 | 1.26198 | 0.0715 | 44.490 | 44980.6 | 49523.7 | 240.966 | 76.98 | 87.22 | 409 |
| 580.000 | 0.762 | 1.31292 | 0.0684 | 46.482 | 46561.0 | 51287.5 | 244.061 | 79.13 | 89.19 | 417 |
| 600.000 | 0.733 | 1.36346 | 0.0656 | 48.445 | 48182.1 | 53090.5 | 247.117 | 81.23 | 91.14 | 425 |

Table 27. Thermophysical properties along isobars (Continued)

ETHANE ISOBAR AT P = 38.0 BAR

| T DEG K | DEN MOL/L | VOL L/MOL | DP/DT BAR/K | DP/DD BAR-L/MOL | E J/MOL | H J/MOL | S J/MOL/K | CV J/MOL/K | CP J/MOL/K | W M/SEC |
|---|---|---|---|---|---|---|---|---|---|---|
| 90.491 | 21.698 | 0.04609 | 34.8396 | 968.377 | 5312.8 | 5487.9 | 76.653 | 44.36 | 68.46 | 2229 |
| 100.000 | 21.358 | 0.04682 | 31.1330 | 874.238 | 5961.4 | 6139.3 | 83.498 | 44.25 | 68.55 | 2122 |
| 110.000 | 21.002 | 0.04761 | 27.8692 | 785.151 | 6644.7 | 6825.6 | 90.038 | 44.04 | 68.71 | 2018 |
| 120.000 | 20.647 | 0.04843 | 25.0907 | 704.719 | 7329.8 | 7513.8 | 96.026 | 43.80 | 68.94 | 1921 |
| 130.000 | 20.290 | 0.04929 | 22.6627 | 631.788 | 8017.5 | 8204.8 | 101.557 | 43.54 | 69.26 | 1828 |
| 140.000 | 19.929 | 0.05018 | 20.5649 | 565.465 | 8708.6 | 8899.3 | 106.703 | 43.30 | 69.67 | 1739 |
| 150.000 | 19.562 | 0.05112 | 18.6791 | 505.007 | 9404.2 | 9598.4 | 111.527 | 43.10 | 70.18 | 1654 |
| 160.000 | 19.188 | 0.05212 | 16.9823 | 449.783 | 10105.3 | 10303.3 | 116.076 | 42.95 | 70.82 | 1570 |
| 170.000 | 18.806 | 0.05317 | 15.4423 | 399.243 | 10813.2 | 11015.2 | 120.391 | 42.88 | 71.59 | 1489 |
| 180.000 | 18.414 | 0.05431 | 14.0341 | 352.895 | 11529.2 | 11735.6 | 124.508 | 42.88 | 72.51 | 1409 |
| 190.000 | 18.010 | 0.05552 | 12.7383 | 310.302 | 12255.1 | 12466.0 | 128.458 | 42.98 | 73.61 | 1329 |
| 200.000 | 17.592 | 0.05684 | 11.5390 | 271.069 | 12992.5 | 13208.5 | 132.265 | 43.17 | 74.91 | 1251 |
| 210.000 | 17.158 | 0.05828 | 10.4232 | 234.836 | 13743.6 | 13965.1 | 135.957 | 43.46 | 76.46 | 1172 |
| 220.000 | 16.703 | 0.05987 | 9.3799 | 201.292 | 14511.1 | 14738.6 | 139.555 | 43.84 | 78.30 | 1093 |
| 230.000 | 16.224 | 0.06164 | 8.3988 | 170.152 | 15298.2 | 15532.4 | 143.083 | 44.31 | 80.53 | 1014 |
| 240.000 | 15.713 | 0.06364 | 7.4702 | 141.165 | 16109.2 | 16351.0 | 146.566 | 44.86 | 83.29 | 934 |
| 250.000 | 15.162 | 0.06596 | 6.5841 | 114.110 | 16950.1 | 17200.7 | 150.035 | 45.50 | 86.81 | 851 |
| 260.000 | 14.553 | 0.06872 | 5.7284 | 88.787 | 17830.2 | 18091.4 | 153.527 | 46.21 | 91.58 | 765 |
| 270.000 | 13.859 | 0.07216 | 4.8866 | 64.996 | 18765.7 | 19039.9 | 157.106 | 47.00 | 98.65 | 674 |
| 280.000 | 13.021 | 0.07680 | 4.0295 | 42.507 | 19789.4 | 20081.2 | 160.892 | 47.91 | 111.00 | 572 |
| 290.000 | 11.864 | 0.08429 | 3.0797 | 20.825 | 20997.8 | 21318.1 | 165.229 | 49.13 | 142.97 | 449 |
| 293.582 | 11.245 | 0.08892 | 2.6631 | 12.914 | 21544.5 | 21882.4 | 167.163 | 49.82 | 177.32 | 391 |
| | | | | | | | | | | |
| 293.582 | 2.925 | 0.34188 | 0.3912 | 4.001 | 26657.1 | 27956.3 | 187.877 | 55.27 | 186.51 | 212 |
| 300.000 | 2.516 | 0.39747 | 0.3125 | 7.001 | 27364.2 | 28874.6 | 190.974 | 52.46 | 118.58 | 229 |
| 310.000 | 2.187 | 0.45730 | 0.2556 | 10.210 | 28169.4 | 29907.2 | 194.363 | 51.45 | 92.92 | 248 |
| 320.000 | 1.979 | 0.50530 | 0.2221 | 12.751 | 28860.7 | 30780.8 | 197.138 | 51.45 | 83.07 | 262 |
| 330.000 | 1.827 | 0.54731 | 0.1989 | 14.939 | 29503.8 | 31583.6 | 199.610 | 51.89 | 78.08 | 273 |
| 340.000 | 1.708 | 0.58558 | 0.1815 | 16.898 | 30123.9 | 32349.1 | 201.895 | 52.56 | 75.29 | 284 |
| 350.000 | 1.610 | 0.62125 | 0.1677 | 18.694 | 30732.3 | 33093.0 | 204.053 | 53.39 | 73.71 | 293 |
| 360.000 | 1.527 | 0.65501 | 0.1564 | 20.365 | 31336.6 | 33825.6 | 206.116 | 54.32 | 72.87 | 301 |
| 370.000 | 1.455 | 0.68728 | 0.1469 | 21.938 | 31940.4 | 34552.0 | 208.107 | 55.32 | 72.53 | 309 |
| 380.000 | 1.392 | 0.71837 | 0.1388 | 23.432 | 32547.5 | 35277.3 | 210.041 | 56.38 | 72.52 | 317 |
| 390.000 | 1.336 | 0.74850 | 0.1318 | 24.860 | 33158.9 | 36003.2 | 211.927 | 57.48 | 72.75 | 323 |
| 400.000 | 1.286 | 0.77782 | 0.1256 | 26.233 | 33776.7 | 36732.4 | 213.774 | 58.61 | 73.17 | 330 |
| 410.000 | 1.240 | 0.80648 | 0.1201 | 27.558 | 34402.0 | 37466.6 | 215.587 | 59.76 | 73.72 | 336 |
| 420.000 | 1.198 | 0.83455 | 0.1152 | 28.843 | 35036.1 | 38207.4 | 217.371 | 60.93 | 74.38 | 342 |
| 430.000 | 1.160 | 0.86213 | 0.1107 | 30.092 | 35678.6 | 38954.7 | 219.130 | 62.10 | 75.12 | 348 |
| 440.000 | 1.125 | 0.88927 | 0.1067 | 31.310 | 36330.4 | 39709.7 | 220.866 | 63.28 | 75.92 | 353 |
| 450.000 | 1.092 | 0.91604 | 0.1030 | 32.500 | 36992.0 | 40473.0 | 222.582 | 64.46 | 76.78 | 359 |
| 460.000 | 1.061 | 0.94246 | 0.0996 | 33.666 | 37663.6 | 41244.9 | 224.279 | 65.63 | 77.66 | 364 |
| 470.000 | 1.032 | 0.96858 | 0.0964 | 34.809 | 38345.4 | 42026.0 | 225.959 | 66.81 | 78.58 | 369 |
| 480.000 | 1.006 | 0.99444 | 0.0935 | 35.933 | 39037.4 | 42816.3 | 227.623 | 67.98 | 79.52 | 374 |
| 490.000 | 0.980 | 1.02005 | 0.0908 | 37.039 | 39740.7 | 43616.8 | 229.273 | 69.14 | 80.48 | 379 |
| 500.000 | 0.957 | 1.04544 | 0.0882 | 38.129 | 40453.6 | 44426.3 | 230.908 | 70.29 | 81.45 | 383 |
| 520.000 | 0.913 | 1.09565 | 0.0836 | 40.266 | 41911.1 | 46074.5 | 234.141 | 72.57 | 83.41 | 392 |
| 540.000 | 0.873 | 1.14519 | 0.0795 | 42.354 | 43410.4 | 47762.1 | 237.326 | 74.81 | 85.38 | 401 |
| 560.000 | 0.837 | 1.19417 | 0.0759 | 44.399 | 44951.3 | 49489.2 | 240.467 | 77.00 | 87.35 | 409 |
| 580.000 | 0.805 | 1.24267 | 0.0726 | 46.410 | 46533.3 | 51255.5 | 243.566 | 79.15 | 89.31 | 417 |
| 600.000 | 0.775 | 1.29076 | 0.0696 | 48.389 | 48156.7 | 53061.6 | 246.626 | 81.25 | 91.24 | 425 |

Table 27. Thermophysical properties along isobars (Continued)

ETHANE ISOBAR AT P = 40.0 BAR

| T DEG K | DEN MOL/L | VOL L/MOL | DP/DT BAR/K | DP/DD BAR-L/MOL | E J/MOL | H J/MOL | S J/MOL/K | CV J/MOL/K | CP J/MOL/K | W M/SEC |
|---|---|---|---|---|---|---|---|---|---|---|
| 90.522 | 21.699 | 0.04609 | 34.8277 | 968.692 | 5313.6 | 5497.9 | 76.662 | 44.38 | 68.45 | 2229 |
| 100.000 | 21.360 | 0.04682 | 31.1359 | 874.923 | 5959.9 | 6147.1 | 83.482 | 44.26 | 68.55 | 2123 |
| 110.000 | 21.005 | 0.04761 | 27.8735 | 785.879 | 6642.9 | 6833.4 | 90.022 | 44.06 | 68.71 | 2019 |
| 120.000 | 20.650 | 0.04843 | 25.0962 | 705.484 | 7327.8 | 7521.5 | 96.010 | 43.81 | 68.94 | 1921 |
| 130.000 | 20.293 | 0.04928 | 22.6894 | 632.586 | 8015.3 | 8212.4 | 101.539 | 43.56 | 69.25 | 1829 |
| 140.000 | 19.932 | 0.05017 | 20.5727 | 566.293 | 8706.1 | 8906.8 | 106.685 | 43.32 | 69.65 | 1740 |
| 150.000 | 19.566 | 0.05111 | 18.6879 | 505.863 | 9401.3 | 9605.8 | 111.507 | 43.11 | 70.16 | 1655 |
| 160.000 | 19.193 | 0.05210 | 16.9922 | 450.665 | 10102.1 | 10310.5 | 116.055 | 42.97 | 70.80 | 1571 |
| 170.000 | 18.811 | 0.05316 | 15.4532 | 400.150 | 10809.5 | 11022.2 | 120.369 | 42.89 | 71.56 | 1490 |
| 180.000 | 18.420 | 0.05429 | 14.0461 | 353.828 | 11525.1 | 11742.2 | 124.485 | 42.90 | 72.48 | 1410 |
| 190.000 | 18.017 | 0.05550 | 12.7513 | 311.262 | 12250.3 | 12472.3 | 128.432 | 43.00 | 73.57 | 1331 |
| 200.000 | 17.600 | 0.05682 | 11.5533 | 272.057 | 12987.1 | 13214.3 | 132.238 | 43.19 | 74.87 | 1252 |
| 210.000 | 17.166 | 0.05825 | 10.4389 | 235.856 | 13737.4 | 13970.4 | 135.927 | 43.47 | 76.40 | 1174 |
| 220.000 | 16.713 | 0.05983 | 9.3970 | 202.348 | 14503.9 | 14743.3 | 139.521 | 43.85 | 78.22 | 1096 |
| 230.000 | 16.236 | 0.06159 | 8.4177 | 171.249 | 15289.8 | 15536.2 | 143.046 | 44.32 | 80.43 | 1017 |
| 240.000 | 15.728 | 0.06358 | 7.4913 | 142.311 | 16099.1 | 16353.5 | 146.524 | 44.88 | 83.14 | 936 |
| 250.000 | 15.179 | 0.06588 | 6.6078 | 115.316 | 16937.9 | 17201.4 | 149.985 | 45.51 | 86.60 | 854 |
| 260.000 | 14.575 | 0.06861 | 5.7559 | 90.067 | 17814.9 | 18089.4 | 153.467 | 46.22 | 91.24 | 769 |
| 270.000 | 13.889 | 0.07200 | 4.9196 | 66.379 | 18745.4 | 19033.3 | 157.028 | 47.02 | 98.05 | 678 |
| 280.000 | 13.067 | 0.07653 | 4.0724 | 44.044 | 19759.6 | 20065.8 | 160.782 | 47.92 | 109.67 | 579 |
| 290.000 | 11.956 | 0.08364 | 3.1478 | 22.677 | 20941.8 | 21276.3 | 165.027 | 49.09 | 137.74 | 460 |
| 295.974 | 10.881 | 0.09191 | 2.4458 | 9.734 | 21877.0 | 22244.6 | 168.330 | 50.35 | 203.98 | 362 |
| 295.974 | 3.203 | 0.31225 | 0.4380 | 3.288 | 26544.8 | 27793.8 | 187.104 | 56.61 | 225.02 | 208 |
| 300.000 | 2.836 | 0.35261 | 0.3655 | 5.523 | 27084.7 | 28495.1 | 189.459 | 53.83 | 144.04 | 222 |
| 310.000 | 2.393 | 0.41782 | 0.2865 | 9.162 | 27992.5 | 29663.8 | 193.295 | 52.07 | 100.54 | 243 |
| 320.000 | 2.141 | 0.46699 | 0.2449 | 11.893 | 28724.2 | 30592.1 | 196.244 | 51.86 | 87.06 | 258 |
| 330.000 | 1.964 | 0.50906 | 0.2174 | 14.201 | 29390.9 | 31427.1 | 198.814 | 52.19 | 80.63 | 270 |
| 340.000 | 1.828 | 0.54693 | 0.1971 | 16.247 | 30026.1 | 32213.8 | 201.164 | 52.79 | 77.11 | 281 |
| 350.000 | 1.718 | 0.58196 | 0.1813 | 18.112 | 30646.1 | 32973.9 | 203.368 | 53.58 | 75.09 | 291 |
| 360.000 | 1.626 | 0.61493 | 0.1685 | 19.840 | 31258.5 | 33718.3 | 205.466 | 54.47 | 73.96 | 299 |
| 370.000 | 1.547 | 0.64633 | 0.1579 | 21.462 | 31869.6 | 34455.0 | 207.484 | 55.46 | 73.42 | 307 |
| 380.000 | 1.478 | 0.67650 | 0.1489 | 22.997 | 32481.8 | 35187.8 | 209.439 | 56.50 | 73.26 | 315 |
| 390.000 | 1.417 | 0.70566 | 0.1411 | 24.462 | 33097.9 | 35920.6 | 211.343 | 57.58 | 73.39 | 322 |
| 400.000 | 1.362 | 0.73399 | 0.1343 | 25.868 | 33720.3 | 36656.2 | 213.205 | 58.70 | 73.72 | 329 |
| 410.000 | 1.313 | 0.76163 | 0.1282 | 27.222 | 34349.0 | 37395.5 | 215.031 | 59.84 | 74.20 | 335 |
| 420.000 | 1.268 | 0.78867 | 0.1228 | 28.534 | 34985.6 | 38140.2 | 216.826 | 60.99 | 74.81 | 341 |
| 430.000 | 1.227 | 0.81520 | 0.1180 | 29.807 | 35630.7 | 38891.5 | 218.594 | 62.16 | 75.50 | 347 |
| 440.000 | 1.189 | 0.84128 | 0.1135 | 31.047 | 36285.5 | 39650.7 | 220.338 | 63.33 | 76.26 | 353 |
| 450.000 | 1.153 | 0.86698 | 0.1095 | 32.258 | 36949.2 | 40417.2 | 222.061 | 64.51 | 77.08 | 358 |
| 460.000 | 1.121 | 0.89233 | 0.1058 | 33.443 | 37622.7 | 41192.1 | 223.765 | 65.68 | 77.94 | 363 |
| 470.000 | 1.090 | 0.91738 | 0.1024 | 34.604 | 38306.2 | 41975.8 | 225.450 | 66.85 | 78.84 | 368 |
| 480.000 | 1.061 | 0.94215 | 0.0992 | 35.744 | 38999.9 | 42768.5 | 227.120 | 68.02 | 79.76 | 373 |
| 490.000 | 1.034 | 0.96668 | 0.0963 | 36.865 | 39703.9 | 43570.6 | 228.774 | 69.18 | 80.70 | 378 |
| 500.000 | 1.009 | 0.99098 | 0.0936 | 37.970 | 40418.2 | 44382.1 | 230.414 | 70.33 | 81.65 | 383 |
| 520.000 | 0.962 | 1.03901 | 0.0886 | 40.132 | 41878.8 | 46034.8 | 233.654 | 72.60 | 83.58 | 392 |
| 540.000 | 0.921 | 1.08636 | 0.0842 | 42.243 | 43380.2 | 47725.6 | 236.845 | 74.83 | 85.53 | 401 |
| 560.000 | 0.882 | 1.13315 | 0.0803 | 44.309 | 44922.9 | 49455.5 | 239.990 | 77.02 | 87.48 | 409 |
| 580.000 | 0.848 | 1.17946 | 0.0768 | 46.338 | 46506.5 | 51224.4 | 243.094 | 79.17 | 89.43 | 417 |
| 600.000 | 0.816 | 1.22535 | 0.0736 | 48.334 | 48130.5 | 53031.9 | 246.158 | 81.26 | 91.35 | 425 |

Table 27. Thermophysical properties along isobars (Continued)

ETHANE ISOBAR AT P = 44.0 BAR

| T DEG K | DEN MOL/L | VOL L/MOL | DP/DT BAR/K | DP/DD BAR-L/MOL | E J/MOL | H J/MOL | S J/MOL/K | CV J/MOL/K | CP J/MOL/K | W M/SEC |
|---|---|---|---|---|---|---|---|---|---|---|
| 90.584 | 21.701 | 0.04608 | 34.8041 | 969.322 | 5315.1 | 5517.8 | 76.678 | 44.41 | 68.45 | 2229 |
| 100.000 | 21.365 | 0.04681 | 31.1418 | 876.294 | 5956.8 | 6162.7 | 83.451 | 44.29 | 68.54 | 2124 |
| 110.000 | 21.010 | 0.04760 | 27.8822 | 787.335 | 6639.4 | 6848.9 | 89.990 | 44.09 | 68.70 | 2020 |
| 120.000 | 20.656 | 0.04841 | 25.1073 | 707.015 | 7323.9 | 7536.9 | 95.976 | 43.84 | 68.92 | 1923 |
| 130.000 | 20.299 | 0.04926 | 22.7028 | 634.182 | 8010.8 | 8227.6 | 101.504 | 43.59 | 69.23 | 1830 |
| 140.000 | 19.939 | 0.05015 | 20.5881 | 567.948 | 8701.1 | 8921.7 | 106.649 | 43.35 | 69.63 | 1742 |
| 150.000 | 19.574 | 0.05109 | 18.7054 | 507.572 | 9395.6 | 9620.4 | 111.469 | 43.14 | 70.13 | 1656 |
| 160.000 | 19.202 | 0.05208 | 17.0117 | 452.426 | 10095.6 | 10324.8 | 116.014 | 43.00 | 70.76 | 1573 |
| 170.000 | 18.821 | 0.05313 | 15.4748 | 401.961 | 10802.2 | 11036.0 | 120.326 | 42.92 | 71.51 | 1492 |
| 180.000 | 18.431 | 0.05426 | 14.0699 | 355.691 | 11516.8 | 11755.5 | 124.438 | 42.93 | 72.42 | 1413 |
| 190.000 | 18.029 | 0.05546 | 12.7774 | 313.178 | 12240.9 | 12485.0 | 128.382 | 43.03 | 73.50 | 1334 |
| 200.000 | 17.614 | 0.05677 | 11.5818 | 274.030 | 12976.3 | 13226.1 | 132.183 | 43.22 | 74.77 | 1256 |
| 210.000 | 17.183 | 0.05820 | 10.4700 | 237.891 | 13725.1 | 13981.2 | 135.867 | 43.50 | 76.28 | 1178 |
| 220.000 | 16.733 | 0.05976 | 9.4311 | 204.453 | 14489.7 | 14752.6 | 139.455 | 43.88 | 78.07 | 1100 |
| 230.000 | 16.259 | 0.06150 | 8.4552 | 173.435 | 15273.1 | 15543.7 | 142.971 | 44.36 | 80.22 | 1021 |
| 240.000 | 15.755 | 0.06347 | 7.5329 | 144.592 | 16079.3 | 16358.6 | 146.439 | 44.91 | 82.85 | 942 |
| 250.000 | 15.213 | 0.06573 | 6.6548 | 117.711 | 16913.9 | 17203.1 | 149.886 | 45.55 | 86.18 | 861 |
| 260.000 | 14.619 | 0.06840 | 5.8099 | 92.605 | 17784.9 | 18085.9 | 153.348 | 46.25 | 90.60 | 777 |
| 270.000 | 13.948 | 0.07169 | 4.9841 | 69.108 | 18705.9 | 19021.3 | 156.877 | 47.04 | 96.93 | 688 |
| 280.000 | 13.155 | 0.07602 | 4.1548 | 47.054 | 19702.9 | 20037.4 | 160.572 | 47.93 | 107.29 | 592 |
| 290.000 | 12.119 | 0.08251 | 3.2720 | 26.209 | 20841.3 | 21204.3 | 164.664 | 49.04 | 129.69 | 480 |
| 300.000 | 10.194 | 0.09810 | 2.0882 | 5.535 | 22472.4 | 22904.0 | 170.415 | 51.51 | 278.95 | 316 |
| 300.478 | 9.997 | 0.10003 | 1.9937 | 4.414 | 22606.7 | 23046.8 | 170.891 | 51.90 | 322.65 | 302 |
| | | | | | | | | | | |
| 300.478 | 3.911 | 0.25570 | 0.5622 | 1.794 | 26209.0 | 27334.1 | 185.182 | 60.25 | 406.36 | 201 |
| 310.000 | 2.892 | 0.34574 | 0.3648 | 6.938 | 27573.9 | 29095.1 | 190.968 | 53.61 | 124.67 | 232 |
| 320.000 | 2.505 | 0.39920 | 0.2981 | 10.147 | 28423.2 | 30179.7 | 194.414 | 52.76 | 97.42 | 250 |
| 330.000 | 2.262 | 0.44211 | 0.2586 | 12.721 | 29148.4 | 31093.7 | 197.229 | 52.82 | 86.74 | 264 |
| 340.000 | 2.085 | 0.47962 | 0.2313 | 14.952 | 29820.6 | 31930.9 | 199.728 | 53.28 | 81.26 | 275 |
| 350.000 | 1.947 | 0.51373 | 0.2107 | 16.957 | 30466.1 | 32726.5 | 202.035 | 53.96 | 78.15 | 286 |
| 360.000 | 1.833 | 0.54546 | 0.1945 | 18.799 | 31097.7 | 33497.8 | 204.209 | 54.79 | 76.34 | 295 |
| 370.000 | 1.738 | 0.57544 | 0.1812 | 20.517 | 31723.8 | 34255.7 | 206.285 | 55.73 | 75.33 | 304 |
| 380.000 | 1.655 | 0.60405 | 0.1701 | 22.135 | 32348.1 | 35005.9 | 208.287 | 56.73 | 74.84 | 312 |
| 390.000 | 1.583 | 0.63158 | 0.1606 | 23.673 | 32974.7 | 35753.7 | 210.228 | 57.78 | 74.72 | 319 |
| 400.000 | 1.519 | 0.65821 | 0.1523 | 25.143 | 33605.0 | 36501.2 | 212.122 | 58.87 | 74.86 | 326 |
| 410.000 | 1.462 | 0.68411 | 0.1451 | 26.556 | 34241.0 | 37251.1 | 213.974 | 59.99 | 75.20 | 333 |
| 420.000 | 1.410 | 0.70938 | 0.1386 | 27.920 | 34883.9 | 38005.2 | 215.792 | 61.13 | 75.68 | 339 |
| 430.000 | 1.362 | 0.73411 | 0.1329 | 29.241 | 35535.1 | 38765.2 | 217.579 | 62.28 | 76.28 | 345 |
| 440.000 | 1.319 | 0.75838 | 0.1277 | 30.525 | 36194.3 | 39531.2 | 219.341 | 63.44 | 76.96 | 351 |
| 450.000 | 1.278 | 0.78225 | 0.1230 | 31.777 | 36862.4 | 40304.3 | 221.078 | 64.61 | 77.71 | 357 |
| 460.000 | 1.241 | 0.80576 | 0.1187 | 32.999 | 37539.8 | 41085.2 | 222.795 | 65.77 | 78.51 | 362 |
| 470.000 | 1.206 | 0.82895 | 0.1147 | 34.195 | 38226.9 | 41874.3 | 224.493 | 66.94 | 79.36 | 367 |
| 480.000 | 1.174 | 0.85186 | 0.1110 | 35.368 | 38924.5 | 42672.7 | 226.172 | 68.09 | 80.23 | 372 |
| 490.000 | 1.143 | 0.87452 | 0.1076 | 36.520 | 39631.5 | 43479.4 | 227.836 | 69.25 | 81.14 | 377 |
| 500.000 | 1.115 | 0.89695 | 0.1045 | 37.652 | 40348.6 | 44295.1 | 229.484 | 70.39 | 82.06 | 382 |
| 520.000 | 1.062 | 0.94121 | 0.0988 | 39.867 | 41813.3 | 45954.6 | 232.739 | 72.66 | 83.93 | 391 |
| 540.000 | 1.015 | 0.98479 | 0.0938 | 42.024 | 43318.9 | 47652.0 | 235.942 | 74.88 | 85.84 | 400 |
| 560.000 | 0.973 | 1.02780 | 0.0893 | 44.131 | 44866.1 | 49388.4 | 239.099 | 77.07 | 87.76 | 409 |
| 580.000 | 0.934 | 1.07032 | 0.0853 | 46.197 | 46452.9 | 51162.3 | 242.212 | 79.21 | 89.67 | 417 |
| 600.000 | 0.899 | 1.11242 | 0.0817 | 48.226 | 48079.8 | 52974.5 | 245.284 | 81.30 | 91.57 | 425 |

Table 27. Thermophysical properties along isobars (Continued)

ETHANE ISOBAR AT P = 48.0 BAR

| T | DEN | VOL | DP/DT | DP/DD | E | H | S | CV | CP | W |
|---|---|---|---|---|---|---|---|---|---|---|
| DEG K | MOL/L | L/MOL | BAR/K | BAR-L/MOL | J/MOL | J/MOL | J/MOL/K | J/MOL/K | J/MOL/K | M/SEC |
| 90.646 | 21.703 | 0.04608 | 34.7806 | 969.954 | 5316.6 | 5537.7 | 76.694 | 44.44 | 68.44 | 2229 |
| 100.000 | 21.369 | 0.04680 | 31.1477 | 877.664 | 5953.7 | 6178.4 | 83.420 | 44.33 | 68.53 | 2124 |
| 110.000 | 21.015 | 0.04758 | 27.8908 | 788.790 | 6636.0 | 6864.4 | 89.958 | 44.12 | 68.68 | 2021 |
| 120.000 | 20.661 | 0.04840 | 25.1184 | 708.544 | 7319.9 | 7552.3 | 95.943 | 43.87 | 68.90 | 1924 |
| 130.000 | 20.306 | 0.04925 | 22.7161 | 635.777 | 8006.4 | 8242.7 | 101.470 | 43.62 | 69.21 | 1832 |
| 140.000 | 19.946 | 0.05014 | 20.6036 | 569.601 | 8696.0 | 8936.7 | 106.612 | 43.38 | 69.60 | 1743 |
| 150.000 | 19.582 | 0.05107 | 18.7229 | 509.279 | 9390.0 | 9635.1 | 111.430 | 43.17 | 70.10 | 1658 |
| 160.000 | 19.210 | 0.05206 | 17.0313 | 454.184 | 10089.2 | 10339.1 | 115.974 | 43.03 | 70.72 | 1576 |
| 170.000 | 18.831 | 0.05310 | 15.4964 | 403.769 | 10795.0 | 11049.9 | 120.282 | 42.95 | 71.47 | 1495 |
| 180.000 | 18.442 | 0.05422 | 14.0936 | 357.549 | 11508.6 | 11768.9 | 124.392 | 42.96 | 72.36 | 1415 |
| 190.000 | 18.042 | 0.05543 | 12.8033 | 315.088 | 12231.6 | 12497.6 | 128.332 | 43.06 | 73.42 | 1337 |
| 200.000 | 17.629 | 0.05673 | 11.6101 | 275.996 | 12965.7 | 13238.0 | 132.129 | 43.25 | 74.68 | 1259 |
| 210.000 | 17.200 | 0.05814 | 10.5009 | 239.919 | 13712.9 | 13992.0 | 135.807 | 43.53 | 76.16 | 1181 |
| 220.000 | 16.752 | 0.05969 | 9.4649 | 206.549 | 14475.6 | 14762.1 | 139.390 | 43.92 | 77.92 | 1104 |
| 230.000 | 16.282 | 0.06142 | 8.4923 | 175.609 | 15256.6 | 15551.4 | 142.898 | 44.39 | 80.02 | 1026 |
| 240.000 | 15.783 | 0.06336 | 7.5741 | 146.857 | 16059.8 | 16364.0 | 146.356 | 44.94 | 82.58 | 947 |
| 250.000 | 15.247 | 0.06559 | 6.7010 | 120.085 | 16890.3 | 17205.1 | 149.789 | 45.58 | 85.79 | 867 |
| 260.000 | 14.662 | 0.06821 | 5.8628 | 95.114 | 17755.6 | 18083.0 | 153.232 | 46.28 | 89.99 | 784 |
| 270.000 | 14.005 | 0.07140 | 5.0467 | 71.792 | 18667.9 | 19010.6 | 156.732 | 47.07 | 95.90 | 697 |
| 280.000 | 13.237 | 0.07555 | 4.2333 | 49.987 | 19649.5 | 20012.1 | 160.373 | 47.94 | 105.23 | 604 |
| 290.000 | 12.263 | 0.08155 | 3.3839 | 29.559 | 20752.5 | 21143.9 | 164.343 | 49.00 | 123.71 | 498 |
| 300.000 | 10.712 | 0.09336 | 2.3649 | 10.196 | 22178.0 | 22626.1 | 169.361 | 50.79 | 194.21 | 360 |
| 304.629 | 8.441 | 0.11846 | 1.4139 | 0.559 | 23675.1 | 24243.7 | 174.701 | 57.73 | 1586.21 | 226 |
| 304.629 | 5.319 | 0.18801 | 0.8207 | 0.272 | 25398.6 | 26301.1 | 181.474 | 71.86 | 2741.74 | 186 |
| 310.000 | 3.605 | 0.27740 | 0.4839 | 4.409 | 27000.0 | 28331.5 | 188.102 | 55.90 | 182.61 | 219 |
| 320.000 | 2.939 | 0.34029 | 0.3647 | 8.349 | 28073.3 | 29706.7 | 192.474 | 53.82 | 112.86 | 241 |
| 330.000 | 2.596 | 0.38519 | 0.3071 | 11.243 | 28881.4 | 30730.3 | 195.625 | 53.52 | 94.60 | 257 |
| 340.000 | 2.365 | 0.42289 | 0.2701 | 13.673 | 29599.8 | 31629.7 | 198.312 | 53.79 | 86.23 | 270 |
| 350.000 | 2.191 | 0.45647 | 0.2433 | 15.823 | 30276.0 | 32467.0 | 200.739 | 54.37 | 81.66 | 281 |
| 360.000 | 2.052 | 0.48731 | 0.2228 | 17.780 | 30929.7 | 33268.7 | 202.999 | 55.12 | 78.99 | 291 |
| 370.000 | 1.937 | 0.51618 | 0.2063 | 19.592 | 31572.5 | 34050.2 | 205.140 | 56.00 | 77.42 | 300 |
| 380.000 | 1.840 | 0.54355 | 0.1927 | 21.291 | 32210.2 | 34819.3 | 207.192 | 56.96 | 76.55 | 308 |
| 390.000 | 1.755 | 0.56976 | 0.1813 | 22.899 | 32847.8 | 35582.6 | 209.174 | 57.99 | 76.15 | 316 |
| 400.000 | 1.681 | 0.59501 | 0.1714 | 24.432 | 33487.2 | 36343.3 | 211.101 | 59.05 | 76.08 | 324 |
| 410.000 | 1.614 | 0.61947 | 0.1628 | 25.902 | 34131.0 | 37104.5 | 212.981 | 60.15 | 76.25 | 330 |
| 420.000 | 1.555 | 0.64328 | 0.1552 | 27.317 | 34781.1 | 37868.9 | 214.822 | 61.27 | 76.60 | 337 |
| 430.000 | 1.500 | 0.66653 | 0.1485 | 28.685 | 35437.7 | 38637.0 | 216.630 | 62.41 | 77.09 | 343 |
| 440.000 | 1.451 | 0.68930 | 0.1424 | 30.012 | 36102.0 | 39410.6 | 218.409 | 63.56 | 77.69 | 349 |
| 450.000 | 1.405 | 0.71165 | 0.1369 | 31.303 | 36774.7 | 40190.6 | 220.163 | 64.71 | 78.36 | 355 |
| 460.000 | 1.363 | 0.73362 | 0.1319 | 32.562 | 37456.9 | 40978.2 | 221.893 | 65.87 | 79.10 | 361 |
| 470.000 | 1.324 | 0.75528 | 0.1274 | 33.792 | 38147.7 | 41773.0 | 223.603 | 67.02 | 79.89 | 366 |
| 480.000 | 1.288 | 0.77664 | 0.1232 | 34.997 | 38848.0 | 42575.9 | 225.293 | 68.17 | 80.72 | 371 |
| 490.000 | 1.254 | 0.79775 | 0.1193 | 36.178 | 39558.1 | 43387.3 | 226.966 | 69.32 | 81.59 | 376 |
| 500.000 | 1.222 | 0.81862 | 0.1157 | 37.339 | 40278.0 | 44207.3 | 228.624 | 70.46 | 82.47 | 381 |
| 520.000 | 1.163 | 0.85975 | 0.1092 | 39.605 | 41748.3 | 45875.2 | 231.893 | 72.71 | 84.29 | 391 |
| 540.000 | 1.111 | 0.90019 | 0.1035 | 41.807 | 43258.3 | 47579.2 | 235.109 | 74.93 | 86.15 | 400 |
| 560.000 | 1.064 | 0.94005 | 0.0985 | 43.955 | 44808.5 | 49320.7 | 238.276 | 77.11 | 88.03 | 409 |
| 580.000 | 1.021 | 0.97941 | 0.0940 | 46.057 | 46398.6 | 51099.8 | 241.398 | 79.24 | 89.91 | 417 |
| 600.000 | 0.982 | 1.01835 | 0.0899 | 48.120 | 48029.2 | 52917.3 | 244.478 | 81.33 | 91.79 | 425 |

Table 27. Thermophysical properties along isobars (Continued)

ETHANE ISOBAR AT P = 52.0 BAR

| T<br>DEG K | DEN<br>MOL/L | VOL<br>L/MOL | DP/DT<br>BAR/K | DP/DD<br>BAR-L/MOL | E<br>J/MOL | H<br>J/MOL | S<br>J/MOL/K | CV<br>J/MOL/K | CP<br>J/MOL/K | W<br>M/SEC |
|---|---|---|---|---|---|---|---|---|---|---|
| 90.708 | 21.705 | 0.04607 | 34.7573 | 970.588 | 5318.1 | 5557.6 | 76.711 | 44.47 | 68.44 | 2229 |
| 100.000 | 21.374 | 0.04679 | 31.1537 | 879.034 | 5950.7 | 6194.0 | 83.389 | 44.36 | 68.52 | 2125 |
| 110.000 | 21.020 | 0.04757 | 27.8995 | 790.245 | 6632.5 | 6879.9 | 89.926 | 44.15 | 68.67 | 2022 |
| 120.000 | 20.667 | 0.04839 | 25.1295 | 710.072 | 7316.0 | 7567.6 | 95.910 | 43.90 | 68.89 | 1925 |
| 130.000 | 20.312 | 0.04923 | 22.7294 | 637.369 | 8001.9 | 8257.9 | 101.435 | 43.65 | 69.19 | 1833 |
| 140.000 | 19.953 | 0.05012 | 20.6190 | 571.252 | 8691.0 | 8951.7 | 106.576 | 43.40 | 69.58 | 1745 |
| 150.000 | 19.589 | 0.05105 | 18.7403 | 510.984 | 9384.3 | 9649.8 | 111.392 | 43.20 | 70.07 | 1660 |
| 160.000 | 19.219 | 0.05203 | 17.0507 | 455.939 | 10082.8 | 10353.4 | 115.933 | 43.06 | 70.68 | 1578 |
| 170.000 | 18.841 | 0.05308 | 15.5179 | 405.574 | 10787.8 | 11063.8 | 120.239 | 42.98 | 71.42 | 1497 |
| 180.000 | 18.453 | 0.05419 | 14.1172 | 359.404 | 11500.4 | 11782.2 | 124.346 | 42.99 | 72.30 | 1418 |
| 190.000 | 18.055 | 0.05539 | 12.8291 | 316.994 | 12222.3 | 12510.3 | 128.282 | 43.09 | 73.35 | 1340 |
| 200.000 | 17.643 | 0.05668 | 11.6382 | 277.957 | 12955.1 | 13249.9 | 132.075 | 43.28 | 74.59 | 1262 |
| 210.000 | 17.217 | 0.05808 | 10.5315 | 241.939 | 13700.8 | 14002.8 | 135.748 | 43.57 | 76.04 | 1185 |
| 220.000 | 16.772 | 0.05962 | 9.4984 | 208.636 | 14461.6 | 14771.6 | 139.325 | 43.95 | 77.77 | 1108 |
| 230.000 | 16.305 | 0.06133 | 8.5291 | 177.772 | 15240.3 | 15559.3 | 142.825 | 44.42 | 79.82 | 1031 |
| 240.000 | 15.810 | 0.06325 | 7.6148 | 149.108 | 16040.6 | 16369.5 | 146.273 | 44.97 | 82.31 | 953 |
| 250.000 | 15.280 | 0.06544 | 6.7465 | 122.440 | 16867.2 | 17207.5 | 149.694 | 45.61 | 85.41 | 873 |
| 260.000 | 14.703 | 0.06801 | 5.9147 | 97.596 | 17727.1 | 18080.8 | 153.118 | 46.31 | 89.42 | 792 |
| 270.000 | 14.060 | 0.07113 | 5.1075 | 74.437 | 18631.2 | 19001.0 | 156.591 | 47.09 | 94.96 | 707 |
| 280.000 | 13.315 | 0.07510 | 4.3083 | 52.853 | 19598.9 | 19989.5 | 160.184 | 47.96 | 103.42 | 616 |
| 290.000 | 12.391 | 0.08070 | 3.4864 | 32.768 | 20672.6 | 21092.2 | 164.053 | 48.98 | 119.04 | 515 |
| 300.000 | 11.042 | 0.09056 | 2.5575 | 14.143 | 21985.7 | 22456.6 | 168.674 | 50.50 | 164.29 | 391 |
| 310.000 | 5.105 | 0.19588 | 0.7494 | 1.449 | 25891.7 | 26910.2 | 183.207 | 60.85 | 521.92 | 203 |
| 320.000 | 3.481 | 0.28729 | 0.4522 | 6.471 | 27650.3 | 29144.1 | 190.324 | 55.10 | 138.55 | 233 |
| 330.000 | 2.978 | 0.33584 | 0.3649 | 9.763 | 28583.2 | 30329.6 | 193.975 | 54.28 | 105.06 | 251 |
| 340.000 | 2.672 | 0.37431 | 0.3144 | 12.416 | 29361.6 | 31308.0 | 196.897 | 54.34 | 92.26 | 265 |
| 350.000 | 2.453 | 0.40769 | 0.2797 | 14.718 | 30074.4 | 32194.4 | 199.468 | 54.79 | 85.71 | 277 |
| 360.000 | 2.284 | 0.43790 | 0.2538 | 16.790 | 30754.0 | 33031.0 | 201.825 | 55.46 | 81.96 | 287 |
| 370.000 | 2.146 | 0.46591 | 0.2335 | 18.695 | 31415.7 | 33838.5 | 204.037 | 56.28 | 79.71 | 297 |
| 380.000 | 2.031 | 0.49229 | 0.2171 | 20.473 | 32068.2 | 34628.1 | 206.144 | 57.20 | 78.39 | 305 |
| 390.000 | 1.933 | 0.51740 | 0.2033 | 22.150 | 32717.6 | 35408.1 | 208.170 | 58.19 | 77.67 | 314 |
| 400.000 | 1.847 | 0.54150 | 0.1916 | 23.743 | 33366.9 | 36182.7 | 210.132 | 59.23 | 77.36 | 321 |
| 410.000 | 1.771 | 0.56477 | 0.1815 | 25.266 | 34019.5 | 36956.3 | 212.041 | 60.31 | 77.35 | 328 |
| 420.000 | 1.703 | 0.58735 | 0.1726 | 26.730 | 34676.2 | 37730.4 | 213.907 | 61.41 | 77.56 | 335 |
| 430.000 | 1.641 | 0.60935 | 0.1648 | 28.143 | 35338.9 | 38507.6 | 215.736 | 62.53 | 77.93 | 342 |
| 440.000 | 1.585 | 0.63085 | 0.1577 | 29.512 | 36009.2 | 39289.6 | 217.534 | 63.67 | 78.44 | 348 |
| 450.000 | 1.534 | 0.65192 | 0.1514 | 30.841 | 36686.7 | 40076.7 | 219.303 | 64.81 | 79.03 | 354 |
| 460.000 | 1.487 | 0.67261 | 0.1457 | 32.135 | 37372.6 | 40870.1 | 221.047 | 65.96 | 79.71 | 359 |
| 470.000 | 1.443 | 0.69296 | 0.1405 | 33.398 | 38067.3 | 41670.7 | 222.769 | 67.11 | 80.44 | 365 |
| 480.000 | 1.402 | 0.71302 | 0.1357 | 34.634 | 38771.1 | 42478.8 | 224.471 | 68.25 | 81.23 | 370 |
| 490.000 | 1.365 | 0.73281 | 0.1313 | 35.844 | 39484.9 | 43295.5 | 226.154 | 69.39 | 82.05 | 375 |
| 500.000 | 1.329 | 0.75237 | 0.1272 | 37.032 | 40207.7 | 44120.0 | 227.820 | 70.52 | 82.89 | 380 |
| 520.000 | 1.264 | 0.79086 | 0.1199 | 39.348 | 41682.6 | 45795.0 | 231.105 | 72.77 | 84.65 | 390 |
| 540.000 | 1.207 | 0.82864 | 0.1135 | 41.594 | 43196.9 | 47505.9 | 234.334 | 74.98 | 86.47 | 399 |
| 560.000 | 1.155 | 0.86584 | 0.1078 | 43.783 | 44751.6 | 49253.9 | 237.512 | 77.15 | 88.31 | 408 |
| 580.000 | 1.108 | 0.90253 | 0.1028 | 45.921 | 46345.1 | 51038.2 | 240.643 | 79.28 | 90.16 | 417 |
| 600.000 | 1.065 | 0.93880 | 0.0983 | 48.017 | 47977.8 | 52859.6 | 243.730 | 81.37 | 92.01 | 425 |

Table 27. Thermophysical properties along isobars (Continued)

ETHANE ISOBAR AT P = 56.0 BAR

| T DEG K | DEN MOL/L | VOL L/MOL | DP/DT BAR/K | DP/DD BAR-L/MOL | E J/MOL | H J/MOL | S J/MOL/K | CV J/MOL/K | CP J/MOL/K | W M/SEC |
|---|---|---|---|---|---|---|---|---|---|---|
| 90.770 | 21.706 | 0.04607 | 34.7340 | 971.224 | 5319.6 | 5577.5 | 76.727 | 44.50 | 68.44 | 2229 |
| 100.000 | 21.378 | 0.04678 | 31.1596 | 880.402 | 5947.6 | 6209.6 | 83.358 | 44.39 | 68.52 | 2125 |
| 110.000 | 21.025 | 0.04756 | 27.9082 | 791.698 | 6629.1 | 6895.4 | 89.894 | 44.18 | 68.66 | 2023 |
| 120.000 | 20.673 | 0.04837 | 25.1406 | 711.598 | 7312.1 | 7583.0 | 95.877 | 43.93 | 68.87 | 1926 |
| 130.000 | 20.318 | 0.04922 | 22.7427 | 638.961 | 7997.5 | 8273.1 | 101.401 | 43.67 | 69.17 | 1834 |
| 140.000 | 19.960 | 0.05010 | 20.6344 | 572.902 | 8686.1 | 8966.6 | 106.540 | 43.43 | 69.55 | 1747 |
| 150.000 | 19.597 | 0.05103 | 18.7577 | 512.686 | 9378.7 | 9664.5 | 111.354 | 43.23 | 70.04 | 1662 |
| 160.000 | 19.228 | 0.05201 | 17.0701 | 457.692 | 10076.5 | 10367.8 | 115.893 | 43.09 | 70.64 | 1580 |
| 170.000 | 18.851 | 0.05305 | 15.5393 | 407.376 | 10780.6 | 11077.7 | 120.196 | 43.01 | 71.37 | 1499 |
| 180.000 | 18.465 | 0.05416 | 14.1407 | 361.254 | 11492.3 | 11795.6 | 124.300 | 43.02 | 72.24 | 1420 |
| 190.000 | 18.067 | 0.05535 | 12.8548 | 318.895 | 12213.1 | 12523.1 | 128.232 | 43.12 | 73.28 | 1343 |
| 200.000 | 17.658 | 0.05663 | 11.6661 | 279.911 | 12944.6 | 13261.8 | 132.021 | 43.31 | 74.50 | 1265 |
| 210.000 | 17.233 | 0.05803 | 10.5620 | 243.953 | 13688.8 | 14013.8 | 135.690 | 43.60 | 75.93 | 1189 |
| 220.000 | 16.791 | 0.05956 | 9.5316 | 210.714 | 14447.8 | 14781.3 | 139.260 | 43.98 | 77.62 | 1112 |
| 230.000 | 16.327 | 0.06125 | 8.5655 | 179.923 | 15224.3 | 15567.3 | 142.754 | 44.45 | 79.63 | 1035 |
| 240.000 | 15.837 | 0.06315 | 7.6550 | 151.344 | 16021.7 | 16375.3 | 146.192 | 45.00 | 82.06 | 958 |
| 250.000 | 15.312 | 0.06531 | 6.7913 | 124.775 | 16844.6 | 17210.3 | 149.600 | 45.64 | 85.05 | 879 |
| 260.000 | 14.744 | 0.06783 | 5.9655 | 100.052 | 17699.3 | 18079.1 | 153.007 | 46.34 | 88.88 | 799 |
| 270.000 | 14.113 | 0.07086 | 5.1667 | 77.043 | 18595.7 | 18992.5 | 156.454 | 47.11 | 94.09 | 715 |
| 280.000 | 13.389 | 0.07469 | 4.3803 | 55.658 | 19550.8 | 19969.1 | 160.005 | 47.97 | 101.82 | 627 |
| 290.000 | 12.508 | 0.07995 | 3.5816 | 35.861 | 20599.5 | 21047.2 | 163.787 | 48.97 | 115.27 | 530 |
| 300.000 | 11.294 | 0.08854 | 2.7133 | 17.738 | 21837.1 | 22333.0 | 168.143 | 50.33 | 147.94 | 416 |
| 310.000 | 8.551 | 0.11695 | 1.4924 | 2.392 | 23911.5 | 24566.4 | 175.445 | 54.19 | 448.90 | 257 |
| 320.000 | 4.214 | 0.23730 | 0.5760 | 4.564 | 27105.0 | 28433.9 | 187.776 | 56.69 | 187.68 | 224 |
| 330.000 | 3.422 | 0.29223 | 0.4351 | 8.281 | 28245.5 | 29882.0 | 192.238 | 55.13 | 119.55 | 244 |
| 340.000 | 3.011 | 0.33212 | 0.3653 | 11.181 | 29103.5 | 30963.3 | 195.468 | 54.92 | 99.66 | 260 |
| 350.000 | 2.735 | 0.36562 | 0.3202 | 13.645 | 29861.2 | 31908.7 | 198.209 | 55.22 | 90.39 | 273 |
| 360.000 | 2.529 | 0.39542 | 0.2878 | 15.834 | 30570.2 | 32784.6 | 200.677 | 55.81 | 85.26 | 284 |
| 370.000 | 2.365 | 0.42276 | 0.2630 | 17.832 | 31253.2 | 33620.6 | 202.968 | 56.57 | 82.21 | 294 |
| 380.000 | 2.231 | 0.44831 | 0.2431 | 19.687 | 31921.9 | 34432.5 | 205.134 | 57.44 | 80.37 | 303 |
| 390.000 | 2.116 | 0.47251 | 0.2267 | 21.429 | 32584.2 | 35230.3 | 207.206 | 58.40 | 79.28 | 311 |
| 400.000 | 2.018 | 0.49563 | 0.2129 | 23.080 | 33244.1 | 36019.6 | 209.206 | 59.41 | 78.71 | 319 |
| 410.000 | 1.931 | 0.51789 | 0.2011 | 24.655 | 33905.4 | 36805.6 | 211.146 | 60.47 | 78.50 | 326 |
| 420.000 | 1.854 | 0.53943 | 0.1908 | 26.166 | 34569.7 | 37590.5 | 213.038 | 61.55 | 78.56 | 333 |
| 430.000 | 1.785 | 0.56036 | 0.1817 | 27.621 | 35239.3 | 38377.4 | 214.889 | 62.66 | 78.81 | 340 |
| 440.000 | 1.722 | 0.58078 | 0.1737 | 29.029 | 35914.8 | 39167.1 | 216.705 | 63.78 | 79.21 | 346 |
| 450.000 | 1.665 | 0.60075 | 0.1665 | 30.394 | 36597.3 | 39961.5 | 218.491 | 64.91 | 79.72 | 352 |
| 460.000 | 1.612 | 0.62033 | 0.1600 | 31.722 | 37287.6 | 40761.5 | 220.249 | 66.05 | 80.33 | 358 |
| 470.000 | 1.564 | 0.63957 | 0.1540 | 33.017 | 37986.8 | 41568.4 | 221.984 | 67.19 | 81.01 | 364 |
| 480.000 | 1.519 | 0.65851 | 0.1486 | 34.282 | 38694.2 | 42381.9 | 223.697 | 68.33 | 81.74 | 369 |
| 490.000 | 1.477 | 0.67718 | 0.1436 | 35.520 | 39410.7 | 43202.9 | 225.390 | 69.46 | 82.51 | 375 |
| 500.000 | 1.438 | 0.69561 | 0.1390 | 36.734 | 40136.5 | 44031.9 | 227.065 | 70.59 | 83.32 | 380 |
| 520.000 | 1.366 | 0.73183 | 0.1308 | 39.098 | 41617.2 | 45715.5 | 230.366 | 72.83 | 85.02 | 390 |
| 540.000 | 1.303 | 0.76734 | 0.1237 | 41.388 | 43136.1 | 47433.2 | 233.608 | 75.03 | 86.79 | 399 |
| 560.000 | 1.246 | 0.80225 | 0.1174 | 43.615 | 44693.9 | 49186.6 | 236.797 | 77.20 | 88.59 | 408 |
| 580.000 | 1.195 | 0.83666 | 0.1118 | 45.789 | 46291.5 | 50976.8 | 239.937 | 79.32 | 90.40 | 417 |
| 600.000 | 1.149 | 0.87064 | 0.1068 | 47.917 | 47927.3 | 52802.8 | 243.032 | 81.40 | 92.23 | 425 |

Table 27. Thermophysical properties along isobars (Continued)

ETHANE ISOBAR AT P = 60.0 BAR

| T | DEN | VOL | DP/DT | DP/DD | E | H | S | CV | CP | W |
|---|---|---|---|---|---|---|---|---|---|---|
| DEG K | MOL/L | L/MOL | BAR/K | BAR-L/MOL | J/MCL | J/MOL | J/MCL/K | J/MOL/K | J/MOL/K | M/SEC |
| 90.831 | 21.708 | 0.04607 | 34.7109 | 971.862 | 5321.1 | 5597.5 | 76.743 | 44.54 | 68.43 | 2228 |
| 100.000 | 21.383 | 0.04677 | 31.1656 | 881.770 | 5944.6 | 6225.2 | 83.327 | 44.42 | 68.51 | 2127 |
| 110.000 | 21.030 | 0.04755 | 27.9169 | 793.150 | 6625.6 | 6910.9 | 89.862 | 44.21 | 68.65 | 2024 |
| 120.000 | 20.678 | 0.04836 | 25.1517 | 713.124 | 7308.2 | 7598.4 | 95.844 | 43.96 | 68.86 | 1927 |
| 130.000 | 20.324 | 0.04920 | 22.7560 | 640.551 | 7993.1 | 8288.4 | 101.366 | 43.70 | 69.15 | 1836 |
| 140.000 | 19.967 | 0.05008 | 20.6497 | 574.549 | 8681.1 | 8981.6 | 106.504 | 43.46 | 69.52 | 1748 |
| 150.000 | 19.605 | 0.05101 | 18.7751 | 514.386 | 9373.1 | 9679.2 | 111.316 | 43.26 | 70.01 | 1664 |
| 160.000 | 19.237 | 0.05198 | 17.0895 | 459.442 | 10070.2 | 10382.1 | 115.852 | 43.12 | 70.60 | 1582 |
| 170.000 | 18.861 | 0.05302 | 15.5607 | 409.174 | 10773.5 | 11091.6 | 120.153 | 43.04 | 71.32 | 1502 |
| 180.000 | 18.476 | 0.05413 | 14.1641 | 363.100 | 11484.3 | 11809.0 | 124.254 | 43.05 | 72.19 | 1423 |
| 190.000 | 18.080 | 0.05531 | 12.8803 | 320.791 | 12204.0 | 12535.9 | 128.183 | 43.15 | 73.21 | 1345 |
| 200.000 | 17.672 | 0.05659 | 11.6939 | 281.860 | 12934.3 | 13273.8 | 131.968 | 43.34 | 74.41 | 1269 |
| 210.000 | 17.249 | 0.05797 | 10.5923 | 245.959 | 13676.9 | 14024.8 | 135.632 | 43.63 | 75.82 | 1192 |
| 220.000 | 16.810 | 0.05949 | 9.5646 | 212.784 | 14434.1 | 14791.1 | 139.196 | 44.01 | 77.48 | 1116 |
| 230.000 | 16.349 | 0.06117 | 8.6016 | 182.064 | 15208.4 | 15575.4 | 142.683 | 44.48 | 79.45 | 1040 |
| 240.000 | 15.863 | 0.06304 | 7.6947 | 153.566 | 16003.1 | 16381.3 | 146.112 | 45.04 | 81.81 | 963 |
| 250.000 | 15.344 | 0.06517 | 6.8355 | 127.093 | 16822.3 | 17213.4 | 149.508 | 45.67 | 84.70 | 885 |
| 260.000 | 14.783 | 0.06765 | 6.0154 | 102.483 | 17672.1 | 18078.0 | 152.899 | 46.37 | 88.38 | 806 |
| 270.000 | 14.164 | 0.07060 | 5.2244 | 79.615 | 18561.3 | 18984.9 | 156.321 | 47.14 | 93.28 | 724 |
| 280.000 | 13.459 | 0.07430 | 4.4496 | 58.409 | 19505.0 | 19950.8 | 159.833 | 47.99 | 100.39 | 637 |
| 290.000 | 12.615 | 0.07927 | 3.6708 | 38.858 | 20532.1 | 21007.7 | 163.541 | 48.96 | 112.15 | 544 |
| 300.000 | 11.500 | 0.08695 | 2.8471 | 21.106 | 21713.9 | 22235.6 | 167.701 | 50.22 | 137.34 | 438 |
| 310.000 | 9.560 | 0.10460 | 1.8502 | 6.065 | 23348.6 | 23976.2 | 173.400 | 52.65 | 244.09 | 306 |
| 320.000 | 5.294 | 0.18889 | 0.7675 | 3.091 | 26358.0 | 27491.4 | 184.564 | 58.46 | 276.06 | 220 |
| 330.000 | 3.953 | 0.25297 | 0.5225 | 6.845 | 27856.1 | 29374.0 | 190.368 | 56.04 | 140.26 | 239 |
| 340.000 | 3.390 | 0.29502 | 0.4242 | 9.976 | 28822.6 | 30592.8 | 194.009 | 55.52 | 108.89 | 255 |
| 350.000 | 3.040 | 0.32894 | 0.3656 | 12.605 | 29634.7 | 31608.4 | 196.955 | 55.67 | 95.83 | 269 |
| 360.000 | 2.789 | 0.35852 | 0.3251 | 14.914 | 30378.1 | 32529.2 | 199.549 | 56.16 | 88.96 | 280 |
| 370.000 | 2.595 | 0.38534 | 0.2948 | 17.005 | 31084.9 | 33396.9 | 201.927 | 56.86 | 84.94 | 291 |
| 380.000 | 2.438 | 0.41021 | 0.2710 | 18.935 | 31771.4 | 34232.7 | 204.157 | 57.68 | 82.48 | 300 |
| 390.000 | 2.306 | 0.43363 | 0.2516 | 20.741 | 32447.7 | 35049.4 | 206.278 | 58.60 | 80.99 | 309 |
| 400.000 | 2.193 | 0.45592 | 0.2355 | 22.447 | 33119.1 | 35854.7 | 208.317 | 59.59 | 80.13 | 317 |
| 410.000 | 2.095 | 0.47730 | 0.2217 | 24.071 | 33789.4 | 36653.2 | 210.289 | 60.62 | 79.70 | 324 |
| 420.000 | 2.008 | 0.49793 | 0.2099 | 25.626 | 34461.6 | 37449.2 | 212.208 | 61.69 | 79.59 | 332 |
| 430.000 | 1.931 | 0.51794 | 0.1995 | 27.122 | 35138.0 | 38245.7 | 214.082 | 62.78 | 79.71 | 338 |
| 440.000 | 1.861 | 0.53742 | 0.1903 | 28.567 | 35819.3 | 39043.9 | 215.917 | 63.89 | 80.00 | 345 |
| 450.000 | 1.797 | 0.55644 | 0.1821 | 29.966 | 36507.5 | 39846.1 | 217.719 | 65.02 | 80.43 | 351 |
| 460.000 | 1.739 | 0.57506 | 0.1747 | 31.327 | 37202.4 | 40652.8 | 219.493 | 66.14 | 80.96 | 357 |
| 470.000 | 1.685 | 0.59334 | 0.1680 | 32.651 | 37905.2 | 41465.3 | 221.241 | 67.27 | 81.58 | 363 |
| 480.000 | 1.636 | 0.61131 | 0.1619 | 33.945 | 38616.4 | 42284.2 | 222.965 | 68.40 | 82.26 | 368 |
| 490.000 | 1.590 | 0.62900 | 0.1563 | 35.209 | 39336.7 | 43110.7 | 224.669 | 69.53 | 82.99 | 374 |
| 500.000 | 1.547 | 0.64645 | 0.1512 | 36.448 | 40065.6 | 43944.3 | 226.353 | 70.66 | 83.76 | 379 |
| 520.000 | 1.469 | 0.68071 | 0.1420 | 38.858 | 41551.1 | 45635.3 | 229.670 | 72.89 | 85.39 | 389 |
| 540.000 | 1.400 | 0.71424 | 0.1341 | 41.189 | 43074.5 | 47360.0 | 232.924 | 75.08 | 87.11 | 399 |
| 560.000 | 1.338 | 0.74718 | 0.1271 | 43.454 | 44636.9 | 49120.0 | 236.124 | 77.24 | 88.87 | 408 |
| 580.000 | 1.283 | 0.77960 | 0.1210 | 45.663 | 46237.3 | 50914.9 | 239.274 | 79.36 | 90.65 | 416 |
| 600.000 | 1.232 | 0.81159 | 0.1154 | 47.822 | 47876.1 | 52745.6 | 242.377 | 81.44 | 92.45 | 425 |

Table 27. Thermophysical properties along isobars (Continued)

ETHANE ISOBAR AT P = 65.0 BAR

| T DEG K | DEN MOL/L | VOL L/MOL | DP/DT BAR/K | DP/DD BAR-L/MOL | E J/MOL | H J/MOL | S J/MOL/K | CV J/MOL/K | CP J/MOL/K | W M/SEC |
|---|---|---|---|---|---|---|---|---|---|---|
| 90.909 | 21.711 | 0.04606 | 34.6821 | 972.661 | 5322.9 | 5622.3 | 76.763 | 44.57 | 68.43 | 2228 |
| 100.000 | 21.388 | 0.04675 | 31.1731 | 883.480 | 5940.8 | 6244.7 | 83.288 | 44.46 | 68.50 | 2128 |
| 110.000 | 21.037 | 0.04754 | 27.9277 | 794.964 | 6621.3 | 6930.3 | 89.823 | 44.25 | 68.63 | 2025 |
| 120.000 | 20.685 | 0.04834 | 25.1655 | 715.029 | 7303.4 | 7617.6 | 95.803 | 44.00 | 68.84 | 1929 |
| 130.000 | 20.332 | 0.04918 | 22.7725 | 642.536 | 7987.7 | 8307.4 | 101.323 | 43.74 | 69.12 | 1838 |
| 140.000 | 19.976 | 0.05006 | 20.6688 | 576.606 | 8675.0 | 9000.3 | 106.459 | 43.50 | 69.49 | 1750 |
| 150.000 | 19.615 | 0.05098 | 18.7967 | 516.508 | 9366.2 | 9697.6 | 111.269 | 43.30 | 69.97 | 1666 |
| 160.000 | 19.248 | 0.05195 | 17.1136 | 461.626 | 10062.4 | 10400.1 | 115.802 | 43.15 | 70.55 | 1584 |
| 170.000 | 18.873 | 0.05299 | 15.5872 | 411.417 | 10764.6 | 11109.0 | 120.100 | 43.08 | 71.26 | 1504 |
| 180.000 | 18.489 | 0.05409 | 14.1932 | 365.403 | 11474.3 | 11825.8 | 124.197 | 43.09 | 72.12 | 1426 |
| 190.000 | 18.095 | 0.05526 | 12.9120 | 323.155 | 12192.7 | 12551.9 | 128.122 | 43.19 | 73.12 | 1349 |
| 200.000 | 17.690 | 0.05653 | 11.7285 | 284.288 | 12921.4 | 13288.8 | 131.902 | 43.38 | 74.30 | 1273 |
| 210.000 | 17.270 | 0.05791 | 10.6298 | 248.457 | 13662.2 | 14038.6 | 135.560 | 43.66 | 75.69 | 1197 |
| 220.000 | 16.833 | 0.05941 | 9.6055 | 215.358 | 14417.2 | 14803.4 | 139.117 | 44.05 | 77.31 | 1121 |
| 230.000 | 16.376 | 0.06106 | 8.6462 | 184.725 | 15188.9 | 15585.8 | 142.595 | 44.52 | 79.23 | 1046 |
| 240.000 | 15.895 | 0.06291 | 7.7437 | 156.325 | 15980.2 | 16389.1 | 146.013 | 45.07 | 81.51 | 970 |
| 250.000 | 15.383 | 0.06501 | 6.8898 | 129.965 | 16795.1 | 17217.6 | 149.395 | 45.70 | 84.29 | 893 |
| 260.000 | 14.831 | 0.06743 | 6.0764 | 105.490 | 17639.0 | 18077.3 | 152.766 | 46.40 | 87.78 | 815 |
| 270.000 | 14.225 | 0.07030 | 5.2945 | 82.783 | 18519.8 | 18976.7 | 156.160 | 47.17 | 92.35 | 734 |
| 280.000 | 13.542 | 0.07384 | 4.5329 | 61.779 | 19450.4 | 19930.4 | 159.628 | 48.01 | 98.79 | 650 |
| 290.000 | 12.738 | 0.07850 | 3.7754 | 42.490 | 20454.2 | 20964.5 | 163.256 | 48.95 | 108.91 | 561 |
| 300.000 | 11.717 | 0.08535 | 2.9940 | 25.089 | 21583.0 | 22137.7 | 167.231 | 50.13 | 128.20 | 462 |
| 310.000 | 10.182 | 0.09821 | 2.1254 | 10.334 | 22996.0 | 23634.4 | 172.134 | 51.98 | 182.68 | 348 |
| 320.000 | 7.018 | 0.14248 | 1.1141 | 3.100 | 25334.9 | 26261.1 | 180.459 | 54.97 | 315.05 | 243 |
| 330.000 | 4.782 | 0.20912 | 0.6657 | 5.382 | 27278.1 | 28637.4 | 187.786 | 57.18 | 176.01 | 235 |
| 340.000 | 3.931 | 0.25440 | 0.5121 | 8.565 | 28433.3 | 30086.9 | 192.118 | 56.28 | 123.65 | 250 |
| 350.000 | 3.458 | 0.28919 | 0.4303 | 11.364 | 29331.7 | 31211.5 | 195.379 | 56.23 | 103.92 | 264 |
| 360.000 | 3.138 | 0.31872 | 0.3769 | 13.818 | 30125.4 | 32197.1 | 198.156 | 56.60 | 94.19 | 277 |
| 370.000 | 2.898 | 0.34505 | 0.3383 | 16.023 | 30866.0 | 33108.8 | 200.655 | 57.22 | 88.68 | 287 |
| 380.000 | 2.708 | 0.36923 | 0.3086 | 18.046 | 31577.4 | 33977.5 | 202.972 | 57.99 | 85.33 | 297 |
| 390.000 | 2.552 | 0.39184 | 0.2849 | 19.929 | 32272.6 | 34819.5 | 205.160 | 58.86 | 83.25 | 306 |
| 400.000 | 2.420 | 0.41323 | 0.2654 | 21.702 | 32958.9 | 35644.9 | 207.250 | 59.81 | 81.98 | 315 |
| 410.000 | 2.306 | 0.43367 | 0.2490 | 23.384 | 33641.9 | 36460.8 | 209.265 | 60.82 | 81.26 | 322 |
| 420.000 | 2.206 | 0.45333 | 0.2349 | 24.991 | 34324.5 | 37271.2 | 211.218 | 61.86 | 80.92 | 330 |
| 430.000 | 2.117 | 0.47234 | 0.2227 | 26.535 | 35009.8 | 38080.0 | 213.121 | 62.94 | 80.86 | 337 |
| 440.000 | 2.037 | 0.49080 | 0.2119 | 28.023 | 35698.8 | 38889.0 | 214.981 | 64.03 | 81.02 | 343 |
| 450.000 | 1.965 | 0.50880 | 0.2024 | 29.463 | 36393.7 | 39700.8 | 216.805 | 65.14 | 81.33 | 350 |
| 460.000 | 1.900 | 0.52638 | 0.1938 | 30.860 | 37094.6 | 40516.1 | 218.597 | 66.26 | 81.77 | 356 |
| 470.000 | 1.840 | 0.54361 | 0.1861 | 32.220 | 37802.7 | 41336.2 | 220.362 | 67.38 | 82.31 | 362 |
| 480.000 | 1.784 | 0.56053 | 0.1791 | 33.546 | 38519.1 | 42162.5 | 222.101 | 68.50 | 82.92 | 367 |
| 490.000 | 1.733 | 0.57717 | 0.1727 | 34.842 | 39243.2 | 42994.8 | 223.817 | 69.62 | 83.59 | 373 |
| 500.000 | 1.685 | 0.59356 | 0.1668 | 36.110 | 39976.0 | 43834.2 | 225.513 | 70.74 | 84.31 | 378 |
| 520.000 | 1.598 | 0.62570 | 0.1564 | 38.575 | 41468.9 | 45535.9 | 228.850 | 72.96 | 85.87 | 389 |
| 540.000 | 1.522 | 0.65711 | 0.1474 | 40.955 | 42998.1 | 47269.3 | 232.121 | 75.14 | 87.52 | 398 |
| 560.000 | 1.454 | 0.68790 | 0.1396 | 43.265 | 44565.0 | 49036.4 | 235.335 | 77.30 | 89.22 | 408 |
| 580.000 | 1.392 | 0.71819 | 0.1326 | 45.514 | 46170.3 | 50838.5 | 238.496 | 79.41 | 90.97 | 416 |
| 600.000 | 1.337 | 0.74804 | 0.1264 | 47.711 | 47812.9 | 52675.2 | 241.610 | 81.48 | 92.73 | 425 |

Table 27. Thermophysical properties along isobars (Continued)

ETHANE ISOBAR AT P = 70.0 BAR

| T | DEN | VOL | DP/DT | DP/DD | E | H | S | CV | CP | W |
|---|---|---|---|---|---|---|---|---|---|---|
| DEG K | MOL/L | L/MOL | BAR/K | BAR-L/MOL | J/MOL | J/MOL | J/MOL/K | J/MOL/K | J/MOL/K | M/SEC |
| 90.986 | 21.713 | 0.04605 | 34.6536 | 973.463 | 5324.8 | 5647.2 | 76.784 | 44.61 | 68.42 | 2228 |
| 100.000 | 21.394 | 0.04674 | 31.1806 | 885.188 | 5937.0 | 6264.2 | 83.250 | 44.49 | 68.49 | 2129 |
| 110.000 | 21.043 | 0.04752 | 27.9386 | 796.777 | 6617.1 | 6949.7 | 89.783 | 44.28 | 68.62 | 2026 |
| 120.000 | 20.692 | 0.04833 | 25.1793 | 716.932 | 7298.6 | 7636.9 | 95.762 | 44.03 | 68.82 | 1930 |
| 130.000 | 20.340 | 0.04916 | 22.7891 | 644.518 | 7982.2 | 8326.4 | 101.280 | 43.78 | 69.10 | 1839 |
| 140.000 | 19.984 | 0.05004 | 20.6879 | 578.659 | 8668.8 | 9019.1 | 106.414 | 43.54 | 69.46 | 1752 |
| 150.000 | 19.624 | 0.05096 | 18.8183 | 518.627 | 9359.3 | 9716.0 | 111.221 | 43.33 | 69.93 | 1668 |
| 160.000 | 19.258 | 0.05193 | 17.1376 | 463.805 | 10054.6 | 10418.0 | 115.752 | 43.19 | 70.51 | 1587 |
| 170.000 | 18.885 | 0.05295 | 15.6137 | 413.655 | 10755.8 | 11126.5 | 120.047 | 43.12 | 71.21 | 1507 |
| 180.000 | 18.503 | 0.05405 | 14.2221 | 367.699 | 11464.3 | 11842.7 | 124.140 | 43.12 | 72.05 | 1429 |
| 190.000 | 18.111 | 0.05522 | 12.9436 | 325.511 | 12181.4 | 12567.9 | 128.061 | 43.22 | 73.04 | 1352 |
| 200.000 | 17.707 | 0.05647 | 11.7627 | 286.708 | 12908.6 | 13303.9 | 131.836 | 43.41 | 74.20 | 1277 |
| 210.000 | 17.290 | 0.05784 | 10.6670 | 250.944 | 13647.7 | 14052.5 | 135.488 | 43.70 | 75.56 | 1201 |
| 220.000 | 16.856 | 0.05933 | 9.6459 | 217.920 | 14400.5 | 14815.8 | 139.039 | 44.08 | 77.14 | 1126 |
| 230.000 | 16.403 | 0.06096 | 8.6904 | 187.369 | 15169.6 | 15596.3 | 142.508 | 44.56 | 79.01 | 1051 |
| 240.000 | 15.927 | 0.06279 | 7.7920 | 159.063 | 15957.7 | 16397.2 | 145.916 | 45.11 | 81.22 | 976 |
| 250.000 | 15.421 | 0.06485 | 6.9432 | 132.811 | 16768.4 | 17222.3 | 149.284 | 45.74 | 83.90 | 900 |
| 260.000 | 14.878 | 0.06721 | 6.1362 | 108.461 | 17606.8 | 18077.3 | 152.637 | 46.44 | 87.22 | 823 |
| 270.000 | 14.284 | 0.07001 | 5.3626 | 85.903 | 18479.8 | 18969.9 | 156.005 | 47.20 | 91.50 | 744 |
| 280.000 | 13.621 | 0.07342 | 4.6127 | 65.080 | 19398.6 | 19912.5 | 159.432 | 48.03 | 97.37 | 662 |
| 290.000 | 12.851 | 0.07781 | 3.8735 | 46.013 | 20382.3 | 20927.0 | 162.992 | 48.96 | 106.21 | 576 |
| 300.000 | 11.903 | 0.08401 | 3.1248 | 28.882 | 21469.9 | 22058.0 | 166.824 | 50.07 | 121.66 | 483 |
| 310.000 | 10.591 | 0.09442 | 2.3310 | 14.318 | 22760.1 | 23421.1 | 171.291 | 51.65 | 156.53 | 380 |
| 320.000 | 8.344 | 0.11985 | 1.4556 | 4.903 | 24569.2 | 25408.2 | 177.591 | 54.28 | 252.93 | 276 |
| 330.000 | 5.784 | 0.17289 | 0.8525 | 4.777 | 26623.6 | 27833.9 | 185.062 | 58.02 | 208.10 | 239 |
| 340.000 | 4.560 | 0.21932 | 0.6194 | 7.432 | 27998.9 | 29534.1 | 190.144 | 57.01 | 141.44 | 248 |
| 350.000 | 3.922 | 0.25499 | 0.5052 | 10.242 | 29004.9 | 30789.8 | 193.786 | 56.79 | 113.50 | 261 |
| 360.000 | 3.514 | 0.28460 | 0.4350 | 12.798 | 29858.6 | 31850.8 | 196.776 | 57.04 | 100.16 | 273 |
| 370.000 | 3.220 | 0.31060 | 0.3861 | 15.104 | 30637.9 | 32812.1 | 199.411 | 57.57 | 92.81 | 285 |
| 380.000 | 2.992 | 0.33422 | 0.3495 | 17.214 | 31377.0 | 33716.6 | 201.823 | 58.28 | 88.41 | 295 |
| 390.000 | 2.808 | 0.35613 | 0.3207 | 19.171 | 32092.6 | 34585.5 | 204.081 | 59.12 | 85.66 | 304 |
| 400.000 | 2.654 | 0.37677 | 0.2974 | 21.008 | 32795.4 | 35432.8 | 206.226 | 60.03 | 83.93 | 313 |
| 410.000 | 2.523 | 0.39640 | 0.2779 | 22.746 | 33491.6 | 36266.4 | 208.285 | 61.01 | 82.88 | 321 |
| 420.000 | 2.408 | 0.41521 | 0.2613 | 24.402 | 34185.2 | 37091.7 | 210.274 | 62.04 | 82.30 | 328 |
| 430.000 | 2.308 | 0.43336 | 0.2470 | 25.990 | 34879.8 | 37913.4 | 212.207 | 63.09 | 82.05 | 335 |
| 440.000 | 2.218 | 0.45095 | 0.2346 | 27.519 | 35576.9 | 38733.5 | 214.093 | 64.17 | 82.06 | 342 |
| 450.000 | 2.137 | 0.46805 | 0.2235 | 28.996 | 36278.7 | 39555.1 | 215.939 | 65.26 | 82.25 | 349 |
| 460.000 | 2.063 | 0.48474 | 0.2137 | 30.428 | 36985.8 | 40379.0 | 217.750 | 66.37 | 82.59 | 355 |
| 470.000 | 1.996 | 0.50107 | 0.2049 | 31.821 | 37699.8 | 41207.3 | 219.531 | 67.48 | 83.05 | 361 |
| 480.000 | 1.934 | 0.51709 | 0.1969 | 33.177 | 38420.6 | 42040.3 | 221.285 | 68.59 | 83.59 | 367 |
| 490.000 | 1.877 | 0.53282 | 0.1896 | 34.502 | 39149.2 | 42879.0 | 223.015 | 69.71 | 84.20 | 372 |
| 500.000 | 1.824 | 0.54830 | 0.1830 | 35.798 | 39886.0 | 43724.1 | 224.723 | 70.82 | 84.87 | 378 |
| 520.000 | 1.728 | 0.57861 | 0.1712 | 38.313 | 41385.9 | 45436.2 | 228.080 | 73.02 | 86.34 | 388 |
| 540.000 | 1.644 | 0.60819 | 0.1611 | 40.739 | 42921.1 | 47178.4 | 231.368 | 75.20 | 87.92 | 398 |
| 560.000 | 1.569 | 0.63715 | 0.1523 | 43.091 | 44493.5 | 48953.6 | 234.595 | 77.35 | 89.58 | 407 |
| 580.000 | 1.502 | 0.66560 | 0.1445 | 45.379 | 46102.7 | 50761.9 | 237.768 | 79.46 | 91.26 | 416 |
| 600.000 | 1.442 | 0.69361 | 0.1376 | 47.612 | 47749.2 | 52604.5 | 240.892 | 81.52 | 93.01 | 425 |

Table 27. Thermophysical properties along isobars (Continued)

ETHANE ISOBAR AT P = 75.0 BAR

| T DEG K | DEN MOL/L | VOL L/MOL | DP/DT BAR/K | DP/DD BAR-L/MOL | E J/MOL | H J/MOL | S J/MOL/K | CV J/MOL/K | CP J/MOL/K | W M/SEC |
|---|---|---|---|---|---|---|---|---|---|---|
| 91.063 | 21.716 | 0.04605 | 34.6252 | 974.268 | 5326.7 | 5672.1 | 76.804 | 44.65 | 68.41 | 2228 |
| 100.000 | 21.400 | 0.04673 | 31.1882 | 886.895 | 5933.3 | 6283.8 | 83.211 | 44.53 | 68.48 | 2130 |
| 110.000 | 21.049 | 0.04751 | 27.9495 | 798.589 | 6612.8 | 6969.1 | 89.743 | 44.32 | 68.61 | 2028 |
| 120.000 | 20.699 | 0.04831 | 25.1932 | 718.833 | 7293.8 | 7656.1 | 95.721 | 44.07 | 68.80 | 1932 |
| 130.000 | 20.348 | 0.04915 | 22.8056 | 646.499 | 7976.8 | 8345.4 | 101.238 | 43.81 | 69.07 | 1841 |
| 140.000 | 19.993 | 0.05002 | 20.7070 | 580.710 | 8662.7 | 9037.9 | 106.369 | 43.57 | 69.43 | 1754 |
| 150.000 | 19.634 | 0.05093 | 18.8398 | 520.742 | 9352.4 | 9734.4 | 111.174 | 43.37 | 69.89 | 1671 |
| 160.000 | 19.269 | 0.05190 | 17.1615 | 465.980 | 10046.8 | 10436.1 | 115.703 | 43.23 | 70.46 | 1589 |
| 170.000 | 18.897 | 0.05292 | 15.6400 | 415.888 | 10747.1 | 11144.0 | 119.994 | 43.15 | 71.15 | 1510 |
| 180.000 | 18.517 | 0.05401 | 14.2509 | 369.990 | 11454.5 | 11859.5 | 124.084 | 43.16 | 71.98 | 1432 |
| 190.000 | 18.126 | 0.05517 | 12.9749 | 327.861 | 12170.3 | 12584.0 | 128.001 | 43.26 | 72.95 | 1356 |
| 200.000 | 17.724 | 0.05642 | 11.7968 | 289.118 | 12896.0 | 13319.1 | 131.771 | 43.45 | 74.09 | 1280 |
| 210.000 | 17.309 | 0.05777 | 10.7039 | 253.421 | 13633.3 | 14066.6 | 135.418 | 43.74 | 75.43 | 1206 |
| 220.000 | 16.879 | 0.05925 | 9.6860 | 220.469 | 14384.1 | 14828.4 | 138.961 | 44.12 | 76.98 | 1131 |
| 230.000 | 16.430 | 0.06087 | 8.7340 | 189.998 | 15150.6 | 15607.1 | 142.422 | 44.59 | 78.80 | 1057 |
| 240.000 | 15.958 | 0.06266 | 7.8397 | 161.782 | 15935.5 | 16405.5 | 145.820 | 45.15 | 80.95 | 982 |
| 250.000 | 15.458 | 0.06469 | 6.9958 | 135.633 | 16742.3 | 17227.5 | 149.175 | 45.78 | 83.53 | 907 |
| 260.000 | 14.923 | 0.06701 | 6.1947 | 111.400 | 17575.4 | 18078.0 | 152.511 | 46.47 | 86.69 | 831 |
| 270.000 | 14.342 | 0.06973 | 5.4289 | 88.980 | 18441.2 | 18964.1 | 155.854 | 47.23 | 90.71 | 754 |
| 280.000 | 13.696 | 0.07302 | 4.6896 | 68.318 | 19349.1 | 19896.8 | 159.245 | 48.05 | 96.11 | 674 |
| 290.000 | 12.956 | 0.07719 | 3.9662 | 49.443 | 20315.3 | 20894.2 | 162.745 | 48.96 | 103.93 | 591 |
| 300.000 | 12.066 | 0.08288 | 3.2437 | 32.526 | 21369.7 | 21991.3 | 166.463 | 50.03 | 116.69 | 502 |
| 310.000 | 10.900 | 0.09174 | 2.5006 | 18.097 | 22578.8 | 23266.9 | 170.643 | 51.45 | 141.59 | 407 |
| 320.000 | 9.150 | 0.10929 | 1.7207 | 7.807 | 24111.7 | 24931.3 | 175.923 | 53.64 | 198.59 | 310 |
| 330.000 | 6.801 | 0.14703 | 1.0662 | 5.219 | 26016.7 | 27119.4 | 182.655 | 55.72 | 211.10 | 256 |
| 340.000 | 5.267 | 0.18988 | 0.7476 | 6.823 | 27531.8 | 28955.8 | 188.143 | 57.61 | 158.02 | 249 |
| 350.000 | 4.434 | 0.22554 | 0.5919 | 9.348 | 28655.0 | 30346.5 | 192.177 | 57.30 | 124.02 | 259 |
| 360.000 | 3.919 | 0.25515 | 0.5003 | 11.895 | 29577.7 | 31491.3 | 195.403 | 57.46 | 106.78 | 271 |
| 370.000 | 3.560 | 0.28087 | 0.4388 | 14.263 | 30400.9 | 32507.5 | 198.188 | 57.92 | 97.33 | 282 |
| 380.000 | 3.289 | 0.30402 | 0.3939 | 16.445 | 31170.1 | 33450.2 | 200.703 | 58.57 | 91.71 | 293 |
| 390.000 | 3.074 | 0.32534 | 0.3592 | 18.469 | 31908.4 | 34348.4 | 203.036 | 59.36 | 88.21 | 302 |
| 400.000 | 2.896 | 0.34531 | 0.3314 | 20.365 | 32628.6 | 35218.4 | 205.239 | 60.25 | 85.97 | 311 |
| 410.000 | 2.745 | 0.36423 | 0.3085 | 22.156 | 33338.8 | 36070.6 | 207.343 | 61.20 | 84.57 | 319 |
| 420.000 | 2.616 | 0.38232 | 0.2892 | 23.859 | 34044.0 | 36911.4 | 209.370 | 62.20 | 83.72 | 327 |
| 430.000 | 2.502 | 0.39971 | 0.2726 | 25.489 | 34748.3 | 37746.1 | 211.334 | 63.24 | 83.27 | 334 |
| 440.000 | 2.401 | 0.41653 | 0.2582 | 27.056 | 35453.7 | 38577.7 | 213.246 | 64.30 | 83.12 | 341 |
| 450.000 | 2.318 | 0.43285 | 0.2456 | 28.568 | 36162.8 | 39409.2 | 215.115 | 65.39 | 83.19 | 348 |
| 460.000 | 2.228 | 0.44876 | 0.2344 | 30.033 | 36876.2 | 40241.9 | 216.945 | 66.48 | 83.43 | 354 |
| 470.000 | 2.154 | 0.46430 | 0.2243 | 31.456 | 37595.8 | 41[illegible]8.1 | 218.743 | 67.58 | 83.79 | 360 |
| 480.000 | 2.085 | 0.47953 | 0.2153 | 32.841 | 38321.7 | 41918.1 | 220.512 | 68.69 | 84.27 | 366 |
| 490.000 | 2.022 | 0.49446 | 0.2071 | 34.192 | 39054.8 | 42763.3 | 222.255 | 69.79 | 84.82 | 372 |
| 500.000 | 1.964 | 0.50915 | 0.1996 | 35.513 | 39796.1 | 43614.8 | 223.975 | 70.90 | 85.44 | 377 |
| 520.000 | 1.859 | 0.53787 | 0.1864 | 38.075 | 41302.7 | 45336.7 | 227.352 | 73.09 | 86.82 | 388 |
| 540.000 | 1.767 | 0.56584 | 0.1751 | 40.545 | 42844.4 | 47088.2 | 230.657 | 75.26 | 88.34 | 398 |
| 560.000 | 1.686 | 0.59321 | 0.1653 | 42.936 | 44421.5 | 48870.6 | 233.898 | 77.40 | 89.94 | 407 |
| 580.000 | 1.613 | 0.62006 | 0.1567 | 45.260 | 46035.1 | 50685.6 | 237.083 | 79.50 | 91.60 | 416 |
| 600.000 | 1.547 | 0.64648 | 0.1491 | 47.526 | 47686.2 | 52534.7 | 240.217 | 81.57 | 93.29 | 425 |

Table 27. Thermophysical properties along isobars (Continued)

ETHANE ISOBAR AT P = 80.0 BAR

| T | DEN | VOL | DP/DT | DP/DD | E | H | S | CV | CP | W |
|---|---|---|---|---|---|---|---|---|---|---|
| DEG K | MOL/L | L/MOL | BAR/K | BAR-L/MOL | J/MCL | J/MOL | J/MCL/K | J/MOL/K | J/MOL/K | M/SEC |
| 91.140 | 21.718 | 0.04604 | 34.5971 | 975.076 | 5328.6 | 5696.9 | 76.824 | 44.69 | 68.41 | 2228 |
| 100.000 | 21.405 | 0.04672 | 31.1957 | 888.601 | 5929.5 | 6303.3 | 83.173 | 44.57 | 68.47 | 2131 |
| 110.000 | 21.055 | 0.04749 | 27.9604 | 800.398 | 6608.6 | 6988.5 | 89.704 | 44.36 | 68.59 | 2029 |
| 120.000 | 20.706 | 0.04830 | 25.2070 | 720.733 | 7289.0 | 7675.4 | 95.680 | 44.11 | 68.78 | 1933 |
| 130.000 | 20.355 | 0.04913 | 22.8221 | 648.477 | 7971.4 | 8364.5 | 101.195 | 43.85 | 69.05 | 1843 |
| 140.000 | 20.002 | 0.05000 | 20.7260 | 582.758 | 8656.7 | 9056.6 | 106.325 | 43.61 | 69.40 | 1756 |
| 150.000 | 19.644 | 0.05091 | 18.8612 | 522.854 | 9345.6 | 9752.8 | 111.128 | 43.41 | 69.85 | 1673 |
| 160.000 | 19.280 | 0.05187 | 17.1853 | 468.151 | 10039.1 | 10454.1 | 115.653 | 43.26 | 70.42 | 1592 |
| 170.000 | 18.909 | 0.05288 | 15.6662 | 418.116 | 10738.4 | 11161.5 | 119.942 | 43.19 | 71.10 | 1513 |
| 180.000 | 18.530 | 0.05397 | 14.2796 | 372.275 | 11444.7 | 11876.4 | 124.028 | 43.20 | 71.91 | 1436 |
| 190.000 | 18.141 | 0.05512 | 13.0061 | 330.203 | 12159.2 | 12600.2 | 127.941 | 43.30 | 72.87 | 1360 |
| 200.000 | 17.742 | 0.05636 | 11.8306 | 291.521 | 12883.5 | 13334.4 | 131.706 | 43.49 | 73.99 | 1284 |
| 210.000 | 17.329 | 0.05771 | 10.7406 | 255.890 | 13619.0 | 14080.7 | 135.347 | 43.78 | 75.30 | 1210 |
| 220.000 | 16.901 | 0.05917 | 9.7257 | 223.006 | 14367.8 | 14841.1 | 138.885 | 44.16 | 76.82 | 1136 |
| 230.000 | 16.456 | 0.06077 | 8.7771 | 192.612 | 15131.9 | 15618.0 | 142.338 | 44.63 | 78.60 | 1062 |
| 240.000 | 15 989 | 0.06254 | 7.8868 | 164.482 | 15913.8 | 16414.2 | 145.726 | 45.18 | 80.69 | 988 |
| 250.000 | 15.495 | 0.06454 | 7.0475 | 138.430 | 16716.8 | 17233.1 | 149.068 | 45.81 | 83.17 | 914 |
| 260.000 | 14.968 | 0.06681 | 6.2521 | 114.308 | 17544.9 | 18079.4 | 152.387 | 46.51 | 86.19 | 839 |
| 270.000 | 14.397 | 0.06946 | 5.4935 | 92.015 | 18403.8 | 18959.5 | 155.708 | 47.26 | 89.98 | 763 |
| 280.000 | 13.767 | 0.07264 | 4.7639 | 71.501 | 19301.9 | 19883.0 | 159.066 | 48.08 | 94.97 | 685 |
| 290.000 | 13.054 | 0.07661 | 4.0543 | 52.792 | 20252.5 | 20865.4 | 162.513 | 48.97 | 101.96 | 605 |
| 300.000 | 12.212 | 0.08189 | 3.3534 | 36.049 | 21279.4 | 21934.6 | 166.137 | 50.00 | 112.75 | 520 |
| 310.000 | 11.152 | 0.08967 | 2.6476 | 21.721 | 22429.7 | 23147.1 | 170.111 | 51.31 | 131.75 | 431 |
| 320.000 | 9.688 | 0.10322 | 1.9305 | 10.976 | 23804.8 | 24630.6 | 174.818 | 53.23 | 169.00 | 340 |
| 330.000 | 7.684 | 0.13015 | 1.2816 | 6.265 | 25497.2 | 26538.4 | 180.685 | 55.56 | 202.10 | 275 |
| 340.000 | 6.005 | 0.16653 | 0.8926 | 6.815 | 27064.8 | 28397.0 | 186.237 | 57.96 | 168.19 | 256 |
| 350.000 | 4.987 | 0.20054 | 0.6905 | 8.817 | 28289.8 | 29894.1 | 190.579 | 57.73 | 133.86 | 261 |
| 360.000 | 4.353 | 0.22970 | 0.5734 | 11.184 | 29284.5 | 31122.1 | 194.041 | 57.84 | 113.68 | 270 |
| 370.000 | 3.920 | 0.25507 | 0.4967 | 13.535 | 30155.3 | 32195.9 | 196.984 | 58.24 | 102.13 | 281 |
| 380.000 | 3.600 | 0.27777 | 0.4420 | 15.754 | 30957.4 | 33179.6 | 199.608 | 58.85 | 95.21 | 291 |
| 390.000 | 3.349 | 0.29857 | 0.4005 | 17.830 | 31720.0 | 34108.5 | 202.021 | 59.60 | 90.88 | 301 |
| 400.000 | 3.145 | 0.31795 | 0.3677 | 19.777 | 32458.8 | 35002.4 | 204.284 | 60.46 | 88.10 | 310 |
| 410.000 | 2.974 | 0.33625 | 0.3409 | 21.615 | 33183.7 | 35873.7 | 206.436 | 61.39 | 86.31 | 318 |
| 420.000 | 2.827 | 0.35368 | 0.3185 | 23.362 | 33901.0 | 36730.4 | 208.501 | 62.37 | 85.18 | 326 |
| 430.000 | 2.700 | 0.37040 | 0.2994 | 25.031 | 34615.4 | 37578.6 | 210.497 | 63.39 | 84.52 | 333 |
| 440.000 | 2.587 | 0.38653 | 0.2830 | 26.634 | 35329.8 | 38422.0 | 212.436 | 64.44 | 84.20 | 340 |
| 450.000 | 2.486 | 0.40217 | 0.2686 | 28.180 | 36046.0 | 39263.3 | 214.327 | 65.51 | 84.14 | 347 |
| 460.000 | 2.396 | 0.41739 | 0.2559 | 29.675 | 36766.3 | 40105.4 | 216.177 | 66.59 | 84.27 | 353 |
| 470.000 | 2.314 | 0.43223 | 0.2445 | 31.126 | 37491.3 | 40949.2 | 217.992 | 67.68 | 84.55 | 360 |
| 480.000 | 2.238 | 0.44675 | 0.2343 | 32.537 | 38222.3 | 41796.3 | 219.776 | 68.78 | 84.95 | 366 |
| 490.000 | 2.169 | 0.46099 | 0.2251 | 33.914 | 38960.5 | 42648.4 | 221.533 | 69.88 | 85.44 | 371 |
| 500.000 | 2.105 | 0.47498 | 0.2167 | 35.258 | 39705.5 | 43505.3 | 223.264 | 70.98 | 86.00 | 377 |
| 520.000 | 1.991 | 0.50229 | 0.2020 | 37.864 | 41219.8 | 45238.1 | 226.662 | 73.16 | 87.30 | 388 |
| 540.000 | 1.891 | 0.52886 | 0.1894 | 40.373 | 42767.1 | 46998.0 | 229.983 | 75.32 | 88.75 | 398 |
| 560.000 | 1.802 | 0.55482 | 0.1786 | 42.801 | 44349.5 | 48788.0 | 233.239 | 77.45 | 90.30 | 407 |
| 580.000 | 1.723 | 0.58027 | 0.1691 | 45.159 | 45963.1 | 50610.3 | 236.436 | 79.55 | 91.92 | 417 |
| 600.000 | 1.652 | 0.60528 | 0.1607 | 47.457 | 47622.6 | 52464.9 | 239.579 | 81.61 | 93.57 | 425 |

Table 27. Thermophysical properties along isobars (Continued)

ETHANE ISOBAR AT P = 85.0 BAR

| T | DEN | VOL | DP/DT | DP/DD | E | H | S | CV | CP | W |
|---|---|---|---|---|---|---|---|---|---|---|
| DEG K | MOL/L | L/MOL | BAR/K | BAR-L/MOL | J/MOL | J/MOL | J/MOL/K | J/MOL/K | J/MOL/K | M/SEC |
| 91.217 | 21.720 | 0.04604 | 34.5691 | 975.886 | 5330.5 | 5721.8 | 76.844 | 44.73 | 68.40 | 2228 |
| 100.000 | 21.411 | 0.04670 | 31.2033 | 890.306 | 5925.8 | 6322.8 | 83.135 | 44.61 | 68.46 | 2132 |
| 110.000 | 21.062 | 0.04748 | 27.9713 | 802.207 | 6604.4 | 7008.0 | 89.665 | 44.39 | 68.58 | 2030 |
| 120.000 | 20.713 | 0.04828 | 25.2208 | 722.630 | 7284.2 | 7694.6 | 95.639 | 44.14 | 68.76 | 1935 |
| 130.000 | 20.363 | 0.04911 | 22.8386 | 650.453 | 7966.1 | 8383.5 | 101.153 | 43.88 | 69.02 | 1845 |
| 140.000 | 20.010 | 0.04997 | 20.7450 | 584.803 | 8650.6 | 9075.4 | 106.280 | 43.64 | 69.37 | 1758 |
| 150.000 | 19.653 | 0.05088 | 18.8826 | 524.962 | 9338.8 | 9771.3 | 111.081 | 43.44 | 69.82 | 1675 |
| 160.000 | 19.290 | 0.05184 | 17.2090 | 470.318 | 10031.5 | 10472.1 | 115.604 | 43.30 | 70.37 | 1594 |
| 170.000 | 18.921 | 0.05285 | 15.6924 | 420.340 | 10729.8 | 11179.1 | 119.889 | 43.22 | 71.04 | 1516 |
| 180.000 | 18.543 | 0.05393 | 14.3081 | 374.554 | 11435.0 | 11893.4 | 123.972 | 43.23 | 71.84 | 1439 |
| 190.000 | 18.156 | 0.05508 | 13.0371 | 332.538 | 12148.3 | 12616.4 | 127.881 | 43.33 | 72.79 | 1363 |
| 200.000 | 17.759 | 0.05631 | 11.8642 | 293.915 | 12871.1 | 13349.7 | 131.642 | 43.52 | 73.89 | 1288 |
| 210.000 | 17.349 | 0.05764 | 10.7770 | 258.347 | 13605.0 | 14094.9 | 135.278 | 43.81 | 75.18 | 1214 |
| 220.000 | 16.924 | 0.05909 | 9.7651 | 225.531 | 14351.7 | 14854.0 | 138.809 | 44.19 | 76.67 | 1141 |
| 230.000 | 16.482 | 0.06067 | 8.8198 | 195.211 | 15113.4 | 15629.1 | 142.254 | 44.67 | 78.40 | 1068 |
| 240.000 | 16.019 | 0.06243 | 7.9332 | 167.164 | 15892.4 | 16423.1 | 145.633 | 45.22 | 80.43 | 994 |
| 250.000 | 15.531 | 0.06439 | 7.0983 | 141.204 | 16691.7 | 17239.0 | 148.963 | 45.85 | 82.83 | 921 |
| 260.000 | 15.011 | 0.06662 | 6.3083 | 117.187 | 17515.1 | 18081.3 | 152.266 | 46.54 | 85.72 | 847 |
| 270.000 | 14.450 | 0.06920 | 5.5564 | 95.012 | 18367.6 | 18955.8 | 155.566 | 47.29 | 89.31 | 772 |
| 280.000 | 13.836 | 0.07228 | 4.8357 | 74.630 | 19256.5 | 19870.9 | 158.894 | 48.10 | 93.93 | 696 |
| 290.000 | 13.146 | 0.07607 | 4.1384 | 56.068 | 20193.3 | 20839.9 | 162.294 | 48.98 | 100.24 | 618 |
| 300.000 | 12.344 | 0.08101 | 3.4557 | 39.471 | 21196.9 | 21885.5 | 165.837 | 49.98 | 109.54 | 536 |
| 310.000 | 11.365 | 0.08799 | 2.7787 | 25.220 | 22302.1 | 23050.0 | 169.654 | 51.22 | 124.69 | 452 |
| 320.000 | 10.087 | 0.09913 | 2.1058 | 14.190 | 23574.8 | 24417.5 | 173.994 | 52.95 | 151.23 | 367 |
| 330.000 | 8.390 | 0.11918 | 1.4829 | 8.064 | 25089.4 | 26102.4 | 179.176 | 55.26 | 183.09 | 298 |
| 340.000 | 6.713 | 0.14897 | 1.0458 | 7.408 | 26633.7 | 27900.0 | 184.544 | 58.09 | 169.49 | 268 |
| 350.000 | 5.560 | 0.17987 | 0.7993 | 8.705 | 27923.2 | 29452.1 | 189.045 | 58.05 | 141.16 | 265 |
| 360.000 | 4.811 | 0.20787 | 0.6540 | 10.744 | 28983.4 | 30750.3 | 192.705 | 58.17 | 120.11 | 272 |
| 370.000 | 4.298 | 0.23265 | 0.5600 | 12.969 | 29902.9 | 31880.4 | 195.802 | 58.54 | 106.97 | 281 |
| 380.000 | 3.924 | 0.25486 | 0.4940 | 15.167 | 30739.8 | 32906.2 | 198.538 | 59.11 | 98.82 | 290 |
| 390.000 | 3.634 | 0.27515 | 0.4447 | 17.265 | 31527.7 | 33866.5 | 201.033 | 59.83 | 93.65 | 300 |
| 400.000 | 3.401 | 0.29399 | 0.4062 | 19.248 | 32286.0 | 34784.9 | 203.359 | 60.66 | 90.29 | 309 |
| 410.000 | 3.208 | 0.31172 | 0.3751 | 21.126 | 33026.4 | 35676.0 | 205.559 | 61.56 | 88.09 | 317 |
| 420.000 | 3.044 | 0.32856 | 0.3493 | 22.912 | 33756.5 | 36549.2 | 207.664 | 62.53 | 86.67 | 325 |
| 430.000 | 2.901 | 0.34468 | 0.3275 | 24.617 | 34481.3 | 37411.1 | 209.692 | 63.53 | 85.79 | 332 |
| 440.000 | 2.776 | 0.36020 | 0.3088 | 26.253 | 35204.6 | 38266.3 | 211.658 | 64.56 | 85.30 | 340 |
| 450.000 | 2.665 | 0.37523 | 0.2925 | 27.830 | 35928.4 | 39117.8 | 213.572 | 65.62 | 85.10 | 346 |
| 460.000 | 2.565 | 0.38982 | 0.2781 | 29.353 | 36655.4 | 39968.9 | 215.442 | 66.70 | 85.12 | 353 |
| 470.000 | 2.475 | 0.40404 | 0.2654 | 30.831 | 37386.3 | 40820.7 | 217.274 | 67.78 | 85.31 | 359 |
| 480.000 | 2.393 | 0.41794 | 0.2540 | 32.267 | 38122.9 | 41675.4 | 219.074 | 68.87 | 85.63 | 365 |
| 490.000 | 2.317 | 0.43155 | 0.2437 | 33.667 | 38865.4 | 42533.6 | 220.843 | 69.96 | 86.06 | 371 |
| 500.000 | 2.248 | 0.44491 | 0.2343 | 35.033 | 39614.7 | 43396.5 | 222.587 | 71.05 | 86.57 | 377 |
| 520.000 | 2.123 | 0.47097 | 0.2180 | 37.679 | 41136.3 | 45139.5 | 226.005 | 73.23 | 87.77 | 388 |
| 540.000 | 2.015 | 0.49629 | 0.2041 | 40.225 | 42689.8 | 46908.3 | 229.343 | 75.38 | 89.16 | 398 |
| 560.000 | 1.919 | 0.52101 | 0.1922 | 42.687 | 44277.9 | 48706.5 | 232.612 | 77.50 | 90.66 | 407 |
| 580.000 | 1.834 | 0.54521 | 0.1818 | 45.077 | 45900.7 | 50534.9 | 235.821 | 79.59 | 92.23 | 417 |
| 600.000 | 1.758 | 0.56897 | 0.1726 | 47.404 | 47559.6 | 52395.9 | 238.975 | 81.65 | 93.85 | 426 |

Table 27. Thermophysical properties along isobars (Continued)

ETHANE ISOBAR AT P = 90.0 BAR

| T DEG K | DEN MOL/L | VOL L/MOL | DF/DT BAR/K | DF/DD BAR-L/MOL | E J/MOL | H J/MOL | S J/MOL/K | CV J/MOL/K | CP J/MOL/K | W M/SEC |
|---|---|---|---|---|---|---|---|---|---|---|
| 91.294 | 21.723 | 0.04603 | 34.5413 | 976.700 | 5332.3 | 5746.7 | 76.865 | 44.76 | 68.40 | 2228 |
| 100.000 | 21.417 | 0.04669 | 31.2110 | 892.010 | 5922.1 | 6342.3 | 83.097 | 44.64 | 68.45 | 2133 |
| 110.000 | 21.068 | 0.04747 | 27.9822 | 804.014 | 6600.2 | 7027.4 | 89.625 | 44.43 | 68.57 | 2031 |
| 120.000 | 20.720 | 0.04826 | 25.2346 | 724.526 | 7279.5 | 7713.9 | 95.598 | 44.18 | 68.75 | 1936 |
| 130.000 | 20.371 | 0.04909 | 22.8550 | 652.426 | 7960.7 | 8402.6 | 101.111 | 43.92 | 69.00 | 1846 |
| 140.000 | 20.019 | 0.04995 | 20.7639 | 586.846 | 8644.6 | 9094.2 | 106.236 | 43.68 | 69.34 | 1760 |
| 150.000 | 19.663 | 0.05086 | 18.9039 | 527.067 | 9332.0 | 9789.7 | 111.034 | 43.48 | 69.78 | 1677 |
| 160.000 | 19.301 | 0.05181 | 17.2327 | 472.481 | 10023.9 | 10490.2 | 115.555 | 43.33 | 70.33 | 1597 |
| 170.000 | 18.933 | 0.05282 | 15.7183 | 422.558 | 10721.3 | 11196.7 | 119.837 | 43.26 | 70.99 | 1519 |
| 180.000 | 18.557 | 0.05389 | 14.3364 | 376.827 | 11425.4 | 11910.4 | 123.917 | 43.27 | 71.78 | 1442 |
| 190.000 | 18.171 | 0.05503 | 13.0679 | 334.867 | 12137.4 | 12632.7 | 127.822 | 43.37 | 72.71 | 1366 |
| 200.000 | 17.776 | 0.05626 | 11.8975 | 296.301 | 12858.8 | 13365.1 | 131.578 | 43.56 | 73.80 | 1292 |
| 210.000 | 17.368 | 0.05758 | 10.8130 | 260.794 | 13591.0 | 14109.2 | 135.209 | 43.85 | 75.06 | 1218 |
| 220.000 | 16.946 | 0.05901 | 9.8041 | 228.044 | 14335.9 | 14867.0 | 138.733 | 44.23 | 76.52 | 1145 |
| 230.000 | 16.507 | 0.06058 | 8.8620 | 197.796 | 15095.2 | 15640.4 | 142.171 | 44.70 | 78.22 | 1073 |
| 240.000 | 16.048 | 0.06231 | 7.9791 | 169.828 | 15871.4 | 16432.2 | 145.541 | 45.25 | 80.19 | 1000 |
| 250.000 | 15.566 | 0.06424 | 7.1485 | 143.957 | 16667.2 | 17245.3 | 148.860 | 45.88 | 82.51 | 928 |
| 260.000 | 15.053 | 0.06643 | 6.3635 | 120.038 | 17486.0 | 18083.8 | 152.148 | 46.57 | 85.28 | 855 |
| 270.000 | 14.502 | 0.06895 | 5.6179 | 97.972 | 18332.4 | 18953.0 | 155.428 | 47.32 | 88.68 | 781 |
| 280.000 | 13.901 | 0.07194 | 4.9053 | 77.712 | 19213.0 | 19860.4 | 158.727 | 48.12 | 92.99 | 707 |
| 290.000 | 13.232 | 0.07557 | 4.2189 | 59.280 | 20137.3 | 20817.5 | 162.085 | 48.99 | 98.72 | 630 |
| 300.000 | 12.466 | 0.08022 | 3.5519 | 42.806 | 21120.8 | 21842.8 | 165.561 | 49.97 | 106.86 | 552 |
| 310.000 | 11.551 | 0.08657 | 2.8980 | 28.614 | 22189.9 | 22969.0 | 169.252 | 51.15 | 119.34 | 471 |
| 320.000 | 10.405 | 0.09611 | 2.2581 | 17.388 | 23390.1 | 24255.1 | 173.334 | 52.76 | 139.43 | 391 |
| 330.000 | 8.939 | 0.11187 | 1.6623 | 10.327 | 24774.8 | 25781.7 | 178.029 | 54.96 | 165.47 | 322 |
| 340.000 | 7.353 | 0.13601 | 1.1999 | 8.274 | 26253.6 | 27477.6 | 183.092 | 58.04 | 167.49 | 282 |
| 350.000 | 6.127 | 0.16321 | 0.9152 | 8.982 | 27570.5 | 29039.4 | 187.621 | 58.23 | 145.18 | 273 |
| 360.000 | 5.280 | 0.18940 | 0.7413 | 10.616 | 28682.2 | 30386.7 | 191.419 | 58.43 | 125.28 | 275 |
| 370.000 | 4.690 | 0.21323 | 0.6285 | 12.616 | 29646.7 | 31565.7 | 194.650 | 58.80 | 111.47 | 282 |
| 380.000 | 4.259 | 0.23482 | 0.5499 | 14.720 | 30518.3 | 32631.7 | 197.494 | 59.35 | 102.39 | 291 |
| 390.000 | 3.928 | 0.25457 | 0.4918 | 16.795 | 31332.6 | 33623.8 | 200.071 | 60.04 | 96.45 | 300 |
| 400.000 | 3.664 | 0.27289 | 0.4470 | 18.791 | 32111.1 | 34567.1 | 202.460 | 60.85 | 92.52 | 308 |
| 410.000 | 3.447 | 0.29009 | 0.4111 | 20.694 | 32867.5 | 35478.3 | 204.710 | 61.73 | 89.91 | 317 |
| 420.000 | 3.264 | 0.30639 | 0.3816 | 22.510 | 33610.6 | 36368.1 | 206.855 | 62.68 | 88.18 | 325 |
| 430.000 | 3.106 | 0.32196 | 0.3568 | 24.247 | 34346.3 | 37244.0 | 208.916 | 63.67 | 87.07 | 332 |
| 440.000 | 2.968 | 0.33694 | 0.3356 | 25.913 | 35078.6 | 38111.0 | 210.909 | 64.69 | 86.40 | 339 |
| 450.000 | 2.846 | 0.35140 | 0.3173 | 27.518 | 35810.3 | 38972.9 | 212.846 | 65.74 | 86.06 | 346 |
| 460.000 | 2.736 | 0.36543 | 0.3012 | 29.068 | 36544.1 | 39833.0 | 214.736 | 66.80 | 85.97 | 353 |
| 470.000 | 2.638 | 0.37909 | 0.2870 | 30.570 | 37281.0 | 40692.8 | 216.586 | 67.87 | 86.07 | 359 |
| 480.000 | 2.548 | 0.39243 | 0.2743 | 32.030 | 38022.9 | 41554.8 | 218.400 | 68.96 | 86.31 | 365 |
| 490.000 | 2.466 | 0.40548 | 0.2628 | 33.451 | 38770.2 | 42419.5 | 220.184 | 70.04 | 86.68 | 371 |
| 500.000 | 2.391 | 0.41827 | 0.2525 | 34.838 | 39524.1 | 43288.6 | 221.939 | 71.13 | 87.13 | 377 |
| 520.000 | 2.256 | 0.44321 | 0.2344 | 37.522 | 41052.8 | 45041.7 | 225.378 | 73.29 | 88.25 | 388 |
| 540.000 | 2.139 | 0.46741 | 0.2192 | 40.103 | 42613.0 | 46819.7 | 228.732 | 75.44 | 89.57 | 398 |
| 560.000 | 2.037 | 0.49101 | 0.2061 | 42.596 | 44205.9 | 48625.0 | 232.016 | 77.55 | 91.01 | 408 |
| 580.000 | 1.945 | 0.51409 | 0.1947 | 45.015 | 45833.7 | 50460.6 | 235.236 | 79.64 | 92.54 | 417 |
| 600.000 | 1.863 | 0.53675 | 0.1846 | 47.369 | 47496.3 | 52327.0 | 238.400 | 81.69 | 94.13 | 426 |

Table 27. Thermophysical properties along isobars (Continued)

ETHANE ISOBAR AT P = 95.0 BAR

| T<br>DEG K | DEN<br>MOL/L | VOL<br>L/MOL | DP/DT<br>BAR/K | DP/DD<br>BAR-L/MOL | E<br>J/MOL | H<br>J/MOL | S<br>J/MOL/K | CV<br>J/MOL/K | CP<br>J/MOL/K | W<br>M/SEC |
|---|---|---|---|---|---|---|---|---|---|---|
| 91.371 | 21.725 | 0.04603 | 34.5137 | 977.515 | 5334.2 | 5771.5 | 76.885 | 44.80 | 68.39 | 2228 |
| 100.000 | 21.422 | 0.04668 | 31.2186 | 893.713 | 5918.4 | 6361.9 | 83.058 | 44.68 | 68.44 | 2134 |
| 110.000 | 21.074 | 0.04745 | 27.9932 | 805.820 | 6596.0 | 7046.8 | 89.586 | 44.47 | 68.55 | 2033 |
| 120.000 | 20.727 | 0.04825 | 25.2484 | 726.420 | 7274.8 | 7733.1 | 95.558 | 44.21 | 68.73 | 1938 |
| 130.000 | 20.378 | 0.04907 | 22.8714 | 654.398 | 7955.4 | 8421.6 | 101.068 | 43.95 | 68.98 | 1848 |
| 140.000 | 20.027 | 0.04993 | 20.7828 | 588.886 | 8638.6 | 9113.0 | 106.192 | 43.71 | 69.31 | 1762 |
| 150.000 | 19.672 | 0.05083 | 18.9252 | 529.169 | 9325.3 | 9808.2 | 110.988 | 43.51 | 69.75 | 1680 |
| 160.000 | 19.312 | 0.05178 | 17.2563 | 474.641 | 10016.3 | 10508.3 | 115.506 | 43.37 | 70.28 | 1599 |
| 170.000 | 18.945 | 0.05279 | 15.7442 | 424.772 | 10712.8 | 11214.3 | 119.786 | 43.29 | 70.94 | 1521 |
| 180.000 | 18.570 | 0.05385 | 14.3647 | 379.095 | 11415.8 | 11927.4 | 123.862 | 43.30 | 71.71 | 1445 |
| 190.000 | 18.186 | 0.05499 | 13.0985 | 337.189 | 12126.6 | 12649.0 | 127.763 | 43.40 | 72.63 | 1370 |
| 200.000 | 17.793 | 0.05620 | 11.9306 | 298.679 | 12846.6 | 13380.5 | 131.515 | 43.60 | 73.70 | 1296 |
| 210.000 | 17.387 | 0.05751 | 10.8488 | 263.231 | 13577.2 | 14123.6 | 135.140 | 43.88 | 74.94 | 1223 |
| 220.000 | 16.968 | 0.05894 | 9.8427 | 230.545 | 14320.2 | 14880.1 | 138.659 | 44.27 | 76.38 | 1150 |
| 230.000 | 16.532 | 0.06049 | 8.9038 | 200.367 | 15077.3 | 15651.9 | 142.090 | 44.74 | 78.03 | 1078 |
| 240.000 | 16.078 | 0.06220 | 8.0244 | 172.476 | 15850.7 | 16441.6 | 145.450 | 45.29 | 79.95 | 1006 |
| 250.000 | 15.600 | 0.06410 | 7.1979 | 146.688 | 16643.1 | 17252.0 | 148.758 | 45.91 | 82.20 | 935 |
| 260.000 | 15.094 | 0.06625 | 6.4177 | 122.862 | 17457.5 | 18086.9 | 152.032 | 46.60 | 84.86 | 863 |
| 270.000 | 14.553 | 0.06872 | 5.6780 | 100.899 | 18298.3 | 18951.1 | 155.293 | 47.35 | 88.09 | 790 |
| 280.000 | 13.964 | 0.07161 | 4.9729 | 80.750 | 19171.0 | 19851.3 | 158.567 | 48.15 | 92.12 | 717 |
| 290.000 | 13.314 | 0.07511 | 4.2964 | 62.434 | 20084.0 | 20797.5 | 161.887 | 49.01 | 97.37 | 642 |
| 300.000 | 12.578 | 0.07950 | 3.6429 | 46.065 | 21050.0 | 21805.2 | 165.302 | 49.96 | 104.59 | 566 |
| 310.000 | 11.717 | 0.08535 | 3.0081 | 31.921 | 22089.4 | 22900.2 | 168.892 | 51.10 | 115.11 | 489 |
| 320.000 | 10.669 | 0.09373 | 2.3937 | 20.546 | 23235.1 | 24125.5 | 172.780 | 52.62 | 131.02 | 412 |
| 330.000 | 9.373 | 0.10669 | 1.8217 | 12.834 | 24525.4 | 25538.9 | 177.128 | 54.72 | 151.86 | 344 |
| 340.000 | 7.917 | 0.12631 | 1.3513 | 9.545 | 25923.6 | 27123.5 | 181.858 | 57.91 | 161.68 | 298 |
| 350.000 | 6.666 | 0.15003 | 1.0344 | 9.643 | 27243.7 | 28668.9 | 186.340 | 58.31 | 145.72 | 283 |
| 360.000 | 5.748 | 0.17396 | 0.8338 | 10.779 | 28388.3 | 30041.0 | 190.206 | 58.61 | 128.87 | 281 |
| 370.000 | 5.088 | 0.19652 | 0.7015 | 12.504 | 29390.8 | 31257.8 | 193.541 | 59.01 | 115.26 | 285 |
| 380.000 | 4.602 | 0.21730 | 0.6095 | 14.446 | 30295.1 | 32359.5 | 196.480 | 59.56 | 105.70 | 292 |
| 390.000 | 4.229 | 0.23645 | 0.5419 | 16.447 | 31135.4 | 33381.7 | 199.136 | 60.24 | 99.17 | 300 |
| 400.000 | 3.933 | 0.25424 | 0.4901 | 18.421 | 31934.6 | 34349.8 | 201.587 | 61.03 | 94.74 | 308 |
| 410.000 | 3.691 | 0.27093 | 0.4490 | 20.330 | 32707.3 | 35281.1 | 203.887 | 61.89 | 91.73 | 317 |
| 420.000 | 3.488 | 0.28672 | 0.4154 | 22.163 | 33463.7 | 36187.6 | 206.072 | 62.82 | 89.70 | 324 |
| 430.000 | 3.314 | 0.30179 | 0.3874 | 23.923 | 34210.4 | 37077.4 | 208.166 | 63.80 | 88.36 | 332 |
| 440.000 | 3.162 | 0.31625 | 0.3636 | 25.615 | 34952.1 | 37956.5 | 210.187 | 64.81 | 87.52 | 339 |
| 450.000 | 3.028 | 0.33021 | 0.3430 | 27.244 | 35691.7 | 38828.7 | 212.147 | 65.84 | 87.03 | 346 |
| 460.000 | 2.909 | 0.34373 | 0.3251 | 28.818 | 36432.5 | 39697.9 | 214.057 | 66.90 | 86.83 | 353 |
| 470.000 | 2.802 | 0.35688 | 0.3092 | 30.344 | 37175.5 | 40565.8 | 215.925 | 67.97 | 86.83 | 359 |
| 480.000 | 2.705 | 0.36971 | 0.2951 | 31.825 | 37922.8 | 41435.0 | 217.754 | 69.04 | 87.00 | 365 |
| 490.000 | 2.616 | 0.38225 | 0.2825 | 33.267 | 38674.8 | 42306.2 | 219.551 | 70.12 | 87.30 | 371 |
| 500.000 | 2.535 | 0.39453 | 0.2711 | 34.673 | 39433.1 | 43181.2 | 221.318 | 71.20 | 87.70 | 377 |
| 520.000 | 2.390 | 0.41845 | 0.2512 | 37.392 | 40969.6 | 44944.9 | 224.777 | 73.35 | 88.73 | 388 |
| 540.000 | 2.264 | 0.44164 | 0.2345 | 40.005 | 42535.7 | 46731.3 | 228.148 | 75.49 | 89.97 | 398 |
| 560.000 | 2.154 | 0.46423 | 0.2202 | 42.528 | 44134.5 | 48544.6 | 231.445 | 77.60 | 91.37 | 408 |
| 580.000 | 2.056 | 0.48631 | 0.2078 | 44.974 | 45766.5 | 50386.4 | 234.677 | 79.68 | 92.85 | 417 |
| 600.000 | 1.969 | 0.50796 | 0.1969 | 47.354 | 47433.5 | 52259.1 | 237.851 | 81.73 | 94.41 | 427 |

Table 27. Thermophysical properties along isobars (Continued)

ETHANE ISOBAR AT P = 100.0 BAR

| T DEG K | DEN MOL/L | VOL L/MOL | DP/DT BAR/K | DP/DD BAR-L/MOL | E J/MOL | H J/MOL | S J/MOL/K | CV J/MOL/K | CP J/MOL/K | W M/SEC |
|---|---|---|---|---|---|---|---|---|---|---|
| 91.448 | 21.728 | 0.04602 | 34.4863 | 978.334 | 5336.1 | 5796.4 | 76.905 | 44.84 | 68.39 | 2228 |
| 100.000 | 21.428 | 0.04667 | 31.2263 | 895.416 | 5914.7 | 6381.4 | 83.020 | 44.72 | 68.43 | 2135 |
| 110.000 | 21.080 | 0.04744 | 28.0041 | 807.624 | 6591.9 | 7066.2 | 89.547 | 44.50 | 68.54 | 2034 |
| 120.000 | 20.734 | 0.04823 | 25.2622 | 728.313 | 7270.1 | 7752.4 | 95.518 | 44.25 | 68.71 | 1939 |
| 130.000 | 20.386 | 0.04905 | 22.8879 | 656.367 | 7950.2 | 8440.7 | 101.026 | 43.99 | 68.96 | 1850 |
| 140.000 | 20.036 | 0.04991 | 20.8017 | 590.923 | 8632.7 | 9131.8 | 106.148 | 43.75 | 69.29 | 1764 |
| 150.000 | 19.682 | 0.05081 | 18.9464 | 531.267 | 9318.6 | 9826.7 | 110.942 | 43.55 | 69.71 | 1682 |
| 160.000 | 19.322 | 0.05175 | 17.2797 | 476.796 | 10008.8 | 10526.4 | 115.457 | 43.40 | 70.24 | 1602 |
| 170.000 | 18.956 | 0.05275 | 15.7700 | 426.982 | 10704.4 | 11231.9 | 119.734 | 43.33 | 70.88 | 1524 |
| 180.000 | 18.583 | 0.05381 | 14.3927 | 381.357 | 11406.3 | 11944.4 | 123.807 | 43.34 | 71.65 | 1448 |
| 190.000 | 18.201 | 0.05494 | 13.1290 | 339.505 | 12115.9 | 12665.4 | 127.704 | 43.44 | 72.56 | 1373 |
| 200.000 | 17.809 | 0.05615 | 11.9636 | 301.050 | 12834.6 | 13396.1 | 131.452 | 43.63 | 73.61 | 1300 |
| 210.000 | 17.406 | 0.05745 | 10.8843 | 265.659 | 13563.6 | 14138.1 | 135.072 | 43.92 | 74.83 | 1227 |
| 220.000 | 16.989 | 0.05886 | 9.8810 | 233.035 | 14304.7 | 14893.3 | 138.585 | 44.30 | 76.24 | 1155 |
| 230.000 | 16.557 | 0.06040 | 8.9452 | 202.925 | 15059.6 | 15663.5 | 142.009 | 44.77 | 77.85 | 1083 |
| 240.000 | 16.106 | 0.06209 | 8.0692 | 175.106 | 15830.3 | 16451.2 | 145.361 | 45.32 | 79.72 | 1012 |
| 250.000 | 15.634 | 0.06396 | 7.2465 | 149.359 | 16619.4 | 17259.0 | 148.658 | 45.95 | 81.90 | 941 |
| 260.000 | 15.134 | 0.06607 | 6.4710 | 125.661 | 17429.7 | 18090.5 | 151.919 | 46.64 | 84.46 | 870 |
| 270.000 | 14.601 | 0.06849 | 5.7368 | 103.793 | 18265.1 | 18950.0 | 155.162 | 47.38 | 87.54 | 799 |
| 280.000 | 14.025 | 0.07130 | 5.0386 | 83.747 | 19130.6 | 19843.6 | 158.412 | 48.17 | 91.32 | 727 |
| 290.000 | 13.393 | 0.07467 | 4.3710 | 65.534 | 20033.2 | 20779.9 | 161.697 | 49.02 | 96.16 | 654 |
| 300.000 | 12.683 | 0.07885 | 3.7294 | 49.257 | 20983.6 | 21772.1 | 165.060 | 49.96 | 102.62 | 580 |
| 310.000 | 11.866 | 0.08428 | 3.1106 | 35.151 | 21998.1 | 22840.8 | 168.563 | 51.06 | 111.67 | 506 |
| 320.000 | 10.896 | 0.09178 | 2.5169 | 23.659 | 23101.0 | 24018.8 | 172.302 | 52.52 | 124.69 | 432 |
| 330.000 | 9.727 | 0.10280 | 1.9648 | 15.466 | 24320.5 | 25348.5 | 176.393 | 54.53 | 141.59 | 365 |
| 340.000 | 8.401 | 0.11903 | 1.4954 | 11.206 | 25642.8 | 26833.1 | 180.824 | 57.75 | 153.87 | 315 |
| 350.000 | 7.164 | 0.13959 | 1.1541 | 10.460 | 26946.6 | 28342.5 | 185.200 | 58.30 | 145.14 | 294 |
| 360.000 | 6.204 | 0.16119 | 0.9296 | 11.216 | 28108.0 | 29719.8 | 189.082 | 58.73 | 130.79 | 288 |
| 370.000 | 5.487 | 0.18225 | 0.7784 | 12.627 | 29139.9 | 30962.4 | 192.487 | 59.18 | 118.15 | 290 |
| 380.000 | 4.949 | 0.20205 | 0.6724 | 14.365 | 30072.9 | 32093.4 | 195.504 | 59.74 | 108.57 | 295 |
| 390.000 | 4.535 | 0.22049 | 0.5948 | 16.243 | 30937.8 | 33142.7 | 198.230 | 60.41 | 101.70 | 302 |
| 400.000 | 4.207 | 0.23771 | 0.5355 | 18.157 | 31756.9 | 34134.0 | 200.740 | 61.19 | 96.88 | 309 |
| 410.000 | 3.939 | 0.25388 | 0.4887 | 20.044 | 32546.3 | 35085.1 | 203.089 | 62.04 | 93.53 | 317 |
| 420.000 | 3.715 | 0.26919 | 0.4507 | 21.879 | 33316.2 | 36008.1 | 205.313 | 62.96 | 91.22 | 325 |
| 430.000 | 3.524 | 0.28378 | 0.4192 | 23.651 | 34074.0 | 36911.9 | 207.440 | 63.92 | 89.65 | 332 |
| 440.000 | 3.358 | 0.29778 | 0.3925 | 25.360 | 34825.1 | 37802.9 | 209.489 | 64.92 | 88.63 | 339 |
| 450.000 | 3.213 | 0.31126 | 0.3696 | 27.010 | 35572.9 | 38685.5 | 211.473 | 65.95 | 88.00 | 346 |
| 460.000 | 3.083 | 0.32432 | 0.3497 | 28.605 | 36320.6 | 39563.8 | 213.403 | 67.00 | 87.68 | 353 |
| 470.000 | 2.967 | 0.33700 | 0.3322 | 30.151 | 37070.1 | 40440.1 | 215.287 | 68.05 | 87.59 | 359 |
| 480.000 | 2.862 | 0.34936 | 0.3167 | 31.652 | 37822.5 | 41316.1 | 217.132 | 69.12 | 87.68 | 365 |
| 490.000 | 2.767 | 0.36143 | 0.3027 | 33.112 | 38579.8 | 42194.1 | 218.942 | 70.20 | 87.91 | 371 |
| 500.000 | 2.679 | 0.37325 | 0.2902 | 34.537 | 39342.1 | 43074.6 | 220.722 | 71.27 | 88.26 | 377 |
| 520.000 | 2.524 | 0.39625 | 0.2685 | 37.289 | 40886.2 | 44848.7 | 224.200 | 73.42 | 89.20 | 388 |
| 540.000 | 2.389 | 0.41852 | 0.2502 | 39.932 | 42458.9 | 46644.1 | 227.588 | 75.55 | 90.38 | 399 |
| 560.000 | 2.272 | 0.44019 | 0.2347 | 42.483 | 44062.7 | 48464.6 | 230.899 | 77.65 | 91.72 | 408 |
| 580.000 | 2.168 | 0.46136 | 0.2212 | 44.954 | 45699.7 | 50313.3 | 234.142 | 79.73 | 93.16 | 418 |
| 600.000 | 2.074 | 0.48211 | 0.2094 | 47.358 | 47370.4 | 52191.4 | 237.326 | 81.77 | 94.68 | 427 |

Table 27. Thermophysical properties along isobars (Continued)

ETHANE ISOBAR AT P = 110.0 BAR

| T | DEN | VOL | DP/DT | DP/DD | E | H | S | CV | CP | W |
|---|---|---|---|---|---|---|---|---|---|---|
| DEG K | MOL/L | L/MOL | BAR/K | BAR-L/MOL | J/MOL | J/MOL | J/MOL/K | J/MOL/K | J/MOL/K | M/SEC |
| 91.601 | 21.732 | 0.04601 | 34.4320 | 979.979 | 5339.9 | 5846.1 | 76.945 | 44.91 | 68.38 | 2227 |
| 100.000 | 21.439 | 0.04664 | 31.2418 | 898.817 | 5907.4 | 6420.5 | 82.945 | 44.79 | 68.42 | 2137 |
| 110.000 | 21.093 | 0.04741 | 28.0260 | 811.229 | 6583.6 | 7105.1 | 89.469 | 44.57 | 68.51 | 2036 |
| 120.000 | 20.747 | 0.04820 | 25.2898 | 732.092 | 7260.8 | 7791.0 | 95.437 | 44.32 | 68.68 | 1942 |
| 130.000 | 20.401 | 0.04902 | 22.9206 | 660.304 | 7939.7 | 8478.8 | 100.943 | 44.06 | 68.91 | 1853 |
| 140.000 | 20.053 | 0.04987 | 20.8392 | 594.989 | 8620.9 | 9169.5 | 106.061 | 43.82 | 69.23 | 1768 |
| 150.000 | 19.700 | 0.05076 | 18.9886 | 535.454 | 9305.4 | 9863.7 | 110.850 | 43.62 | 69.64 | 1686 |
| 160.000 | 19.343 | 0.05170 | 17.3265 | 481.095 | 9993.9 | 10562.6 | 115.361 | 43.47 | 70.16 | 1607 |
| 170.000 | 18.980 | 0.05269 | 15.8212 | 431.386 | 10687.6 | 11267.2 | 119.632 | 43.40 | 70.78 | 1530 |
| 180.000 | 18.609 | 0.05374 | 14.4485 | 385.865 | 11387.5 | 11978.7 | 123.698 | 43.41 | 71.53 | 1454 |
| 190.000 | 18.230 | 0.05485 | 13.1894 | 344.116 | 12094.8 | 12698.2 | 127.588 | 43.51 | 72.41 | 1380 |
| 200.000 | 17.842 | 0.05605 | 12.0288 | 305.768 | 12810.8 | 13427.3 | 131.328 | 43.70 | 73.43 | 1307 |
| 210.000 | 17.443 | 0.05733 | 10.9546 | 270.488 | 13536.7 | 14167.3 | 134.938 | 43.99 | 74.61 | 1235 |
| 220.000 | 17.032 | 0.05871 | 9.9567 | 237.983 | 14274.2 | 14920.1 | 138.440 | 44.37 | 75.96 | 1164 |
| 230.000 | 16.606 | 0.06022 | 9.0267 | 208.000 | 15024.8 | 15687.3 | 141.850 | 44.84 | 77.51 | 1094 |
| 240.000 | 16.163 | 0.06187 | 8.1572 | 180.320 | 15790.5 | 16471.1 | 145.185 | 45.39 | 79.29 | 1023 |
| 250.000 | 15.700 | 0.06370 | 7.3419 | 154.763 | 16573.4 | 17274.0 | 148.463 | 46.01 | 81.34 | 954 |
| 260.000 | 15.212 | 0.06574 | 6.5749 | 131.187 | 17375.9 | 18099.0 | 151.698 | 46.70 | 83.72 | 884 |
| 270.000 | 14.695 | 0.06805 | 5.8509 | 109.493 | 18201.3 | 18949.9 | 154.909 | 47.44 | 86.53 | 815 |
| 280.000 | 14.141 | 0.07072 | 5.1651 | 89.628 | 19053.6 | 19831.5 | 158.115 | 48.22 | 89.90 | 745 |
| 290.000 | 13.539 | 0.07386 | 4.5131 | 71.593 | 19938.0 | 20750.5 | 161.339 | 49.05 | 94.06 | 676 |
| 300.000 | 12.874 | 0.07767 | 3.8913 | 55.465 | 20862.1 | 21716.5 | 164.614 | 49.96 | 99.38 | 606 |
| 310.000 | 12.127 | 0.08246 | 3.2982 | 41.415 | 21836.6 | 22743.6 | 167.981 | 51.01 | 106.38 | 536 |
| 320.000 | 11.272 | 0.08872 | 2.7357 | 29.746 | 22876.1 | 23852.0 | 171.499 | 52.37 | 115.74 | 468 |
| 330.000 | 10.282 | 0.09726 | 2.2143 | 20.886 | 23997.1 | 25066.9 | 175.237 | 54.26 | 127.54 | 404 |
| 340.000 | 9.167 | 0.10909 | 1.7563 | 15.251 | 25200.0 | 26400.0 | 179.216 | 57.44 | 139.27 | 351 |
| 350.000 | 8.033 | 0.12448 | 1.3898 | 12.811 | 26436.1 | 27805.4 | 183.290 | 58.16 | 139.93 | 320 |
| 360.000 | 7.043 | 0.14198 | 1.1248 | 12.714 | 27603.2 | 29165.0 | 187.121 | 58.79 | 130.99 | 307 |
| 370.000 | 6.257 | 0.15982 | 0.9395 | 13.493 | 28666.2 | 30424.2 | 190.572 | 59.37 | 121.19 | 303 |
| 380.000 | 5.639 | 0.17734 | 0.8062 | 14.758 | 29641.4 | 31592.1 | 193.687 | 60.00 | 112.63 | 304 |
| 390.000 | 5.152 | 0.19411 | 0.7077 | 16.312 | 30547.6 | 32682.8 | 196.520 | 60.69 | 105.81 | 308 |
| 400.000 | 4.761 | 0.21003 | 0.6325 | 18.008 | 31403.6 | 33713.9 | 199.131 | 61.46 | 100.66 | 313 |
| 410.000 | 4.442 | 0.22512 | 0.5734 | 19.768 | 32224.1 | 34700.4 | 201.568 | 62.30 | 96.87 | 320 |
| 420.000 | 4.176 | 0.23946 | 0.5258 | 21.540 | 33020.5 | 35654.6 | 203.867 | 63.20 | 94.12 | 327 |
| 430.000 | 3.950 | 0.25315 | 0.4866 | 23.291 | 33800.8 | 36585.4 | 206.058 | 64.15 | 92.17 | 334 |
| 440.000 | 3.756 | 0.26627 | 0.4537 | 25.004 | 34570.9 | 37499.8 | 208.160 | 65.13 | 90.82 | 340 |
| 450.000 | 3.586 | 0.27890 | 0.4256 | 26.672 | 35335.3 | 38403.2 | 210.190 | 66.14 | 89.92 | 347 |
| 460.000 | 3.435 | 0.29111 | 0.4014 | 28.293 | 36096.9 | 39299.2 | 212.160 | 67.18 | 89.38 | 354 |
| 470.000 | 3.301 | 0.30296 | 0.3802 | 29.869 | 36858.8 | 40191.4 | 214.079 | 68.22 | 89.10 | 360 |
| 480.000 | 3.180 | 0.31449 | 0.3615 | 31.401 | 37622.5 | 41081.9 | 215.953 | 69.28 | 89.03 | 366 |
| 490.000 | 3.070 | 0.32575 | 0.3448 | 32.893 | 38389.3 | 41972.5 | 217.790 | 70.34 | 89.13 | 372 |
| 500.000 | 2.970 | 0.33675 | 0.3299 | 34.349 | 39160.7 | 42865.0 | 219.593 | 71.41 | 89.37 | 378 |
| 520.000 | 2.792 | 0.35812 | 0.3041 | 37.161 | 40720.0 | 44659.3 | 223.112 | 73.54 | 90.13 | 389 |
| 540.000 | 2.640 | 0.37878 | 0.2826 | 39.858 | 42305.1 | 46471.7 | 226.532 | 75.65 | 91.17 | 400 |
| 560.000 | 2.507 | 0.39884 | 0.2644 | 42.459 | 43920.0 | 48307.3 | 229.870 | 77.75 | 92.41 | 410 |
| 580.000 | 2.390 | 0.41842 | 0.2487 | 44.977 | 45566.3 | 50169.0 | 233.136 | 79.81 | 93.77 | 419 |
| 600.000 | 2.285 | 0.43758 | 0.2350 | 47.424 | 47245.1 | 52058.5 | 236.339 | 81.84 | 95.22 | 428 |

Table 27. Thermophysical properties along isobars (Continued)

ETHANE ISOBAR AT P = 120.0 BAR

| T | DEN | VOL | DP/DT | DP/DD | E | H | S | CV | CP | W |
|---|---|---|---|---|---|---|---|---|---|---|
| DEG K | MOL/L | L/MOL | BAR/K | BAR-L/MOL | J/MOL | J/MOL | J/MOL/K | J/MOL/K | J/MOL/K | M/SEC |
| 91.754 | 21.737 | 0.04600 | 34.3784 | 981.635 | 5343.7 | 5895.7 | 76.985 | 44.99 | 68.37 | 2227 |
| 100.000 | 21.450 | 0.04662 | 31.2574 | 902.215 | 5900.1 | 6459.6 | 82.869 | 44.86 | 68.40 | 2139 |
| 110.000 | 21.105 | 0.04738 | 28.0480 | 814.829 | 6575.4 | 7144.0 | 89.392 | 44.65 | 68.49 | 2039 |
| 120.000 | 20.761 | 0.04817 | 25.3174 | 735.865 | 7251.5 | 7829.6 | 95.357 | 44.39 | 68.64 | 1945 |
| 130.000 | 20.416 | 0.04898 | 22.9533 | 664.226 | 7929.3 | 8517.0 | 100.860 | 44.13 | 68.87 | 1857 |
| 140.000 | 20.069 | 0.04983 | 20.8766 | 599.044 | 8609.2 | 9207.2 | 105.974 | 43.89 | 69.17 | 1772 |
| 150.000 | 19.719 | 0.05071 | 19.0305 | 539.629 | 9292.3 | 9900.8 | 110.759 | 43.68 | 69.57 | 1691 |
| 160.000 | 19.364 | 0.05164 | 17.3729 | 485.378 | 9979.2 | 10599.0 | 115.265 | 43.54 | 70.07 | 1612 |
| 170.000 | 19.003 | 0.05262 | 15.8720 | 435.773 | 10671.1 | 11302.6 | 119.531 | 43.47 | 70.68 | 1535 |
| 180.000 | 18.635 | 0.05366 | 14.5037 | 390.352 | 11369.0 | 12013.0 | 123.591 | 43.48 | 71.41 | 1460 |
| 190.000 | 18.259 | 0.05477 | 13.2491 | 348.703 | 12074.0 | 12731.2 | 127.474 | 43.58 | 72.26 | 1387 |
| 200.000 | 17.875 | 0.05595 | 12.0931 | 310.456 | 12787.4 | 13458.7 | 131.205 | 43.77 | 73.26 | 1315 |
| 210.000 | 17.480 | 0.05721 | 11.0238 | 275.282 | 13510.4 | 14196.9 | 134.806 | 44.06 | 74.40 | 1243 |
| 220.000 | 17.073 | 0.05857 | 10.0310 | 242.889 | 14244.4 | 14947.2 | 138.297 | 44.44 | 75.71 | 1173 |
| 230.000 | 16.653 | 0.06005 | 9.1066 | 213.026 | 14991.0 | 15711.6 | 141.694 | 44.91 | 77.19 | 1104 |
| 240.000 | 16.217 | 0.06166 | 8.2432 | 185.473 | 15751.9 | 16491.8 | 145.014 | 45.46 | 78.89 | 1035 |
| 250.000 | 15.763 | 0.06344 | 7.4347 | 160.053 | 16528.9 | 17290.2 | 148.273 | 46.08 | 80.83 | 966 |
| 260.000 | 15.287 | 0.06542 | 6.6755 | 136.624 | 17324.3 | 18109.3 | 151.485 | 46.76 | 83.05 | 898 |
| 270.000 | 14.784 | 0.06764 | 5.9606 | 115.083 | 18140.7 | 18952.3 | 154.667 | 47.49 | 85.63 | 831 |
| 280.000 | 14.249 | 0.07018 | 5.2856 | 95.373 | 18981.2 | 19823.4 | 157.834 | 48.27 | 88.67 | 763 |
| 290.000 | 13.673 | 0.07314 | 4.6467 | 77.486 | 19850.1 | 20727.7 | 161.007 | 49.09 | 92.32 | 696 |
| 300.000 | 13.045 | 0.07666 | 4.0411 | 61.473 | 20752.6 | 21672.5 | 164.210 | 49.97 | 96.80 | 629 |
| 310.000 | 12.353 | 0.08095 | 3.4675 | 47.460 | 21696.2 | 22667.6 | 167.472 | 50.99 | 102.46 | 563 |
| 320.000 | 11.578 | 0.08637 | 2.9278 | 35.659 | 22690.4 | 23726.8 | 170.835 | 52.28 | 109.67 | 499 |
| 330.000 | 10.707 | 0.09340 | 2.4288 | 26.353 | 23745.9 | 24866.6 | 174.341 | 54.08 | 118.52 | 438 |
| 340.000 | 9.742 | 0.10265 | 1.9839 | 19.811 | 24865.7 | 26097.6 | 178.015 | 57.20 | 128.38 | 385 |
| 350.000 | 8.731 | 0.11453 | 1.6104 | 16.087 | 26029.8 | 27404.2 | 181.803 | 57.96 | 131.97 | 349 |
| 360.000 | 7.776 | 0.12860 | 1.3192 | 14.759 | 27170.8 | 28713.9 | 185.493 | 58.72 | 128.91 | 328 |
| 370.000 | 6.961 | 0.14366 | 1.1044 | 15.007 | 28243.4 | 29967.4 | 188.928 | 59.43 | 121.49 | 319 |
| 380.000 | 6.296 | 0.15883 | 0.9466 | 15.801 | 29240.1 | 31146.1 | 192.072 | 60.14 | 114.50 | 316 |
| 390.000 | 5.754 | 0.17378 | 0.8278 | 16.966 | 30174.8 | 32260.1 | 194.966 | 60.88 | 108.44 | 317 |
| 400.000 | 5.312 | 0.18825 | 0.7363 | 18.387 | 31059.6 | 33318.6 | 197.646 | 61.67 | 103.47 | 320 |
| 410.000 | 4.947 | 0.20215 | 0.6643 | 19.940 | 31907.2 | 34333.1 | 200.151 | 62.51 | 99.60 | 325 |
| 420.000 | 4.641 | 0.21548 | 0.6063 | 21.569 | 32727.6 | 35313.5 | 202.514 | 63.41 | 96.65 | 331 |
| 430.000 | 4.381 | 0.22827 | 0.5587 | 23.229 | 33529.2 | 36268.5 | 204.762 | 64.35 | 94.46 | 337 |
| 440.000 | 4.157 | 0.24057 | 0.5189 | 24.892 | 34317.8 | 37204.6 | 206.914 | 65.32 | 92.87 | 343 |
| 450.000 | 3.962 | 0.25242 | 0.4852 | 26.538 | 35098.3 | 38127.3 | 208.987 | 66.32 | 91.75 | 349 |
| 460.000 | 3.790 | 0.26388 | 0.4561 | 28.155 | 35874.2 | 39040.8 | 210.995 | 67.34 | 91.01 | 356 |
| 470.000 | 3.636 | 0.27500 | 0.4309 | 29.739 | 36648.3 | 39948.2 | 212.947 | 68.38 | 90.56 | 362 |
| 480.000 | 3.499 | 0.28581 | 0.4087 | 31.286 | 37423.0 | 40852.7 | 214.851 | 69.42 | 90.35 | 368 |
| 490.000 | 3.374 | 0.29635 | 0.3890 | 32.798 | 38199.9 | 41756.0 | 216.714 | 70.48 | 90.33 | 374 |
| 500.000 | 3.261 | 0.30665 | 0.3714 | 34.276 | 38979.9 | 42659.6 | 218.540 | 71.53 | 90.45 | 380 |
| 520.000 | 3.062 | 0.32662 | 0.3412 | 37.134 | 40554.3 | 44473.8 | 222.098 | 73.65 | 91.04 | 391 |
| 540.000 | 2.891 | 0.34591 | 0.3162 | 39.878 | 42152.5 | 46303.3 | 225.550 | 75.75 | 91.96 | 401 |
| 560.000 | 2.743 | 0.36461 | 0.2951 | 42.522 | 43778.1 | 48153.5 | 228.914 | 77.84 | 93.09 | 411 |
| 580.000 | 2.612 | 0.38284 | 0.2770 | 45.081 | 45433.4 | 50027.5 | 232.202 | 79.89 | 94.37 | 421 |
| 600.000 | 2.496 | 0.40067 | 0.2613 | 47.566 | 47120.6 | 51928.5 | 235.425 | 81.92 | 95.75 | 430 |

Table 27. Thermophysical properties along isobars (Continued)

ETHANE ISOBAR AT P = 130.0 BAR

| T | DEN | VOL | DP/DT | DP/DD | E | H | S | CV | CP | W |
|---|---|---|---|---|---|---|---|---|---|---|
| DEG K | MOL/L | L/MOL | BAR/K | BAR-L/MOL | J/MOL | J/MOL | J/MOL/K | J/MOL/K | J/MOL/K | M/SEC |
| 91.907 | 21.742 | 0.04599 | 34.3255 | 983.301 | 5347.5 | 5945.4 | 77.025 | 45.06 | 68.36 | 2227 |
| 100.000 | 21.461 | 0.04660 | 31.2731 | 905.610 | 5892.9 | 6498.7 | 82.794 | 44.94 | 68.38 | 2141 |
| 110.000 | 21.117 | 0.04735 | 28.0700 | 818.424 | 6567.2 | 7182.9 | 89.315 | 44.72 | 68.46 | 2041 |
| 120.000 | 20.775 | 0.04814 | 25.3450 | 739.631 | 7242.4 | 7868.2 | 95.277 | 44.46 | 68.61 | 1948 |
| 130.000 | 20.431 | 0.04894 | 22.9859 | 668.140 | 7919.0 | 8555.2 | 100.777 | 44.20 | 68.82 | 1860 |
| 140.000 | 20.086 | 0.04979 | 20.9139 | 603.089 | 8597.7 | 9244.9 | 105.887 | 43.95 | 69.12 | 1776 |
| 150.000 | 19.737 | 0.05067 | 19.0723 | 543.791 | 9279.3 | 9937.9 | 110.669 | 43.75 | 69.51 | 1695 |
| 160.000 | 19.384 | 0.05159 | 17.4190 | 489.648 | 9964.7 | 10635.4 | 115.170 | 43.61 | 69.99 | 1617 |
| 170.000 | 19.026 | 0.05256 | 15.9224 | 440.143 | 10654.9 | 11338.2 | 119.430 | 43.53 | 70.59 | 1541 |
| 180.000 | 18.660 | 0.05359 | 14.5584 | 394.819 | 11350.8 | 12047.5 | 123.484 | 43.54 | 71.29 | 1466 |
| 190.000 | 18.288 | 0.05468 | 13.3082 | 353.265 | 12053.6 | 12764.4 | 127.360 | 43.64 | 72.13 | 1393 |
| 200.000 | 17.907 | 0.05585 | 12.1567 | 315.116 | 12764.4 | 13490.4 | 131.084 | 43.84 | 73.09 | 1322 |
| 210.000 | 17.516 | 0.05709 | 11.0920 | 280.043 | 13484.5 | 14226.7 | 134.676 | 44.12 | 74.20 | 1251 |
| 220.000 | 17.114 | 0.05843 | 10.1043 | 247.757 | 14215.2 | 14974.8 | 138.156 | 44.51 | 75.46 | 1182 |
| 230.000 | 16.699 | 0.05988 | 9.1851 | 218.004 | 14958.0 | 15736.4 | 141.541 | 44.97 | 76.89 | 1113 |
| 240.000 | 16.271 | 0.06146 | 8.3274 | 190.570 | 15714.3 | 16513.3 | 144.847 | 45.52 | 78.51 | 1045 |
| 250.000 | 15.825 | 0.06319 | 7.5253 | 165.276 | 16485.9 | 17307.4 | 148.089 | 46.14 | 80.35 | 978 |
| 260.000 | 15.359 | 0.06511 | 6.7732 | 141.978 | 17274.7 | 18121.1 | 151.280 | 46.82 | 82.44 | 912 |
| 270.000 | 14.869 | 0.06725 | 6.0664 | 120.574 | 18082.8 | 18957.1 | 154.435 | 47.55 | 84.82 | 846 |
| 280.000 | 14.351 | 0.06968 | 5.4010 | 100.999 | 18912.9 | 19818.8 | 157.568 | 48.32 | 87.59 | 780 |
| 290.000 | 13.797 | 0.07248 | 4.7733 | 83.235 | 19768.2 | 20710.4 | 160.697 | 49.13 | 90.83 | 715 |
| 300.000 | 13.201 | 0.07575 | 4.1810 | 67.314 | 20652.6 | 21637.4 | 163.839 | 49.99 | 94.70 | 651 |
| 310.000 | 12.551 | 0.07967 | 3.6230 | 53.325 | 21571.4 | 22607.2 | 167.018 | 50.98 | 99.42 | 588 |
| 320.000 | 11.838 | 0.08447 | 3.1007 | 41.418 | 22531.3 | 23629.4 | 170.263 | 52.23 | 105.23 | 527 |
| 330.000 | 11.052 | 0.09048 | 2.6186 | 31.784 | 23539.7 | 24715.9 | 173.606 | 53.97 | 112.25 | 469 |
| 340.000 | 10.194 | 0.09810 | 2.1853 | 24.601 | 24600.3 | 25875.5 | 177.067 | 57.02 | 120.54 | 416 |
| 350.000 | 9.290 | 0.10764 | 1.8119 | 19.923 | 25704.3 | 27103.7 | 180.627 | 57.77 | 124.60 | 378 |
| 360.000 | 8.399 | 0.11906 | 1.5067 | 17.529 | 26806.1 | 28353.9 | 184.149 | 58.59 | 124.68 | 352 |
| 370.000 | 7.590 | 0.13175 | 1.2692 | 16.883 | 27870.6 | 29583.3 | 187.518 | 59.40 | 120.67 | 338 |
| 380.000 | 6.901 | 0.14491 | 1.0893 | 17.326 | 28877.1 | 30760.9 | 190.659 | 60.18 | 114.83 | 332 |
| 390.000 | 6.326 | 0.15808 | 0.9520 | 18.132 | 29827.6 | 31882.7 | 193.573 | 60.98 | 109.70 | 329 |
| 400.000 | 5.845 | 0.17109 | 0.8449 | 19.226 | 30732.8 | 32957.0 | 196.294 | 61.81 | 105.28 | 330 |
| 410.000 | 5.442 | 0.18377 | 0.7599 | 20.548 | 31601.5 | 33990.5 | 198.846 | 62.67 | 101.58 | 333 |
| 420.000 | 5.101 | 0.19606 | 0.6913 | 21.991 | 32442.4 | 34991.1 | 201.257 | 63.57 | 98.65 | 337 |
| 430.000 | 4.809 | 0.20794 | 0.6349 | 23.509 | 33262.5 | 35965.7 | 203.551 | 64.51 | 96.39 | 342 |
| 440.000 | 4.558 | 0.21942 | 0.5878 | 25.070 | 34068.2 | 36920.6 | 205.746 | 65.48 | 94.67 | 347 |
| 450.000 | 4.338 | 0.23052 | 0.5479 | 26.648 | 34863.9 | 37860.7 | 207.859 | 66.47 | 93.41 | 353 |
| 460.000 | 4.145 | 0.24128 | 0.5137 | 28.224 | 35653.4 | 38790.1 | 209.902 | 67.49 | 92.53 | 359 |
| 470.000 | 3.973 | 0.25172 | 0.4841 | 29.786 | 36439.8 | 39712.2 | 211.885 | 68.52 | 91.95 | 365 |
| 480.000 | 3.818 | 0.26189 | 0.4581 | 31.326 | 37225.1 | 40629.6 | 213.817 | 69.55 | 91.61 | 370 |
| 490.000 | 3.679 | 0.27180 | 0.4352 | 32.840 | 38011.6 | 41545.0 | 215.704 | 70.60 | 91.48 | 376 |
| 500.000 | 3.553 | 0.28147 | 0.4148 | 34.325 | 38800.6 | 42459.8 | 217.552 | 71.65 | 91.50 | 382 |
| 520.000 | 3.331 | 0.30024 | 0.3799 | 37.211 | 40390.2 | 44293.3 | 221.148 | 73.75 | 91.93 | 393 |
| 540.000 | 3.141 | 0.31833 | 0.3511 | 39.989 | 42001.0 | 46139.2 | 224.631 | 75.85 | 92.72 | 403 |
| 560.000 | 2.977 | 0.33586 | 0.3269 | 42.669 | 43637.3 | 48003.5 | 228.021 | 77.92 | 93.75 | 413 |
| 580.000 | 2.833 | 0.35293 | 0.3063 | 45.262 | 45301.8 | 49889.8 | 231.331 | 79.97 | 94.94 | 423 |
| 600.000 | 2.706 | 0.36960 | 0.2885 | 47.780 | 46997.0 | 51801.8 | 234.572 | 81.99 | 96.26 | 432 |

Table 27. Thermophysical properties along isobars (Continued)

ETHANE ISOBAR AT P = 140.0 BAR

| T<br>DEG K | DEN<br>MOL/L | VOL<br>L/MCL | DP/DT<br>BAR/K | DP/DD<br>BAR-L/MOL | E<br>J/MOL | H<br>J/MCL | S<br>J/MCL/K | CV<br>J/MCL/K | CP<br>J/MOL/K | W<br>M/SEC |
|---|---|---|---|---|---|---|---|---|---|---|
| 92.060 | 21.747 | 0.04598 | 34.2734 | 984.978 | 5351.3 | 5995.0 | 77.064 | 45.13 | 68.35 | 2227 |
| 100.000 | 21.472 | 0.04657 | 31.2889 | 909.001 | 5885.8 | 6537.8 | 82.719 | 45.01 | 68.37 | 2143 |
| 110.000 | 21.129 | 0.04733 | 28.0921 | 822.013 | 6559.2 | 7221.8 | 89.238 | 44.79 | 68.44 | 2044 |
| 120.000 | 20.788 | 0.04810 | 25.3725 | 743.390 | 7233.3 | 7906.8 | 95.198 | 44.53 | 68.57 | 1951 |
| 130.000 | 20.446 | 0.04891 | 23.0184 | 672.046 | 7908.8 | 8593.5 | 100.695 | 44.26 | 68.78 | 1864 |
| 140.000 | 20.103 | 0.04974 | 20.9510 | 607.125 | 8586.2 | 9282.7 | 105.802 | 44.02 | 69.07 | 1780 |
| 150.000 | 19.756 | 0.05062 | 19.1138 | 547.941 | 9266.5 | 9975.1 | 110.579 | 43.82 | 69.44 | 1699 |
| 160.000 | 19.405 | 0.05153 | 17.4648 | 493.902 | 9950.4 | 10671.8 | 115.075 | 43.67 | 69.91 | 1622 |
| 170.000 | 19.048 | 0.05250 | 15.9724 | 444.495 | 10638.8 | 11373.8 | 119.331 | 43.60 | 70.49 | 1546 |
| 180.000 | 18.686 | 0.05352 | 14.6127 | 399.265 | 11332.8 | 12082.0 | 123.379 | 43.61 | 71.18 | 1472 |
| 190.000 | 18.316 | 0.05460 | 13.3667 | 357.804 | 12033.4 | 12797.8 | 127.248 | 43.71 | 71.99 | 1400 |
| 200.000 | 17.938 | 0.05575 | 12.2196 | 319.748 | 12741.8 | 13522.3 | 130.964 | 43.90 | 72.93 | 1329 |
| 210.000 | 17.551 | 0.05698 | 11.1594 | 284.770 | 13459.2 | 14256.8 | 134.548 | 44.19 | 74.00 | 1259 |
| 220.000 | 17.154 | 0.05830 | 10.1763 | 252.584 | 14186.7 | 15002.8 | 138.018 | 44.57 | 75.22 | 1191 |
| 230.000 | 16.745 | 0.05972 | 9.2621 | 222.936 | 14925.7 | 15761.8 | 141.392 | 45.04 | 76.60 | 1123 |
| 240.000 | 16.322 | 0.06127 | 8.4099 | 195.613 | 15677.8 | 16535.5 | 144.684 | 45.59 | 78.16 | 1056 |
| 250.000 | 15.884 | 0.06296 | 7.6136 | 170.434 | 16444.2 | 17325.6 | 147.909 | 46.20 | 79.90 | 990 |
| 260.000 | 15.428 | 0.06482 | 6.8681 | 147.257 | 17226.8 | 18134.3 | 151.081 | 46.88 | 81.87 | 925 |
| 270.000 | 14.950 | 0.06689 | 6.1688 | 125.973 | 18027.4 | 18963.9 | 154.211 | 47.60 | 84.09 | 860 |
| 280.000 | 14.447 | 0.06922 | 5.5117 | 106.516 | 18848.2 | 19817.2 | 157.314 | 48.37 | 86.63 | 797 |
| 290.000 | 13.913 | 0.07187 | 4.8938 | 88.856 | 19691.5 | 20697.7 | 160.404 | 49.16 | 89.54 | 734 |
| 300.000 | 13.343 | 0.07494 | 4.3128 | 73.009 | 20560.4 | 21609.6 | 163.495 | 50.01 | 92.94 | 672 |
| 310.000 | 12.730 | 0.07856 | 3.7675 | 59.036 | 21458.8 | 22558.6 | 166.607 | 50.98 | 96.97 | 611 |
| 320.000 | 12.065 | 0.08289 | 3.2588 | 47.039 | 22391.4 | 23551.9 | 169.760 | 52.19 | 101.83 | 552 |
| 330.000 | 11.343 | 0.08816 | 2.7900 | 37.151 | 23364.1 | 24598.4 | 172.980 | 53.89 | 107.63 | 497 |
| 340.000 | 10.565 | 0.09465 | 2.3666 | 29.489 | 24380.5 | 25705.7 | 176.284 | 56.89 | 114.75 | 445 |
| 350.000 | 9.746 | 0.10261 | 1.9958 | 24.087 | 25437.0 | 26873.5 | 179.669 | 57.62 | 118.55 | 406 |
| 360.000 | 8.923 | 0.11207 | 1.6835 | 20.816 | 26499.8 | 28068.8 | 183.037 | 58.46 | 120.02 | 377 |
| 370.000 | 8.145 | 0.12277 | 1.4307 | 19.320 | 27544.5 | 29263.3 | 186.310 | 59.32 | 118.41 | 358 |
| 380.000 | 7.451 | 0.13421 | 1.2322 | 19.107 | 28550.5 | 30429.4 | 189.420 | 60.17 | 114.56 | 348 |
| 390.000 | 6.856 | 0.14586 | 1.0777 | 19.667 | 29510.0 | 31552.1 | 192.337 | 61.02 | 110.03 | 343 |
| 400.000 | 6.350 | 0.15749 | 0.9562 | 20.483 | 30427.6 | 32632.5 | 195.072 | 61.89 | 106.17 | 342 |
| 410.000 | 5.918 | 0.16899 | 0.8587 | 21.524 | 31311.6 | 33677.4 | 197.653 | 62.78 | 102.89 | 343 |
| 420.000 | 5.548 | 0.18025 | 0.7796 | 22.770 | 32168.4 | 34691.9 | 200.097 | 63.70 | 100.11 | 345 |
| 430.000 | 5.229 | 0.19122 | 0.7143 | 24.127 | 33004.2 | 35681.3 | 202.426 | 64.64 | 97.89 | 349 |
| 440.000 | 4.953 | 0.20190 | 0.6598 | 25.555 | 33824.7 | 36651.3 | 204.656 | 65.61 | 96.16 | 353 |
| 450.000 | 4.711 | 0.21227 | 0.6136 | 27.029 | 34634.1 | 37605.9 | 206.801 | 66.60 | 94.84 | 358 |
| 460.000 | 4.497 | 0.22236 | 0.5740 | 28.529 | 35436.2 | 38549.2 | 208.875 | 67.61 | 93.88 | 363 |
| 470.000 | 4.307 | 0.23217 | 0.5397 | 30.038 | 36234.0 | 39484.4 | 210.886 | 68.64 | 93.21 | 368 |
| 480.000 | 4.137 | 0.24174 | 0.5098 | 31.543 | 37029.8 | 40414.1 | 212.844 | 69.67 | 92.78 | 374 |
| 490.000 | 3.983 | 0.25107 | 0.4833 | 33.036 | 37825.7 | 41340.7 | 214.754 | 70.71 | 92.56 | 379 |
| 500.000 | 3.843 | 0.26019 | 0.4599 | 34.512 | 38623.0 | 42265.6 | 216.623 | 71.76 | 92.50 | 385 |
| 520.000 | 3.599 | 0.27787 | 0.4199 | 37.399 | 40227.6 | 44117.8 | 220.255 | 73.85 | 92.78 | 395 |
| 540.000 | 3.391 | 0.29491 | 0.3872 | 40.194 | 41850.8 | 45979.5 | 223.768 | 75.93 | 93.45 | 406 |
| 560.000 | 3.211 | 0.31141 | 0.3598 | 42.898 | 43497.5 | 47857.2 | 227.183 | 78.00 | 94.39 | 415 |
| 580.000 | 3.054 | 0.32746 | 0.3364 | 45.519 | 45171.4 | 49755.8 | 230.514 | 80.04 | 95.51 | 425 |
| 600.000 | 2.914 | 0.34313 | 0.3163 | 48.065 | 46874.5 | 51678.4 | 233.773 | 82.05 | 96.76 | 434 |

Table 27. Thermophysical properties along isobars (Continued)

ETHANE ISOBAR AT P = 150.0 BAR

| T | DEN | VOL | DP/DT | DP/DD | E | H | S | CV | CP | W |
|---|---|---|---|---|---|---|---|---|---|---|
| DEG K | MOL/L | L/MOL | BAR/K | BAR-L/MOL | J/MOL | J/MOL | J/MOL/K | J/MOL/K | J/MOL/K | M/SEC |
| 92.212 | 21.752 | 0.04597 | 34.2219 | 986.666 | 5355.1 | 6044.7 | 77.104 | 45.20 | 68.34 | 2227 |
| 100.000 | 21.483 | 0.04655 | 31.3048 | 912.388 | 5878.7 | 6576.9 | 82.645 | 45.08 | 68.35 | 2145 |
| 110.000 | 21.142 | 0.04730 | 28.1142 | 825.598 | 6551.2 | 7260.7 | 89.162 | 44.85 | 68.42 | 2046 |
| 120.000 | 20.801 | 0.04807 | 25.4001 | 747.143 | 7224.3 | 7945.4 | 95.119 | 44.60 | 68.54 | 1954 |
| 130.000 | 20.461 | 0.04887 | 23.0508 | 675.944 | 7898.7 | 8631.8 | 100.613 | 44.33 | 68.74 | 1867 |
| 140.000 | 20.119 | 0.04970 | 20.9880 | 611.150 | 8574.9 | 9320.5 | 105.717 | 44.09 | 69.02 | 1784 |
| 150.000 | 19.774 | 0.05057 | 19.1551 | 552.079 | 9253.8 | 10012.4 | 110.490 | 43.88 | 69.38 | 1704 |
| 160.000 | 19.425 | 0.05148 | 17.5102 | 498.143 | 9936.2 | 10708.4 | 114.982 | 43.74 | 69.84 | 1626 |
| 170.000 | 19.071 | 0.05244 | 16.0220 | 448.831 | 10622.9 | 11409.5 | 119.232 | 43.67 | 70.40 | 1551 |
| 180.000 | 18.710 | 0.05345 | 14.6664 | 403.692 | 11315.1 | 12116.8 | 123.274 | 43.68 | 71.07 | 1478 |
| 190.000 | 18.344 | 0.05451 | 13.4245 | 362.320 | 12013.6 | 12831.3 | 127.138 | 43.77 | 71.86 | 1406 |
| 200.000 | 17.969 | 0.05565 | 12.2816 | 324.353 | 12719.6 | 13554.4 | 130.846 | 43.97 | 72.77 | 1336 |
| 210.000 | 17.586 | 0.05686 | 11.2258 | 289.467 | 13434.3 | 14287.2 | 134.422 | 44.26 | 73.82 | 1267 |
| 220.000 | 17.193 | 0.05816 | 10.2473 | 257.375 | 14158.7 | 15031.2 | 137.882 | 44.64 | 75.00 | 1199 |
| 230.000 | 16.789 | 0.05956 | 9.3379 | 227.825 | 14894.3 | 15787.7 | 141.245 | 45.10 | 76.33 | 1132 |
| 240.000 | 16.373 | 0.06108 | 8.4907 | 200.605 | 15642.2 | 16558.3 | 144.524 | 45.65 | 77.82 | 1066 |
| 250.000 | 15.942 | 0.06273 | 7.7000 | 175.533 | 16403.8 | 17344.7 | 147.735 | 46.26 | 79.49 | 1001 |
| 260.000 | 15.495 | 0.06454 | 6.9605 | 152.464 | 17180.7 | 18148.8 | 150.888 | 46.94 | 81.35 | 937 |
| 270.000 | 15.028 | 0.06654 | 6.2679 | 131.290 | 17974.4 | 18972.5 | 153.996 | 47.66 | 83.43 | 874 |
| 280.000 | 14.539 | 0.06878 | 5.6184 | 111.936 | 18786.5 | 19818.3 | 157.072 | 48.41 | 85.77 | 812 |
| 290.000 | 14.023 | 0.07131 | 5.0091 | 94.364 | 19619.2 | 20688.9 | 160.127 | 49.20 | 88.42 | 751 |
| 300.000 | 13.475 | 0.07421 | 4.4376 | 78.577 | 20474.7 | 21587.9 | 163.174 | 50.04 | 91.44 | 691 |
| 310.000 | 12.891 | 0.07757 | 3.9029 | 64.612 | 21355.9 | 22519.4 | 166.228 | 50.98 | 94.96 | 633 |
| 320.000 | 12.266 | 0.08153 | 3.4054 | 52.538 | 22266.3 | 23489.2 | 169.307 | 52.17 | 99.12 | 576 |
| 330.000 | 11.594 | 0.08625 | 2.9471 | 42.445 | 23210.8 | 24504.6 | 172.431 | 53.83 | 104.07 | 522 |
| 340.000 | 10.878 | 0.09193 | 2.5320 | 34.406 | 24192.9 | 25571.8 | 175.617 | 56.80 | 110.34 | 471 |
| 350.000 | 10.128 | 0.09874 | 2.1646 | 28.440 | 25211.7 | 26692.8 | 178.866 | 57.50 | 113.71 | 432 |
| 360.000 | 9.366 | 0.10677 | 1.8489 | 24.454 | 26239.9 | 27841.4 | 182.102 | 58.34 | 115.71 | 402 |
| 370.000 | 8.628 | 0.11590 | 1.5862 | 22.207 | 27261.0 | 28999.5 | 185.275 | 59.23 | 115.54 | 380 |
| 380.000 | 7.947 | 0.12583 | 1.3734 | 21.319 | 28258.0 | 30145.4 | 188.331 | 60.13 | 113.36 | 366 |
| 390.000 | 7.344 | 0.13617 | 1.2036 | 21.392 | 29220.2 | 31262.8 | 191.233 | 61.03 | 110.00 | 358 |
| 400.000 | 6.821 | 0.14661 | 1.0685 | 22.026 | 30145.6 | 32344.8 | 193.973 | 61.93 | 106.50 | 355 |
| 410.000 | 6.369 | 0.15701 | 0.9595 | 22.849 | 31039.6 | 33394.7 | 196.566 | 62.85 | 103.57 | 354 |
| 420.000 | 5.977 | 0.16730 | 0.8701 | 23.852 | 31908.3 | 34417.7 | 199.031 | 63.78 | 101.10 | 355 |
| 430.000 | 5.637 | 0.17741 | 0.7962 | 25.037 | 32756.6 | 35417.7 | 201.385 | 64.74 | 99.00 | 357 |
| 440.000 | 5.339 | 0.18731 | 0.7341 | 26.324 | 33589.5 | 36399.1 | 203.641 | 65.72 | 97.32 | 360 |
| 450.000 | 5.077 | 0.19697 | 0.6815 | 27.679 | 34410.8 | 37365.4 | 205.813 | 66.71 | 96.01 | 364 |
| 460.000 | 4.845 | 0.20641 | 0.6364 | 29.080 | 35224.0 | 38320.2 | 207.911 | 67.72 | 95.02 | 368 |
| 470.000 | 4.638 | 0.21563 | 0.5974 | 30.510 | 36032.2 | 39266.7 | 209.947 | 68.75 | 94.31 | 373 |
| 480.000 | 4.452 | 0.22463 | 0.5633 | 31.956 | 36837.7 | 40207.1 | 211.927 | 69.78 | 93.83 | 378 |
| 490.000 | 4.284 | 0.23342 | 0.5333 | 33.406 | 37642.5 | 41143.8 | 213.858 | 70.81 | 93.54 | 383 |
| 500.000 | 4.132 | 0.24202 | 0.5066 | 34.852 | 38448.1 | 42078.5 | 215.747 | 71.86 | 93.42 | 388 |
| 520.000 | 3.865 | 0.25872 | 0.4614 | 37.709 | 40066.8 | 43947.6 | 219.412 | 73.94 | 93.59 | 398 |
| 540.000 | 3.639 | 0.27481 | 0.4244 | 40.500 | 41702.2 | 45824.4 | 222.954 | 76.02 | 94.15 | 408 |
| 560.000 | 3.444 | 0.29040 | 0.3935 | 43.214 | 43359.5 | 47715.5 | 226.393 | 78.08 | 95.00 | 418 |
| 580.000 | 3.273 | 0.30556 | 0.3674 | 45.852 | 45042.3 | 49625.7 | 229.744 | 80.11 | 96.05 | 428 |
| 600.000 | 3.122 | 0.32034 | 0.3449 | 48.419 | 46753.3 | 51558.5 | 233.020 | 82.12 | 97.24 | 437 |

Table 27. Thermophysical properties along isobars (Continued)

ETHANE ISOBAR AT P = 160.0 BAR

| T DEG K | DEN MOL/L | VOL L/MOL | DP/DT BAR/K | DP/DD BAR-L/MOL | E J/MOL | H J/MOL | S J/MOL/K | CV J/MOL/K | CP J/MOL/K | W M/SEC |
|---|---|---|---|---|---|---|---|---|---|---|
| 92.364 | 21.757 | 0.04596 | 34.1712 | 988.363 | 5358.9 | 6094.3 | 77.144 | 45.27 | 68.33 | 2227 |
| 100.000 | 21.494 | 0.04652 | 31.3209 | 915.772 | 5871.6 | 6616.0 | 82.571 | 45.15 | 68.34 | 2147 |
| 110.000 | 21.154 | 0.04727 | 28.1364 | 829.177 | 6543.2 | 7299.6 | 89.086 | 44.92 | 68.39 | 2049 |
| 120.000 | 20.815 | 0.04804 | 25.4276 | 750.889 | 7215.4 | 7984.1 | 95.041 | 44.66 | 68.51 | 1957 |
| 130.000 | 20.476 | 0.04884 | 23.0832 | 679.834 | 7888.6 | 8670.1 | 100.532 | 44.40 | 68.70 | 1870 |
| 140.000 | 20.135 | 0.04966 | 21.0248 | 615.165 | 8563.7 | 9358.3 | 105.632 | 44.15 | 68.97 | 1788 |
| 150.000 | 19.792 | 0.05053 | 19.1962 | 556.205 | 9241.2 | 10049.7 | 110.402 | 43.95 | 69.32 | 1708 |
| 160.000 | 19.445 | 0.05143 | 17.5554 | 502.370 | 9922.1 | 10745.0 | 114.889 | 43.80 | 69.76 | 1631 |
| 170.000 | 19.093 | 0.05238 | 16.0713 | 453.151 | 10607.3 | 11445.3 | 119.134 | 43.73 | 70.31 | 1557 |
| 180.000 | 18.735 | 0.05338 | 14.7196 | 408.100 | 11297.6 | 12151.6 | 123.171 | 43.74 | 70.97 | 1484 |
| 190.000 | 18.371 | 0.05443 | 13.4818 | 366.814 | 11994.1 | 12865.0 | 127.028 | 43.84 | 71.74 | 1413 |
| 200.000 | 18.000 | 0.05556 | 12.3430 | 328.932 | 12697.8 | 13586.7 | 130.730 | 44.03 | 72.62 | 1343 |
| 210.000 | 17.620 | 0.05675 | 11.2914 | 294.133 | 13409.8 | 14317.9 | 134.297 | 44.32 | 73.64 | 1275 |
| 220.000 | 17.232 | 0.05803 | 10.3172 | 262.130 | 14131.4 | 15059.9 | 137.749 | 44.70 | 74.79 | 1208 |
| 230.000 | 16.833 | 0.05941 | 9.4123 | 232.675 | 14863.5 | 15814.0 | 141.101 | 45.16 | 76.07 | 1142 |
| 240.000 | 16.422 | 0.06089 | 8.5700 | 205.548 | 15607.5 | 16581.8 | 144.368 | 45.71 | 77.51 | 1077 |
| 250.000 | 15.998 | 0.06251 | 7.7844 | 180.575 | 16364.6 | 17364.7 | 147.564 | 46.32 | 79.10 | 1013 |
| 260.000 | 15.559 | 0.06427 | 7.0506 | 157.606 | 17136.1 | 18164.4 | 150.700 | 46.99 | 80.87 | 950 |
| 270.000 | 15.103 | 0.06621 | 6.3641 | 136.529 | 17923.3 | 18982.8 | 153.788 | 47.71 | 82.83 | 889 |
| 280.000 | 14.626 | 0.06837 | 5.7215 | 117.266 | 18727.7 | 19821.7 | 156.839 | 48.46 | 85.00 | 827 |
| 290.000 | 14.126 | 0.07079 | 5.1196 | 99.771 | 19550.9 | 20683.6 | 159.863 | 49.24 | 87.42 | 768 |
| 300.000 | 13.598 | 0.07354 | 4.5564 | 84.032 | 20394.6 | 21571.2 | 162.872 | 50.07 | 90.15 | 709 |
| 310.000 | 13.040 | 0.07669 | 4.0307 | 70.070 | 21260.9 | 22487.9 | 165.878 | 51.00 | 93.27 | 653 |
| 320.000 | 12.447 | 0.08034 | 3.5425 | 57.928 | 22152.8 | 23438.3 | 168.895 | 52.16 | 96.91 | 598 |
| 330.000 | 11.816 | 0.08463 | 3.0929 | 47.662 | 23074.4 | 24428.4 | 171.941 | 53.79 | 101.23 | 545 |
| 340.000 | 11.150 | 0.08969 | 2.6846 | 39.318 | 24029.1 | 25464.1 | 175.033 | 56.73 | 106.86 | 496 |
| 350.000 | 10.455 | 0.09565 | 2.3207 | 32.898 | 25017.5 | 26547.9 | 178.174 | 57.41 | 109.83 | 458 |
| 360.000 | 9.746 | 0.10260 | 2.0036 | 28.327 | 26016.1 | 27657.8 | 181.301 | 58.24 | 111.95 | 426 |
| 370.000 | 9.049 | 0.11051 | 1.7344 | 25.428 | 27013.7 | 28781.9 | 184.381 | 59.14 | 112.60 | 401 |
| 380.000 | 8.390 | 0.11918 | 1.5110 | 23.916 | 27997.2 | 29904.2 | 187.374 | 60.07 | 111.60 | 384 |
| 390.000 | 7.790 | 0.12836 | 1.3287 | 23.449 | 28956.0 | 31009.8 | 190.246 | 61.01 | 109.39 | 374 |
| 400.000 | 7.258 | 0.13777 | 1.1810 | 23.718 | 29885.4 | 32089.8 | 192.981 | 61.94 | 106.59 | 368 |
| 410.000 | 6.793 | 0.14722 | 1.0609 | 24.401 | 30786.4 | 33141.8 | 195.578 | 62.89 | 103.87 | 366 |
| 420.000 | 6.385 | 0.15661 | 0.9621 | 25.229 | 31663.2 | 34168.9 | 198.054 | 63.84 | 101.63 | 365 |
| 430.000 | 6.027 | 0.16591 | 0.8797 | 26.203 | 32521.1 | 35175.6 | 200.423 | 64.81 | 99.77 | 366 |
| 440.000 | 5.712 | 0.17507 | 0.8103 | 27.339 | 33364.0 | 36165.2 | 202.698 | 65.80 | 98.19 | 368 |
| 450.000 | 5.433 | 0.18407 | 0.7514 | 28.570 | 34195.3 | 37140.4 | 204.890 | 66.80 | 96.93 | 371 |
| 460.000 | 5.184 | 0.19289 | 0.7007 | 29.863 | 35018.4 | 38104.7 | 207.009 | 67.81 | 95.96 | 375 |
| 470.000 | 4.962 | 0.20153 | 0.6569 | 31.201 | 35835.9 | 39060.4 | 209.064 | 68.84 | 95.23 | 379 |
| 480.000 | 4.762 | 0.21000 | 0.6185 | 32.571 | 36650.1 | 40010.1 | 211.064 | 69.87 | 94.73 | 383 |
| 490.000 | 4.581 | 0.21829 | 0.5847 | 33.959 | 37463.1 | 40955.6 | 213.014 | 70.90 | 94.41 | 388 |
| 500.000 | 4.417 | 0.22641 | 0.5548 | 35.358 | 38276.1 | 41898.6 | 214.919 | 71.94 | 94.25 | 392 |
| 520.000 | 4.129 | 0.24219 | 0.5040 | 38.153 | 39908.7 | 43783.8 | 218.616 | 74.02 | 94.33 | 402 |
| 540.000 | 3.885 | 0.25743 | 0.4627 | 40.915 | 41555.7 | 45674.6 | 222.184 | 76.09 | 94.82 | 412 |
| 560.000 | 3.674 | 0.27219 | 0.4282 | 43.621 | 43223.1 | 47578.2 | 225.645 | 78.15 | 95.59 | 421 |
| 580.000 | 3.490 | 0.28654 | 0.3991 | 46.264 | 44914.7 | 49499.5 | 229.016 | 80.18 | 96.57 | 430 |
| 600.000 | 3.327 | 0.30054 | 0.3742 | 48.843 | 46633.4 | 51442.1 | 232.309 | 82.18 | 97.71 | 439 |

Table 27. Thermophysical properties along isobars (Continued)

ETHANE ISOBAR AT P = 170.0 BAR

| T DEG K | DEN MOL/L | VOL L/MOL | DP/DT BAR/K | DP/DD BAR-L/MOL | E J/MOL | H J/MOL | S J/MOL/K | CV J/MOL/K | CP J/MOL/K | W M/SEC |
|---|---|---|---|---|---|---|---|---|---|---|
| 92.516 | 21.761 | 0.04595 | 34.1211 | 990.071 | 5362.7 | 6143.9 | 77.183 | 45.34 | 68.32 | 2227 |
| 100.000 | 21.505 | 0.04650 | 31.3370 | 919.153 | 5864.6 | 6655.1 | 82.497 | 45.22 | 68.32 | 2149 |
| 110.000 | 21.166 | 0.04725 | 28.1586 | 832.752 | 6535.3 | 7338.5 | 89.010 | 44.99 | 68.37 | 2051 |
| 120.000 | 20.828 | 0.04801 | 25.4551 | 754.629 | 7206.5 | 8022.7 | 94.963 | 44.73 | 68.48 | 1960 |
| 130.000 | 20.490 | 0.04880 | 23.1154 | 683.716 | 7878.7 | 8708.4 | 100.451 | 44.46 | 68.66 | 1874 |
| 140.000 | 20.151 | 0.04962 | 21.0615 | 619.171 | 8552.6 | 9396.2 | 105.548 | 44.22 | 68.92 | 1791 |
| 150.000 | 19.810 | 0.05048 | 19.2370 | 560.320 | 9228.8 | 10087.0 | 110.314 | 44.01 | 69.26 | 1712 |
| 160.000 | 19.465 | 0.05138 | 17.6004 | 506.583 | 9908.3 | 10781.7 | 114.797 | 43.87 | 69.69 | 1636 |
| 170.000 | 19.115 | 0.05232 | 16.1202 | 457.455 | 10591.8 | 11481.2 | 119.037 | 43.79 | 70.23 | 1562 |
| 180.000 | 18.759 | 0.05331 | 14.7724 | 412.489 | 11280.3 | 12186.5 | 123.069 | 43.80 | 70.86 | 1490 |
| 190.000 | 18.398 | 0.05435 | 13.5385 | 371.286 | 11974.8 | 12898.8 | 126.920 | 43.90 | 71.61 | 1419 |
| 200.000 | 18.030 | 0.05546 | 12.4037 | 333.486 | 12676.3 | 13619.2 | 130.615 | 44.10 | 72.48 | 1350 |
| 210.000 | 17.654 | 0.05664 | 11.3561 | 298.770 | 13385.8 | 14348.8 | 134.174 | 44.38 | 73.47 | 1282 |
| 220.000 | 17.269 | 0.05791 | 10.3861 | 266.852 | 14104.5 | 15088.9 | 137.617 | 44.76 | 74.58 | 1216 |
| 230.000 | 16.875 | 0.05926 | 9.4856 | 237.483 | 14833.4 | 15840.8 | 140.959 | 45.23 | 75.83 | 1151 |
| 240.000 | 16.470 | 0.06072 | 8.6478 | 210.446 | 15573.7 | 16605.9 | 144.215 | 45.77 | 77.21 | 1087 |
| 250.000 | 16.053 | 0.06229 | 7.8671 | 185.563 | 16326.5 | 17385.5 | 147.398 | 46.38 | 78.74 | 1024 |
| 260.000 | 15.622 | 0.06401 | 7.1385 | 162.685 | 17093.0 | 18181.2 | 150.518 | 47.05 | 80.42 | 962 |
| 270.000 | 15.175 | 0.06590 | 6.4577 | 141.697 | 17874.2 | 18994.5 | 153.587 | 47.76 | 82.27 | 901 |
| 280.000 | 14.709 | 0.06798 | 5.8212 | 122.514 | 18671.5 | 19827.2 | 156.615 | 48.51 | 84.30 | 841 |
| 290.000 | 14.223 | 0.07031 | 5.2260 | 105.085 | 19486.0 | 20681.2 | 159.612 | 49.28 | 86.54 | 783 |
| 300.000 | 13.714 | 0.07292 | 4.6701 | 89.386 | 20319.2 | 21558.8 | 162.587 | 50.10 | 89.02 | 727 |
| 310.000 | 13.177 | 0.07589 | 4.1521 | 75.423 | 21172.6 | 22462.7 | 165.550 | 51.01 | 91.82 | 672 |
| 320.000 | 12.612 | 0.07929 | 3.6716 | 63.218 | 22048.7 | 23396.6 | 168.515 | 52.16 | 95.06 | 619 |
| 330.000 | 12.016 | 0.08322 | 3.2293 | 52.805 | 22951.2 | 24366.0 | 171.498 | 53.77 | 98.91 | 568 |
| 340.000 | 11.390 | 0.08780 | 2.8268 | 44.207 | 23883.4 | 25376.0 | 174.513 | 56.68 | 104.06 | 520 |
| 350.000 | 10.739 | 0.09311 | 2.4661 | 37.412 | 24846.9 | 26429.9 | 177.567 | 57.34 | 106.67 | 481 |
| 360.000 | 10.076 | 0.09924 | 2.1488 | 32.355 | 25820.4 | 27507.6 | 180.603 | 58.15 | 108.75 | 449 |
| 370.000 | 9.418 | 0.10618 | 1.8752 | 28.897 | 26796.3 | 28601.4 | 183.600 | 59.06 | 109.82 | 423 |
| 380.000 | 8.785 | 0.11382 | 1.6440 | 26.817 | 27764.7 | 29699.8 | 186.529 | 60.01 | 109.63 | 404 |
| 390.000 | 8.197 | 0.12200 | 1.4516 | 25.835 | 28716.3 | 30790.2 | 189.362 | 60.97 | 108.31 | 391 |
| 400.000 | 7.664 | 0.13048 | 1.2930 | 25.664 | 29645.4 | 31863.5 | 192.080 | 61.93 | 106.30 | 383 |
| 410.000 | 7.189 | 0.13910 | 1.1625 | 26.071 | 30550.6 | 32915.2 | 194.677 | 62.90 | 104.02 | 379 |
| 420.000 | 6.770 | 0.14771 | 1.0546 | 26.787 | 31433.6 | 33944.6 | 197.158 | 63.88 | 101.92 | 377 |
| 430.000 | 6.399 | 0.15627 | 0.9643 | 27.621 | 32298.4 | 34954.9 | 199.535 | 64.86 | 100.21 | 377 |
| 440.000 | 6.070 | 0.16475 | 0.8878 | 28.572 | 33149.0 | 35949.7 | 201.822 | 65.86 | 98.81 | 378 |
| 450.000 | 5.776 | 0.17312 | 0.8226 | 29.667 | 33988.6 | 36931.7 | 204.029 | 66.87 | 97.63 | 380 |
| 460.000 | 5.514 | 0.18136 | 0.7664 | 30.851 | 34819.9 | 37903.1 | 206.164 | 67.89 | 96.70 | 382 |
| 470.000 | 5.278 | 0.18946 | 0.7177 | 32.094 | 35645.4 | 38866.3 | 208.236 | 68.91 | 95.99 | 386 |
| 480.000 | 5.065 | 0.19742 | 0.6751 | 33.379 | 36467.4 | 39823.5 | 210.251 | 69.95 | 95.49 | 389 |
| 490.000 | 4.873 | 0.20523 | 0.6376 | 34.695 | 37287.8 | 40776.6 | 212.217 | 70.98 | 95.16 | 393 |
| 500.000 | 4.697 | 0.21290 | 0.6043 | 36.033 | 38108.0 | 41727.3 | 214.137 | 72.02 | 94.99 | 398 |
| 520.000 | 4.389 | 0.22784 | 0.5479 | 38.739 | 39753.3 | 43626.5 | 217.862 | 74.10 | 95.01 | 406 |
| 540.000 | 4.127 | 0.24228 | 0.5019 | 41.448 | 41411.5 | 45530.3 | 221.454 | 76.16 | 95.43 | 416 |
| 560.000 | 3.902 | 0.25629 | 0.4638 | 44.127 | 43088.6 | 47445.5 | 224.937 | 78.21 | 96.14 | 425 |
| 580.000 | 3.705 | 0.26991 | 0.4316 | 46.760 | 44788.8 | 49377.3 | 228.326 | 80.24 | 97.07 | 434 |
| 600.000 | 3.531 | 0.28320 | 0.4041 | 49.339 | 46515.0 | 51329.4 | 231.635 | 82.24 | 98.16 | 443 |

Table 27. Thermophysical properties along isobars (Continued)

ETHANE ISOBAR AT P = 180.0 BAR

| T DEG K | DEN MOL/L | VOL L/MOL | DP/DT BAR/K | DP/DD BAR-L/MOL | E J/MOL | H J/MOL | S J/MOL/K | CV J/MOL/K | CP J/MOL/K | W M/SEC |
|---|---|---|---|---|---|---|---|---|---|---|
| 92.668 | 21.766 | 0.04594 | 34.0718 | 991.789 | 5366.5 | 6193.5 | 77.222 | 45.41 | 68.31 | 2227 |
| 100.000 | 21.516 | 0.04648 | 31.3533 | 922.531 | 5857.7 | 6694.3 | 82.423 | 45.29 | 68.31 | 2151 |
| 110.000 | 21.178 | 0.04722 | 28.1809 | 836.323 | 6527.5 | 7377.5 | 88.935 | 45.06 | 68.35 | 2054 |
| 120.000 | 20.841 | 0.04798 | 25.4826 | 758.363 | 7197.8 | 8061.4 | 94.886 | 44.80 | 68.45 | 1963 |
| 130.000 | 20.505 | 0.04877 | 23.1476 | 687.590 | 7868.9 | 8746.7 | 100.371 | 44.53 | 68.62 | 1877 |
| 140.000 | 20.168 | 0.04958 | 21.0981 | 623.168 | 8541.6 | 9434.1 | 105.465 | 44.28 | 68.87 | 1795 |
| 150.000 | 19.828 | 0.05043 | 19.2777 | 564.424 | 9216.5 | 10124.4 | 110.227 | 44.08 | 69.20 | 1717 |
| 160.000 | 19.484 | 0.05132 | 17.6450 | 510.783 | 9894.6 | 10818.4 | 114.706 | 43.93 | 69.62 | 1641 |
| 170.000 | 19.136 | 0.05226 | 16.1687 | 461.743 | 10576.5 | 11517.1 | 118.941 | 43.86 | 70.14 | 1567 |
| 180.000 | 18.784 | 0.05324 | 14.8248 | 416.860 | 11263.3 | 12221.6 | 122.968 | 43.87 | 70.76 | 1495 |
| 190.000 | 18.425 | 0.05427 | 13.5947 | 375.737 | 11955.8 | 12932.8 | 126.813 | 43.97 | 71.50 | 1425 |
| 200.000 | 18.060 | 0.05537 | 12.4638 | 338.016 | 12655.1 | 13651.8 | 130.501 | 44.16 | 72.34 | 1357 |
| 210.000 | 17.687 | 0.05654 | 11.4201 | 303.378 | 13362.3 | 14379.9 | 134.053 | 44.44 | 73.30 | 1290 |
| 220.000 | 17.307 | 0.05778 | 10.4541 | 271.540 | 14078.2 | 15118.3 | 137.488 | 44.82 | 74.38 | 1224 |
| 230.000 | 16.917 | 0.05911 | 9.5577 | 242.253 | 14804.0 | 15868.0 | 140.820 | 45.29 | 75.59 | 1160 |
| 240.000 | 16.517 | 0.06054 | 8.7243 | 215.300 | 15540.8 | 16630.5 | 144.065 | 45.83 | 76.93 | 1096 |
| 250.000 | 16.106 | 0.06209 | 7.9481 | 190.501 | 16289.5 | 17407.1 | 147.235 | 46.44 | 78.40 | 1034 |
| 260.000 | 15.682 | 0.06377 | 7.2243 | 167.706 | 17051.1 | 18198.9 | 150.341 | 47.10 | 80.01 | 973 |
| 270.000 | 15.244 | 0.06560 | 6.5488 | 146.797 | 17826.8 | 19007.6 | 153.392 | 47.81 | 81.76 | 914 |
| 280.000 | 14.789 | 0.06762 | 5.9178 | 127.686 | 18617.5 | 19834.6 | 156.400 | 48.55 | 83.67 | 855 |
| 290.000 | 14.316 | 0.06985 | 5.3287 | 110.314 | 19424.2 | 20681.5 | 159.371 | 49.32 | 85.74 | 799 |
| 300.000 | 13.822 | 0.07235 | 4.7792 | 94.648 | 20247.9 | 21550.2 | 162.316 | 50.13 | 88.02 | 743 |
| 310.000 | 13.306 | 0.07516 | 4.2679 | 80.680 | 21090.0 | 22442.8 | 165.243 | 51.03 | 90.56 | 690 |
| 320.000 | 12.764 | 0.07835 | 3.7940 | 68.419 | 21952.5 | 23362.7 | 168.163 | 52.17 | 93.49 | 639 |
| 330.000 | 12.196 | 0.08199 | 3.3579 | 57.877 | 22838.7 | 24314.5 | 171.092 | 53.76 | 96.97 | 589 |
| 340.000 | 11.604 | 0.08617 | 2.9604 | 49.061 | 23752.1 | 25303.2 | 174.043 | 56.65 | 101.75 | 541 |
| 350.000 | 10.992 | 0.09098 | 2.6026 | 41.951 | 24694.8 | 26332.4 | 177.026 | 57.28 | 104.05 | 503 |
| 360.000 | 10.367 | 0.09646 | 2.2854 | 36.485 | 25647.0 | 27383.3 | 179.986 | 58.08 | 106.04 | 471 |
| 370.000 | 9.744 | 0.10263 | 2.0090 | 32.545 | 26603.4 | 28450.7 | 182.911 | 58.99 | 107.32 | 444 |
| 380.000 | 9.138 | 0.10943 | 1.7719 | 29.956 | 27556.6 | 29526.3 | 185.780 | 59.95 | 107.64 | 423 |
| 390.000 | 8.566 | 0.11674 | 1.5715 | 28.490 | 28498.8 | 30600.2 | 188.569 | 60.92 | 107.00 | 408 |
| 400.000 | 8.038 | 0.12441 | 1.4038 | 27.893 | 29424.5 | 31663.9 | 191.262 | 61.91 | 105.65 | 398 |
| 410.000 | 7.560 | 0.13227 | 1.2639 | 27.939 | 30331.0 | 32711.9 | 193.850 | 62.90 | 103.92 | 392 |
| 420.000 | 7.132 | 0.14020 | 1.1472 | 28.445 | 31218.2 | 33741.9 | 196.332 | 63.90 | 102.09 | 389 |
| 430.000 | 6.752 | 0.14811 | 1.0492 | 29.185 | 32088.5 | 34754.5 | 198.715 | 64.90 | 100.48 | 388 |
| 440.000 | 6.411 | 0.15597 | 0.9660 | 30.023 | 32944.9 | 35752.4 | 201.010 | 65.91 | 99.18 | 388 |
| 450.000 | 6.106 | 0.16376 | 0.8947 | 30.957 | 33791.1 | 36738.8 | 203.226 | 66.92 | 98.13 | 389 |
| 460.000 | 5.832 | 0.17146 | 0.8332 | 32.017 | 34629.2 | 37715.6 | 205.373 | 67.95 | 97.27 | 390 |
| 470.000 | 5.585 | 0.17906 | 0.7797 | 33.162 | 35461.8 | 38684.9 | 207.458 | 68.98 | 96.60 | 393 |
| 480.000 | 5.361 | 0.18654 | 0.7328 | 34.361 | 36290.6 | 39648.3 | 209.486 | 70.01 | 96.12 | 396 |
| 490.000 | 5.157 | 0.19390 | 0.6915 | 35.601 | 37117.5 | 40607.8 | 211.465 | 71.05 | 95.80 | 400 |
| 500.000 | 4.972 | 0.20115 | 0.6548 | 36.871 | 37944.1 | 41564.7 | 213.398 | 72.09 | 95.62 | 403 |
| 520.000 | 4.645 | 0.21529 | 0.5927 | 39.470 | 39600.9 | 43476.1 | 217.147 | 74.17 | 95.62 | 411 |
| 540.000 | 4.367 | 0.22900 | 0.5421 | 42.105 | 41269.8 | 45391.8 | 220.761 | 76.23 | 95.99 | 420 |
| 560.000 | 4.127 | 0.24231 | 0.5002 | 44.738 | 42956.2 | 47317.8 | 224.264 | 78.28 | 96.66 | 429 |
| 580.000 | 3.917 | 0.25527 | 0.4648 | 47.345 | 44664.6 | 49259.4 | 227.670 | 80.30 | 97.54 | 437 |
| 600.000 | 3.733 | 0.26791 | 0.4346 | 49.912 | 46398.1 | 51220.5 | 230.994 | 82.29 | 98.59 | 446 |

Table 27. Thermophysical properties along isobars (Continued)

ETHANE ISOBAR AT P = 190.0 BAR

| T DEG K | DEN MOL/L | VOL L/MOL | DP/DT BAR/K | DP/DD BAR-L/MOL | E J/MOL | H J/MOL | S J/MOL/K | CV J/MOL/K | CP J/MOL/K | W M/SEC |
|---|---|---|---|---|---|---|---|---|---|---|
| 92.819 | 21.771 | 0.04593 | 34.0231 | 993.518 | 5370.3 | 6243.0 | 77.261 | 45.48 | 68.30 | 2227 |
| 100.000 | 21.527 | 0.04645 | 31.3697 | 925.906 | 5850.8 | 6733.4 | 82.350 | 45.36 | 68.29 | 2153 |
| 110.000 | 21.190 | 0.04719 | 28.2033 | 839.888 | 6519.8 | 7416.4 | 88.860 | 45.13 | 68.33 | 2057 |
| 120.000 | 20.854 | 0.04795 | 25.5101 | 762.091 | 7189.1 | 8100.1 | 94.808 | 44.86 | 68.42 | 1966 |
| 130.000 | 20.520 | 0.04873 | 23.1798 | 691.457 | 7859.2 | 8785.1 | 100.291 | 44.59 | 68.58 | 1881 |
| 140.000 | 20.184 | 0.04955 | 21.1345 | 627.155 | 8530.7 | 9472.1 | 105.382 | 44.35 | 68.82 | 1799 |
| 150.000 | 19.845 | 0.05039 | 19.3182 | 568.517 | 9204.4 | 10161.8 | 110.140 | 44.14 | 69.14 | 1721 |
| 160.000 | 19.504 | 0.05127 | 17.6894 | 514.970 | 9881.0 | 10855.2 | 114.615 | 43.99 | 69.55 | 1645 |
| 170.000 | 19.158 | 0.05220 | 16.2169 | 466.017 | 10561.4 | 11553.2 | 118.846 | 43.92 | 70.06 | 1572 |
| 180.000 | 18.807 | 0.05317 | 14.8767 | 421.214 | 11246.5 | 12256.7 | 122.867 | 43.93 | 70.67 | 1501 |
| 190.000 | 18.451 | 0.05420 | 13.6504 | 380.168 | 11937.1 | 12966.8 | 126.707 | 44.03 | 71.38 | 1432 |
| 200.000 | 18.089 | 0.05528 | 12.5231 | 342.522 | 12634.3 | 13684.7 | 130.389 | 44.22 | 72.21 | 1364 |
| 210.000 | 17.720 | 0.05643 | 11.4832 | 307.960 | 13339.1 | 14411.3 | 133.934 | 44.51 | 73.14 | 1297 |
| 220.000 | 17.343 | 0.05766 | 10.5211 | 276.197 | 14052.4 | 15147.9 | 137.360 | 44.88 | 74.20 | 1232 |
| 230.000 | 16.958 | 0.05897 | 9.6287 | 246.987 | 14775.2 | 15895.6 | 140.684 | 45.35 | 75.37 | 1168 |
| 240.000 | 16.563 | 0.06038 | 8.7994 | 220.113 | 15508.5 | 16655.7 | 143.918 | 45.89 | 76.66 | 1106 |
| 250.000 | 16.158 | 0.06189 | 8.0276 | 195.391 | 16253.4 | 17429.3 | 147.076 | 46.49 | 78.08 | 1045 |
| 260.000 | 15.741 | 0.06353 | 7.3083 | 172.673 | 17010.6 | 18217.6 | 150.168 | 47.16 | 79.62 | 985 |
| 270.000 | 15.311 | 0.06531 | 6.6375 | 151.836 | 17781.1 | 19022.0 | 153.203 | 47.86 | 81.28 | 926 |
| 280.000 | 14.866 | 0.06727 | 6.0117 | 132.788 | 18565.7 | 19843.7 | 156.191 | 48.60 | 83.08 | 869 |
| 290.000 | 14.405 | 0.06942 | 5.4281 | 115.465 | 19365.1 | 20684.1 | 159.140 | 49.36 | 85.02 | 813 |
| 300.000 | 13.925 | 0.07181 | 4.8842 | 99.826 | 20180.3 | 21544.8 | 162.058 | 50.16 | 87.13 | 759 |
| 310.000 | 13.426 | 0.07448 | 4.3787 | 85.852 | 21012.3 | 22427.5 | 164.952 | 51.05 | 89.46 | 707 |
| 320.000 | 12.905 | 0.07749 | 3.9106 | 73.537 | 21862.8 | 23335.1 | 167.833 | 52.17 | 92.14 | 657 |
| 330.000 | 12.362 | 0.08089 | 3.4797 | 62.881 | 22735.0 | 24272.0 | 170.716 | 53.75 | 95.33 | 609 |
| 340.000 | 11.799 | 0.08475 | 3.0865 | 53.877 | 23632.5 | 25242.8 | 173.614 | 56.62 | 99.81 | 562 |
| 350.000 | 11.218 | 0.08914 | 2.7313 | 46.496 | 24557.4 | 26251.1 | 176.537 | 57.24 | 101.86 | 525 |
| 360.000 | 10.627 | 0.09410 | 2.4146 | 40.679 | 25491.4 | 27279.3 | 179.433 | 58.03 | 103.72 | 492 |
| 370.000 | 10.035 | 0.09965 | 2.1362 | 36.323 | 26430.5 | 28323.9 | 182.295 | 58.93 | 105.09 | 464 |
| 380.000 | 9.455 | 0.10576 | 1.8947 | 33.282 | 27369.2 | 29378.7 | 185.108 | 59.89 | 105.74 | 442 |
| 390.000 | 8.900 | 0.11236 | 1.6879 | 31.366 | 28301.3 | 30436.0 | 187.854 | 60.88 | 105.60 | 425 |
| 400.000 | 8.382 | 0.11931 | 1.5125 | 30.359 | 29221.5 | 31488.4 | 190.519 | 61.88 | 104.79 | 413 |
| 410.000 | 7.905 | 0.12650 | 1.3645 | 30.049 | 30126.8 | 32530.2 | 193.092 | 62.89 | 103.54 | 406 |
| 420.000 | 7.473 | 0.13381 | 1.2397 | 30.256 | 31016.1 | 33558.5 | 195.570 | 63.90 | 102.10 | 401 |
| 430.000 | 7.085 | 0.14114 | 1.1343 | 30.834 | 31890.4 | 34572.2 | 197.955 | 64.92 | 100.66 | 399 |
| 440.000 | 6.736 | 0.14845 | 1.0445 | 31.593 | 32751.8 | 35572.4 | 200.254 | 65.94 | 99.43 | 398 |
| 450.000 | 6.422 | 0.15571 | 0.9675 | 32.433 | 33602.9 | 36561.5 | 202.477 | 66.97 | 98.45 | 398 |
| 460.000 | 6.138 | 0.16291 | 0.9007 | 33.354 | 34446.7 | 37542.1 | 204.633 | 68.00 | 97.69 | 399 |
| 470.000 | 5.881 | 0.17004 | 0.8425 | 34.385 | 35285.0 | 38515.8 | 206.727 | 69.03 | 97.09 | 401 |
| 480.000 | 5.647 | 0.17708 | 0.7914 | 35.496 | 36119.7 | 39484.2 | 208.766 | 70.07 | 96.63 | 403 |
| 490.000 | 5.434 | 0.18402 | 0.7464 | 36.659 | 36952.4 | 40448.8 | 210.755 | 71.11 | 96.33 | 406 |
| 500.000 | 5.239 | 0.19087 | 0.7063 | 37.860 | 37784.6 | 41411.1 | 212.699 | 72.15 | 96.15 | 410 |
| 520.000 | 4.896 | 0.20427 | 0.6384 | 40.341 | 39452.3 | 43333.4 | 216.469 | 74.23 | 96.15 | 417 |
| 540.000 | 4.602 | 0.21729 | 0.5831 | 42.887 | 41130.7 | 45259.2 | 220.103 | 76.29 | 96.50 | 425 |
| 560.000 | 4.349 | 0.22995 | 0.5373 | 45.457 | 42826.1 | 47195.2 | 223.623 | 78.33 | 97.13 | 433 |
| 580.000 | 4.127 | 0.24229 | 0.4987 | 48.023 | 44542.4 | 49146.0 | 227.046 | 80.35 | 97.98 | 441 |
| 600.000 | 3.932 | 0.25435 | 0.4657 | 50.566 | 46282.9 | 51115.4 | 230.384 | 82.34 | 98.99 | 450 |

Table 27. Thermophysical properties along isobars (Continued)

ETHANE ISOBAR AT P = 200.0 BAR

| T DEG K | DEN MOL/L | VOL L/MOL | DP/DT BAR/K | DP/DD BAR-L/MOL | E J/MOL | H J/MOL | S J/MOL/K | CV J/MOL/K | CP J/MOL/K | W M/SEC |
|---|---|---|---|---|---|---|---|---|---|---|
| 92.971 | 21.776 | 0.04592 | 33.9750 | 995.256 | 5374.1 | 6292.6 | 77.300 | 45.55 | 68.29 | 2228 |
| 100.000 | 21.537 | 0.04643 | 31.3862 | 929.277 | 5843.9 | 6772.5 | 82.277 | 45.42 | 68.28 | 2155 |
| 110.000 | 21.201 | 0.04717 | 28.2257 | 843.450 | 6512.1 | 7455.4 | 88.785 | 45.19 | 68.31 | 2059 |
| 120.000 | 20.868 | 0.04792 | 25.5376 | 765.814 | 7180.4 | 8138.9 | 94.732 | 44.92 | 68.39 | 1969 |
| 130.000 | 20.534 | 0.04870 | 23.2119 | 695.317 | 7849.5 | 8823.5 | 100.212 | 44.66 | 68.55 | 1884 |
| 140.000 | 20.199 | 0.04951 | 21.1708 | 631.134 | 8519.9 | 9510.0 | 105.299 | 44.41 | 68.78 | 1803 |
| 150.000 | 19.863 | 0.05035 | 19.3585 | 572.600 | 9192.4 | 10199.3 | 110.054 | 44.20 | 69.09 | 1725 |
| 160.000 | 19.523 | 0.05122 | 17.7335 | 519.145 | 9867.6 | 10892.0 | 114.525 | 44.06 | 69.48 | 1650 |
| 170.000 | 19.179 | 0.05214 | 16.2647 | 470.275 | 10546.5 | 11589.3 | 118.752 | 43.98 | 69.98 | 1577 |
| 180.000 | 18.831 | 0.05310 | 14.9282 | 425.551 | 11229.9 | 12291.9 | 122.768 | 43.99 | 70.57 | 1507 |
| 190.000 | 18.478 | 0.05412 | 13.7055 | 384.579 | 11918.7 | 13001.1 | 126.602 | 44.09 | 71.27 | 1438 |
| 200.000 | 18.118 | 0.05519 | 12.5819 | 347.006 | 12613.8 | 13717.7 | 130.277 | 44.28 | 72.07 | 1371 |
| 210.000 | 17.752 | 0.05633 | 11.5457 | 312.515 | 13316.3 | 14442.9 | 133.816 | 44.57 | 72.99 | 1305 |
| 220.000 | 17.379 | 0.05754 | 10.5872 | 280.824 | 14027.0 | 15177.9 | 137.234 | 44.94 | 74.02 | 1240 |
| 230.000 | 16.998 | 0.05883 | 9.6986 | 251.686 | 14747.0 | 15923.6 | 140.549 | 45.40 | 75.15 | 1177 |
| 240.000 | 16.608 | 0.06021 | 8.8733 | 224.885 | 15477.1 | 16681.3 | 143.774 | 45.94 | 76.41 | 1115 |
| 250.000 | 16.208 | 0.06170 | 8.1055 | 200.235 | 16218.2 | 17452.1 | 146.920 | 46.55 | 77.77 | 1055 |
| 260.000 | 15.798 | 0.06330 | 7.3905 | 177.587 | 16971.2 | 18237.2 | 149.999 | 47.21 | 79.25 | 996 |
| 270.000 | 15.376 | 0.06504 | 6.7242 | 156.816 | 17736.8 | 19037.5 | 153.019 | 47.91 | 80.84 | 938 |
| 280.000 | 14.940 | 0.06693 | 6.1031 | 137.825 | 18515.7 | 19854.4 | 155.990 | 48.64 | 82.55 | 882 |
| 290.000 | 14.490 | 0.06902 | 5.5243 | 120.545 | 19308.6 | 20688.9 | 158.918 | 49.40 | 84.37 | 827 |
| 300.000 | 14.023 | 0.07131 | 4.9856 | 104.928 | 20116.0 | 21542.3 | 161.811 | 50.19 | 86.33 | 775 |
| 310.000 | 13.539 | 0.07386 | 4.4852 | 90.945 | 20938.9 | 22416.2 | 164.676 | 51.08 | 88.49 | 724 |
| 320.000 | 13.036 | 0.07671 | 4.0221 | 78.579 | 21778.8 | 23313.0 | 167.523 | 52.19 | 90.95 | 675 |
| 330.000 | 12.515 | 0.07990 | 3.5958 | 67.821 | 22638.8 | 24236.9 | 170.366 | 53.75 | 93.91 | 628 |
| 340.000 | 11.977 | 0.08350 | 3.2062 | 58.650 | 23522.4 | 25192.3 | 173.218 | 56.61 | 98.15 | 582 |
| 350.000 | 11.423 | 0.08754 | 2.8534 | 51.035 | 24432.2 | 26183.0 | 176.090 | 57.21 | 100.00 | 545 |
| 360.000 | 10.861 | 0.09208 | 2.5373 | 44.913 | 25350.3 | 27191.9 | 178.932 | 57.98 | 101.73 | 512 |
| 370.000 | 10.296 | 0.09712 | 2.2575 | 40.193 | 26274.1 | 28216.5 | 181.739 | 58.88 | 103.13 | 484 |
| 380.000 | 9.741 | 0.10266 | 2.0126 | 36.750 | 27199.4 | 29252.6 | 184.502 | 59.84 | 103.98 | 461 |
| 390.000 | 9.205 | 0.10864 | 1.8006 | 34.423 | 28121.1 | 30293.9 | 187.207 | 60.83 | 104.19 | 443 |
| 400.000 | 8.697 | 0.11498 | 1.6188 | 33.026 | 29034.8 | 31334.3 | 189.841 | 61.85 | 103.81 | 429 |
| 410.000 | 8.226 | 0.12157 | 1.4637 | 32.369 | 29937.1 | 32368.4 | 192.395 | 62.87 | 102.98 | 420 |
| 420.000 | 7.794 | 0.12831 | 1.3317 | 32.274 | 30826.8 | 33393.0 | 194.864 | 63.90 | 101.89 | 414 |
| 430.000 | 7.400 | 0.13513 | 1.2193 | 32.604 | 31703.5 | 34406.0 | 197.248 | 64.93 | 100.73 | 410 |
| 440.000 | 7.045 | 0.14195 | 1.1232 | 33.236 | 32568.6 | 35407.6 | 199.550 | 65.96 | 99.61 | 409 |
| 450.000 | 6.723 | 0.14874 | 1.0404 | 34.008 | 33424.1 | 36398.9 | 201.778 | 67.00 | 98.69 | 408 |
| 460.000 | 6.432 | 0.15548 | 0.9687 | 34.851 | 34272.3 | 37381.9 | 203.939 | 68.04 | 97.98 | 409 |
| 470.000 | 6.166 | 0.16217 | 0.9059 | 35.762 | 35115.5 | 38359.0 | 206.040 | 69.08 | 97.44 | 410 |
| 480.000 | 5.924 | 0.16880 | 0.8507 | 36.768 | 35955.2 | 39331.2 | 208.087 | 70.12 | 97.04 | 411 |
| 490.000 | 5.703 | 0.17536 | 0.8019 | 37.849 | 36793.0 | 40300.1 | 210.085 | 71.16 | 96.76 | 414 |
| 500.000 | 5.500 | 0.18183 | 0.7585 | 38.980 | 37630.2 | 41266.8 | 212.038 | 72.20 | 96.60 | 416 |
| 520.000 | 5.141 | 0.19453 | 0.6848 | 41.342 | 39307.5 | 43198.2 | 215.825 | 74.28 | 96.60 | 423 |
| 540.000 | 4.833 | 0.20691 | 0.6248 | 43.790 | 40994.9 | 45133.1 | 219.477 | 76.34 | 96.95 | 430 |
| 560.000 | 4.567 | 0.21897 | 0.5750 | 46.286 | 42698.5 | 47077.9 | 223.013 | 78.38 | 97.57 | 438 |
| 580.000 | 4.334 | 0.23074 | 0.5331 | 48.798 | 44422.2 | 49037.1 | 226.451 | 80.40 | 98.39 | 446 |
| 600.000 | 4.128 | 0.24225 | 0.4974 | 51.304 | 46169.4 | 51014.3 | 229.802 | 82.39 | 99.37 | 454 |

Table 27. Thermophysical properties along isobars (Continued)

ETHANE ISOBAR AT P = 220.0 BAR

| T DEG K | DEN MOL/L | VOL L/MOL | DP/DT BAR/K | DP/DD BAR-L/MOL | E J/MOL | H J/MOL | S J/MOL/K | CV J/MOL/K | CP J/MOL/K | W M/SEC |
|---|---|---|---|---|---|---|---|---|---|---|
| 93.272 | 21.786 | 0.04590 | 33.8810 | 998.762 | 5381.8 | 6391.6 | 77.378 | 45.68 | 68.27 | 2228 |
| 100.000 | 21.559 | 0.04638 | 31.4197 | 936.011 | 5830.4 | 6850.9 | 82.132 | 45.56 | 68.25 | 2159 |
| 110.000 | 21.225 | 0.04711 | 28.2707 | 850.559 | 6496.9 | 7533.4 | 88.637 | 45.32 | 68.27 | 2064 |
| 120.000 | 20.894 | 0.04786 | 25.5927 | 773.241 | 7163.4 | 8216.4 | 94.579 | 45.05 | 68.34 | 1975 |
| 130.000 | 20.563 | 0.04863 | 23.2759 | 703.014 | 7830.5 | 8900.4 | 100.054 | 44.78 | 68.47 | 1891 |
| 140.000 | 20.231 | 0.04943 | 21.2431 | 639.069 | 8498.6 | 9586.1 | 105.136 | 44.53 | 68.69 | 1811 |
| 150.000 | 19.897 | 0.05026 | 19.4385 | 580.733 | 9168.7 | 10274.3 | 109.884 | 44.33 | 68.98 | 1734 |
| 160.000 | 19.561 | 0.05112 | 17.8210 | 527.458 | 9841.2 | 10965.9 | 114.347 | 44.18 | 69.35 | 1659 |
| 170.000 | 19.221 | 0.05203 | 16.3594 | 478.750 | 10517.2 | 11661.7 | 118.565 | 44.10 | 69.82 | 1588 |
| 180.000 | 18.878 | 0.05297 | 15.0300 | 434.175 | 11197.3 | 12362.7 | 122.572 | 44.11 | 70.39 | 1518 |
| 190.000 | 18.529 | 0.05397 | 13.8143 | 393.344 | 11882.6 | 13069.9 | 126.395 | 44.21 | 71.06 | 1450 |
| 200.000 | 18.175 | 0.05502 | 12.6976 | 355.906 | 12573.8 | 13784.2 | 130.059 | 44.40 | 71.83 | 1384 |
| 210.000 | 17.815 | 0.05613 | 11.6684 | 321.549 | 13271.9 | 14506.8 | 133.584 | 44.68 | 72.70 | 1319 |
| 220.000 | 17.449 | 0.05731 | 10.7170 | 289.991 | 13977.7 | 15238.6 | 136.988 | 45.06 | 73.68 | 1256 |
| 230.000 | 17.076 | 0.05856 | 9.8355 | 260.985 | 14692.2 | 15980.6 | 140.287 | 45.52 | 74.75 | 1194 |
| 240.000 | 16.695 | 0.05990 | 9.0175 | 234.316 | 15416.2 | 16734.0 | 143.493 | 46.05 | 75.94 | 1134 |
| 250.000 | 16.306 | 0.06133 | 8.2572 | 209.797 | 16150.4 | 17499.6 | 146.618 | 46.66 | 77.21 | 1075 |
| 260.000 | 15.908 | 0.06286 | 7.5500 | 187.272 | 16895.6 | 18278.6 | 149.673 | 47.31 | 78.59 | 1017 |
| 270.000 | 15.499 | 0.06452 | 6.8917 | 166.613 | 17652.3 | 19071.7 | 152.666 | 48.01 | 80.05 | 961 |
| 280.000 | 15.080 | 0.06631 | 6.2789 | 147.719 | 18420.9 | 19879.8 | 155.605 | 48.73 | 81.59 | 907 |
| 290.000 | 14.649 | 0.06826 | 5.7087 | 130.508 | 19202.0 | 20703.8 | 158.496 | 49.48 | 83.23 | 854 |
| 300.000 | 14.205 | 0.07040 | 5.1786 | 114.923 | 19995.9 | 21544.7 | 161.347 | 50.26 | 84.96 | 804 |
| 310.000 | 13.747 | 0.07274 | 4.6869 | 100.917 | 20803.1 | 22403.4 | 164.162 | 51.13 | 86.83 | 755 |
| 320.000 | 13.276 | 0.07532 | 4.2321 | 88.460 | 21625.1 | 23282.2 | 166.952 | 52.22 | 88.98 | 708 |
| 330.000 | 12.791 | 0.07818 | 3.8132 | 77.522 | 22464.6 | 24184.6 | 169.729 | 53.75 | 91.59 | 663 |
| 340.000 | 12.293 | 0.08135 | 3.4296 | 68.070 | 23325.3 | 25115.0 | 172.506 | 56.59 | 95.47 | 618 |
| 350.000 | 11.784 | 0.08486 | 3.0807 | 60.061 | 24210.3 | 26077.3 | 175.295 | 57.16 | 96.99 | 582 |
| 360.000 | 11.268 | 0.08874 | 2.7660 | 53.435 | 25102.5 | 27054.8 | 178.049 | 57.92 | 98.51 | 550 |
| 370.000 | 10.751 | 0.09302 | 2.4844 | 48.111 | 26000.6 | 28047.0 | 180.767 | 58.80 | 99.87 | 521 |
| 380.000 | 10.238 | 0.09768 | 2.2347 | 43.989 | 26902.3 | 29051.1 | 183.445 | 59.75 | 100.91 | 497 |
| 390.000 | 9.737 | 0.10270 | 2.0150 | 40.946 | 27804.4 | 30063.8 | 186.076 | 60.76 | 101.54 | 477 |
| 400.000 | 9.256 | 0.10804 | 1.8232 | 38.842 | 28703.7 | 31080.5 | 188.650 | 61.78 | 101.74 | 461 |
| 410.000 | 8.800 | 0.11363 | 1.6567 | 37.526 | 29597.2 | 32097.2 | 191.160 | 62.83 | 101.55 | 449 |
| 420.000 | 8.374 | 0.11942 | 1.5126 | 36.846 | 30483.3 | 33110.5 | 193.602 | 63.88 | 101.06 | 440 |
| 430.000 | 7.980 | 0.12532 | 1.3880 | 36.664 | 31360.9 | 34118.0 | 195.973 | 64.93 | 100.41 | 434 |
| 440.000 | 7.617 | 0.13129 | 1.2802 | 36.866 | 32230.0 | 35118.4 | 198.273 | 65.98 | 99.70 | 430 |
| 450.000 | 7.284 | 0.13728 | 1.1866 | 37.366 | 33091.7 | 36111.8 | 200.505 | 67.03 | 98.99 | 428 |
| 460.000 | 6.981 | 0.14325 | 1.1051 | 38.068 | 33947.0 | 37098.5 | 202.674 | 68.09 | 98.37 | 428 |
| 470.000 | 6.703 | 0.14919 | 1.0336 | 38.860 | 34797.5 | 38079.6 | 204.784 | 69.14 | 97.90 | 428 |
| 480.000 | 6.448 | 0.15509 | 0.9705 | 39.706 | 35644.9 | 39056.8 | 206.842 | 70.19 | 97.58 | 428 |
| 490.000 | 6.213 | 0.16095 | 0.9145 | 40.601 | 36490.7 | 40031.5 | 208.851 | 71.24 | 97.38 | 430 |
| 500.000 | 5.997 | 0.16675 | 0.8645 | 41.568 | 37336.3 | 41004.9 | 210.818 | 72.29 | 97.28 | 431 |
| 520.000 | 5.611 | 0.17821 | 0.7794 | 43.679 | 39029.8 | 42950.4 | 214.633 | 74.37 | 97.34 | 436 |
| 540.000 | 5.279 | 0.18942 | 0.7099 | 45.927 | 40733.0 | 44900.3 | 218.313 | 76.44 | 97.70 | 442 |
| 560.000 | 4.990 | 0.20039 | 0.6522 | 48.255 | 42451.3 | 46859.9 | 221.876 | 78.48 | 98.30 | 448 |
| 580.000 | 4.736 | 0.21113 | 0.6036 | 50.633 | 44188.5 | 48833.4 | 225.339 | 80.49 | 99.09 | 455 |
| 600.000 | 4.512 | 0.22165 | 0.5621 | 53.037 | 45948.2 | 50824.5 | 228.714 | 82.48 | 100.04 | 463 |

Table 27. Thermophysical properties along isobars (Continued)

ETHANE ISOBAR AT P = 240.0 BAR

| T<br>DEG K | DEN<br>MOL/L | VOL<br>L/MOL | DP/DT<br>BAR/K | DP/DD<br>BAR-L/MOL | E<br>J/MOL | H<br>J/MOL | S<br>J/MOL/K | CV<br>J/MOL/K | CP<br>J/MOL/K | W<br>M/SEC |
|---|---|---|---|---|---|---|---|---|---|---|
| 93.573 | 21.796 | 0.04588 | 33.7895 | 1002.307 | 5389.5 | 6490.6 | 77.455 | 45.81 | 68.25 | 2228 |
| 100.000 | 21.580 | 0.04634 | 31.4536 | 942.734 | 5817.1 | 6929.2 | 81.988 | 45.69 | 68.23 | 2164 |
| 110.000 | 21.248 | 0.04706 | 28.3159 | 857.652 | 6481.9 | 7611.4 | 88.490 | 45.45 | 68.23 | 2069 |
| 120.000 | 20.919 | 0.04780 | 25.6477 | 780.646 | 7146.6 | 8293.9 | 94.428 | 45.18 | 68.28 | 1981 |
| 130.000 | 20.591 | 0.04857 | 23.3397 | 710.684 | 7811.7 | 8977.3 | 99.898 | 44.90 | 68.41 | 1897 |
| 140.000 | 20.262 | 0.04935 | 21.3149 | 646.965 | 8477.8 | 9662.3 | 104.974 | 44.65 | 68.60 | 1818 |
| 150.000 | 19.932 | 0.05017 | 19.5179 | 588.826 | 9145.5 | 10349.6 | 109.716 | 44.45 | 68.87 | 1742 |
| 160.000 | 19.599 | 0.05102 | 17.9075 | 535.723 | 9815.5 | 11040.0 | 114.172 | 44.30 | 69.23 | 1669 |
| 170.000 | 19.263 | 0.05191 | 16.4528 | 487.169 | 10488.6 | 11734.5 | 118.382 | 44.22 | 69.68 | 1598 |
| 180.000 | 18.923 | 0.05285 | 15.1302 | 442.735 | 11165.6 | 12433.9 | 122.379 | 44.23 | 70.22 | 1529 |
| 190.000 | 18.579 | 0.05382 | 13.9211 | 402.035 | 11847.4 | 13139.2 | 126.193 | 44.32 | 70.86 | 1462 |
| 200.000 | 18.231 | 0.05485 | 12.8111 | 364.723 | 12534.9 | 13851.4 | 129.845 | 44.51 | 71.59 | 1397 |
| 210.000 | 17.877 | 0.05594 | 11.7884 | 330.487 | 13228.9 | 14571.4 | 133.358 | 44.80 | 72.43 | 1333 |
| 220.000 | 17.517 | 0.05709 | 10.8436 | 299.049 | 13930.2 | 15300.3 | 136.749 | 45.17 | 73.36 | 1271 |
| 230.000 | 17.151 | 0.05830 | 9.9687 | 270.161 | 14639.6 | 16038.9 | 140.032 | 45.63 | 74.39 | 1210 |
| 240.000 | 16.779 | 0.05960 | 9.1573 | 243.606 | 15357.9 | 16788.3 | 143.221 | 46.16 | 75.51 | 1151 |
| 250.000 | 16.399 | 0.06098 | 8.4038 | 219.199 | 16085.8 | 17549.3 | 146.328 | 46.76 | 76.71 | 1094 |
| 260.000 | 16.012 | 0.06245 | 7.7035 | 196.780 | 16823.9 | 18322.8 | 149.361 | 47.41 | 78.00 | 1038 |
| 270.000 | 15.616 | 0.06404 | 7.0522 | 176.216 | 17572.6 | 19109.5 | 152.330 | 48.10 | 79.35 | 983 |
| 280.000 | 15.211 | 0.06574 | 6.4465 | 157.398 | 18332.2 | 19910.0 | 155.241 | 48.82 | 80.77 | 931 |
| 290.000 | 14.797 | 0.06758 | 5.8835 | 140.239 | 19103.1 | 20725.1 | 158.101 | 49.56 | 82.25 | 880 |
| 300.000 | 14.372 | 0.06958 | 5.3606 | 124.671 | 19885.4 | 21555.3 | 160.916 | 50.33 | 83.80 | 831 |
| 310.000 | 13.937 | 0.07175 | 4.8759 | 110.639 | 20679.5 | 22401.6 | 163.690 | 51.18 | 85.48 | 784 |
| 320.000 | 13.491 | 0.07413 | 4.4276 | 98.098 | 21486.6 | 23265.7 | 166.433 | 52.26 | 87.39 | 739 |
| 330.000 | 13.034 | 0.07672 | 4.0146 | 87.006 | 22309.7 | 24151.0 | 169.158 | 53.78 | 89.76 | 695 |
| 340.000 | 12.568 | 0.07957 | 3.6356 | 77.322 | 23152.2 | 25061.8 | 171.876 | 56.59 | 93.39 | 651 |
| 350.000 | 12.094 | 0.08268 | 3.2898 | 68.994 | 24017.7 | 26002.1 | 174.602 | 57.15 | 94.68 | 617 |
| 360.000 | 11.616 | 0.08609 | 2.9762 | 61.964 | 24889.4 | 26955.6 | 177.288 | 57.88 | 96.03 | 585 |
| 370.000 | 11.135 | 0.08980 | 2.6936 | 56.157 | 25767.1 | 27922.4 | 179.937 | 58.75 | 97.30 | 556 |
| 380.000 | 10.658 | 0.09383 | 2.4406 | 51.485 | 26649.2 | 28901.0 | 182.547 | 59.69 | 98.40 | 531 |
| 390.000 | 10.189 | 0.09815 | 2.2156 | 47.849 | 27534.0 | 29889.5 | 185.114 | 60.69 | 99.23 | 510 |
| 400.000 | 9.734 | 0.10274 | 2.0166 | 45.136 | 28419.0 | 30884.7 | 187.634 | 61.73 | 99.77 | 493 |
| 410.000 | 9.297 | 0.10756 | 1.8414 | 43.225 | 29302.2 | 31883.7 | 190.101 | 62.78 | 99.99 | 478 |
| 420.000 | 8.883 | 0.11258 | 1.6877 | 41.991 | 30181.7 | 32883.5 | 192.510 | 63.84 | 99.95 | 468 |
| 430.000 | 8.494 | 0.11773 | 1.5531 | 41.312 | 31056.3 | 33882.0 | 194.859 | 64.91 | 99.71 | 459 |
| 440.000 | 8.131 | 0.12299 | 1.4353 | 41.076 | 31925.7 | 34877.4 | 197.148 | 65.98 | 99.36 | 454 |
| 450.000 | 7.795 | 0.12829 | 1.3321 | 41.190 | 32790.0 | 35869.0 | 199.376 | 67.05 | 98.96 | 450 |
| 460.000 | 7.484 | 0.13362 | 1.2415 | 41.579 | 33649.6 | 36856.5 | 201.547 | 68.12 | 98.56 | 447 |
| 470.000 | 7.197 | 0.13895 | 1.1616 | 42.185 | 34505.6 | 37840.3 | 203.663 | 69.18 | 98.20 | 446 |
| 480.000 | 6.932 | 0.14425 | 1.0909 | 42.928 | 35358.8 | 38820.8 | 205.727 | 70.24 | 97.93 | 446 |
| 490.000 | 6.688 | 0.14952 | 1.0280 | 43.734 | 36210.6 | 39799.2 | 207.744 | 71.30 | 97.77 | 447 |
| 500.000 | 6.462 | 0.15476 | 0.9717 | 44.582 | 37062.2 | 40776.5 | 209.719 | 72.35 | 97.72 | 447 |
| 520.000 | 6.056 | 0.16513 | 0.8756 | 46.404 | 38768.7 | 42731.8 | 213.553 | 74.44 | 97.87 | 450 |
| 540.000 | 5.704 | 0.17533 | 0.7967 | 48.435 | 40484.8 | 44692.7 | 217.254 | 76.51 | 98.27 | 455 |
| 560.000 | 5.395 | 0.18535 | 0.7310 | 50.592 | 42215.5 | 46663.9 | 220.838 | 78.56 | 98.88 | 460 |
| 580.000 | 5.123 | 0.19519 | 0.6757 | 52.823 | 43964.5 | 48649.0 | 224.321 | 80.57 | 99.67 | 466 |
| 600.000 | 4.882 | 0.20485 | 0.6285 | 55.104 | 45735.2 | 50651.5 | 227.715 | 82.56 | 100.60 | 473 |

Table 27. Thermophysical properties along isobars (Continued)

ETHANE ISOBAR AT P = 260.0 BAR

| T<br>DEG K | DEN<br>MOL/L | VOL<br>L/MOL | DP/DT<br>BAR/K | DP/DD<br>BAR-L/MOL | E<br>J/MOL | H<br>J/MOL | S<br>J/MOL/K | CV<br>J/MOL/K | CP<br>J/MOL/K | W<br>M/SEC |
|---|---|---|---|---|---|---|---|---|---|---|
| 93.872 | 21.806 | 0.04586 | 33.7006 | 1005.890 | 5397.2 | 6589.6 | 77.532 | 45.94 | 68.23 | 2229 |
| 100.000 | 21.601 | 0.04629 | 31.4880 | 949.446 | 5803.9 | 7007.5 | 81.845 | 45.82 | 68.20 | 2168 |
| 110.000 | 21.272 | 0.04701 | 28.3614 | 864.729 | 6467.2 | 7689.5 | 88.344 | 45.58 | 68.19 | 2074 |
| 120.000 | 20.945 | 0.04774 | 25.7028 | 788.029 | 7130.2 | 8371.5 | 94.279 | 45.30 | 68.23 | 1987 |
| 130.000 | 20.619 | 0.04850 | 23.4032 | 718.327 | 7793.4 | 9054.3 | 99.744 | 45.02 | 68.34 | 1904 |
| 140.000 | 20.293 | 0.04928 | 21.3863 | 654.829 | 8457.3 | 9738.6 | 104.815 | 44.77 | 68.52 | 1826 |
| 150.000 | 19.965 | 0.05009 | 19.5965 | 596.881 | 9122.7 | 10425.0 | 109.550 | 44.56 | 68.77 | 1750 |
| 160.000 | 19.636 | 0.05093 | 17.9931 | 543.943 | 9790.2 | 11114.3 | 113.999 | 44.41 | 69.11 | 1678 |
| 170.000 | 19.304 | 0.05180 | 16.5451 | 495.536 | 10460.6 | 11807.5 | 118.201 | 44.34 | 69.54 | 1608 |
| 180.000 | 18.968 | 0.05272 | 15.2290 | 451.234 | 11134.7 | 12505.4 | 122.190 | 44.34 | 70.06 | 1540 |
| 190.000 | 18.628 | 0.05368 | 14.0262 | 410.657 | 11813.2 | 13208.9 | 125.994 | 44.44 | 70.67 | 1474 |
| 200.000 | 18.285 | 0.05469 | 12.9224 | 373.461 | 12497.1 | 13919.1 | 129.636 | 44.63 | 71.37 | 1409 |
| 210.000 | 17.936 | 0.05575 | 11.9059 | 339.336 | 13187.2 | 14636.7 | 133.138 | 44.91 | 72.18 | 1347 |
| 220.000 | 17.583 | 0.05687 | 10.9672 | 308.005 | 13884.2 | 15362.9 | 136.515 | 45.28 | 73.07 | 1286 |
| 230.000 | 17.224 | 0.05806 | 10.0985 | 279.221 | 14588.9 | 16098.4 | 139.785 | 45.73 | 74.05 | 1226 |
| 240.000 | 16.859 | 0.05931 | 9.2932 | 252.767 | 15302.0 | 16844.1 | 142.958 | 46.27 | 75.11 | 1168 |
| 250.000 | 16.489 | 0.06065 | 8.5458 | 228.456 | 16024.1 | 17600.9 | 146.048 | 46.86 | 76.26 | 1112 |
| 260.000 | 16.111 | 0.06207 | 7.8516 | 206.126 | 16755.7 | 18369.5 | 149.062 | 47.51 | 77.47 | 1057 |
| 270.000 | 15.727 | 0.06359 | 7.2065 | 185.639 | 17497.2 | 19150.4 | 152.009 | 48.19 | 78.73 | 1004 |
| 280.000 | 15.335 | 0.06521 | 6.6070 | 166.883 | 18248.8 | 19944.3 | 154.896 | 48.90 | 80.05 | 953 |
| 290.000 | 14.935 | 0.06696 | 6.0501 | 149.763 | 19010.7 | 20751.6 | 157.729 | 49.63 | 81.41 | 904 |
| 300.000 | 14.527 | 0.06884 | 5.5332 | 134.204 | 19782.9 | 21572.7 | 160.512 | 50.39 | 82.83 | 856 |
| 310.000 | 14.110 | 0.07087 | 5.0542 | 120.142 | 20565.8 | 22408.5 | 163.253 | 51.24 | 84.35 | 811 |
| 320.000 | 13.685 | 0.07307 | 4.6113 | 107.523 | 21360.5 | 23260.4 | 165.957 | 52.30 | 86.09 | 767 |
| 330.000 | 13.253 | 0.07546 | 4.2028 | 96.296 | 22169.9 | 24131.8 | 168.638 | 53.80 | 88.27 | 725 |
| 340.000 | 12.813 | 0.07805 | 3.8275 | 86.414 | 22997.6 | 25026.8 | 171.310 | 56.61 | 91.72 | 692 |
| 350.000 | 12.367 | 0.08086 | 3.4841 | 77.821 | 23847.2 | 25949.5 | 173.985 | 57.14 | 92.84 | 648 |
| 360.000 | 11.918 | 0.08391 | 3.1715 | 70.456 | 24702.4 | 26883.9 | 176.617 | 57.87 | 94.05 | 617 |
| 370.000 | 11.468 | 0.08720 | 2.8882 | 64.250 | 25563.2 | 27830.4 | 179.210 | 58.72 | 95.24 | 589 |
| 380.000 | 11.020 | 0.09074 | 2.6329 | 59.124 | 26429.1 | 28788.4 | 181.765 | 59.65 | 96.34 | 564 |
| 390.000 | 10.579 | 0.09453 | 2.4039 | 54.991 | 27298.9 | 29756.7 | 184.280 | 60.65 | 97.27 | 542 |
| 400.000 | 10.147 | 0.09855 | 2.1994 | 51.757 | 28170.8 | 30733.1 | 186.752 | 61.68 | 97.99 | 523 |
| 410.000 | 9.730 | 0.10277 | 2.0175 | 49.321 | 29043.5 | 31715.6 | 189.178 | 62.74 | 98.48 | 507 |
| 420.000 | 9.330 | 0.10718 | 1.8562 | 47.579 | 29915.3 | 32701.9 | 191.555 | 63.81 | 98.75 | 495 |
| 430.000 | 8.950 | 0.11173 | 1.7134 | 46.426 | 30785.1 | 33689.9 | 193.880 | 64.89 | 98.83 | 485 |
| 440.000 | 8.592 | 0.11638 | 1.5872 | 45.762 | 31652.2 | 34678.1 | 196.151 | 65.97 | 98.78 | 477 |
| 450.000 | 8.257 | 0.12111 | 1.4757 | 45.495 | 32516.3 | 35665.2 | 198.370 | 67.05 | 98.64 | 472 |
| 460.000 | 7.944 | 0.12589 | 1.3769 | 45.547 | 33377.7 | 36650.8 | 200.536 | 68.13 | 98.47 | 468 |
| 470.000 | 7.652 | 0.13069 | 1.2893 | 45.854 | 34236.8 | 37634.6 | 202.652 | 69.20 | 98.30 | 465 |
| 480.000 | 7.381 | 0.13549 | 1.2113 | 46.367 | 35094.3 | 38616.9 | 204.720 | 70.27 | 98.16 | 464 |
| 490.000 | 7.129 | 0.14027 | 1.1418 | 47.042 | 35950.8 | 39597.9 | 206.743 | 71.34 | 98.06 | 464 |
| 500.000 | 6.895 | 0.14504 | 1.0794 | 47.810 | 36807.3 | 40578.2 | 208.723 | 72.40 | 98.03 | 464 |
| 520.000 | 6.473 | 0.15448 | 0.9726 | 49.473 | 38523.8 | 42540.2 | 212.571 | 74.50 | 98.23 | 466 |
| 540.000 | 6.105 | 0.16380 | 0.8846 | 51.266 | 40250.2 | 44509.0 | 216.286 | 76.58 | 98.69 | 469 |
| 560.000 | 5.781 | 0.17299 | 0.8111 | 53.231 | 41991.3 | 46489.0 | 219.886 | 78.62 | 99.34 | 473 |
| 580.000 | 5.493 | 0.18204 | 0.7491 | 55.314 | 43750.4 | 48483.4 | 223.386 | 80.64 | 100.14 | 478 |
| 600.000 | 5.237 | 0.19094 | 0.6961 | 57.467 | 45530.8 | 50495.2 | 226.796 | 82.62 | 101.07 | 484 |

Table 27. Thermophysical properties along isobars (Continued)

ETHANE ISOBAR AT P = 280.0 BAR

| T DEG K | DEN MOL/L | VOL L/MOL | DP/DT BAR/K | DP/DD BAR-L/MOL | E J/MOL | H J/MOL | S J/MOL/K | CV J/MOL/K | CP J/MOL/K | W M/SEC |
|---|---|---|---|---|---|---|---|---|---|---|
| 94.171 | 21.815 | 0.04584 | 33.6141 | 1009.512 | 5404.9 | 6688.4 | 77.608 | 46.07 | 68.22 | 2230 |
| 100.000 | 21.622 | 0.04625 | 31.5229 | 956.148 | 5791.0 | 7085.9 | 81.704 | 45.95 | 68.18 | 2172 |
| 110.000 | 21.295 | 0.04696 | 28.4072 | 871.790 | 6452.7 | 7767.6 | 88.200 | 45.70 | 68.15 | 2079 |
| 120.000 | 20.970 | 0.04769 | 25.7579 | 795.392 | 7114.0 | 8449.2 | 94.131 | 45.42 | 68.18 | 1993 |
| 130.000 | 20.647 | 0.04843 | 23.4666 | 725.944 | 7775.3 | 9131.5 | 99.592 | 45.14 | 68.28 | 1911 |
| 140.000 | 20.323 | 0.04920 | 21.4573 | 662.661 | 8437.2 | 9815.0 | 104.657 | 44.89 | 68.44 | 1833 |
| 150.000 | 19.999 | 0.05000 | 19.6746 | 604.898 | 9100.4 | 10500.5 | 109.386 | 44.68 | 68.68 | 1758 |
| 160.000 | 19.672 | 0.05083 | 18.0778 | 552.120 | 9765.5 | 11188.8 | 113.829 | 44.53 | 69.00 | 1687 |
| 170.000 | 19.344 | 0.05170 | 16.6362 | 503.853 | 10433.3 | 11880.8 | 118.023 | 44.45 | 69.41 | 1618 |
| 180.000 | 19.012 | 0.05260 | 15.3263 | 459.676 | 11104.5 | 12577.2 | 122.004 | 44.45 | 69.90 | 1550 |
| 190.000 | 18.677 | 0.05354 | 14.1296 | 419.214 | 11779.9 | 13279.1 | 125.799 | 44.55 | 70.49 | 1485 |
| 200.000 | 18.338 | 0.05453 | 13.0318 | 382.124 | 12460.4 | 13987.3 | 129.431 | 44.74 | 71.17 | 1422 |
| 210.000 | 17.994 | 0.05557 | 12.0211 | 348.099 | 13146.7 | 14702.8 | 132.922 | 45.02 | 71.94 | 1360 |
| 220.000 | 17.647 | 0.05667 | 11.0881 | 316.865 | 13839.7 | 15426.4 | 136.288 | 45.38 | 72.80 | 1300 |
| 230.000 | 17.295 | 0.05782 | 10.2250 | 288.173 | 14539.9 | 16159.0 | 139.544 | 45.84 | 73.74 | 1242 |
| 240.000 | 16.937 | 0.05904 | 9.4253 | 261.809 | 15248.2 | 16901.3 | 142.704 | 46.37 | 74.75 | 1185 |
| 250.000 | 16.574 | 0.06033 | 8.6835 | 237.580 | 15964.9 | 17654.3 | 145.777 | 46.96 | 75.84 | 1130 |
| 260.000 | 16.206 | 0.06171 | 7.9948 | 215.325 | 16690.6 | 18418.4 | 148.774 | 47.60 | 76.99 | 1076 |
| 270.000 | 15.832 | 0.06316 | 7.3552 | 194.902 | 17425.6 | 19194.2 | 151.701 | 48.28 | 78.18 | 1024 |
| 280.000 | 15.451 | 0.06472 | 6.7611 | 176.195 | 18170.0 | 19982.1 | 154.567 | 48.99 | 79.42 | 975 |
| 290.000 | 15.064 | 0.06638 | 6.2095 | 159.103 | 18923.9 | 20782.6 | 157.376 | 49.71 | 80.68 | 927 |
| 300.000 | 14.671 | 0.06816 | 5.6977 | 143.545 | 19687.3 | 21595.9 | 160.133 | 50.46 | 81.99 | 881 |
| 310.000 | 14.270 | 0.07008 | 5.2235 | 129.451 | 20460.5 | 22422.6 | 162.843 | 51.30 | 83.38 | 837 |
| 320.000 | 13.864 | 0.07213 | 4.7849 | 116.758 | 21244.5 | 23264.2 | 165.515 | 52.35 | 85.00 | 794 |
| 330.000 | 13.451 | 0.07434 | 4.3802 | 105.411 | 22042.3 | 24124.0 | 168.161 | 53.84 | 87.04 | 753 |
| 340.000 | 13.033 | 0.07673 | 4.0078 | 95.356 | 22857.5 | 25005.9 | 170.794 | 56.63 | 90.34 | 711 |
| 350.000 | 12.611 | 0.07930 | 3.6663 | 86.535 | 23693.9 | 25914.2 | 173.426 | 57.15 | 91.34 | 678 |
| 360.000 | 12.186 | 0.08206 | 3.3544 | 78.887 | 24535.4 | 26833.1 | 176.015 | 57.86 | 92.44 | 647 |
| 370.000 | 11.761 | 0.08503 | 3.0706 | 72.345 | 25382.4 | 27763.1 | 178.563 | 58.70 | 93.56 | 619 |
| 380.000 | 11.338 | 0.08820 | 2.8135 | 66.835 | 26234.6 | 28704.2 | 181.072 | 59.63 | 94.63 | 594 |
| 390.000 | 10.920 | 0.09157 | 2.5813 | 62.281 | 27091.4 | 29655.4 | 183.543 | 60.62 | 95.60 | 572 |
| 400.000 | 10.510 | 0.09514 | 2.3725 | 58.599 | 27951.7 | 30615.7 | 185.975 | 61.65 | 96.43 | 552 |
| 410.000 | 10.111 | 0.09890 | 2.1853 | 55.703 | 28814.3 | 31583.4 | 188.364 | 62.71 | 97.09 | 536 |
| 420.000 | 9.727 | 0.10281 | 2.0178 | 53.504 | 29678.1 | 32556.8 | 190.710 | 63.78 | 97.57 | 522 |
| 430.000 | 9.358 | 0.10686 | 1.8684 | 51.910 | 30542.1 | 33534.2 | 193.010 | 64.87 | 97.89 | 510 |
| 440.000 | 9.007 | 0.11102 | 1.7351 | 50.835 | 31405.4 | 34514.1 | 195.262 | 65.96 | 98.08 | 501 |
| 450.000 | 8.675 | 0.11527 | 1.6163 | 50.195 | 32267.9 | 35495.4 | 197.468 | 67.05 | 98.17 | 494 |
| 460.000 | 8.363 | 0.11957 | 1.5104 | 49.912 | 33129.2 | 36477.2 | 199.625 | 68.13 | 98.20 | 489 |
| 470.000 | 8.070 | 0.12391 | 1.4159 | 49.920 | 33989.6 | 37459.1 | 201.737 | 69.22 | 98.20 | 485 |
| 480.000 | 7.796 | 0.12828 | 1.3313 | 50.166 | 34849.4 | 38441.2 | 203.805 | 70.29 | 98.20 | 483 |
| 490.000 | 7.539 | 0.13264 | 1.2554 | 50.605 | 35709.2 | 39423.2 | 205.830 | 71.37 | 98.22 | 481 |
| 500.000 | 7.299 | 0.13700 | 1.1872 | 51.203 | 36569.4 | 40405.5 | 207.814 | 72.43 | 98.26 | 481 |
| 520.000 | 6.865 | 0.14566 | 1.0699 | 52.707 | 38294.2 | 42372.8 | 211.672 | 74.54 | 98.51 | 481 |
| 540.000 | 6.484 | 0.15423 | 0.9731 | 54.376 | 40029.0 | 44347.4 | 215.398 | 76.63 | 99.00 | 483 |
| 560.000 | 6.147 | 0.16269 | 0.8921 | 56.146 | 41778.6 | 46333.9 | 219.011 | 78.68 | 99.69 | 486 |
| 580.000 | 5.846 | 0.17104 | 0.8234 | 58.058 | 43546.4 | 48335.6 | 222.523 | 80.70 | 100.51 | 490 |
| 600.000 | 5.578 | 0.17928 | 0.7647 | 60.079 | 45335.2 | 50355.2 | 225.946 | 82.68 | 101.45 | 495 |

Table 27. Thermophysical properties along isobars (Continued)

ETHANE ISOBAR AT P = 300.0 BAR

| T | DEN | VOL | DP/DT | DP/DD | E | H | S | CV | CP | W |
|---|---|---|---|---|---|---|---|---|---|---|
| DEG K | MOL/L | L/MOL | BAR/K | BAR-L/MOL | J/MOL | J/MOL | J/MOL/K | J/MOL/K | J/MOL/K | M/SEC |
| 94.469 | 21.825 | 0.04582 | 33.5302 | 1013.170 | 5412.7 | 6787.2 | 77.684 | 46.19 | 68.20 | 2230 |
| 100.000 | 21.643 | 0.04620 | 31.5582 | 962.840 | 5778.2 | 7164.3 | 81.563 | 46.08 | 68.16 | 2176 |
| 110.000 | 21.318 | 0.04691 | 28.4532 | 878.836 | 6438.4 | 7845.7 | 88.057 | 45.82 | 68.12 | 2084 |
| 120.000 | 20.995 | 0.04763 | 25.8130 | 802.735 | 7098.0 | 8526.9 | 93.984 | 45.54 | 68.14 | 1999 |
| 130.000 | 20.674 | 0.04837 | 23.5298 | 733.536 | 7757.5 | 9208.6 | 99.441 | 45.26 | 68.22 | 1917 |
| 140.000 | 20.353 | 0.04913 | 21.5278 | 670.463 | 8417.5 | 9891.5 | 104.501 | 45.00 | 68.36 | 1840 |
| 150.000 | 20.032 | 0.04992 | 19.7520 | 612.880 | 9078.5 | 10576.2 | 109.225 | 44.79 | 68.59 | 1767 |
| 160.000 | 19.706 | 0.05074 | 18.1617 | 560.255 | 9741.3 | 11263.5 | 113.661 | 44.64 | 68.89 | 1696 |
| 170.000 | 19.383 | 0.05159 | 16.7263 | 512.121 | 10406.5 | 11954.3 | 117.848 | 44.56 | 69.28 | 1627 |
| 180.000 | 19.055 | 0.05248 | 15.4223 | 468.063 | 11075.0 | 12649.4 | 121.821 | 44.56 | 69.76 | 1561 |
| 190.000 | 18.724 | 0.05341 | 14.2314 | 427.707 | 11747.4 | 13349.7 | 125.607 | 44.66 | 70.32 | 1497 |
| 200.000 | 18.389 | 0.05438 | 13.1392 | 390.716 | 12424.7 | 14056.1 | 129.230 | 44.84 | 70.97 | 1434 |
| 210.000 | 18.051 | 0.05540 | 12.1340 | 356.783 | 13107.5 | 14769.4 | 132.711 | 45.12 | 71.72 | 1373 |
| 220.000 | 17.709 | 0.05647 | 11.2064 | 325.635 | 13796.6 | 15490.7 | 136.066 | 45.49 | 72.54 | 1314 |
| 230.000 | 17.363 | 0.05759 | 10.3486 | 297.026 | 14492.7 | 16220.5 | 139.310 | 45.94 | 73.45 | 1257 |
| 240.000 | 17.012 | 0.05878 | 9.5541 | 270.738 | 15196.4 | 16959.8 | 142.456 | 46.46 | 74.42 | 1201 |
| 250.000 | 16.657 | 0.06003 | 8.8174 | 246.581 | 15908.1 | 17709.2 | 145.515 | 47.05 | 75.46 | 1147 |
| 260.000 | 16.297 | 0.06136 | 8.1337 | 224.389 | 16628.4 | 18469.2 | 148.496 | 47.69 | 76.55 | 1094 |
| 270.000 | 15.932 | 0.06277 | 7.4989 | 204.019 | 17357.4 | 19240.4 | 151.406 | 48.37 | 77.69 | 1044 |
| 280.000 | 15.562 | 0.06426 | 6.9096 | 185.349 | 18095.3 | 20023.0 | 154.252 | 49.07 | 78.85 | 995 |
| 290.000 | 15.186 | 0.06585 | 6.3626 | 168.277 | 18842.0 | 20817.4 | 157.040 | 49.78 | 80.03 | 949 |
| 300.000 | 14.806 | 0.06754 | 5.8552 | 152.714 | 19597.6 | 21623.8 | 159.774 | 50.53 | 81.25 | 904 |
| 310.000 | 14.420 | 0.06935 | 5.3850 | 138.585 | 20362.2 | 22442.7 | 162.459 | 51.35 | 82.55 | 861 |
| 320.000 | 14.029 | 0.07128 | 4.9500 | 125.823 | 21137.0 | 23275.5 | 165.103 | 52.40 | 84.06 | 819 |
| 330.000 | 13.633 | 0.07335 | 4.5483 | 114.368 | 21924.8 | 24125.4 | 167.718 | 53.88 | 85.99 | 779 |
| 340.000 | 13.234 | 0.07557 | 4.1782 | 104.159 | 22729.4 | 24996.4 | 170.318 | 56.65 | 89.19 | 738 |
| 350.000 | 12.831 | 0.07794 | 3.8383 | 95.139 | 23554.6 | 25892.7 | 172.916 | 57.17 | 90.09 | 706 |
| 360.000 | 12.427 | 0.08047 | 3.5269 | 87.246 | 24384.5 | 26798.6 | 175.467 | 57.87 | 91.10 | 676 |
| 370.000 | 12.023 | 0.08317 | 3.2427 | 80.414 | 25219.7 | 27714.9 | 177.978 | 58.69 | 92.16 | 648 |
| 380.000 | 11.621 | 0.08605 | 2.9840 | 74.576 | 26060.3 | 28641.7 | 180.450 | 59.61 | 93.21 | 623 |
| 390.000 | 11.224 | 0.08910 | 2.7493 | 69.659 | 26905.9 | 29578.8 | 182.884 | 60.59 | 94.19 | 600 |
| 400.000 | 10.833 | 0.09231 | 2.5370 | 65.589 | 27755.8 | 30525.2 | 185.280 | 61.62 | 95.07 | 580 |
| 410.000 | 10.451 | 0.09569 | 2.3454 | 62.288 | 28609.2 | 31479.8 | 187.637 | 62.68 | 95.83 | 563 |
| 420.000 | 10.080 | 0.09920 | 2.1729 | 59.679 | 29465.3 | 32441.4 | 189.954 | 63.76 | 96.46 | 548 |
| 430.000 | 9.723 | 0.10285 | 2.0178 | 57.683 | 30323.2 | 33408.5 | 192.230 | 64.85 | 96.95 | 536 |
| 440.000 | 9.381 | 0.10660 | 1.8785 | 56.223 | 31182.2 | 34380.0 | 194.463 | 65.94 | 97.32 | 525 |
| 450.000 | 9.055 | 0.11043 | 1.7536 | 55.221 | 32041.7 | 35354.6 | 196.654 | 67.04 | 97.60 | 517 |
| 460.000 | 8.746 | 0.11433 | 1.6414 | 54.609 | 32901.7 | 36331.7 | 198.801 | 68.13 | 97.80 | 511 |
| 470.000 | 8.454 | 0.11828 | 1.5406 | 54.321 | 33761.9 | 37310.5 | 200.906 | 69.22 | 97.96 | 506 |
| 480.000 | 8.179 | 0.12226 | 1.4500 | 54.300 | 34622.8 | 38290.7 | 202.970 | 70.31 | 98.09 | 502 |
| 490.000 | 7.920 | 0.12626 | 1.3683 | 54.500 | 35484.4 | 39272.3 | 204.994 | 71.39 | 98.23 | 499 |
| 500.000 | 7.677 | 0.13027 | 1.2946 | 54.881 | 36347.2 | 40255.2 | 206.979 | 72.46 | 98.37 | 498 |
| 520.000 | 7.233 | 0.13825 | 1.1673 | 56.071 | 38078.4 | 42226.0 | 210.844 | 74.58 | 98.73 | 497 |
| 540.000 | 6.841 | 0.14617 | 1.0619 | 57.616 | 39820.4 | 44205.5 | 214.580 | 76.67 | 99.25 | 498 |
| 560.000 | 6.493 | 0.15400 | 0.9734 | 59.288 | 41577.2 | 46197.3 | 218.201 | 78.73 | 99.95 | 500 |
| 580.000 | 6.182 | 0.16175 | 0.8983 | 61.041 | 43352.2 | 48204.7 | 221.723 | 80.75 | 100.81 | 503 |
| 600.000 | 5.903 | 0.16940 | 0.8339 | 62.907 | 45148.2 | 50230.3 | 225.157 | 82.74 | 101.77 | 507 |

Table 27. Thermophysical properties along isobars (Continued)

ETHANE ISOBAR AT P = 320.0 BAR

| T | DEN | VOL | DP/DT | DP/DD | E | H | S | CV | CP | W |
|---|---|---|---|---|---|---|---|---|---|---|
| DEG K | MOL/L | L/MOL | BAR/K | BAR-L/MOL | J/MOL | J/MOL | J/MOL/K | J/MOL/K | J/MOL/K | M/SEC |
| 94.766 | 21.835 | 0.04580 | 33.4486 | 1016.866 | 5420.5 | 6886.0 | 77.760 | 46.31 | 68.18 | 2231 |
| 100.000 | 21.664 | 0.04616 | 31.5941 | 969.522 | 5765.6 | 7242.8 | 81.424 | 46.20 | 68.14 | 2181 |
| 110.000 | 21.340 | 0.04686 | 28.4995 | 885.869 | 6424.3 | 7923.8 | 87.915 | 45.94 | 68.09 | 2090 |
| 120.000 | 21.020 | 0.04757 | 25.8682 | 810.059 | 7082.3 | 8604.7 | 93.839 | 45.66 | 68.09 | 2004 |
| 130.000 | 20.701 | 0.04831 | 23.5929 | 741.105 | 7740.1 | 9285.9 | 99.292 | 45.37 | 68.16 | 1924 |
| 140.000 | 20.383 | 0.04906 | 21.5980 | 678.237 | 8398.1 | 9968.1 | 104.347 | 45.12 | 68.29 | 1848 |
| 150.000 | 20.064 | 0.04984 | 19.8289 | 620.831 | 9057.1 | 10652.0 | 109.065 | 44.90 | 68.50 | 1775 |
| 160.000 | 19.744 | 0.05065 | 18.2448 | 568.350 | 9717.6 | 11338.4 | 113.495 | 44.75 | 68.79 | 1705 |
| 170.000 | 19.422 | 0.05149 | 16.8153 | 520.344 | 10380.4 | 12028.0 | 117.676 | 44.67 | 69.16 | 1637 |
| 180.000 | 19.097 | 0.05236 | 15.5171 | 476.398 | 11046.2 | 12721.8 | 121.641 | 44.67 | 69.62 | 1571 |
| 190.000 | 18.770 | 0.05328 | 14.3317 | 436.141 | 11715.8 | 13420.6 | 125.419 | 44.76 | 70.16 | 1508 |
| 200.000 | 18.440 | 0.05423 | 13.2448 | 399.240 | 12389.9 | 14125.3 | 129.033 | 44.95 | 70.79 | 1446 |
| 210.000 | 18.107 | 0.05523 | 12.2448 | 365.391 | 13069.4 | 14836.7 | 132.504 | 45.22 | 71.51 | 1386 |
| 220.000 | 17.770 | 0.05628 | 11.3222 | 334.320 | 13754.9 | 15555.7 | 135.849 | 45.59 | 72.30 | 1328 |
| 230.000 | 17.429 | 0.05737 | 10.4694 | 305.784 | 14447.0 | 16283.0 | 139.082 | 46.04 | 73.18 | 1271 |
| 240.000 | 17.085 | 0.05853 | 9.6797 | 279.564 | 15146.4 | 17019.4 | 142.216 | 46.56 | 74.12 | 1217 |
| 250.000 | 16.737 | 0.05975 | 8.9476 | 255.468 | 15853.5 | 17765.5 | 145.261 | 47.14 | 75.11 | 1163 |
| 260.000 | 16.384 | 0.06103 | 8.2685 | 233.329 | 16568.7 | 18521.8 | 148.227 | 47.78 | 76.16 | 1112 |
| 270.000 | 16.028 | 0.06239 | 7.6381 | 213.002 | 17292.3 | 19288.8 | 151.122 | 48.45 | 77.24 | 1063 |
| 280.000 | 15.667 | 0.06383 | 7.0530 | 194.361 | 18024.2 | 20066.7 | 153.951 | 49.15 | 78.34 | 1015 |
| 290.000 | 15.302 | 0.06535 | 6.5100 | 177.301 | 18764.5 | 20855.7 | 156.719 | 49.86 | 79.46 | 969 |
| 300.000 | 14.933 | 0.06697 | 6.0064 | 161.728 | 19513.0 | 21656.0 | 159.432 | 50.59 | 80.61 | 926 |
| 310.000 | 14.559 | 0.06868 | 5.5396 | 147.562 | 20270.1 | 22468.0 | 162.095 | 51.41 | 81.83 | 884 |
| 320.000 | 14.182 | 0.07051 | 5.1076 | 134.734 | 21036.8 | 23293.1 | 164.715 | 52.45 | 83.25 | 843 |
| 330.000 | 13.801 | 0.07246 | 4.7084 | 123.178 | 21815.9 | 24134.4 | 167.303 | 53.92 | 85.10 | 804 |
| 340.000 | 13.418 | 0.07453 | 4.3403 | 112.832 | 22611.2 | 24996.1 | 169.875 | 56.68 | 88.21 | 764 |
| 350.000 | 13.032 | 0.07673 | 4.0015 | 103.636 | 23426.8 | 25882.2 | 172.444 | 57.19 | 89.03 | 732 |
| 360.000 | 12.646 | 0.07908 | 3.6905 | 95.527 | 24246.7 | 26777.1 | 174.965 | 57.88 | 89.97 | 703 |
| 370.000 | 12.260 | 0.08156 | 3.4058 | 88.443 | 25071.8 | 27681.9 | 177.444 | 58.70 | 90.98 | 675 |
| 380.000 | 11.877 | 0.08420 | 3.1458 | 82.318 | 25902.4 | 28596.8 | 179.883 | 59.61 | 91.99 | 650 |
| 390.000 | 11.497 | 0.08698 | 2.9090 | 77.084 | 26738.2 | 29521.6 | 182.286 | 60.58 | 92.98 | 627 |
| 400.000 | 11.122 | 0.08991 | 2.6937 | 72.673 | 27579.0 | 30456.1 | 184.652 | 61.61 | 93.89 | 607 |
| 410.000 | 10.756 | 0.09297 | 2.4985 | 69.015 | 28424.1 | 31399.2 | 186.980 | 62.66 | 94.72 | 589 |
| 420.000 | 10.399 | 0.09616 | 2.3217 | 66.041 | 29272.9 | 32350.1 | 189.272 | 63.74 | 95.44 | 573 |
| 430.000 | 10.053 | 0.09947 | 2.1619 | 63.679 | 30124.6 | 33307.7 | 191.525 | 64.83 | 96.06 | 560 |
| 440.000 | 9.720 | 0.10288 | 2.0175 | 61.861 | 30978.9 | 34270.9 | 193.739 | 65.93 | 96.57 | 549 |
| 450.000 | 9.401 | 0.10637 | 1.8871 | 60.519 | 31835.0 | 35238.7 | 195.914 | 67.03 | 96.99 | 540 |
| 460.000 | 9.097 | 0.10993 | 1.7694 | 59.588 | 32692.8 | 36210.4 | 198.050 | 68.13 | 97.34 | 532 |
| 470.000 | 8.808 | 0.11354 | 1.6631 | 59.006 | 33552.0 | 37185.2 | 200.147 | 69.23 | 97.63 | 526 |
| 480.000 | 8.533 | 0.11719 | 1.5671 | 58.720 | 34412.8 | 38162.9 | 202.205 | 70.32 | 97.89 | 521 |
| 490.000 | 8.274 | 0.12086 | 1.4801 | 58.680 | 35275.2 | 39142.9 | 204.226 | 71.40 | 98.13 | 518 |
| 500.000 | 8.029 | 0.12456 | 1.4013 | 58.846 | 36139.5 | 40125.3 | 206.210 | 72.48 | 98.36 | 515 |
| 520.000 | 7.579 | 0.13194 | 1.2645 | 59.660 | 37875.4 | 42097.6 | 210.078 | 74.61 | 98.87 | 513 |
| 540.000 | 7.179 | 0.13930 | 1.1507 | 60.961 | 39623.2 | 44080.8 | 213.820 | 76.71 | 99.47 | 513 |
| 560.000 | 6.822 | 0.14659 | 1.0549 | 62.533 | 41386.1 | 46076.9 | 217.450 | 78.77 | 100.18 | 514 |
| 580.000 | 6.502 | 0.15380 | 0.9735 | 64.207 | 43167.4 | 48089.0 | 220.980 | 80.79 | 101.05 | 517 |
| 600.000 | 6.214 | 0.16094 | 0.9036 | 65.945 | 44969.5 | 50119.5 | 224.422 | 82.78 | 102.02 | 520 |

Table 27. Thermophysical properties along isobars (Continued)

ETHANE ISOBAR AT P = 340.0 BAR

| T DEG K | DEN MOL/L | VOL L/MOL | DP/DT BAR/K | DP/DD BAR-L/MOL | E J/MOL | H J/MOL | S J/MOL/K | CV J/MOL/K | CP J/MOL/K | W M/SEC |
|---|---|---|---|---|---|---|---|---|---|---|
| 95.062 | 21.845 | 0.04578 | 33.3693 | 1020.596 | 5428.3 | 6984.7 | 77.835 | 46.43 | 68.17 | 2232 |
| 100.000 | 21.684 | 0.04612 | 31.6305 | 976.197 | 5753.3 | 7321.2 | 81.285 | 46.32 | 68.12 | 2185 |
| 110.000 | 21.363 | 0.04681 | 28.5461 | 892.887 | 6410.5 | 8002.0 | 87.774 | 46.06 | 68.06 | 2095 |
| 120.000 | 21.044 | 0.04752 | 25.9235 | 817.365 | 7066.9 | 8682.5 | 93.695 | 45.77 | 68.05 | 2010 |
| 130.000 | 20.728 | 0.04824 | 23.6559 | 748.650 | 7722.9 | 9363.2 | 99.144 | 45.49 | 68.10 | 1931 |
| 140.000 | 20.412 | 0.04899 | 21.6679 | 685.982 | 8379.1 | 10044.8 | 104.194 | 45.23 | 68.22 | 1855 |
| 150.000 | 20.096 | 0.04976 | 19.9051 | 628.745 | 9036.0 | 10727.9 | 108.907 | 45.01 | 68.42 | 1783 |
| 160.000 | 19.779 | 0.05056 | 18.3271 | 576.407 | 9694.4 | 11413.4 | 113.331 | 44.86 | 68.69 | 1713 |
| 170.000 | 19.460 | 0.05139 | 16.9034 | 528.523 | 10354.8 | 12102.0 | 117.505 | 44.77 | 69.04 | 1646 |
| 180.000 | 19.139 | 0.05225 | 15.6106 | 484.682 | 11018.0 | 12794.5 | 121.464 | 44.77 | 69.48 | 1582 |
| 190.000 | 18.816 | 0.05315 | 14.4305 | 444.519 | 11684.9 | 13491.9 | 125.234 | 44.87 | 70.01 | 1519 |
| 200.000 | 18.490 | 0.05408 | 13.3487 | 407.701 | 12356.0 | 14194.9 | 128.840 | 45.05 | 70.62 | 1458 |
| 210.000 | 18.161 | 0.05506 | 12.3536 | 373.927 | 13032.3 | 14904.5 | 132.302 | 45.32 | 71.31 | 1399 |
| 220.000 | 17.829 | 0.05609 | 11.4358 | 342.926 | 13714.3 | 15621.4 | 135.637 | 45.69 | 72.08 | 1341 |
| 230.000 | 17.494 | 0.05716 | 10.5876 | 314.454 | 14402.7 | 16346.3 | 138.859 | 46.13 | 72.92 | 1286 |
| 240.000 | 17.155 | 0.05829 | 9.8024 | 288.292 | 15098.1 | 17080.0 | 141.982 | 46.65 | 73.83 | 1232 |
| 250.000 | 16.814 | 0.05948 | 9.0746 | 264.249 | 15800.9 | 17823.1 | 145.015 | 47.23 | 74.79 | 1180 |
| 260.000 | 16.469 | 0.06072 | 8.3996 | 242.154 | 16511.5 | 18576.0 | 147.968 | 47.87 | 75.80 | 1129 |
| 270.000 | 16.120 | 0.06203 | 7.7732 | 221.861 | 17229.9 | 19339.1 | 150.848 | 48.53 | 76.83 | 1081 |
| 280.000 | 15.768 | 0.06342 | 7.1919 | 203.242 | 17956.4 | 20112.7 | 153.661 | 49.22 | 77.88 | 1034 |
| 290.000 | 15.412 | 0.06488 | 6.6524 | 186.186 | 18690.8 | 20896.8 | 156.412 | 49.93 | 78.95 | 989 |
| 300.000 | 15.053 | 0.06643 | 6.1520 | 170.599 | 19433.0 | 21691.7 | 159.107 | 50.66 | 80.03 | 947 |
| 310.000 | 14.691 | 0.06807 | 5.6882 | 156.397 | 20183.3 | 22497.7 | 161.750 | 51.47 | 81.19 | 906 |
| 320.000 | 14.326 | 0.06980 | 5.2588 | 143.506 | 20942.7 | 23316.0 | 164.348 | 52.50 | 82.54 | 866 |
| 330.000 | 13.958 | 0.07164 | 4.8616 | 131.855 | 21714.1 | 24149.9 | 166.914 | 53.96 | 84.32 | 828 |
| 340.000 | 13.589 | 0.07359 | 4.4950 | 121.384 | 22501.5 | 25003.5 | 169.461 | 56.72 | 87.37 | 789 |
| 350.000 | 13.218 | 0.07565 | 4.1572 | 112.029 | 23308.5 | 25880.8 | 172.004 | 57.21 | 88.12 | 757 |
| 360.000 | 12.847 | 0.07784 | 3.8464 | 103.729 | 24119.8 | 26766.3 | 174.499 | 57.89 | 89.01 | 728 |
| 370.000 | 12.477 | 0.08015 | 3.5613 | 96.421 | 24936.1 | 27661.2 | 176.951 | 58.70 | 89.97 | 701 |
| 380.000 | 12.109 | 0.08259 | 3.3001 | 90.042 | 25757.9 | 28565.8 | 179.363 | 59.61 | 90.96 | 676 |
| 390.000 | 11.744 | 0.08515 | 3.0614 | 84.529 | 26585.2 | 29480.3 | 181.738 | 60.58 | 91.93 | 653 |
| 400.000 | 11.385 | 0.08784 | 2.8436 | 79.817 | 27417.9 | 30404.3 | 184.078 | 61.60 | 92.86 | 633 |
| 410.000 | 11.032 | 0.09064 | 2.6452 | 75.841 | 28255.4 | 31337.3 | 186.382 | 62.65 | 93.73 | 614 |
| 420.000 | 10.688 | 0.09356 | 2.4647 | 72.539 | 29097.4 | 32278.6 | 188.650 | 63.73 | 94.52 | 598 |
| 430.000 | 10.353 | 0.09659 | 2.3008 | 69.846 | 29943.4 | 33227.5 | 190.883 | 64.82 | 95.23 | 584 |
| 440.000 | 10.029 | 0.09971 | 2.1519 | 67.699 | 30792.8 | 34182.8 | 193.079 | 65.92 | 95.84 | 572 |
| 450.000 | 9.718 | 0.10290 | 2.0169 | 66.038 | 31645.2 | 35144.0 | 195.239 | 67.03 | 96.38 | 562 |
| 460.000 | 9.419 | 0.10617 | 1.8943 | 64.802 | 32500.3 | 36110.1 | 197.362 | 68.13 | 96.84 | 553 |
| 470.000 | 9.133 | 0.10949 | 1.7831 | 63.936 | 33358.0 | 37080.7 | 199.450 | 69.23 | 97.25 | 547 |
| 480.000 | 8.861 | 0.11285 | 1.6821 | 63.387 | 34217.9 | 38055.0 | 201.501 | 70.32 | 97.61 | 541 |
| 490.000 | 8.602 | 0.11625 | 1.5904 | 63.108 | 35080.4 | 39032.8 | 203.517 | 71.41 | 97.95 | 537 |
| 500.000 | 8.357 | 0.11966 | 1.5069 | 63.057 | 35945.5 | 40014.0 | 205.499 | 72.49 | 98.28 | 533 |
| 520.000 | 7.904 | 0.12652 | 1.3613 | 63.497 | 37684.2 | 41985.9 | 209.366 | 74.63 | 98.92 | 529 |
| 540.000 | 7.498 | 0.13337 | 1.2394 | 64.485 | 39436.5 | 43971.2 | 213.113 | 76.74 | 99.62 | 528 |
| 560.000 | 7.133 | 0.14018 | 1.1365 | 65.866 | 41204.8 | 45971.1 | 216.749 | 78.80 | 100.38 | 528 |
| 580.000 | 6.806 | 0.14693 | 1.0489 | 67.457 | 42991.4 | 47987.1 | 220.286 | 80.83 | 101.26 | 530 |
| 600.000 | 6.510 | 0.15361 | 0.9735 | 69.130 | 44799.1 | 50021.9 | 223.735 | 82.83 | 102.24 | 533 |

Table 27. Thermophysical properties along isobars (Continued)

ETHANE ISOBAR AT P = 360.0 BAR

| T DEG K | DEN MOL/L | VOL L/MOL | DP/DT BAR/K | DP/DD BAR-L/MOL | E J/MOL | H J/MOL | S J/MOL/K | CV J/MOL/K | CP J/MOL/K | W M/SEC |
|---|---|---|---|---|---|---|---|---|---|---|
| 95.357 | 21.855 | 0.04576 | 33.2924 | 1024.364 | 5436.1 | 7083.3 | 77.909 | 46.55 | 68.15 | 2233 |
| 100.000 | 21.705 | 0.04607 | 31.6674 | 982.862 | 5741.0 | 7399.7 | 81.148 | 46.44 | 68.10 | 2189 |
| 110.000 | 21.385 | 0.04676 | 28.5930 | 899.893 | 6396.8 | 8080.3 | 87.635 | 46.18 | 68.03 | 2100 |
| 120.000 | 21.069 | 0.04746 | 25.9788 | 824.653 | 7051.7 | 8760.4 | 93.553 | 45.88 | 68.01 | 2016 |
| 130.000 | 20.755 | 0.04818 | 23.7187 | 756.173 | 7706.1 | 9440.6 | 98.997 | 45.60 | 68.05 | 1937 |
| 140.000 | 20.441 | 0.04892 | 21.7375 | 693.701 | 8360.4 | 10121.6 | 104.044 | 45.33 | 68.16 | 1862 |
| 150.000 | 20.128 | 0.04968 | 19.9809 | 636.627 | 9015.4 | 10804.0 | 108.752 | 45.12 | 68.34 | 1791 |
| 160.000 | 19.813 | 0.05047 | 18.4087 | 584.427 | 9671.6 | 11488.6 | 113.170 | 44.96 | 68.59 | 1722 |
| 170.000 | 19.497 | 0.05129 | 16.9905 | 536.659 | 10329.7 | 12176.1 | 117.338 | 44.88 | 68.93 | 1656 |
| 180.000 | 19.180 | 0.05214 | 15.7030 | 492.918 | 10990.5 | 12867.5 | 121.289 | 44.88 | 69.35 | 1592 |
| 190.000 | 18.860 | 0.05302 | 14.5280 | 452.842 | 11654.7 | 13563.5 | 125.052 | 44.97 | 69.86 | 1530 |
| 200.000 | 18.538 | 0.05394 | 13.4510 | 416.100 | 12323.0 | 14265.0 | 128.650 | 45.15 | 70.45 | 1469 |
| 210.000 | 18.214 | 0.05490 | 12.4606 | 382.396 | 12996.2 | 14972.8 | 132.104 | 45.42 | 71.12 | 1411 |
| 220.000 | 17.886 | 0.05591 | 11.5473 | 351.457 | 13675.0 | 15687.7 | 135.429 | 45.78 | 71.87 | 1355 |
| 230.000 | 17.556 | 0.05696 | 10.7034 | 323.041 | 14359.9 | 16410.4 | 138.642 | 46.22 | 72.69 | 1300 |
| 240.000 | 17.224 | 0.05806 | 9.9223 | 296.930 | 15051.5 | 17141.6 | 141.753 | 46.74 | 73.57 | 1247 |
| 250.000 | 16.888 | 0.05921 | 9.1985 | 272.930 | 15750.2 | 17881.9 | 144.775 | 47.32 | 74.50 | 1195 |
| 260.000 | 16.550 | 0.06042 | 8.5273 | 250.872 | 16456.4 | 18631.6 | 147.716 | 47.95 | 75.46 | 1146 |
| 270.000 | 16.208 | 0.06170 | 7.9045 | 230.605 | 17170.2 | 19391.2 | 150.582 | 48.61 | 76.46 | 1098 |
| 280.000 | 15.864 | 0.06304 | 7.3265 | 212.001 | 17891.6 | 20160.9 | 153.381 | 49.30 | 77.47 | 1053 |
| 290.000 | 15.517 | 0.06444 | 6.7902 | 194.946 | 18620.6 | 20940.6 | 156.117 | 50.00 | 78.48 | 1009 |
| 300.000 | 15.168 | 0.06593 | 6.2926 | 179.341 | 19357.1 | 21730.6 | 158.795 | 50.72 | 79.52 | 967 |
| 310.000 | 14.816 | 0.06750 | 5.8314 | 165.101 | 20101.3 | 22531.1 | 161.420 | 51.53 | 80.62 | 927 |
| 320.000 | 14.461 | 0.06915 | 5.4041 | 152.147 | 20854.2 | 23343.6 | 164.000 | 52.55 | 81.92 | 888 |
| 330.000 | 14.105 | 0.07090 | 5.0087 | 140.410 | 21618.7 | 24170.9 | 166.545 | 54.00 | 83.64 | 850 |
| 340.000 | 13.748 | 0.07274 | 4.6433 | 129.823 | 22398.9 | 25017.4 | 169.072 | 56.76 | 86.63 | 812 |
| 350.000 | 13.390 | 0.07468 | 4.3062 | 120.324 | 23198.5 | 25887.1 | 171.593 | 57.24 | 87.33 | 781 |
| 360.000 | 13.033 | 0.07673 | 3.9956 | 111.851 | 24002.1 | 26764.4 | 174.064 | 57.92 | 88.17 | 753 |
| 370.000 | 12.676 | 0.07889 | 3.7100 | 104.343 | 24810.7 | 27650.7 | 176.493 | 58.72 | 89.09 | 726 |
| 380.000 | 12.322 | 0.08116 | 3.4477 | 97.737 | 25624.8 | 28546.4 | 178.881 | 59.62 | 90.06 | 701 |
| 390.000 | 11.971 | 0.08354 | 3.2073 | 91.975 | 26444.6 | 29451.8 | 181.233 | 60.58 | 91.02 | 678 |
| 400.000 | 11.625 | 0.08602 | 2.9873 | 86.993 | 27269.9 | 30366.7 | 183.549 | 61.60 | 91.96 | 657 |
| 410.000 | 11.285 | 0.08862 | 2.7861 | 82.734 | 28100.7 | 31290.8 | 185.831 | 62.65 | 92.86 | 639 |
| 420.000 | 10.952 | 0.09131 | 2.6025 | 79.136 | 28936.5 | 32223.7 | 188.079 | 63.72 | 93.69 | 622 |
| 430.000 | 10.627 | 0.09410 | 2.4349 | 76.142 | 29776.9 | 33164.4 | 190.293 | 64.82 | 94.46 | 607 |
| 440.000 | 10.313 | 0.09697 | 2.2821 | 73.694 | 30621.7 | 34112.6 | 192.473 | 65.92 | 95.16 | 595 |
| 450.000 | 10.008 | 0.09992 | 2.1429 | 71.735 | 31470.3 | 35067.3 | 194.618 | 67.02 | 95.78 | 584 |
| 460.000 | 9.715 | 0.10293 | 2.0160 | 70.213 | 32322.5 | 36028.0 | 196.729 | 68.13 | 96.34 | 575 |
| 470.000 | 9.434 | 0.10600 | 1.9004 | 69.073 | 33178.0 | 36993.9 | 198.807 | 69.23 | 96.84 | 567 |
| 480.000 | 9.165 | 0.10911 | 1.7950 | 68.268 | 34036.7 | 37964.7 | 200.851 | 70.33 | 97.30 | 560 |
| 490.000 | 8.908 | 0.11226 | 1.6989 | 67.753 | 34898.6 | 38939.8 | 202.861 | 71.42 | 97.73 | 555 |
| 500.000 | 8.664 | 0.11543 | 1.6111 | 67.485 | 35763.7 | 39919.0 | 204.840 | 72.51 | 98.13 | 551 |
| 520.000 | 8.209 | 0.12181 | 1.4572 | 67.549 | 37504.2 | 41889.4 | 208.704 | 74.65 | 98.91 | 546 |
| 540.000 | 7.799 | 0.12822 | 1.3278 | 68.223 | 39259.8 | 43875.5 | 212.451 | 76.76 | 99.70 | 543 |
| 560.000 | 7.429 | 0.13460 | 1.2180 | 69.340 | 41032.2 | 45877.8 | 216.092 | 78.83 | 100.54 | 542 |
| 580.000 | 7.095 | 0.14094 | 1.1243 | 70.781 | 42823.7 | 47897.5 | 219.636 | 80.87 | 101.44 | 543 |
| 600.000 | 6.793 | 0.14722 | 1.0436 | 72.384 | 44636.2 | 49936.1 | 223.091 | 82.86 | 102.43 | 545 |

Table 27. Thermophysical properties along isobars (Continued)

ETHANE ISOBAR AT P = 380.0 BAR

| T<br>DEG K | DEN<br>MOL/L | VCL<br>L/MOL | DF/DT<br>BAR/K | DF/DD<br>BAR-L/MOL | E<br>J/MOL | H<br>J/MOL | S<br>J/MOL/K | CV<br>J/MOL/K | CP<br>J/MOL/K | W<br>M/SEC |
|---|---|---|---|---|---|---|---|---|---|---|
| 95.651 | 21.865 | 0.04574 | 33.2177 | 1028.166 | 5444.0 | 7131.9 | 77.983 | 46.66 | 68.13 | 2234 |
| 100.000 | 21.725 | 0.04603 | 31.7048 | 989.521 | 5729.0 | 7478.1 | 81.012 | 46.56 | 68.08 | 2194 |
| 110.000 | 21.407 | 0.04671 | 28.6401 | 906.887 | 6383.4 | 8158.5 | 87.496 | 46.29 | 68.00 | 2105 |
| 120.000 | 21.093 | 0.04741 | 26.0343 | 831.924 | 7036.8 | 8838.3 | 93.411 | 46.00 | 67.97 | 2022 |
| 130.000 | 20.781 | 0.04812 | 23.7814 | 763.675 | 7689.5 | 9518.1 | 98.852 | 45.70 | 68.00 | 1944 |
| 140.000 | 20.470 | 0.04885 | 21.8067 | 701.394 | 8342.1 | 10198.5 | 103.894 | 45.44 | 68.09 | 1870 |
| 150.000 | 20.159 | 0.04961 | 20.0562 | 644.479 | 8995.1 | 10880.2 | 108.597 | 45.22 | 68.26 | 1799 |
| 160.000 | 19.847 | 0.05038 | 18.4896 | 592.412 | 9649.3 | 11563.9 | 113.010 | 45.06 | 68.50 | 1731 |
| 170.000 | 19.534 | 0.05119 | 17.0767 | 544.755 | 10305.2 | 12250.5 | 117.172 | 44.98 | 68.83 | 1665 |
| 180.000 | 19.220 | 0.05203 | 15.7943 | 501.109 | 10963.6 | 12940.7 | 121.117 | 44.98 | 69.23 | 1602 |
| 190.000 | 18.904 | 0.05290 | 14.6241 | 461.113 | 11625.3 | 13635.4 | 124.873 | 45.06 | 69.72 | 1540 |
| 200.000 | 18.586 | 0.05380 | 13.5518 | 424.442 | 12290.9 | 14335.4 | 128.464 | 45.24 | 70.29 | 1481 |
| 210.000 | 18.265 | 0.05475 | 12.5658 | 390.800 | 12961.1 | 15041.6 | 131.909 | 45.51 | 70.95 | 1423 |
| 220.000 | 17.943 | 0.05573 | 11.6567 | 359.916 | 13636.7 | 15754.6 | 135.226 | 45.87 | 71.67 | 1368 |
| 230.000 | 17.618 | 0.05676 | 10.8169 | 331.550 | 14318.3 | 16475.2 | 138.429 | 46.31 | 72.47 | 1313 |
| 240.000 | 17.290 | 0.05784 | 10.0396 | 305.482 | 15006.3 | 17204.1 | 141.531 | 46.83 | 73.32 | 1261 |
| 250.000 | 16.960 | 0.05896 | 9.3195 | 281.519 | 15701.2 | 17941.7 | 144.542 | 47.41 | 74.22 | 1211 |
| 260.000 | 16.628 | 0.06014 | 8.6518 | 259.490 | 16403.3 | 18688.6 | 147.471 | 48.03 | 75.16 | 1162 |
| 270.000 | 16.293 | 0.06137 | 8.0323 | 239.243 | 17112.7 | 19444.9 | 150.325 | 48.69 | 76.12 | 1115 |
| 280.000 | 15.957 | 0.06267 | 7.4573 | 220.648 | 17829.5 | 20211.0 | 153.111 | 49.37 | 77.09 | 1070 |
| 290.000 | 15.618 | 0.06403 | 6.9238 | 203.588 | 18553.6 | 20986.7 | 155.833 | 50.07 | 78.06 | 1027 |
| 300.000 | 15.277 | 0.06546 | 6.4288 | 187.963 | 19284.8 | 21772.3 | 158.496 | 50.79 | 79.05 | 986 |
| 310.000 | 14.934 | 0.06696 | 5.9697 | 173.684 | 20023.4 | 22568.0 | 161.105 | 51.59 | 80.11 | 947 |
| 320.000 | 14.589 | 0.06854 | 5.5442 | 160.670 | 20770.4 | 23375.1 | 163.668 | 52.60 | 81.36 | 909 |
| 330.000 | 14.244 | 0.07021 | 5.1503 | 148.851 | 21528.8 | 24196.6 | 166.196 | 54.05 | 83.04 | 872 |
| 340.000 | 13.897 | 0.07196 | 4.7859 | 138.157 | 22302.5 | 25036.8 | 168.704 | 56.79 | 85.98 | 834 |
| 350.000 | 13.551 | 0.07380 | 4.4493 | 128.526 | 23095.5 | 25899.8 | 171.205 | 57.27 | 86.63 | 804 |
| 360.000 | 13.205 | 0.07573 | 4.1388 | 119.896 | 23892.3 | 26770.0 | 173.656 | 57.94 | 87.43 | 776 |
| 370.000 | 12.861 | 0.07776 | 3.8526 | 112.206 | 24694.1 | 27648.8 | 176.064 | 58.74 | 88.33 | 749 |
| 380.000 | 12.519 | 0.07988 | 3.5894 | 105.396 | 25501.3 | 28536.7 | 178.432 | 59.63 | 89.27 | 724 |
| 390.000 | 12.180 | 0.08210 | 3.3474 | 99.409 | 26314.4 | 29434.2 | 180.763 | 60.59 | 90.22 | 702 |
| 400.000 | 11.846 | 0.08442 | 3.1254 | 94.185 | 27133.2 | 30341.1 | 183.059 | 61.60 | 91.16 | 681 |
| 410.000 | 11.517 | 0.08683 | 2.9218 | 89.669 | 27957.8 | 31257.3 | 185.322 | 62.65 | 92.08 | 662 |
| 420.000 | 11.194 | 0.08933 | 2.7353 | 85.804 | 28788.0 | 32182.5 | 187.551 | 63.72 | 92.95 | 645 |
| 430.000 | 10.880 | 0.09192 | 2.5645 | 82.535 | 29623.2 | 33116.0 | 189.748 | 64.81 | 93.76 | 630 |
| 440.000 | 10.573 | 0.09458 | 2.4083 | 79.810 | 30463.5 | 34057.5 | 191.912 | 65.91 | 94.51 | 617 |
| 450.000 | 10.276 | 0.09731 | 2.2653 | 77.577 | 31308.3 | 35006.1 | 194.044 | 67.02 | 95.21 | 605 |
| 460.000 | 9.989 | 0.10011 | 2.1346 | 75.785 | 32157.4 | 35961.4 | 196.143 | 68.13 | 95.84 | 595 |
| 470.000 | 9.713 | 0.10295 | 2.0151 | 74.386 | 33010.6 | 36922.8 | 198.211 | 69.23 | 96.43 | 587 |
| 480.000 | 9.448 | 0.10585 | 1.9057 | 73.334 | 33867.6 | 37889.7 | 200.247 | 70.34 | 96.96 | 580 |
| 490.000 | 9.193 | 0.10877 | 1.8055 | 72.587 | 34728.6 | 38862.0 | 202.251 | 71.43 | 97.47 | 574 |
| 500.000 | 8.950 | 0.11173 | 1.7137 | 72.104 | 35593.3 | 39839.0 | 204.225 | 72.52 | 97.94 | 569 |
| 520.000 | 8.497 | 0.11769 | 1.5522 | 71.791 | 37334.5 | 41806.9 | 208.084 | 74.67 | 98.84 | 562 |
| 540.000 | 8.084 | 0.12369 | 1.4156 | 72.151 | 39092.2 | 43792.6 | 211.831 | 76.79 | 99.73 | 558 |
| 560.000 | 7.711 | 0.12969 | 1.2993 | 73.001 | 40868.0 | 45796.3 | 215.475 | 78.86 | 100.64 | 557 |
| 580.000 | 7.371 | 0.13566 | 1.1997 | 74.218 | 42663.5 | 47818.7 | 219.023 | 80.90 | 101.60 | 557 |
| 600.000 | 7.063 | 0.14159 | 1.1136 | 75.702 | 44480.2 | 49860.5 | 222.484 | 82.90 | 102.60 | 558 |

Table 27. Thermophysical properties along isobars (Continued)

ETHANE ISOBAR AT P = 400.0 BAR

| T DEG K | DEN MOL/L | VOL L/MOL | DP/DT BAR/K | DP/DD BAR-L/MOL | E J/MOL | H J/MOL | S J/MOL/K | CV J/MOL/K | CP J/MOL/K | W M/SEC |
|---|---|---|---|---|---|---|---|---|---|---|
| 95.944 | 21.875 | 0.04571 | 33.1452 | 1032.003 | 5451.9 | 7280.4 | 78.057 | 46.78 | 68.12 | 2236 |
| 100.000 | 21.745 | 0.04599 | 31.7427 | 996.172 | 5717.1 | 7556.6 | 80.877 | 46.68 | 68.07 | 2198 |
| 110.000 | 21.429 | 0.04667 | 28.6875 | 913.868 | 6370.2 | 8236.8 | 87.359 | 46.40 | 67.97 | 2110 |
| 120.000 | 21.117 | 0.04736 | 26.0898 | 839.180 | 7022.1 | 8916.3 | 93.271 | 46.10 | 67.93 | 2028 |
| 130.000 | 20.807 | 0.04806 | 23.8440 | 771.156 | 7673.2 | 9595.6 | 98.709 | 45.81 | 67.95 | 1950 |
| 140.000 | 20.498 | 0.04878 | 21.8757 | 709.063 | 8324.1 | 10275.5 | 103.747 | 45.54 | 68.03 | 1877 |
| 150.000 | 20.190 | 0.04953 | 20.1310 | 652.301 | 8975.2 | 10956.5 | 108.445 | 45.32 | 68.18 | 1807 |
| 160.000 | 19.881 | 0.05030 | 18.5699 | 600.367 | 9627.4 | 11639.4 | 112.853 | 45.16 | 68.41 | 1739 |
| 170.000 | 19.571 | 0.05110 | 17.1621 | 552.813 | 10281.2 | 12325.0 | 117.009 | 45.08 | 68.72 | 1674 |
| 180.000 | 19.260 | 0.05192 | 15.8845 | 509.255 | 10937.3 | 13014.2 | 120.948 | 45.07 | 69.12 | 1611 |
| 190.000 | 18.947 | 0.05278 | 14.7190 | 469.335 | 11596.5 | 13707.6 | 124.697 | 45.16 | 69.59 | 1551 |
| 200.000 | 18.632 | 0.05367 | 13.6511 | 432.729 | 12259.5 | 14406.2 | 128.281 | 45.34 | 70.15 | 1492 |
| 210.000 | 18.316 | 0.05460 | 12.6693 | 399.143 | 12926.9 | 15110.8 | 131.718 | 45.61 | 70.78 | 1435 |
| 220.000 | 17.998 | 0.05556 | 11.7643 | 368.308 | 13599.6 | 15822.1 | 135.027 | 45.96 | 71.49 | 1380 |
| 230.000 | 17.677 | 0.05657 | 10.9282 | 339.985 | 14277.9 | 16540.7 | 138.221 | 46.40 | 72.26 | 1327 |
| 240.000 | 17.355 | 0.05762 | 10.1546 | 313.953 | 14962.5 | 17267.4 | 141.314 | 46.91 | 73.09 | 1275 |
| 250.000 | 17.030 | 0.05872 | 9.4379 | 290.021 | 15653.8 | 18002.6 | 144.315 | 47.49 | 73.96 | 1226 |
| 260.000 | 16.704 | 0.05987 | 8.7734 | 268.014 | 16352.1 | 18746.7 | 147.233 | 48.11 | 74.87 | 1178 |
| 270.000 | 16.376 | 0.06107 | 8.1568 | 247.782 | 17057.4 | 19500.1 | 150.076 | 48.77 | 75.80 | 1132 |
| 280.000 | 16.046 | 0.06232 | 7.5846 | 229.191 | 17769.9 | 20262.8 | 152.850 | 49.44 | 76.74 | 1088 |
| 290.000 | 15.714 | 0.06364 | 7.0536 | 212.122 | 18489.4 | 21034.9 | 155.559 | 50.13 | 77.68 | 1045 |
| 300.000 | 15.381 | 0.06502 | 6.5608 | 196.474 | 19215.8 | 21816.4 | 158.209 | 50.85 | 78.63 | 1005 |
| 310.000 | 15.046 | 0.06646 | 6.1036 | 182.155 | 19949.3 | 22607.8 | 160.803 | 51.64 | 79.65 | 967 |
| 320.000 | 14.711 | 0.06798 | 5.6797 | 169.084 | 20690.9 | 23410.1 | 163.350 | 52.65 | 80.86 | 929 |
| 330.000 | 14.374 | 0.06957 | 5.2870 | 157.186 | 21443.7 | 24226.4 | 165.862 | 54.10 | 82.50 | 893 |
| 340.000 | 14.038 | 0.07124 | 4.9235 | 146.392 | 22211.6 | 25061.0 | 168.354 | 56.83 | 85.40 | 855 |
| 350.000 | 13.702 | 0.07298 | 4.5872 | 136.639 | 22998.7 | 25918.0 | 170.838 | 57.31 | 86.02 | 826 |
| 360.000 | 13.367 | 0.07481 | 4.2766 | 127.864 | 23789.5 | 26782.0 | 173.272 | 57.97 | 86.79 | 798 |
| 370.000 | 13.033 | 0.07673 | 3.9900 | 120.008 | 24585.0 | 27654.1 | 175.661 | 58.76 | 87.65 | 772 |
| 380.000 | 12.702 | 0.07873 | 3.7257 | 113.013 | 25386.1 | 28535.2 | 178.011 | 59.64 | 88.57 | 747 |
| 390.000 | 12.374 | 0.08081 | 3.4824 | 106.822 | 26193.1 | 29425.7 | 180.324 | 60.60 | 89.51 | 724 |
| 400.000 | 12.050 | 0.08299 | 3.2585 | 101.379 | 27006.1 | 30325.5 | 182.602 | 61.61 | 90.46 | 704 |
| 410.000 | 11.732 | 0.08524 | 3.0527 | 96.629 | 27825.1 | 31234.7 | 184.847 | 62.65 | 91.38 | 685 |
| 420.000 | 11.419 | 0.08757 | 2.8636 | 92.520 | 28650.0 | 32153.0 | 187.060 | 63.72 | 92.27 | 667 |
| 430.000 | 11.113 | 0.08999 | 2.6900 | 89.001 | 29480.6 | 33080.0 | 189.241 | 64.81 | 93.12 | 652 |
| 440.000 | 10.815 | 0.09247 | 2.5306 | 86.021 | 30316.5 | 34015.2 | 191.391 | 65.91 | 93.92 | 638 |
| 450.000 | 10.525 | 0.09501 | 2.3844 | 83.533 | 31157.6 | 34958.2 | 193.510 | 67.02 | 94.67 | 626 |
| 460.000 | 10.244 | 0.09762 | 2.2502 | 81.489 | 32003.6 | 35908.4 | 195.598 | 68.13 | 95.37 | 616 |
| 470.000 | 9.973 | 0.10027 | 2.1270 | 79.845 | 32854.4 | 36865.4 | 197.656 | 69.24 | 96.01 | 607 |
| 480.000 | 9.711 | 0.10297 | 2.0140 | 78.558 | 33709.6 | 37828.5 | 199.684 | 70.34 | 96.62 | 599 |
| 490.000 | 9.460 | 0.10571 | 1.9101 | 77.586 | 34569.2 | 38797.6 | 201.682 | 71.44 | 97.19 | 592 |
| 500.000 | 9.219 | 0.10847 | 1.8147 | 76.893 | 35433.2 | 39772.1 | 203.651 | 72.53 | 97.73 | 587 |
| 520.000 | 8.767 | 0.11406 | 1.6460 | 76.203 | 37174.3 | 41736.9 | 207.504 | 74.69 | 98.74 | 579 |
| 540.000 | 8.354 | 0.11970 | 1.5027 | 76.246 | 38933.5 | 43721.5 | 211.249 | 76.81 | 99.72 | 574 |
| 560.000 | 7.978 | 0.12535 | 1.3802 | 76.830 | 40711.8 | 45725.8 | 214.893 | 78.89 | 100.70 | 571 |
| 580.000 | 7.634 | 0.13099 | 1.2749 | 77.817 | 42510.3 | 47749.7 | 218.445 | 80.93 | 101.71 | 570 |
| 600.000 | 7.321 | 0.13659 | 1.1837 | 79.111 | 44330.8 | 49794.4 | 221.910 | 82.93 | 102.75 | 571 |

Table 27. Thermophysical properties along isobars (Continued)

ETHANE ISOBAR AT P = 420.0 BAR

| T | DEN | VCL | DF/CT | DF/DD | E | H | S | CV | CF | W |
|---|---|---|---|---|---|---|---|---|---|---|
| DEG K | MOL/L | L/MOL | BAR/K | BAR-L/MOL | J/MOL | J/MOL | J/MCL/K | J/MOL/K | J/MOL/K | M/SEC |
| 96.236 | 21.885 | 0.04569 | 33.0749 | 1035.875 | 5459.8 | 7378.9 | 78.131 | 46.89 | 68.11 | 2237 |
| 100.000 | 21.765 | 0.04594 | 31.7811 | 1002.816 | 5705.4 | 7635.1 | 80.742 | 46.79 | 68.05 | 2202 |
| 110.000 | 21.451 | 0.04662 | 28.7353 | 920.839 | 6357.1 | 8315.1 | 87.223 | 46.51 | 67.95 | 2115 |
| 120.000 | 21.141 | 0.04730 | 26.1454 | 846.419 | 7007.6 | 8994.3 | 93.133 | 46.21 | 67.90 | 2034 |
| 130.000 | 20.833 | 0.04800 | 23.9065 | 778.618 | 7657.2 | 9673.2 | 98.567 | 45.91 | 67.90 | 1957 |
| 140.000 | 20.526 | 0.04872 | 21.9444 | 716.707 | 8306.3 | 10352.5 | 103.601 | 45.65 | 67.97 | 1884 |
| 150.000 | 20.220 | 0.04946 | 20.2054 | 660.096 | 8955.7 | 11032.9 | 108.295 | 45.42 | 68.11 | 1814 |
| 160.000 | 19.914 | 0.05022 | 18.6495 | 608.285 | 9605.9 | 11715.0 | 112.697 | 45.26 | 68.33 | 1748 |
| 170.000 | 19.607 | 0.05100 | 17.2467 | 560.833 | 10257.6 | 12399.7 | 116.848 | 45.17 | 68.63 | 1683 |
| 180.000 | 19.299 | 0.05182 | 15.9738 | 517.360 | 10911.5 | 13087.8 | 120.781 | 45.17 | 69.01 | 1621 |
| 190.000 | 18.989 | 0.05266 | 14.8126 | 477.510 | 11568.3 | 13780.1 | 124.524 | 45.25 | 69.47 | 1561 |
| 200.000 | 18.678 | 0.05354 | 13.7490 | 440.963 | 12228.8 | 14477.4 | 128.100 | 45.43 | 70.00 | 1503 |
| 210.000 | 18.366 | 0.05445 | 12.7712 | 407.428 | 12893.6 | 15180.5 | 131.530 | 45.70 | 70.62 | 1447 |
| 220.000 | 18.051 | 0.05540 | 11.8700 | 376.637 | 13563.4 | 15890.1 | 134.831 | 46.05 | 71.31 | 1393 |
| 230.000 | 17.735 | 0.05638 | 11.0375 | 348.349 | 14238.7 | 16606.8 | 138.017 | 46.49 | 72.06 | 1340 |
| 240.000 | 17.418 | 0.05741 | 10.2673 | 322.349 | 14920.1 | 17331.5 | 141.101 | 47.00 | 72.87 | 1289 |
| 250.000 | 17.098 | 0.05849 | 9.5538 | 298.440 | 15608.0 | 18064.4 | 144.093 | 47.57 | 73.72 | 1240 |
| 260.000 | 16.777 | 0.05960 | 8.8922 | 276.451 | 16302.6 | 18806.0 | 147.002 | 48.19 | 74.61 | 1193 |
| 270.000 | 16.455 | 0.06077 | 8.2784 | 256.228 | 17004.2 | 19556.6 | 149.834 | 48.84 | 75.51 | 1148 |
| 280.000 | 16.131 | 0.06199 | 7.7087 | 237.636 | 17712.6 | 20316.2 | 152.597 | 49.51 | 76.42 | 1104 |
| 290.000 | 15.806 | 0.06327 | 7.1759 | 220.556 | 18427.8 | 21085.0 | 155.294 | 50.20 | 77.33 | 1063 |
| 300.000 | 15.480 | 0.06460 | 6.6890 | 204.884 | 19149.7 | 21862.8 | 157.931 | 50.91 | 78.25 | 1023 |
| 310.000 | 15.153 | 0.06599 | 6.2335 | 190.524 | 19878.5 | 22650.2 | 160.513 | 51.70 | 79.23 | 985 |
| 320.000 | 14.826 | 0.06745 | 5.8110 | 177.395 | 20615.3 | 23448.2 | 163.046 | 52.70 | 80.41 | 949 |
| 330.000 | 14.498 | 0.06897 | 5.4193 | 165.421 | 21363.0 | 24259.9 | 165.544 | 54.14 | 82.01 | 913 |
| 340.000 | 14.171 | 0.07057 | 5.0564 | 154.534 | 22125.7 | 25089.5 | 168.020 | 56.87 | 84.88 | 876 |
| 350.000 | 13.844 | 0.07223 | 4.7204 | 144.667 | 22907.3 | 25941.1 | 170.489 | 57.34 | 85.47 | 847 |
| 360.000 | 13.519 | 0.07397 | 4.4097 | 135.759 | 23692.6 | 26799.4 | 172.907 | 58.00 | 86.21 | 819 |
| 370.000 | 13.195 | 0.07579 | 4.1225 | 127.751 | 24482.6 | 27665.7 | 175.280 | 58.78 | 87.05 | 793 |
| 380.000 | 12.873 | 0.07768 | 3.8573 | 120.586 | 25278.2 | 28540.7 | 177.614 | 59.66 | 87.95 | 769 |
| 390.000 | 12.555 | 0.07965 | 3.6126 | 114.208 | 26079.7 | 29424.9 | 179.910 | 60.61 | 88.89 | 746 |
| 400.000 | 12.241 | 0.08169 | 3.3870 | 108.564 | 26887.3 | 30318.4 | 182.173 | 61.62 | 89.83 | 725 |
| 410.000 | 11.931 | 0.08381 | 3.1792 | 103.601 | 27701.3 | 31221.4 | 184.402 | 62.66 | 90.76 | 706 |
| 420.000 | 11.627 | 0.08600 | 2.9878 | 99.269 | 28521.3 | 32133.5 | 186.600 | 63.73 | 91.66 | 689 |
| 430.000 | 11.330 | 0.08826 | 2.8116 | 95.520 | 29347.5 | 33054.5 | 188.767 | 64.82 | 92.54 | 673 |
| 440.000 | 11.039 | 0.09059 | 2.6494 | 92.305 | 30179.4 | 33984.1 | 190.904 | 65.92 | 93.37 | 659 |
| 450.000 | 10.756 | 0.09297 | 2.5001 | 89.581 | 31017.0 | 34921.8 | 193.011 | 67.02 | 94.16 | 647 |
| 460.000 | 10.481 | 0.09541 | 2.3628 | 87.302 | 31859.9 | 35867.2 | 195.089 | 68.13 | 94.91 | 636 |
| 470.000 | 10.215 | 0.09790 | 2.2363 | 85.427 | 32708.1 | 36819.8 | 197.138 | 69.24 | 95.61 | 626 |
| 480.000 | 9.958 | 0.10043 | 2.1199 | 83.915 | 33561.4 | 37779.3 | 199.158 | 70.35 | 96.27 | 618 |
| 490.000 | 9.710 | 0.10299 | 2.0127 | 82.728 | 34419.5 | 38745.1 | 201.150 | 71.45 | 96.90 | 611 |
| 500.000 | 9.471 | 0.10559 | 1.9139 | 81.830 | 35282.5 | 39717.1 | 203.113 | 72.54 | 97.49 | 605 |
| 520.000 | 9.022 | 0.11084 | 1.7387 | 80.769 | 37022.9 | 41678.2 | 206.959 | 74.70 | 98.61 | 595 |
| 540.000 | 8.609 | 0.11615 | 1.5890 | 80.492 | 38782.7 | 43661.1 | 210.701 | 76.82 | 99.68 | 589 |
| 560.000 | 8.231 | 0.12148 | 1.4606 | 80.808 | 40562.8 | 45665.2 | 214.345 | 78.91 | 100.73 | 586 |
| 580.000 | 7.885 | 0.12682 | 1.3498 | 81.567 | 42364.0 | 47690.3 | 217.898 | 80.95 | 101.79 | 584 |
| 600.000 | 7.569 | 0.13212 | 1.2536 | 82.660 | 44187.6 | 49736.8 | 221.367 | 82.96 | 102.87 | 584 |

Table 27. Thermophysical properties along isobars (Continued)

ETHANE ISOBAR AT P = 450.0 BAR

| T DEG K | DEN MOL/L | VOL L/MOL | DP/DT BAR/K | DP/DD BAR-L/MOL | E J/MOL | H J/MOL | S J/MOL/K | CV J/MOL/K | CP J/MOL/K | W M/SEC |
|---|---|---|---|---|---|---|---|---|---|---|
| 96.673 | 21.900 | 0.04566 | 32.9735 | 1041.744 | 5471.7 | 7526.5 | 78.240 | 47.05 | 68.08 | 2239 |
| 100.000 | 21.795 | 0.04588 | 31.8396 | 1012.770 | 5688.2 | 7752.9 | 80.543 | 46.96 | 68.03 | 2209 |
| 110.000 | 21.483 | 0.04655 | 28.8075 | 931.274 | 6338.0 | 8432.6 | 87.021 | 46.67 | 67.91 | 2123 |
| 120.000 | 21.176 | 0.04722 | 26.2291 | 857.251 | 6986.3 | 9111.3 | 92.927 | 46.37 | 67.84 | 2042 |
| 130.000 | 20.871 | 0.04791 | 24.0002 | 789.775 | 7633.6 | 9789.7 | 98.356 | 46.07 | 67.83 | 1967 |
| 140.000 | 20.568 | 0.04862 | 22.0470 | 728.131 | 8280.3 | 10468.2 | 103.384 | 45.80 | 67.89 | 1895 |
| 150.000 | 20.265 | 0.04935 | 20.3161 | 671.737 | 8927.1 | 11147.7 | 108.072 | 45.57 | 68.01 | 1826 |
| 160.000 | 19.963 | 0.05009 | 18.7679 | 620.103 | 9574.5 | 11828.7 | 112.467 | 45.41 | 68.21 | 1760 |
| 170.000 | 19.660 | 0.05087 | 17.3721 | 572.797 | 10223.2 | 12512.1 | 116.610 | 45.32 | 68.49 | 1697 |
| 180.000 | 19.356 | 0.05166 | 16.1059 | 529.442 | 10873.9 | 13198.8 | 120.535 | 45.31 | 68.85 | 1636 |
| 190.000 | 19.051 | 0.05249 | 14.9511 | 489.689 | 11527.3 | 13889.4 | 124.269 | 45.39 | 69.29 | 1577 |
| 200.000 | 18.745 | 0.05335 | 13.8933 | 453.222 | 12184.2 | 14584.8 | 127.835 | 45.56 | 69.80 | 1520 |
| 210.000 | 18.438 | 0.05424 | 12.9212 | 419.752 | 12845.1 | 15285.7 | 131.255 | 45.83 | 70.40 | 1464 |
| 220.000 | 18.130 | 0.05516 | 12.0253 | 389.016 | 13510.8 | 15992.9 | 134.545 | 46.18 | 71.06 | 1411 |
| 230.000 | 17.820 | 0.05612 | 11.1979 | 360.774 | 14181.9 | 16707.1 | 137.720 | 46.61 | 71.79 | 1359 |
| 240.000 | 17.509 | 0.05711 | 10.4324 | 334.809 | 14858.7 | 17428.9 | 140.791 | 47.12 | 72.57 | 1309 |
| 250.000 | 17.197 | 0.05815 | 9.7232 | 310.927 | 15541.9 | 18158.6 | 143.770 | 47.69 | 73.39 | 1261 |
| 260.000 | 16.884 | 0.05923 | 9.0657 | 288.954 | 16231.5 | 18896.8 | 146.665 | 48.30 | 74.24 | 1215 |
| 270.000 | 16.569 | 0.06035 | 8.4555 | 268.736 | 16927.7 | 19643.6 | 149.483 | 48.95 | 75.11 | 1171 |
| 280.000 | 16.254 | 0.06152 | 7.8892 | 250.135 | 17630.5 | 20399.0 | 152.231 | 49.62 | 75.99 | 1129 |
| 290.000 | 15.939 | 0.06274 | 7.3633 | 233.031 | 18339.9 | 21163.2 | 154.913 | 50.30 | 76.86 | 1088 |
| 300.000 | 15.622 | 0.06401 | 6.8750 | 217.317 | 19055.7 | 21936.2 | 157.533 | 51.00 | 77.74 | 1050 |
| 310.000 | 15.306 | 0.06533 | 6.4216 | 202.897 | 19778.1 | 22718.1 | 160.097 | 51.78 | 78.68 | 1013 |
| 320.000 | 14.989 | 0.06671 | 6.0008 | 189.684 | 20508.3 | 23510.4 | 162.612 | 52.78 | 79.82 | 977 |
| 330.000 | 14.673 | 0.06815 | 5.6103 | 177.604 | 21249.1 | 24315.9 | 165.091 | 54.21 | 81.37 | 942 |
| 340.000 | 14.358 | 0.06965 | 5.2481 | 166.585 | 22004.7 | 25138.9 | 167.547 | 56.93 | 84.20 | 905 |
| 350.000 | 14.043 | 0.07121 | 4.9123 | 156.560 | 22779.1 | 25983.5 | 169.995 | 57.39 | 84.75 | 877 |
| 360.000 | 13.730 | 0.07283 | 4.6012 | 147.469 | 23557.1 | 26834.5 | 172.392 | 58.04 | 85.46 | 850 |
| 370.000 | 13.420 | 0.07452 | 4.3132 | 139.254 | 24339.7 | 27693.0 | 174.745 | 58.82 | 86.27 | 824 |
| 380.000 | 13.111 | 0.07627 | 4.0467 | 131.858 | 25127.9 | 28560.1 | 177.057 | 59.69 | 87.15 | 800 |
| 390.000 | 12.806 | 0.07809 | 3.8001 | 125.228 | 25922.1 | 29436.1 | 179.333 | 60.64 | 88.06 | 778 |
| 400.000 | 12.504 | 0.07997 | 3.5722 | 119.312 | 26722.7 | 30321.4 | 181.574 | 61.64 | 89.00 | 757 |
| 410.000 | 12.207 | 0.08192 | 3.3616 | 114.061 | 27529.7 | 31216.0 | 183.783 | 62.67 | 89.93 | 738 |
| 420.000 | 11.915 | 0.08393 | 3.1670 | 109.427 | 28343.3 | 32120.0 | 185.961 | 63.74 | 90.86 | 720 |
| 430.000 | 11.629 | 0.08599 | 2.9873 | 105.365 | 29163.3 | 33033.1 | 188.110 | 64.83 | 91.76 | 704 |
| 440.000 | 11.348 | 0.08812 | 2.8213 | 101.831 | 29989.7 | 33955.1 | 190.229 | 65.92 | 92.63 | 690 |
| 450.000 | 11.075 | 0.09030 | 2.6680 | 98.782 | 30822.3 | 34885.5 | 192.320 | 67.03 | 93.47 | 677 |
| 460.000 | 10.808 | 0.09252 | 2.5264 | 96.179 | 31660.8 | 35824.3 | 194.383 | 68.14 | 94.27 | 665 |
| 470.000 | 10.550 | 0.09479 | 2.3956 | 93.983 | 32505.3 | 36770.9 | 196.419 | 69.25 | 95.04 | 655 |
| 480.000 | 10.299 | 0.09710 | 2.2747 | 92.157 | 33355.4 | 37724.9 | 198.428 | 70.36 | 95.77 | 646 |
| 490.000 | 10.056 | 0.09944 | 2.1629 | 90.665 | 34211.1 | 38686.0 | 200.410 | 71.46 | 96.46 | 638 |
| 500.000 | 9.822 | 0.10182 | 2.0595 | 89.474 | 35072.2 | 39653.9 | 202.365 | 72.55 | 97.13 | 631 |
| 520.000 | 9.378 | 0.10663 | 1.8751 | 87.870 | 36810.8 | 41609.2 | 206.199 | 74.72 | 98.38 | 620 |
| 540.000 | 8.968 | 0.11151 | 1.7167 | 87.118 | 38570.7 | 43588.7 | 209.934 | 76.85 | 99.56 | 613 |
| 560.000 | 8.589 | 0.11642 | 1.5799 | 87.025 | 40352.4 | 45591.5 | 213.576 | 78.94 | 100.71 | 608 |
| 580.000 | 8.241 | 0.12135 | 1.4614 | 87.438 | 42156.4 | 47617.0 | 217.130 | 80.99 | 101.85 | 605 |
| 600.000 | 7.920 | 0.12626 | 1.3581 | 88.234 | 43983.6 | 49665.5 | 220.602 | 83.00 | 102.99 | 603 |

Table 27. Thermophysical properties along isobars (Continued)

ETHANE ISOBAR AT P = 500.0 BAR

| T DEG K | DEN MOL/L | VOL L/MOL | DP/DT BAR/K | DP/DD BAR-L/MOL | E J/MOL | H J/MOL | S J/MOL/K | CV J/MOL/K | CP J/MOL/K | W M/SEC |
|---|---|---|---|---|---|---|---|---|---|---|
| 97.397 | 21.925 | 0.04561 | 32.8146 | 1051.691 | 5491.7 | 7772.2 | 78.420 | 47.30 | 68.05 | 2243 |
| 100.000 | 21.844 | 0.04578 | 31.9398 | 1029.333 | 5660.3 | 7949.3 | 80.215 | 47.23 | 68.00 | 2220 |
| 110.000 | 21.537 | 0.04643 | 28.9293 | 948.618 | 6306.9 | 8628.5 | 86.689 | 46.94 | 67.86 | 2136 |
| 120.000 | 21.234 | 0.04710 | 26.3691 | 875.234 | 6951.9 | 9306.6 | 92.589 | 46.62 | 67.77 | 2057 |
| 130.000 | 20.934 | 0.04777 | 24.1560 | 808.282 | 7595.5 | 9984.1 | 98.011 | 46.31 | 67.73 | 1983 |
| 140.000 | 20.636 | 0.04846 | 22.2169 | 747.063 | 8238.4 | 10661.4 | 103.031 | 46.04 | 67.76 | 1912 |
| 150.000 | 20.339 | 0.04917 | 20.4988 | 691.013 | 8881.0 | 11339.4 | 107.709 | 45.81 | 67.86 | 1845 |
| 160.000 | 20.042 | 0.04990 | 18.9623 | 639.655 | 9524.0 | 12018.8 | 112.093 | 45.64 | 68.03 | 1781 |
| 170.000 | 19.746 | 0.05064 | 17.5776 | 592.574 | 10168.0 | 12700.2 | 116.224 | 45.54 | 68.28 | 1719 |
| 180.000 | 19.449 | 0.05142 | 16.3216 | 549.392 | 10813.7 | 13384.6 | 120.136 | 45.53 | 68.61 | 1659 |
| 190.000 | 19.151 | 0.05222 | 15.1765 | 509.778 | 11461.8 | 14072.6 | 123.856 | 45.61 | 69.01 | 1602 |
| 200.000 | 18.853 | 0.05304 | 14.1279 | 473.422 | 12113.1 | 14765.1 | 127.408 | 45.78 | 69.50 | 1545 |
| 210.000 | 18.554 | 0.05390 | 13.1644 | 440.039 | 12768.1 | 15462.9 | 130.812 | 46.04 | 70.06 | 1492 |
| 220.000 | 18.255 | 0.05478 | 12.2765 | 409.371 | 13427.6 | 16166.6 | 134.085 | 46.39 | 70.69 | 1440 |
| 230.000 | 17.955 | 0.05570 | 11.4565 | 381.180 | 14092.1 | 16876.9 | 137.243 | 46.81 | 71.38 | 1390 |
| 240.000 | 17.654 | 0.05664 | 10.6979 | 355.251 | 14762.1 | 17594.4 | 140.296 | 47.31 | 72.12 | 1342 |
| 250.000 | 17.352 | 0.05763 | 9.9951 | 331.390 | 15438.0 | 18319.4 | 143.256 | 47.87 | 72.90 | 1295 |
| 260.000 | 17.051 | 0.05865 | 9.3433 | 309.423 | 16120.1 | 19052.5 | 146.131 | 48.48 | 73.71 | 1251 |
| 270.000 | 16.749 | 0.05971 | 8.7384 | 289.193 | 16808.4 | 19793.7 | 148.928 | 49.12 | 74.53 | 1208 |
| 280.000 | 16.446 | 0.06080 | 8.1767 | 270.562 | 17503.0 | 20543.2 | 151.654 | 49.78 | 75.36 | 1167 |
| 290.000 | 16.144 | 0.06194 | 7.6548 | 253.406 | 18203.8 | 21300.9 | 154.312 | 50.45 | 76.18 | 1128 |
| 300.000 | 15.842 | 0.06312 | 7.1699 | 237.614 | 18910.7 | 22066.8 | 156.909 | 51.15 | 77.01 | 1091 |
| 310.000 | 15.541 | 0.06435 | 6.7193 | 223.089 | 19623.9 | 22841.2 | 159.448 | 51.92 | 77.90 | 1055 |
| 320.000 | 15.240 | 0.06562 | 6.3005 | 209.742 | 20344.5 | 23625.3 | 161.938 | 52.90 | 78.98 | 1020 |
| 330.000 | 14.940 | 0.06693 | 5.9114 | 197.495 | 21075.5 | 24422.2 | 164.390 | 54.32 | 80.48 | 986 |
| 340.000 | 14.641 | 0.06830 | 5.5498 | 186.275 | 21821.1 | 25236.1 | 166.819 | 57.04 | 83.26 | 951 |
| 350.000 | 14.344 | 0.06971 | 5.2140 | 176.016 | 22585.4 | 26071.1 | 169.239 | 57.49 | 83.76 | 924 |
| 360.000 | 14.049 | 0.07118 | 4.9022 | 166.656 | 23352.9 | 26911.9 | 171.608 | 58.12 | 84.42 | 897 |
| 370.000 | 13.756 | 0.07269 | 4.6127 | 158.138 | 24125.2 | 27760.0 | 173.931 | 58.89 | 85.20 | 872 |
| 380.000 | 13.466 | 0.07426 | 4.3439 | 150.408 | 24903.1 | 28616.2 | 176.215 | 59.76 | 86.05 | 849 |
| 390.000 | 13.179 | 0.07588 | 4.0946 | 143.414 | 25687.1 | 29481.1 | 178.461 | 60.69 | 86.94 | 827 |
| 400.000 | 12.895 | 0.07755 | 3.8632 | 137.108 | 26477.6 | 30355.1 | 180.674 | 61.68 | 87.87 | 806 |
| 410.000 | 12.615 | 0.07927 | 3.6485 | 131.444 | 27275.0 | 31238.4 | 182.855 | 62.71 | 88.80 | 787 |
| 420.000 | 12.340 | 0.08104 | 3.4493 | 126.376 | 28079.3 | 32131.2 | 185.006 | 63.77 | 89.74 | 769 |
| 430.000 | 12.070 | 0.08285 | 3.2646 | 121.864 | 28890.5 | 33033.2 | 187.129 | 64.85 | 90.67 | 753 |
| 440.000 | 11.804 | 0.08471 | 3.0931 | 117.868 | 29708.7 | 33944.4 | 189.224 | 65.95 | 91.58 | 738 |
| 450.000 | 11.545 | 0.08662 | 2.9340 | 114.350 | 30533.8 | 34864.7 | 191.292 | 67.05 | 92.47 | 724 |
| 460.000 | 11.291 | 0.08856 | 2.7863 | 111.273 | 31365.5 | 35793.7 | 193.334 | 68.16 | 93.33 | 712 |
| 470.000 | 11.044 | 0.09055 | 2.6492 | 108.603 | 32204.0 | 36731.2 | 195.350 | 69.27 | 94.17 | 701 |
| 480.000 | 10.804 | 0.09256 | 2.5218 | 106.307 | 33048.9 | 37677.0 | 197.341 | 70.38 | 94.98 | 691 |
| 490.000 | 10.570 | 0.09461 | 2.4035 | 104.354 | 33900.3 | 38630.8 | 199.308 | 71.48 | 95.76 | 682 |
| 500.000 | 10.343 | 0.09668 | 2.2934 | 102.714 | 34758.0 | 39592.2 | 201.250 | 72.58 | 96.51 | 674 |
| 520.000 | 9.911 | 0.10090 | 2.0958 | 100.260 | 36491.8 | 41536.9 | 205.064 | 74.75 | 97.95 | 661 |
| 540.000 | 9.507 | 0.10519 | 1.9243 | 98.739 | 38250.0 | 43509.5 | 208.786 | 76.89 | 99.30 | 651 |
| 560.000 | 9.131 | 0.10952 | 1.7751 | 97.967 | 40032.4 | 45508.4 | 212.420 | 78.99 | 100.59 | 644 |
| 580.000 | 8.782 | 0.11388 | 1.6447 | 97.790 | 41839.0 | 47532.8 | 215.972 | 81.04 | 101.85 | 639 |
| 600.000 | 8.457 | 0.11824 | 1.5304 | 98.081 | 43670.1 | 49582.1 | 219.446 | 83.05 | 103.08 | 636 |

NBS-114A (REV. 7-73)

| U.S. DEPT. OF COMM. **BIBLIOGRAPHIC DATA SHEET** | 1. PUBLICATION OR REPORT NO. NBSIR 74-398 | 2. Gov't Accession No. | 3. Recipient's Accession No. |
|---|---|---|---|

| | |
|---|---|
| 4. TITLE AND SUBTITLE<br>PROVISIONAL VALUES FOR THE THERMODYNAMIC FUNCTIONS OF ETHANE | 5. Publication Date<br>June 1, 1974 |
| | 6. Performing Organization Code |
| 7. AUTHOR(S) Robert D. Goodwin | 8. Performing Organ. Report No.<br>-- |
| 9. PERFORMING ORGANIZATION NAME AND ADDRESS<br>**NATIONAL BUREAU OF STANDARDS**<br>**DEPARTMENT OF COMMERCE**<br>**WASHINGTON, D.C. 20234** | 10. Project/Task/Work Unit No.<br>2750364 |
| | 11. Contract/Grant No.<br>-- |
| 12. Sponsoring Organization Name and Complete Address *(Street, City, State, ZIP)*<br>American Gas Association<br>1515 Wilson Boulevard<br>Arlington, VA 22209 | 13. Type of Report & Period Covered<br>Technical 6-73/6-74 |
| | 14. Sponsoring Agency Code<br>AGA |

15. SUPPLEMENTARY NOTES

16. ABSTRACT *(A 200-word or less factual summary of most significant information. If document includes a significant bibliography or literature survey, mention it here.)*


Thermophysical properties are tabulated at uniform temperatures over the entire range of fluid states from 90 to 600 K along isobars to 700 bar. A new, rational equation of state is employed for the first time. Thermodynamic functions in the compressed liquid at $T < T_c$ are obtained by use of specific heats $C_p(T)$ along a high pressure isobar.


17. KEY WORDS *(six to twelve entries; alphabetical order; capitalize only the first letter of the first key word unless a proper name; separated by semicolons)* Densities; enthalpies, entropies; equation of state; internal energies; isobars; isochores; isotherms; Joule-Thomson inversion; latent heats of vaporization; melting line; orthobaric densities; specific heats; speeds of sound; vapor pressures.

| 18. AVAILABILITY | 19. SECURITY CLASS (THIS REPORT) | 21. NO. OF PAGES |
|---|---|---|
| [X] Unlimited<br>[ ] For Official Distribution. Do Not Release to NTIS | UNCLASSIFIED | |
| [ ] Order From Sup. of Doc., U.S. Government Printing Office Washington, D.C. 20402, SD Cat. No. C13<br>[ ] Order From National Technical Information Service (NTIS) Springfield, Virginia 22151 | 20. SECURITY CLASS (THIS PAGE)<br>UNCLASSIFIED | 22. Price |

Table 27. Thermophysical properties along isobars (Continued)

ETHANE ISOBAR AT P = 700.0 BAR

| T DEG K | DEN MOL/L | VOL L/MOL | DP/DT BAR/K | DP/DD BAR-L/MOL | E J/MOL | H J/MOL | S J/MOL/K | CV J/MOL/K | CP J/MOL/K | W M/SEC |
|---|---|---|---|---|---|---|---|---|---|---|
| 100.239 | 22.025 | 0.04540 | 32.2963 | 1093.402 | 5573.1 | 8751.3 | 79.119 | 48.22 | 67.93 | 2263 |
| 110.000 | 21.740 | 0.04600 | 29.4370 | 1017.517 | 6193.4 | 9413.3 | 85.421 | 47.89 | 67.71 | 2187 |
| 120.000 | 21.453 | 0.04661 | 26.9389 | 946.464 | 6826.5 | 10089.4 | 91.304 | 47.54 | 67.53 | 2115 |
| 130.000 | 21.170 | 0.04724 | 24.7790 | 881.391 | 7457.6 | 10764.1 | 96.704 | 47.20 | 67.41 | 2046 |
| 140.000 | 20.891 | 0.04787 | 22.8866 | 821.670 | 8087.0 | 11437.8 | 101.697 | 46.90 | 67.35 | 1981 |
| 150.000 | 20.613 | 0.04851 | 21.2105 | 766.796 | 8715.4 | 12111.3 | 106.343 | 46.65 | 67.36 | 1919 |
| 160.000 | 20.337 | 0.04917 | 19.7122 | 716.344 | 9343.3 | 12785.2 | 110.693 | 46.46 | 67.45 | 1860 |
| 170.000 | 20.063 | 0.04984 | 18.3627 | 669.943 | 9971.4 | 13460.4 | 114.786 | 46.35 | 67.61 | 1803 |
| 180.000 | 19.789 | 0.05053 | 17.1393 | 627.262 | 10600.3 | 14137.7 | 118.657 | 46.32 | 67.85 | 1748 |
| 190.000 | 19.516 | 0.05124 | 16.0244 | 587.997 | 11230.9 | 14817.7 | 122.333 | 46.38 | 68.17 | 1695 |
| 200.000 | 19.244 | 0.05196 | 15.0039 | 551.868 | 11863.8 | 15501.3 | 125.840 | 46.54 | 68.57 | 1644 |
| 210.000 | 18.972 | 0.05271 | 14.0662 | 518.614 | 12499.7 | 16189.2 | 129.196 | 46.78 | 69.04 | 1595 |
| 220.000 | 18.701 | 0.05347 | 13.2021 | 487.996 | 13139.2 | 16882.2 | 132.420 | 47.11 | 69.57 | 1548 |
| 230.000 | 18.431 | 0.05426 | 12.4037 | 459.790 | 13783.0 | 17580.9 | 135.525 | 47.52 | 70.17 | 1503 |
| 240.000 | 18.162 | 0.05506 | 11.6647 | 433.791 | 14431.6 | 18285.8 | 138.525 | 47.99 | 70.82 | 1459 |
| 250.000 | 17.894 | 0.05589 | 10.9793 | 409.809 | 15085.3 | 18997.3 | 141.430 | 48.53 | 71.50 | 1417 |
| 260.000 | 17.626 | 0.05673 | 10.3429 | 387.673 | 15744.5 | 19715.9 | 144.248 | 49.12 | 72.21 | 1377 |
| 270.000 | 17.360 | 0.05760 | 9.7513 | 367.227 | 16409.3 | 20441.5 | 146.987 | 49.73 | 72.93 | 1338 |
| 280.000 | 17.095 | 0.05850 | 9.2007 | 348.330 | 17079.7 | 21174.4 | 149.652 | 50.36 | 73.65 | 1302 |
| 290.000 | 16.832 | 0.05941 | 8.6880 | 330.853 | 17755.6 | 21914.4 | 152.249 | 51.01 | 74.36 | 1267 |
| 300.000 | 16.570 | 0.06035 | 8.2101 | 314.681 | 18437.1 | 22661.6 | 154.782 | 51.67 | 75.08 | 1233 |
| 310.000 | 16.310 | 0.06131 | 7.7645 | 299.713 | 19124.3 | 23416.2 | 157.256 | 52.42 | 75.86 | 1201 |
| 320.000 | 16.052 | 0.06230 | 7.3487 | 285.853 | 19818.5 | 24179.4 | 159.679 | 53.37 | 76.83 | 1170 |
| 330.000 | 15.796 | 0.06331 | 6.9606 | 273.020 | 20522.7 | 24954.3 | 162.063 | 54.76 | 78.23 | 1139 |
| 340.000 | 15.542 | 0.06434 | 6.5981 | 261.138 | 21241.2 | 25745.1 | 164.424 | 57.44 | 80.91 | 1106 |
| 350.000 | 15.291 | 0.06540 | 6.2595 | 250.139 | 21978.1 | 26556.1 | 166.774 | 57.86 | 81.31 | 1081 |
| 360.000 | 15.042 | 0.06648 | 5.9429 | 239.961 | 22718.2 | 27372.0 | 169.073 | 58.47 | 81.89 | 1057 |
| 370.000 | 14.795 | 0.06759 | 5.6470 | 230.549 | 23463.1 | 28194.3 | 171.326 | 59.21 | 82.59 | 1034 |
| 380.000 | 14.552 | 0.06872 | 5.3701 | 221.851 | 24213.7 | 29024.1 | 173.539 | 60.05 | 83.37 | 1012 |
| 390.000 | 14.311 | 0.06987 | 5.1110 | 213.819 | 24970.8 | 29862.0 | 175.715 | 60.96 | 84.22 | 991 |
| 400.000 | 14.074 | 0.07105 | 4.8684 | 206.410 | 25734.8 | 30708.6 | 177.859 | 61.92 | 85.11 | 971 |
| 410.000 | 13.840 | 0.07226 | 4.6412 | 199.584 | 26506.4 | 31564.3 | 179.972 | 62.93 | 86.03 | 953 |
| 420.000 | 13.609 | 0.07348 | 4.4283 | 193.303 | 27285.6 | 32429.3 | 182.056 | 63.97 | 86.98 | 935 |
| 430.000 | 13.382 | 0.07473 | 4.2286 | 187.533 | 28072.8 | 33303.9 | 184.114 | 65.04 | 87.93 | 918 |
| 440.000 | 13.158 | 0.07600 | 4.0414 | 182.240 | 28868.1 | 34188.1 | 186.146 | 66.12 | 88.89 | 903 |
| 450.000 | 12.938 | 0.07729 | 3.8657 | 177.395 | 29671.4 | 35081.8 | 188.155 | 67.21 | 89.86 | 888 |
| 460.000 | 12.722 | 0.07860 | 3.7007 | 172.969 | 30482.9 | 35985.2 | 190.140 | 68.31 | 90.81 | 874 |
| 470.000 | 12.510 | 0.07994 | 3.5457 | 168.935 | 31302.6 | 36898.0 | 192.103 | 69.41 | 91.76 | 862 |
| 480.000 | 12.302 | 0.08129 | 3.4000 | 165.268 | 32130.4 | 37820.4 | 194.045 | 70.52 | 92.70 | 850 |
| 490.000 | 12.099 | 0.08265 | 3.2630 | 161.945 | 32966.3 | 38752.0 | 195.966 | 71.62 | 93.63 | 839 |
| 500.000 | 11.899 | 0.08404 | 3.1340 | 158.943 | 33810.2 | 39692.9 | 197.867 | 72.72 | 94.54 | 829 |
| 520.000 | 11.514 | 0.08685 | 2.8983 | 153.820 | 35521.8 | 41601.5 | 201.610 | 74.89 | 96.31 | 811 |
| 540.000 | 11.146 | 0.08972 | 2.6887 | 149.743 | 37264.6 | 43545.0 | 205.277 | 77.04 | 98.02 | 796 |
| 560.000 | 10.796 | 0.09263 | 2.5021 | 146.574 | 39037.9 | 45522.1 | 208.872 | 79.15 | 99.67 | 783 |
| 580.000 | 10.463 | 0.09558 | 2.3355 | 144.186 | 40841.0 | 47531.4 | 212.397 | 81.21 | 101.26 | 773 |
| 600.000 | 10.147 | 0.09855 | 2.1864 | 142.469 | 42673.7 | 49572.0 | 215.856 | 83.24 | 102.79 | 765 |

Table 27. Thermophysical properties along isobars (Continued)

ETHANE ISOBAR AT P = 650.0 BAR

| T | DEN | VOL | DP/DT | DP/DD | E | H | S | CV | CP | W |
|---|---|---|---|---|---|---|---|---|---|---|
| DEG K | MOL/L | L/MOL | BAR/K | BAR-L/MOL | J/MOL | J/MOL | J/MOL/K | J/MOL/K | J/MOL/K | M/SEC |
| 99.536 | 22.000 | 0.04545 | 32.4094 | 1082.699 | 5552.5 | 8507.0 | 78.947 | 48.01 | 67.96 | 2258 |
| 100.000 | 21.986 | 0.04548 | 32.2595 | 1078.869 | 5582.2 | 8538.6 | 79.264 | 47.99 | 67.95 | 2254 |
| 110.000 | 21.691 | 0.04610 | 29.3069 | 1000.347 | 6220.3 | 9217.0 | 85.729 | 47.66 | 67.74 | 2174 |
| 120.000 | 21.400 | 0.04673 | 26.7949 | 928.747 | 6856.1 | 9893.5 | 91.616 | 47.32 | 67.58 | 2100 |
| 130.000 | 21.113 | 0.04736 | 24.6230 | 863.233 | 7490.1 | 10568.7 | 97.021 | 46.99 | 67.48 | 2030 |
| 140.000 | 20.829 | 0.04801 | 22.7203 | 803.165 | 8122.6 | 11243.2 | 102.019 | 46.70 | 67.44 | 1964 |
| 150.000 | 20.547 | 0.04867 | 21.0350 | 748.024 | 8754.2 | 11917.7 | 106.672 | 46.45 | 67.47 | 1901 |
| 160.000 | 20.267 | 0.04934 | 19.5283 | 697.371 | 9385.6 | 12592.8 | 111.029 | 46.27 | 67.57 | 1840 |
| 170.000 | 19.987 | 0.05003 | 18.1712 | 650.827 | 10017.3 | 13269.4 | 115.131 | 46.16 | 67.75 | 1782 |
| 180.000 | 19.708 | 0.05074 | 16.9408 | 608.047 | 10650.0 | 13948.1 | 119.011 | 46.14 | 68.01 | 1726 |
| 190.000 | 19.430 | 0.05147 | 15.8195 | 568.722 | 11284.5 | 14629.9 | 122.696 | 46.20 | 68.35 | 1673 |
| 200.000 | 19.152 | 0.05221 | 14.7930 | 532.563 | 11921.4 | 15315.4 | 126.213 | 46.36 | 68.77 | 1621 |
| 210.000 | 18.874 | 0.05298 | 13.8499 | 499.305 | 12561.6 | 16005.4 | 129.579 | 46.61 | 69.25 | 1571 |
| 220.000 | 18.597 | 0.05377 | 12.9809 | 468.701 | 13205.5 | 16700.7 | 132.813 | 46.94 | 69.81 | 1523 |
| 230.000 | 18.320 | 0.05458 | 12.1781 | 440.525 | 13853.8 | 17401.8 | 135.930 | 47.35 | 70.42 | 1476 |
| 240.000 | 18.044 | 0.05542 | 11.4352 | 414.569 | 14507.0 | 18109.3 | 138.941 | 47.84 | 71.09 | 1431 |
| 250.000 | 17.769 | 0.05628 | 10.7464 | 390.642 | 15165.5 | 18823.6 | 141.857 | 48.38 | 71.79 | 1388 |
| 260.000 | 17.494 | 0.05716 | 10.1070 | 368.570 | 15829.6 | 19545.1 | 144.686 | 48.97 | 72.51 | 1347 |
| 270.000 | 17.220 | 0.05807 | 9.5129 | 348.198 | 16499.3 | 20274.0 | 147.437 | 49.59 | 73.25 | 1308 |
| 280.000 | 16.948 | 0.05901 | 8.9604 | 329.383 | 17174.8 | 21010.2 | 150.114 | 50.23 | 73.99 | 1270 |
| 290.000 | 16.676 | 0.05997 | 8.4461 | 311.999 | 17855.9 | 21753.7 | 152.723 | 50.88 | 74.72 | 1234 |
| 300.000 | 16.406 | 0.06095 | 7.9671 | 295.932 | 18542.6 | 22504.6 | 155.269 | 51.55 | 75.46 | 1200 |
| 310.000 | 16.138 | 0.06197 | 7.5209 | 281.077 | 19235.2 | 23263.0 | 157.756 | 52.30 | 76.25 | 1167 |
| 320.000 | 15.871 | 0.06301 | 7.1049 | 267.344 | 19934.8 | 24030.2 | 160.192 | 53.26 | 77.25 | 1136 |
| 330.000 | 15.606 | 0.06408 | 6.7169 | 254.650 | 20644.4 | 24809.4 | 162.589 | 54.66 | 78.66 | 1104 |
| 340.000 | 15.344 | 0.06517 | 6.3551 | 242.919 | 21368.3 | 25604.6 | 164.963 | 57.35 | 81.36 | 1071 |
| 350.000 | 15.083 | 0.06630 | 6.0174 | 232.085 | 22110.6 | 26420.1 | 167.326 | 57.77 | 81.77 | 1045 |
| 360.000 | 14.825 | 0.06745 | 5.7021 | 222.086 | 22856.2 | 27240.6 | 169.638 | 58.38 | 82.36 | 1021 |
| 370.000 | 14.570 | 0.06864 | 5.4078 | 212.866 | 23606.5 | 28067.8 | 171.904 | 59.13 | 83.08 | 997 |
| 380.000 | 14.317 | 0.06985 | 5.1329 | 204.373 | 24362.5 | 28902.5 | 174.130 | 59.97 | 83.87 | 975 |
| 390.000 | 14.067 | 0.07109 | 4.8761 | 196.558 | 25124.8 | 29745.4 | 176.320 | 60.89 | 84.73 | 954 |
| 400.000 | 13.821 | 0.07235 | 4.6360 | 189.378 | 25894.1 | 30597.1 | 178.476 | 61.86 | 85.62 | 934 |
| 410.000 | 13.578 | 0.07365 | 4.4116 | 182.791 | 26670.8 | 31458.0 | 180.602 | 62.87 | 86.55 | 915 |
| 420.000 | 13.338 | 0.07497 | 4.2016 | 176.760 | 27455.0 | 32328.2 | 182.699 | 63.92 | 87.49 | 897 |
| 430.000 | 13.103 | 0.07632 | 4.0052 | 171.248 | 28247.0 | 33207.9 | 184.768 | 64.98 | 88.45 | 880 |
| 440.000 | 12.871 | 0.07770 | 3.8213 | 166.221 | 29046.9 | 34097.1 | 186.813 | 66.07 | 89.40 | 865 |
| 450.000 | 12.643 | 0.07910 | 3.6491 | 161.648 | 29854.6 | 34995.9 | 188.832 | 67.16 | 90.36 | 850 |
| 460.000 | 12.419 | 0.08052 | 3.4878 | 157.499 | 30670.3 | 35904.1 | 190.829 | 68.27 | 91.30 | 837 |
| 470.000 | 12.200 | 0.08197 | 3.3365 | 153.747 | 31494.0 | 36821.8 | 192.802 | 69.37 | 92.24 | 825 |
| 480.000 | 11.985 | 0.08344 | 3.1946 | 150.364 | 32325.5 | 37748.9 | 194.754 | 70.48 | 93.16 | 813 |
| 490.000 | 11.775 | 0.08492 | 3.0615 | 147.327 | 33164.9 | 38685.0 | 196.684 | 71.58 | 94.06 | 802 |
| 500.000 | 11.570 | 0.08643 | 2.9365 | 144.612 | 34011.9 | 39630.0 | 198.593 | 72.68 | 94.95 | 793 |
| 520.000 | 11.173 | 0.08950 | 2.7087 | 140.058 | 35729.0 | 41546.4 | 202.351 | 74.86 | 96.68 | 776 |
| 540.000 | 10.796 | 0.09263 | 2.5071 | 136.540 | 37476.0 | 43496.6 | 206.031 | 77.00 | 98.33 | 761 |
| 560.000 | 10.439 | 0.09580 | 2.3284 | 133.908 | 39252.2 | 45479.1 | 209.636 | 79.11 | 99.91 | 750 |
| 580.000 | 10.101 | 0.09900 | 2.1695 | 132.031 | 41057.4 | 47492.7 | 213.169 | 81.17 | 101.44 | 741 |
| 600.000 | 9.781 | 0.10224 | 2.0279 | 130.792 | 42891.0 | 49536.4 | 216.633 | 83.20 | 102.92 | 734 |

Table 27. Thermophysical properties along isobars (Continued)

ETHANE ISOBAR AT P = 600.0 BAR

| T DEG K | DEN MOL/L | VOL L/MOL | DP/DT BAR/K | DP/DD BAR-L/MOL | E J/MOL | H J/MOL | S J/MOL/K | CV J/MOL/K | CP J/MOL/K | W M/SEC |
|---|---|---|---|---|---|---|---|---|---|---|
| 98.828 | 21.975 | 0.04551 | 32.5332 | 1072.177 | 5532.1 | 8262.4 | 78.774 | 47.79 | 67.99 | 2252 |
| 100.000 | 21.940 | 0.04558 | 32.1497 | 1062.379 | 5607.3 | 8342.1 | 79.575 | 47.75 | 67.96 | 2242 |
| 110.000 | 21.640 | 0.04621 | 29.1790 | 983.148 | 6248.1 | 9020.7 | 86.043 | 47.43 | 67.77 | 2161 |
| 120.000 | 21.346 | 0.04685 | 26.6520 | 910.974 | 6886.8 | 9697.7 | 91.934 | 47.10 | 67.63 | 2086 |
| 130.000 | 21.055 | 0.04750 | 24.4673 | 845.002 | 7523.9 | 10373.6 | 97.344 | 46.78 | 67.55 | 2015 |
| 140.000 | 20.766 | 0.04816 | 22.5534 | 784.569 | 8159.7 | 11049.0 | 102.349 | 46.49 | 67.53 | 1947 |
| 150.000 | 20.479 | 0.04883 | 20.8580 | 729.144 | 8794.7 | 11724.5 | 107.009 | 46.25 | 67.58 | 1882 |
| 160.000 | 20.194 | 0.04952 | 19.3422 | 678.275 | 9429.7 | 12400.9 | 111.375 | 46.07 | 67.71 | 1821 |
| 170.000 | 19.909 | 0.05023 | 17.9767 | 631.569 | 10065.2 | 13079.0 | 115.485 | 45.97 | 67.91 | 1762 |
| 180.000 | 19.624 | 0.05096 | 16.7386 | 588.676 | 10702.0 | 13759.4 | 119.374 | 45.95 | 68.19 | 1705 |
| 190.000 | 19.340 | 0.05171 | 15.6102 | 549.274 | 11340.7 | 14443.0 | 123.070 | 46.02 | 68.55 | 1650 |
| 200.000 | 19.056 | 0.05248 | 14.5771 | 513.070 | 11982.0 | 15130.6 | 126.597 | 46.18 | 68.99 | 1597 |
| 210.000 | 18.772 | 0.05327 | 13.6279 | 479.786 | 12626.7 | 15823.0 | 129.975 | 46.43 | 69.49 | 1545 |
| 220.000 | 18.488 | 0.05409 | 12.7533 | 449.180 | 13275.4 | 16520.8 | 133.221 | 46.76 | 70.07 | 1496 |
| 230.000 | 18.204 | 0.05493 | 11.9456 | 421.018 | 13928.6 | 17224.6 | 136.350 | 47.18 | 70.71 | 1449 |
| 240.000 | 17.921 | 0.05580 | 11.1981 | 395.090 | 14586.9 | 17935.0 | 139.373 | 47.67 | 71.39 | 1403 |
| 250.000 | 17.637 | 0.05670 | 10.5054 | 371.203 | 15250.6 | 18652.5 | 142.302 | 48.22 | 72.11 | 1359 |
| 260.000 | 17.355 | 0.05762 | 9.8625 | 349.184 | 15920.0 | 19377.3 | 145.145 | 48.81 | 72.86 | 1317 |
| 270.000 | 17.072 | 0.05857 | 9.2655 | 328.874 | 16595.3 | 20109.7 | 147.909 | 49.44 | 73.62 | 1276 |
| 280.000 | 16.791 | 0.05956 | 8.7105 | 310.135 | 17276.4 | 20849.7 | 150.600 | 50.08 | 74.38 | 1238 |
| 290.000 | 16.511 | 0.06057 | 8.1942 | 292.835 | 17963.3 | 21597.3 | 153.223 | 50.74 | 75.13 | 1201 |
| 300.000 | 16.232 | 0.06161 | 7.7138 | 276.866 | 18655.9 | 22352.4 | 155.783 | 51.42 | 75.89 | 1166 |
| 310.000 | 15.954 | 0.06268 | 7.2666 | 262.123 | 19354.4 | 23115.3 | 158.285 | 52.18 | 76.71 | 1132 |
| 320.000 | 15.677 | 0.06379 | 6.8501 | 248.517 | 20060.1 | 23887.3 | 160.735 | 53.14 | 77.73 | 1099 |
| 330.000 | 15.402 | 0.06492 | 6.4621 | 235.966 | 20775.8 | 24671.3 | 163.148 | 54.55 | 79.16 | 1067 |
| 340.000 | 15.130 | 0.06610 | 6.1006 | 224.395 | 21505.9 | 25471.7 | 165.537 | 57.24 | 81.88 | 1033 |
| 350.000 | 14.859 | 0.06730 | 5.7638 | 213.737 | 22254.5 | 26292.5 | 167.916 | 57.68 | 82.32 | 1007 |
| 360.000 | 14.590 | 0.06854 | 5.4498 | 203.930 | 23006.3 | 27118.6 | 170.243 | 58.30 | 82.93 | 982 |
| 370.000 | 14.324 | 0.06981 | 5.1571 | 194.919 | 23762.8 | 27951.5 | 172.525 | 59.05 | 83.65 | 958 |
| 380.000 | 14.061 | 0.07112 | 4.8842 | 186.651 | 24524.9 | 28792.0 | 174.767 | 59.90 | 84.46 | 936 |
| 390.000 | 13.801 | 0.07246 | 4.6297 | 179.076 | 25293.4 | 29640.8 | 176.972 | 60.82 | 85.33 | 914 |
| 400.000 | 13.544 | 0.07383 | 4.3923 | 172.151 | 26068.7 | 30498.6 | 179.143 | 61.80 | 86.23 | 894 |
| 410.000 | 13.291 | 0.07524 | 4.1709 | 165.832 | 26851.2 | 31365.6 | 181.284 | 62.81 | 87.16 | 875 |
| 420.000 | 13.041 | 0.07668 | 3.9642 | 160.080 | 27641.1 | 32241.9 | 183.396 | 63.86 | 88.10 | 857 |
| 430.000 | 12.796 | 0.07815 | 3.7712 | 154.858 | 28438.6 | 33127.7 | 185.480 | 64.93 | 89.05 | 840 |
| 440.000 | 12.554 | 0.07965 | 3.5910 | 150.129 | 29243.7 | 34023.0 | 187.538 | 66.02 | 90.00 | 825 |
| 450.000 | 12.317 | 0.08119 | 3.4227 | 145.862 | 30056.5 | 34927.7 | 189.571 | 67.12 | 90.94 | 811 |
| 460.000 | 12.085 | 0.08275 | 3.2653 | 142.024 | 30877.0 | 35841.7 | 191.580 | 68.23 | 91.87 | 797 |
| 470.000 | 11.858 | 0.08433 | 3.1182 | 138.588 | 31705.0 | 36765.0 | 193.566 | 69.33 | 92.79 | 785 |
| 480.000 | 11.635 | 0.08595 | 2.9806 | 135.523 | 32540.6 | 37697.4 | 195.529 | 70.44 | 93.68 | 774 |
| 490.000 | 11.418 | 0.08758 | 2.8517 | 132.806 | 33383.6 | 38638.6 | 197.469 | 71.54 | 94.56 | 764 |
| 500.000 | 11.206 | 0.08924 | 2.7311 | 130.409 | 34234.1 | 39588.5 | 199.388 | 72.64 | 95.42 | 755 |
| 520.000 | 10.798 | 0.09261 | 2.5121 | 126.485 | 35956.8 | 41513.6 | 203.163 | 74.82 | 97.07 | 739 |
| 540.000 | 10.411 | 0.09605 | 2.3194 | 123.576 | 37707.9 | 43470.8 | 206.856 | 76.96 | 98.65 | 726 |
| 560.000 | 10.047 | 0.09953 | 2.1494 | 121.524 | 39487.0 | 45459.1 | 210.472 | 79.07 | 100.16 | 716 |
| 580.000 | 9.704 | 0.10305 | 1.9991 | 120.190 | 41293.6 | 47476.8 | 214.012 | 81.13 | 101.61 | 708 |
| 600.000 | 9.381 | 0.10660 | 1.8657 | 119.450 | 43127.5 | 49523.3 | 217.480 | 83.15 | 103.02 | 702 |

Table 27. Thermophysical properties along isobars (Continued)

ETHANE ISOBAR AT P = 550.0 BAR

| T DEG K | DEN MOL/L | VOL L/MOL | DP/DT BAR/K | DP/DD BAR-L/MOL | E J/MOL | H J/MOL | S J/MOL/K | CV J/MOL/K | CP J/MOL/K | W M/SEC |
|---|---|---|---|---|---|---|---|---|---|---|
| 98.115 | 21.950 | 0.04556 | 32.6681 | 1061.842 | 5511.8 | 8017.5 | 78.598 | 47.55 | 68.02 | 2247 |
| 100.000 | 21.892 | 0.04568 | 32.0432 | 1045.873 | 5633.3 | 8145.6 | 79.892 | 47.50 | 67.98 | 2231 |
| 110.000 | 21.589 | 0.04632 | 29.0532 | 965.907 | 6277.0 | 8824.6 | 86.363 | 47.19 | 67.81 | 2149 |
| 120.000 | 21.290 | 0.04697 | 26.5101 | 893.140 | 6918.7 | 9502.1 | 92.258 | 46.86 | 67.70 | 2071 |
| 130.000 | 20.995 | 0.04763 | 24.3117 | 826.687 | 7559.0 | 10178.7 | 97.674 | 46.55 | 67.64 | 1999 |
| 140.000 | 20.702 | 0.04831 | 22.3856 | 765.872 | 8198.2 | 10855.0 | 102.686 | 46.27 | 67.64 | 1930 |
| 150.000 | 20.410 | 0.04900 | 20.6793 | 710.144 | 8837.0 | 11531.7 | 107.355 | 46.03 | 67.71 | 1864 |
| 160.000 | 20.119 | 0.04970 | 19.1537 | 659.041 | 9475.8 | 12209.5 | 111.729 | 45.86 | 67.86 | 1801 |
| 170.000 | 19.829 | 0.05043 | 17.7790 | 612.157 | 10115.4 | 12889.2 | 115.849 | 45.76 | 68.09 | 1740 |
| 180.000 | 19.538 | 0.05118 | 16.5324 | 569.132 | 10756.5 | 13571.5 | 119.749 | 45.74 | 68.39 | 1682 |
| 190.000 | 19.248 | 0.05195 | 15.3960 | 529.632 | 11399.7 | 14257.2 | 123.457 | 45.82 | 68.77 | 1625 |
| 200.000 | 18.957 | 0.05275 | 14.3556 | 493.361 | 12045.8 | 14947.2 | 126.995 | 45.98 | 69.23 | 1572 |
| 210.000 | 18.666 | 0.05357 | 13.3996 | 460.040 | 12695.5 | 15642.1 | 130.386 | 46.24 | 69.76 | 1519 |
| 220.000 | 18.374 | 0.05442 | 12.5188 | 429.414 | 13349.3 | 16342.6 | 133.645 | 46.58 | 70.36 | 1469 |
| 230.000 | 18.083 | 0.05530 | 11.7054 | 401.248 | 14007.9 | 17049.5 | 136.787 | 47.00 | 71.02 | 1420 |
| 240.000 | 17.791 | 0.05621 | 10.9527 | 375.330 | 14671.7 | 17763.2 | 139.824 | 47.50 | 71.73 | 1373 |
| 250.000 | 17.499 | 0.05715 | 10.2553 | 351.467 | 15341.2 | 18484.3 | 142.767 | 48.05 | 72.48 | 1328 |
| 260.000 | 17.207 | 0.05812 | 9.6084 | 329.483 | 16016.6 | 19212.9 | 145.625 | 48.65 | 73.26 | 1284 |
| 270.000 | 16.916 | 0.05912 | 9.0078 | 309.221 | 16698.0 | 19949.4 | 148.405 | 49.28 | 74.04 | 1243 |
| 280.000 | 16.625 | 0.06015 | 8.4498 | 290.543 | 17385.5 | 20693.8 | 151.112 | 49.94 | 74.83 | 1203 |
| 290.000 | 16.334 | 0.06122 | 7.9311 | 273.321 | 18078.8 | 21446.0 | 153.751 | 50.60 | 75.61 | 1165 |
| 300.000 | 16.044 | 0.06233 | 7.4487 | 257.443 | 18778.1 | 22206.1 | 156.328 | 51.29 | 76.40 | 1129 |
| 310.000 | 15.756 | 0.06347 | 7.0001 | 242.811 | 19483.4 | 22974.3 | 158.847 | 52.05 | 77.25 | 1095 |
| 320.000 | 15.468 | 0.06465 | 6.5827 | 229.333 | 20196.0 | 23751.7 | 161.315 | 53.03 | 78.30 | 1061 |
| 330.000 | 15.182 | 0.06587 | 6.1943 | 216.930 | 20918.8 | 24541.6 | 163.746 | 54.44 | 79.76 | 1028 |
| 340.000 | 14.897 | 0.06713 | 5.8330 | 205.528 | 21656.0 | 25348.1 | 166.153 | 57.14 | 82.50 | 993 |
| 350.000 | 14.614 | 0.06843 | 5.4968 | 195.059 | 22411.8 | 26175.3 | 168.551 | 57.58 | 82.97 | 967 |
| 360.000 | 14.333 | 0.06977 | 5.1840 | 185.464 | 23170.8 | 27008.0 | 170.896 | 58.21 | 83.60 | 941 |
| 370.000 | 14.055 | 0.07115 | 4.8929 | 176.685 | 23934.5 | 27847.7 | 173.197 | 58.97 | 84.35 | 917 |
| 380.000 | 13.780 | 0.07257 | 4.6220 | 168.668 | 24703.9 | 28695.3 | 175.457 | 59.82 | 85.17 | 894 |
| 390.000 | 13.507 | 0.07403 | 4.3700 | 161.364 | 25479.4 | 29551.4 | 177.681 | 60.75 | 86.05 | 872 |
| 400.000 | 13.238 | 0.07554 | 4.1355 | 154.727 | 26261.7 | 30416.4 | 179.871 | 61.74 | 86.96 | 851 |
| 410.000 | 12.973 | 0.07708 | 3.9173 | 148.712 | 27051.1 | 31290.7 | 182.030 | 62.76 | 87.90 | 832 |
| 420.000 | 12.711 | 0.07867 | 3.7141 | 143.277 | 27847.6 | 32174.4 | 184.159 | 63.81 | 88.84 | 814 |
| 430.000 | 12.454 | 0.08029 | 3.5250 | 138.384 | 28651.4 | 33067.5 | 186.261 | 64.89 | 89.78 | 798 |
| 440.000 | 12.202 | 0.08195 | 3.3489 | 133.995 | 29462.5 | 33970.0 | 188.335 | 65.98 | 90.72 | 783 |
| 450.000 | 11.955 | 0.08365 | 3.1849 | 130.075 | 30281.1 | 34881.8 | 190.384 | 67.08 | 91.64 | 769 |
| 460.000 | 11.712 | 0.08538 | 3.0320 | 126.592 | 31106.8 | 35802.7 | 192.408 | 68.19 | 92.54 | 756 |
| 470.000 | 11.476 | 0.08714 | 2.8896 | 123.512 | 31939.8 | 36732.5 | 194.408 | 69.30 | 93.43 | 744 |
| 480.000 | 11.245 | 0.08893 | 2.7567 | 120.807 | 32779.9 | 37671.1 | 196.384 | 70.41 | 94.29 | 733 |
| 490.000 | 11.019 | 0.09075 | 2.6327 | 118.448 | 33626.9 | 38618.2 | 198.337 | 71.51 | 95.13 | 724 |
| 500.000 | 10.800 | 0.09259 | 2.5170 | 116.408 | 34480.9 | 39573.5 | 200.267 | 72.61 | 95.94 | 715 |
| 520.000 | 10.380 | 0.09634 | 2.3080 | 113.182 | 36209.4 | 41508.1 | 204.061 | 74.79 | 97.50 | 701 |
| 540.000 | 9.984 | 0.10016 | 2.1252 | 110.938 | 37964.4 | 43473.0 | 207.768 | 76.93 | 98.98 | 689 |
| 560.000 | 9.613 | 0.10402 | 1.9650 | 109.509 | 39745.6 | 45466.8 | 211.394 | 79.03 | 100.39 | 680 |
| 580.000 | 9.266 | 0.10792 | 1.8241 | 108.744 | 41552.9 | 47488.3 | 214.940 | 81.09 | 101.76 | 674 |
| 600.000 | 8.942 | 0.11183 | 1.6998 | 108.518 | 43386.1 | 49536.8 | 218.412 | 83.11 | 103.08 | 669 |

AMERICAN REVOLUTION BICENTENNIAL 1776-1976