2020-2021

HPLC Columns

Shodex™

Capture the Essence

Shodex™

We provide a wide range of products to meet your analytical needs, from pretreatment and separation columns to calibration standards for size exclusion chromatography.
Please visit the Shodex website to see detailed information about our products and their uses with abundant application data.

Shodex website

https://www.shodexhplc.com/

[Caution]

1. Please read the operating manual packaged with the product carefully before the use.
2. For improvement purposes, some specifications are subject to change without notice.
3. Figures and descriptions in this catalogue are provided to help you select appropriate columns. However they do not guarantee nor warrant the suitability for your applications.
4. It is essential to take normal precautions when handling reagents and other chemical products even if the safety information is not included in the operating manual.
5. Products described in this brochure are not intended for medical use or medical applications including medical diagnosis.

Contents

Types of Columns, Base Materials, Functional Groups and Ligands

Separation Type	Product Name		Base Material	Functional Group, Ligand	Page
Reversed Phase & HILIC (Polymer-based)		ODP2 HP	Polyhydroxymethacrylate	—	8
	Asahipak	ODP-40, ODP-50, ODP-90	Polyvinyl alcohol	Octadecyl	10
	Asahipak	C8P-50	Polyvinyl alcohol	Octyl	10
	Asahipak	C4P-50	Polyvinyl alcohol	Butyl	10
	RSpak	RP18-415, DS-613, DS-413	Styrene divinylbenzene copolymer	—	12
	RSpak	DE-613, DE-413, DE-213	Polymethacrylate	—	12
	RSpak	DM-614	Polyhydroxymethacrylate	—	12
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	RSpak	JJ-50	Polyvinyl alcohol	Quaternary ammonium	13
	HILICpak	VG-50	Polyvinyl alcohol	Amino	16
	HILICpak	VT-50	Polyvinyl alcohol	Quaternary ammonium	16
	HILICpak	VC-50	Polyvinyl alcohol	Carboxyl	16
	HILICpak	VN-50	Polyvinyl alcohol	Diol	16
	Asahipak	NH2P-40, NH2P-50, NH2P-90	Polyvinyl alcohol	Amino	20
		ET-RP1	Polyvinyl alcohol	Octadecyl	74
Reversed Phase, Normal Phase & HILIC (Silica-based)		C18	Silica	Octadecyl	22
	Silica	C18M, C18P	Silica	Octadecyl	22
	Silica	5C8	Silica	Octyl	22
	Silica	5CN	Silica	Cyanopropyl	22
	Silica	5NPE	Silica	Nitrophenylethyl	22
		C18U	Organic/inorganic hybrid silica	Octadecyl	23
	Silica	5SIL	Silica	—	23
	Silica	5NH	Silica	Aminopropyl	23
Ligand Exchange	SUGAR	SC1011, SC1821, SC1211	Styrene divinylbenzene copolymer	Sulfo (Ca^{2+})	26
	SUGAR	SP0810	Styrene divinylbenzene copolymer	Sulfo (Pb^{2+})	26
	SUGAR	KS-800	Styrene divinylbenzene copolymer	Sulfo (Na^{+})	26
	SUGAR	KS-2000	Styrene divinylbenzene copolymer	Sulfo (Na^{+})	27
	RSpak	DC-613	Styrene divinylbenzene copolymer	Sulfo (Na^{+})	26
	SUGAR	SZ5532	Styrene divinylbenzene copolymer	Sulfo (Zn^{2+})	26
	EP	SC1011-7F	Styrene divinylbenzene copolymer	Sulfo (Ca^{2+})	27
	USPpak	MN-431	Styrene divinylbenzene copolymer	Sulfo (Ca^{2+})	27
Ion Exclusion	SUGAR	SH1011, SH1821	Styrene divinylbenzene copolymer	Sulfo	30
	RSpak	KC-811	Styrene divinylbenzene copolymer	Sulfo	30
Ion Chromatography	IC	NI-424, I-524A	Polyhydroxymethacrylate	Quaternary ammonium	32
	IC	SI-90, SI-50, SI-52, SI-35, SI-36	Polyvinyl alcohol	Quaternary ammonium	32
	IC	YS-50	Polyvinyl alcohol	Carboxyl	34
	IC	YK-421	Silica	Carboxyl	34
	IC	Y-521, T-521	Styrene divinylbenzene copolymer	Sulfo	34
Aqueous SEC (GFC)	PROTEIN	KW-800	Silica	Hydrophilic polymer	38
		KW400	Silica	Hydrophilic polymer	38
	PROTEIN	KW-2000	Silica	Hydrophilic polymer	39
	PROTEIN	LW-803, LW-403 4D	Silica	Hydrophilic polymer	39
	OHpak	SB-800 HQ	Polyhydroxymethacrylate	—	42
	OHpak	SB-2000	Polyhydroxymethacrylate	—	43
	OHpak	LB-800	Polyhydroxymethacrylate	—	42
Multimode	Asahipak	GS-HQ	Polyvinyl alcohol	—	46
Aqueous/Organic SEC	Asahipak	GF-HQ	Polyvinyl alcohol	—	48
	MSpak	GF-310	Polyvinyl alcohol	—	48
Organic SEC (GPC)	GPC	KF-800, KF-2000, K-800, K-2000, KD-800, KF-600, KF-400HQ, HK-400, LF, HT-800, UT-800, AT-806MS, HFIP-800, HFIP-600, FP-2002, H-2000, KF-5000, K-5000	Styrene divinylbenzene copolymer	—	50 - 67
Ion Exchange	IEC	QA-825, QA-2025	Polyhydroxymethacrylate	Quaternary ammonium	70
	IEC	DEAE-825, DEAE-2025	Polyhydroxymethacrylate	Diethylaminoethyl	70
	Asahipak	ES-502N	Polyvinyl alcohol	Diethylaminoethyl	70
	AXpak	WA-624	Polyhydroxymethacrylate	Diethylaminoethyl	70
	IEC	SP-825, SP-2025	Polyhydroxymethacrylate	Sulfopropyl	72
	IEC	SP-FT 4A	Polyhydroxymethacrylate	Sulfopropyl	72
	IEC	CM-825, CM-2025	Polyhydroxymethacrylate	Carboxymethyl	72
	Asahipak	ES-502C	Polyvinyl alcohol	Carboxymethyl	72
	CXpak	P-421S	Styrene divinylbenzene copolymer	Sulfo (Na^{+})	72
Hydrophobic Interaction	HIC	PH-814	Polyhydroxymethacrylate	Phenyl	74
Affinity	AFpak	APA-894	Polyhydroxymethacrylate	Protein A	74
	AFpak	ACH-494	Polyhydroxymethacrylate	Choline oxydase, Acetylcholine esterase	74
Chiral Separation	ORpak	CDBS-453	Silica	ß-Cyclodextrin derivative	74
	ORpak	CRX-853	Polyhydroxymethacrylate	L-Amino acid derivative	74
Column Switching Pretreatment	MSpak	GF-4A	Polyvinyl alcohol	—	74
GPC Clean-up	CLNpak	EV	Styrene divinylbenzene copolymer	—	76
	CLNpak	PAE	Polyvinyl alcohol	—	76

HPLC Separation Modes

Liquid chromatography (LC) uses liquid as mobile phase (eluent). It is an analytical method that separates a mixture of compounds based on their physical and chemical differences. High performance liquid chromatography (HPLC) is a method that introduces the mobile phase under high-pressure conditions resulting in rapid and high-performance separations. The various interactions between the analyte, stationary phase (packing material), and mobile phase are the key factors for the separation. A wide variety of separation modes can be achieved by using particular combinations of stationary and mobile phases.

Separation mode	Characteristics
Reversed Phase Chromatography (RPC)	• Separation is based on the partition equilibrium between stationary phase and mobile phase. • The polarity of the stationary phase is lower than that of the mobile phase. • Typically the mobile phase contains a mixture of organic solvents (methanol, acetonitrile, or THF) and aqueous solvents (water or buffer). • Use of lower polarity mobile phases fasten the elution.
Hydrophilic Interaction Chromatography (HILIC)	• Separation is based on hydrophilic interaction. • A high polarity stationary phase is used. • Typically the mobile phase contains a mixture of organic solvents such as acetonitrile and aqueous solvents (water or buffer). • Using the higher polarity mobile phase causes a faster elution. • Applicable for the analysis of high polar substances.
Normal Phase Chromatography (NPC)	• Separation is based on the partition equilibrium between the stationary phase and the mobile phase. • The polarity of the stationary phase is higher than that of the mobile phase. • Typically the mobile phase contains a mixture of organic solvents with different polarities such as hexane and isopropanol. • Using the higher polarity mobile phase causes a faster elution.
Ligand Exchange Chromatography (LEX)	• Separation is based on differences in analytes' coordination complex. • Stationary phase modified with metal sulfonate complex ion. • Works in combination with size exclusion or HILIC modes.
Ion Exclusion Chromatography (IEX)	• Separation is based on electrostatic interaction (repulsion) between the ion exchanger and ionic solutes. • Dissociated ionic molecules elute faster than non-dissociated forms. • Used mainly for the analysis of organic acids.
Ion Chromatography (IC)	• Separation is based on electrostatic interaction (bonding) between the ion exchanger and ionic solutes. • Electrical conductivity detector can be used with a mobile phase with low-salt concentration. • Used mainly for the analysis of inorganic compounds.
Size Exclusion Chromatography (SEC)	• Network or pores on the surface of the packing material works as molecular sieve to separate molecules based on their sizes. • To separate molecules solely based on their sizes, it requires an analytical condition without any compounds and packing gel interaction. • The bigger the molecule size, the faster the elution sequence. • Used for molecular weight or molecular distribution determination of macromolecules and qualification of oligomers.
Ion Exchange Chromatography (IEC)	• Separation is based on electrostatic interactions between the ion exchanger and ionic solutes. • The mobile phase of choice should have a sufficient buffering capacity at the pH that produces the largest charge differences between the analyte of interest. • The elution position is optimized by varying the pH, salt concentration, and/or ionic strength of the mobile phase.
Hydrophobic Interaction Chromatography (HIC)	• Separation is based on hydrophobic interaction. • Hydrophobic functional group is modified on the stationary phase. • Adsorption of analytes generally occurs at a high salt concentration and they are released by lowering the salt concentration. • Used mainly for the analysis of proteins.
Affinity Chromatography (AFC)	• Separation is based on adsorption of the analyte to the specific biologically derived ligand pair. • Highly selective. • A buffer solution with the appropriate pH and ionic strength is selected based on the type of ligand, analytes, and their interaction. • Used mainly for the purification and concentration of biologically active substances.
Chiral Separation Chromatography (CS)	• Separation of optical isomers using chiral selectors. • Highly selective.
Multimode Chromatography	•Separation is based on the combination of different modes.

Column Selection by Sample Character and Separation Mode

Sample Solubility	Sample MW	Separation Mode
Aqueous soluble	≥ 2,000	RPC
		LEX
		IEX
		SEC
		IEC
		HIC
		AFC
	≤ 2,000	RPC
		HILIC
		LEX
		IEX
		IC
		SEC
		IEC
		AFC
		CS

Sample Solubility	Sample MW	Separation Mode
Organic soluble	≥ 2,000	SEC
	≤ 2,000	SEC
		PRC
		NPC

RPC : Reversed Phase Chromatography
HILIC : Hydrophilic Interaction Chromatography
NPC : Normal Phase Chromatography
LEX : Ligand Exchange Chromatography
IEX : Ion Exclusion Chromatography
IC : Ion Chromatography
SEC : Size Exclusion Chromatography
IEC : Ion Exchange Chromatography
HIC : Hydrophobic Interaction Chromatography
AFC : Affinity Chromatography
CS : Chiral Separation Chromatography

Column Selection (Application)

Pharmaceuticals, Cosmetics

		Separation Mode	Page
Pharmaceuticals Metabolites Additives	Hydrophobic substances	RPC	8, 10, 12, 22
	Hydrophilic substances	HILIC	16, 20
		IEC + RPC	12
		LEX + SEC	26, 27
	Substances in bio-fluid (serum·plasma·urine)	RPC	8
		SEC + RPC	46, 48
	Polymer	SEC	38, 42, 48, 54, 60
Moisturizers	Polyalcohols	RPC	12
		LEX + SEC	26
		LEX + HILIC	26
		SEC	42, 48
	Protein hydrolysates	RPC	10, 12, 23
		SEC	38, 39
	Mucopolysaccharides	SEC	42
Emulsifiers	Surfactants	RPC	8
		SEC + RPC	48
		SEC	50, 56, 58
Preservatives	Paraben Dehydroacetic acid	RPC	10, 12, 22, 23
Optical active materials		CS	74

Foods

		Separation Mode	Page
Nutritional ingredients	Monosaccharides Disaccharides Sugar alcohols	HILIC	16, 20
		LEX + SEC	26
		LEX + HILIC	26
	Oligosaccharides	HILIC	16, 20
		LEX + HILIC	26
		SEC	26, 42, 46
	Low molecular weight water-soluble dietary fiber	SEC	46
	Polysaccharides	SEC	26, 42
	Organic acids	RPC	8, 12
		IEX + RPC	30
		IC	32
	Water-soluble vitamins	RPC	8, 10, 12, 14
		IEC + RPC	12
		HILIC	16, 20
	Fat-soluble vitamins	RPC	10
		NPC	23
		SEC	50, 54
	Fatty acids	RPC	12, 22
		SEC	48, 50, 52, 54
	Nucleic acids (umami)	IEC+SEC	46
	Amino acids	IEC + IEX + RPC	12
		HILIC	16
		IC	34
		IEC	72
Food safety	Food additives	RPC	10, 12, 74
		HILIC	16, 20
	Pesticides	RPC	12, 22, 23
		IEC + RPC	12
		HILIC	16
		IC	32
	Mycotoxin	RPC	22, 23
	Pretreatment of residual pesticides	SEC GPC (clean-up)	76

New Materials

		Separation Mode	Page
Synthetic polymers	Organic solvent soluble	SEC	48, 50, 52, 54, 56, 58, 60
	Polar organic solvent soluble		42, 48, 54, 56, 58, 60
	High temperature/ Ultra high temperature		62
	Water-soluble		38, 42, 46, 48
Additives Oligomers		RPC	10, 12, 22, 23
	Organic solvent soluble	SEC	48, 50, 52, 56, 58
	Polar organic solvent soluble		42, 48, 54, 56, 58
	Water-soluble		38, 42, 46, 48

Separation Mode (Page 4 and Page 5)

RPC : Reversed Phase Chromatography
HILIC : Hydrophilic Interaction Chromatography
NPC : Normal Phase Chromatography
LEX : Ligand Exchange Chromatography
IEX : Ion Exclusion Chromatography
IC : Ion Chromatography
SEC : Size Exclusion Chromatography
IEC : Ion Exchange Chromatography
HIC : Hydrophobic Interaction Chromatography
AFC : Affinity Chromatography
CS : Chiral Separation Chromatography

Biotechnology

		Separation Mode	Page
Genomics	Nucleobases Nucleotides Nucleosides	RPC	12
		IEC + SEC	12, 46
		IEC	70
	Oligo nucleic acids	HILIC	16
		RPC	12
		IEC + SEC	46
		IEC	70
	DNA/RNA	SEC	42, 46
Proteomics	Amino acids	RPC	10
		IEC + IEX + RPC	12
		HILIC	16
		IEC	72
		IEC + SEC	46
	Peptides Proteins	RPC	10, 12, 23
		SEC	38, 42, 46, 48
		IEC	70, 72
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Glycomics	Glycoproteins	RPC	10, 12
		SEC	38, 42, 46, 48
		IEC	70, 72
		HIC	74
	Sugar chains	HILIC	16, 20
	Monosaccharides	HILIC	16, 20
		LEX + SEC	26
		LEX + HILIC	26
	Sialic acids Uronic acids Aldonic acids	IEX + RPC	30
Hormones	Amines	RPC	8, 10, 12
		IEC	72
	Steroids	RPC	10
		HILIC	16, 20
		SEC	42, 48
Lipids	Phospholipids	NPC	23
		SEC	48, 50, 54
	Lipoproteins	SEC	38, 42

Environment

		Separation Mode	Page
Water quality	Anions	IC	32
	Oxyhalides	IC	32
		IEC+HILIC	16
	Cyanide Cyanogen chloride	IEX	30
	Cations	IC	34
	Surfactants	RPC	10, 22, 23
		SEC+RPC	48
	Pesticides	RPC	12, 22, 23
		IEC+RPC	12
		HILIC	16
		IC	32
Soil	Anions	IC	32
	Heavy metals	IC	34
	Humic substances	SEC	42
	Organic arsenic	IEX+RPC	12
	Pesticides	RPC	12, 22, 23
		IEC+RPC	12
		HILIC	16
		IC	32
Environmental hormones	Pretreatment of Phthalates PCBs Benzo [a] pyrene	SEC GPC (clean-up)	76
Bioethanols	Monosaccharides Oligosaccharides	HILIC	16, 20
		LEX+SEC	26
	Oligosaccharides Alcohols Furfural	LEX+SEC	26
	Saccharides Organic acids Alcohols Furfural	IEX+RPC+SEC	30
	Hemicelluloses Celluloses	SEC	54, 62
Biodiesels	Cations	IC	34
	Fatty acid glycerides	SEC	48
	Fatty acid methyl esters	RPC	12
	Organic acids	IC	32

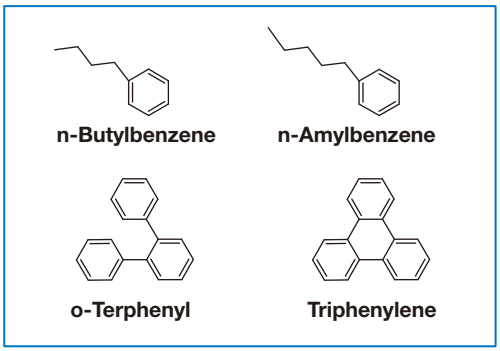
Comparison of Shodex Reversed Phase Chromatography (RPC) Column Features

ODS columns are the most popular reversed phase columns that are packed with silica-based octadecyl group. Shodex provides not only ODS columns but also polymer-based reversed phase columns with different functional groups. Please use following descriptions about the column features as guidelines to select suitable columns for your application purposes.

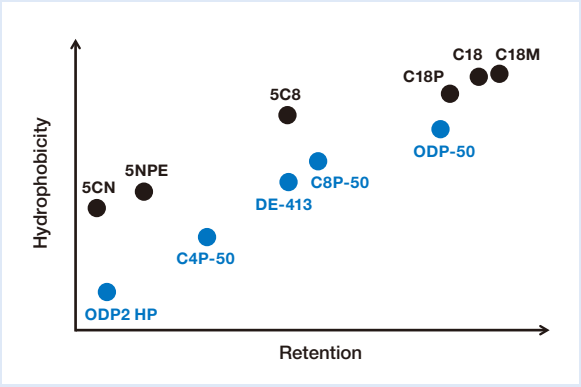
Features

ODP2 HP	• Provides a large theoretical plate number nearly twice as much as generally available polymer-based reversed phase columns do • Offers enhanced retention of high polar substances compared to ODS columns • Suitable for the analysis of small molecules such as pharmaceuticals in the presence of protein matrix • Ideal for LC/MS analysis of high polar compounds • Fulfills USP L39 requirements
ODP-50 **C8P-50** **C4P-50**	• Relatively large pore size is suitable for the analysis of amino acids, peptides, and proteins • Usable in a wide pH range from pH 2 to 13 • Usable in 100 % water and buffer solution • Best used for the analysis of basic substances • ODP-50 fulfills USP L67 requirements
ODP-40	• Higher performance type of ODP-50 series • Fulfills USP L67 requirements
RP18-415	• Large pore size is suitable for the analysis of proteins and peptides • Fulfills USP L21 requirements
DS-613 **DS-413**	• Suitable for reversed phase analysis of highly hydrophilic substances that are not well retained by ODS columns • Fulfill USP L21 requirements
DE-613 **DE-413** **DE-213**	• General purpose polymer-based column having similar polarity as ODS columns • Wide working pH range (from pH 2 to 12), usable in 100 % water and buffer solutions • Fulfill USP L71 requirements
DM-614	• Suitable for the analysis of amino acids and water-soluble vitamins • Fulfills USP L39 requirements
NN-814 **NN-614** **NN-414**	• The packing material modified with sulfo groups supports multimode (reversed phase and cation exchange) analysis • Ideal for the analysis of complex samples containing neutral and ionic substances
JJ-50	• The packing material is modified with trace amounts of quaternary ammonium groups, and supports multimode (reversed phase and anion exchange) analysis • Ideal for analysis of complex samples containing neutral and ionic substances
C18	• Fully end capped ODS column available at very reasonable price • Fulfills USP L1 requirements
C18M	• Monomeric type ODS column, fully end capped high purity silica (99.99 % or higher) • Fulfills USP L1 requirements
C18P	• Polymeric type ODS column, fully end capped high purity silica (99.99 % or higher) • Excellent acid tolerance • Advantageous for separating planar and nonplanar compounds from each other • Fulfills USP L1 requirements
New **C18U**	• UHPLC column (Maximum pressure: 100 MPa) • Achieves high performance analysis with sub-2 μm particles • Organic/inorganic silica hybrid particles provide excellent resolution and mechanical stability and improved alkali durability (from pH 1 to 12) • Usable in 100 % water and buffer solution • Fulfills USP L1 requirements
5C8	• Use when the retention capacity of C18 is too strong • Rapid mass transfer and fast equilibration allow its use as an ion-pair chromatography • Fulfills USP L7 requirements
5CN	• Utilizes reversed phase interaction and π-electron interaction to separate regioisomers, which typically cannot be separated with ODS or C8 columns • Fulfills USP L10 requirements
5NPE	• Utilizes several types of interactions based on π-electrons to separate structural isomers

The interrelation between hydrophobicity and retention, and the interrelation between steric selectivity and retention were compared among Shodex columns for reversed phase chromatography. The retention factor (k') of amylbenzene was used as the retention, the separation factor (α) between n-butylbenzene and n-amino benzene was used as the hydrophobicity. The separation factor between o-terphenil and triphenylene was used as the steric recognition.
Larger separation factor means higher hydrophobicity and higher steric selectivity.

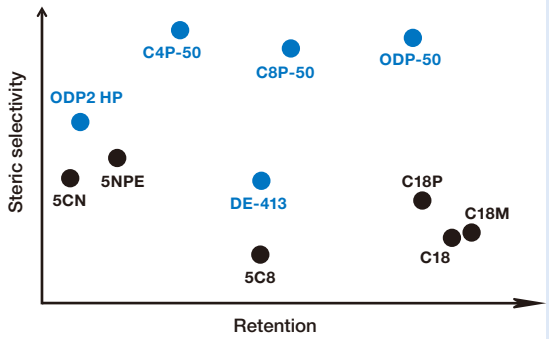


Hydrophobicity differences among Shodex RPCs



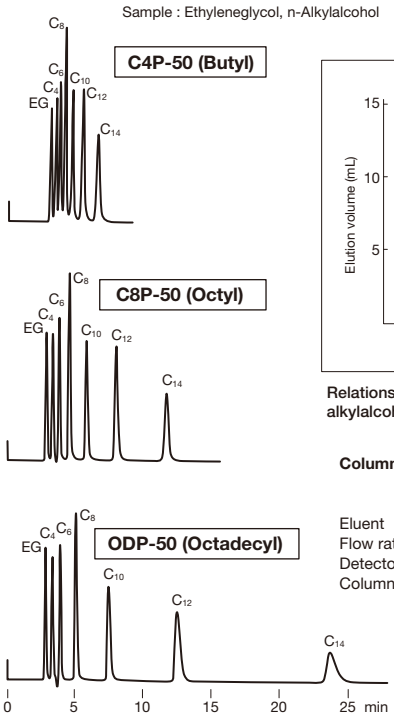
Column size : 4.6 mm I.D. x 150 mm each
Eluent : H_2O/CH_3OH=20/80
Flow rate : 1.0 mL/min
Detector : UV (254 nm)
Column temp. : 40 ℃

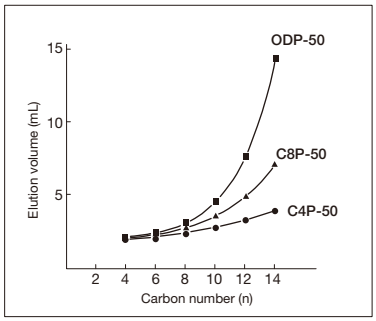
Steric selectivity differences among Shodex RPCs



Column size : 4.6 mm I.D. x 150 mm each
Eluent : H_2O/CH_3OH=20/80
Flow rate : 1.0 mL/min
Detector : UV (254 nm)
Column temp. : 40 ℃

Comparison of different functional groups on the separation of alkylalcohols

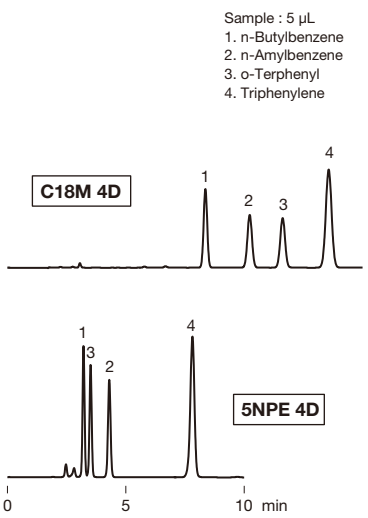




Relationship between the carbon number in alkylalcohols and elution volume

Column : Shodex Asahipak ODP-50 4D
Shodex Asahipak C8P-50 4D
Shodex Asahipak C4P-50 4D
Eluent : H_2O/CH_3OH=20/80
Flow rate : 0.6 mL/min
Detector : RI
Column temp. : 30 ℃

Effects of steric selectivity differences



Column : Shodex Silica C18M 4D
Shodex Silica 5NPE 4D
Eluent : H_2O/CH_3OH=20/80
Flow rate : 1.0 mL/min
Detector : UV (254 nm)
Column temp. : 40 ℃

Polymer-based Reversed Phase Chromatography Columns (ODP2 HP)

Please refer to “Comparison of Shodex Reversed Phase Chromatography (RPC) Column Features” on page 6 and 7 for features.

Standard columns

Product Code	Product Name	Plate Number (TP/column)	Functional Group	Particle Size (µm)	Pore Size (Å)	Column Size (mm) I.D. x Length	Shipping Solvent
F7622001	**ODP2 HP-4B**	≥ 3,500	–	5	40	**4.6 x 50**	H_2O/CH_3CN=55/45
F7622002	**ODP2 HP-4D**	≥ 13,000	–	5	40	**4.6 x 150**	H_2O/CH_3CN=55/45
F7622003	**ODP2 HP-4E**	≥ 17,000	–	5	40	**4.6 x 250**	H_2O/CH_3CN=55/45
F6714010	**ODP2 HPG-4A**	(guard column)	–	5	–	**4.6 x 10**	H_2O/CH_3CN=55/45

Base Material: Polyhydroxymethacrylate

Semi-micro columns

Product Code	Product Name	Plate Number (TP/column)	Functional Group	Particle Size (µm)	Pore Size (Å)	Column Size (mm) I.D. x Length	Shipping Solvent
F7622004	**ODP2 HP-2B**	≥ 3,000	–	5	40	**2.0 x 50**	H_2O/CH_3CN=55/45
F7622005	**ODP2 HP-2D**	≥ 7,000	–	5	40	**2.0 x 150**	H_2O/CH_3CN=55/45
F6714011	**ODP2 HPG-2A**	(guard column)	–	5	–	**2.0 x 10**	H_2O/CH_3CN=55/45

Base Material: Polyhydroxymethacrylate

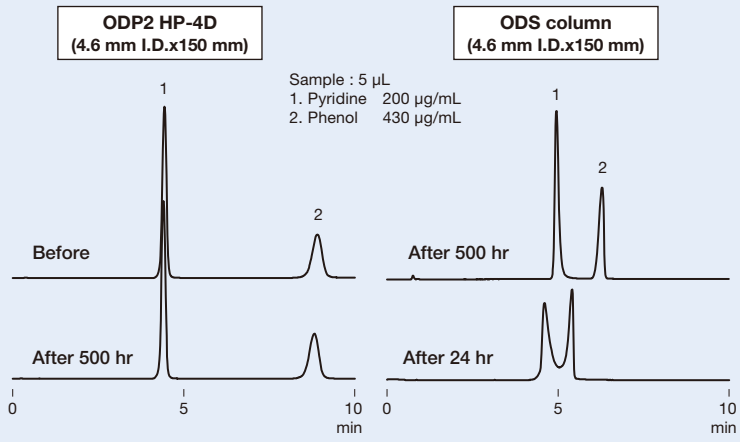
Preparative columns [Preparative columns are made to order.]

Product Code	Product Name	Plate Number (TP/column)	Particle Size (µm)	Column Size (mm) I.D. x Length	Standard Column
F6822001	**ODP2 HP-10E**	≥ 9,500	6	**10.0 x 250**	ODP2 HP
F6714015	**ODP2 HPG-7B**	(guard column)	6	**7.5 x 50**	(guard column)

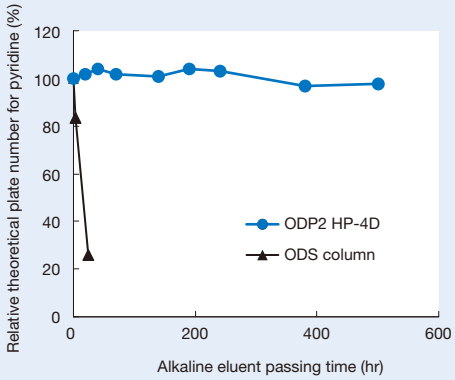
Base Material: Polyhydroxymethacrylate

Comparison between ODP2 HP-4D and an ODS column for their alkaline tolerances

Chromatograms obtained before and after passing alkaline eluent



Correlation between alkaline eluent passing time and relative theoretical plate number



Analysis condition

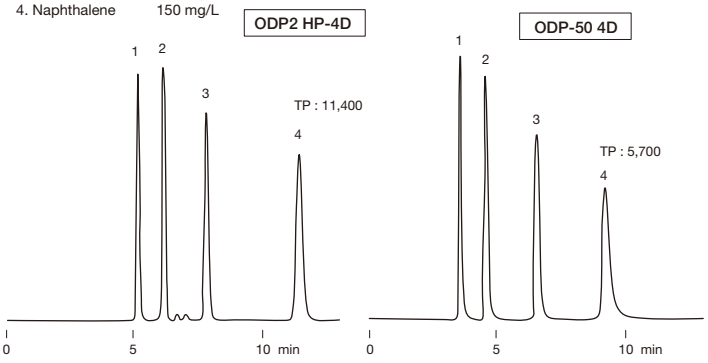
Column : **Shodex ODP2 HP-4D**
ODS column from other manufacturer
Eluent : H_2O/CH_3OH=70/30
Flow rate : 1.0 mL/min
Detector : UV (254 nm)
Column temp. : 40 ℃

Eluent passing conditions for alkaline tolerance test

Column : **Shodex ODP2 HP-4D**
ODS column from other manufacturer
Eluent : 10 mM Sodium phosphate buffer (pH12) /CH_3CN=45/55
Flow rate : 0.6 mL/min
Column temp. : 30 ℃

Comparison between ODP2 HP and ODP-50

Sample : 5 µL
1. Phenol 300 mg/L
2. Methyl benzoate 350 mg/L
3. Toluene 1000 mg/L
4. Naphthalene 150 mg/L

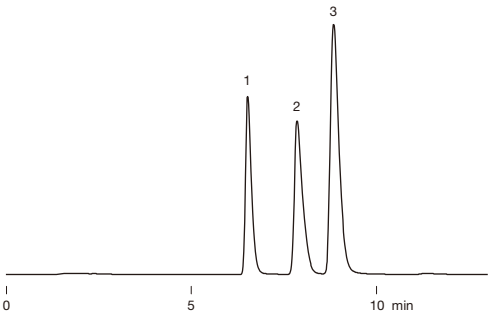


Column : Shodex ODP2 HP-4D
Eluent : H_2O/CH_3CN=55/45
Flow rate : 0.6 mL/min
Detector : UV (254 nm)
Column temp. : 40 ℃

Column : Shodex Asahipak ODP-50 4D
Eluent : H_2O/CH_3CN=35/65
Flow rate : 0.6 mL/min
Detector : UV (254 nm)
Column temp. : 40 ℃

Imidazoles

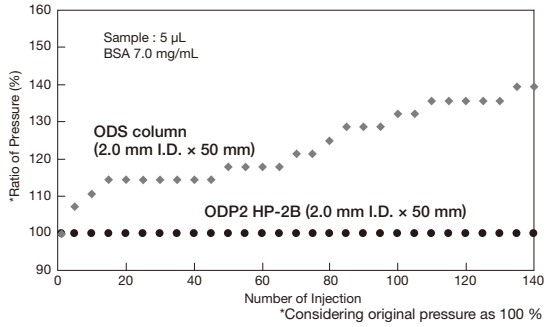
Sample : 0.1 % each, 10 µL
1. Imidazole
2. 2-Methylimidazole
3. 4-Methylimidazole



Column : Shodex ODP2 HP-4E
Eluent : 10 mM Na_2HPO_4 aq./CH_3CN=90/10
Flow rate : 0.8 mL/min
Detector : UV (220 nm)
Column temp. : 40 ℃

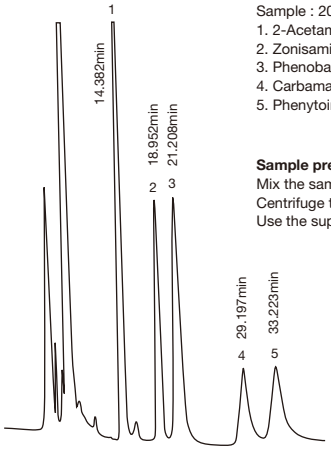
Influence of repeated protein injection on column pressure

ODP2 HP columns are packed with gels with increased surface polarity and smaller pore size which prevent the adsorption of proteins.
BSA was injected multiple times to both ODS and ODP2 HP columns.
A significant column pressure increase was observed for the ODS column, while no considerable change was observed for the ODP2 HP column even after 140 injections.



Column : Shodex ODP2 HP-2B
ODS column from other manufacturer
Eluent : 1 mM CH_3COONH_4 aq./CH_3CN=90/10
Flow rate : 0.2 mL/min
Detector : UV (220 nm)
Column temp. : 30 ℃

Anticonvulsant in serum



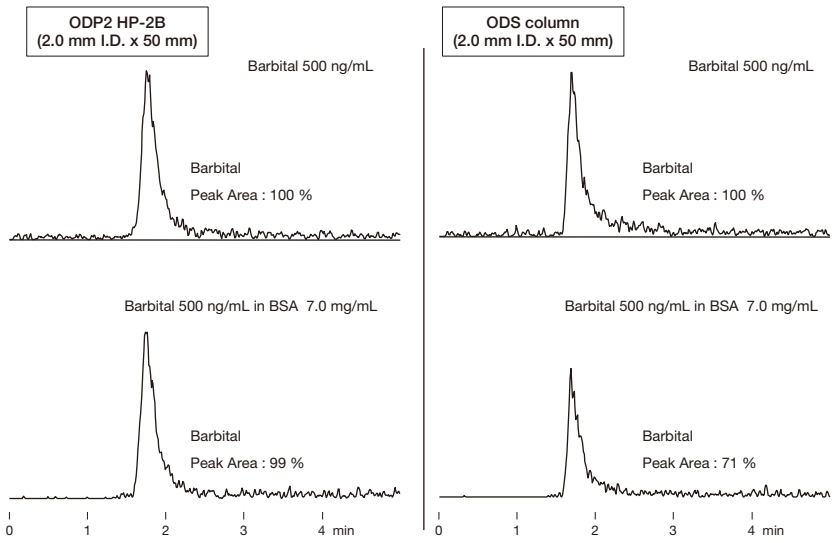
Sample : 20 µL
1. 2-Acetaminophenol (I.S.) 10 µg/mL
2. Zonisamide 13.0 µg/mL
3. Phenobarbital 19.0 µg/mL
4. Carbamazepine 4.5 µg/mL
5. Phenytoin 9.0 µg/mL

Sample pretreatment:
Mix the same volumes of serum and acetonitrile. Centrifuge the mixture at 6000 x *g* for 5 minutes. Use the supernatant as sample.

Data provided by Katsuko Hara.MT Yutaka Komiyama .Ph.D., Department of Clinical Sciences and Laboratory Medicine, Kansai Medical University.

Column : Shodex ODP2 HP-4E
Eluent : 25 mM Sodium phosphate buffer (pH5.2)/CH_3CN=680/320
Flow rate : 0.35 mL/min
Detector : UV (210 nm)
Column temp. : 40 ℃

Comparison of barbital recovery rate using ODP2 HP-2B and ODS in the presence of BSA



For the LC/MS analysis of drugs in samples containing a protein matrix, use of ODP2 HP column showed less matrix effect (ion suppression in this case) compared to when ODS column was used. The ODP2 HP column does not retain proteins as they are eluted in the void volume.

Column : Shodex ODP2 HP-2B
ODS column from other manufacturer
Eluent : 10 mM Ammonium acetate aq. /CH_3CN=70/30
Flow rate : 0.2 mL/min
Detector : ESI-MS (SIM Negative : m/z 183)
Column temp. : 30 ℃
Injection vol. : 10 µL

Polymer-based Reversed Phase Chromatography Columns (Asahipak)

Please refer to “Comparison of Shodex Reversed Phase Chromatography (RPC) Column Features” on page 6 and 7 for features.

Standard columns

Product Code	Product Name	Plate Number (TP/column)	Functional Group	Particle Size (μm)	Pore Size (Å)	Column Size (mm) I.D. x Length	Shipping Solvent
F7621001	**Asahipak ODP-40 4D**	≥ 11,000	Octadecyl	4	250	**4.6 x 150**	H_2O/CH_3CN=35/65
F7621002	**Asahipak ODP-40 4E**	≥ 17,000	Octadecyl	4	250	**4.6 x 250**	H_2O/CH_3CN=35/65
F7620002	**Asahipak ODP-50 6D**	≥ 9,000	Octadecyl	5	250	**6.0 x 150**	H_2O/CH_3CN=35/65
F7620001	**Asahipak ODP-50 6E**	≥ 14,000	Octadecyl	5	250	**6.0 x 250**	H_2O/CH_3CN=35/65
F6710001	**Asahipak ODP-50G 6A**	(guard column)	Octadecyl	5	–	**6.0 x 10**	H_2O/CH_3CN=35/65
F6710023	**Asahipak ODP-50 4B**	≥ 2,500	Octadecyl	5	250	**4.6 x 50**	H_2O/CH_3CN=35/65
F7620004	**Asahipak ODP-50 4D**	≥ 9,000	Octadecyl	5	250	**4.6 x 150**	H_2O/CH_3CN=35/65
F7620003	**Asahipak ODP-50 4E**	≥ 14,000	Octadecyl	5	250	**4.6 x 250**	H_2O/CH_3CN=35/65
F6710022	**Asahipak ODP-50G 4A**	(guard column)	Octadecyl	5	–	**4.6 x 10**	H_2O/CH_3CN=35/65
F7620006	**Asahipak C8P-50 4D**	≥ 7,000	Octyl	5	250	**4.6 x 150**	H_2O/CH_3CN=35/65
F7620005	**Asahipak C8P-50 4E**	≥ 11,000	Octyl	5	250	**4.6 x 250**	H_2O/CH_3CN=35/65
F6710002	**Asahipak C8P-50G 4A**	(guard column)	Octyl	5	–	**4.6 x 1 0**	H_2O/CH_3CN=35/65
F7620008	**Asahipak C4P-50 4D**	≥ 6,000	Butyl	5	250	**4.6 x 150**	H_2O/CH_3CN=35/65
F7620007	**Asahipak C4P-50 4E**	≥ 9,000	Butyl	5	250	**4.6 x 250**	H_2O/CH_3CN=35/65
F6710003	**Asahipak C4P-50G 4A**	(guard column)	Butyl	5	–	**4.6 x 10**	H_2O/CH_3CN=35/65

Base Material: Polyvinyl alcohol

Semi-micro columns

Product Code	Product Name	Plate Number (TP/column)	Functional Group	Particle Size (μm)	Pore Size (Å)	Column Size (mm) I.D. x Length	Shipping Solvent
F7620009	**Asahipak ODP-50 2D**	≥ 5,000	Octadecyl	5	250	**2.0 x 150**	H_2O/CH_3CN=35/65
F6713001	**Asahipak ODP-50G 2A**	(guard column)	Octadecyl	5	–	**2.0 x 10**	H_2O/CH_3CN=35/65

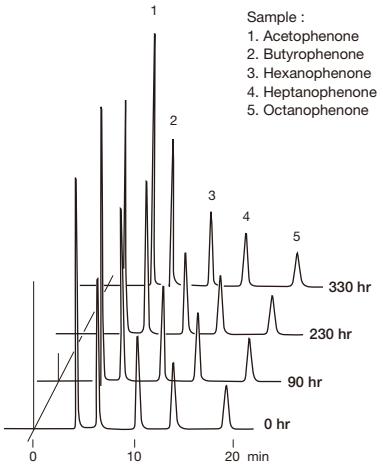
Base Material: Polyvinyl alcohol

Preparative columns [Preparative columns are made to order.]

Product Code	Product Name	Plate Number (TP/column)	Particle Size (μm)	Column Size (mm) I.D. x Length	Standard Column
F6820001	**Asahipak ODP-50 10E**	≥ 10,000	5	**10.0 x 250**	ODP-40, ODP-50
F6820035	**Asahipak ODP-90 20F**	≥ 9,000	9	**20.0 x 300**	ODP-40, ODP-50
F6710004	**Asahipak ODP-130G 7B**	(guard column)	13	**7.5 x 50**	(guard column)

Base Material: Polyvinyl alcohol

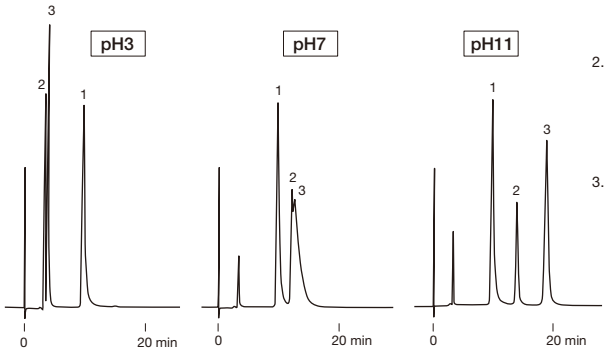
Alkaline tolerance of ODP-50

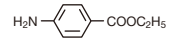
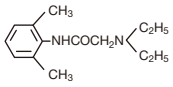
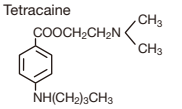


Column : Shodex Asahipak ODP-50 4D
Eluent : 10 mM NaOH aq. (pH12.0)/CH_3CN=35/65
Flow rate : 0.6 mL/min
Detector : UV (254 nm)
Column temp. : 30 ℃

Local anesthetics

Dissociation of tertiary amino groups in basic drugs can be suppressed by making pH of the eluent higher than pKa of the amino groups. This increases the relative hydrophobicity of the basic drugs, thereby allowing the column to retain the drugs stronger and provide baseline separation of them.

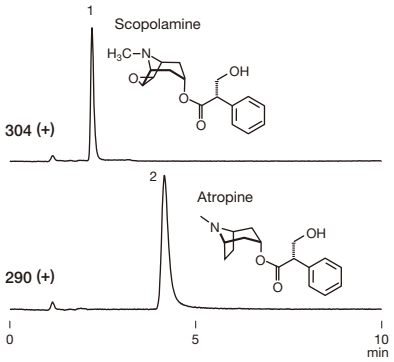


Sample :
1. Benzocaine

2. Lidocaine

3. Tetracaine


Column : Shodex Asahipak ODP-50 4D
Eluent : 25 mM Phosphate buffer/CH_3CN=60/40
Flow rate : 0.6 mL/min
Detector : UV (254 nm)
Column temp. : 30 ℃

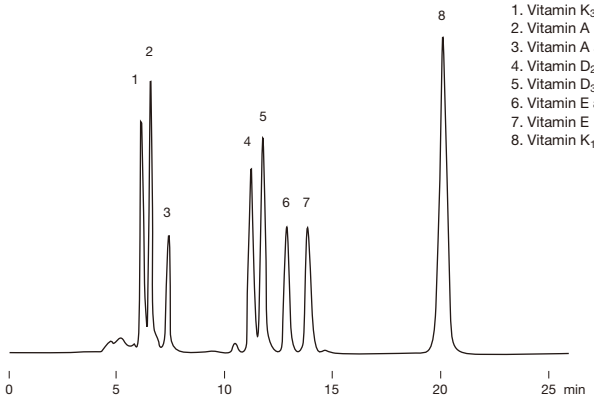
LC/MS analysis of basic drugs

Sample : 10 ng/mL each, 5 µL
1. Scopolamine
2. Atropine



Column : Shodex ODP40-2D
Eluent : 0.05 % NH_3 aq./CH_3CN=50/50
Flow rate : 0.2 mL/min
Detector : ESI-MS (SIM)
Column temp. : 30 ℃

Fat-soluble vitamins



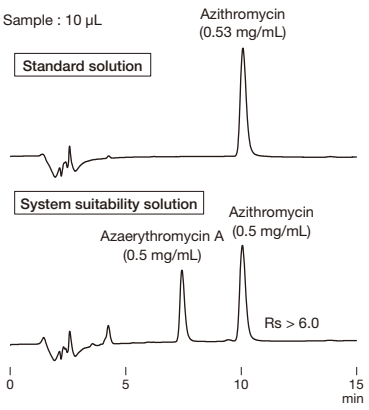
Sample : 20 µL

1. Vitamin K_3	1.5 µg/mL
2. Vitamin A	1.0 IU/mL
3. Vitamin A acetate	0.5 IU/mL
4. Vitamin D_2	13.2 µg/mL
5. Vitamin D_3	13.2 IU/mL
6. Vitamin E acetate	2.4 µg/mL
7. Vitamin E	2.5 µg/mL
8. Vitamin K_1	2.4 µg/mL

Column : Shodex Asahipak ODP-50 4E
Eluent : CH_3CN/CH_3OH=50/50
Flow rate : 0.6 mL/min
Detector : UV (280 nm)
Column temp. : 30 ℃

Analysis of azithromycin following USP method

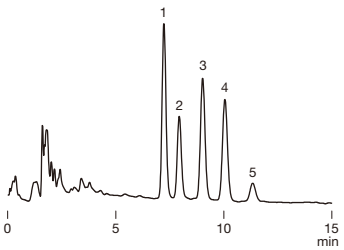
Sample : 10 µL



Column : Shodex Asahipak ODP-50 4E
Eluent : 6.7 g/L Dibasic potassium phosphate aq. (pH11.0 adjusted with 10 M KOH) /CH_3CN=40/60
Flow rate : 1.0 mL/min
Detector : UV (210 nm)
Column temp. : 40 ℃

Unsaturated fatty acids

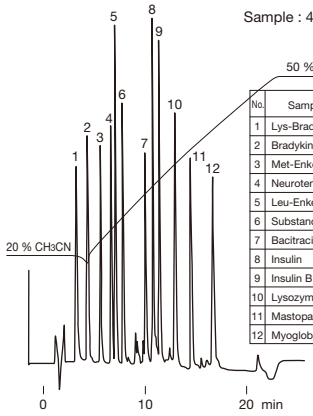
Sample : 0.002 % each (in Ethanol), 5 µL
1. EPA (Eicosapentaenoic acid)
2. α-Linolenic acid
3. DHA (Docosahexaenoic acid)
4. Arachidonic acid
5. Linoleic acid



Column : Shodex Asahipak ODP-50 4D
Eluent : 0.1 % H_3PO_4 in (H_2O/CH_3CN=30/70)
Flow rate : 1.0 mL/min
Detector : UV (215 nm)
Column temp. : 40 ℃

Gradient analysis of proteins and peptides

Sample : 40 µL



No.	Sample	MW	Recovery (%)
1	Lys-Bradykinin	1188	97
2	Bradykinin	1060	92
3	Met-Enkephalin	574	97
4	Neurotensin	1673	99
5	Leu-Enkephalin	556	100
6	Substance P	1348	93
7	Bacitracin	1450	81
8	Insulin	5750	95
9	Insulin B chain	3496	91
10	Lysozyme	14300	96
11	Mastoparan	1479	96
12	Myoglobin	17500	83

Column : Shodex Asahipak ODP-50 6D
Eluent : (A); 0.05 % TFA aq./CH_3CN=80/20
(B); 0.05 % TFA aq./CH_3CN=50/50
Linear gradient; (A) to (B), 20 min
Flow rate : 1.0 mL/min
Detector : UV (220 nm)
Column temp. : 30 ℃

Polymer-based Reversed Phase Chromatography Columns (RSpak)

Please refer to “Comparison of Shodex Reversed Phase Chromatography (RPC) Column Features” on page 6 and 7 for features.

Standard columns

Product Code	Product Name	Plate Number (TP/column)	Base Material	Particle Size (μm)	Pore Size (Å)	Column Size (mm) I.D. x Length	Shipping Solvent
F7009000	**RSpak RP18-415**	≥ 5,000	Styrene divinylbenzene copolymer	6	450	**4.6 x 150**	H_2O/CH_3CN=5/95
F6709558	**RSpak RP18-G**	(guard column)	Styrene divinylbenzene copolymer	6	–	**4.6 x 10**	$H_2O/CH_3CN/THF$=40/30/30
F7001001	**RSpak DS-613**	≥ 6,500	Styrene divinylbenzene copolymer	6	200	**6.0 x 150**	$H_2O/CH_3CN/THF$=30/40/30
F7001012	**RSpak DS-413**	≥ 11,000	Styrene divinylbenzene copolymer	3.5	200	**4.6 x 150**	$H_2O/CH_3CN/THF$=40/30/30
F6700140	**RSpak DS-G**	(guard column)	Styrene divinylbenzene copolymer	10	–	**4.6 x 10**	$H_2O/CH_3CN/THF$=30/40/30
F7001004	**RSpak DE-613**	≥ 7,000	Polymethacrylate	6	25	**6.0 x 150**	H_2O
F7001005	**RSpak DE-413**	≥ 11,000	Polymethacrylate	4	25	**4.6 x 150**	H_2O/CH_3CN=50/50
F7009030	**RSpak DE-413L**	≥ 17,000	Polymethacrylate	4	25	**4.6 x 250**	H_2O/CH_3CN=50/50
F6700150	**RSpak DE-G 4A**	(guard column)	Polymethacrylate	10	–	**4.6 x 10**	H_2O
F7001002	**RSpak DM-614**	≥ 4,500	Polyhydroxymethacrylate	10	200	**6.0 x 150**	5 mM H_3PO_4 aq.
F6700160	**RSpak DM-G 4A**	(guard column)	Polyhydroxymethacrylate	12	–	**4.6 x 10**	5 mM H_3PO_4 aq.

Semi-micro columns

Product Code	Product Name	Plate Number (TP/column)	Base Material	Particle Size (μm)	Pore Size (Å)	Column Size (mm) I.D. x Length	Shipping Solvent
F7001007	**RSpak DE-213**	≥ 8,000	Polymethacrylate	4	25	**2.0 x 150**	H_2O/CH_3CN=50/50
F6700151	**RSpak DE-G 2A**	(guard column)	Polymethacrylate	6	–	**2.0 x 10**	H_2O/CH_3CN=50/50

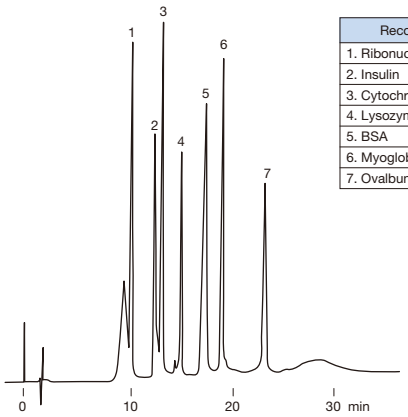
Standard columns

Product Code	Product Name	Plate Number (TP/column)	Functional Group	Base Material	Particle Size (μm)	Pore Size (Å)	Column Size (mm) I.D. x Length	Shipping Solvent
F7008140	**RSpak NN-814**	≥ 9,000	Sulfo	Polyhydroxymethacrylate	10	200	**8.0 x 250**	0.1 M Sodium phosphate buffer (pH3.0)
F7008150	**RSpak NN-614**	≥ 4,000	Sulfo	Polyhydroxymethacrylate	10	200	**6.0 x 150**	0.1M Sodium phosphate buffer (pH3.0)
F6700510	**RSpak NN-G**	(guard column)	Sulfo	Polyhydroxymethacrylate	10	–	**6.0 x 50**	0.1M Sodium phosphate buffer (pH3.0)
F7008160	**RSpak NN-414**	≥ 6,000	Sulfo	Polyhydroxymethacrylate	10	200	**4.6 x 150**	0.1M Sodium phosphate buffer (pH3.0)
F7008240	**RSpak JJ-50 4D**	≥ 4,500	Quaternary ammonium	Polyvinyl alcohol	5	100	**4.6 x 150**	H_2O/CH_3CN=40/60

Semi-micro columns

Product Code	Product Name	Plate Number (TP/column)	Functional Group	Base Material	Particle Size (μm)	Pore Size (Å)	Column Size (mm) I.D. x Length	Shipping Solvent
F7008220	**RSpak JJ-50 2D**	≥ 3,500	Quaternary ammonium	Polyvinyl alcohol	5	100	**2.0 x 150**	H_2O/CH_3CN=40/60

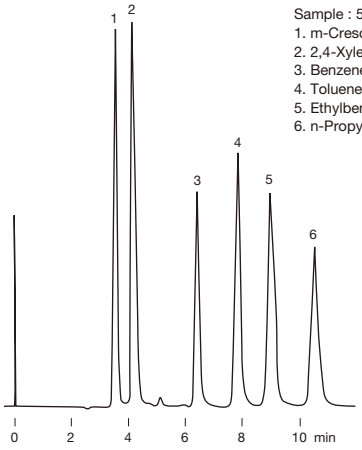
Separation and recovery rate of standard proteins



Recovery (%)	
1. Ribonuclease A	93
2. Insulin	98
3. Cytochrome c	100
4. Lysozyme	100
5. BSA	98
6. Myoglobin	108
7. Ovalbumin	–

Column : **Shodex RSpak RP18-415**
Eluent : (A); 0.1 % TFA aq./CH_3CN=99/1
(B); 0.1 % TFA aq./CH_3CN=5/95
Linear gradient; (B %) 20 % to 60 %, 20 min
Flow rate : 1.0 mL/min
Detector : UV (220 nm)
Column temp. : Room temp.

Alkylbenzenes

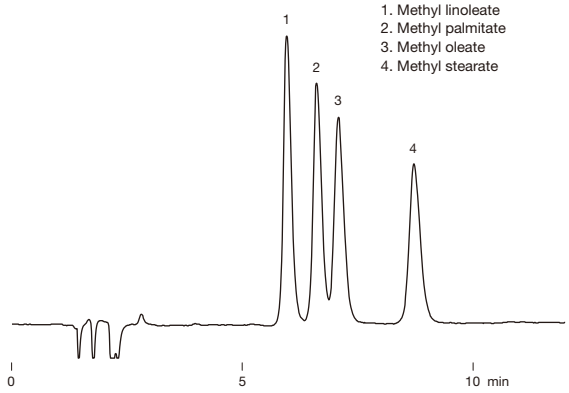


Sample : 5 µL

1. m-Cresol	0.1 %
2. 2,4-Xylenol	0.1 %
3. Benzene	0.5 %
4. Toluene	0.5 %
5. Ethylbenzene	0.5 %
6. n-Propylbenzene	0.5 %

Column : **Shodex RSpak DS-613**
Eluent : $H_2O/CH_3CN/THF$=30/40/30
Flow rate : 1.0 mL/min
Detector : UV (254 nm)
Column temp. : 40 ℃

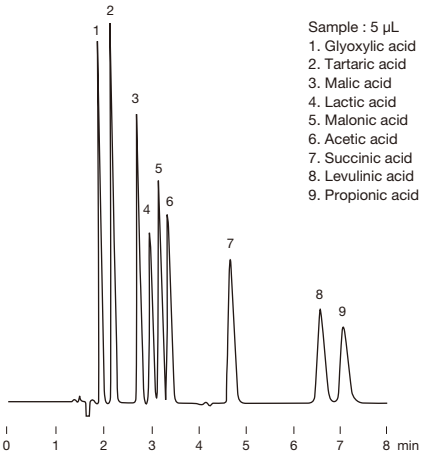
Fatty acid methyl esters



Sample : 0.2 % each, 20 µL
1. Methyl linoleate
2. Methyl palmitate
3. Methyl oleate
4. Methyl stearate

Column : **Shodex RSpak DS-413**
Eluent : $H_2O/CH_3CN/THF$=25/45/30
Flow rate : 1.0 mL/min
Detetor : RI
Column temp. : 40 ℃

Organic acids

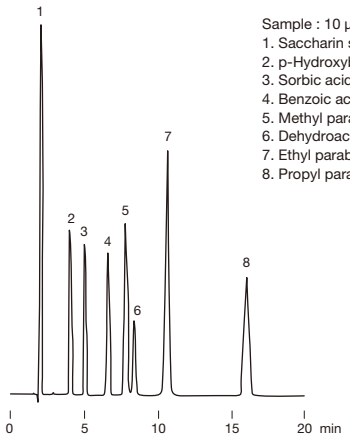


Sample : 5 µL

1. Glyoxylic acid	1.78 mg/mL
2. Tartaric acid	1.95 mg/mL
3. Malic acid	2.06 mg/mL
4. Lactic acid	2 µL/mL
5. Malonic acid	1.95 mg/mL
6. Acetic acid	2 µL/mL
7. Succinic acid	2.05 mg/mL
8. Levulinic acid	1.95 mg/mL
9. Propionic acid	2 µL/mL

Column : **Shodex RSpak DE-413**
Eluent : 10 mM H_3PO_4 aq.
Flow rate : 1.0 mL/min
Detector : RI
Column temp. : 50 ℃

Food additives (Preservatives)

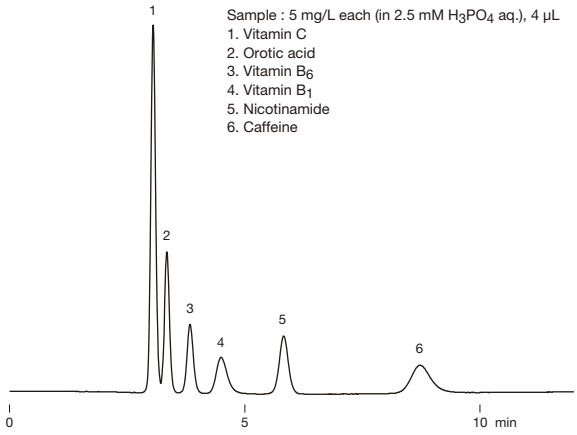


Sample : 10 µL

1. Saccharin sodium	0.005 %
2. p-Hydroxybenzoic acid	0.005 %
3. Sorbic acid	0.02 %
4. Benzoic acid	0.02 %
5. Methyl paraben	0.01 %
6. Dehydroacetic acid	0.01 %
7. Ethyl paraben	0.02 %
8. Propyl paraben	0.02 %

Column : **Shodex RSpak DE-413**
Eluent : 50 mM KH_2PO_4 + 0.1 % H_3PO_4 aq./CH_3CN =65/35
Flow rate : 1.0 mL/min
Detector : UV (210 nm)
Column temp. : 40 ℃

Vitamins

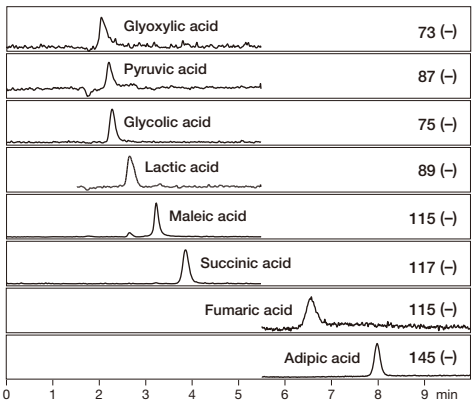


Sample : 5 mg/L each (in 2.5 mM H_3PO_4 aq.), 4 µL
1. Vitamin C
2. Orotic acid
3. Vitamin B_6
4. Vitamin B_1
5. Nicotinamide
6. Caffeine

Column : **Shodex RSpak DM-614**
Eluent : 0.055 M Na_2HPO_4 + 0.045 M KH_2PO_4 aq.
Flow rate : 1.0 mL/min
Detector : UV (254 nm)
Column temp. : 30 ℃

LC/MS analysis of organic acids

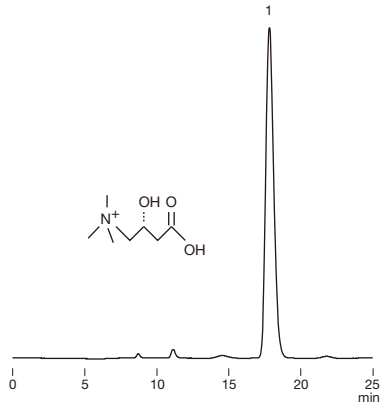
Sample : 50 ng/mL each, 10 µL



Column : Shodex RSpak DE-213
Eluent : (A); 0.1 % (v/v) Formic acid aq./(B); CH_3CN
Linear gradient; (B %) 5 % (0 min) → 5 % (2 min) → 15 % (2.5 min) → 15 % (10 min)
Flow rate : 0.2 mL/min
Detector : ESI-MS (SIM)
Column temp. : 30 ˚C

Carnitine

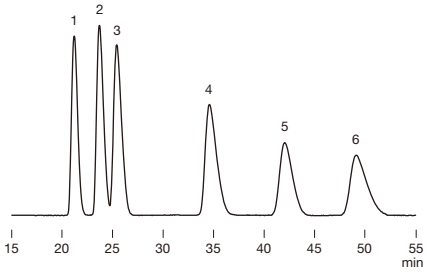
Sample : 20 µL
1. L-Carnitine 0.1 %



Column : Shodex RSpak NN-814
Eluent : 0.1 M H_3PO_4 aq.
Flow rate : 1.0 mL/min
Detector : UV (210 nm)
Column temp. : 25 ˚C

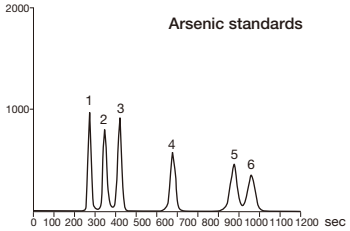
Amino acids

Sample : 0.1 % each, 20 µL
1. Aspartic acid
2. Glycine
3. Alanine
4. Valine
5. Methionine
6. Isoleucine

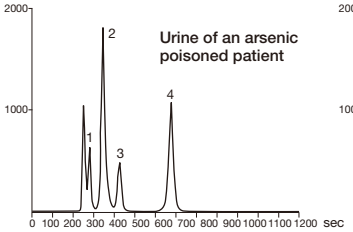


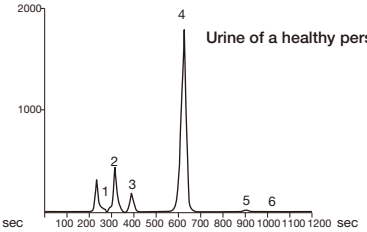
Column : Shodex RSpak NN-814
Eluent : 40 mM H_3PO_4 aq.
Flow rate : 1.0 mL/min
Detector : RI
Column temp. : 40 ˚C

Speciation of arsenic



Sample : Arsenic standards, 50 µL
1. Monomethylarsonic acid
2. Arsinic acid
3. Dimethylarsinic acid
4. Arsenobetaine
5. Tetramethylarsonium
6. Trimethylarsine oxide



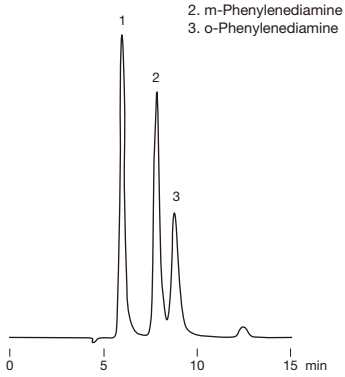


Column : Shodex RSpak NN-614
Eluent : 5 mM HNO_3/8 mM NH_4NO_3 aq.
Flow rate : 0.8 mL/min
Detector : ICP-MS (SIM m/z 75)

Source:
Noriko Tsunoda,
Pharmacia. 1998, vol.34, No.12, p.1237-1241

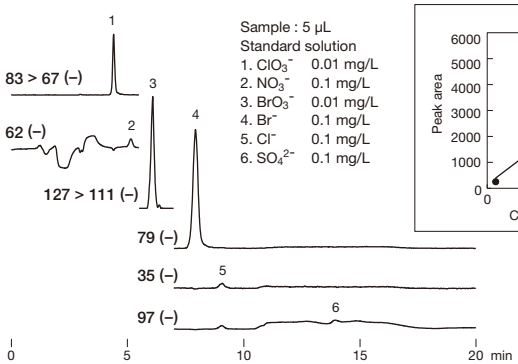
Phenylenediamine isomers

Sample : 100 mg/L each, 20 µL
1. p-Phenylenediamine
2. m-Phenylenediamine
3. o-Phenylenediamine

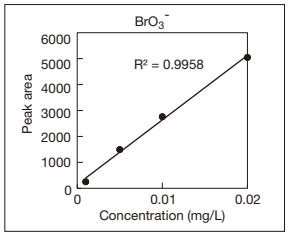


Column : Shodex RSpak JJ-50 4D
Eluent : 25 mM Ammonium acetate buffer (pH9.2)/CH_3CN=70/30
Flow rate : 0.4 mL/min
Detector : UV (254 nm)
Column temp. : 30 ˚C

High sensitive analysis of bromate by LC/MS/MS



Sample : 5 µL
Standard solution
1. ClO_3^- 0.01 mg/L
2. NO_3^- 0.1 mg/L
3. BrO_3^- 0.01 mg/L
4. Br^- 0.1 mg/L
5. Cl^- 0.1 mg/L
6. SO_4^{2-} 0.1 mg/L



Column : Shodex RSpak JJ-50 2D
Eluent : (A); 200 mM $HCOONH_4$ aq./(B); CH_3CN
Linear gradient (High pressure);
(B %) 85 % (0 min) → 85 % (8 min) → 50 % (9 min) → 50 % (14 min)
→ 85 % (15 min) → 85 % (20 min)
Flow rate : 0.3 mL/min
Detector : ESI-MS/MS (MRM) for ClO_3^-, BrO_3^-
ESI-MS (SIM) for NO_3^-, Br^-, Cl^-, SO_4^{2-}
Column temp. : 50 ˚C

Polymer-based Hydrophilic Interaction Chromatography (HILIC) Columns (HILICpak)

Features

VG-50
- Suitable for saccharide analysis using HILIC mode
- Recovers reducing saccharides with high ratio
- Polymer-based packing material provides excellent chemical stability and minimum deterioration over an extended time period
- Easily regenerated by washing in an alkaline solution
- Appropriate for evaporative light scattering detector, corona charged aerosol detector, and LC/MS

VT-50
- Suitable for anionic substances (especially phosphate compounds) analysis using HILIC mode
- Use of some eluents add ion exchange mode
- Polymer-based packing material provides excellent chemical stability and minimum deterioration over an extended time period
- Suitable for LC/MS analysis

VC-50
- Modified carboxyl group is suitable for cationic substance analysis including amines
- The dominant separation mode is RP or IEX rather than HILIC mode

VN-50
- The modified diol groups on the packing material create the HILIC mode
- Suitable for oligosaccharide and oligonucleotide separation which is not possible by SEC column or conventional HILIC columns

VG-50

● **Standard columns (Housing Material: SUS)**

Product Code	Product Name	Plate Number (TP/column)	Functional Group	Particle Size (μm)	Pore Size (Å)	Column Size (mm) I.D. x Length	Shipping Solvent
F7630200	**HILICpak VG-50 4D**	≥ 5,500	Amino	5	100	**4.6 × 150**	H_2O/CH_3CN=20/80
F7630100	**HILICpak VG-50 4E**	≥ 7,500	Amino	5	100	**4.6 × 250**	H_2O/CH_3CN=20/80
F6711100	**HILICpak VG-50G 4A**	(guard column)	Amino	5	100	**4.6 × 10**	H_2O/CH_3CN=20/80

Base Material: Polyvinyl alcohol

● **Semi-micro columns (Housing Material: PEEK)**

Product Code	Product Name	Plate Number (TP/column)	Functional Group	Particle Size (μm)	Pore Size (Å)	Column Size (mm) I.D. x Length	Shipping Solvent
F7630300	**HILICpak VG-50 2D**	≥ 3,500	Amino	5	100	**2.0 x 150**	H_2O/CH_3CN=15/85
F6711200	**HILICpak VG-50G 2A**	(guard column)	Amino	5	100	**2.0 x 10**	H_2O/CH_3CN=15/85

Base Material: Polyvinyl alcohol

VT-50

● **Semi-micro columns (Housing Material: PEEK)**

Product Code	Product Name	Plate Number (TP/column)	Functional Group	Particle Size (μm)	Pore Size (Å)	Column Size (mm) I.D. x Length	Shipping Solvent
F7630400	**HILICpak VT-50 2D**	≥ 4,500	Quaternary ammonium	5	100	**2.0 x 150**	25 mM $HCOONH_4$ aq./ CH_3CN=15/85
F6711300	**HILICpak VT-50G 2A**	(guard column)	Quaternary ammonium	5	100	**2.0 x 10**	25 mM $HCOONH_4$ aq./ CH_3CN=15/85

Base Material: Polyvinyl alcohol

VC-50

● **Semi-micro columns (Housing Material: PEEK)**

Product Code	Product Name	Plate Number (TP/column)	Functional Group	Particle Size (μm)	Pore Size (Å)	Column Size (mm) I.D. x Length	Shipping Solvent
F7630700	**HILICpak VC-50 2D**	≥ 3,500	Carboxyl	5	100	**2.0 x 150**	H_2O
F6711600	**HILICpak VC-50G 2A**	(guard column)	Carboxyl	5	100	**2.0 x 10**	H_2O

Base Material: Polyvinyl alcohol

VN-50

● **Standard columns (Housing Material: PEEK)**

Product Code	Product Name	Plate Number (TP/column)	Functional Group	Particle Size (μm)	Pore Size (Å)	Column Size (mm) I.D. x Length	Shipping Solvent
F7630500	**HILICpak VN-50 4D**	≥ 10,000	Diol	5	100	**4.6 × 150**	H_2O/CH_3CN=25/75
F6711400	**HILICpak VN-50G 4A**	(guard column)	Diol	5	100	**4.6 × 10**	H_2O/CH_3CN=25/75

Base Material: Polyvinyl alcohol

● **Semi-micro columns (Housing Material: PEEK)**

Product Code	Product Name	Plate Number (TP/column)	Functional Group	Particle Size (μm)	Pore Size (Å)	Column Size (mm) I.D. x Length	Shipping Solvent
F7630600	**HILICpak VN-50 2D**	≥ 3,500	Diol	5	100	**2.0 x 150**	H_2O/CH_3CN=25/75
F6711500	**HILICpak VN-50G 2A**	(guard column)	Diol	5	100	**2.0 x 10**	H_2O/CH_3CN=25/75

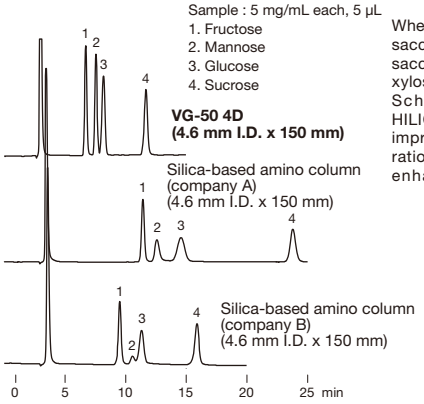
Base Material: Polyvinyl alcohol

● **Preparative columns (Housing Material: SUS)** **[Preparative columns are made to order.]**

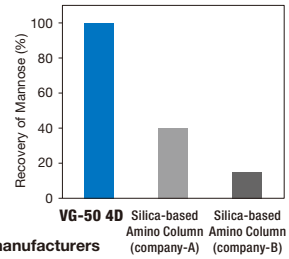
Product Code	Product Name	Plate Number (TP/column)	Particle Size (μm)	Column Size (mm) I.D. x Length	Standard Column
F6830100	**HILICpak VN-50 10E**	≥ 11,000	5	**10.0 x 250**	VN-50
F6711400	**HILICpak VN-50G 4A**	(guard column)	5	**4.6 x 10**	(guard column)

Base Material: Polyvinyl alcohol

Recovery of reducing sugar

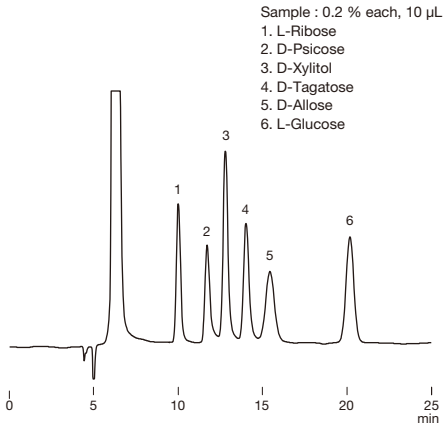


When an amino column is used for analyzing saccharides, the recovery ratio of reducing saccharides such as mannose, arabinose or xylose is low because the amino group forms Schiff base with reducing saccharides. HILICpak VG-50 is an amino column with improved reducing saccharides' recovery ratios. Improved recovery ratio results in enhancing the sensitivity of the analysis.



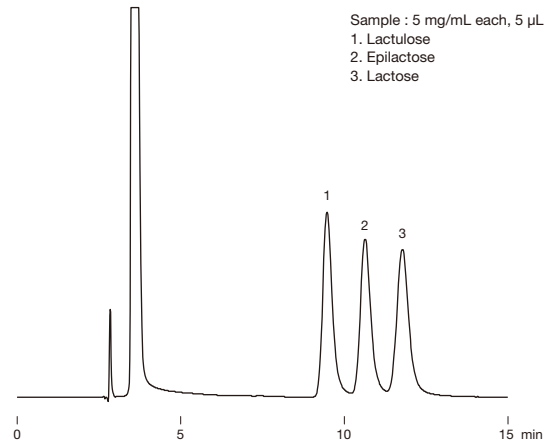
Column : **Shodex HILICpak VG-50 4D**
Silica based amino columns from other manufacturers
Eluent : H_2O/CH_3CN=20/80
Flow rate : 0.6 mL/min (VG-50 4D)
1.0 mL/min (Silica based amino column)
Detector : RI
Column temp. : 40 ˚C

Rare sugar



Column : **Shodex HILICpak VG-50 4E**
Eluent : $H_2O/CH_3CN/CH_3OH$=5/85/10
Flow rate : 0.6 mL/min
Detector : RI
Column temp. : 50 ˚C

Lactose, epilactose, and lactulose

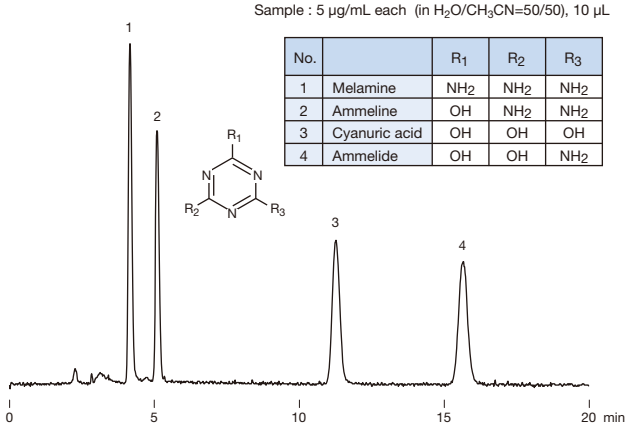


Column : **Shodex HILICpak VG-50 4E**
Eluent : $H_2O/CH_3CN/CH_3OH$=5/75/20
Flow rate : 1.0 mL/min
Detector : RI
Column temp. : 40 ˚C

Melamine and related substances

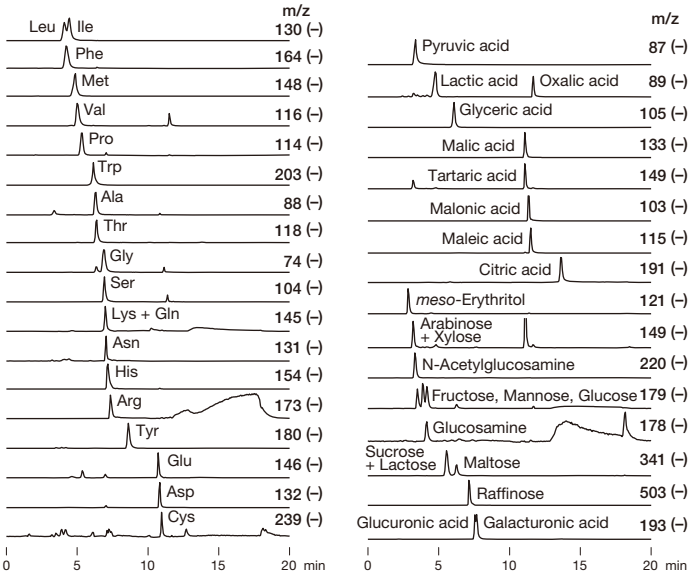
Sample : 5 µg/mL each (in H_2O/CH_3CN=50/50), 10 µL

No.		R_1	R_2	R_3
1	Melamine	NH_2	NH_2	NH_2
2	Ammeline	OH	NH_2	NH_2
3	Cyanuric acid	OH	OH	OH
4	Ammelide	OH	OH	NH_2



Column : **Shodex HILICpak VG-50 4D**
Eluent : 30 mM $HCOONH_4$ aq./CH_3CN=35/65
Flow rate : 0.6 mL/min
Detector : Corona charged aerosol
Column temp. : 40 ˚C

Simultaneous analysis of saccharides, organic acids and amino acids with LC/MS

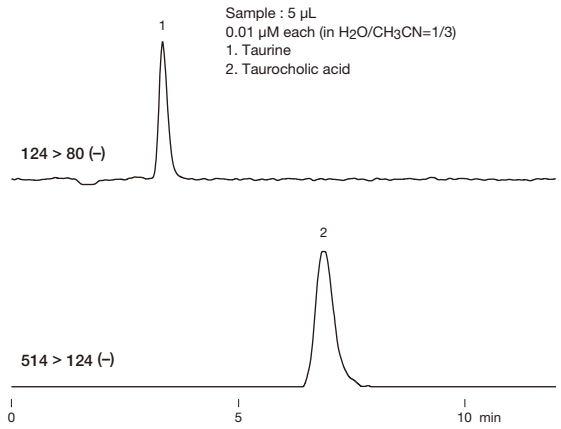


Sample : 1 µg/mL each (in H_2O/CH_3CN=1/4), 5 µL

VG-50 2D allows simultaneous analysis of saccharides, organic acids and amino acids with LC/MS detection under alkaline conditions. High anionic substances elute under alkaline conditions. Furthermore, alkaline conditions promote the deprotonation of hydroxyl groups at the time of ionization. Therefore, alkaline conditions are suitable for high sensitive detection of substances with hydroxyl groups such as saccharides under the negative mode.

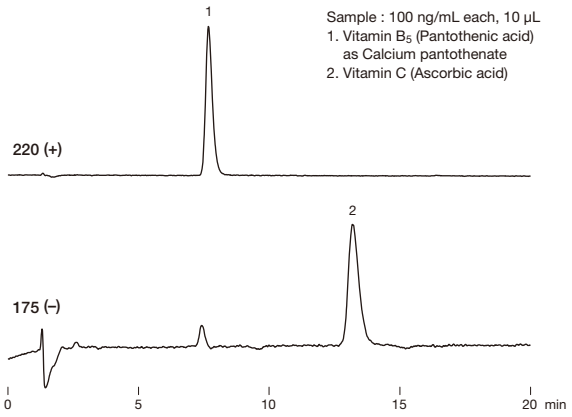
Column : **Shodex HILICpak VG-50 2D**
Eluent : (A); 0.5 % NH_3 aq./(B); CH_3CN
Linear gradient (High pressure);
(B %) 80 % (0 to 2 min), 80 % to 10 % (2 to 12 min),
10 % (12 to 15 min), 80 % (15 to 20 min)
Flow rate : 0.2 mL/min
Detector : ESI-MS (SIM)
Column temp. : 40 ˚C

LC/MS/MS analysis of organic sulfonic acids



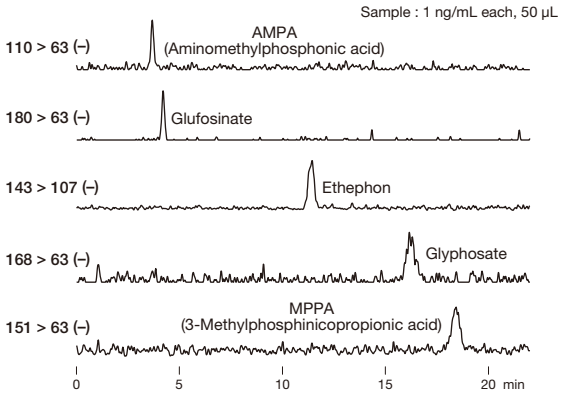
Column : **Shodex HILICpak VT-50 2D**
Eluent : 50 mM $HCOONH_4$ aq./CH_3CN=20/80
Flow rate : 0.3 mL/min
Detector : ESI-MS/MS (MRM)
Column temp. : 30 ℃

LC/MS analysis of pantothenic acid and vitamin C



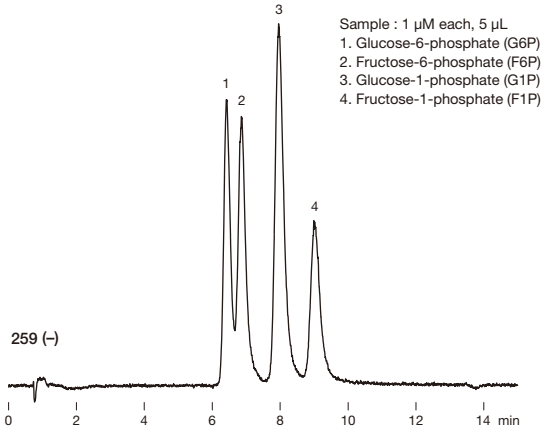
Column : **Shodex HILICpak VT-50 2D**
Eluent : 50 mM $HCOONH_4$ aq./CH_3CN=30/70
Flow rate : 0.2 mL/min
Detector : ESI-MS (SIM)
Column temp. : 30 ℃

LC/MS/MS analysis of glyphosate and glufosinate



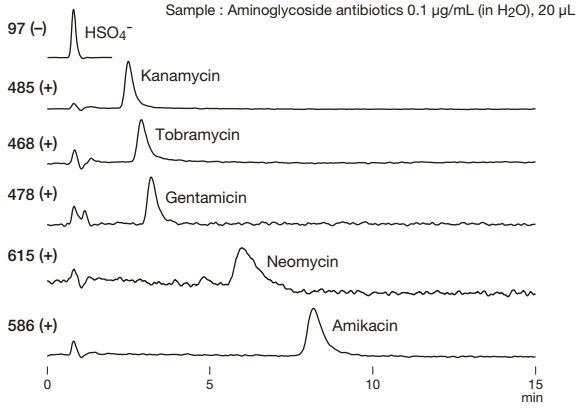
Column : **Shodex HILICpak VT-50 2D**
Eluent : 50 mM HNH_4CO_3 aq./CH_3CN=50/50
Flow rate : 0.3 mL/min
Detector : ESI-MS/MS (MRM)
Column temp. : 40 ℃

LC/MS analysis of phosphorylated saccharides



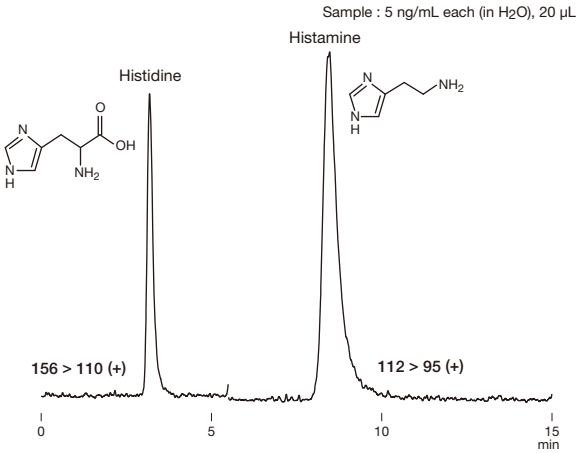
Column : **Shodex HILICpak VT-50 2D**
Eluent : 25 mM $HCOONH_4$ aq./CH_3CN=80/20
Flow rate : 0.3 mL/min
Detector : ESI-MS (SIM)
Column temp. : 60 ℃

LC/MS analysis of aminoglycoside antibiotics



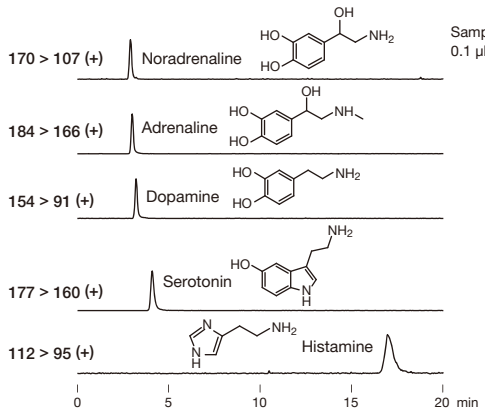
Column : **Shodex HILICpak VC-50 2D**
Eluent : (A); 1.5 % NH_3 aq./(B); CH_3CN
Linear gradient (High pressure);
(B %) 30 % to 10 % (0 to 5 min), 10 % (5 to 15 min)
Flow rate : 0.3 mL/min
Detector : ESI-MS (SIM)
Column temp. : 40 ℃

LC/MS/MS analysis of histamine and histidine



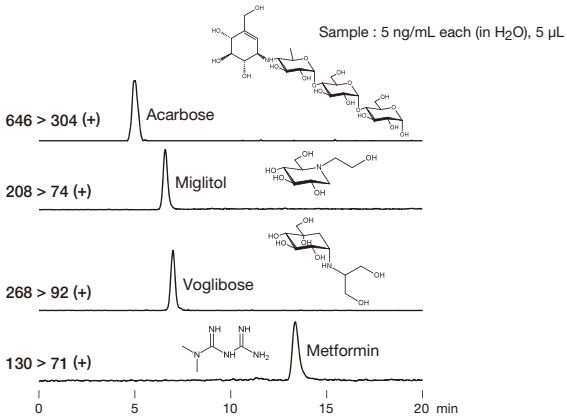
Column : **Shodex HILICpak VC-50 2D**
Eluent : 250 mM HCOOH aq./CH_3CN=70/30
Flow rate : 0.3 mL/min
Detector : ESI-MS/MS (MRM)
Column temp. : 40 ℃

LC/MS/MS analysis of monoamine neurotransmitters



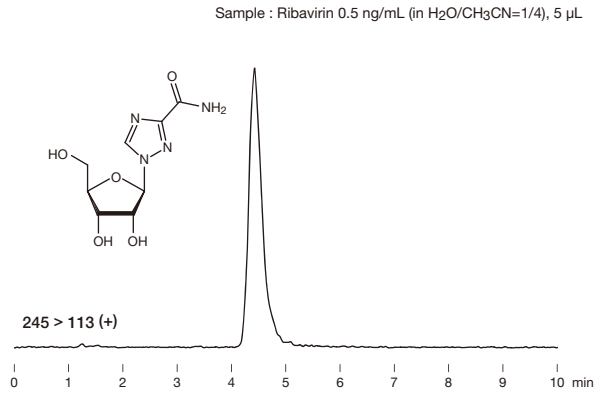
Column : **Shodex HILICpak VC-50 2D**
Eluent : (A); 200 mM HCOOH aq./(B); CH_3CN
Linear gradient (High pressure) ;
(B %) 60 % (0 to 5 min), 60 % to 10 % (5 to 6 min), 10 % (6 to 20 min)
Flow rate : 0.3 mL/min
Detector : ESI-MS/MS (MRM)
Column temp. : 40 ˚C

LC/MS/MS analysis of oral anti-diabetes drugs



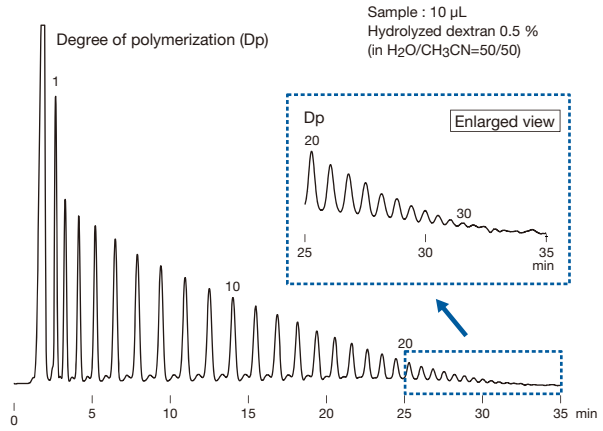
Column : **Shodex HILICpak VC-50 2D**
Eluent : (A); 200 mM HCOOH aq./(B); CH_3CN
Linear gradient (High pressure) ;
(B %) 60 % (0 to 5 min), 60 % to 20 % (5 to 6 min), 20 % (6 to 20 min)
Flow rate : 0.3 mL/min
Detector : ESI-MS/MS (MRM)
Column temp. : 40 ˚C

LC/MS/MS analysis of ribavirin



Column : **Shodex HILICpak VC-50 2D**
Eluent : 50 mM HCOOH aq./CH_3CN=10/90
Flow rate : 0.25 mL/min
Detector : ESI-MS/MS (MRM)
Column temp. : 40 ˚C

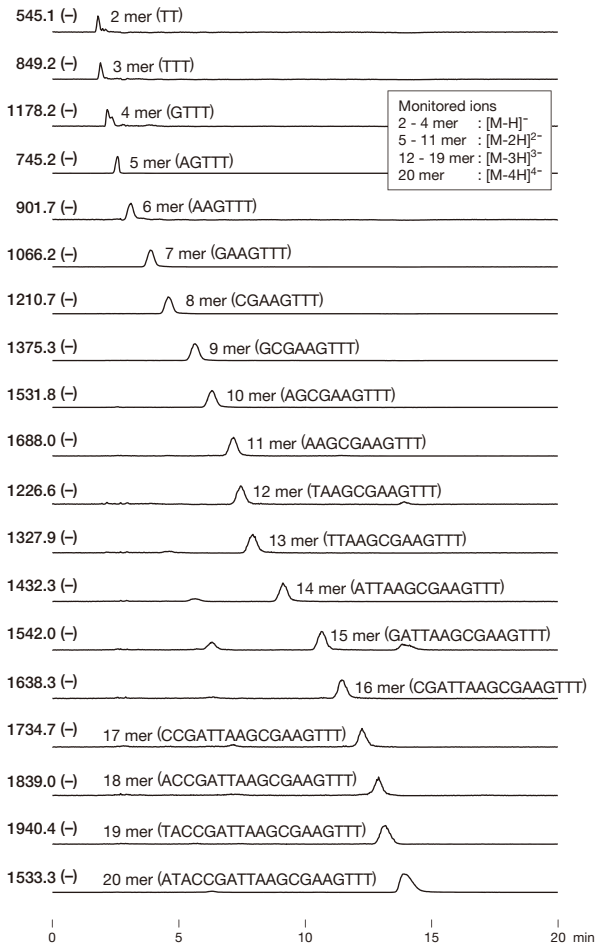
Hydrolyzed dextran



Column : **Shodex HILICpak VN-50 4D**
Eluent : (A); H_2O/(B); CH_3CN
Linear gradient ; (B %) 70 % to 50 % (0 to 40 min)
Flow rate : 1.0 mL/min
Detector : Corona charged aerosol
Column temp. : 40 ˚C

LC/MS analysis of oligo DNA

Sample : 1 µL
Synthesized oligo DNA 20 mer (ATACCGATTAAGCGAAGTTT; crude)
2.2 mg/mL (in H_2O)



Column : **Shodex HILICpak VN-50 2D**
Eluent : (A); 50 mM $HCOONH_4$ aq./(B); CH_3CN
Linear gradient ;
(B %) 60 % (0 to 10 min), 60 % to 55 % (10 to 15 min),
60 % (15 to 20 min)
Flow rate : 0.2 mL/min
Detector : ESI-MS (SIM)
Column temp. : 40 ˚C

Polymer-based Hydrophilic Interaction Chromatography (HILIC) Columns (Asahipak)

Features

NH2P-50

- Suitable for saccharides analysis using HILIC mode
- Polymer-based packing material provides excellent chemical stability and minimum deterioration over extended time period
- Easily regenerated by washing in an alkaline solution
- Appropriate for evaporative light scattering detector, corona charged aerosol detector, and LC/MS
- Fulfills USP L82 requirements

NH2P-40

- Provides higher theoretical plate number than NH2P-50 series

Standard columns

Product Code	Product Name	Plate Number (TP/column)	Functional Group	Particle Size (µm)	Pore Size (Å)	Column Size (mm) I.D. x Length	Shipping Solvent
F7630005	**Asahipak NH2P-50 4B**	≥ 1,500	Amino	5	100	**4.6 x 50**	CH_3CN
F7630002	**Asahipak NH2P-50 4D**	≥ 5,500	Amino	5	100	**4.6 x 150**	CH_3CN
F7630001	**Asahipak NH2P-50 4E**	≥ 7,500	Amino	5	100	**4.6 x 250**	CH_3CN
F6710016	**Asahipak NH2P-50G 4A**	(guard column)	Amino	5	–	**4.6 x 10**	CH_3CN
F7630007	**Asahipak NH2P-40 3E**	≥ 8,500	Amino	4	100	**3.0 x 250**	CH_3CN
F6710030	**Asahipak NH2P-50G 3A**	(guard column)	Amino	5	–	**3.0 x 10**	CH_3CN
F6710100	**Asahipak NH2P-LF**	(line filter)	Amino	–	–	**8.0 x 75**	CH_3CN

Base Material: Polyvinyl alcohol

Semi-micro columns

Product Code	Product Name	Plate Number (TP/column)	Functional Group	Particle Size (µm)	Pore Size (Å)	Column Size (mm) I.D. x Length	Shipping Solvent
F7630006	**Asahipak NH2P-50 2D**	≥ 3,500	Amino	5	100	**2.0 x 150**	CH_3CN
F6713000	**Asahipak NH2P-50G 2A**	(guard column)	Amino	5	–	**2.0 x 10**	CH_3CN
F7630008	**Asahipak NH2P-40 2B**	≥ 2,000	Amino	4	100	**2.0 x 50**	CH_3CN
F7630009	**Asahipak NH2P-40 2D**	≥ 5,500	Amino	4	100	**2.0 x 150**	CH_3CN
F7630010	**Asahipak NH2P-40 2E**	≥ 7,000	Amino	4	100	**2.0 x 250**	CH_3CN

Base Material: Polyvinyl alcohol

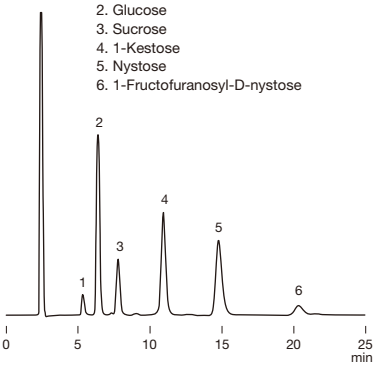
Preparative columns [Preparative columns are made to order.]

Product Code	Product Name	Plate Number (TP/column)	Particle Size (µm)	Column Size (mm) I.D. x Length	Shipping Solvent
F6830001	**Asahipak NH2P-50 10E**	≥ 10,000	5	**10.0 x 250**	NH2P-50
F6710016	**Asahipak NH2P-50G 4A**	(guard column)	5	**4.6 x 10**	(guard column)
F6830031	**Asahipak NH2P-90 20F**	≥ 10,000	9	**20.0 x 300**	NH2P-50
F6710017	**Asahipak NH2P-130G 7B**	(guard column)	13	**7.5 x 50**	(guard column)

Base Material: Polyvinyl alcohol

Fructooligosaccharide syrup

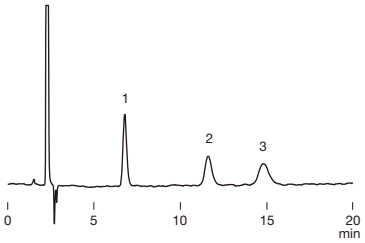
Sample :
Fructooligosaccharide syrup 2.5 %, 20 µL
1. Fructose
2. Glucose
3. Sucrose
4. 1-Kestose
5. Nystose
6. 1-Fructofuranosyl-D-nystose



Column : Shodex Asahipak NH2P-50 4E
Eluent : H_2O/CH_3CN=30/70
Flow rate : 1.0 mL/min
Detector : RI
Column temp. : 25 ℃

Cyclodextrins

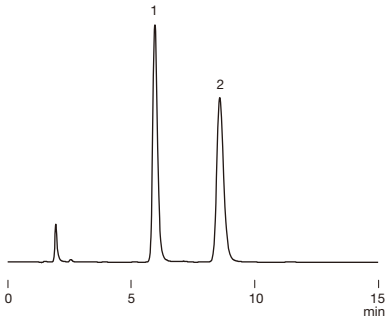
Sample : 250 µg/mL each, 20 µL
1. α-Cyclodextrin
2. γ-Cyclodextrin
3. β-Cyclodextrin



Column : Shodex Asahipak NH2P-50 4E
Eluent : H_2O/CH_3CN=40/60
Flow rate : 1.0 mL/min
Detector : RI
Column temp. : 40 ℃

Stevioside and rebaudioside A

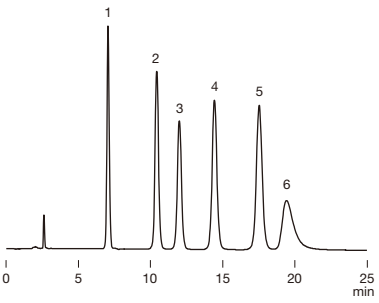
Sample : 0.05 % each, 20 µL
1. Stevioside
2. Rebaudioside A



Column : Shodex Asahipak NH2P-50 4E
Eluent : H_2O/CH_3CN=25/75
Flow rate : 1.0 mL/min
Detector : UV (210 nm)
Column temp. : 30 ℃

Imidazole dipeptides

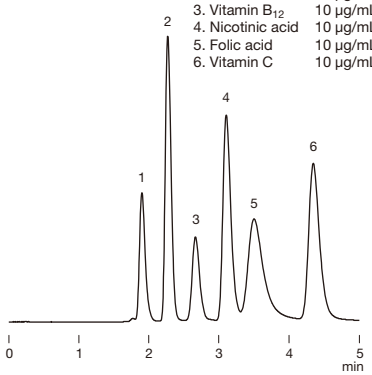
Sample : 20 µL
1. β-Alanine 200 µg/mL
2. 1-Methyl-L-histidine 2 µg/mL
3. L-Anserine 5 µg/mL
4. Histidine 5 µg/mL
5. L-Carnosine 5 µg/mL
6. Nitrate (derived from L-Anserine Nitrate)



Column : Shodex Asahipak NH2P-50 4E
Eluent : 50 mM NaH_2PO_4 aq./CH_3CN=40/60
Flow rate : 1.0 mL/min
Detector : UV (210 nm)
Column temp. : 40 ℃

Simultaneous analysis of water-soluble vitamins

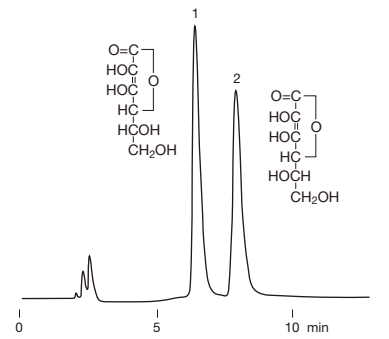
Sample : 20 µL
1. Vitamin B_6 50 µg/mL
2. Nicotinamide 10 µg/mL
3. Vitamin B_{12} 10 µg/mL
4. Nicotinic acid 10 µg/mL
5. Folic acid 10 µg/mL
6. Vitamin C 10 µg/mL



Column : Shodex Asahipak NH2P-50 4E
Eluent : 40 mM H_3PO_4 aq./CH_3CN=45/55
Flow rate : 1.0 mL/min
Detector : UV (254 nm)
Column temp. : 40 ℃

Ascorbic acid and erythorbic acid

Sample : 5 µg/mL each, 10 µL
1. Erythorbic acid
2. L-Ascorbic acid



Column : Shodex Asahipak NH2P-50 4E
Eluent : 20 mM NaH_2PO_4 + 30 mM H_3PO_4 aq. /CH_3CN=20/80
Flow rate : 1.0 mL/min
Detector : UV (254 nm)
Column temp. : 30 ℃

Comparison of saccharide analysis using corona charged aerosol detector

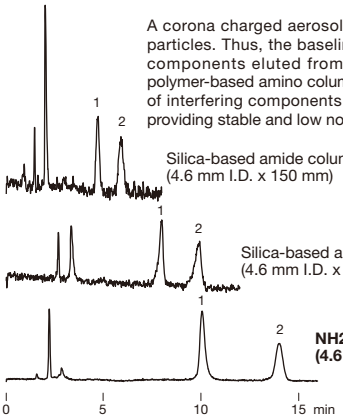
A corona charged aerosol detector measures effluents as particles. Thus, the baseline is significantly affected by all components eluted from the column. The NH2P series polymer-based amino column eliminates insignificant amount of interfering components from the column. This results in providing stable and low noise baseline.

Silica-based amide column (4.6 mm I.D. x 150 mm)

Sample : 40 µg/mL each, 5 µL
1. Fructose
2. Glucose

Silica-based amino column (4.6 mm I.D. x 250 mm)

NH2P-50 4E (4.6 mm I.D. x 250 mm)

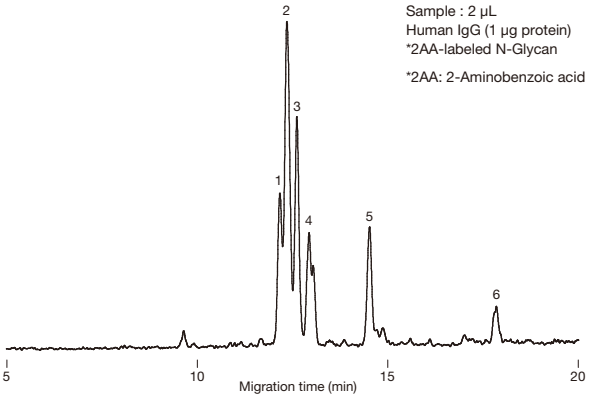


Column : Shodex Asahipak NH2P-50 4E
Silica based amino column from other manufacturer
Silica based amide column from other manufacturer
Eluent : H_2O/CH_3CN=20/80
Flow rate : 1.0 mL/min
Detector : Corona charged aerosol
Column temp : 30 ℃ (NH2P-50 4E, Silica based amino column)
80 ℃ (Silica based amide column)

LC/TOF-MS analysis of 2-amino benzoic acid derivatized sugar chains

Sample : 2 µL
Human IgG (1 µg protein)
*2AA-labeled N-Glycan

*2AA: 2-Aminobenzoic acid



Column : Shodex Asahipak NH2P-40 2D
Eluent : (A); 95 % CH_3CN/0.1 % Formic acid aq.
(B); 5 % CH_3CN/0.1 % Formic acid aq.
Linear gradient; (B %) 30 % (0 - 2.5 min), 30 - 95 % (2.5 - 20 min)
Flow rate : 0.2 mL/min
Detector : ESI-TOF MS (Polarity : Negative, Full MS range : 2000)
Column temp. : 45 ℃

Data provided by Michihiro Kinoshita Ph.D., Faculty of Pharmacy, Kinki University

Silica-based Reversed Phase Chromatography Columns (ODS Columns)

Please refer to “Comparison of Shodex Reversed Phase Chromatography (RPC) Column Features” on page 6 and 7 for features.

Standard columns

Product Code	Product Name	Plate Number (TP/column)	Functional Group	Particle Size (µm)	Carbon Load (%)	Pore Size (Å)	Column Size (mm) I.D. x Length	Shipping Solvent
F6651010	**C18-4D**	≥ 13,000	Octadecyl	5	17	120	**4.6 x 150**	H_2O/CH_3OH=25/75
F6651011	**C18-4E**	≥ 21,000	Octadecyl	5	17	120	**4.6 x 250**	H_2O/CH_3OH=25/75
F6650040	**Silica C18M 4D**	≥ 10,000	Octadecyl	5	16	100	**4.6 x 150**	H_2O/CH_3OH=30/70
F6650041	**Silica C18M 4E**	≥ 16,000	Octadecyl	5	16	100	**4.6 x 250**	H_2O/CH_3OH=30/70
F6650045	**Silica C18P 4D**	≥ 10,000	Octadecyl	5	17	100	**4.6 x 150**	H_2O/CH_3OH=30/70
F6650046	**Silica C18P 4E**	≥ 16,000	Octadecyl	5	17	100	**4.6 x 250**	H_2O/CH_3OH=30/70

Base Material: Silica

Semi-micro columns

Product Code	Product Name	Plate Number (TP/column)	Functional Group	Particle Size (µm)	Carbon Load (%)	Pore Size (Å)	Column Size (mm) I.D. x Length	Shipping Solvent
F6650042	**Silica C18M 2D**	≥ 9,000	Octadecyl	5	16	100	**2.0 x 150**	H_2O/CH_3CN=40/60
F6650047	**Silica C18P 2D**	≥ 9,000	Octadecyl	5	17	100	**2.0 x 150**	H_2O/CH_3CN=40/60

Base Material: Silica

Preparative columns **[Preparative columns are made to order.]**

Product Code	Product Name	Plate Number (TP/column)	Particle Size (µm)	Column Size (mm) I.D. x Length	Standard Column
F7560040	**Silica C18M 10E**	≥ 16,000	5	**10.0 x 250**	C18M
F7560041	**Silica C18M 20E**	≥ 16,000	5	**20.0 x 250**	C18M

Base Material: Silica

Silica-based Reversed Phase Chromatography Columns (Other Columns)

Please refer to “Comparison of Shodex Reversed Phase Chromatography (RPC) Column Features” on page 6 and 7 for features.

Standard columns

Product Code	Product Name	Plate Number (TP/column)	Functional Group	Particle Size (µm)	Carbon Load (%)	Pore Size (Å)	Column Size (mm) I.D. x Length	Shipping Solvent
F6650052	**Silica 5C8 4D**	≥ 9,000	Octyl	5	10	100	**4.6 x 150**	H_2O/CH_3OH=34/66
F6650053	**Silica 5C8 4E**	≥ 15,000	Octyl	5	10	100	**4.6 x 250**	H_2O/CH_3OH=34/66
F6650058	**Silica 5CN 4D**	≥ 7,000	Cyanopropyl	5	–	100	**4.6 x 150**	H_2O/CH_3OH=60/40
F6650059	**Silica 5CN 4E**	≥ 12,000	Cyanopropyl	5	–	100	**4.6 x 250**	H_2O/CH_3OH=60/40
F6650062	**Silica 5NPE 4D**	≥ 8,000	Nitrophenylethyl	5	–	100	**4.6 x 150**	H_2O/CH_3OH=45/55

Base Material: Silica

Silica-based Reversed Phase Chromatography Columns (ODS Columns for UHPLC)

Please refer to “Comparison of Shodex Reversed Phase Chromatography (RPC) Column Features” on page 6 and 7 for features.

Semi-micro columns

Product Code	Product Name	Functional Group	Particle Size (µm)	*Carbon Load (%)	Pore Size (Å)	Column Size (mm) I.D. x Length	Shipping Solvent
F6654011	New **C18U 2B**	Octadecyl	1.9	20	120	**2.0 × 50**	CH_3CN
F6654012	New **C18U 2D**	Octadecyl	1.9	20	120	**2.0 × 150**	CH_3CN

*Containing 8 % for hybrid silica base material.

Base Material: Organic/inorganic hybrid silica

Guard column for C18 series

Product Code	Product Name	Contents
F6709801	New **EXP® cartridges**	3 Cartridge columns
F6709802	New **EXP® direct connect holder**	One holder (2 titanium hybrid ferrules and 1 nut included)

EXP is registered trademark of Optimize Technologies, Inc.

Allows direct attachment to the analytical column

Silica-based Normal Phase Chromatography and HILIC Columns

Features

5SIL
- Packed with high purity silica (99.99 % or higher)
- Suitable used with nonpolar organic solvents for normal phase analysis
- Fulfills USP L3 requirements

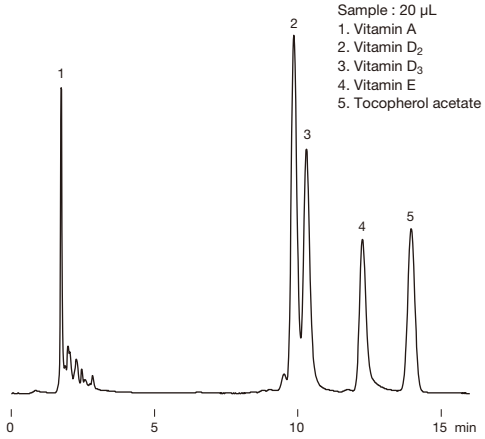
5NH
- Suitable for saccharides analysis using HILIC mode
- Fulfills USP L8 requirements

Standard columns

Product Code	Product Name	Plate Number (TP/column)	Functional Group	Particle Size (µm)	Carbon Load (%)	Pore Size (Å)	Column Size (mm) I.D. x Length	Shipping Solvent
F6650050	**Silica 5SIL 4D**	≥ 9,000	–	5	–	100	**4.6 x 150**	C_6H_{14}/C_2H_5OH=95/5
F6650051	**Silica 5SIL 4E**	≥ 15,000	–	5	–	100	**4.6 x 250**	C_6H_{14}/C_2H_5OH=95/5
F6650060	**Silica 5NH 4D**	≥ 5,000	Aminopropyl	5	–	100	**4.6 x 150**	H_2O/CH_3CN=5/95
F6650061	**Silica 5NH 4E**	≥ 8,000	Aminopropyl	5	–	100	**4.6 x 250**	H_2O/CH_3CN=5/95

Base Material: Silica

Fat-soluble vitamins

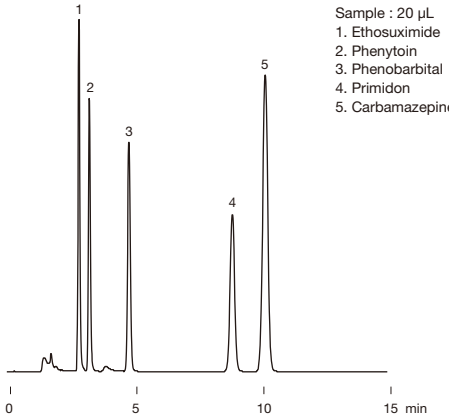


Sample : 20 µL

1. Vitamin A	50 µg/mL
2. Vitamin D_2	25 µg/mL
3. Vitamin D_3	25 µg/mL
4. Vitamin E	100 µg/mL
5. Tocopherol acetate	100 µg/mL

Column : Shodex C18-4D
Eluent : CH_3CN
Flow rate : 1.0 mL/min
Detector : UV (280 nm)
Column temp. : 40 ℃

Anticonvulsant

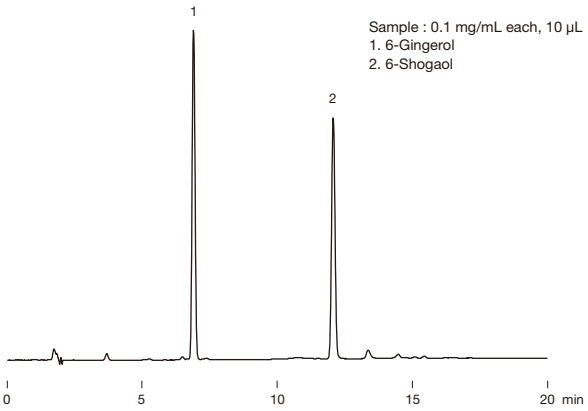


Sample : 20 µL

1. Ethosuximide	100 µg/mL
2. Phenytoin	10 µg/mL
3. Phenobarbital	10 µg/mL
4. Primidon	10 µg/mL
5. Carbamazepine	10 µg/mL

Column : Shodex C18-4D
Eluent : 100 mM Phosphate buffer(pH2.1)
/CH_3OH/CH_3CN=4/2/1
Flow rate : 1.0 mL/min
Detector : UV (210 nm)
Column temp. : 40 ℃

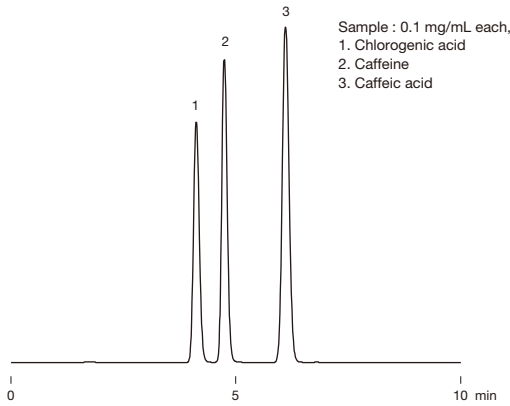
Gingerol and shogaol



Sample : 0.1 mg/mL each, 10 µL
1. 6-Gingerol
2. 6-Shogaol

Column : Shodex Silica C18M 4D
Eluent : (A) ; H_2O/(B) ; CH_3CN
Linear gradient : (B %) 40 % to 70 % (15 min)
Flow rate : 1.0 mL/min
Detector : UV (280 nm)
Column temp. : 40 ℃

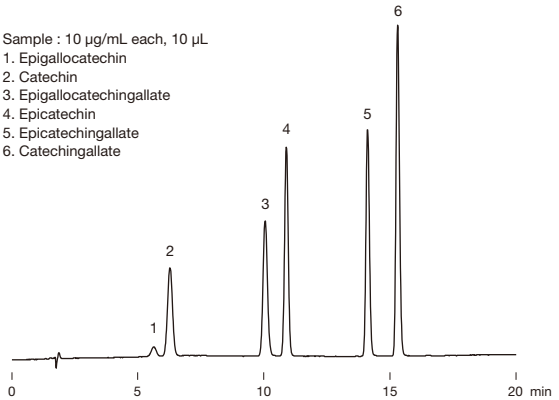
Chlorogenic acid



Sample : 0.1 mg/mL each, 10 µL
1. Chlorogenic acid
2. Caffeine
3. Caffeic acid

Column : Shodex Silica C18M 4D
Eluent : 20 mM H_3PO_4 aq. /CH_3OH=70/30
Flow rate : 1.0 mL/min
Detector : UV (280 nm)
Column temp. : 30 ℃

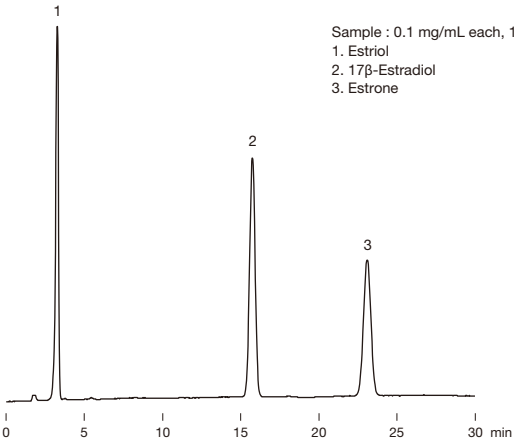
Catechins



Sample : 10 µg/mL each, 10 µL
1. Epigallocatechin
2. Catechin
3. Epigallocatechingallate
4. Epicatechin
5. Epicatechingallate
6. Catechingallate

Column : Shodex Silica C18P 4D
Eluent : (A) ; 20 mM H_3PO_4 aq./(B) ; CH_3CN
Linear gradient:
(B %) 20 % (0 to 5 min), 20 to 40 % (5 to 15 min),
40 % (15 to 20 min)
Flow rate : 1.0 mL/min
Detector : UV (280 nm)
Column temp. : 30 ℃

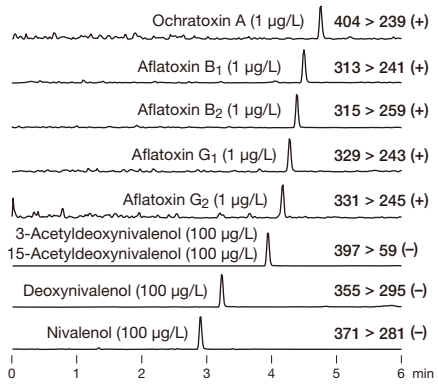
Estrogens



Sample : 0.1 mg/mL each, 10 µL
1. Estriol
2. 17β-Estradiol
3. Estrone

Column : Shodex Silica C18P 4D
Eluent : H_2O/CH_3CN=65/35
Flow rate : 1.0 mL/min
Detector : UV (280 nm)
Column temp. : 30 ℃

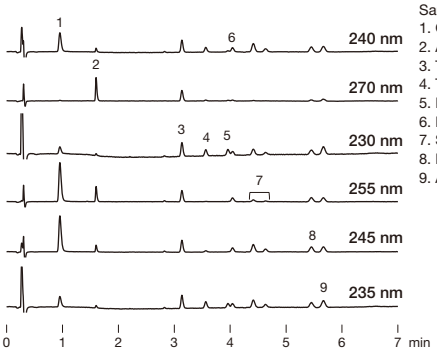
LC/MS/MS simultaneous analysis of aflatoxins



Sample : 10 µL

Column : **Shodex C18U 2B**
Eluent : (A); 10 mM CH_3COONH_4 aq. (B); CH_3OH
Gradient :
(B %) 0 to 90 % (0 to 5 min), 90 % (5 to 7 min), 0 % (7.01 min), 0 % (7.01 to 10 min)
Flow rate : 0.4 mL/min
Detector : ESI-MS/MS (MRM)
Column temp. : 40 ˚C

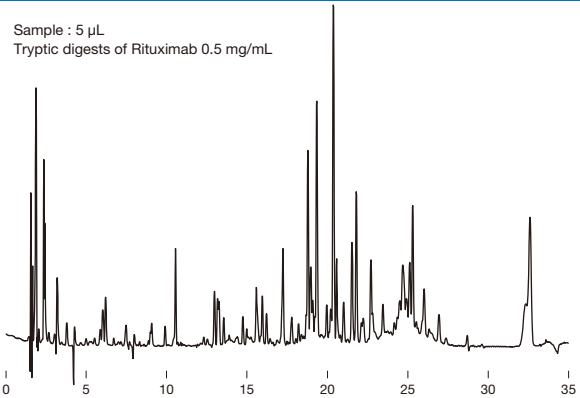
Golf course pesticides



Sample : 1 mg/L each, 2 µL
1. Oxine-copper
2. Asulam
3. Thiuram
4. Triclopyr
5. Mecoprop
6. Flazasulfuron
7. Siduron
8. Halosulfuron-methyl
9. Azoxystrobin

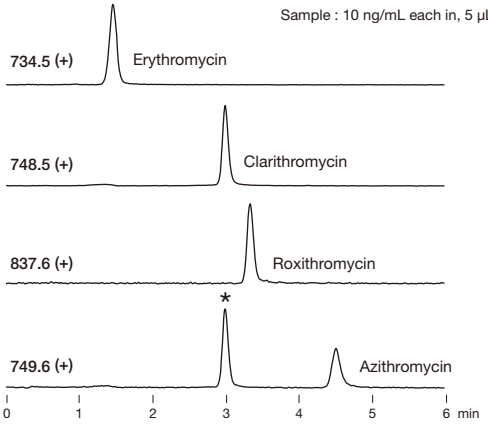
Column : **Shodex C18U 2B**
Eluent : (A); 0.1 % Formic acid in H_2O, (B); 0.1 % Formic acid in CH_3CN
Gradient :
(B %) 5 % (0 to 0.3 min), 5 to 35 % (0.3 to 1.0 min), 35 to 45 % (1.0 to 6.0 min)
Flow rate : 0.6 mL/min
Detector : UV
Column temp. : 40 ˚C

Tryptic digests of rituximab



Column : **Shodex C18U 2D**
Eluent : (A); 0.1 % TFA in H_2O
(B); 0.1 % TFA in CH_3CN
Linear gradient:
(B %) 10 to 40 % (0 to 25 min), 40 % (25 to 30 min), 90 % (30 to 35 min)
Flow rate : 0.2 mL/min
Detector : UV (220 nm)
Column temp. : 40 ˚C

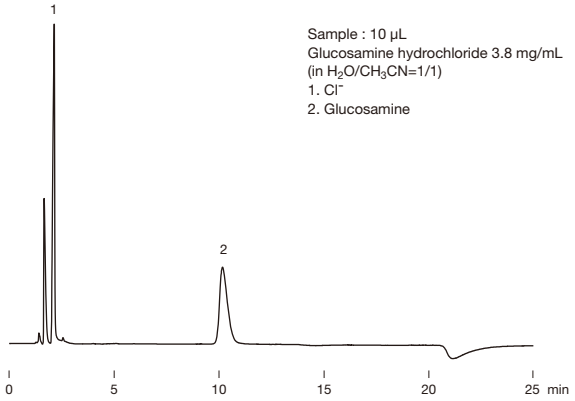
LC/MS simultaneous analysis of macrolide antibiotics



Column : **Shodex C18U 2B**
Eluent : 0.05 % NH_3 aq./CH_3CN=40/60
Flow rate : 0.4 mL/min
Detector : ESI-MS (SIM)
Column temp. : 40 ˚C

*: Clarithromycin containing one ^{13}C isotope

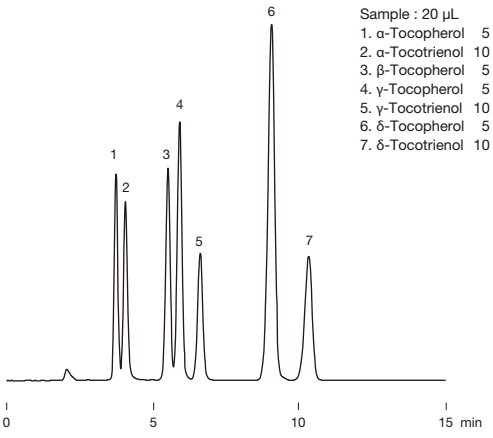
Analysis of glucosamine following USP method



Sample : 10 µL
Glucosamine hydrochloride 3.8 mg/mL
(in H_2O/CH_3CN=1/1)
1. Cl^-
2. Glucosamine

Column : **Shodex Silica 5NH 4D**
Eluent : *Buffer(pH7.5)/CH_3CN=30/70
*Buffer ; in a 1-L volumetric flask, dissolve 3.5 g K_2HPO_4 in water. Add 0.25 mL Ammonium hydroxide (25 %), dilute with water to volume, and mix. Adjusted with H_3PO_4 to a pH7.5
Flow rate : 1.1 mL/min
Detector : UV (195 nm)
Column temp. : 35 ˚C

Simultaneous analysis of vitamin E homologs



Sample : 20 µL
1. α-Tocopherol 5 µg/mL
2. α-Tocotrienol 10 µg/mL
3. β-Tocopherol 5 µg/mL
4. γ-Tocopherol 5 µg/mL
5. γ-Tocotrienol 10 µg/mL
6. δ-Tocopherol 5 µg/mL
7. δ-Tocotrienol 10 µg/mL

Column : **Shodex Silica 5SIL 4D**
Eluent : n-Hexane/Isopropanol/Acetic acid=1000/6/5
Flow rate : 1.0 mL/min
Detector : Fluorescence (Ex. : 298 nm, Em. : 325 nm)
Column temp. : 30 ˚C

Ligand Exchange Chromatography Columns

*Lists summarizing elution volumes of various saccharides using Shodex columns is available. Please refer to our website (https://www.shodex.com/en/) or technical notebook (No.2 and 3).

Features

SC1011 **SC1821** **SP0810** **KS-801** **KS-802**	• Separates saccharides by combination of ligand exchange and size exclusion modes • Three types of counter ions are available: Ca^{2+}, Pb^{2+} and Na^{+} • Only water is required for the analysis of neutral sugars • SC1011 and SC1821 fulfill USP L19 and L22 requirements • SP0810 fulfills USP L22 and L34 requirements • KS-801 and KS-802 fulfill USP L22 and L58 requirements
KS-803 to 806	• Suitable for separation of polysaccharides by size exclusion mode • Can be used in combination with other columns e.g., KS-802 and KS-801 • Only water is required for the analysis of neutral sugars • Fulfill USP L22 and L58 requirements
DC-613 **SZ5532** **SC1211**	• Separates elements by combination of ligand exchange and HILIC modes • DC-613 can analyze sugars without removing sodium salts in the sample • SZ5532 is recommended for the separation of disaccharides or trisaccharides • SC1211 is suitable for separating sugar alcohols • DC-613 fulfills USP L22 and L58 requirements • SZ5532 fulfills USP L22 requirements • SC1211 fulfills USP L19 and L22 requirements
SC1011-7F	• Fulfills mannitol analysis requirements of JP, USP, and EP methods • Ca^{2+} modified ligand exchange chromatography column • Only water is required for the analysis of neutral sugars • Fulfills USP L19 and L22 requirements

●Standard columns

[Ligand exchange and size exclusion]

Product Code	Product Name	Plate Number (TP/column)	Functional Group (Counter Ion)	Exclusion Limit (Pullulan)	Particle Size (μm)	Column Size (mm) I.D. x Length	Shipping Solvent
F6378102	**SUGAR SC1011**	≥ 13,000	Sulfo (Ca^{2+})	1,000	6	**8.0 x 300**	H_2O
F6378103	**SUGAR SC1821**	≥ 13,000	Sulfo (Ca^{2+})	10,000	6	**8.0 x 300**	H_2O
F6700090	**SUGAR SC-G 6B**	(guard column)	Sulfo (Ca^{2+})	–	10	**6.0 x 50**	H_2O
F6378105	**SUGAR SP0810**	≥ 11,000	Sulfo (Pb^{2+})	1,000	7	**8.0 x 300**	H_2O
F6700081	**SUGAR SP-G 6B**	(guard column)	Sulfo (Pb^{2+})	–	10	**6.0 x 50**	H_2O
F6378106	**SUGAR SP0810 8C**	≥ 3,000	Sulfo (Pb^{2+})	1,000	7	**8.0 x 100**	H_2O
F6378010	**SUGAR KS-801**	≥ 17,000	Sulfo (Na^{+})	1,000	6	**8.0 x 300**	H_2O
F6378020	**SUGAR KS-802**	≥ 17,000	Sulfo (Na^{+})	10,000	6	**8.0 x 300**	H_2O
F6378025	**SUGAR KS-803**	≥ 17,000	Sulfo (Na^{+})	50,000	6	**8.0 x 300**	H_2O
F6378035	**SUGAR KS-804**	≥ 17,000	Sulfo (Na^{+})	400,000	7	**8.0 x 300**	H_2O
F6378050	**SUGAR KS-805**	≥ 9,000	Sulfo (Na^{+})	5,000,000	17	**8.0 x 300**	H_2O
F6378060	**SUGAR KS-806**	≥ 9,000	Sulfo (Na^{+})	(50,000,000)*	17	**8.0 x 300**	H_2O
F6700020	**SUGAR KS-G 6B**	(guard column)	Sulfo (Na^{+})	–	10	**6.0 x 50**	H_2O

( )* Estimated value
Base Material: Styrene divinylbenzene copolymer

[Ligand exchange and HILIC]

Product Code	Product Name	Plate Number (TP/column)	Functional Group (Counter Ion)	Particle Size (μm)	Pore Size (Å)	Column Size (mm) I.D. x Length	Shipping Solvent
F7001003	**RSpak DC-613**	≥ 5,500	Sulfo (Na^{+})	6	100	**6.0 x 150**	H_2O/CH_3CN=30/70
F6700170	**RSpak DC-G 4A**	(guard column)	Sulfo (Na^{+})	10	–	**4.6 x 10**	H_2O/CH_3CN=30/70
F7001300	**SUGAR SZ5532**	≥ 5,500	Sulfo (Zn^{2+})	6	–	**6.0 x 150**	H_2O/CH_3CN=30/70
F6700110	**SUGAR SZ-G**	(guard column)	Sulfo (Zn^{2+})	6	–	**4.6 x 10**	H_2O/CH_3CN=30/70
F7001400	**SUGAR SC1211**	≥ 5,500	Sulfo (Ca^{2+})	6	50	**6.0 x 250**	H_2O/CH_3CN=75/25
F6700120	**SUGAR SC1211G 4A**	(guard column)	Sulfo (Ca^{2+})	10	–	**4.6 x 10**	H_2O/CH_3CN=75/25

Base Material: Styrene divinylbenzene copolymer

For mannitol analysis following JP, USP, and EP methods

Product Code	Product Name	Functional Group (Counter Ion)	Particle Size (µm)	Column Size (mm) I.D. x Length	Shipping Solvent
F6379300	**EP SC1011-7F**	Sulfo (Ca^{2+})	8	**7.8 × 300**	H_2O
F6700090	**SUGAR SC-G 6B** (guard column)	Sulfo (Ca^{2+})	10	**6.0 × 50**	H_2O
F6379230	**USPpak MN-431**	Sulfo (Ca^{2+})	8	**4.0 × 250**	H_2O

See page 82 for USP42-NF37 Column List.

Base Material: Styrene divinylbenzene copolymer

Preparative columns [Preparative columns are made to order.]

[Ligand exchange and size exclusion]

Product Code	Product Name	Plate Number (TP/column)	Particle Size (µm)	Column Size (mm) I.D. x Length	Standard Column
F6502007	**SUGAR KS-2001**	≥ 7,000	13	**20.0 x 300**	KS-801
F6502008	**SUGAR KS-2002**	≥ 7,000	13	**20.0 x 300**	KS-802
F6502009	**SUGAR KS-2003**	≥ 8,000	13	**20.0 x 300**	KS-803
F6502010	**SUGAR KS-2004**	≥ 6,000	18	**20.0 x 300**	KS-804
F6502011	**SUGAR KS-2005**	≥ 6,000	18	**20.0 x 300**	KS-805
F6502012	**SUGAR KS-2006**	≥ 6,000	18	**20.0 x 300**	KS-806
F6700002	**SUGAR KS-G 8B**	(guard column)	13	**8.0 x 50**	(guard column)

Elution volumes of saccharides analyzed by Shodex columns

[Partial list only; refer to our website for complete list]

Substances	Elution Volume (mL)					
	SP0810	SC1011	KS-801	SZ5532	NH2P-50 4E	SC1211
Arabinose	10.42	8.91	8.21	5.11	6.18	5.56
D-Arabitol	15.86	11.33	7.63	7.27	6.29	8.16
Dulcitol	20.18	12.76	7.40	9.46	7.45	11.28
***meso*-Erythritol**	12.70	10.09	7.86	5.73	5.43	6.27
D(-)-Fructose	11.05	8.85	7.71	5.37	6.75	5.90
D(+)-Fucose	10.48	8.84	8.09	4.50	5.43	4.96
D(+)-Galactose	9.74	7.98	7.58	6.46	8.10	4.98
Gentiobiose	7.22	6.08	5.75	10.50	16.36	*
Glucose	8.63	7.30	7.17	5.87	8.61	4.76
***myo*-Inositol**	12.77	8.86	7.99	12.63	9.96	7.87
Isomaltose	7.68	6.26	5.95	10.57	15.18	*
Isomaltotriose	7.09	5.75	5.34	21.17	27.55	*
1-Kestose	6.79	5.75	5.26	13.09	20.11	*
Kojibiose	7.56	6.21	5.88	9.65	14.82	*
Lactitol	13.27	8.09	6.13	16.35	11.82	6.67
Lactose	8.05	6.51	5.99	10.12	13.27	4.07
Lactulose	9.13	6.99	6.19	9.16	10.72	4.65
Maltitol	12.23	8.26	6.03	13.04	11.82	6.77
Maltose	7.85	6.34	5.94	8.67	14.24	*
Maltotriose	7.48	5.89	5.38	13.79	24.96	*
Mannitol	15.80	11.10	7.23	8.75	7.39	9.03

Substances	Elution Volume (mL)					
	SP0810	SC1011	KS-801	SZ5532	NH2P-50 4E	SC1211
D-Mannose	10.72	8.17	7.64	5.83	7.84	5.01
Melibiose	8.16	6.45	5.98	11.69	14.70	4.23
Nystose	6.38	5.45	4.93	20.05	31.90	*
Palatinit	2peaks	2peaks	5.90	2peaks	12.73	2peaks
Palatinose	7.84	6.45	5.89	8.08	12.12	3.99
Panose	7.14	5.78	5.32	16.87	25.60	*
D(+)-Raffinose	7.14	5.78	5.29	16.36	20.25	*
Rhamnose	9.77	8.23	7.37	3.93	5.52	4.43
D(-)-Ribose	19.35	13.66	9.04	4.82	5.45	8.64
D(-)-Sorbitol	21.61	13.31	7.42	9.79	7.09	11.88
Sorbose	9.67	8.03	7.38	5.12	7.35	4.92
Stachyose	6.82	5.57	4.97	–	36.22	*
Sucrose	7.54	6.29	5.87	7.91	11.87	*
***α*-D-Talose**	21.33	12.59	8.76	5.69	6.47	8.51
Trehalose	7.62	6.27	5.78	10.85	13.25	*
Trehalulose	8.92	6.95	6.10	9.54	11.68	4.78
Xylitol	19.87	13.14	7.94	7.77	6.10	10.16
Xylobiose	8.16	6.68	6.40	5.65	9.05	*
D(+)-Xylose	9.21	7.90	7.71	4.55	6.58	4.48
D-Xylulose	10.64	9.02	8.04	4.06	5.41	5.07

(–)→Not detected (+)→Overlap with solvent peak

(–)→Not detected (+)→Overlap with solvent peak

Column : SUGAR SP0810, SC1011, KS-801
Eluent : H_2O
Flow rate : 1.0 mL/min
Detector : RI
Column temp. : 80 ℃

Column : SUGAR SC1211
Eluent : H_2O/CH_3CN=65/35
Flow rate : 1.0 mL/min
Detector : RI
Column temp. : 70 ℃

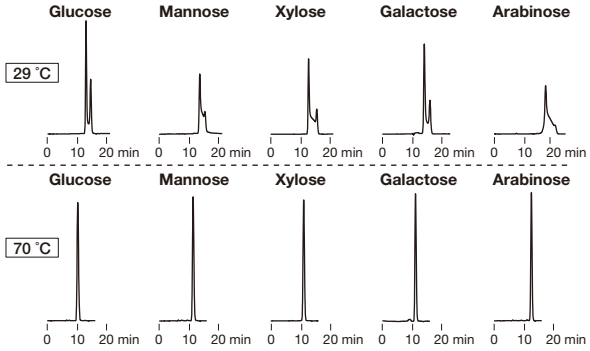
Column : SUGAR SZ5532
Eluent : H_2O/CH_3CN=25/75
Flow rate : 1.0 mL/min
Detector : RI
Column temp. : 60 ℃

Column : Asahipak NH2P-50 4E
Eluent : H_2O/CH_3CN=25/75
Flow rate : 1.0 mL/min
Detector : RI
Column temp. : 30 ℃

Saccharides anomer separation

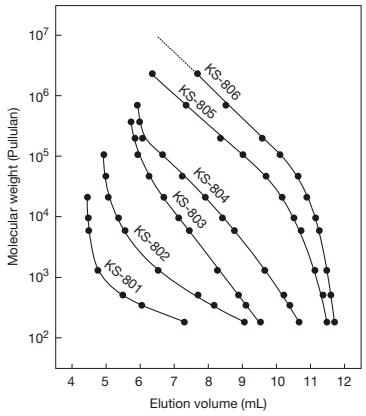
Saccharides may present their anomers at lower temperatures. By setting the SUGAR series columns at higher temperatures will prevent the anomer separation and this results in providing better chromatograms of each saccharide.

Sample : 0.5 % each, 10 µL



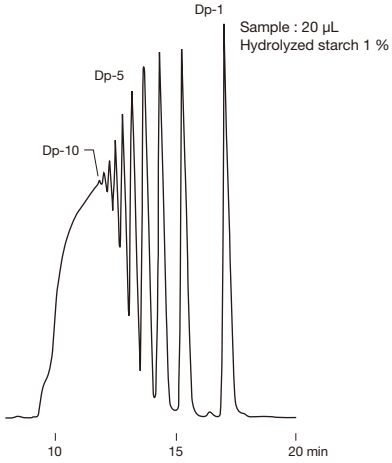
Column : Shodex SUGAR SC1011
Eluent : H_2O
Flow rate : 0.7 mL/min
Detector : RI
Column temp. : 29 ˚C, 70 ˚C

Calibration curves for KS-800 series using pullulan



Column : Shodex SUGAR KS-800 series
Eluent : H_2O
Detector : RI
Column temp. : 80 ˚C

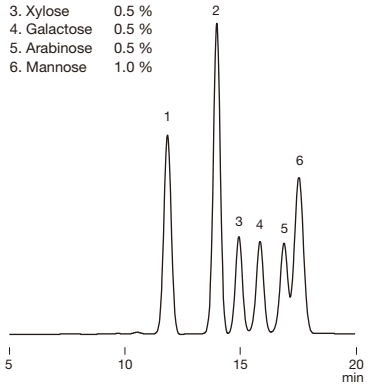
Hydrolyzed starch



Column : Shodex SUGAR KS-802 x 2
Eluent : H_2O
Flow rate : 1.0 mL/min
Detector : RI
Column temp. : 80 ˚C

Biomass sugars

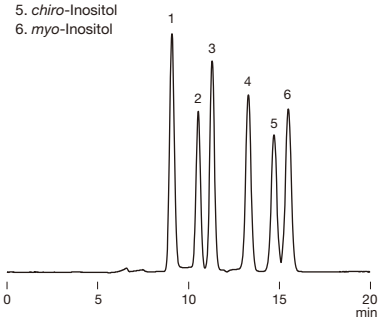
Sample : 5 µL
1. Cellobiose 1.0 %
2. Glucose 1.5 %
3. Xylose 0.5 %
4. Galactose 0.5 %
5. Arabinose 0.5 %
6. Mannose 1.0 %



Column : Shodex SUGAR SP0810
Eluent : H_2O
Flow rate : 0.6 mL/min
Detector : RI
Column temp. : 85 ˚C

Pinitol

Sample : 0.1 % each, 20 µL
1. Sucrose
2. Glucose
3. Pinitol
4. Fructose
5. *chiro*-Inositol
6. *myo*-Inositol

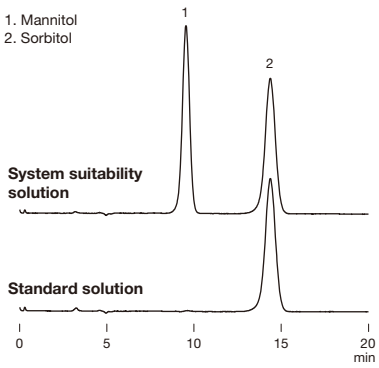


Column : Shodex SUGAR SP0810
Eluent : H_2O
Flow rate : 0.8 mL/min
Detector : RI
Column temp. : 85 ˚C

Analysis of sorbitol following USP method

Sample : 10 µL
(System suitability solution) Mannitol, Sorbitol 4.8 mg/g each
(Standard solution) Sorbitol 4.8 mg/g

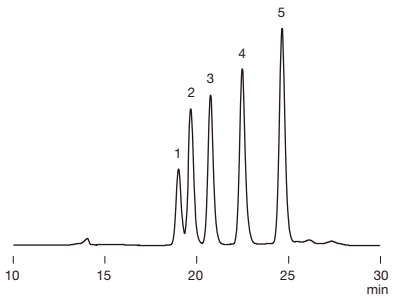
1. Mannitol
2. Sorbitol



Column : Shodex SUGAR SP0810 8C
Eluent : H_2O
Flow rate : 0.7 mL/min
Detector : RI (35 ˚C)
Column temp. : 50 ˚C

Oligosaccharides in soybean

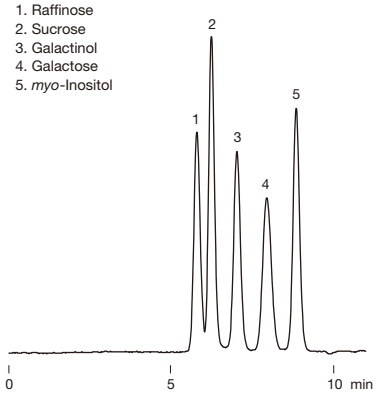
Sample : 0.1 % each, 20 µL
1. Verbascose
2. Stachyose
3. Raffinose
4. Sucrose
5. Pinitol



Column : Shodex SUGAR KS-802 + KS-801
Eluent : H_2O
Flow rate : 0.6 mL/min
Detector : RI
Column temp. : 85 ˚C

Saccharides related to raffinose biosynthesis

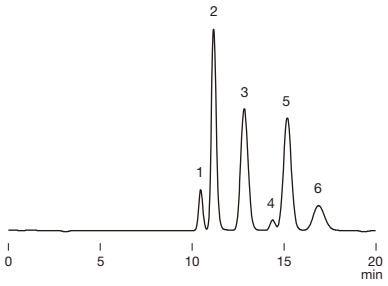
Sample : 0.1 % each, 20 µL
1. Raffinose
2. Sucrose
3. Galactinol
4. Galactose
5. *myo*-Inositol



Column : Shodex SUGAR SC1011
Eluent : H_2O
Flow rate : 1.0 mL/min
Detector : RI
Column temp. : 80 ˚C

Acesulfame K and sucralose

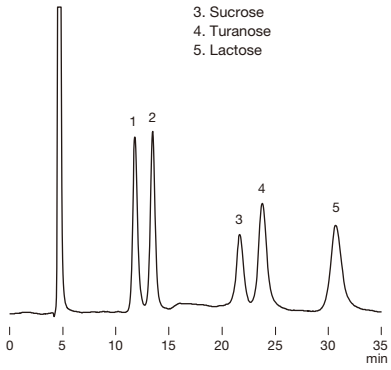
Sample : 20 µL
1. Acesulfame K 0.1 %
2. Sucrose 0.5 %
3. Glucose 0.5 %
4. Unknown from Acesulfame K
5. Fructose 0.5 %
6. Sucralose 0.1 %



Column : Shodex SUGAR SC1011
Eluent : 10 mM $CaSO_4$ aq.
Flow rate : 0.6 mL/min
Detector : RI
Column temp. : 80 ˚C

Sucrose and turanose

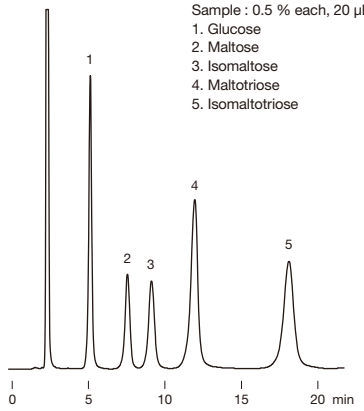
Sample : 0.5 % each, 10 µL
1. Fructose
2. Glucose
3. Sucrose
4. Turanose
5. Lactose



Column : Shodex SUGAR SZ5532
Eluent : H_2O/CH_3CN=20/80
Flow rate : 0.6 mL/min
Detector : RI
Column temp. : 60 ˚C

Maltose and isomaltose

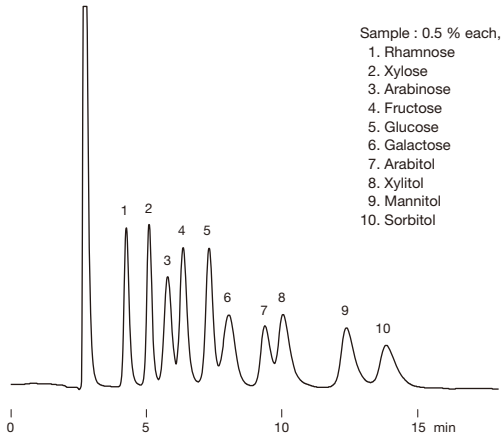
Sample : 0.5 % each, 20 µL
1. Glucose
2. Maltose
3. Isomaltose
4. Maltotriose
5. Isomaltotriose



Column : Shodex SUGAR SZ5532
Eluent : H_2O/CH_3CN=25/75
Flow rate : 1.0 mL/min
Detector : RI
Column temp. : 60 ˚C

Saccharides and sugar alcohols

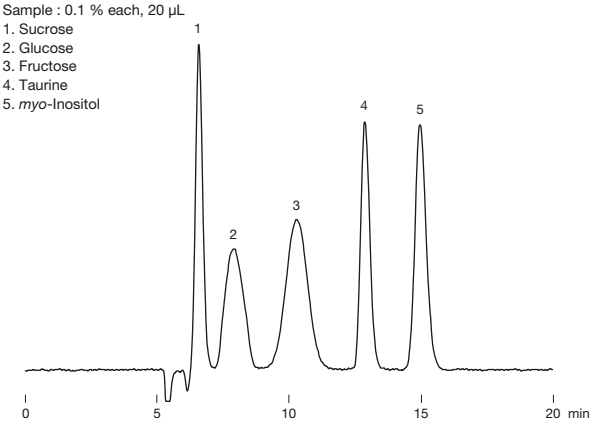
Sample : 0.5 % each, 20 µL
1. Rhamnose
2. Xylose
3. Arabinose
4. Fructose
5. Glucose
6. Galactose
7. Arabitol
8. Xylitol
9. Mannitol
10. Sorbitol



Column : Shodex SUGAR SZ5532
Eluent : H_2O/CH_3CN=20/80
Flow rate : 1.0 mL/min
Detector : RI
Column temp. : 65 ˚C

Saccharides and taurine

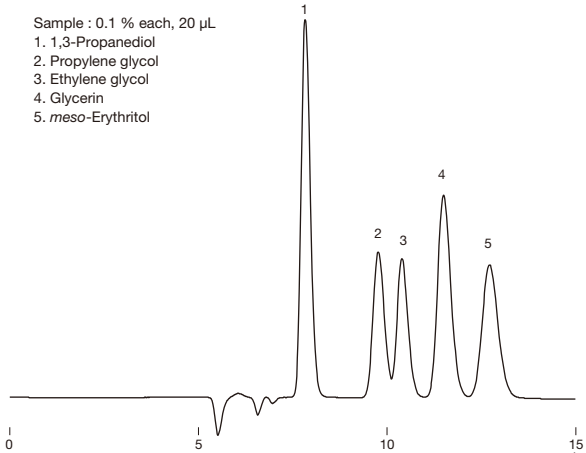
Sample : 0.1 % each, 20 µL
1. Sucrose
2. Glucose
3. Fructose
4. Taurine
5. *myo*-Inositol



Column : Shodex SUGAR SC1211
Eluent : H_2O/CH_3CN=60/40
Flow rate : 0.6 mL/min
Detector : RI
Column temp. : 70 ˚C

Moisturizing components

Sample : 0.1 % each, 20 µL
1. 1,3-Propanediol
2. Propylene glycol
3. Ethylene glycol
4. Glycerin
5. *meso*-Erythritol



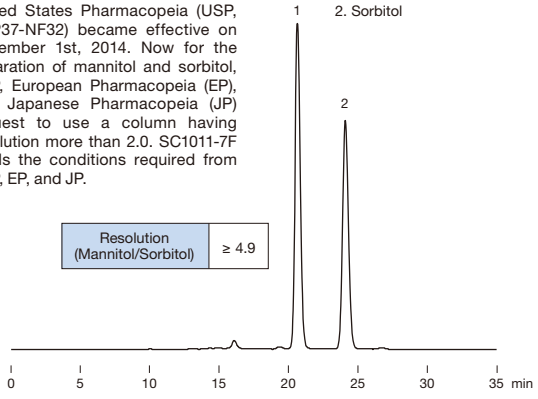
Column : Shodex SUGAR SC1211
Eluent : H_2O/CH_3CN=60/40
Flow rate : 0.6 mL/min
Detector : RI
Column temp. : 40 ˚C

Mannitol and sorbitol

Partial modifications on the analytical conditions of mannitol stated in the United States Pharmacopeia (USP, USP37-NF32) became effective on December 1st, 2014. Now for the separation of mannitol and sorbitol, USP, European Pharmacopeia (EP), and Japanese Pharmacopeia (JP) request to use a column having resolution more than 2.0. SC1011-7F fulfills the conditions required from USP, EP, and JP.

Resolution (Mannitol/Sorbitol)	≥ 4.9

Sample : 25 mg/mL each, 20 µL
1. Mannitol
2. Sorbitol



Column : Shodex EP SC1011-7F
Eluent : H_2O
Flow rate : 0.5 mL/min
Detector : RI
Column temp. : 85 ˚C

Ion Exclusion Chromatography Columns

Features

SH1011 **SH1821**	• Columns for simultaneous analysis of saccharides and organic acids • Separates neutral sugars in size exclusion mode and organic acids in ion exclusion mode • Suitable for the analysis of uronic and aldonic acids • Fulfill USP L17 and L22 requirements
KC-811	• Columns suitable for the analysis of organic acids • Separates compounds by ion exclusion mode and reversed phase mode • Highly selective when used with post column method • KC-811 6E is suitable for the analysis of cyanide ions and cyanogen chloride in accordance with the Japanese Water Supply Act • Fulfills USP L17 and L22 requirements

● Standard columns

[For simultaneous analysis of saccharides and organic acids]

Product Code	Product Name	Plate Number (TP/column)	Functional Group	Exclusion Limit (Pullulan)	Particle Size (µm)	Column Size (mm) I.D. x Length	Shipping Solvent
F6378100	**SUGAR SH1011**	≥ 17,000	Sulfo	1,000	6	**8.0 x 300**	H_2O
F6378101	**SUGAR SH1821**	≥ 17,000	Sulfo	10,000	6	**8.0 x 300**	H_2O
F6700080	**SUGAR SH-G**	(guard column)	Sulfo	–	10	**6.0 x 50**	H_2O
F6378104	**SUGAR SH1011 8C**	≥ 5,000	Sulfo	1,000	6	**8.0 x 100**	H_2O

Base Material: Styrene divinylbenzene copolymer

[For organic acids, cyanide ions and cyanogen chloride]

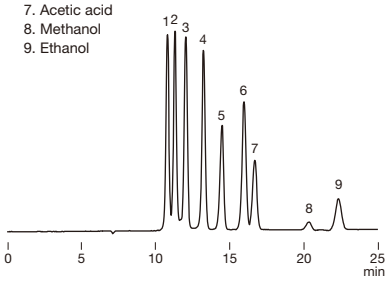
Product Code	Product Name	Plate Number (TP/column)	Functional Group	Particle Size (µm)	Column Size (mm) I.D. x Length	Shipping Solvent
F6378030	**RSpak KC-811**	≥ 17,000	Sulfo	6	**8.0 x 300**	0.1 % H_3PO_4 aq.
F6378033	**RSpak KC-811 6E**	≥ 13,000	Sulfo	6	**6.0 x 250**	0.1 % H_3PO_4 aq.
F6700030	**RSpak KC-G 6B**	(guard column)	Sulfo	10	**6.0 x 50**	0.1 % H_3PO_4 aq.
F6700010	**RSpak KC-G 8B**	(guard column)	Sulfo	13	**8.0 x 50**	0.1 % H_3PO_4 aq.

Use KC-G 8B for samples with relatively high impurity and KC-G 6B for samples with relatively low impurity.

Base Material: Styrene divinylbenzene copolymer

Maltooligosaccharides, organic acids and ethanol

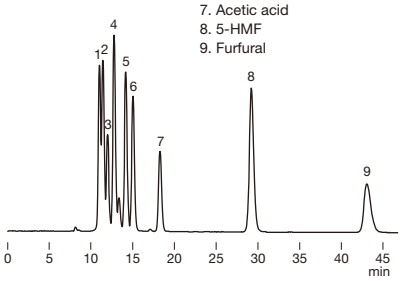
Sample : 0.05 % each, 20 µL
1. Maltotetraose
2. Maltotriose
3. Maltose
4. Glucose
5. Lactic acid
6. Glycerin
7. Acetic acid
8. Methanol
9. Ethanol



Column : Shodex SUGAR SH1821
Eluent : 0.5 mM H_2SO_4 aq.
Flow rate : 0.6 mL/min
Detector : RI
Column temp. : 75 ℃

Cello-oligosaccharides and furfurals

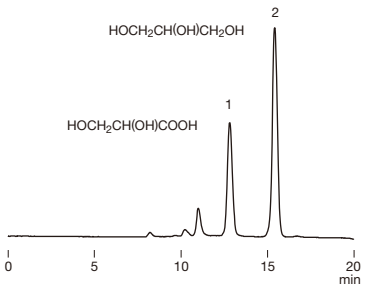
Sample : 0.1 % each, 10 µL
1. Cellopentaose
2. Cellotetraose
3. Cellotriose
4. Cellobiose
5. Glucose
6. Glyceric acid
7. Acetic acid
8. 5-HMF
9. Furfural



Column : Shodex SUGAR SH1821
Eluent : 2 mM H_2SO_4 aq.
Flow rate : 0.6 mL/min
Detector : RI
Column temp. : 60 ℃

Glycerin and glyceric acid

Sample : 0.1 % each, 10 µL
1. Glyceric acid
2. Glycerin

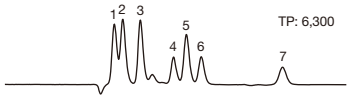


Column : Shodex SUGAR SH1011
Eluent : 2 mM H_2SO_4 aq.
Flow rate : 0.6 mL/min
Detector : RI
Column temp. : 60 ℃

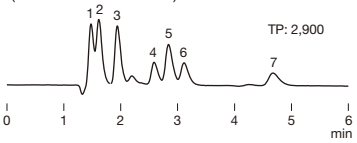
Rapid analysis of maltooligosaccharides, organic acids and ethanol

Sample : 0.1 % each, 5 µL
1. Maltotriose
2. Maltose
3. Glucose
4. Lactic acid
5. Acetic acid
6. Glycerin
7. Ethanol

(1) Shodex SUGAR SH1011 8C (8.0 mm I.D. x 100 mm)



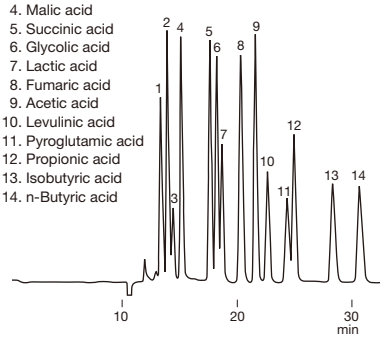
(2) Ion exclusion columm from other manufacture (7.8 mm I.D. x 100 mm)



Column : (1) Shodex SUGAR SH1011 8C
(2) Ion exclusion column from other manufacturer
Eluent : 1 mM H_2SO_4 aq.
Flow rate : (1) 1.0 mL/min
(2) 0.95 mL/min
Detector : RI
Column temp. : 65 ℃

Common organic acids

Sample :
1. Citric acid
2. Tartaric acid
3. Pyruvic acid
4. Malic acid
5. Succinic acid
6. Glycolic acid
7. Lactic acid
8. Fumaric acid
9. Acetic acid
10. Levulinic acid
11. Pyroglutamic acid
12. Propionic acid
13. Isobutyric acid
14. n-Butyric acid

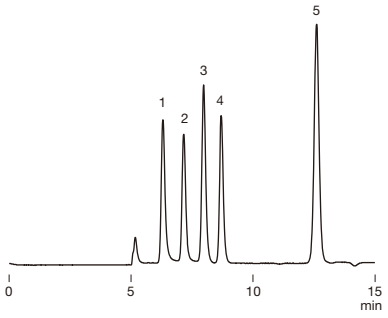


Column : Shodex RSpak KC-811 x 2
Eluent : 6 mM $HClO_4$ aq.
Flow rate : 1.0 mL/min
Detector : VIS (430 nm)
post column method
Column temp. : 50 ℃

Glucronolactone and organic acids

Sample : 20 µL

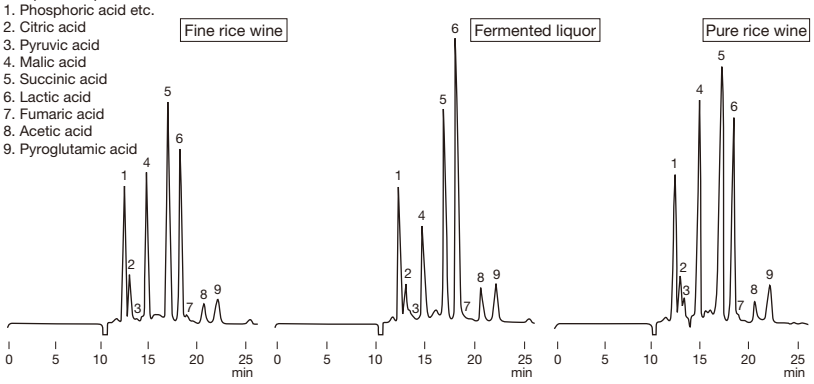
1. Citric acid	0.01 %
2. Malic acid	0.01 %
3. Glucronolactone	0.01 %
4. Glycerin	0.01 %
5. Ethanol	0.05 %



Column : Shodex RSpak KC-811
Eluent : 3 mM $HClO_4$ aq.
Flow rate : 1.0 mL/min
Detector : RI
Column temp. : 40 ℃

Organic acids in sake

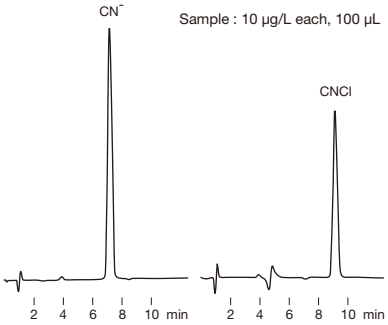
Sample : 100 µL
1. Phosphoric acid etc.
2. Citric acid
3. Pyruvic acid
4. Malic acid
5. Succinic acid
6. Lactic acid
7. Fumaric acid
8. Acetic acid
9. Pyroglutamic acid



Column : Shodex RSpak KC-G 8B + KC-811 x 2
Eluent : 4.8 mM $HClO_4$ aq.
Flow rate : 1.0 mL/min
Detector : VIS (430 nm)
post column method
Column temp. : 63 ℃

Analysis of cyanide ion and cyanogen chloride with post column method

Sample : 10 µg/L each, 100 µL



Column : Shodex RSpak KC-811 6E
Eluent : 1 mM H_2SO_4 aq.
Reagent A : Chloramine T solution
Reagent B : 4-Pyridinecarboxylic acid-Pyrazolone solution
Flow rate : (Eluent) 1.0 mL/min
(Reagent) 0.5 mL/min each
Detector : VIS (638 nm)
Column temp. : 40 ℃
Reaction temp. : (Reagent A) 40 ℃
(Reagent B) 80 ℃

Ion Chromatography Columns (Anion Analysis)

Features

NI-424 **I-524A**	• Ideal for anion non-suppressor methods • NI-424 provides simultaneous analysis of fluoride and phosphate ions
SI-90 4E **SI-50 4E** **SI-52 4E**	• Suitable for anion suppressor methods with sodium carbonate eluent • Suitable for the quantitative analysis of fluoride ion • SI-50 4E separates target inorganic anions from organic acids • SI-52 4E provides simultaneous analysis of oxyhalides and general inorganic ions • Carbonate peak does not interfere with analysis
SI-35	• Columns for rapid analysis with suppressor method • SI-35 4D provides rapid analysis of oxyhalides and general inorganic ions • SI-35 2B provides rapid analysis of general inorganic ions
New **SI-36 4D**	• A column using potassium hydroxide as eluent for anion analysis with suppressor method • Good separation of sulfite ion / sulfate ion • Analysis of seven general inorganic anions within 30 minutes under isocratic conditions

For anion non-suppressor method

● Standard columns

Product Code	Product Name	Plate Number (TP/column)	Functional Group	Particle Size (µm)	Column Size (mm) I.D. x Length	Shipping Solvent
F6995243	**IC NI-424**	≥ 5,000	Quaternary ammonium	5	**4.6 x 100**	8 mM 4-Hydroxybenzoic acid + 2.8 mM Bis-Tris + 2 mM Phenylboronic acid + 0.005 mM CyDTA aq.
F6709616	**IC NI-G**	(guard column)	Quaternary ammonium	5	**4.6 x 10**	8 mM 4-Hydroxybenzoic acid + 2.8 mM Bis-Tris + 2 mM Phenylboronic acid + 0.005 mM CyDTA aq.
F6995240	**IC I-524A**	≥ 2,000	Quaternary ammonium	12	**4.6 x 100**	2.5 mM Phthalic acid aq.
F6700400	**IC IA-G**	(guard column)	Quaternary ammonium	12	**4.6 x 10**	2.5 mM Phthalic acid aq.

Base Material: Polyhydroxymethacrylate Housing Material: SUS

For anion suppressor method (Sodium carbonate eluent)

● Standard columns

Product Code	Product Name	Plate Number (TP/column)	Functional Group	Particle Size (µm)	Column Size (mm) I.D. x Length	Shipping Solvent
F6995244	**IC SI-90 4E**	≥ 5,000	Quaternary ammonium	9	**4.0 x 250**	1.8 mM Na_2CO_3 + 1.7 mM $NaHCO_3$ aq.
F6709620	**IC SI-90G**	(guard column)	Quaternary ammonium	9	**4.6 x 10**	1.8 mM Na_2CO_3 + 1.7 mM $NaHCO_3$ aq.
F6995245	**IC SI-50 4E**	≥ 10,000	Quaternary ammonium	5	**4.0 x 250**	3.2 mM Na_2CO_3 + 1.0 mM $NaHCO_3$ aq.
F6709625	**IC SI-50G**	(guard column)	Quaternary ammonium	5	**4.6 x 10**	3.2 mM Na_2CO_3 + 1.0 mM $NaHCO_3$ aq.

Base Material: Polyvinyl alcohol Housing Material: PEEK

[For oxyhalides suppressor method]

Product Code	Product Name	Plate Number (TP/column)	Functional Group	Particle Size (µm)	Column Size (mm) I.D. x Length	Shipping Solvent
F6995260	**IC SI-52 4E**	≥ 14,000	Quaternary ammonium	5	**4.0 x 250**	3.6 mM Na_2CO_3 aq.
F6709626	**IC SI-92G**	(guard column)	Quaternary ammonium	9	**4.6 x 10**	3.6 mM Na_2CO_3 aq.

Base Material: Polyvinyl alcohol Housing Material: PEEK

[For rapid analysis]

Product Code	Product Name	Plate Number (TP/column)	Functional Group	Particle Size (µm)	Column Size (mm) I.D. x Length	Shipping Solvent
F6995290	**IC SI-35 4D**	≥ 13,000	Quaternary ammonium	3.5	**4.0 x 150**	3.6 mM Na_2CO_3 aq.
F6709627	**IC SI-95G**	(guard column)	Quaternary ammonium	9	**4.6 x 10**	3.6 mM Na_2CO_3 aq.

Base Material: Polyvinyl alcohol Housing Material: PEEK

● Semi-micro columns

[For rapid analysis]

Product Code	Product Name	Plate Number (TP/column)	Functional Group	Particle Size (µm)	Column Size (mm) I.D. x Length	Shipping Solvent
F6995291	**IC SI-35 2B**	≥ 4,000	Quaternary ammonium	3.5	**2.0 x 50**	1.0 mM Na_2CO_3 + 2.0 mM $NaHCO_3$ aq.

Base Material: Polyvinyl alcohol Housing Material: PEEK

For anion suppressor method (Potassium hydroxide eluent)

● Standard columns

Product Code	Product Name	Plate Number (TP/column)	Functional Group	Particle Size (µm)	Column Size (mm) I.D. x Length	Shipping Solvent
F6999361	New **IC SI-36 4D**	≥ 8,500	Quaternary ammonium	3.5	**4.0 x 150**	25 mM KOH aq.

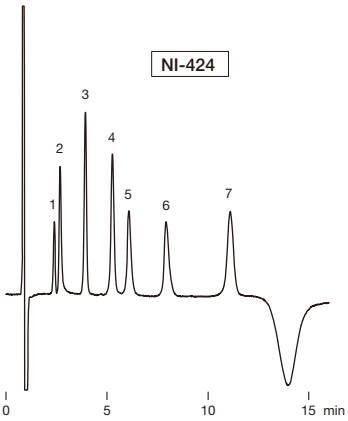
Base Material: Polyvinyl alcohol Housing Material: PEEK

[Guard filter for SI-35 2B]

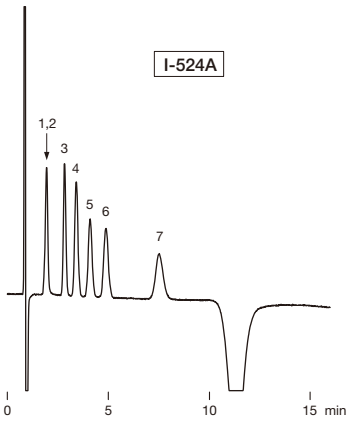
Product Code	Product Name	Contents
F6709720	**IC SI-2GF**	One holder and one filter
F6709730	**IC SI-2GF filter**	3 filters

Removes insoluble components in the sample

Anion analysis using NI-424 and I-524A (non-suppressor methods)



Sample : 20 µL
1. $H_2PO_4^-$ 10 mg/L
2. F^- 1 mg/L
3. Cl^- 1 mg/L
4. NO_2^- 5 mg/L
5. Br^- 5 mg/L
6. NO_3^- 5 mg/L
7. SO_4^{2-} 5 mg/L



With twice increased theoretical plate number, NI-424 provides a higher performance compared to I-524A.

[Features of NI-424]
(1) Enables the separation of $H_2PO_4^-$ and F^- which were difficult to separate with I-524A.
(2) Provides sharper peaks, and resolution between all peaks are well defined. Especially, the separation of Cl^- and NO_2^- is improved.

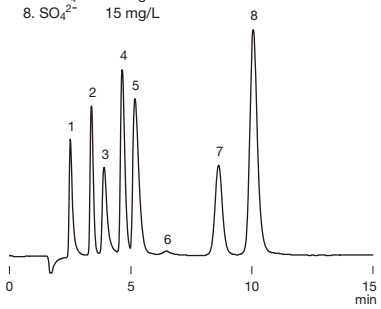
Column : **Shodex IC NI-424**
Eluent : 8 mM 4-Hydroxybenzoic acid + 2.8 mM Bis-Tris + 2 mM Phenylboronic acid + 0.005 mM *CyDTA aq.
Flow rate : 1.0 mL/min
Detector : Non-suppressed conductivity
Column temp. : 40 ˚C

Column : **Shodex IC I-524A**
Eluent : 2.5 mM Phthalic acid + 2.3 mM Tris(hydroxymethyl)aminomethane aq.
Flow rate : 1.2 mL/min
Detector : Non-suppressed conductivity
Column temp. : 40 ˚C

*CyDTA : trans-1,2-Diaminocyclohexane-N,N,N',N'-tetra acetic acid

Anion analysis using SI-90 4E (suppressor method)

Sample : 20 µL
1. F^- 2 mg/L
2. Cl^- 3 mg/L
3. NO_2^- 5 mg/L
4. Br^- 10 mg/L
5. NO_3^- 10 mg/L
6. HCO_3^- 300 mg/L
7. HPO_4^{2-} 15 mg/L
8. SO_4^{2-} 15 mg/L

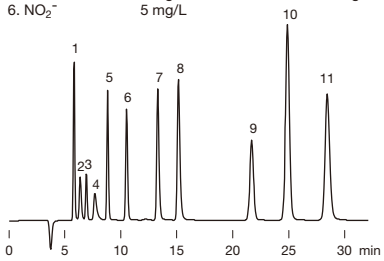


Column : **Shodex IC SI-90 4E**
Eluent : 1.8 mM Na_2CO_3 + 1.7 mM $NaHCO_3$ aq.
Flow rate : 1.5 mL/min
Detector : Suppressed conductivity
Column temp. : Room temp. (25 ˚C)

Anion analysis using SI-90 4E (suppressor method)

SI-50 4E is a high performance type of SI-90 4E. Acetic acid, formic acid, and methacrylic acid eluted between F^- and Cl^-.
The carbonate system peak appears between NO_2^- and Br^- peaks.

Sample : 20 µL
1. F^- 2 mg/L
2. Acetic acid 10 mg/L
3. Formic acid 2 mg/L
4. Methacrylic acid 10 mg/L
5. Cl^- 3 mg/L
6. NO_2^- 5 mg/L
7. Br^- 10 mg/L
8. NO_3^- 10 mg/L
9. HPO_4^{2-} 15 mg/L
10. SO_4^{2-} 15 mg/L
11. Oxalic acid 15 mg/L

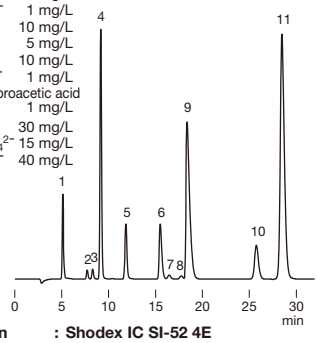


Column : **Shodex IC SI-50 4E**
Eluent : 3.2 mM Na_2CO_3 + 1.0 mM $NaHCO_3$ aq.
Flow rate : 0.7 mL/min
Detector : Suppressed conductivity
Column temp. : 25 ˚C

Oxyhalides and anions analysis using SI-52 4E (suppressor method)

SI-52 4E is a high resolution column offering 14,000 or higher theoretical plate number. It supports simultaneous analysis of oxyhalides and inorganic anions. It is recommended to set the column temperature at 45 °C.

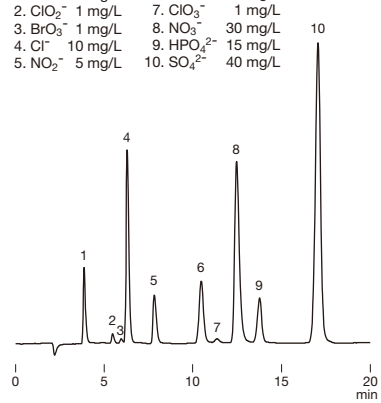
Sample : 50 µL
1. F^- 2 mg/L
2. ClO_2^- 1 mg/L
3. BrO_3^- 1 mg/L
4. Cl^- 10 mg/L
5. NO_2^- 5 mg/L
6. Br^- 10 mg/L
7. ClO_3^- 1 mg/L
8. Dichloroacetic acid 1 mg/L
9. NO_3^- 30 mg/L
10. HPO_4^{2-} 15 mg/L
11. SO_4^{2-} 40 mg/L



Column : **Shodex IC SI-52 4E**
Eluent : 3.6 mM Na_2CO_3 aq.
Flow rate : 0.8 mL/min
Detector : Suppressed conductivity
Column temp. : 45 ˚C

Rapid analysis of oxyhalides and anions using SI-35 4D (suppressor method)

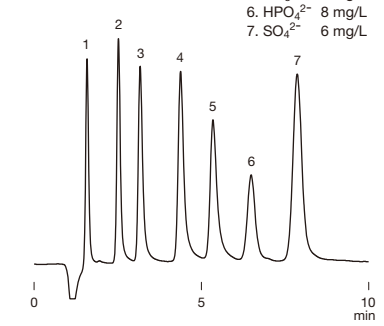
Sample : 20 µL
1. F^- 2 mg/L
2. ClO_2^- 1 mg/L
3. BrO_3^- 1 mg/L
4. Cl^- 10 mg/L
5. NO_2^- 5 mg/L
6. Br^- 10 mg/L
7. ClO_3^- 1 mg/L
8. NO_3^- 30 mg/L
9. HPO_4^{2-} 15 mg/L
10. SO_4^{2-} 40 mg/L



Column : **Shodex IC SI-35 4D**
Eluent : 2.0 mM Na_2CO_3 + 4.5 mM $NaHCO_3$ aq.
Flow rate : 0.6 mL/min
Detector : Suppressed conductivity
Column temp. : 45 ˚C

Rapid analysis of anions using SI-35 2B (suppressor method)

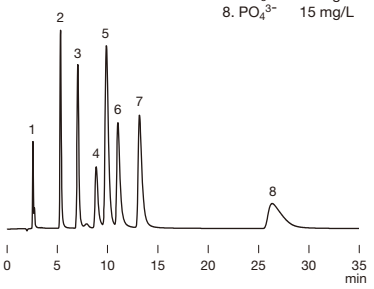
Sample : 2 µL
1. F^- 1 mg/L
2. Cl^- 2 mg/L
3. NO_2^- 3 mg/L
4. Br^- 5 mg/L
5. NO_3^- 5 mg/L
6. HPO_4^{2-} 8 mg/L
7. SO_4^{2-} 6 mg/L



Column : **Shodex IC SI-35 2B**
Eluent : 1.0 mM Na_2CO_3 + 2.0 mM $NaHCO_3$ aq.
Flow rate : 0.2 mL/min
Detector : Suppressed conductivity
Column temp. : 30 ˚C

Anions and sulfite ion analysis using SI-36 4D (suppressor method)

Sample : 25 µL
1. F^- 0.5 mg/L
2. Cl^- 3 mg/L
3. NO_2^- 5 mg/L
4. SO_3^{2-} 5 mg/L
5. SO_4^{2-} 10 mg/L
6. Br^- 10 mg/L
7. NO_3^- 10 mg/L
8. PO_4^{3-} 15 mg/L



Column : **Shodex IC SI-36 4D**
Eluent : 25 mM KOH aq.
Flow rate : 0.7 mL/min
Detector : Suppressed conductivity
Column temp. : 30 ˚C

Eluent source : Dionex™ EGC 500 KOH

Ion Chromatography Columns (Cation Analysis)

Features

YS-50
- High performance type of YK-421
- Applicable to both suppressor and non-suppressor methods
- Provides sharp peaks; more significant for divalent cation analysis
- Supports the analysis of alkylamines and transition metals

YK-421
- Column for cation analysis with non-suppressor method
- Simultaneous analysis of monovalent and divalent cations
- Suitable separating of alkylamines
- Fulfills USP L76 requirements

Y-521
- Column for cation analysis with non-suppressor method
- Separates monovalent cations or divalent cations
- Fulfills USP L17 and L22 requirements

T-521
- Column for transition metal ion analysis
- Highly sensitive analysis achievable using post column color reaction method
- Fulfills USP L17 and L22 requirements

●Standard columns

[For cations]

Product Code	Product Name	Plate Number (TP/column)	Functional Group	Base Material	Particle Size (μm)	Column Size (mm) I.D. x Length	Shipping Solvent
F7122000	**IC YS-50**	≥ 5,500	Carboxyl	Polyvinyl alcohol	5	**4.6 × 125**	H_2O
F6700530	**IC YS-G**	(guard column)	Carboxyl	Polyvinyl alcohol	5	**4.6 × 10**	H_2O
F7120012	**IC YK-421**	≥ 2,800	Carboxyl	Silica	5	**4.6 × 125**	5 mM Tartaric acid + 1 mM Dipicolinic acid + 1.5 g/L Boric acid aq.
F6709608	**IC YK-G**	(guard column)	Carboxyl	Silica	5	**4.6 × 10**	5 mM Tartaric acid + 1 mM Dipicolinic acid + 1.5 g/L Boric acid aq.
F6995210	**IC Y-521**	≥ 3,000	Sulfo	Styrene divinylbenzene copolymer	12	**4.6 × 150**	4 mM HNO_3 aq.
F6700230	**IC Y-G**	(guard column)	Sulfo	Styrene divinylbenzene copolymer	12	**4.6 × 10**	4 mM HNO_3 aq.

Housing Material: SUS

●Standard columns

[For transition metal ions]

Product Code	Product Name	Plate Number (TP/column)	Functional Group	Particle Size (μm)	Column Size (mm) I.D. x Length	Shipping Solvent
F6995250	**IC T-521**	≥ 3,000	Sulfo	12	**4.6 × 150**	3 mM HNO_3 aq.
F6700412	**IC T-G**	(guard column)	Sulfo	12	**4.6 × 10**	3 mM HNO_3 aq.

Base Material: Styrene divinylbenzene copolymer Housing Material: PEEK

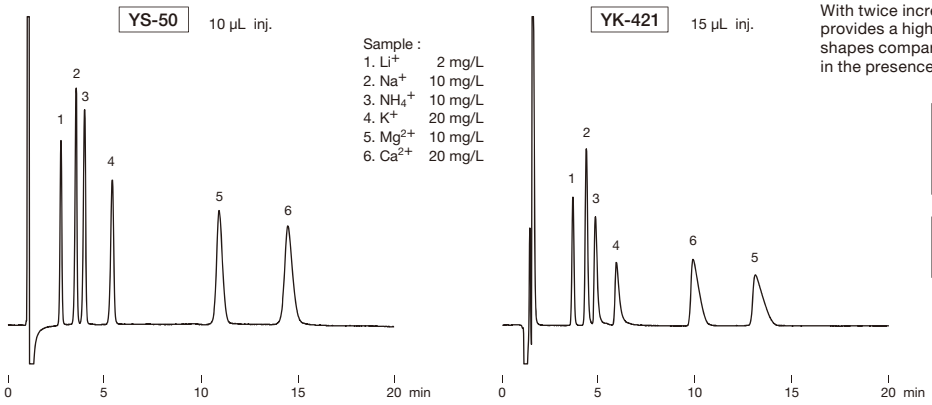
●Line filters for IC

[Shareable for anion analysis and cation analysis]

Product Code	Product Name	Contents
F8500630	**IC FL-1**	One holder and one filter
F8500640	**IC FL-1 filter**	5 filters

Removes insoluble components in the eluent by installing it upstream of the injector

Cation analysis using YS-50 and YK-421



With twice increased theoretical plate number, YS-50 provides a higher performance with improved peak shapes compared to YK-421. The quantitation of NH_4^+ in the presence of high Na^+ content is also improved.

TP	YS-50	YK-421
Mg^{2+}	6,900	3,000
Ca^{2+}	6,600	3,000

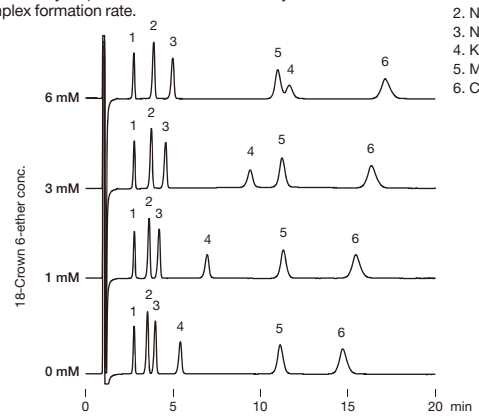
Resolution ($Na^+$and NH_4^+)	YS-50	YK-421
	2.5	2.1

Column : Shodex IC YS-50
Eluent : 4 mM Methanesulfonic acid aq.
Flow rate : 1.0 mL/min
Detector : Non-suppressed conductivity
Column temp. : 40 ℃

Column : Shodex IC YK-421
Eluent : 5 mM Tartaric acid + 1 mM Dipicolinic acid + 1.5 g/L Boric acid aq.
Flow rate : 1.0 mL/min
Detector : Non-suppressed conductivity
Column temp. : 40 ℃

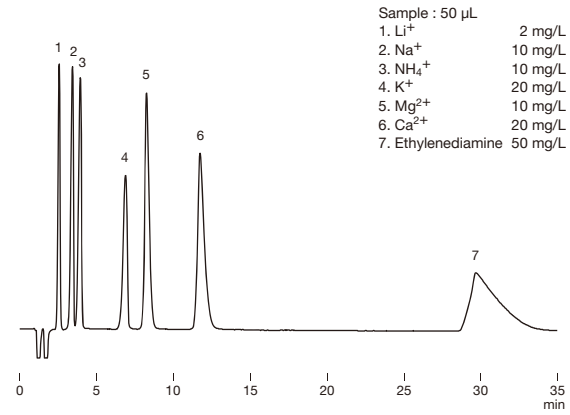
Effects of added crown ether in the eluent

Crown ether forms complex with cations. The elution of cations (particularly K^+) can be well controlled by the difference in complex formation rate.



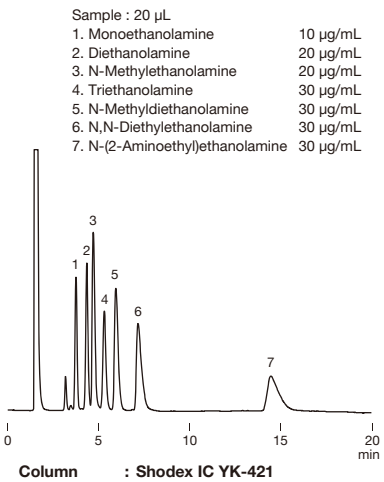
Column : Shodex IC YS-50
Eluent : 4 mM Methanesulfonic acid + 18-Crown 6-ether aq.
Flow rate : 1.0 mL/min
Detector : Non-suppressed conductivity
Column temp. : 40 ℃

Simultaneous analysis of cations and ethylenediamine



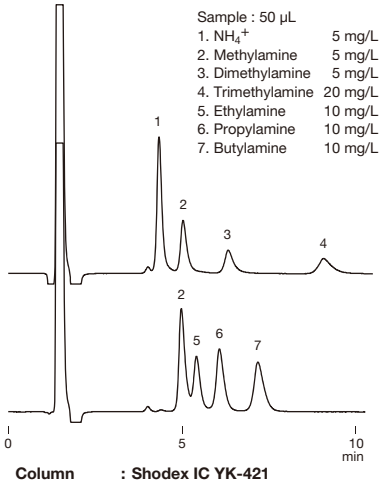
Column : Shodex IC YS-50
Eluent : 4 mM HNO_3 + 1.5 mM 18-Crown 6-ether aq. /CH_3CN=90/10
Flow rate : 1.0 mL/min
Detector : Non-suppressed conductivity
Column temp. : 40 ℃

Amino alcohols



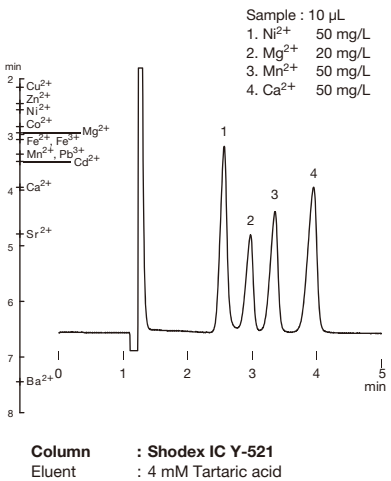
Column : Shodex IC YK-421
Eluent : 4 mM HNO_3 aq.
Flow rate : 1.0 mL/min
Detector : Non-suppressed conductivity
Column temp. : 40 ℃

Alkylamines



Column : Shodex IC YK-421
Eluent : 4 mM H_3PO_4 aq./CH_3CN=90/10
Flow rate : 1.0 mL/min
Detector : Non-suppressed conductivity
Column temp. : 25 ℃

Alkaline earth metal ions

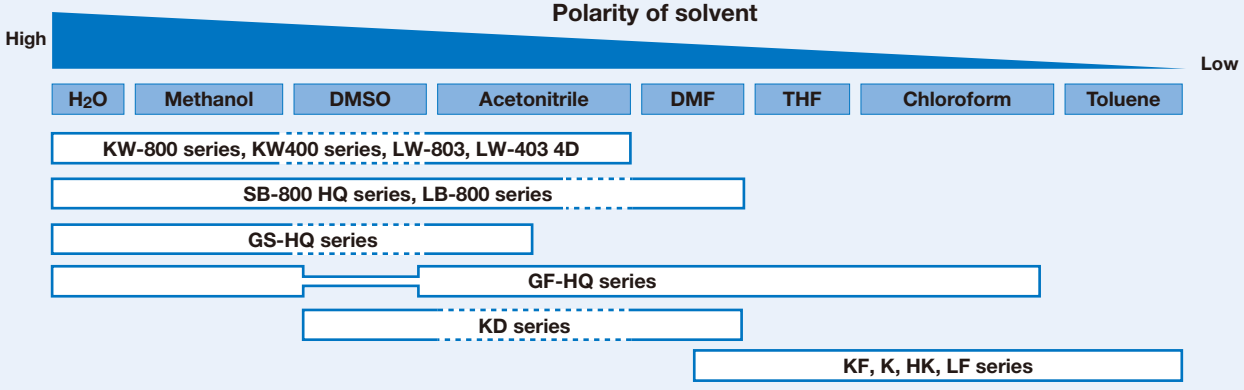


Column : Shodex IC Y-521
Eluent : 4 mM Tartaric acid + 2 mM Ethylenediamine aq.
Flow rate : 1.0 mL/min
Detector : Non-suppressed conductivity
Column temp. : 40 ℃

Column Selection for Size Exclusion Chromatography (SEC)

	Application	Solvent	Column		Page
Aqueous SEC (GFC)	Biological macromolecules (proteins, peptides, nucleic acids, etc.)	Buffer etc.	**KW-800 series**		38
			KW400 series	High performance (solvent-saving)	38
			LW-803	High performance	39
			LW-403 4D	High performance (Rapid analysis)	39
	Biological macromolecules (high MW range)	Buffer etc.	**SB-800 HQ series**		42
			LB-800 series	For light scattering detector	42
	Water-soluble polymers (polyacrylamide, polyethylenimine, etc.) Polysaccharides	Water, Buffer, Aqueous solution, etc.	**SB-800 HQ series**		42
			LB-800 series	For light scattering detector	42
	Oligosaccharide, polysaccharides	Water, Aqueous solution, etc.	**KS-800 series**		26
			GS-HQ series		46
Organic SEC (GPC)	General polymers	THF	**KF-800 series**		50
			KF-600 series	Rapid analysis (solvent-saving)	56
			KF-400HQ series	High performance (solvent-saving)	56
			HK-400 series	Ultra-rapid Analysis (solvent-saving)	58
			LF series	High-linear calibration curves	60
		Chloroform	**K-800 series**		52
			HK-400 series	Ultra-rapid Analysis (solvent-saving)	58
			LF series	High-linear calibration curves	60
	Polar polymers (polyimides, polyvinylpyrrolidones etc.)	DMF	**KD-800 series**		54
			HK-400 series	Ultra-rapid Analysis (solvent-saving)	58
			LF series	High-linear calibration curves	60
			SB-800 HQ series		42
			LB-800 series	For light scattering detector	42
	Analysis at high temperature (polyethylene, polypropylene etc.)	ODCB etc.	**HT-800 series**		62
			UT-800 series		62
			AT-806MS		62
	Engineering resin analysis at room temperature [polyamide (Nylon), polyethylene terephthalate (PET) etc.]	HFIP	**HFIP-800 series**		64
			HFIP-600 series	Rapid analysis (solvent-saving)	64
			HK-400 series	Ultra-rapid Analysis (solvent-saving)	58
			LF series	High-linear calibration curves	60
Aqueous/Organic SEC			**GF-HQ series**		48

Solvent usability guideline for the Shodex SEC columns



See page 68 for the solvent replaceability of organic solvent SEC (GPC) packed columns.

Precautions for Polar Polymer Analysis

Unexpected interactions in the column can affect the size exclusion chromatography analysis of polar polymers.
These interactions may change elution patterns and results in an invalid molecular weight calculation.
It is important to reduce these interfering interactions in order to obtain the accurate molecular weight distribution.

Interfering interactions likely to be observed

Interactions between the analyte and the packing materials

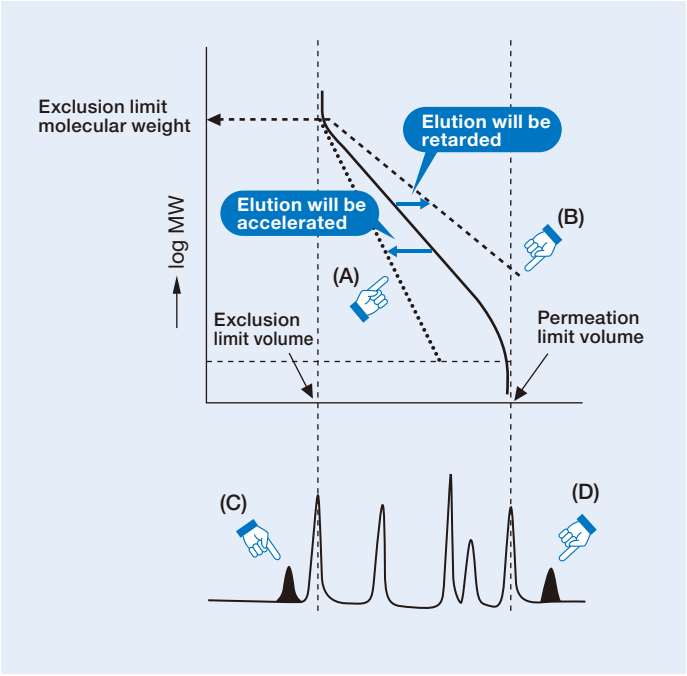
- **Hydrophobic interaction**
  → The analyte is adsorbed on the packing material. This delays the analyte elution and results in under estimating the analyte's molecular weight. See (B) and (D).
- **Ionic interaction**
  (1) Ion Exclusion
  →The analyte is repelled from the packing material. This accelerates the analyte elution and results in over estimating the analyte's molecular weight. See (A) and (C).
  (2) Ion Exchange
  →The analyte is adsorbed on the packing material. This delays the analyte elution and results in under estimating the analyte's molecular weight. See (B) and (D).

Interaction within and between the analyte

- **Ionic repulsion effects observed within the multivalent macromolecules causes structure expansion**
  → This accelerates the analyte elution and results in over estimating the analyte's molecular weight. See (A).
- **Association between the molecules**
  → This accelerates the analyte elution and results in over estimating the analyte's molecular weight. See (A).

Interactions between the analyte and the solvent

- **The multivalent ion in the solvent works as a bridge to bind ionic molecules (analyte).**



Methods to reduce interactions

Aqueous SEC (GFC)

Ionic interaction

- **Add salt**

Hydrophobic interaction

- **Increase the analyte dissociation**
  Cationic polymer → Lower the pH
  Anionic polymer → Higher the pH
- **Lower the eluent polarity**
  (Example) Add acetonitrile or methanol

Organic SEC (GPC)

Ionic interaction

- **Add salt**
  (Example) Add LiBr to DMF
  Add CF_3COONa to HFIP

Hydrophobic interaction

- **Lower the eluent polarity**
  (Example) Change the eluent from DMF to THF

Hydrophilic interaction

- **Increase the eluent polarity**
  (Example) Change the eluent from THF to DMF

Aqueous SEC (GFC) Columns: Silica-based

Features

KW-800	• Silica-based packed columns for aqueous SEC (GFC) analysis • Suitable for the analysis of proteins and enzymes • Fulfills USP L20, L33, and L59 requirements
KW400	• Reduced packing material particle size enhances column performance • Three to four-fold higher sensitivity than KW-800 series • KW405-4F is applicable analyzing samples with molecular weight above 1,000,000 • Fulfills USP L20, L33, and L59 requirements
LW-803	• Pore size specifically controlled for analyzing proteins with a molecular weight of several hundred of thousand • High performance analysis of antibody drugs and various proteins • High lot-to-lot reproducibility • Fulfills USP L20, L33, and L59 requirements
New **LW-403 4D**	• Rapid analysis column for LW-803 • Achieves approximately halved analysis time compared with standard column • Fulfills USP L20, L33, and L59 requirements

Standard columns

Product Code	Product Name	* Plate Number (TP/column)	Particle Size (µm)	Pore Size (Å)	Column Size (mm) I.D. x Length	Shipping Solvent
F6989000	**PROTEIN KW-802.5**	≥ 21,000	5	400	**8.0 × 300**	H_2O
F6989103	**PROTEIN KW-803**	≥ 21,000	5	1,000	**8.0 × 300**	H_2O
F6989104	**PROTEIN KW-804**	≥ 16,000	7	1,500	**8.0 × 300**	H_2O
F6700131	**PROTEIN KW-G 6B**	(guard column)	7	–	**6.0 × 50**	H_2O

*Measured with ethylene glycol

Base Material: Silica
Usable pH range: pH3.0 - 7.5
Usable concentration of methanol and acetonitrile is up to 100 %

High performance semi-micro columns

◎ KW400 series is recommended to be used with semi-micro type devices.

Product Code	Product Name	* Plate Number (TP/column)	Particle Size (µm)	Pore Size (Å)	Column Size (mm) I.D. x Length	Shipping Solvent
F6989201	**KW402.5-4F**	≥ 35,000	3	400	**4.6 x 300**	H_2O
F6989202	**KW403-4F**	≥ 35,000	3	800	**4.6 x 300**	H_2O
F6989203	**KW404-4F**	≥ 25,000	5	1,500	**4.6 x 300**	H_2O
F6989204	**KW405-4F**	≥ 25,000	5	2,000	**4.6 x 300**	H_2O
F6700132	**KW400G-4A**	(guard column)	5	–	**4.6 x 10**	H_2O

*Measured with uridine

Base Material: Silica
Usable pH range: pH3.0 - 7.5
Usable concentration of methanol and acetonitrile is up to 100 %

For antibody drugs analysis

●Standard columns

Product Code	Product Name	* Plate Number (TP/column)	Particle Size (μm)	Pore Size (Å)	Column Size (mm) I.D. x Length	Shipping Solvent
F6989303	**PROTEIN LW-803**	≥ 12,000	3	1,000	**8.0 x 300**	H_2O
F6700133	**PROTEIN LW-G 6B**	(guard column)	3	–	**6.0 x 50**	H_2O

*Measured with bovine serum albumin

Base Material: Silica
Usable pH range: pH3.0 - 7.5
Usable concentration of methanol and acetonitrile is up to 100 %

●Semi-micro columns

◎ LW-403 is recommended to be used with semi-micro type devices.

Product Code	Product Name	* Plate Number (TP/column)	Particle Size (μm)	Pore Size (Å)	Column Size (mm) I.D. x Length	Shipping Solvent
F6989403	New **PROTEIN LW-403 4D**	≥ 11,000	1.9	1,000	**4.6 x 150**	H_2O
F6700134	New **PROTEIN LS-G 4J**	(guard column)	1.9	–	**4.6 x 20**	H_2O

*Measured with bovine serum albumin

Base Material: Silica
Usable pH range: pH3.0 - 7.5
Usable concentration of methanol and acetonitrile is up to 100 %

●Preparative columns [Preparative columns are made to order.]

Product Code	Product Name	* Plate Number (TP/column)	Particle Size (μm)	Column Size (mm) I.D. x Length	Standard Column
F6505020	**PROTEIN KW-2002.5**	≥ 17,000	5	**20.0 x 300**	KW-802.5
F6505021	**PROTEIN KW-2003**	≥ 17,000	5	**20.0 x 300**	KW-803
F6505022	**PROTEIN KW-2004**	≥ 14,000	7	**20.0 x 300**	KW-804
F6709556	**PROTEIN KW-G 8B**	(guard column)	7	**8.0 x 50**	(guard column)

*Measured with ethylene glycol

Base Material: Silica

Target molecular weight range and exclusion limit

●Measured with protein (eluent: phosphate buffer)

Product Name	Target Molecular Weight Range	Exclusion Limit
KW-802.5	5,000 – 100,000	150,000
KW-803	10,000 – 700,000	*(1,000,000)
KW-804	30,000 – *(4,000,000)	*(4,000,000)
KW402.5	5,000 – 70,000	150,000
KW403	10,000 – 500,000	600,000
KW404	30,000 – *(4,000,000)	*(4,000,000)
KW405	200,000 – *(20,000,000)	*(20,000,000)
LW-803, LW-403 4D	10,000 – 700,000	*(1,000,000)

Please use the above table for reference purposes only when selecting columns.

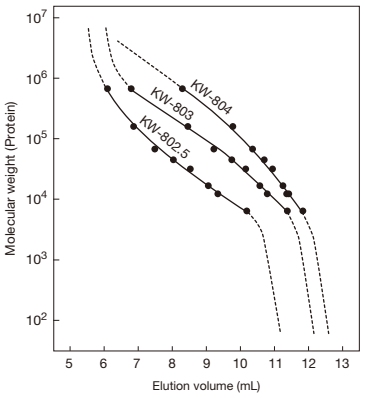
*( ) Estimated value

●Measured with pullulan (eluent: ultrapure water)

Product Name	Target Molecular Weight Range	Exclusion Limit
KW-802.5	2,000 – 50,000	60,000
KW-803	5,000 – 100,000	170,000
KW-804	20,000 – 300,000	500,000
KW402.5	2,000 – 40,000	60,000
KW403	3,000 – 50,000	80,000
KW404	20,000 – 300,000	400,000
KW405	100,000 – 700,000	1,300,000

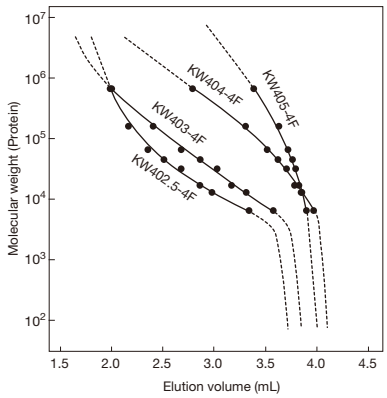
Please use the above table for reference purposes only when selecting columns.

Calibration curves for KW-800 series using protein



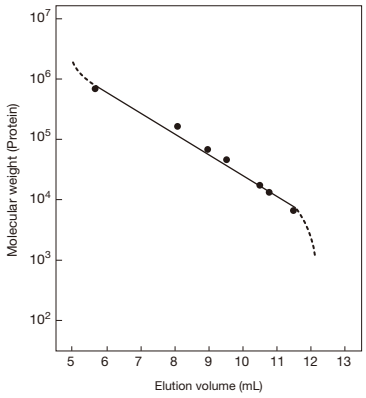
Column : **Shodex PROTEIN KW-800 series**
Eluent : 50 mM Sodium phosphate buffer (pH7.0) + 0.3 M NaCl
Flow rate : 1.0 mL/min
Detector : UV (280 nm)
Column temp. : 30 ℃

Calibration curves for KW400 series using protein



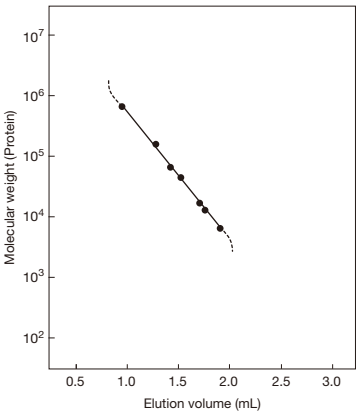
Column : **Shodex KW400-4F series**
Eluent : 50 mM Sodium phosphate buffer (pH7.0) + 0.3 M NaCl
Flow rate : 0.33 mL/min
Detector : UV (280 nm) (small cell volume)
Column temp. : 30 ℃

Calibration curve for LW-803 using protein



Column : **Shodex PROTEIN LW-803**
Eluent : 50 mM Sodium phosphate buffer (pH7.0) + 0.3 M NaCl
Flow rate : 1.0 mL/min
Detector : UV (280 nm)
Column temp. : Room temp.

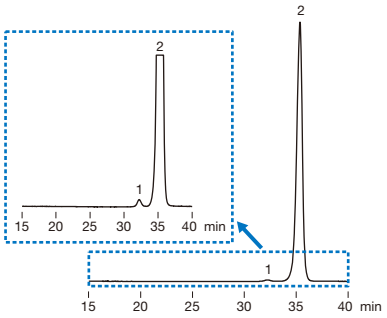
Calibration curve for LW-403 4D using protein



Column : **Shodex PROTEIN LW-403 4D**
Eluent : 50 mM Sodium phosphate buffer (pH7.0) + 0.3 M NaCl
Flow rate : 0.35 mL/min
Detector : UV (280 nm) (small cell volume)
Column temp. : 30 ℃

Analysis of impurities (high molecular weight proteins) in insulin glargine following USP method

Sample : 100 µL
System suitability solution
(prepared following USP method)
1. High molecular weight proteins
2. Insulin glargine

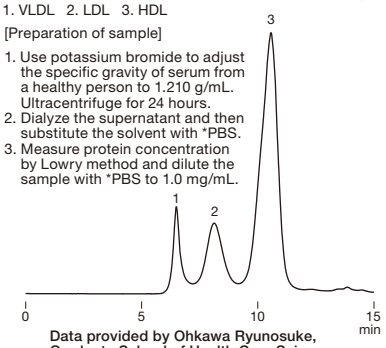


Column : **Shodex PROTEIN KW-802.5 x 2**
Eluent : $CH_3COOH/CH_3CN/H_2O$=20/30/50 (pH to 3.0 adjusted with 25 % NH_3 aq.)
Flow rate : 0.5 mL/min
Detector : UV (276 nm)
Column temp. : Ambient

Lipoproteins in serum

Sample : 40 µL
Whole lipoproteins from serum of a healthy person 1.0 mg/mL
1. VLDL 2. LDL 3. HDL

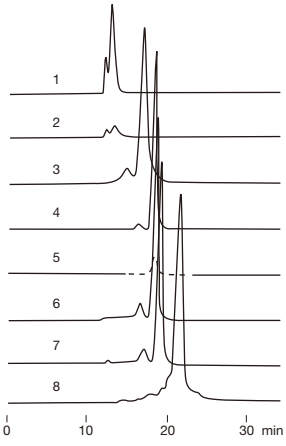
[Preparation of sample]
1. Use potassium bromide to adjust the specific gravity of serum from a healthy person to 1.210 g/mL. Ultracentrifuge for 24 hours.
2. Dialyze the supernatant and then substitute the solvent with *PBS.
3. Measure protein concentration by Lowry method and dilute the sample with *PBS to 1.0 mg/mL.



Data provided by Ohkawa Ryunosuke,
Graduate School of Health Care Sciences,
Analytical Laboratory Chemistry,
Tokyo Medical and Dental University

Column : **Shodex PROTEIN KW-G + KW-804**
Eluent : 10-fold diluted x 10 *PBS with H_2O
Flow rate : 1.0 mL/min
Detector : UV (280 nm)
Column temp. : 30 ℃
x 10 *PBS : 80 g NaCl + 29 g $Na_2HPO_4 \cdot 12H_2O$ + 2 g KCl + 2 g KH_2PO_4 in 1000 mL of H_2O

Proteins in human blood serum



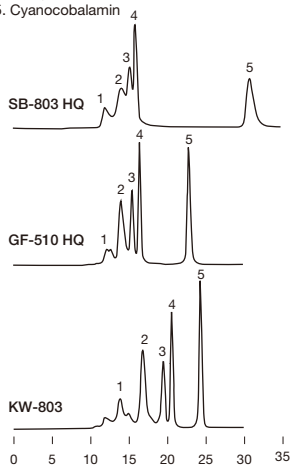
Sample : 0.1 % each

1. Fibrinogen	50 µL
2. α_2 -Macroglobulin	50 µL
3. IgG	50 µL
4. Transferrin	50 µL
5. Plasminogen	50 µL
6. Albumin	100 µL
7. Antitrypsin	100 µL
8. Hemoglobin	100 µL

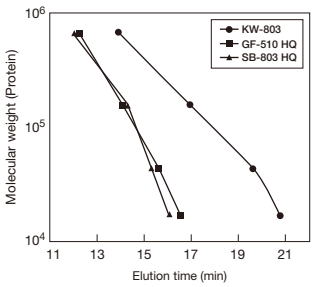
Column : **Shodex PROTEIN KW-803**
Eluent : 50 mM Sodium phosphate buffer (pH7.0) + 0.3 M NaCl
Flow rate : 1.0 mL/min
Detector : UV (280 nm)
Column temp. : Room temp.

Comparing three GFC columns for the separation of common proteins

Sample :
1. Thyroglobulin (bovine)
2. γ-Globulin (bovine)
3. Ovalbumin (chicken)
4. Myoglobin (horse)
5. Cyanocobalamin



Separation performances of three aqueous SEC columns (SB-803 HQ, GF-510 HQ, and KW-803) were compared. KW-803, silica-based column, showed the best separation performance for the analysis of protein standards.

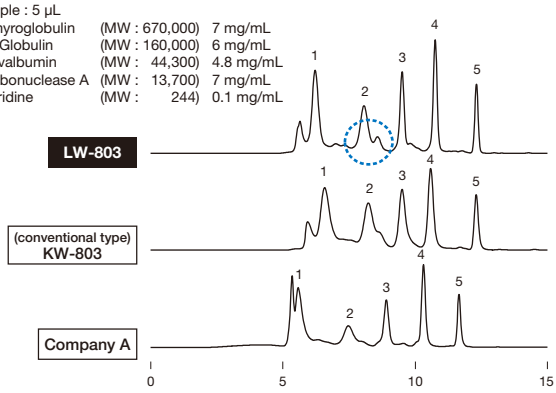


Column : **Shodex OHpak SB-803 HQ**
Shodex Asahipak GF-510 HQ
Shodex PROTEIN KW-803
Eluent : 0.2 M Phosphate buffer (pH6.9)
Flow rate : 0.5 mL/min
Detector : UV (280 nm)
Column temp. : 30 ℃

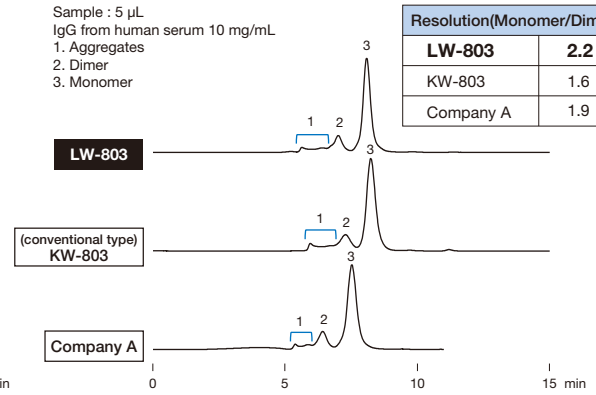
Comparison of LW-803, conventional column, and other manufacturer's column

PROTEIN LW-803 is suitable for analyzing proteins with molecular weight of several hundreds of thousands. Compared to our conventional columns and other manufacturer's columns, LW-803 has improved separation performance in the molecular weight range around 160,000 (about the size of γ-Globulin). This improvement is advantageous for the separation of monomer and dimer of IgG which is a mainstream antibody drug.

Sample : 5 µL
1. Thyroglobulin (MW : 670,000) 7 mg/mL
2. γ-Globulin (MW : 160,000) 6 mg/mL
3. Ovalbumin (MW : 44,300) 4.8 mg/mL
4. Ribonuclease A (MW : 13,700) 7 mg/mL
5. Uridine (MW : 244) 0.1 mg/mL



Sample : 5 µL
IgG from human serum 10 mg/mL
1. Aggregates
2. Dimer
3. Monomer

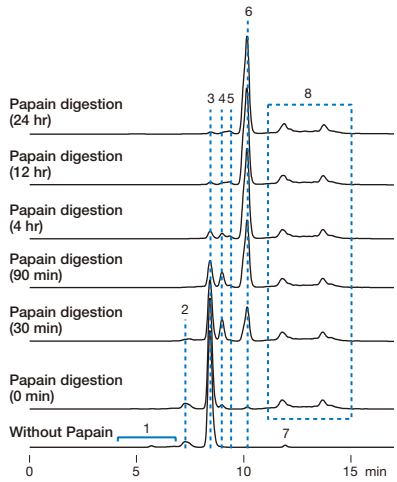


Resolution(Monomer/Dimer)	
LW-803	**2.2**
KW-803	1.6
Company A	1.9

Column : **Shodex PROTEIN LW-803, Shodex PROTEIN KW-803, Silica-based SEC column from other manufacturer**
Eluent : 50 mM Sodium phosphate buffer (pH7.0) + 0.3 M NaCl
Flow rate : 1.0 mL/min
Detector : UV (280 nm)
Column temp. : Room temp.

Monitoring papain digestion of humanized monoclonal IgG

Papain digestion of humanized monoclonal IgG was monitored using PROTEIN LW-803, an aqueous SEC (GFC) column. During the papain digestion of IgG, Fc and Fab fragments from the IgG and their decomposition intermediates are expected to be observed. LW-803 separates IgG and decomposed fragments and intermediates well from each other, thus it is suitable for the monitoring of papain digestion of IgG.



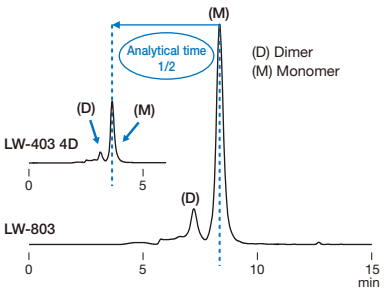
Sample : 10 µL
Humanized monoclonal IgG
1. Aggregates of IgG
2. Dimer of IgG
3. Monomer of IgG
4 - 6. Fragments of IgG from papain digestion
7. Citric acid
8. Papain

[Procedure of papain digestion]
(1) Dissolve 3 mg of humanized monoclonal IgG in 500 µL of the eluent. (6 mg/mL conc.)
(2) Dissolve 1 mg of papain in 500 µL of the eluent. (1 mg/mL conc.)
(3) Pass (1) and (2) through 0.2 µm membrane filter.
(4) Mix each solution in equal amounts.
(5) Keep temperature at 25 °C.
(6) Takes a sample with time and analyze it by HPLC.

Column : **Shodex PROTEIN LW-803**
Eluent : 0.1 M Sodium phosphate buffer (pH7.0) + 0.3 M NaCl
Flow rate : 1.0 mL/min
Detector : UV (280 nm)
Column temp. : 25 ℃

Comparison of separation of IgG between LW-403 4D and LW-803

Sample : IgG from human serum 10 mg/mL
(LW-403 4D) 0.5 µL
(LW-803) 5 µL

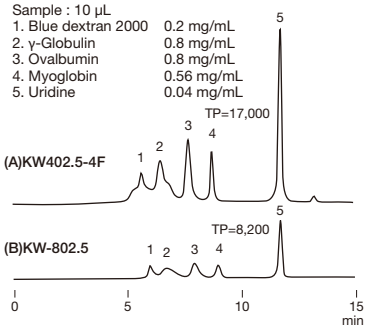


Column : **Shodex PROTEIN LW-403 4D**
Shodex PROTEIN LW-803
Eluent : 50 mM Sodium phosphate buffer (pH7.0) + 0.3 M NaCl
Flow rate : (LW-403 4D) 0.35 mL/min
(LW-803) 1.0 mL/min
Detector : (LW-403 4D) UV (280 nm) (small cell volume)
(LW-803) UV (280 nm) (conventional type)
Column temp. : Room temp.

Comparison of KW402.5-4F and KW-802.5

KW400 series is a high performance type of semi-micro columns. It offers approximately 1.5 times larger theoretical plate number and 3 to 4 times higher detection sensitivity (peak height) than KW-800 series columns do.

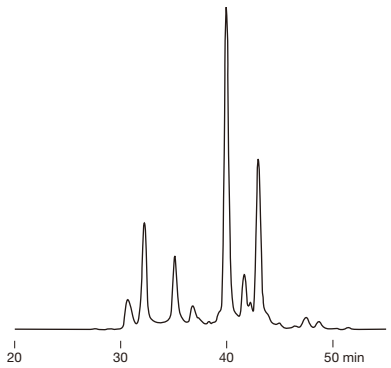
Sample : 10 µL
1. Blue dextran 2000 0.2 mg/mL
2. γ-Globulin 0.8 mg/mL
3. Ovalbumin 0.8 mg/mL
4. Myoglobin 0.56 mg/mL
5. Uridine 0.04 mg/mL



Column : **Shodex KW402.5-4F**
Shodex PROTEIN KW-802.5
Eluent : 50 mM Sodium phosphate buffer (pH7.0) + 0.3 M NaCl
Flow rate : (A) 0.33 mL/min, (B) 1.0 mL/min
Detector : UV (280 nm) (small cell volume)
Column temp. : 25 ℃

Whey in yogurt

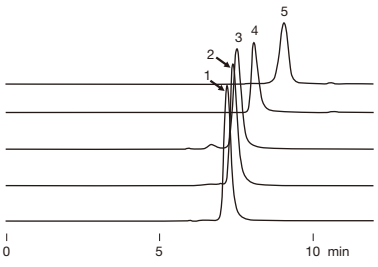
Sample : Whey, 5 µL



Column : **Shodex KW403-4F + KW402.5-4F**
Eluent : 50 mM Sodium phosphate buffer (pH7.0) + 0.3 M NaCl
Flow rate : 0.20 mL/min
Detector : UV (280 nm) (small cell volume)
Column temp. : 30 ℃

Lectins

Sample : 5 µL
1. Lectin from soybean 0.6 mg/mL
2. Lectin from arachis hypogaea 1.1 mg/mL
3. Lectin from canavalia ensiformis (Con A) 0.9 mg/mL
4. Lectin from lens culinaris (LCA) 0.7 mg/mL
5. Lectin from triticum vulgaris (WGA) 0.8 mg/mL



Column : **Shodex KW402.5-4F**
Eluent : 50 mM Sodium phosphate buffer (pH7.0) + 0.3 M NaCl
Flow rate : 0.33 mL/min
Detector : UV (220 nm) (small cell volume)
Column temp. : 30 ℃

Aqueous SEC (GFC) Columns: Polymer-based

Features

SB-800 HQ

- Polymer-based packed columns for aqueous SEC (GFC) analysis
- Supports a wide range of molecular weight sample analysis
- The eluent can be replaced with DMF (except SB-802 HQ and SB-807 HQ), enabling the analysis of polar polymers
- Method using SB-804 HQ or SB-805 HQ for gelatin's mean molecular weight determination is comparable with PAGI method (Ver. 10, Japan)
- Fulfills USP L38 and L39 requirements
- SB-802 HQ fulfills USP L25 requirements
- SB-802.5 HQ fulfills USP L25 and L89 requirements
- SB-803 HQ fulfills USP L37 requirements

SB-807 HQ

- Column for the analysis of water-soluble ultra high molecular weight polymers
- Large particle-size gel prevents shear degradation of polymers
- Fulfills USP L38 and L39 requirements

LB-800

- Polymer-based packed columns for aqueous SEC (GFC) analysis
- Low column bleeding allows its use with light scattering detectors
- The eluent can be replaced with DMF enabling the analysis of polar polymers
- LB-804 (exclusion limit: about 1,000,000) and LB-806 (exclusion limit: about 20,000,000) newly added to the series
- Fulfills USP L38 and L39 requirements
- LB-803 fulfills USP L37 requirements

● Standard columns

Product Code	Product Name	Plate Number (TP/column)	Particle Size (μm)	Pore Size (Å)	Column Size (mm) I.D. x Length	Shipping Solvent
F6429100	**OHpak SB-802 HQ**	≥ 12,000	8	100	**8.0 x 300**	0.02 % NaN_3 aq.
F6429101	**OHpak SB-802.5 HQ**	≥ 16,000	6	200	**8.0 x 300**	0.02 % NaN_3 aq.
F6429102	**OHpak SB-803 HQ**	≥ 16,000	6	800	**8.0 x 300**	0.02 % NaN_3 aq.
F6429103	**OHpak SB-804 HQ**	≥ 16,000	10	2,000	**8.0 x 300**	0.02 % NaN_3 aq.
F6429104	**OHpak SB-805 HQ**	≥ 12,000	13	7,000	**8.0 x 300**	0.02 % NaN_3 aq.
F6429105	**OHpak SB-806 HQ**	≥ 12,000	13	15,000	**8.0 x 300**	0.02 % NaN_3 aq.
F6429106	**OHpak SB-806M HQ**	≥ 12,000	13	15,000	**8.0 x 300**	0.02 % NaN_3 aq.
F6709430	**OHpak SB-G 6B**	(guard column)	10	–	**6.0 x 50**	0.02 % NaN_3 aq.

SB-806M HQ is a mixed-gel column capable of analyzing samples over a wide range of molecular weight distribution.

Base Material: Polyhydroxymethacrylate
Usable pH range: pH3 - 10

[Aqueous high molecular weight analysis column]

Product Code	Product Name	Plate Number (TP/column)	Particle Size (μm)	Pore Size (Å)	Column Size (mm) I.D. x Length	Shipping Solvent
F6429108	**OHpak SB-807 HQ**	≥ 1,500	35	30,000	**8.0 x 300**	H_2O
F6709431	**OHpak SB-807G**	(guard column)	35	–	**8.0 x 50**	H_2O

Base Material: Polyhydroxymethacrylate
Usable pH range: pH3 - 10

[GFC columns to be used with light scattering detector]

Product Code	Product Name	Plate Number (TP/column)	Particle Size (μm)	Pore Size (Å)	Column Size (mm) I.D. x Length	Shipping Solvent
F6429201	**OHpak LB-803**	≥ 16,000	6	800	**8.0 x 300**	H_2O
F6429204	New **OHpak LB-804**	≥ 16,000	10	2,000	**8.0 x 300**	H_2O
F6429203	**OHpak LB-805**	≥ 12,000	13	7,000	**8.0 x 300**	H_2O
F6429205	New **OHpak LB-806**	≥ 12,000	13	15,000	**8.0 x 300**	H_2O
F6429202	**OHpak LB-806M**	≥ 12,000	13	15,000	**8.0 x 300**	H_2O
F6709434	**OHpak LB-G 6B**	(guard column)	13	–	**6.0 x 50**	H_2O

LB-806M is a mixed-gel column capable of analyzing samples over a wide range of molecular weight distribution.

Base Material: Polyhydroxymethacrylate
Usable pH range: pH3 - 10

●Preparative columns [Preparative columns are made to order.]

Product Code	Product Name	Plate Number (TP/column)	Particle Size (μm)	Column Size (mm) I.D. x Length	Standard Column
F6516011	**OHpak SB-2002**	≥ 9,000	15	**20.0 x 300**	SB-802 HQ
F6516012	**OHpak SB-2002.5**	≥ 12,000	10	**20.0 x 300**	SB-802.5 HQ
F6516013	**OHpak SB-2003**	≥ 12,000	10	**20.0 x 300**	SB-803 HQ
F6516014	**OHpak SB-2004**	≥ 12,000	18	**20.0 x 300**	SB-804 HQ
F6516015	**OHpak SB-2005**	≥ 12,000	20	**20.0 x 300**	SB-805 HQ
F6516016	**OHpak SB-2006**	≥ 12,000	20	**20.0 x 300**	SB-806 HQ
F6516017	**OHpak SB-2006M**	≥ 12,000	20	**20.0 x 300**	SB-806M HQ
F6709555	**OHpak SB-G 8B**	(guard column)	18	**8.0 x 50**	(guard column)

Base Material: Polyhydroxymethacrylate

●Usable concentration of organic solvents

Product Code	The maximum usable concentration (%)		
	Methanol	**Acetonitrile**	**DMF**
SB-802 HQ	0	0	0
SB-802.5 HQ, SB-803 HQ	100	75	100
SB-804 HQ ~ SB-806M HQ	75	75	100
SB-G 6B	75	75	100
SB-807 HQ, SB-807G	30	30	0
LB-803 ~ LB-806M, LB-G 6B	100	100	100

(Note)
The maximum solvent tolerance of SB-2000 series, preparative columns of SB-800 series, is 50 % methanol, acetonitrile, or DMF (SB-2002 is not tolerant to organic solvents).

Target molecular weight range and exclusion limit

●Measured with pullulan (eluent: ultrapure water)

Product Name	Target Molecular Weight Range	Exclusion Limit
SB-802 HQ	200 - 1,000	1000
SB-802.5 HQ	500 - 10,000	10000
SB-803 HQ	1,000 - 100,000	100000
SB-804 HQ	5,000 - 400,000	1000000
SB-805 HQ	100,000 - 1,000,000	*(4,000,000)
SB-806 HQ	100,000 - *(20,000,000)	*(20,000,000)
SB-806M HQ	500 - *(20,000,000)	*(20,000,000)
SB-807 HQ	500,000 - *(500,000,000)	*(500,000,000)
LB-803	1,000 - 100,000	100000
LB-804	5,000 - 400,000	1,000,000
LB-805	100,000 - 1,000,000	*(4,000,000)
LB-806	100,000 - *(20,000,000)	*(20,000,000)
LB-806M	500 - *(20,000,000)	*(20,000,000)

Please use the above table for reference purposes only when selecting columns.

*( ) Estimated value

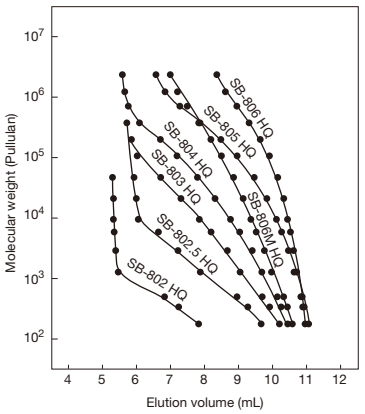
●Measured with *PEG/PEO (eluent: DMF)

Product Name	Target Molecular Weight Range
SB-802.5 HQ	100 - 2,000
SB-803 HQ	200 - 40,000
SB-804 HQ	500 - 300,000
SB-805 HQ	50,000 - 700,000
SB-806 HQ	70,000 - **(20,000,000)
SB-806M HQ	200 - **(20,000,000)
LB-803	500 - 50,000
LB-804	500 - 300,000
LB-805	50,000 - 700,000
LB-806	70,000 - **(20,000,000)
LB-806M	200 - **(20,000,000)

Please use the above table for reference purposes only when selecting columns.

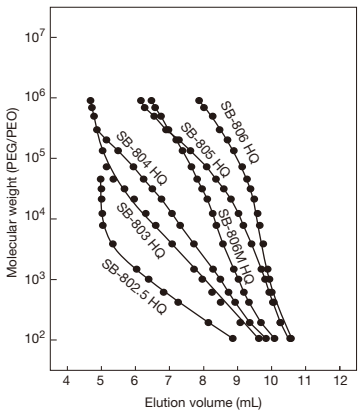
*PEG: polyethylene glycol
*PEO: polyethylene oxide
**( ) Estimated value

Calibration curves for SB-800 HQ series using pullulan (eluent: H_2O)



Column : **Shodex OHpak SB-800 HQ series**
Eluent : H_2O
Flow rate : 1.0 mL/min
Detector : RI
Column temp. : 30 ˚C

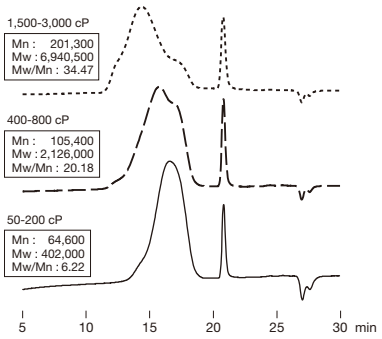
Calibration curves for SB-800 HQ series using PEG/PEO (eluent: DMF)



Column : **Shodex OHpak SB-800 HQ series**
Eluent : DMF
Flow rate : 1.0 mL/min
Detector : RI
Column temp. : 40 ˚C

Carboxymethylcellulose

Sample : Carboxymethylcellulose 0.1 % each, 50 µL



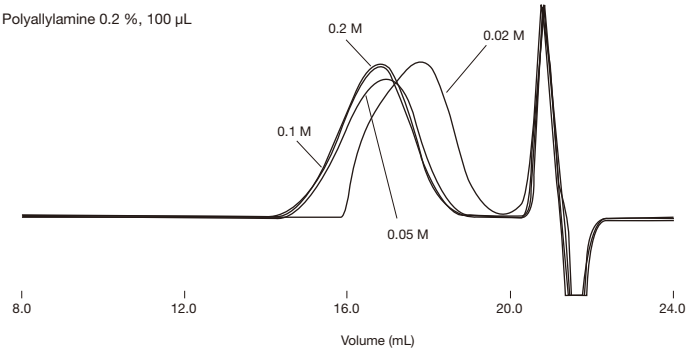
Molecular weight was determined from the calibration curve of pullulan.

Column : **Shodex OHpak SB-806M HQ x 2**
Eluent : 0.1 M NaCl aq.
Flow rate : 1.0 mL/min
Detector : RI
Column temp. : 40 ˚C

Effects of sodium nitrate in eluent on the analysis of polyallylamine

For the analysis of cationic polymers, such as pollyallylamine, the polymer is observed to adsorb on the column or delayed in elution when low sodium nitrate eluent was used. These phenomena can be suppressed by increasing the concentration of sodium nitrate in the eluent. In the case of polyallylamine, a good shape chromatogram is obtained when sodium nitrate concentration is 0.1 M or higher.

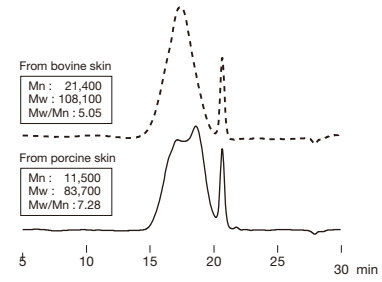
Sample : Polyallylamine 0.2 %, 100 µL



Column : **Shodex OHpak SB-806M HQ x 2**
Eluent : 0.5 M CH_3COOH + $NaNO_3$ aq.
Flow rate : 1.0 mL/min
Detector : RI
Column temp. : 40 ˚C

Gelatin

Sample : 0.1 % each, 100 µL
Gelatin from bovine skin
(Acid treatment, Gel strength : 225 g)
Gelatin from porcine skin
(Alkali treatment, Gel strength : 90-100 g)

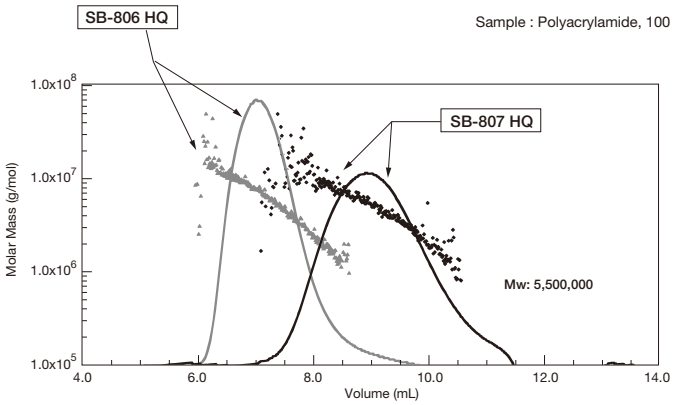


Molecular weight was determined from the calibration curve of pullulan.

Column : **Shodex OHpak SB-806M HQ x 2**
Eluent : 0.1 M KH_2PO_4 aq./
0.1 M Na_2HPO_4 aq.=50/50
Flow rate : 1.0 mL/min
Detector : RI
Column temp. : 40 ˚C

Polyacrylamide

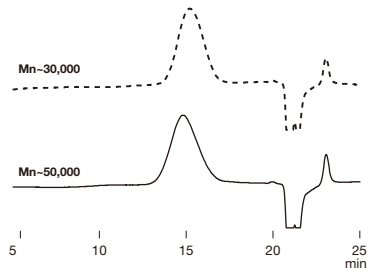
Sample : Polyacrylamide, 100 µL



Column : **Shodex OHpak SB-807 HQ, SB-806 HQ**
Eluent : 0.2 M NaCl aq.
Flow rate : 0.5 mL/min
Detector : RI
MALS (Multi angle light scattering)
Column temp. : 30 ˚C

Cellulose acetate

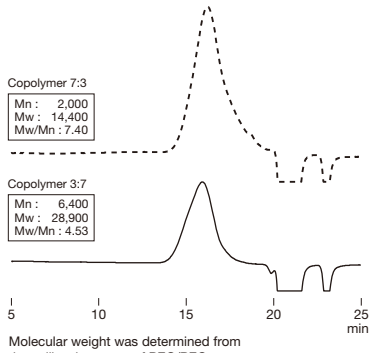
Sample : Cellulose acetate 0.1 % each, 100 µL



Column : **Shodex OHpak SB-806M HQ x 2**
Eluent : 20 mM LiBr in DMF
Flow rate : 1.0 mL/min
Detector : RI
Column temp. : 40 ˚C

Copovidones

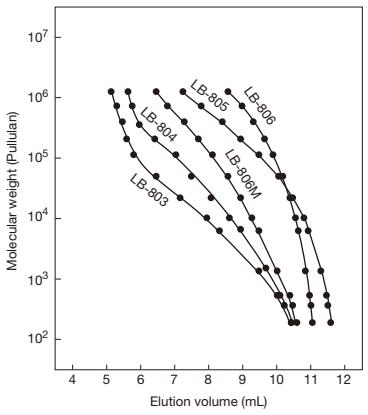
Sample : 100 µL
Poly(1-vinylpyrrolidone-co-vinyl acetate) 0.1 % each



Molecular weight was determined from the calibration curve of PEG/PEO.

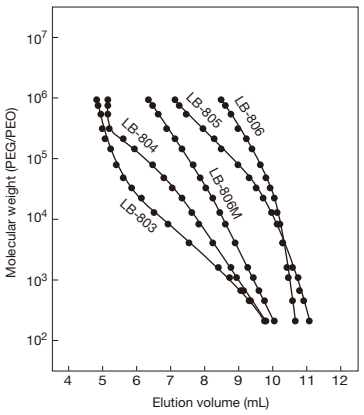
Column : Shodex OHpak SB-806M HQ x 2
Eluent : 20 mM LiBr in DMF
Flow rate : 1.0 mL/min
Detector : RI
Column temp. : 40 ℃

Calibration curves for LB-800 series using pullulan (eluent: H_2O)



Column : Shodex OHpak LB-800 series
Eluent : H_2O
Flow rate : 1.0 mL/min
Detector : RI
Column temp. : 30 ℃

Calibration curves for LB-800 series using PEG/PEO (eluent: DMF)

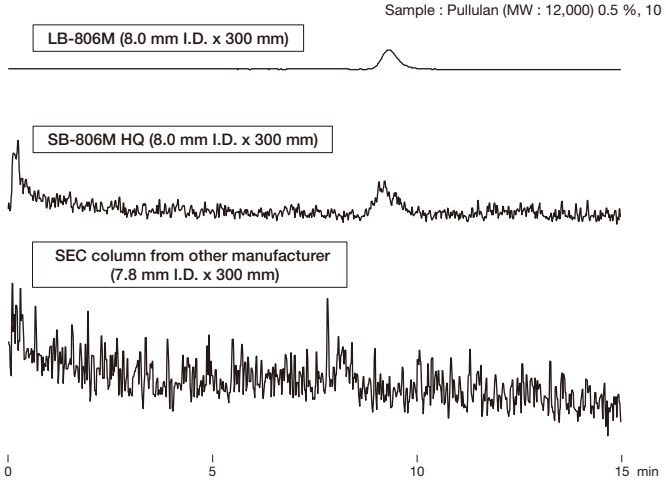


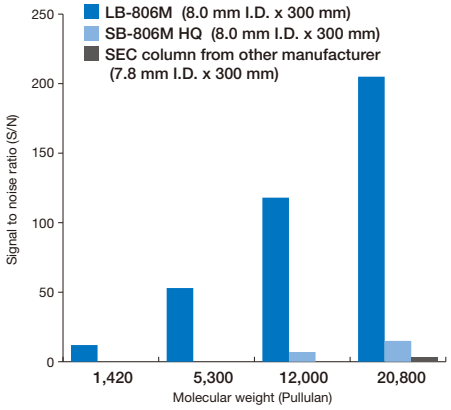
Column : Shodex OHpak LB-800 series
Eluent : DMF
Flow rate : 1.0 mL/min
Detector : RI
Column temp. : 40 ℃

Pullulan detection by LB-806M and multiangle light scattering detector

The OHpak LB-800 series is able to detect low molecular weight substances owing to its improved low baseline noise level while using it with a multiangle light scattering detector. This cannot be achieved with other manufacturer's SEC column.

Sample : Pullulan (MW : 12,000) 0.5 %, 10 µL

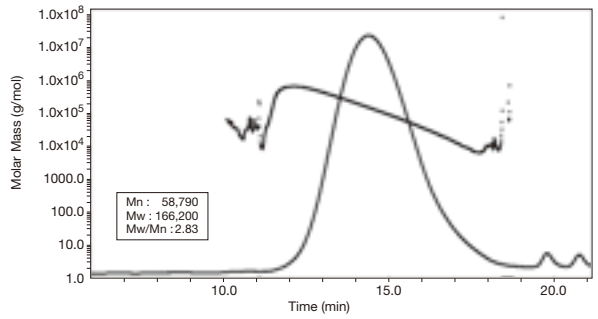




Column : Shodex OHpak LB-806M
Shodex OHpak SB-806M HQ
SEC column from other manufacturer
Eluent : 0.1 M $NaNO_3$ aq.
Flow rate : 1.0 mL/min
Detector : MALS (Multi angle light scattering) (90 °)
Column temp. : 30 ℃

Sodium alginate

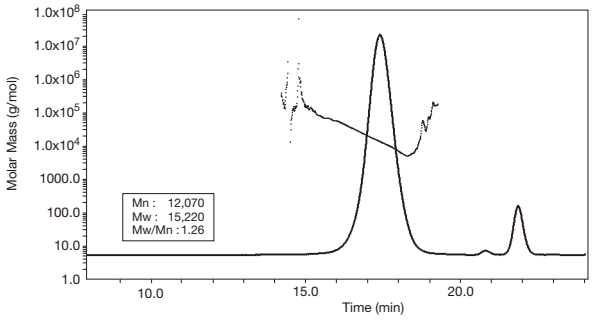
Sample : Sodium alginate 0.1 %, 100 µL



Column : Shodex OHpak LB-806M x 2
Eluent : 0.1 M $NaNO_3$ aq.
Flow rate : 1.0 mL/min
Detector : RI
MALS (Multi angle light scattering)
Column temp. : 30 ℃

Sodium heparin

Sample : Sodium heparin 0.1 %, 100 µL



Column : Shodex OHpak LB-806M x 2
Eluent : 0.1 M $NaNO_3$ aq.
Flow rate : 1.0 mL/min
Detector : RI
MALS (Multi angle light scattering)
Column temp. : 30 ℃

Multimode Columns

Features

GS-HQ

- SEC is the main separation mode
- With the choice of eluent, the column provides multimode features of reversed phase, HILIC, and ion exchange modes to SEC
- Suitable for the separation of peptides or nucleic acids with similar molecular weights
- Suitable for desalting samples or substituting buffer in protein analysis

Standard columns

Product Code	Product Name	Plate Number (TP/column)	Particle Size (µm)	Pore Size (Å)	Column Size (mm) I.D. x Length	Shipping Solvent
F7600005	**Asahipak GS-220 HQ**	≥ 19,000	6	150	**7.5 × 300**	H_2O/CH_3OH=70/30
F7600006	**Asahipak GS-320 HQ**	≥ 19,000	6	400	**7.5 × 300**	H_2O/CH_3OH=70/30
F7600007	**Asahipak GS-520 HQ**	≥ 18,000	7	2,000	**7.5 × 300**	H_2O/CH_3OH=70/30
F7600008	**Asahipak GS-620 HQ**	≥ 18,000	7	7,000	**7.5 × 300**	H_2O/CH_3OH=70/30
F6710019	**Asahipak GS-2G 7B**	(guard column)	9	–	**7.5 × 50**	H_2O/CH_3OH=70/30

Base Material: Polyvinyl alcohol
Usable pH range: pH2 - 12 (GS-220 HQ: pH2 - 9)
Usable concentration of methanol is up to 100 % (GS-220 HQ: up to 30 %)
Usable concentration of acetonitrile is up to 50 %

Semi-micro columns [The following semi-micro columns are made to order.]

Product Code	Product Name	Particle Size (µm)	Pore Size (Å)	Column Size (mm) I.D. x Length
F7750312	**GS320A-4D**	6	400	**4.6 × 150**
F7750311	**GS320A-4E**	6	400	**4.6 × 250**

Base Material: Polyvinyl alcohol

Preparative columns [Preparative columns are made to order.]

Product Code	Product Name	Plate Number (TP/column)	Particle Size (µm)	Column Size (mm) I.D. x Length	Standard Column
F6810017	**Asahipak GS-220 20F**	≥ 8,000	13	**20.0 x 300**	GS-220 HQ
F6810018	**Asahipak GS-320 20F**	≥ 8,000	13	**20.0 x 300**	GS-320 HQ
F6810019	**Asahipak GS-520 20F**	≥ 8,000	13	**20.0 x 300**	GS-520 HQ
F6810034	**Asahipak GS-220 20G**	≥ 14,000	13	**20.0 x 500**	GS-220 HQ
F6810035	**Asahipak GS-320 20G**	≥ 14,000	13	**20.0 x 500**	GS-320 HQ
F6810036	**Asahipak GS-520 20G**	≥ 14,000	13	**20.0 x 500**	GS-520 HQ
F6710021	**Asahipak GS-20G 7B**	(guard column)	20	**7.5 x 50**	(guard column)

Base Material: Polyvinyl alcohol

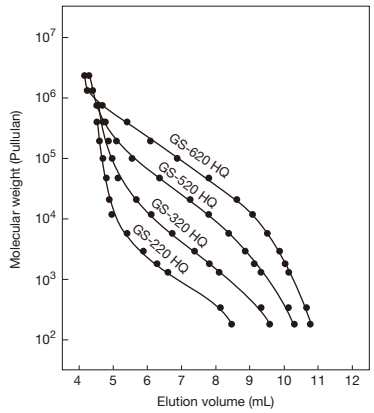
Target molecular weight range and exclusion limit

Measured with pullulan (eluent: ultrapure water)

Product Name	Target Molecular Weight Range	Exclusion Limit
GS-220	300 - 3,000	7,000
GS-320	300 - 20,000	40,000
GS-520	5,000 - 200,000	300,000
GS-620	10,000 - 800,000	1,000,000

Please use the above table for reference purposes only when selecting columns.

Calibration curves for GS-HQ series using pullulan



Column : **Shodex Asahipak GS-HQ series**
Eluent : H_2O
Flow rate : 0.6 mL/min
Detector : RI
Column temp. : 30 ℃

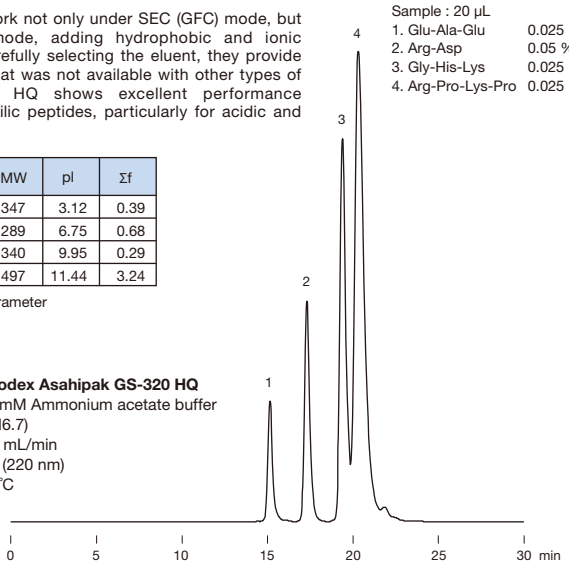
Peptides

GS-HQ columns work not only under SEC (GFC) mode, but also under multimode, adding hydrophobic and ionic interactions. By carefully selecting the eluent, they provide separation mode that was not available with other types of columns. GS-320 HQ shows excellent performance separating hydrophilic peptides, particularly for acidic and basic peptides.

	MW	pI	Σf
Glu-Ala-Glu	347	3.12	0.39
Arg-Asp	289	6.75	0.68
Gly-His-Lys	340	9.95	0.29
Arg-Pro-Lys-Pro	497	11.44	3.24

Σf: Hydrophobic parameter
pI: Isoelectric point

Sample : 20 µL
1. Glu-Ala-Glu 0.025 %
2. Arg-Asp 0.05 %
3. Gly-His-Lys 0.025 %
4. Arg-Pro-Lys-Pro 0.025 %

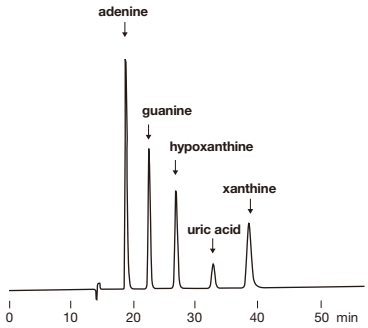


Column : **Shodex Asahipak GS-320 HQ**
Eluent : 30 mM Ammonium acetate buffer (pH6.7)
Flow rate : 0.5 mL/min
Detector : UV (220 nm)
Column temp. : 30 ℃

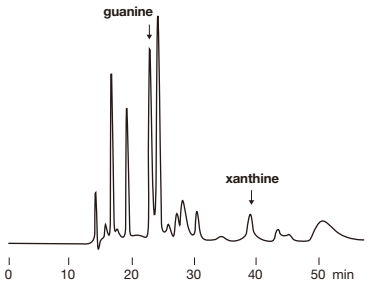
Purine bases in beer

Purine present in food is detected as its purine base form after sample preparation including: homogenization, freeze drying, hydolyzation with 70 % perchloric acid, and neutralization. The example below shows the analysis of purine in regular beer and beer treated with guanase (an enzyme that degrades guanine to xanthine). The following data indicate that guanine was decreased and xanthine was increased by guanase.

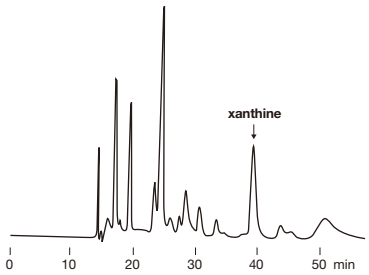
Purine bases in beer



Normal beer



Guanase treated beer

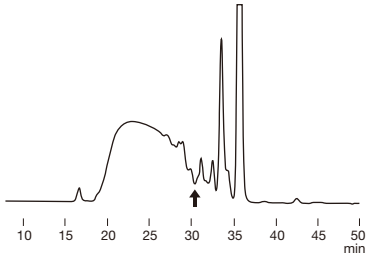


Column : **Shodex Asahipak GS-320 HQ**
Eluent : 150 mM Sodium phosphate buffer (pH2.5)
Flow rate : 0.6 mL/min
Detector : UV (260 nm)
Column temp. : 35 ℃

Data provided by Kiyoko Kaneko Ph.D.,
Faculty of Pharmaceutical Sciences, Teikyo University

Low molecular weight water-soluble dietary fiber

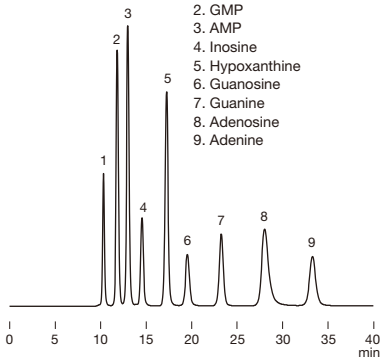
By using the GS-220 HQ, monosaccharides, disaccharides, and sugar alcohols can elute after the indigestible component fraction (indicated by an arrow on the chromatogram).
This separation makes the method preferable for thequantification of low molecular weight water-soluble dietary fiber.



Column : **Shodex Asahipak GS-220 HQ x 2**
Eluent : H_2O
Flow rate : 0.5 mL/min
Detector : RI
Column temp. : 60 ℃

"Umami"

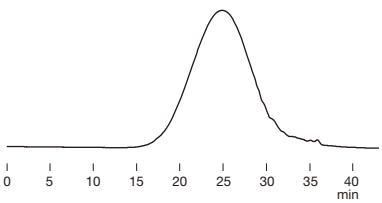
Sample : 50 µg/mL each, 20 µL
1. IMP
2. GMP
3. AMP
4. Inosine
5. Hypoxanthine
6. Guanosine
7. Guanine
8. Adenosine
9. Adenine



Column : **Shodex Asahipak GS-320 HQ**
Eluent : 10 mM NaH_2PO_4 aq./10 mM Na_2HPO_4 aq. =1000/31
Flow rate : 1.0 mL/min
Detector : UV (260 nm)
Column temp. : 40 ℃

Lignosulfonic acid

Sample : 100 µL
Lignosulfonic acid sodium salt 0.1 %



Column : **Shodex Asahipak GS-520 HQ x 2**
Eluent : 20 mM Na_2HPO_4 aq.
Flow rate : 0.6 mL/min
Detector : UV (254 nm)
Column temp. : 40 ℃

Aqueous/Organic SEC Columns

Features

GF-HQ
- Polymer-based SEC columns with high solvent durability
- Works well with both aqueous and organic solvents

Standard columns

Product Code	Product Name	Plate Number (TP/column)	Particle Size (μm)	Pore Size (Å)	Column Size (mm) I.D. x Length	Shipping Solvent
F7600000	**Asahipak GF-210 HQ**	≥ 19,000	5	180	**7.5 × 300**	H_2O
F7600001	**Asahipak GF-310 HQ**	≥ 19,000	5	400	**7.5 × 300**	H_2O/CH_3OH=70/30
F7600002	**Asahipak GF-510 HQ**	≥ 19,000	5	2,000	**7.5 × 300**	H_2O/CH_3OH=70/30
F7600003	**Asahipak GF-710 HQ**	≥ 11,000	9	10,000	**7.5 × 300**	H_2O/CH_3OH=70/30
F7600004	**Asahipak GF-7M HQ**	≥ 13,000	9	10,000	**7.5 × 300**	H_2O/CH_3OH=70/30
F6710018	**Asahipak GF-1G 7B**	(guard column)	9	–	**7.5 × 50**	H_2O/CH_3OH=70/30
F7600100	**MSpak GF-310 4B**	≥ 3,000	5	400	**4.6 × 50**	H_2O
F7600110	**MSpak GF-310 4D**	≥ 10,000	5	400	**4.6 × 150**	H_2O
F7600024	**MSpak GF-310 4E**	≥ 16,000	5	400	**4.6 × 250**	H_2O
F7600120	**MSpak GF-310 2D**	≥ 5,500	5	400	**2.0 × 150**	H_2O

GF-7M HQ is a mixed-gel column capable of analyzing samples over a wide range of molecular weight.

Base Material: Polyvinyl alcohol
Usable pH range: pH2 - 9

Semi-micro columns [The following semi-micro columns are made to order.]

Product Code	Product Name	Particle Size (μm)	Pore Size (Å)	Column Size (mm) I.D. x Length
F7600200	**Asahipak GF-210 4D**	5	180	**4.6 × 150**

Base Material: Polyvinyl alcohol

Preparative columns [Preparative columns are made to order.]

Product Code	Product Name	Plate Number (TP/column)	Particle Size (μm)	Column Size (mm) I.D. x Length	Standard Column
F6810030	**Asahipak GS-310 20F**	≥ 8,000	13	**20.0 x 300**	GF-310 HQ
F6810031	**Asahipak GS-510 20F**	≥ 8,000	13	**20.0 x 300**	GF-510 HQ
F6810038	**Asahipak GS-310 20G**	≥ 14,000	13	**20.0 x 500**	GF-310 HQ
F6810039	**Asahipak GS-510 20G**	≥ 14,000	13	**20.0 x 500**	GF-510 HQ
F6710020	**Asahipak GS-10G 7B**	(guard column)	20	**7.5 x 50**	(guard column)

Base Material: Polyvinyl alcohol

Target molecular weight range and exclusion limit

Measured with pullulan (eluent: ultrapure water)

Product Name	Target Molecular Weight Range	Exclusion Limit
GF-210	300 – 4,000	9,000
GF-310	300 – 30,000	40,000
GF-510	5,000 – 200,000	300,000
GF-710	100,000 – *(10,000,000)	*(10,000,000)
GF-7M	300 – *(10,000,000)	*(10,000,000)

Please use the above table for reference purposes only when selecting columns.

*( ) Estimated value

Measured with *PEG/PEO (eluent: DMF)

Product Name	Target Molecular Weight Range
GF-210	100 – 2,000
GF-310	200 – 4,000
GF-510	2,000 – 200,000
GF-710	20,000 – **(10,000,000)
GF-7M	200 – **(10,000,000)

Please use the above table for reference purposes only when selecting columns.

*PEG: polyethylene glycol
*PEO: polyethylene oxide
**( ) Estimated value

Usable solvents

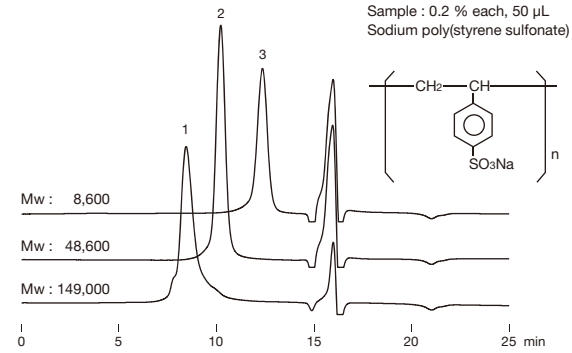
Solvent	GF-210	GF-310 GF-510 GF-710 GF-7M
Water (0 - 0.5 M sodium concentration)	○	○
Methanol	○	○
Ethanol	○	○
Acetonitrile	*○	○
THF	○	○
DMF	○	○
Acetone	○	○
Chloroform	*○	○
Ethylacetate	*○	○
DMSO	○	(0 ~ 50 %) ○

*When replacing acetonitrile, ethyl acetate or chloroform with water, replace with methanol first and then replace with water.

*When replacing water with ethyl acetate or chloroform, replace with methanol first and then replace with the required eluent condition.

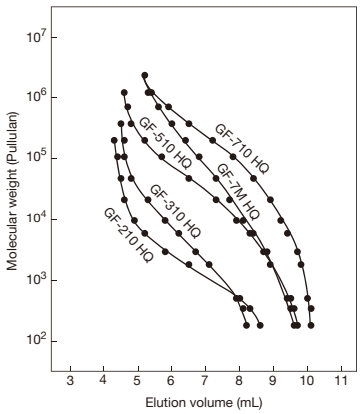
Sodium polystyrene sulfonates

Polymers having both hydrophobic and hydrophilic functional groups may exhibit hydrophobic interactions with packing materials.
When analyzing such polymers, addition of organic solvents to the eluent can suppress the hydrophobic interaction.



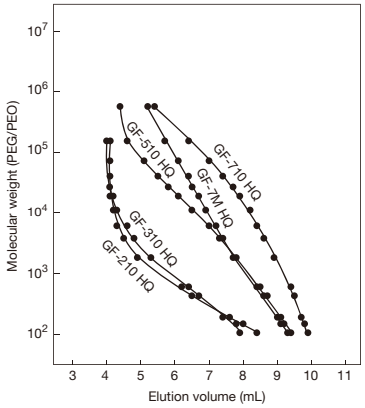
Column : **Shodex Asahipak GF-510 HQ**
Eluent : 50 mM LiCl aq./CH_3CN=60/40
Flow rate : 0.6 mL/min
Detector : UV (254 nm)
Column temp. : 30 ℃

Calibration curves for GF-HQ series using pullulan (eluent: H_2O)



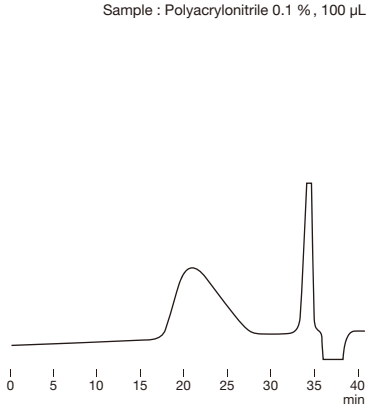
Column : **Shodex Asahipak GF-HQ series**
Eluent : H_2O
Flow rate : 0.6 mL/min
Detector : RI
Column temp. : 30 ℃

Calibration curves for GF-HQ series using PEG/PEO (eluent: DMF)



Column : **Shodex Asahipak GF-HQ series**
Eluent : DMF
Flow rate : 0.6 mL/min
Detector : RI
Column temp. : 40 ℃

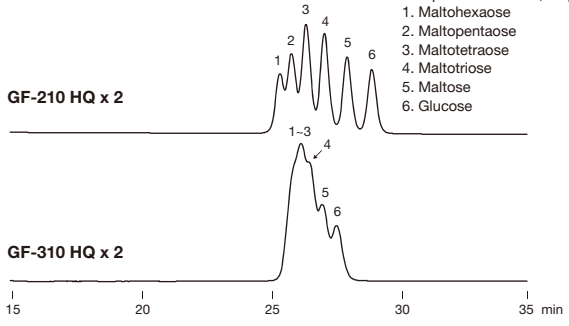
Polyacrylonitrile



Column : **Shodex Asahipak GF-710 HQ x 2**
Eluent : 20 mM LiBr in DMF
Flow rate : 0.6 mL/min
Detector : RI
Column temp. : 40 ℃

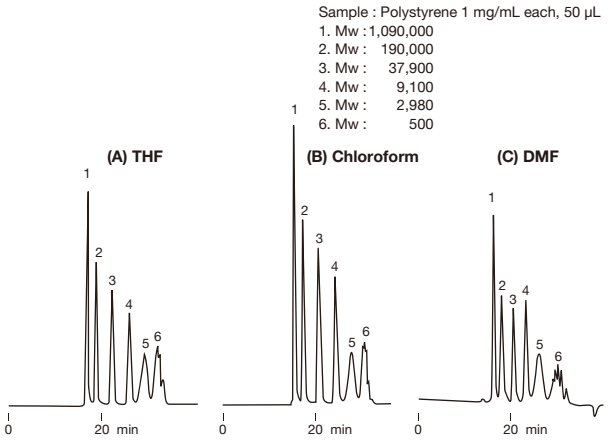
Comparison of two GF column performances for the separation of maltooligosaccharides

GF-210 HQ demonstrates an improved separation of low molecular substances. The chromatograms below show that the peaks obtained by GF-210 HQ are separated with deeper notches compared to peaks obtained by GF-310 HQ. GF-210 HQ is capable of separating oligosaccharides (trisaccharides to hexasaccharides) while those oligosaccharides were eluted all together when analyzed by GF-310 HQ.



Column : **Shodex Asahipak GF-210 HQ x 2**
Shodex Asahipak GF-310 HQ x 2
Eluent : H_2O
Flow rate : 0.6 mL/min
Detector : RI
Column temp. : 50 ℃

Comparison of polystyrene separation under three different solvent conditions



Column : **Shodex Asahipak GF-510 HQ + GF-310 HQ**
Eluent : (A); THF, (B); Chloroform, (C); DMF
Flow rate : 0.5 mL/min
Detector : (A),(B); UV (254 nm), (C); UV (270 nm)
Column temp. : 30 ℃

Organic SEC (GPC) Columns (General Analysis): THF

Features

KF-800

- Standard organic solvent SEC (GPC) column
- Supports a wide range of applications from low to high molecular weight compounds
- Fulfills USP L21 requirements

● Standard columns

[KF-800 series] Shipping Solvent: Tetrahydrofuran (THF)

Product Code	Product Name	Plate Number (TP/column)	Particle Size (µm)	Pore Size (Å)	Column Size (mm) I.D. x Length
F6028010	**GPC KF-801**	≥ 18,000	6	50	**8.0 x 300**
F6028020	**GPC KF-802**	≥ 18,000	6	150	**8.0 x 300**
F6028025	**GPC KF-802.5**	≥ 18,000	6	300	**8.0 x 300**
F6028030	**GPC KF-803**	≥ 18,000	6	500	**8.0 x 300**
F6027030	**GPC KF-803L**	≥ 18,000	6	500	**8.0 x 300**
F6028040	**GPC KF-804**	≥ 18,000	7	1,500	**8.0 x 300**
F6027040	**GPC KF-804L**	≥ 18,000	7	1,500	**8.0 x 300**
F6028050	**GPC KF-805**	≥ 11,000	10	5,000	**8.0 x 300**
F6027050	**GPC KF-805L**	≥ 11,000	10	5,000	**8.0 x 300**
F6028060	**GPC KF-806**	≥ 11,000	10	10,000	**8.0 x 300**
F6028090	**GPC KF-806M**	≥ 13,000	10	10,000	**8.0 x 300**
F6027060	**GPC KF-806L**	≥ 11,000	10	10,000	**8.0 x 300**
F6028070	**GPC KF-807**	≥ 6,000	18	20,000	**8.0 x 300**
F6027070	**GPC KF-807L**	≥ 6,000	18	20,000	**8.0 x 300**
F6700300	**GPC KF-G 4A**	(guard column)	8	–	**4.6 x 10**
F6709350	**GPC KF-800D**	(solvent-peak separation column)	10	–	**8.0 x 100**

The columns with 'L' or 'M' at the end of column names are mixed-gel column capable of analyzing samples over a wide range of molecular weight distribution.
See page 54 for details of the solvent-peak separation columns.
See page 68 for applicability of SEC (GPC) columns to solvent replacement.

Base Material: Styrene divinylbenzene copolymer

● Preparative columns [Preparative columns are made to order.]

Product Code	Product Name	Plate Number (TP/column)	Particle Size (µm)	Column Size (mm) I.D. x Length	Standard Column
F6102401	**GPC KF-2001**	≥ 18,000	6	**20.0 x 300**	KF-801
F6102402	**GPC KF-2002**	≥ 18,000	6	**20.0 x 300**	KF-802
F6102425	**GPC KF-2002.5**	≥ 18,000	6	**20.0 x 300**	KF-802.5
F6102403	**GPC KF-2003**	≥ 18,000	6	**20.0 x 300**	KF-803
F6102404	**GPC KF-2004**	≥ 14,000	7	**20.0 x 300**	KF-804
F6102405	**GPC KF-2005**	≥ 10,000	10	**20.0 x 300**	KF-805
F6102406	**GPC KF-2006**	≥ 10,000	10	**20.0 x 300**	KF-806
F6102409	**GPC KF-2006M**	≥ 10,000	10	**20.0 x 300**	KF-806M
F6700406	**GPC KF-G 8B**	(guard column)	15	**8.0 x 50**	(guard column)

See page 67 for other preparative columns.

Base Material: Styrene divinylbenzene copolymer

Target molecular weight range and exclusion limit

● Measured with polystyrene (eluent: THF)

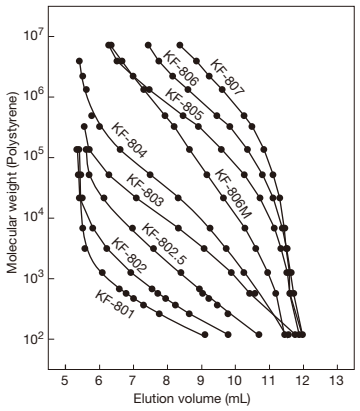
Product Name	Target Molecular Weight Range	Exclusion Limit
KF-801	100 – 700	1,500
KF-802	300 – 3,000	5,000
KF-802.5	300 – 8,000	20,000
KF-803	1,000 – 50,000	70,000
KF-803L	100 – 50,000	70,000
KF-804	7,000 – 300,000	400,000
KF-804L	100 – 300,000	400,000

Product Name	Target Molecular Weight Range	Exclusion Limit
KF-805	50,000 – 2,000,000	4,000,000
KF-805L	300 – 2,000,000	4,000,000
KF-806	150,000 – *(20,000,000)	*(20,000,000)
KF-806M	1,000 – *(20,000,000)	*(20,000,000)
KF-806L	300 – *(20,000,000)	*(20,000,000)
KF-807	300,000 – *(200,000,000)	*(200,000,000)
KF-807L	300 – *(200,000,000)	*(200,000,000)

Please use the above tables for reference purposes only when selecting columns.

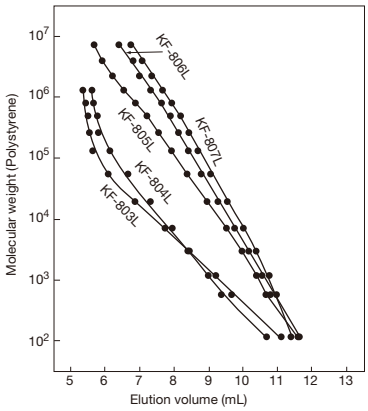
*( ) Estimated value

Calibration curves for KF-800 series using polystyrene



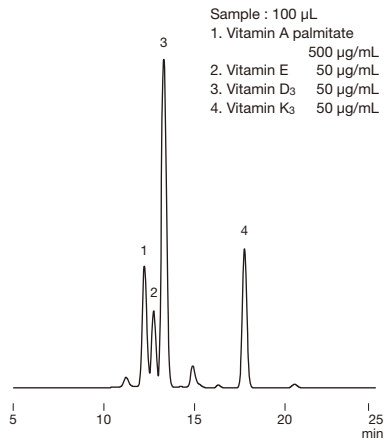
Column : Shodex GPC KF-800 series
Eluent : THF
Flow rate : 1.0 mL/min
Detector : RI
Column temp. : 40 ℃

Calibration curves for KF-800L (linear type) series using polystyrene



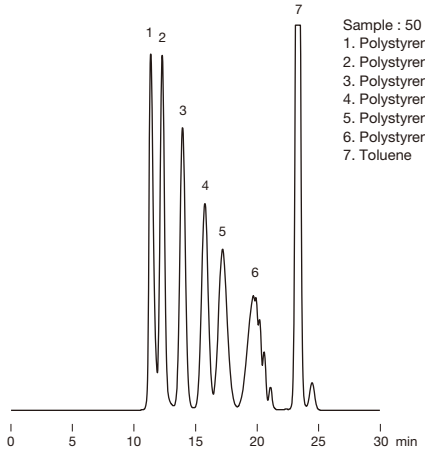
Column : Shodex GPC KF-800L series
Eluent : THF
Flow rate : 1.0 mL/min
Detector : RI
Column temp. : 40 ℃

Fat-soluble vitamins

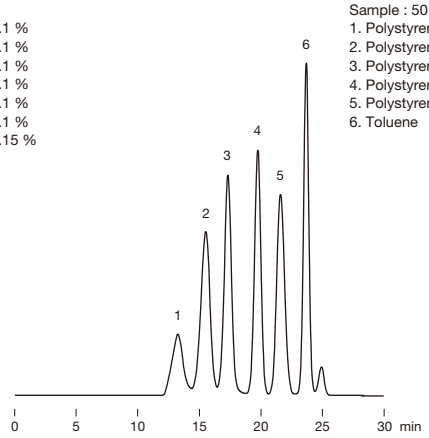


Column : Shodex GPC KF-801 x 2
Eluent : THF
Flow rate : 1.0 mL/min
Detector : UV (280 nm)
Column temp. : 40 ℃

Polystyrene standards

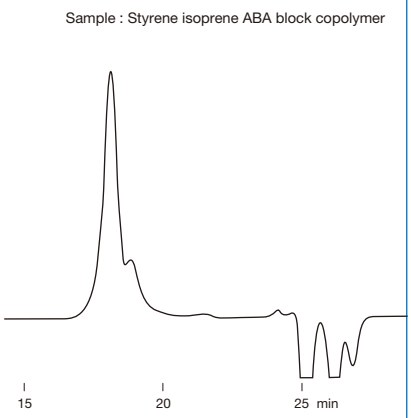


Column : Shodex GPC KF-803L x 2
Eluent : THF
Flow rate : 1.0 mL/min
Detector : UV (254 nm)
Column temp. : 40 ℃



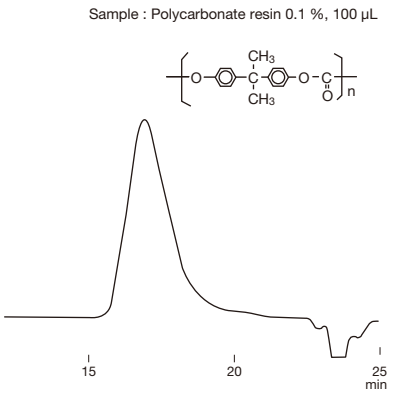
Column : Shodex GPC KF-807L x 2
Eluent : THF
Flow rate : 1.0 mL/min
Detector : UV (254 nm)
Column temp. : 40 ℃

Styrene isoprene ABA block copolymer



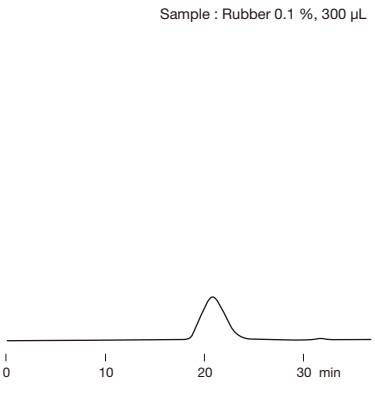
Column : Shodex GPC KF-806M x 2
Eluent : THF
Flow rate : 1.0 mL/min
Detector : RI
Column temp. : 30 ℃

Polycarbonate resin



Column : Shodex GPC KF-806L x 2
Eluent : THF
Flow rate : 1.0 mL/min
Detector : RI
Column temp. : 40 ℃

Raw rubber



Column : Shodex GPC KF-806M x 2 + KF-802
Eluent : Toluene
Flow rate : 1.0 mL/min
Detector : RI
Column temp. : Room temp.

Organic SEC (GPC) Columns (General Analysis): Chloroform

Features

K-800

- Standard organic solvent SEC (GPC) column
- Supports a wide range of applications from low to high molecular weight compounds
- Fulfills USP L21 requirements

● Standard columns

[K-800 series] Shipping Solvent: Chloroform

Product Code	Product Name	Plate Number (TP/column)	Particle Size (μm)	Pore Size (Å)	Column Size (mm) I.D. x Length
F6028110	**GPC K-801**	≥ 18,000	6	50	**8.0 x 300**
F6028120	**GPC K-802**	≥ 18,000	6	150	**8.0 x 300**
F6028125	**GPC K-802.5**	≥ 18,000	6	300	**8.0 x 300**
F6028130	**GPC K-803**	≥ 18,000	6	500	**8.0 x 300**
F6028194	**GPC K-803L**	≥ 18,000	6	500	**8.0 x 300**
F6028140	**GPC K-804**	≥ 18,000	7	1,500	**8.0 x 300**
F6028195	**GPC K-804L**	≥ 18,000	7	1,500	**8.0 x 300**
F6028150	**GPC K-805**	≥ 11,000	10	5,000	**8.0 x 300**
F6028196	**GPC K-805L**	≥ 11,000	10	5,000	**8.0 x 300**
F6028160	**GPC K-806**	≥ 11,000	10	10,000	**8.0 x 300**
F6028190	**GPC K-806M**	≥ 13,000	10	10,000	**8.0 x 300**
F6028197	**GPC K-806L**	≥ 11,000	10	10,000	**8.0 x 300**
F6028198	**GPC K-807L**	≥ 6,000	18	20,000	**8.0 x 300**
F6700401	**GPC K-G 4A**	(guard column)	8	–	**4.6 x 10**
F6709450	**GPC K-800D**	(solvent-peak separation column)	10	–	**8.0 x 100**

The columns with 'L' or 'M' at the end of column names are mixed-gel column capable of analyzing samples over a wide range of molecular weight distribution.
See page 54 for details of the solvent-peak separation columns.
See page 68 for applicability of SEC (GPC) columns to solvent replacement.

Base Material: Styrene divinylbenzene copolymer

● Preparative columns [Preparative columns are made to order.]

Product Code	Product Name	Plate Number (TP/column)	Particle Size (μm)	Column Size (mm) I.D. x Length	Standard Column
F6102301	**GPC K-2001**	≥ 18,000	6	**20.0 x 300**	K-801
F6102312	**GPC K-2002**	≥ 18,000	6	**20.0 x 300**	K-802
F6102315	**GPC K-2002.5**	≥ 18,000	6	**20.0 x 300**	K-802.5
F6102303	**GPC K-2003**	≥ 18,000	6	**20.0 x 300**	K-803
F6102304	**GPC K-2004**	≥ 14,000	7	**20.0 x 300**	K-804
F6102305	**GPC K-2005**	≥ 10,000	10	**20.0 x 300**	K-805
F6102306	**GPC K-2006**	≥ 10,000	10	**20.0 x 300**	K-806
F6102309	**GPC K-2006M**	≥ 10,000	10	**20.0 x 300**	K-806M
F6700407	**GPC K-G 8B**	(guard column)	15	**8.0 x 50**	(guard column)

See page 66 and 67 for other preparative columns.

Base Material: Styrene divinylbenzene copolymer

Target molecular weight range and exclusion limit

● Measured with polystyrene (eluent: Chloroform)

Product Name	Target Molecular Weight Range	Exclusion Limit
K-801	100 – 700	1,500
K-802	300 – 3,000	5,000
K-802.5	300 – 8,000	20,000
K-803	1,000 – 50,000	70,000
K-803L	100 – 50,000	70,000
K-804	7,000 – 300,000	400,000
K-804L	100 – 300,000	400,000

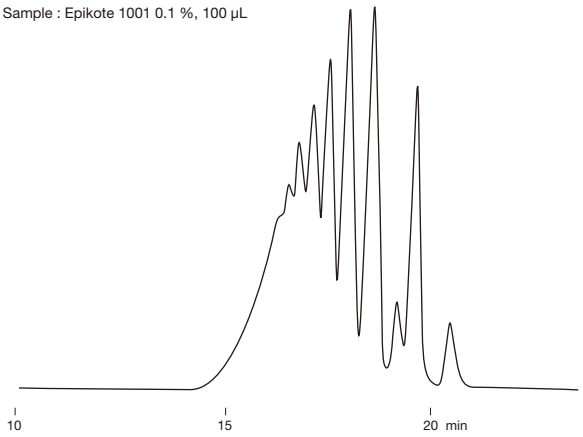
Product Name	Target Molecular Weight Range	Exclusion Limit
K-805	50,000 – 2,000,000	4,000,000
K-805L	300 – 2,000,000	4,000,000
K-806	150,000 – *(20,000,000)	*(20,000,000)
K-806M	1,000 – *(20,000,000)	*(20,000,000)
K-806L	300 – *(20,000,000)	*(20,000,000)
K-807L	300 – *(200,000,000)	*(200,000,000)

Please use the above tables for reference purposes only when selecting columns.

*( ) Estimated value

Epoxy resin

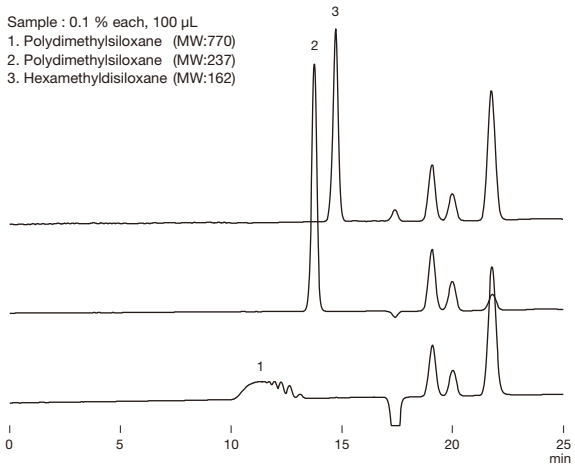
Sample : Epikote 1001 0.1 %, 100 µL



Column : **Shodex GPC K-803L x 2**
Eluent : Chloroform
Flow rate : 1.0 mL/min
Detector : UV (254 nm)
Column temp. : Room temp.

Low molecular polydimethylsiloxanes

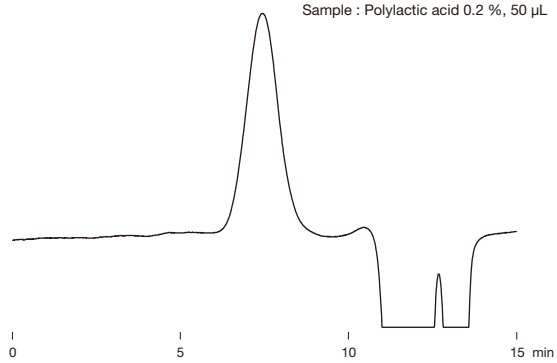
Sample : 0.1 % each, 100 µL
1. Polydimethylsiloxane (MW:770)
2. Polydimethylsiloxane (MW:237)
3. Hexamethyldisiloxane (MW:162)



Column : **Shodex GPC K-801 x 2**
Eluent : Chloroform
Flow rate : 1.0 mL/min
Detector : RI (polarity : -)
Column temp. : 40 ˚C

Polylactic acid

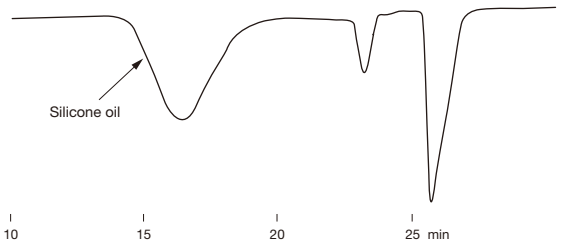
Sample : Polylactic acid 0.2 %, 50 µL



Column : **Shodex GPC K-805L**
Eluent : Chloroform
Flow rate : 1.0 mL/min
Detector : RI
Column temp. : 30 ˚C

Silicone oil

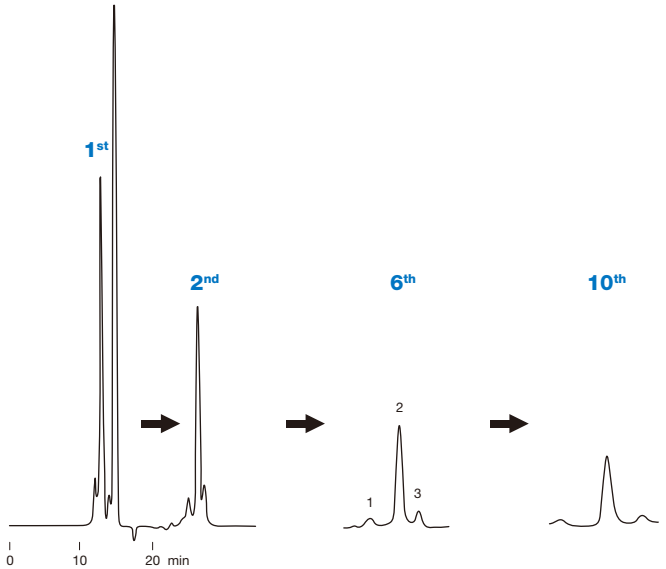
Sample : Silicone oil 0.1 %, 200 µL



Column : **Shodex GPC K-806M x 2**
Eluent : Toluene
Flow rate : 1.0 mL/min
Detector : RI
Column temp. : 45 ˚C

Recycling preparative chromatography of lauryl stearyl thiodipropionate

Sample : 5 %, 500 µL
1. Distearyl stearyl thiodipropionate
2. Lauryl stearyl thiodipropionate
3. Dilauryl thiodipropionate



Column : **Shodex GPC K-LG + K-2001**
Eluent : Chloroform
Flow rate : 3.0 mL/min
Detector : RI (preparative type)
Column temp. : 50 ˚C

Organic SEC (GPC) Columns (General Analysis): DMF

Features

KD-800
- Standard organic solvent SEC (GPC) column
- Supports a wide range of applications from low to high molecular weight compounds
- Fulfills USP L21 requirements

● Standard columns

[KD-800 series] Shipping Solvent: Dimethylformamide (DMF)

Product Code	Product Name	Plate Number (TP/column)	Particle Size (µm)	Pore Size (Å)	Column Size (mm) I.D. x Length
F6028210	**GPC KD-801**	≥ 17,000	6	50	**8.0 x 300**
F6028220	**GPC KD-802**	≥ 17,000	6	150	**8.0 x 300**
F6028225	**GPC KD-802.5**	≥ 17,000	6	300	**8.0 x 300**
F6028230	**GPC KD-803**	≥ 17,000	6	500	**8.0 x 300**
F6028240	**GPC KD-804**	≥ 17,000	7	1,500	**8.0 x 300**
F6028250	**GPC KD-805**	≥ 11,000	10	5,000	**8.0 x 300**
F6028260	**GPC KD-806**	≥ 11,000	10	10,000	**8.0 x 300**
F6028290	**GPC KD-806M**	≥ 13,000	10	10,000	**8.0 x 300**
F6028270	**GPC KD-807**	≥ 6,000	18	20,000	**8.0 x 300**
F6700411	**GPC KD-G 4A**	(guard column)	8	–	**4.6 x 10**

KD-806M is mixed-gel column capable of analyzing samples over a wide range of molecular weight distribution.
See page 68 for applicability of SEC (GPC) columns to solvent replacement.

Base Material: Styrene divinylbenzene copolymer

Target molecular weight range and exclusion limit

● Measured with *PEG/PEO (eluent: DMF)

Product Name	Target Molecular Weight Range	Exclusion Limit
KD-801	100 – 1,500	2,500
KD-802	200 – 4,000	7,000
KD-802.5	400 – 10,000	20,000
KD-803	1,000 – 50,000	70,000
KD-804	4,000 – 200,000	200,000

Product Name	Target Molecular Weight Range	Exclusion Limit
KD-805	30,000 – **(4,000,000)	**(4,000,000)
KD-806	30,000 – **(40,000,000)	**(40,000,000)
KD-806M	1,000 – **(40,000,000)	**(40,000,000)
KD-807	50,000 – **(200,000,000)	**(200,000,000)

Please use the above tables for reference purposes only when selecting columns.

*PEG: polyethylene glycol
*PEO: polyethylene oxide
**( ) Estimated value

Solvent-peak Separation Columns for Organic SEC (GPC)

Features

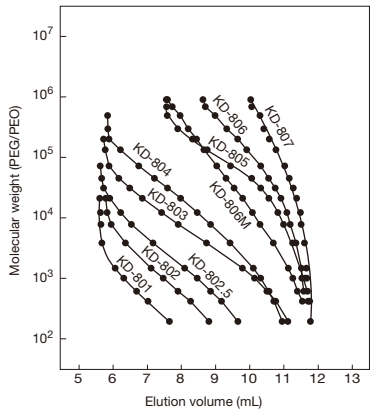
KF-800D
K-800D
- Use this column in combination with a linear column
- Accurate molecular weight distribution of polymers and oligomers are achieved by shifting the elutions of monomers, polymer additives, and solvent-peak in the lower molecular region

● Solvent-peak separation columns

Product Code	Product Name	Column Combination	Particle Size (µm)	Column Size (mm) I.D. x Length	Shipping Solvent
F6709350	**GPC KF-800D**	KF-805L, 806L, 806M, 807L	10	**8.0 x 100**	THF
F6709450	**GPC K-800D**	K-805L, 806L, 806M, 807L	10	**8.0 x 100**	Chloroform

Base Material: Styrene divinylbenzene copolymer

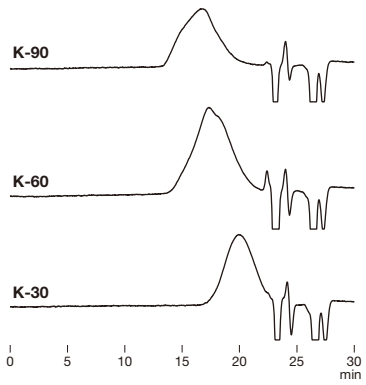
Calibration curves for KD-800 series using PEG/PEO



Column : Shodex GPC KD-800 series
Eluent : DMF
Flow rate : 1.0 mL/min
Detector : RI
Column temp. : 40 ℃

Polyvinylpyrrolidones

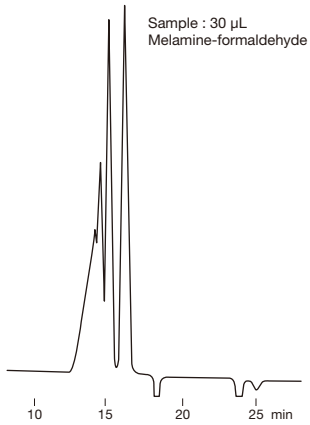
Sample : Polyvinylpyrrolidone 0.1 % each, 100 µL



Column : Shodex GPC KD-806M x 2
Eluent : 10 mM LiBr in DMF
Flow rate : 1.0 mL/min
Detector : RI
Column temp. : 50 ℃

Melamine formaldehyde resin

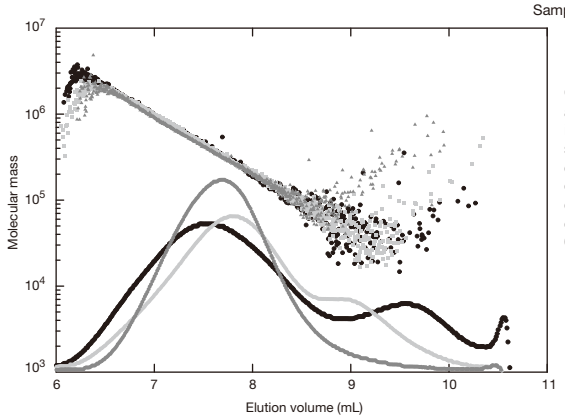
Sample : 30 µL
Melamine-formaldehyde resin 1 %



Column : Shodex GPC KD-802 x 2
Eluent : 10 mM LiBr in DMF
Flow rate : 1.0 mL/min
Detector : RI
Column temp. : 50 ℃

Celluloses

Sample : Cellulose ca. 0.05 % each, 100 µL



Cellulose is difficult to dissolve and repeated solvent replacement is required to prepare the cellulose solution. The time required to completely dissolve cellulose depends on the solvent type, crystallinity and molecular weight of the cellulose. This can be 1 to 60 days.

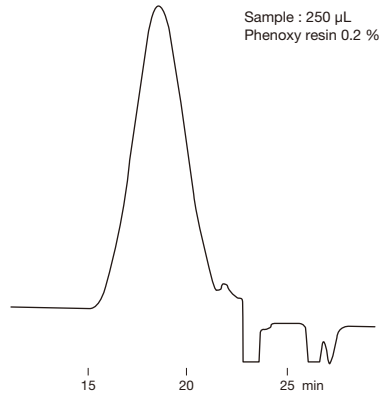
Column : Shodex GPC KD-806M
Eluent : 1 % LiCl in *DMI
Flow rate : 0.5 mL/min
Detector : RI, MALS (Multi angle light scattering)
Column temp. : 60 ℃

*DMI 1,3-dimethyl-2-imidazolidinone

Data provided by Dr. Masahiko Yanagisawa, Isogai group, Graduate School of Agricultural and Life Sciences, The University of Tokyo

Phenoxy resin

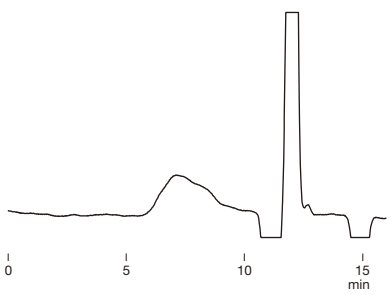
Sample : 250 µL
Phenoxy resin 0.2 %



Column : Shodex GPC KD-806M x 2
Eluent : 10 mM LiBr in DMF
Flow rate : 1.0 mL/min
Detector : RI
Column temp. : 50 ℃

Potato starch

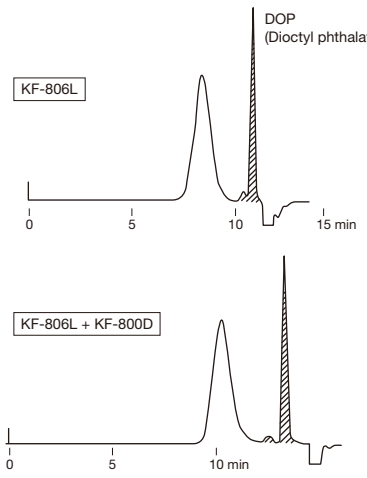
Sample : 100 µL
Potato starch in DMSO 0.1 %
(solved at 80 °C)

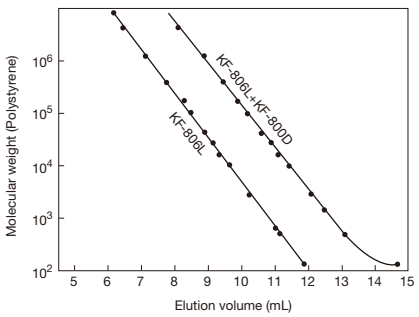


Column : Shodex GPC KD-806M
Eluent : 10 mM LiBr in DMSO/DMF=75/25
Flow rate : 1.0 mL/min
Detector : RI
Column temp. : 50 ℃

Effects of solvent-peak separation column

Sample : Poly(vinyl chloride)





Column : Shodex GPC KF-806L
Shodex GPC KF-806L + KF-800D
Eluent : THF
Flow rate : 1.0 mL/min
Detector : RI

Organic SEC (GPC) Columns: Rapid Analysis, High Performance Analysis

Features

KF-600
- Achieves approximately halved analysis time compared with standard columns
- The amount of solvent used is reduced to about a third
- Improved applicability of solvent replacement
- Fulfills USP L21 requirements

KF-400HQ
- About 1.5 times better separation performance than standard columns, obtains higher resolution
- About 4 times better sensitivity than that of standard columns, supports high sensitivity analysis
- The amount of solvent used is reduced to about a third
- Improved applicability of solvent replacement
- Fulfills USP L21 requirements

●Rapid analysis downsized columns

[KF-600 series] Shipping Solvent: Tetrahydrofuran (THF)

◎ KF-600 series is recommended to be used with semi-micro type devices.

Product Code	Product Name	Plate Number (TP/column)	Particle Size (μm)	Pore Size (Å)	Column Size (mm) I.D. x Length
F6028091	**GPC KF-601**	≥ 17,000	3	50	**6.0 x 150**
F6028092	**GPC KF-602**	≥ 17,000	3	150	**6.0 x 150**
F6028093	**GPC KF-602.5**	≥ 17,000	3	300	**6.0 x 150**
F6028094	**GPC KF-603**	≥ 17,000	3	500	**6.0 x 150**
F6028095	**GPC KF-604**	≥ 16,000	3	1,500	**6.0 x 150**
F6028096	**GPC KF-605**	≥ 7,000	10	5,000	**6.0 x 150**
F6028097	**GPC KF-606**	≥ 7,000	10	10,000	**6.0 x 150**
F6028098	**GPC KF-606M**	≥ 8,000	10	10,000	**6.0 x 150**
F6700300	**GPC KF-G 4A**	(guard column)	8	–	**4.6 x 10**

●High performance semi-micro columns

[KF-400HQ series] Shipping Solvent: Tetrahydrofuran (THF)

◎ KF-400HQ series is recommended to be used with semi-micro type devices.

Product Code	Product Name	Plate Number (TP/column)	Particle Size (μm)	Pore Size (Å)	Column Size (mm) I.D. x Length
F6028111	**GPC KF-401HQ**	≥ 25,000	3	50	**4.6 x 250**
F6028112	**GPC KF-402HQ**	≥ 25,000	3	150	**4.6 x 250**
F6028114	**GPC KF-402.5HQ**	≥ 25,000	3	300	**4.6 x 250**
F6028116	**GPC KF-403HQ**	≥ 25,000	3	500	**4.6 x 250**
F6028118	**GPC KF-404HQ**	≥ 25,000	3	1,500	**4.6 x 250**
F6028119	**GPC KF-405LHQ**	≥ 10,000	10	5,000	**4.6 x 250**
F6028122	**GPC KF-406LHQ**	≥ 10,000	10	10,000	**4.6 x 250**
F6700300	**GPC KF-G 4A**	(guard column)	8	–	**4.6 x 10**

[KF-600 series and KF-400HQ series]
The columns with 'L' or 'M' at the end of column names are mixed-gel column capable of analyzing samples over a wide range of molecular weight distribution.
See page 68 for applicability of SEC (GPC) columns to solvent replacement.

[KF-600 series and KF-400HQ series]
Base Material: Styrene divinylbenzene copolymer

Target molecular weight range and exclusion limit

● Measured with polystyrene (eluent: THF)

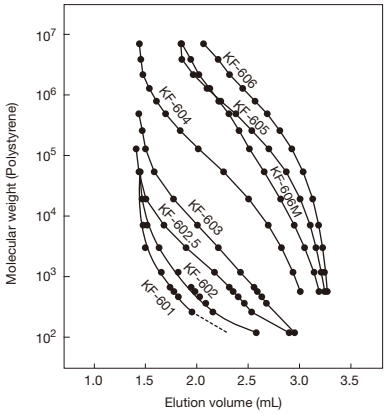
Product Name	Target Molecular Weight Range	Exclusion Limit
KF-601	100 – 700	1,500
KF-602	200 – 1,500	4,000
KF-602.5	300 – 10,000	20,000
KF-603	600 – 50,000	70,000
KF-604	7,000 – 500,000	1,000,000
KF-605	50,000 – 2,000,000	4,000,000
KF-606	150,000 – *(20,000,000)	*(20,000,000)
KF-606M	1,000 – *(20,000,000).	*(20,000,000)

Product Name	Target Molecular Weight Range	Exclusion Limit
KF-401HQ	100 – 700	1,500
KF-402HQ	200 – 1,500	4,000
KF-402.5HQ	300 – 10,000	20,000
KF-403HQ	600 – 50,000	70,000
KF-404HQ	7,000 – 500,000	1,000,000
KF-405LHQ	300 – 2,000,000	4,000,000
KF-406LHQ	300 – *(20,000,000)	*(20,000,000)

Please use the above tables for reference purposes only when selecting columns.

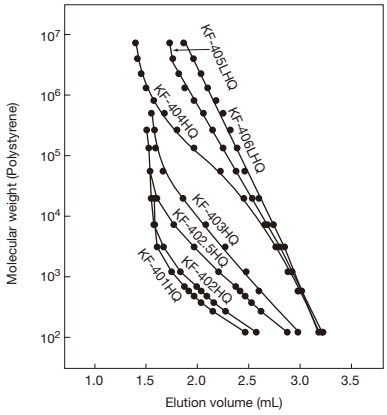
*( ) Estimated value

Calibration curves for KF-600 series using polystyrene



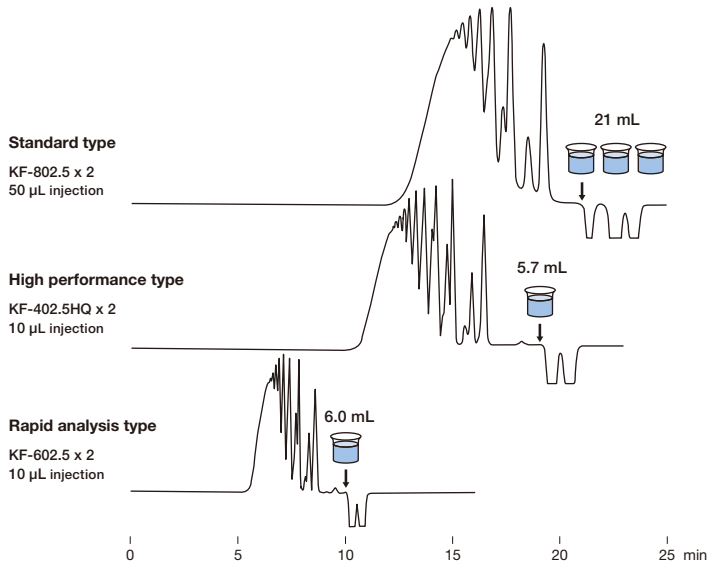
Column : **Shodex GPC KF-600 series**
Eluent : THF
Flow rate : 0.5 mL/min
Detector : RI (small cell volume)
Column temp. : 40 ℃

Calibration curves for KF-400HQ series using polystyrene



Column : **Shodex GPC KF-400HQ series**
Eluent : THF
Flow rate : 0.3 mL/min
Detector : RI (small cell volume)
Column temp. : 40 ℃

Comparison of standard, rapid analysis, and high performance type columns



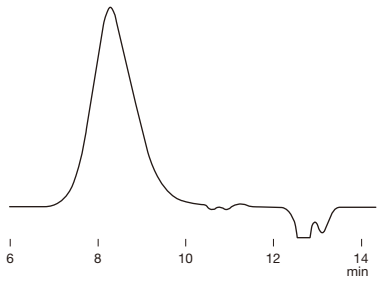
Sample : EPON1001 0.2 %

KF-602.5 provides rapid analysis by reducing the analysis time less than half of the analysis time of KF-802.5. Having 1.5 times more theoretical plate number than standard column, KF-402.5HQ provides improved resolution especially for the separation of small to medium molecular weight substances. Rapid analysis andhigh performance type columns use less than one third ofsolvent per analysis compared to standard type columns do.

Column : **Shodex GPC KF-802.5 x 2**
Shodex GPC KF-402.5HQ x 2
Shodex GPC KF-602.5 x 2
Eluent : THF
Flow rate : 1.0 mL/min (KF-802.5)
0.3 mL/min (KF-402.5HQ)
0.6 mL/min (KF-602.5)
Detector : RI (conventional type) (KF-802.5)
RI (small cell volume) (KF-402.5HQ, KF-602.5)
Column temp. : 40 ℃

Styrene acrylonitrile copolymer

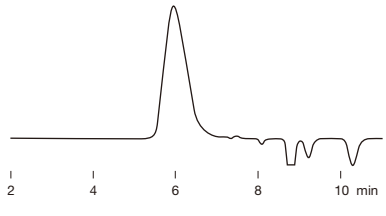
Sample : Styrene-Acrylonitrile (30:70) copolymer



Column : **Shodex GPC KF-606M x 2**
Eluent : 10 mM LiBr in DMF
Flow rate : 0.5 mL/min
Detector : RI (small cell volume)
Column temp. : 40 ℃

Liquid paraffin

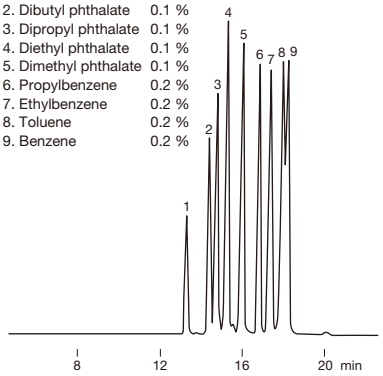
Sample : Liquid paraffin 1 %, 5 µL



Column : **Shodex GPC KF-401HQ**
Eluent : Chloroform
Flow rate : 0.3 mL/min
Detector : RI (small cell volume)
Column temp. : 40 ℃

Phthalates

Sample : 10 µL
1. Dioctyl phthalate 0.1 %
2. Dibutyl phthalate 0.1 %
3. Dipropyl phthalate 0.1 %
4. Diethyl phthalate 0.1 %
5. Dimethyl phthalate 0.1 %
6. Propylbenzene 0.2 %
7. Ethylbenzene 0.2 %
8. Toluene 0.2 %
9. Benzene 0.2 %



Column : **Shodex GPC KF-401HQ x 2**
Eluent : THF
Flow rate : 0.3 mL/min
Detector : UV (254 nm) (small cell volume)
Column temp. : 40 ℃

Organic SEC (GPC) Columns: Ultra-Rapid Analysis

Features

HK-400

- Newly developed styrene divinylbenzene copolymer monodisperse particles
- Analysis time is reduced to about a sixth of conventional column's analysis time
- Low column pressure even under high flow rate does not require a UHPLC system
- The amount of solvent used is reduced to about a sixth
- HK-403 (exclusion limit: 100,000) newly added to the series
- HK-HFIP404L is filled with HFIP
- Fulfills USP L21 requirements

● Ultra-Rapid analysis semi-micro columns

Shipping Solvent: Tetrahydrofuran (THF)

◎ HK-400 series is recommended to be used with semi-micro type devices.

Product Code	Product Name	Plate Number (TP/column)	Particle Size (μm)	Pore Size (Å)	Column Size (mm) I.D. x Length
F6025010	**GPC HK-401**	≥ 9,000	3	50	**4.6 x 150**
F6025030	New **GPC HK-403**	≥ 9,000	3.5	550	**4.6 x 150**
F6026040	**GPC HK-404L**	≥ 9,000	3.5	2,000	**4.6 x 150**
F6025050	**GPC HK-405**	≥ 7,000	3	5,000	**4.6 x 150**

HK-404L is mixed-gel column capable of analyzing samples over a wide range of molecular weight distribution.

Base Material: Styrene divinylbenzene copolymer

Shipping Solvent: hexafluoroisopropanol (HFIP)

◎ HK-HFIP404L is recommended to be used with semi-micro type devices.

Product Code	Product Name	Plate Number (TP/column)	Particle Size (μm)	Pore Size (Å)	Column Size (mm) I.D. x Length
F6026140	**GPC HK-HFIP404L**	≥ 9,000	3.5	800	**4.6 x 150**

HK-HFIP404L is mixed-gel column capable of analyzing samples over a wide range of molecular weight distribution.

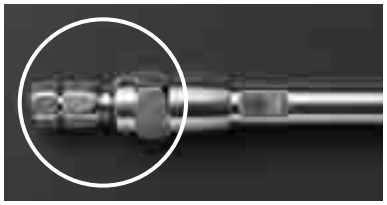
Base Material: Styrene divinylbenzene copolymer

See page 64 for details of other columns filled with HFIP.

● Guard filter for HK series

Product Code	Product Name	Contents
F6700200	**GPC HK-G**	One holder and one filter
F6700100	**GPC HK-G filter**	3 filters

Removes insoluble components in the sample



Allows direct attachment to the analytical column

Target molecular weight range and exclusion limit

● Measured with polystyrene (eluent: THF)

Product Name	Target Molecular Weight Range	Exclusion Limit
HK-401	100 – 1,500	2,000
HK-403	2,000 – 70,000	100,000
HK-404L	100 – 1,000,000	1,000,000
HK-405	10,000 – 2,500,000	4,000,000

Please use the above table for reference purposes only when selecting columns.

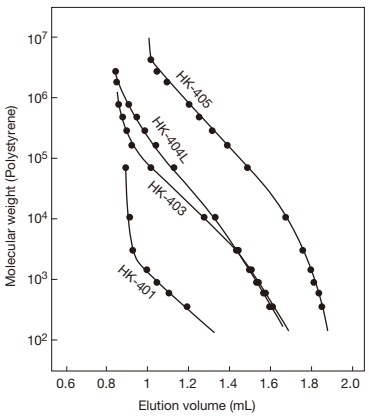
● Measured with *PMMA (eluent: HFIP)

Product Name	Target Molecular Weight Range	Exclusion Limit
HK-HFIP404L	5,000 – 200,000	200,000

Please use the above table for reference purposes only when selecting columns.

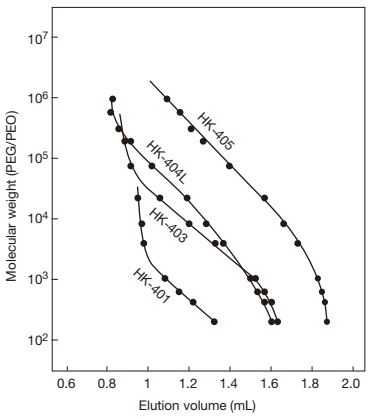
*PMMA: Polymethylmethacrylate

Calibration curves for HK-400 series using polystyrene (eluent : THF)



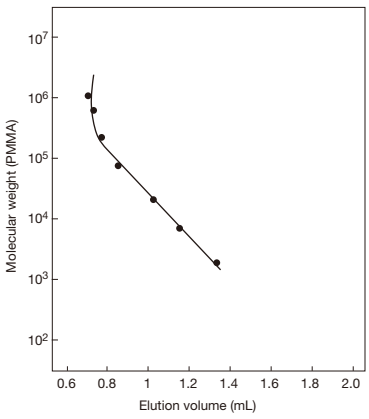
Column : **Shodex GPC HK-400 series**
Eluent : THF
Flow rate : 1.0 mL/min
Detector : RI (small cell volume)
Column temp. : 40 ˚C

Calibration curves for HK-400 series using PEG/PEO (eluent : DMF)



Column : **Shodex GPC HK-400 series**
Eluent : DMF
Flow rate : 1.0 mL/min
Detector : RI (small cell volume)
Column temp. : 40 ˚C

Calibration curve for HK-HFIP404L using PMMA (eluent : HFIP)

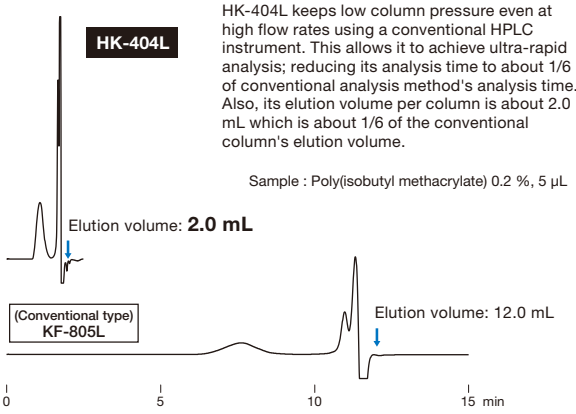


Column : **Shodex GPC HK-HFIP404L**
Eluent : 5 mM CF_3COONa in HFIP
Flow rate : 0.3 mL/min
Detector : RI (small cell volume)
Column temp. : 40 ˚C

Comparison of HK-404L and conventional column (KF-805L)

HK-404L keeps low column pressure even at high flow rates using a conventional HPLC instrument. This allows it to achieve ultra-rapid analysis; reducing its analysis time to about 1/6 of conventional analysis method's analysis time. Also, its elution volume per column is about 2.0 mL which is about 1/6 of the conventional column's elution volume.

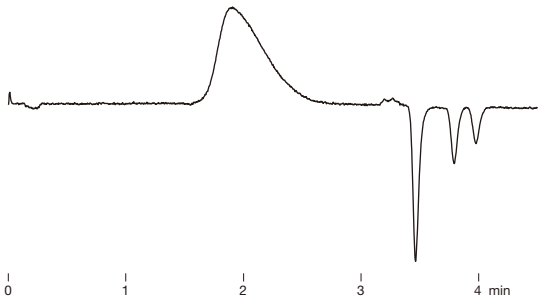
Sample : Poly(isobutyl methacrylate) 0.2 %, 5 µL



Column : **Shodex GPC HK-404L, KF-805L**
Eluent : THF
Flow rate : 1.0 mL/min
Detector : RI (small cell volume)
Column temp. : 40 ˚C

Poly(butyl methacrylate)

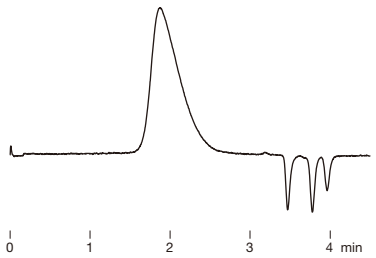
Sample : Poly(n-butyl methacrylate) 0.2 %, 5 µL



Column : **Shodex GPC HK-404L x 2**
Eluent : THF
Flow rate : 1.0 mL/min
Detector : RI (small cell volume)
Column temp. : 40 ˚C

Styrene butyl methacrylate copolymer

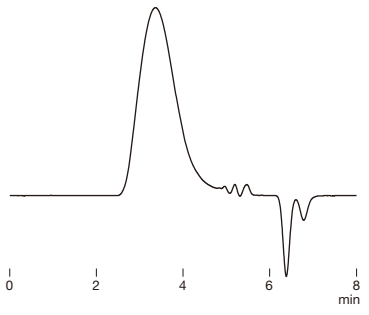
Sample : Styrene butyl methacrylate copolymer 0.2 %, 5 µL



Column : **Shodex GPC HK-404L x 2**
Eluent : THF
Flow rate : 1.0 mL/min
Detector : RI (small cell volume)
Column temp. : 40 ˚C

Polyamide (Nylon 6/9)

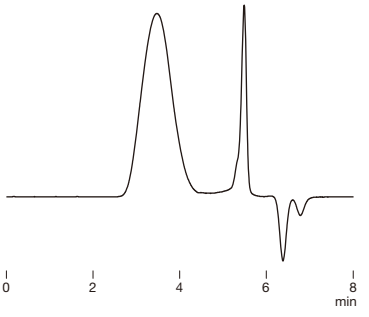
Sample : Nylon 6/9 0.23 %, 5 µL



Column : **Shodex GPC HK-HFIP404L**
Eluent : 5 mM CF_3COONa in HFIP
Flow rate : 0.3 mL/min
Detector : RI (small cell volume)
Column temp. : 40 ˚C

Polyamide (Nylon 11)

Sample : Nylon 11 0.25 %, 5 µL



Column : **Shodex GPC HK-HFIP404L**
Eluent : 5 mM CF_3COONa in HFIP
Flow rate : 0.3 mL/min
Detector : RI (small cell volume)
Column temp. : 40 ˚C

Organic SEC (GPC) Columns: Linear Calibration Type

Features

LF

- Packed with unique multi-pore gels with a wide pore-size distribution
- Highly linear calibration curve without inflection points
- Achieves highly precise molecular weight distribution determination
- Enables analysis over a broad range of molecular weights
- Rapid analysis column (LF-604) and high performance analysis column (LF-404) are also available
- LF-604 and LF-404 enables reduction of solvent use
- Fulfills USP L21 requirements

● Standard column

Shipping Solvent: Tetrahydrofuran (THF)

Product Code	Product Name	Plate Number (TP/column)	Particle Size (µm)	Pore Size (Å)	Column Size (mm) I.D. x Length
F6021041	**GPC LF-804**	≥ 17,000	6	3,000	**8.0 x 300**
F6709621	**GPC LF-G**	(guard column)	6	–	**4.6 x 10**

See page 68 for applicability of SEC (GPC) columns to solvent replacement.

Base Material: Styrene divinylbenzene copolymer

● Rapid analysis downsized column

Shipping Solvent: Tetrahydrofuran (THF)

◎ LF-604 is recommended to be used with semi-micro type devices.

Product Code	Product Name	Plate Number (TP/column)	Particle Size (µm)	Pore Size (Å)	Column Size (mm) I.D. x Length
F6021042	**GPC LF-604**	≥ 9,000	6	3,000	**6.0 x 150**
F6709621	**GPC LF-G**	(guard column)	6	–	**4.6 x 10**

See page 68 for applicability of SEC (GPC) columns to solvent replacement.

Base Material: Styrene divinylbenzene copolymer

● High performance semi-micro column

Shipping Solvent: Tetrahydrofuran (THF)

◎ LF-404 is recommended to be used with semi-micro type devices.

Product Code	Product Name	Plate Number (TP/column)	Particle Size (µm)	Pore Size (Å)	Column Size (mm) I.D. x Length
F6021043	**GPC LF-404**	≥ 14,000	6	3,000	**4.6 x 250**
F6709621	**GPC LF-G**	(guard column)	6	–	**4.6 x 10**

See page 68 for applicability of SEC (GPC) columns to solvent replacement.

Base Material: Styrene divinylbenzene copolymer

Target molecular weight range and exclusion limit

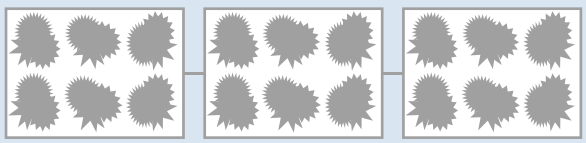
● Measured with polystyrene (eluent: THF)

Product Name	Target Molecular Weight Range	Exclusion Limit
LF-804	300 – 2,000,000	2,000,000
LF-604	300 – 2,000,000	2,000,000
LF-404	300 – 2,000,000	2,000,000

Please use the above table for reference purposes only when selecting columns.

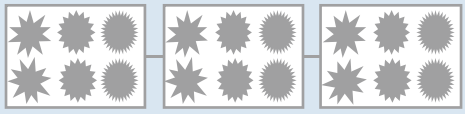
Schematic diagram of linear calibration type packing

Connecting linear calibration type columns (LF series)

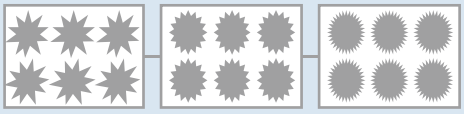


The linear calibration type column covers a broad range of molecular weights with only one kind of packing material.

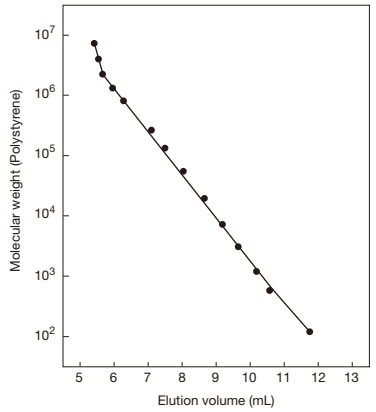
Connecting mixed-gel columns (KF-804L, etc.)



Connecting different single pore-size columns (KF-804 + KF-803 + KF-802, etc.)

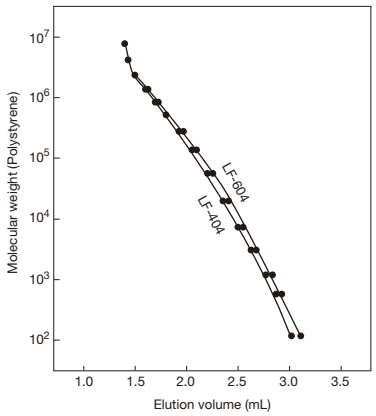


Calibration curve for LF-804 using polystyrene



Column : **Shodex GPC LF-804**
Eluent : THF
Flow rate : 1.0 mL/min
Detector : RI
Column temp. : 40 ℃

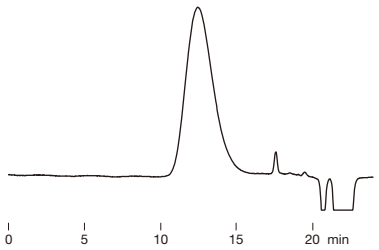
Calibration curves for LF-604 and LF-404 using polystyrene



Column : **Shodex GPC LF-604, LF-404**
Eluent : THF
Flow rate : 0.5 mL/min (LF-604)
0.3 mL/min (LF-404)
Detector : RI (small cell volume)
Column temp. : 40 ℃

Polyurethane

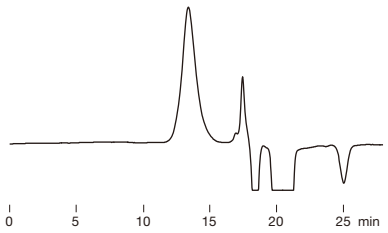
Sample : Polyurethane 0.1 %, 20 µL



Column : **Shodex GPC LF-404 x 2**
Eluent : THF
Flow rate : 0.3 mL/min
Detector : RI (small cell volume)
Column temp. : 40 ℃

Xylan

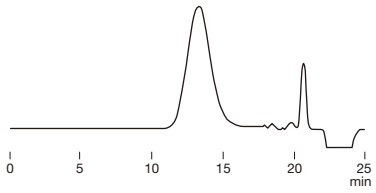
Sample : Xylan 0.1 %, 100 µL



Column : **Shodex GPC LF-804**
Eluent : 20 mM H_3PO_4 + 20 mM LiBr in DMSO/DMF=80/20
Flow rate : 0.6 mL/min
Detector : RI
Column temp. : 50 ℃

Polyamide (Nylon 6/6)

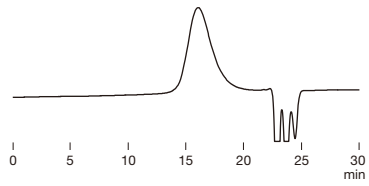
Sample : Nylon 6/6 0.1 %, 20 µL



Column : **Shodex GPC LF-404**
Eluent : 5 mM CF_3COONa in HFIP
Flow rate : 0.15 mL/min
Detector : RI (small cell volume)
Column temp. : 40 ℃

Polymethyl methacrylate

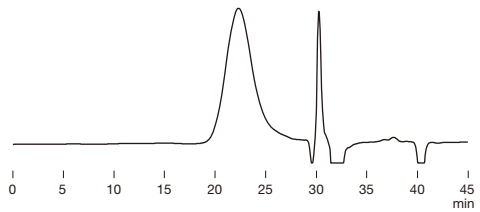
Sample : Polymethyl methacrylate, 100 µL



Column : **Shodex GPC LF-804 x 2**
Eluent : Methyl ethyl ketone
Flow rate : 1.0 mL/min
Detector : RI
Column temp. : 40 ℃

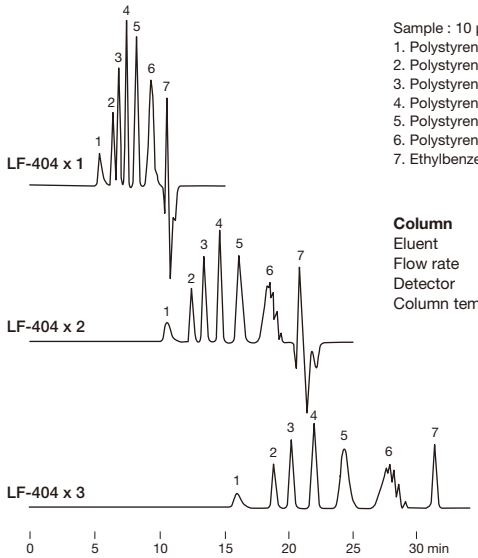
Polyamic acid

Sample : Poly(pyromellitic dianhydride-co-4,4'-oxydianiline), 100 µL



Column : **Shodex GPC LF-804 x 2**
Eluent : 30 mM LiBr + 30 mM H_3PO_4 in NMP
Flow rate : 0.7 mL/min
Detector : RI
Column temp. : 50 ℃

Effects of using multiple LF-404 columns for the separation of polystyrenes



Sample : 10 µL
1. Polystyrene (Mw : 1,030,000)
2. Polystyrene (Mw : 152,000)
3. Polystyrene (Mw : 66,000)
4. Polystyrene (Mw : 22,000)
5. Polystyrene (Mw : 5,050)
6. Polystyrene (Mw : 580)
7. Ethylbenzene

Column : **Shodex GPC LF-404 x n**
Eluent : THF
Flow rate : 0.3 mL/min
Detector : RI (small cell volume)
Column temp. : 40 ℃

Organic SEC (GPC) Columns: High Temperature/Ultra High Temperature Analysis

Features

HT-800
- Wide product lineup to support a broad range of molecular weight analysis
- Fulfills USP L21 requirements

UT-800
- Dedicated to SEC analysis at high/ultra high temperatures with a maximum usable temperature of 210 °C
- Suitable for the analysis of ultra high molecular weight polymer containing samples
- Fulfills USP L21 requirements

● Standard columns

Shipping Solvent: Toluene

Product Code	Product Name	Plate Number (TP/column)	Usable Temperature (°C)	Particle Size (µm)	Pore Size (Å)	Column Size (mm) I.D. x Length
F6208700	**GPC HT-803**	≥ 7,000	100 ~ 150	13	500	**8.0 x 300**
F6208710	**GPC HT-804**	≥ 7,000	100 ~ 150	13	1,500	**8.0 x 300**
F6208720	**GPC HT-805**	≥ 7,000	100 ~ 150	13	5,000	**8.0 x 300**
F6208730	**GPC HT-806**	≥ 7,000	100 ~ 150	13	10,000	**8.0 x 300**
F6208740	**GPC HT-806M**	≥ 7,000	100 ~ 150	13	10,000	**8.0 x 300**
F6208770	**GPC HT-807**	≥ 4,000	100 ~ 150	18	20,000	**8.0 x 300**
F6709410	**GPC HT-G**	(guard column)	100 ~ 150	13	–	**8.0 x 50**
F6208600	**GPC UT-802.5**	≥ 4,400	100 ~ 210	30	300	**8.0 x 300**
F6208610	**GPC UT-806M**	≥ 4,400	100 ~ 210	30	10,000	**8.0 x 300**
F6208620	**GPC UT-807**	≥ 3,300	100 ~ 210	30	20,000	**8.0 x 300**
F6709400	**GPC UT-G**	(guard column)	100 ~ 210	30	–	**8.0 x 50**
F6208390	**GPC AT-806MS**	≥ 6,000	*Ta ~ 150	12	10,000	**8.0 x 250**
F6700280	**GPC AT-G**	(guard column)	*Ta ~ 150	15	–	**8.0 x 50**

The columns with 'M' at the end of column names are mixed-gel column capable of analyzing samples over a wide range of molecular weight distribution.

Base Material: Styrene divinylbenzene copolymer
*Ta: Ambient temperature

Target molecular weight range and exclusion limit

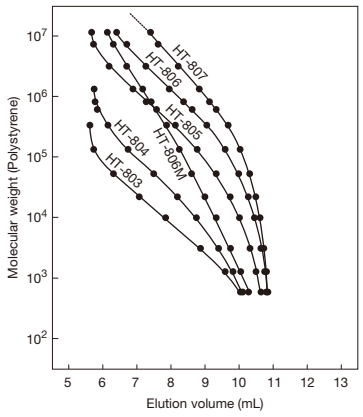
● Measured with polystyrene (eluent: o-Dichlorobenzene (ODCB))

Product Name	Target Molecular Weight Range	Exclusion Limit
HT-803	1,000 – 50,000	70,000
HT-804	7,000 – 300,000	400,000
HT-805	50,000 – 2,000,000	4,000,000
HT-806	150,000 – *(20,000,000)	*(20,000,000)
HT-806M	1,000 – *(20,000,000).	*(20,000,000)
HT-807	300,000 – *(200,000,000)	*(200,000,000)
UT-802.5	300 – 10,000	20,000
UT-806M	1,000 – *(20,000,000).	*(20,000,000)
UT-807	500,000 – *(200,000,000)	*(200,000,000)
AT-806MS	1,000 – *(20,000,000).	*(20,000,000)

Please use the above table for reference purposes only when selecting columns.

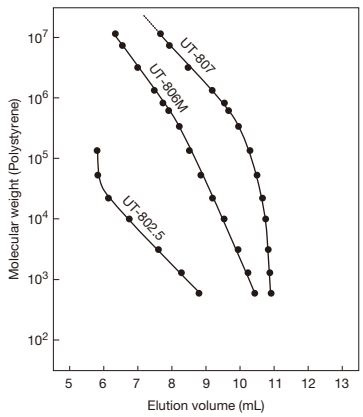
*( ) Estimated value

Calibration curves for HT-800 series using polystyrene



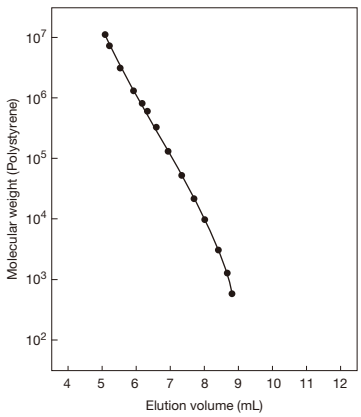
Column : Shodex GPC HT-800 series
Eluent : 0.1 % BHT in ODCB
Flow rate : 1.0 mL/min
Detector : RI
Column temp. : 140 ℃

Calibration curves for UT-800 series using polystyrene



Column : Shodex GPC UT-800 series
Eluent : 0.1 % BHT in ODCB
Flow rate : 1.0 mL/min
Detector : RI
Column temp. : 140 ℃

Calibration curve for AT-806MS using polystyrene



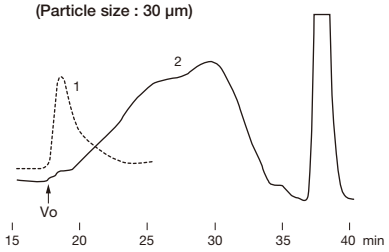
Column : Shodex GPC AT-806MS
Eluent : 0.1 % BHT in ODCB
Flow rate : 1.0 mL/min
Detector : RI
Column temp. : 140 ℃

Effects of gel particle size in high temperature GPC columns

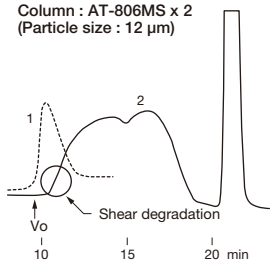
High temperature GPC columns are suitable for the analysis of high molecular weight polymers that are difficult to be dissolved in ambient temperature solvents; examples of such polymers are polyethylene and polypropylene. The GPC UT-800 series packed with large particle size (30 µm) are recommended for the analysis of macromolecules. The large particle size prevents potential molecular shear degradation of the sample.

Sample :
1. Polystyrene (MW : 20,000,000)
2. High density polyethyrene (HDPE-A)

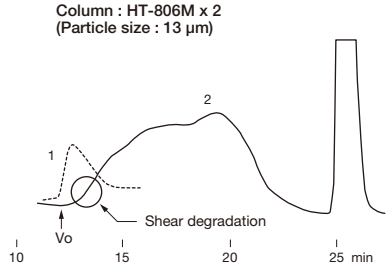
Column : UT-806M x 3
(Particle size : 30 µm)



Column : AT-806MS x 2
(Particle size : 12 µm)



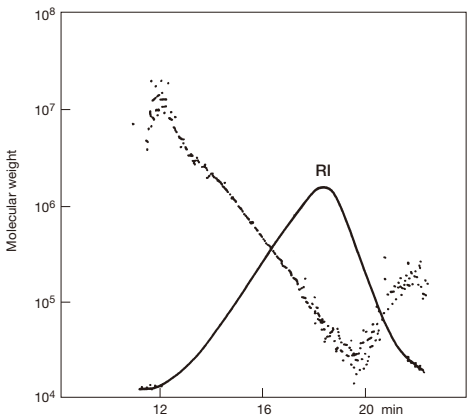
Column : HT-806M x 2
(Particle size : 13 µm)



Column : Shodex GPC UT-806M
Shodex GPC HT-806M
Shodex GPC AT-806MS
Eluent : 0.1 % BHT in ODCB
Flow rate : 1.0 mL/min
Detector : RI
Column temp. : 140 ℃

High density polyethylene

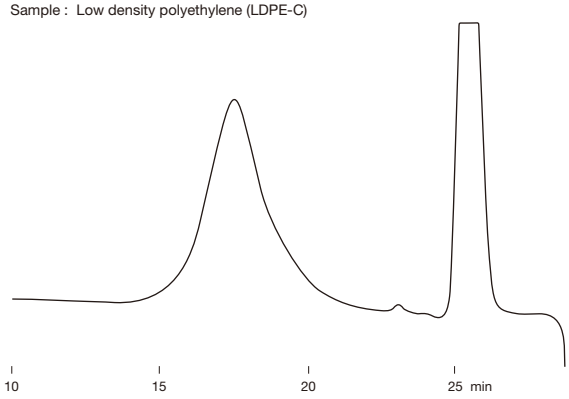
Sample : High density polyethylene (HDPE-B)



Column : Shodex GPC UT-806M x 2
Eluent : 0.1 % BHT in ODCB
Flow rate : 1.0 mL/min
Detector : RI, MALS (Multi angle light scattering)
Column temp. : 145 ℃

Low density polyethylene

Sample : Low density polyethylene (LDPE-C)



Column : Shodex GPC HT-806M x 2
Eluent : 0.1 % BHT in ODCB
Flow rate : 1.0 mL/min
Detector : RI
Column temp. : 140 ℃

Organic SEC (GPC) Columns: HFIP

Features

HFIP-800
- Columns exclusively used with hexafluoroisopropanol (HFIP)
- Fulfills USP L21 requirements

HFIP-600
- Rapid analysis, solvent saving type
- Fulfills USP L21 requirements

● Standard columns

[HFIP-800 series] Shipping Solvent: Hexafluoroisopropanol (HFIP)

Product Code	Product Name	Plate Number (TP/column)	Particle Size (μm)	Pore Size (Å)	Column Size (mm) I.D. x Length
F6028530	**GPC HFIP-803**	≥ 12,000	10	500	**8.0 x 300**
F6028540	**GPC HFIP-804**	≥ 12,000	7	1,500	**8.0 x 300**
F6028550	**GPC HFIP-805**	≥ 10,000	10	5,000	**8.0 x 300**
F6028560	**GPC HFIP-806**	≥ 10,000	10	10,000	**8.0 x 300**
F6028590	**GPC HFIP-806M**	≥ 10,000	10	10,000	**8.0 x 300**
F6700500	**GPC HFIP-G 8B**	(guard column)	15	–	**8.0 x 50**

HFIP-806M is mixed-gel column capable of analyzing samples over a wide range of molecular weight distribution.

Base Material: Styrene divinylbenzene copolymer

● Rapid analysis downsized columns

[HFIP-600 series] Shipping Solvent: Hexafluoroisopropanol (HFIP)

◎ HFIP-600 series is recommended to be used with semi-micro type devices.

Product Code	Product Name	Plate Number (TP/column)	Particle Size (μm)	Pore Size (Å)	Column Size (mm) I.D. x Length
F6021030	**GPC HFIP-603**	≥ 12,000	3	500	**6.0 x 150**
F6021040	**GPC HFIP-604**	≥ 12,000	3	1,500	**6.0 x 150**
F6021050	**GPC HFIP-605**	≥ 5,000	10	5,000	**6.0 x 150**
F6021080	**GPC HFIP-606M**	≥ 6,000	10	10,000	**6.0 x 150**
F6700511	**GPC HFIP-G 4A**	(guard column)	8	–	**4.6 x 10**

HFIP-606M is mixed-gel column capable of analyzing samples over a wide range of molecular weight distribution.

Base Material: Styrene divinylbenzene copolymer

See page 58 for details of a column enclosed with HFIP.

Target molecular weight range and exclusion limit

● Measured with *PMMA (eluent: HFIP)

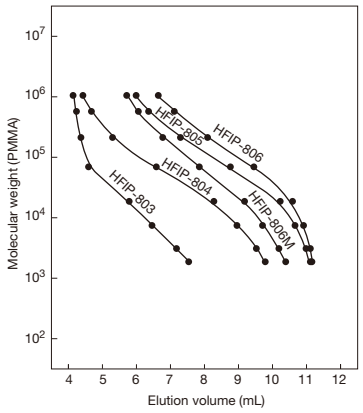
Product Name	Target Molecular Weight Range	Exclusion Limit
HFIP-803	1,000 – 30,000	60,000
HFIP-804	20,000 – 200,000	300,000
HFIP-805	20,000 – 600,000	1,000,000
HFIP-806	70,000 – **(8,000,000)	**(8,000,000)
HFIP-806M	1,000 – **(8,000,000)	**(8,000,000)

Product Name	Target Molecular Weight Range	Exclusion Limit
HFIP-603	1,000 – 30,000	60,000
HFIP-604	20,000 – 200,000	300,000
HFIP-605	20,000 – 600,000	1,000,000
HFIP-606M	1,000 – **(8,000,000)	**(8,000,000)

Please use the above tables for reference purposes only when selecting columns.

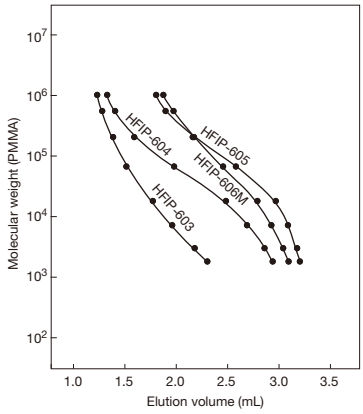
*PMMA: Polymethylmethacrylate
**( ) Estimated value

Calibration curves for HFIP-800 series using PMMA



Column : **Shodex GPC HFIP-800 series**
Eluent : HFIP
Flow rate : 1.0 mL/min
Detector : RI
Column temp. : 40 ˚C

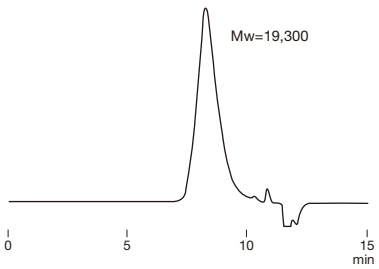
Calibration curves for HFIP-600 series using PMMA



Column : **Shodex GPC HFIP-600 series**
Eluent : HFIP
Flow rate : 0.3 mL/min (HFIP-603, 604)
0.5 mL/min (HFIP-605, 606M)
Detector : RI (small cell volume)
Column temp. : 40 ˚C

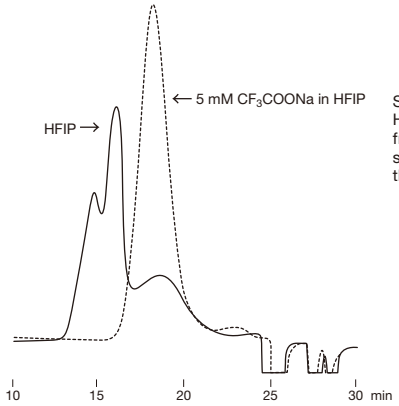
Polyethylene terephthalate (PET)

Sample : Polyethylene terephthalate 0.2 %, 20 µL



Column : **Shodex GPC HFIP-606M x 2**
Eluent : 5 mM CF_3COONa in HFIP
Flow rate : 0.6 mL/min
Detector : RI (small cell volume)
Column temp. : 40 ˚C

Polyamide (added salt)



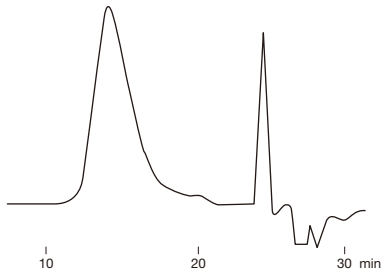
Sample : Polycaprolactum (Nylon 6)

Some samples analyzed under SEC mode with HFIP solvent may show abnormal peaks resulting from the ionic interaction. This interaction can be suppressed by adding sodium trifluoroacetate to the HFIP eluent.

Column : **Shodex GPC HFIP-806M x 2**
Eluent : HFIP (solid line), 5 mM CF_3COONa in HFIP (broken line)
Flow rate : 1.0 mL/min
Detector : RI
Column temp. : 40 ˚C

Polybutylene terephthalate (PBT)

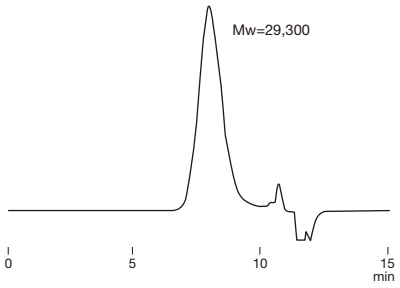
Sample : Polybutylene terephthalate 0.05 %, 500 µL



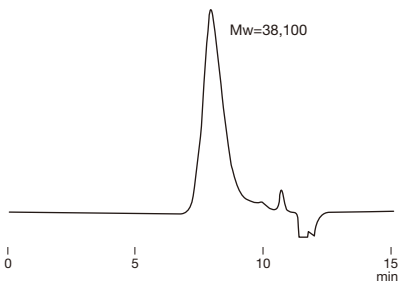
Column : **Shodex GPC HFIP-805 + HFIP-803**
Eluent : 5 mM CF_3COONa in HFIP
Flow rate : 1.0 mL/min
Detector : RI
Column temp. : 40 ˚C

Polyamides (Nylon 6/10 and Nylon 6)

Sample : Nylon 6/10 0.2 %, 20 µL



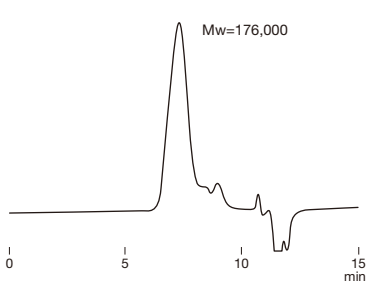
Sample : Nylon 6 0.2 %, 20 µL



Column : **Shodex GPC HFIP-606M x 2**
Eluent : 5 mM CF_3COONa in HFIP
Flow rate : 0.6 mL/min
Detector : RI (small cell volume)
Column temp. : 40 ˚C

Polyacetal

Sample : Polyacetal 0.2 %, 20 µL



Column : **Shodex GPC HFIP-606M x 2**
Eluent : 5 mM CF_3COONa in HFIP
Flow rate : 0.6 mL/min
Detector : RI (small cell volume)
Column temp. : 40 ˚C

Organic SEC (GPC) Column: Rapid Preparation

Features

New
FP-2002

- Newly developed styrene divinylbenzene copolymer monodisperse particles
- Can deliver at four times higher flow rate (10 mL/min or more) compared with conventional products
- Achieves rapid recycling separation
- Suitable for the separation of samples in a wide molecular weight range due to its wide linear range and large pore volume
- Usable with various organic solvents used in GPC analysis in addition to chloroform

Preparative columns [Preparative columns are made to order.]

Shipping Solvent: Chloroform

Product Code	Product Name	Plate Number (TP/column)	Particle Size (μm)	Column Size (mm) I.D. x Length
F6102520	New **GPC FP-2002**	≥ 30,000	8	**20.0 × 600**
F6700340	New **GPC FP-G 8B**	(guard column)	8	**8.0 × 50**

Base Material: Styrene divinylbenzene copolymer

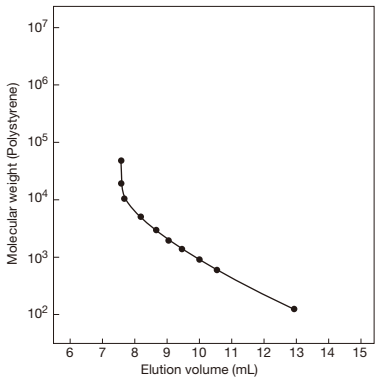
Target molecular weight range and exclusion limit

Measured with polystyrene (eluent: Chloroform)

Product Name	Target Molecular Weight Range	Exclusion Limit
FP-2002	100 – 5,000	8,000

Please use the above tables for reference purposes only when selecting columns.

Calibration curve for FP-2002 using polystyrene

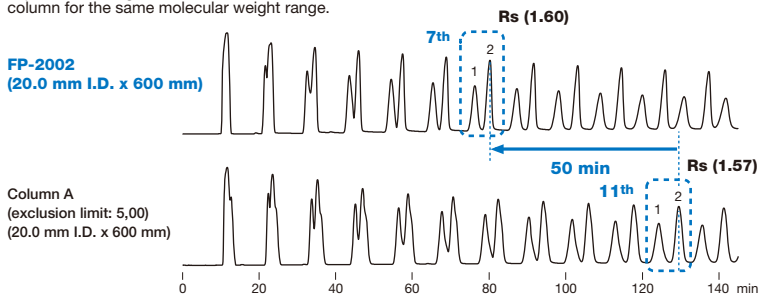


Column : **Shodex GPC FP-2002**
Eluent : Chloroform
Flow rate : 10 mL/min
Detector : UV (254 nm) (preparative type)
Column temp. : 30 ℃

Comparison of recycling separation

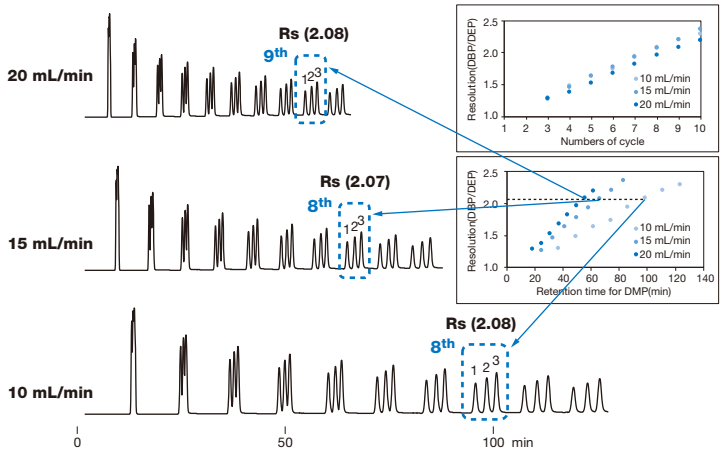
GPC FP-2002 is a column suitable for rapid organic solvent SEC(GPC) separation. Phthalate esters were used to compare recycled separations with other manufacturer's rapid preparative column (exclusion limit: 5,000). The recycling separation using FP-2002 can be made faster than other column for the same molecular weight range.

Sample : 10 % each, 2 mL
1. Ditridecyl Phthalate (MW: 530)
2. Bis(*trans*-3,3,5-trimethylcyclohexyl) phthalate (MW: 414)



Column : **Shodex GPC FP-2002**
Column A from other manufacturer
Eluent : Chloroform
Flow rate : 10 mL/min
Detector : UV (254 nm) (preparative type)
Column temp. : 30 ℃

Effects of flow rate for recycling separation



The standard flow rate of the packed column GPC FP-2002 for organic solvent-based SEC (GPC) is 10 mL/min. We have investigated the flow rate dependency of phthalate esters recycling separation. Even at the maximum usable flow rate of 20 mL/min, there is no extreme drop in column efficiency and further speeding up is possible.

(Note) In the case of a polymer sample, shear degradation of the polymer tends to occur as the molecular weight increases. It is recommended to lower the flow rate, if there is a possibility that shear degradation occurred.

Sample : 3 % each, 1 mL
1. Dibutyl phthalate (DBP) (MW: 278)
2. Diethyl phthalate (DEP) (MW: 222)
3. Dimethyl phthalate (DMP) (MW: 194)

Column : **Shodex GPC FP-2002**
Eluent : Chloroform
Detector : UV (254 nm) (preparative type)
Column temp. : 30 ℃

Organic SEC (GPC) Columns: [Customized columns]

●Preparative columns [Preparative columns are made to order.]

[H-2000 series] Shipping Solvent: Chloroform

Product Code	Product Name	Plate Number (TP/column)	Particle Size (μm)	Column Size (mm) I.D. x Length	Standard Column
F6102001	**GPC H-2001**	≥ 13,000	15	**20.0 x 500**	K-801
F6102002	**GPC H-2002**	≥ 13,000	15	**20.0 x 500**	K-802
F6102025	**GPC H-2002.5**	≥ 13,000	15	**20.0 x 500**	K-802.5
F6102003	**GPC H-2003**	≥ 13,000	15	**20.0 x 500**	K-803
F6102004	**GPC H-2004**	≥ 13,000	15	**20.0 x 500**	K-804
F6102005	**GPC H-2005**	≥ 13,000	15	**20.0 x 500**	K-805
F6102006	**GPC H-2006**	≥ 13,000	15	**20.0 x 500**	K-806
F6102009	**GPC H-2006M**	≥ 12,000	15	**20.0 x 500**	K-806M
F6700310	**GPC H-G 8B**	(guard column)	15	**8.0 x 50**	(guard column)

See page 52 for details of GPC K-800 series.

Base Material: Styrene divinylbenzene copolymer

[KF-5000 series] Shipping Solvent: Tetrahydrofuran (THF)

Product Code	Product Name	Particle Size (μm)	Column Size (mm) I.D. x Length	Standard Column
F6108010	**GPC KF-5001**	15	**50.0 x 300**	KF-801
F6108020	**GPC KF-5002**	15	**50.0 x 300**	KF-802
F6108025	**GPC KF-5002.5**	15	**50.0 x 300**	KF-802.5
F6108030	**GPC KF-5003**	15	**50.0 x 300**	KF-803
F6108040	**GPC KF-5004**	15	**50.0 x 300**	KF-804
F6700408	**GPC KF-G 20C**	15	**20.0 x 100**	(guard column)

See page 50 for details of GPC KF-800 series.

Base Material: Styrene divinylbenzene copolymer

[K-5000 series] Shipping Solvent: Chloroform

Product Code	Product Name	Particle Size (μm)	Column Size (mm) I.D. x Length	Standard Column
F6109010	**GPC K-5001**	15	**50.0 x 300**	K-801
F6109020	**GPC K-5002**	15	**50.0 x 300**	K-802
F6109025	**GPC K-5002.5**	15	**50.0 x 300**	K-802.5
F6109030	**GPC K-5003**	15	**50.0 x 300**	K-803
F6109040	**GPC K-5004**	15	**50.0 x 300**	K-804
F6700409	**GPC K-G 20C**	15	**20.0 x 100**	(guard column)

See page 52 for details of GPC K-800 series.

Base Material: Styrene divinylbenzene copolymer

Solvent Replacement Applicability of SEC (GPC) Columns

Solvent	Product Name									
	Shipping Solvent: THF							Shipping Solvent: DMF		
	KF-801	KF-802 KF-802.5 KF-803L KF-804L	KF-803	KF-804 KF-805 KF-806 KF-807 KF-806M KF-805L KF-806L KF-807L	KF-601 KF-602 KF-602.5	KF-603 KF-604 KF-605 KF-606 KF-606M	LF-804 LF-604 LF-404	KD-801 KD-802 KD-802.5	KD-803	KD-804 KD-805 KD-806 KD-807 KD-806M
	Shipping Solvent: Chloroform				Shipping Solvent: THF					
	K-801	K-802 K-802.5 K-803L K-804L	K-803	K-804 K-805 K-806 K-806M K-805L K-806L K-807L	KF-401HQ KF-402HQ KF-402.5HQ	KF-403HQ KF-404HQ KF-405LHQ KF-406LHQ				
Tetrahydrofuran (THF)	○	○	○	○	○	○	○	×	×	○
Chloroform	○	○	○	○	○	○	○	×	×	○
Carbon tetrachloride	×	○	○	○			○	×	×	○
Benzene	○	○	○	○	○	○		×	○	○
Toluene	○	○	○	○	○	○	○	×	○	○
p-Xylene	×	○	○	○	○	○		×	○	○
o-Dichlorobenzene (ODCB)	×	×	○	○	○	○		×	○	○
Trichlorobenzene (TCB)	×	×	○	○	○	○		×	○	○
Dioxane	×	○	○	○				×	○	○
Diethyl ether	×	×	○	○				×	○	○
Ethyl acetate	×	×	○	○				×	×	○
Acetone	×	×	○	○	○	○		×	○	○
Methyl ethyl ketone	×	×	○	○	○	○	○	×	○	○
Dimethylformamide (DMF)	×	×	○	○	○*	○*	○*	○	○	○
Dimethylacetamide (DMAc)	×	×	○	○	○*	○*	○*	×	○	○
Hexafluoroisopropanol (HFIP)	×	×	×	○	×	△*	○*	×	○	○
m-Cresol	×	×	○	○				×	○	○
o-Chlorophenol	×	×	○	○				×	○	○
Quinoline	×	×	○	○				×	○	○
N-Methylpyrrolidone (NMP)	×	×	○	○	○*	○*	○*	×	○	○
Dimethylsulfoxide (DMSO)	×	×	×	△	△*	○*	○*	×	○	○
30 % m-Cresol/Chloroform	×	○	○	○			○	×	○	○
30 % o-Chlorophenol/Chloroform	×	○	○	○			○	×	○	○
30 % HFIP/Chloroform	×	○	○	○				×	○	○
Hexane	×	×	×	×	×	×	×	×	×	×
Acetonitrile	×	×	×	×	×	×	×	×	×	×
Methanol	×	×	×	×	×	×	×	×	×	×
Water	×	×	×	×	×	×	×	×	×	×

○: Solvent replacement possible
△: Solvent replacement possible, but this may cause column performance to deteriorate slightly
*: Usable at 40 °C or higher
×: Solvent replacement not possible

Calibration Standards for SEC

[Polystyrene (PS)]

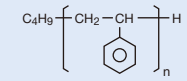
Features

- For organic solvent SEC (GPC)
- Less branched polystyrene with anionic polymerization
- Easily soluble in tetrahydrofuran (THF), chloroform, toluene, and o-dichlorobenzene (ODCB)

Standard kit

Product Code	Product Name	Contents	Molecular weights (Mp) Range
F8601105	**STANDARD SL-105**	0.5 g x 10 kinds	580 – 19,900
F8602105	**STANDARD SM-105**	0.5 g x 10 kinds	1,150 – 2,380,000
F8603075	**STANDARD SH-75**	0.5 g x 7 kinds	508,000 – 6,870,000

Structural formula of S series



SL-105

Std. No.	Mp	Mw/Mn
S-18	18,000	1.02
S-13	13,000	1.02
S-9.8	9,820	1.02
S-6.7	6,660	1.03
S-4.9	4,910	1.03
S-2.8	2,790	1.04
S-1.9	1,890	1.05
S-1.3	1,300	1.06
S-1.1	1140	1.06
S-0.6	580	1.18

SM-105

Std. No.	Mp	Mw/Mn
S-2630	2,630,000	1.05
S-1700	1,700,000	1.03
S-602	602,000	1.02
S-277	277,000	1.04
S-136	136,000	1.04
S-46	46,400	1.02
S-18	18,000	1.02
S-6.7	6,660	1.03
S-2.8	2,790	1.04
S-1.3	1,300	1.06

SH-75

Std. No.	Mp	Mw/Mn
S-6870	6,870,000	1.09
S-5190	5,190,000	1.03
S-3750	3,750,000	1.05
S-2350	2,350,000	1.04
S-2000	2,000,000	1.03
S-991	991,000	1.05
S-508	508,000	1.05

(Note)
Molecular weights (Mp, Mw/Mn) of each standard kit may vary depending on production lots.

[Polymethylmethacrylate (PMMA)]

Features

- For organic solvent SEC (GPC)
- Narrow molecular weight distribution range
- Easily soluble in hexafluoroisopropanol (HFIP) and dimethylformamide (DMF)

Standard kit

Product Code	Product Name	Contents	Molecular weights (Mp) Range
F8604075	**STANDARD M-75**	0.5 g x 7 kinds	2,870 – 965,000

(Note)
Molecular weights (Mp, Mw/Mn) of a standard kit may vary depending on production lots.

Std. No.	Mp	Mw/Mn
M-965	965,000	1.07
M-505	505,000	1.02
M-224	224,000	1.02
M-67	66,700	1.03
M-20	20,100	1.03
M-6.1	6,140	1.11
M-2.9	2,870	1.06

[Pullulan]

Features

- For aqueous SEC (GFC)
- Unbranched pullulan standard
- High solubility in water eliminates the possibility of recrystallization

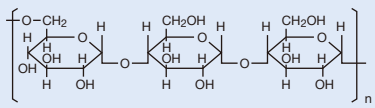
Standard kit

Product Code	Product Name	Contents	Molecular weights (Mp) Range
F8400000	**STANDARD P-82**	0.2 g x 8 kinds	6,300 – 642,000

Single type

Product Code	Product Name	Contents	Mp	Mw/Mn
F8400800	**STD P-800**	0.5 g	642,000	1.23
F8400400	**STD P-400**	0.5 g	334,000	1.30
F8400200	**STD P-200**	0.5 g	201,000	1.31
F8400100	**STD P-100**	0.5 g	106,000	1.11
F8400050	**STD P-50**	0.5 g	49,400	1.09
F8400020	**STD P-20**	0.5 g	22,000	1.08
F8400010	**STD P-10**	0.5 g	9,800	1.07
F8400005	**STD P-5**	0.5 g	6,300	1.09

Structural formula of P series



Std. No.	Mp	Mw/Mn
STD P-800	642,000	1.23
STD P-400	334,000	1.30
STD P-200	201,000	1.31
STD P-100	106,000	1.11
STD P-50	49,400	1.09
STD P-20	22,000	1.08
STD P-10	9,800	1.07
STD P-5	6,300	1.09

(Note)
Molecular weights (Mp, Mw/Mn) of a standard kit or each single type may vary depending on production lots.

Anion Exchange Chromatography Columns

Features

QA-825 **DEAE-825**	• Suitable for analyzing relatively high molecular weight compounds: proteins, peptides, DNA, and RNA • Usable in a wide pH range from pH 2 to 12 • QA-825 fulfills USP L23 requirements
ES-502N 7C	• Compared to IEC series columns, polyvinyl alcohol is used as base material and this offers different separation pattern • Low hydrophobic interaction of proteins allows analysis under mild conditions
WA-624	• Suitable for anion exchange analysis of low molecular weight compounds such as nucleotides

●Standard columns

[Strong anion exchange resin] Functional Group: Quaternary ammonium

Product Code	Product Name	Ion Exchange Capacity (meq/g)	Base Material	Particle Size (μm)	Pore Size (Å)	Column Size (mm) I.D. x Length	Shipping Solvent
F6110011	**IEC QA-825**	0.45	Polyhydroxymethacrylate	12	5,000	**8.0 x 75**	50 mM Na_2SO_4 aq.

[Weak anion exchange resin] Functional Group: Diethylaminoethyl

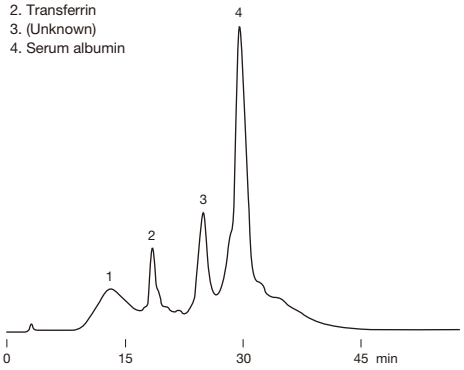
Product Code	Product Name	Ion Exchange Capacity (meq/g)	Base Material	Particle Size (μm)	Pore Size (Å)	Column Size (mm) I.D. x Length	Shipping Solvent
F6118255	**IEC DEAE-825**	0.6	Polyhydroxymethacrylate	8	5,000	**8.0 x 75**	50 mM Na_2SO_4 aq.
F7640002	**Asahipak ES-502N 7C**	0.55	Polyvinyl alcohol	9	2,000	**7.5 x 100**	50 mM 1,3-Diaminopropane + 50 mM NaCl (pH10.0)
F6356240	**AXpak WA-624**	1.2	Polyhydroxymethacrylate	10	2,000	**6.0 x 150**	0.1 M Sodium phosphate buffer (pH3.0)/CH_3CN =80/20
F6700245	**AXpak WA-G** (guard column)	–	Polyhydroxymethacrylate	10	–	**4.6 x 10**	0.1 M Sodium phosphate buffer (pH3.0)/CH_3CN =80/20

●Preparative columns [Preparative columns are made to order.]

Product Code	Product Name	Particle Size (μm)	Column Size (mm) I.D. x Length	Standard column
F6548000	**IEC QA-2025**	20	**20.0 x 150**	QA-825
F6709602	**IEC QA-G 8B**	20	**8.0 x 50**	(guard column)
F6548001	**IEC DEAE-2025**	20	**20.0 x 150**	DEAE-825
F6709603	**IEC DEAE-G 8B**	20	**8.0 x 50**	(guard column)
F6840004	**Asahipak ES-502N 20C**	13	**20.0 x 100**	ES-502N 7C
F6710021	**Asahipak GS-20G 7B**	20	**7.5 x 50**	(guard column)

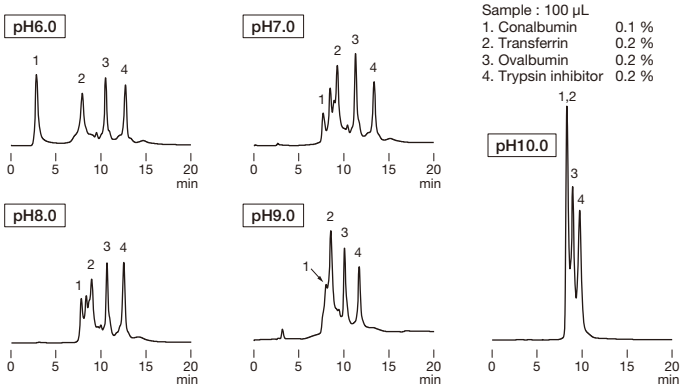
Proteins in human serum

Sample : Human serum 0.5 %, 200 µL
1. IgG
2. Transferrin
3. (Unknown)
4. Serum albumin



Column : **Shodex IEC QA-825**
Eluent : (A); 20 mM Tris-HCl buffer (pH8.6)
(B); (A) + 0.5 M NaCl
Linear gradient; 100 % (A) to 50 % (B), 60 min
Flow rate : 1.0 mL/min
Detector : UV (280 nm)
Column temp. : Room temp.

Effects of eluent pH on DEAE-825 analysis

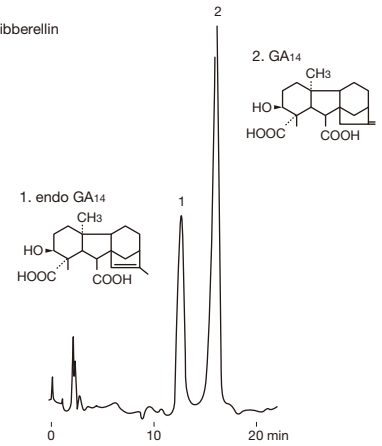


Sample : 100 µL
1. Conalbumin 0.1 %
2. Transferrin 0.2 %
3. Ovalbumin 0.2 %
4. Trypsin inhibitor 0.2 %

Column : **Shodex IEC DEAE-825**
Eluent : (A); 20 mM Piperazine-HCl buffer (pH6.0), 20 mM Bis-Tris-HCl buffer (pH7.0)
20 mM Tris-HCl buffer (pH8.0), 20 mM Ethanolamine-HCl buffer (pH9.0)
20 mM 1,3-Diaminopropane-HCl buffer (pH10.0)
(B); (A) + 0.5 M NaCl
Linear gradient; (A) to (B), 20 min
Flow rate : 1.0 mL/min
Detector : UV (280 nm)
Column temp. : 25 ℃

Gibberellin isomers

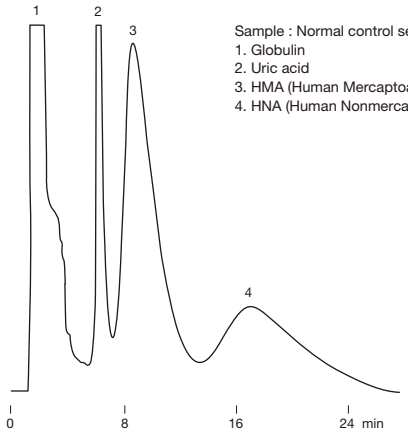
Sample : Gibberellin



Column : **Shodex Asahipak ES-502N 7C**
Eluent : $CH_3COOH/H_2O/CH_3OH$=0.1/0.4/99.5
Flow rate : 1.5 mL/min
Detector : UV (210 nm)
Column temp. : 50 ℃

Data provided by Prof. Yamaguch, Faculty of Agliculture, University of Tokyo.

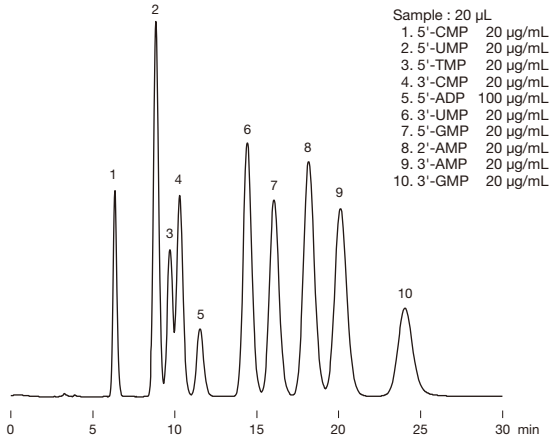
Mercaptoalbumin and non-mercaptoalbumin



Sample : Normal control serum
1. Globulin
2. Uric acid
3. HMA (Human Mercaptoalbumin)
4. HNA (Human Nonmercaptoalbumin)

Column : **Shodex Asahipak ES-502N 7C**
Eluent : 50 mM N-methylpiperazine-HCl buffer (pH4.8)
+ 400 mM Na_2SO_4 + 0.3 % C_2H_5OH
Flow rate : 1.0 mL/min
Detector : UV (280 nm)
Column temp. : 35 ℃

Nucleotides

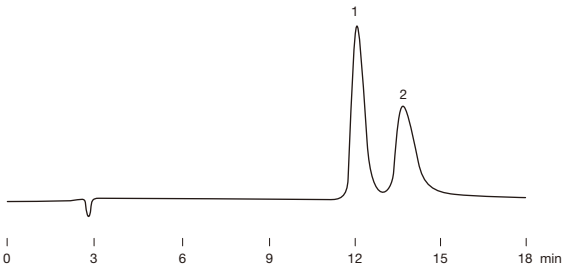


Sample : 20 µL
1. 5'-CMP 20 µg/mL
2. 5'-UMP 20 µg/mL
3. 5'-TMP 20 µg/mL
4. 3'-CMP 20 µg/mL
5. 5'-ADP 100 µg/mL
6. 3'-UMP 20 µg/mL
7. 5'-GMP 20 µg/mL
8. 2'-AMP 20 µg/mL
9. 3'-AMP 20 µg/mL
10. 3'-GMP 20 µg/mL

Column : **Shodex AXpak WA-624**
Eluent : 0.35 M CH_3COOH aq./0.35 M CH_3COONH_4 aq. = 240/100
Flow rate : 1.0 mL/min
Detector : UV (260 nm)
Column temp. : 60 ℃

Sulfide ion and cyanide ion

Sample : 20 µL
1. HS^- 0.1 mg/L
2. CN^- 0.02 mg/L



Column : **Shodex IEC DEAE-825**
Eluent : 10 mM Na_2CO_3 + 1 mM Ethylenediamine aq. + 10 % CH_3OH
Flow rate : 1.0 mL/min
Detector : Electrochemical
(Electrode; Silver, 0 mV SCE)
Column temp. : 25 ℃

Cation Exchange Chromatography Columns

Features

SP-825 **CM-825**	• Suitable for analyzing relatively high molecular weight compounds: proteins, peptides, DNA, and RNA • Usable in a wide pH range from pH 2 to 12
SP-FT 4A	• Non-porous base material • Provides ultra-rapid analysis using conventional devices
ES-502C 7C	• Compared to IEC series columns, polyvinyl alcohol is used as base material offering different separation pattern • Low hydrophobic interaction with proteins allows analysis under mild conditions
P-421S	• Column for amino acids analysis by cation exchange mode • Provides simultaneous analysis of different amino acids • Fulfills USP L22 and L58 requirements

●Standard columns

[Strong cation exchange resin] Functional Group: Sulfopropyl

Product Code	Product Name	Ion Exchange Capacity (meq/g)	Base Material	Particle Size (µm)	Pore Size (Å)	Column Size (mm) I.D. x Length	Shipping Solvent
F6118250	**IEC SP-825**	0.4	Polyhydroxymethacrylate	8	5,000	**8.0 x 75**	50 mM Na_2SO_4 aq.
F6113100	**IEC SP-FT 4A**	0.2	Polyhydroxymethacrylate	2.7	–	**4.6 x 10**	20 mM *MES buffer (pH5.6)

Housing Material of SP-FT 4A: PEEK
*MES: 2-(N-Morpholino)ethanesulfonic acid

[Weak cation exchange resin] Functional Group: Carboxymethyl

Product Code	Product Name	Ion Exchange Capacity (meq/g)	Base Material	Particle Size (µm)	Pore Size (Å)	Column Size (mm) I.D. x Length	Shipping Solvent
F6110002	**IEC CM-825**	0.4	Polyhydroxymethacrylate	8	5,000	**8.0 x 75**	50 mM Na_2SO_4 aq.
F7640001	**Asahipak ES-502C 7C**	0.55	Polyvinyl alcohol	9	2,000	**7.5 x 100**	0.1 M Sodium phosphate buffer (pH4.4)

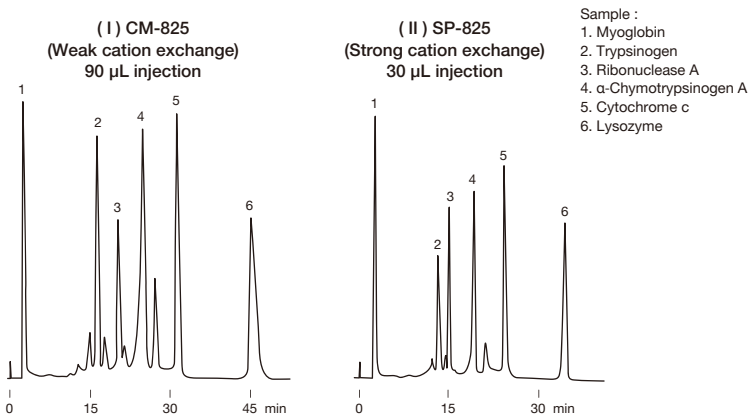
[For amino acid analysis] Functional Group: Sulfo (Na^+)

Product Code	Product Name	Plate Number (TP/column)	Base Material	Particle Size (µm)	Column Size (mm) I.D. x Length	Shipping Solvent
F6354211	**CXpak P-421S**	≥ 3,500	Styrene divinylbenzene copolymer	6	**4.6 x 150**	H_2O
F6700210	**CXpak P-G**	(guard column)	Styrene divinylbenzene copolymer	6	**4.6 x 10**	H_2O

●Preparative columns [Preparative columns are made to order.]

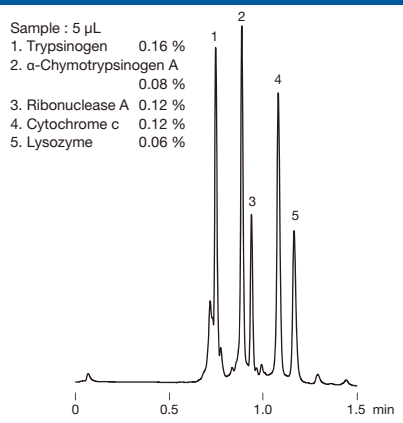
Product Code	Product Name	Particle Size (µm)	Column Size (mm) I.D. x Length	Standard column
F6548002	**IEC SP-2025**	20	**20.0 x 150**	SP-825
F6709604	**IEC SP-G 8B**	20	**8.0 x 50**	(guard column)
F6548003	**IEC CM-2025**	20	**20.0 x 150**	CM-825
F6709605	**IEC CM-G 8B**	20	**8.0 x 50**	(guard column)
F6840003	**Asahipak ES-502C 20C**	13	**20.0 x 100**	ES-502C 7C
F6710021	**Asahipak GS-20G 7B**	20	**7.5 x 50**	(guard column)

Protein separation using cation exchange columns



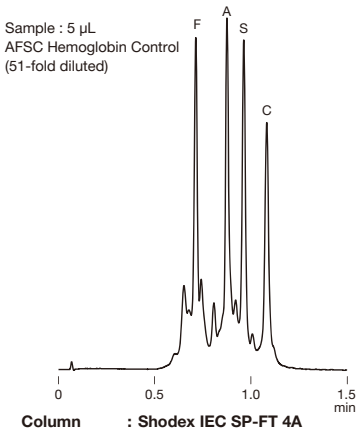
Column : **(I) Shodex IEC CM-825, (II) Shodex IEC SP-825**
Eluent : (A); 20 mM Sodium phosphate buffer (pH7.0)
(B); (A) + 0.5 M NaCl
Linear gradient; (A) to (B), 60 min
Flow rate : 1.0 mL/min
Detector : UV (280 nm)
Column temp. : Room temp.

Ultra-rapid analysis of protein standards



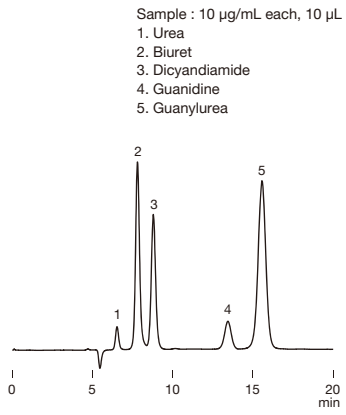
Column : **Shodex IEC SP-FT 4A**
Eluent : (A); 20 mM MES buffer (pH5.6)
(B); (A) + 0.5 M Na_2SO_4
Linear gradient; (A) to (B), 2 min
Flow rate : 1.7 mL/min
Detector : UV (280 nm)
Column temp. : 30 ℃

Ultra-rapid analysis of hemoglobins



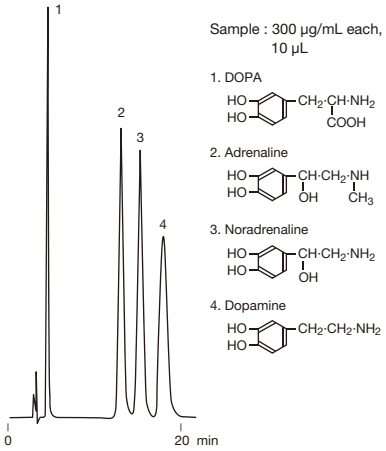
Column : **Shodex IEC SP-FT 4A**
Eluent : (A); 20 mM MES buffer (pH5.6)
(B); (A) + 0.5 M Na_2SO_4
Linear gradient;
5 % (B) to 100 % (B), 2 min
Flow rate : 1.7 mL/min
Detector : VIS (415 nm)
Column temp. : 30 ℃

Analysis of nitrogen compounds following the testing methods for fertilizers



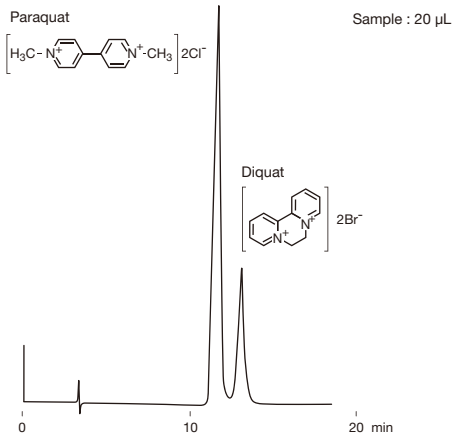
Column : **Shodex Asahipak ES-502C 7C**
Eluent : 3.92 g KH_2PO_4 + 0.12 g H_3PO_4
in 1000 mL of H_2O
Flow rate : 0.6 mL/min
Detector : UV (190 nm)
Column temp. : 40 ℃

Catecholamines



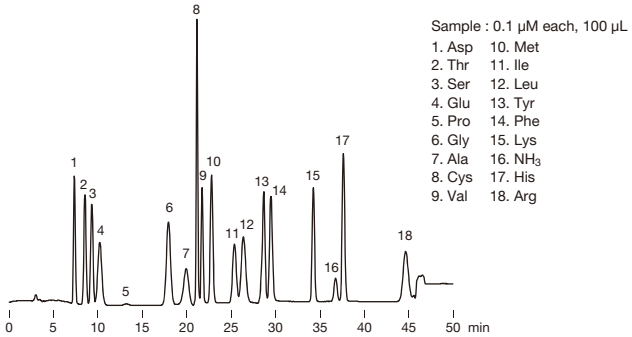
Column : **Shodex Asahipak ES-502C 7C**
Eluent : 20 mM Sodium malonate buffer (pH6.0)
+ 0.5 M NaCl
Flow rate : 1.0 mL/min
Detector : UV (280 nm)
Column temp. : 30 ℃

Paraquat and diquat



Column : **Shodex Asahipak ES-502C 7C**
Eluent : 50 mM Sodium phosphate buffer (pH7.0)
+ 150 mM NaCl
Flow rate : 1.0 mL/min
Detector : UV (288 nm)
Column temp. : 30 ℃

Standard amino acids



Column : **Shodex CXpak P-421S**
Eluent : MCI Buffer L-8500-PH Kit (Mitsubishi Chemical Corporation)
Low pressure gradient:
0 min; PH-1, 0.2 min; PH-2, 12.5 min; PH-3, 22.7 min; PH-4
40.0 - 53.0 min; PH-RG
Reagent : Ninhydrin Coloring Solution Kit for HITACHI
(Wako Pure Chemical Industries, Ltd.)
0 - 52 min; R1:R2=50:50
Flow rate : (Eluent) 0.5 mL/min
(Reagent) 0.35 mL/min
Detector : VIS (570 nm)
Column Temp. : 63 ℃
Reaction Temp. : 120 ℃

Special Separation Modes Columns

Hydrophobic Interaction Chromatography Column

Features

PH-814
- Separates proteins without denaturation
- Applicable to samples obtained after ammonium sulfate fraction treatment

Standard column

Product Code	Product Name	Functional Group	Particle Size (µm)	Pore Size (Å)	Column Size (mm) I.D. x Length	Shipping Solvent
F6110003	**HIC PH-814**	Phenyl	10	2,000	**8.0 × 75**	H_2O

Base Material: Polyhydroxymethacrylate

Affinity Chromatography Columns

Features

AFpak
- Rigid polymer-based packing materials enable high speed analysis
- Functional group modified with chemically stable ligand (spacer)
- Minimum detachment of functional groups ensures highly reproducible analysis

Standard columns

Product Code	Product Name	Ligand	Ligand Load/Gel (g)	Particle Size (µm)	Column Size (mm) I.D. x Length	Shipping Solvent
F7118946	**AFpak APA-894**	Protein A	4 mg	18	**8.0 × 50**	0.1 M Sodium phosphate buffer + 0.5 M NaCl + 0.02 % NaN_3 (pH7.0)
F7118964	**AFpak ACH-494**	Choline oxydase, Acetylcholine esterase	–	18	**4.6 × 10**	10 mM Sodium Phosphate buffer + 1.0 M NaCl (pH7.4)

Base Material: Polyhydroxymethacrylate

Chiral Separation Columns

Features

CDBS-453
- Separates optical isomers by using their conformational compatibility differences
- Versatile column for chiral separation
- Fulfills USP L45 requirements

CRX-853
- Separates optical isomers by using their differences in metal complex formation capacities
- Suitable for amino acids, hydroxyl acids, and their derivatives

Standard columns

Product Code	Product Name	Functional Group	Base Material	Particle Size (µm)	Column Size (mm) I.D. x Length	Shipping Solvent
F7146003	**ORpak CDBS-453**	β -Cyclodextrin derivative	Silica	3	**4.6 × 150**	1.0 % CH_3COOH + 0.2 M NaCl aq. /CH_3CN=70/30
F7140040	**ORpak CRX-853**	L-Amino acid derivative	Polyhydroxymethacrylate	6	**8.0 × 50**	0.25 mM $CuSO_4$ aq.
F6709300	**ORpak CRX-G**	(guard column)	Polyhydroxymethacrylate	6	**4.6 × 10**	0.25 mM $CuSO_4$ aq.

High Temperature Reversed Phase Chromatography Column

Features

ET-RP1
- Capable of high temperature analysis up to 150 °C
- High temperature analysis improves column efficiency and enables rapid analysis
- Fulfills USP L67 requirements

Standard column

Product Code	Product Name	Plate Number (TP/column)	Functional Group	Particle Size (µm)	Pore Size (Å)	Column Size (mm) I.D. x Length	Shipping Solvent
F7623001	**ET-RP1 4D**	≥ 11,000	Octadecyl	4	250	**4.6 × 150**	H_2O/CH_3CN=35/65

Base Material: Polyvinyl alcohol

Pretreatment Column for Column Switching Method

Feature

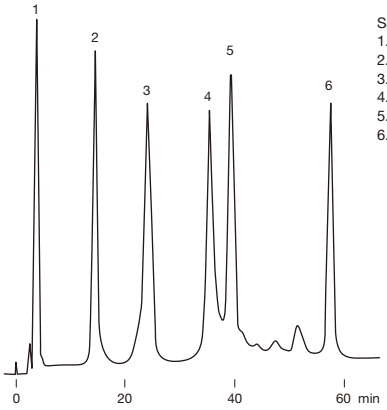
GF-4A
- High protein removal rate
- Removes surfactants well but is not suitable for trapping hydrophilic substances

Column for column switching method

Product Code	Product Name	Particle Size (µm)	Pore Size (Å)	Column Size (mm) I.D. x Length	Shipping Solvent
F8700015	**MSpak GF-4A**	9	400	**4.6 × 10**	H_2O

Base Material: Polyvinyl alcohol

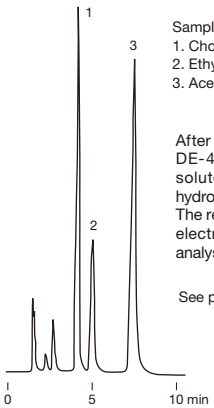
Protein separation by hydrophobic interaction chromatography



Sample : 370 µL
1. Cytochrome c 0.03 %
2. Myoglobin 0.08 %
3. Ribonuclease A 0.16 %
4. Ovalbumin 0.16 %
5. Lysozyme 0.04 %
6. α-Chymotrypsinogen 0.05 %

Column : Shodex HIC PH-814
Eluent : (A); 1.8 M Ammonium sulfate + (B) (B); 0.1 M Phosphate buffer (pH7.0) Linear gradient; (A) to (B), 60 min
Flow rate : 1.0 mL/min
Detector : UV (280 nm)
Column temp. : Room temp.

Choline and acetylcholine



Sample : 10 µL
1. Choline 5 mg/L
2. Ethylhomocholine 10 mg/L
3. Acetylcholine 10 mg/L

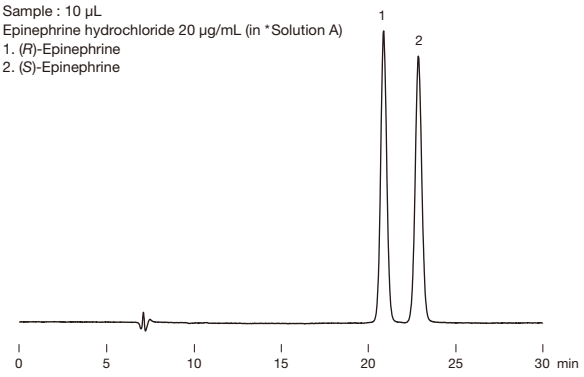
After choline and acetylcholine are separated using DE-413 polymer-based reversed phase column, solutes are passed through ACH-494 to generate hydrogen peroxide.
The resulting hydrogen peroxide is detected using an electrochemical detector to enable highly sensitive analysis.

See page 12 for DE-413

Column : Shodex RSpak DE-413
Post column : Shodex AFpak ACH-494
Eluent : 0.1 M H_3PO_4 + 300 mg/L Sodium 1-decansulfonate + 65 mg/L Tetramethylammonium chloride (pH8.0 adjusted by 1.0 M NaOH)
Flow rate : 1.0 mL/min
Detector : Electrochemical (Electrode : Pt, 350 mV SCE)
Column temp. : 37 ˚C

Analysis of epinephrine following USP (In-Process Revision)

Sample : 10 µL
Epinephrine hydrochloride 20 µg/mL (in *Solution A)
1. (*R*)-Epinephrine
2. (*S*)-Epinephrine

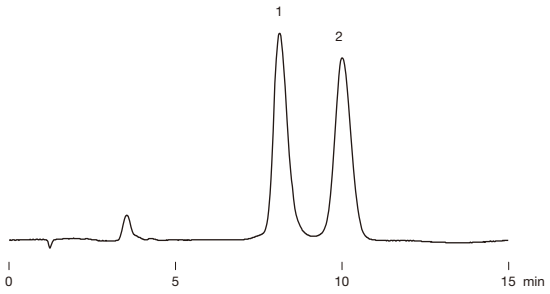


Column : Shodex ORpak CDBS-453
Eluent : *Solution A/CH_3CN=99/1
Flow rate : 0.3 mL/min
Detector : UV (280 nm)
Column temp. : 25 ˚C

*Solution A : 0.75 g/L Ammonium acetate aqueous solution adjusted to pH4.0 with Glacial acetic acid

Chiral separation of lactic acids

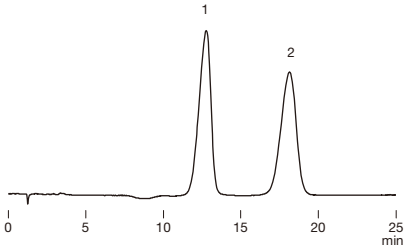
Sample : Lactic acid 50 µg/mL, 50 µL
1. L-Lactic acid
2. D-Lactic acid



Column : Shodex ORpak CRX-853
Eluent : 0.5 mM $CuSO_4$ aq.
Flow rate : 1.0 mL/min
Detector : UV (230 nm)
Column temp. : 50 ˚C

Chiral separation of mandelic acids

Sample : Mandelic acid 100 µg/mL, 20 µL
1. D-Mandelic acid
2. L-Mandelic acid

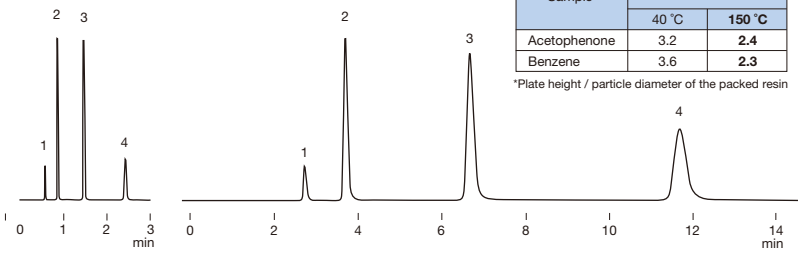


Column : Shodex ORpak CRX-853
Eluent : 0.25 mM $CuSO_4$ aq.
Flow rate : 1.0 mL/min
Detector : UV (230 nm)
Column temp. : 50 ˚C

Comparison of ET-RP1's column efficiencies (theoretical plate height) observed at high and normal temperature conditions

high temp. (150 ˚C) 2.4 mL/min

normal temp. (40 ˚C) 0.5 mL/min



Sample :
1. Uracil
2. Pyridine
3. Acetophenone
4. Benzene

Sample	*Reduced plate height	
	40 ˚C	**150 ˚C**
Acetophenone	3.2	**2.4**
Benzene	3.6	**2.3**

*Plate height / particle diameter of the packed resin

Column : Shodex ET-RP1 4D
Eluent : (Left) H_2O/CH_3CN=50/50 (Right) H_2O/CH_3CN=75/25
Detector : Photodiode array (210 nm)
Column Oven : Polaratherm 9000 Series (SandraSelerity Technologies, Inc)

Note:
The eluent was introduced into the column after being preheated and was cooled after column elution, then introduced into the detector.

Data provided by Research Institute for Chromatography bvba

GPC Clean-up Columns

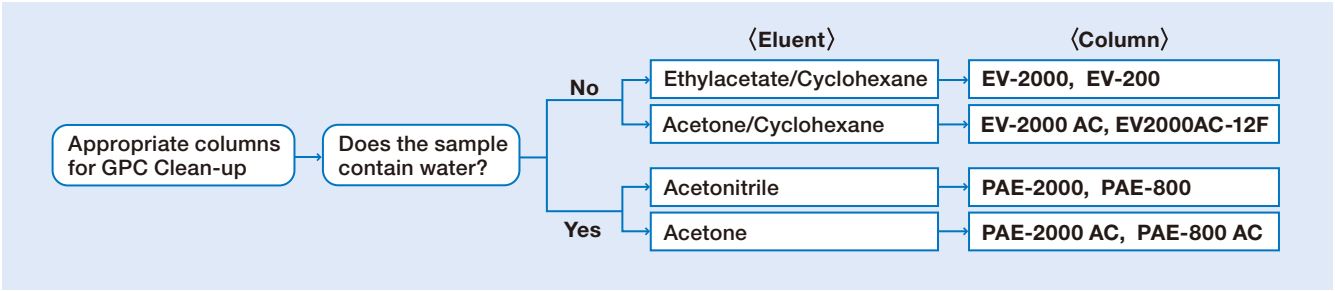
Features

EV

- Suitable for fractionation of residual pesticides in foods
- EV-2000 AC is used in Shoku-An No. 0124001 (January 24th, 2005, Japan) of the Pharmaceutical and Food Safety Bureau, MHLW, Section 2 “Simultaneous GC/MS (LC/MS) Analyses of Agricultural Chemicals in Livestock and Marine Products”.
- EV2000AC-12F is used in Shoku-An No. 0226 (February 26th, 2015, Japan) of the Pharmaceutical and Food Safety Bureau, MHLW, Section 2 “LC/MS Analyses of Agricultural Chemicals in Livestock and Marine Products”.

PAE

- Suitable for cleaning up high-moisture samples such as blood and bottom sediment
- Highly effective for fractionation of endocrine disruptors in environmental samples



GPC Clean-up for residual pesticides in foods, etc.

Product Code	Product Name	Particle Size (μm)	Pore Size (Å)	Column Size (mm) I.D. x Length	Shipping Solvent
F6090006	**CLNpak EV2000AC-12F**	16	30	**12.0 x 300**	Acetone/Cyclohexane=3/7
F6090007	**CLNpak EV-G AC12C**	16	(guard column)	**12.0 x 100**	Acetone/Cyclohexane=3/7
F6090003	**CLNpak EV-2000 AC**	16	30	**20.0 x 300**	Acetone/Cyclohexane=3/7
F6090004	**CLNpak EV-G AC**	16	(guard column)	**20.0 x 100**	Acetone/Cyclohexane=3/7
F6090001	**CLNpak EV-2000**	16	30	**20.0 x 300**	Ethylacetate/Cyclohexane=3/7
F6090002	**CLNpak EV-G**	16	(guard column)	**20.0 x 100**	Ethylacetate/Cyclohexane=3/7
F6090005	**CLNpak EV-200**	16	30	**2.0 x 150**	Ethylacetate/Cyclohexane=3/7

Base Material: Styrene divinylbenzene copolymer

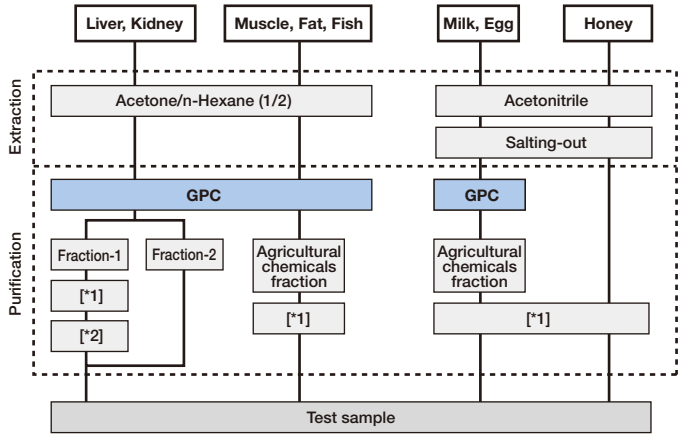
GPC Clean-up for phthalic acid esters in sediments, biological samples, blood, etc.

Product Code	Product Name	Particle Size (μm)	Pore Size (Å)	Column Size (mm) I.D. x Length	Shipping Solvent
F6810022	**CLNpak PAE-2000**	5	400	**20.0 x 300**	Acetonitrile
F6714007	**CLNpak PAE-G**	9	(guard column)	**8.0 x 50**	Acetonitrile
F7600025	**CLNpak PAE-800**	5	400	**8.0 x 300**	Acetonitrile
F6810023	**CLNpak PAE-2000 AC**	5	400	**20.0 x 300**	Acetone
F6714008	**CLNpak PAE-G AC**	9	(guard column)	**8.0 x 50**	Acetone
F7600026	**CLNpak PAE-800 AC**	5	400	**8.0 x 300**	Acetone

Base Material: Polyvinyl alcohol

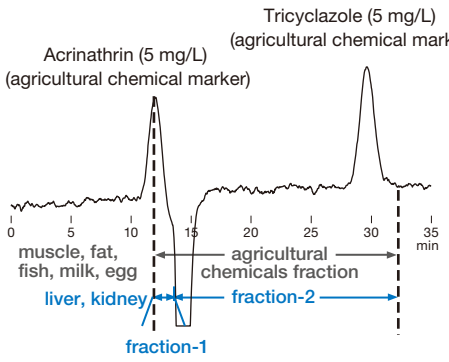
Sample preparation outline for simultaneous GC/MS and LC/MS analysis of agricultural chemicals in livestock and marine products (part 1)

[Outline]



GPC column : Shodex CLNpak EV-2000 AC + EV-G AC
*1 Purification with ethylenediamine-N-propylsilyled silica gel mini-column
*2 Purification with silica gel mini-column

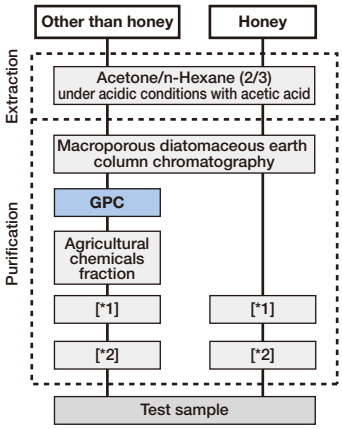
Preparaion range of agricultural chemicals using EV-2000 AC



Column : **Shodex CLNpak EV-G AC + EV-2000 AC**
Eluent : Acetone/Cyclohexane=1/4
Flow rate : 5.0 mL/min
Detector : UV (254 nm) (preparative type)
Column temp. : 40 ℃
Injection vol. : 5 mL

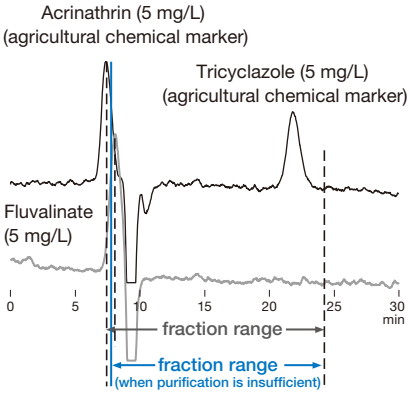
Sample preparation outline for simultaneous LC/MS analysis of agricultural chemicals in livestock and marine products (part 2)

[Outline]



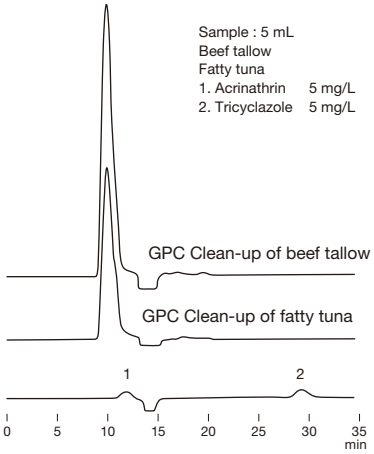
GPC column :
Shodex CLNpak EV2000AC-12F + EV-G AC12C
*1 Purification with trimethyl aminopropylsilyled silica gel mini-column
*2 Purification with ethylenediamine-N-propylsilyled silica gel mini-column

Preparation range of agricultural chemicals using EV2000AC-12F



Column : **Shodex CLNpak EV-G AC12C + EV2000AC-12F**
Eluent : Acetone/Cyclohexane=3/17
Flow rate : 3.0 mL/min
Detector : UV (254 nm) (preparative type)
Column temp. : 45 ℃
Injection vol. : 2 mL

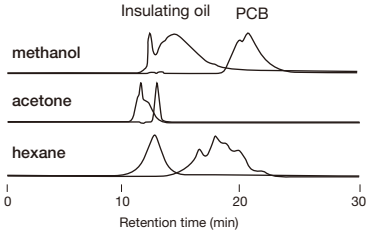
GPC clean-up of fatty tuna and beef tallow



Column : **Shodex CLNpak EV-G AC + EV-2000 AC**
Eluent : Acetone/Cyclohexane=1/4
Flow rate : 5.0 mL/min
Detector : UV (254 nm) (preparative type)
Column temp. : 40 ℃
Injection vol. : 5 mL

Separation of PCB and insulating oil using PAE-800

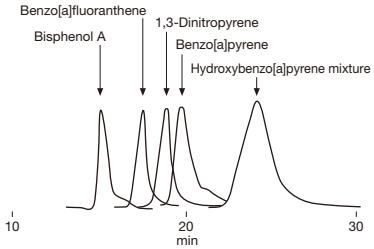
Sample : 30 µL
PCB std. KC-mixture 400 mg/L
Insulating oil 5,000 mg/L
dissolved by Hexane



Column : **Shodex CLNpak PAE-800**
Eluent : Methanol, Acetone, Hexane
Flow rate : 0.8 mL/min
Detector : Photodiode array (209 nm)
Column temp. : 40 ℃

Source:
Mr. Tetsuya Sawatsubashi (Mitsubishi Heavy Industries, Ltd.) et al., Search of Liquid Chromatographic Clean-up Materials for Rapid PCB Analysis and Evaluation of Their Separation Characteristics. Journal of Environmental Chemistry, 2007, Vol. 17, No. 3, p. 471-481.

GPC clean-up of carcinogens in diesel dust measured using PAE-800 AC

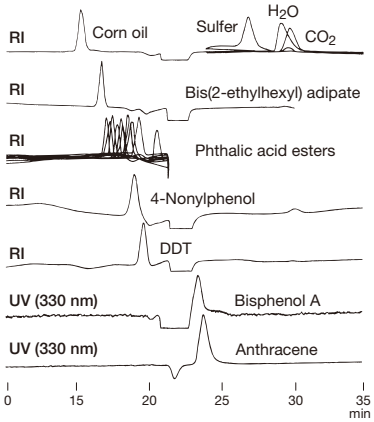


Compound	Rt(min)	Compound	Rt(min)
Anthracene	16.6	Benzo[a]pyrene	19.9
Chrysene	18.0	Hydroxybenzo[a]pyrene compound	23.0
Fluoranthene	17.1		
Benzo[a]fluoranthene	17.7	Bisphenol A	16.1
Benzo[b]fluoranthene	18.6	1,3-Dinitronaphthalene	16.2
Benzo[k]fluoranthene	18.4	1-Nitropyrene	18.6
Pyrene	17.9	1,3-Dinitropyrene	18.6
1-Hydroxypyrene	19.7	1,6-Dinitropyrene	18.9
		1,8-Dinitropyrene	18.7

Column : **Shodex CLNpak PAE-800 AC**
Eluent : Acetone
Flow rate : 0.8 mL/min
Detector : UV (210 nm)
Column temp. : Room temp.

Data provided by Kazuichi Hayakawa Ph.D., Faculty of Pharmaceutical Sciences, Kanazawa University.

Eluting positions of phthalic acid esters using PAE-800 AC



Column : **Shodex CLNpak PAE-800 AC**
Eluent : Acetone
Flow rate : 0.5 mL/min
Detector : UV (330 nm), RI
Column temp. : Room temp.

Column Cleaning Procedures

Change in peak shapes, elution timing, and the elevated column pressure may be resolved by cleaning the column.
This section describes general indications of column deterioration and column cleaning procedures.
For detailed column cleaning procedures, refer to operating manual packaged with each column.

■ Typical indicators of column deterioration

1. Elevated column pressure
2. Abnormal peak shapes (broadening, leading, or tailing) and split peaks
3. Change in retention time
4. Unstable baseline

■ Cleaning solvent selection guide

Solvents capable of dissolving the adsorbed substances

Solvents with high eluting power (variable depending on separation mode)

Use the solvent specified in the operation manual.

■ Standard cleaning procedures :

For an efficient cleaning, reverse the direction and reduce the flow rate at half of the recommended flow rate.

Reversed phase chromatography columns	Clean the columns with solvent containing higher concentration of organic solvent such as methanol, acetonitrile, or THF. (In case of using buffer as a mobile phase, miscibility of the buffer solution and the organic solvents need to be checked)
Sugar analysis columns	**[Ligand exchange columns (SUGAR series)]** • **In case of counter ion detachment** Flush or inject solvent containing the salt corresponding to the modified counter-ligand. **[Polymer-base amino columns (NH2P series, VG-50 series)]** • **In cases where an acidic substance has been bound to the amino functional group** Flush with solvents in the following sequence: water, 0.1 M perchloric acid (aq.), water, 0.1 M NaOH (aq.), water, and mobile phase.
Aqueous SEC (GFC) chromatography columns	• **In cases where an ionic substance has been adsorbed** Use a solvent with higher salt concentration or solvent with different pH from the mobile phase. • **In cases where a hydrophobic substance has been adsorbed** Use a solvent containing organic solvent. (In case of using buffer as a mobile phase, miscibility of the buffer solution and the organic solvents need to be checked)
Ion exchange chromatography columns	• **In cases where an ionic substance has been adsorbed** Use a solvent with higher salt concentration or solvent with different pH from the mobile phase. • **In cases where a hydrophobic substance has been adsorbed** Use a solvent containing organic solvent. (In case of using buffer as a mobile phase, miscibility of the buffer solution and the organic solvents need to be checked) • **In cases where protein have been adsorbed** Inject 1 - 2 mL of 0.1 M NaOH (aq.) or 30 % (v/v) acetic acid (aq.) several times.
Hydrophobic interaction chromatography columns	• **In cases where protein have been adsorbed** Inject 1 - 2 mL of 0.1 M NaOH (aq.) or 30 % (v/v) acetic acid (aq.) several times.

The volume of the cleaning solvent required is 5 - 10 times the column volume.
Avoid pressure elevation during the cleaning.
The cleaning is limited and does not guarantee the full regeneration of the column to its original condition.

For your information

Elevated column pressure are often caused by insoluble components that block the column inlet.
In this case, reverse the direction and reduce the flow rate at half of the recommended flow rate. This may remove the insoluble components causing the elevated pressure.

Use the solvent specified in the operation manual.

General Precautions for Column Handling

For the best performance of the column, please follow the instructions given below.

Column mounting

- Before mounting the column, replace the eluent within all the HPLC system with the mobile phase used for the analysis.
  (If the mobile phase of the choice is not miscible with the eluent already in the system, use solvent that is miscible with both solvents first to clean the system.)
  (Buffer or salt solution may precipitate when mixed with organic solvent of different concentrations.)
- Attach the column in the direction as indicated by arrow marked on the column. Gradually increase the flow rate of the solvent introduced to the column.
- When heating the column, be sure to pump the eluent at a low flow rate until the specified temperature is reached, and then gradually increase the flow rate up to the requirement after the column has been heated sufficiently.

Column dismounting

- If the column is heated, turn off the heater while keeping the flow rate at 1/3 of the regular flow.
- Turn off the pump when the column is cooled to room temperature.
- Remove the column from the system securely tighten the end caps.

Column storage

- For long-term storage, remove the column from the system after replacing the in-column solvent with the shipping solvent.
- Securely tighten the end caps and store the column in a location with stable temperature.
  (A cool and dark space is recommended)

Other

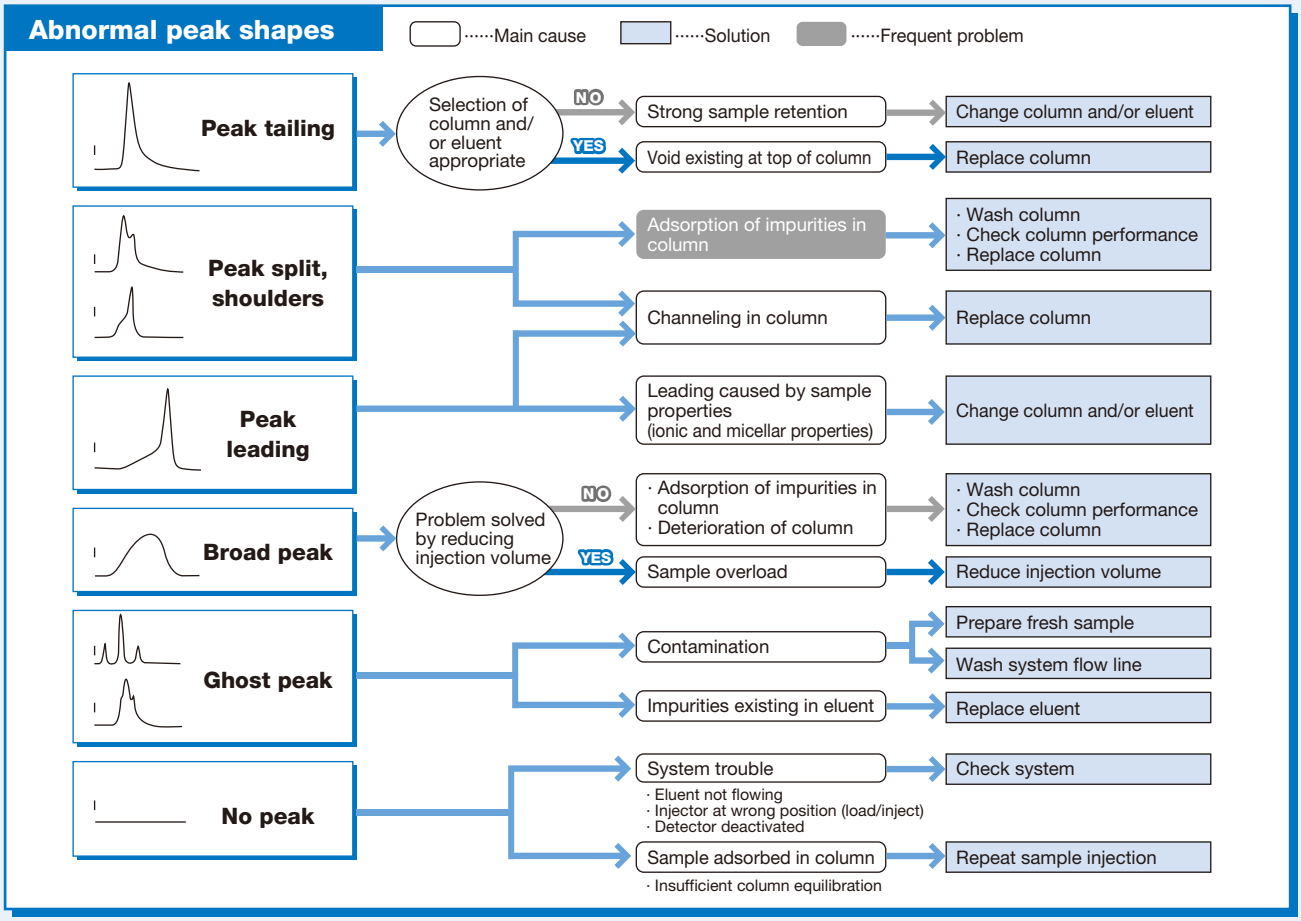
- Do not remove end fittings.
- Do not make a strong impact on the column. Do not drop or hit the column on a hard surface.

Read the operation manual before using the column.

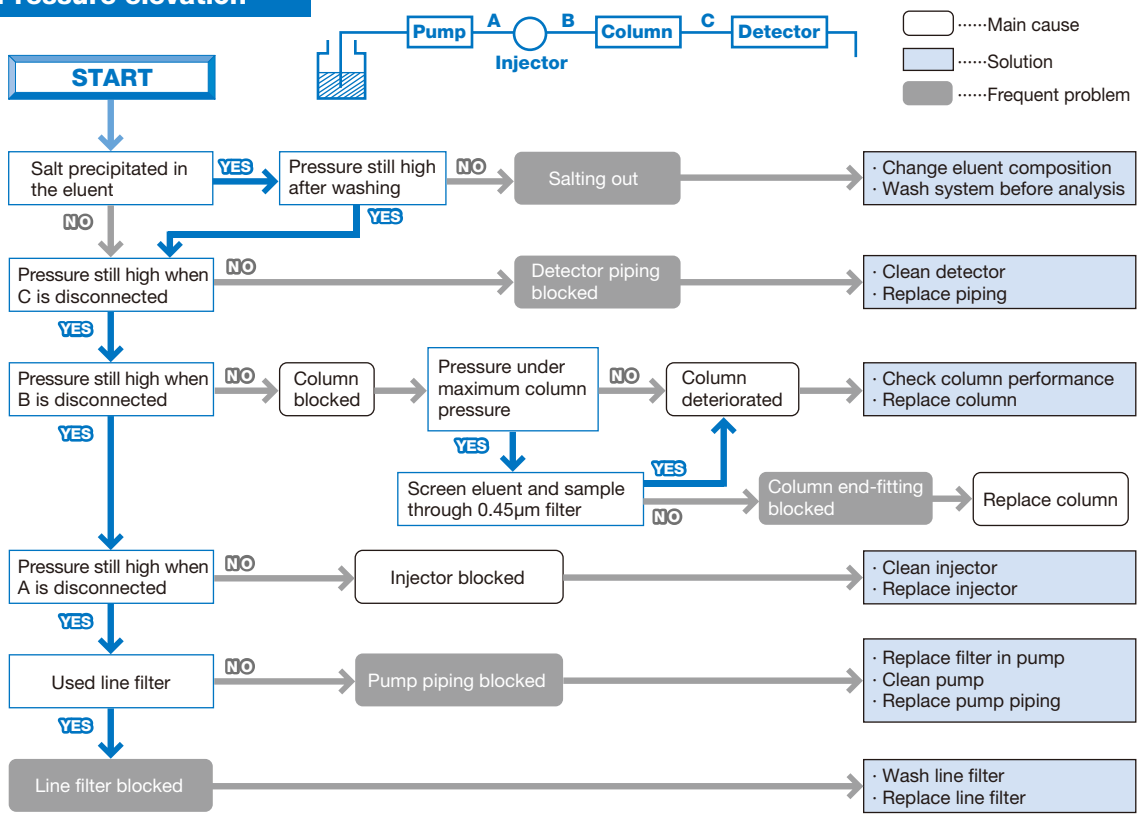
Column Trouble Shooting

Common causes for abnormal chromatograms

Abnormal peak shapes



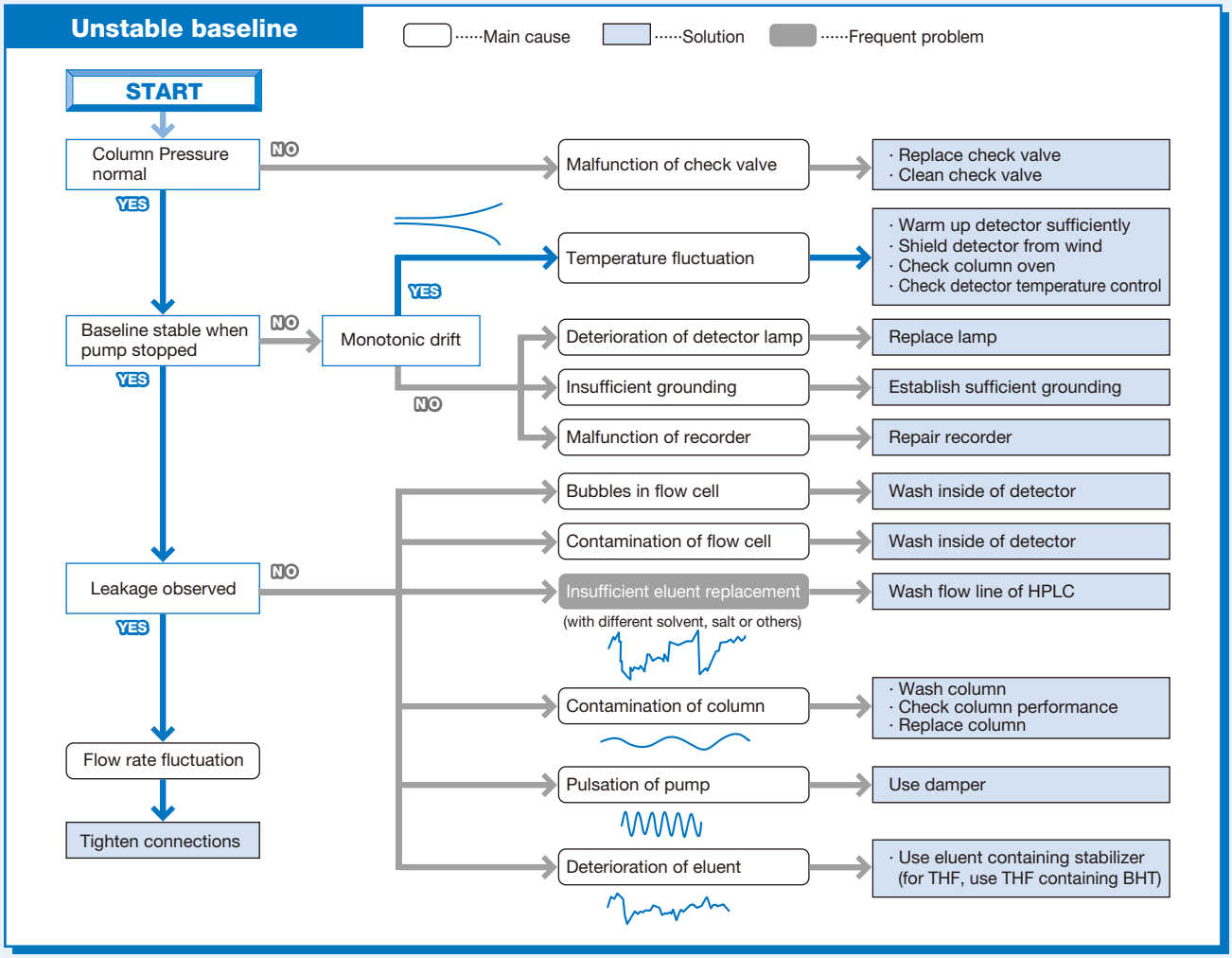
Pressure elevation



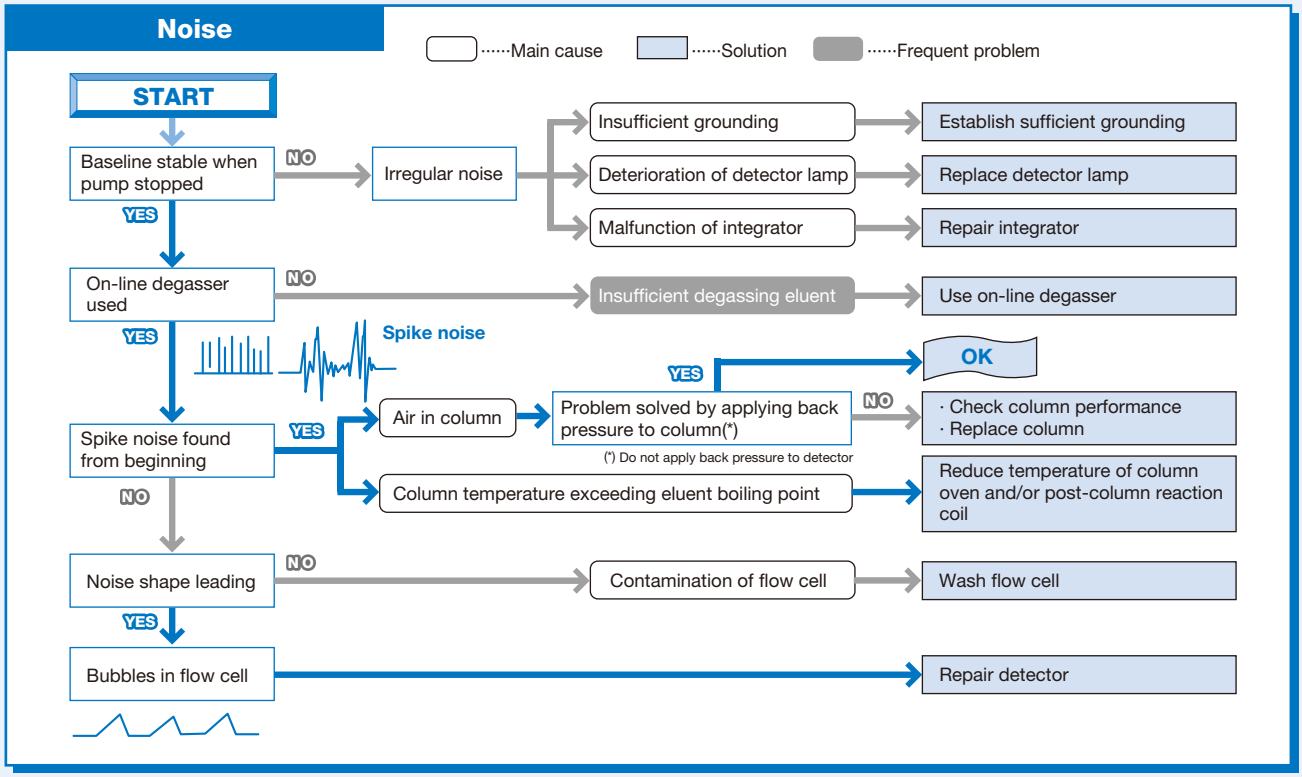
HPLC System Trouble Shooting

Common causes for abnormal chromatograms

Unstable baseline



Noise



USP42-NF37 Column List

No.	Packing material	Recommended Column	Page
L1	Octadecyl silane chemically bonded to porous or non-porous silica or ceramic micro-particles, 1.5 to 10 µm in diameter, or a monolithic rod.	C18	22
		Silica C18M	22
		Silica C18P	22
		C18U	23
L3	Porous silica particles, 1.5 to 10 µm in diameter, or a monolithic silica rod.	Silica 5SIL	23
L7	Octylsilane chemically bonded to totally or superficially porous silica particles, 1.5 to 10 µm in diameter, or a monolithic silica rod.	Silica 5C8	22
L8	An essentially monomolecular layer of aminopropylsilane chemically bonded to totally porous silica gel support, 1.5 to 10 µm in diameter, or a monolithic silica rod.	Silica 5NH	23
L10	Nitrile groups chemically bonded to porous silica particles, 1.5 to 10 µm in diameter, or a monolithic silica rod.	Silica 5CN	22
L17	Strong cation-exchange resin consisting of sulfonated cross-linked styrene-divinylbenzene copolymer in the hydrogen form, 6 to 12 µm in diameter.	SUGAR SH1011	30
		SUGAR SH1821	30
		RSpak KC-811	30
		IC Y-521	34
		IC T-521	34
L19	Strong cation-exchange resin consisting of sulfonated cross-linked styrene-divinylbenzene copolymer in the calcium form, 5 - 15 µm in diameter.	SUGAR SC1011	26
		SUGAR SC1821	26
		SUGAR SC1211	26
		EP SC1011-7F	27
		USPpak MN-431	27
L20	Dihydroxypropane groups chemically bonded to porous silica or hybrid particles, 1.5 to 10 µm in diameter, or a monolithic silica rod.	PROTEIN KW-800 series	38
		KW400 series	38
		PROTEIN LW-803	39
		PROTEIN LW-403 4D	39
L21	A rigid, spherical styrene-divinylbenzene copolymer, 3 to 30 µm in diameter.	RSpak RP18-415	12
		RSpak DS-613	12
		RSpak DS-413	12
		GPC KF, K, KD, HK, LF, HT, UT, AT, HFIP series	50, 52, 54, 56, 58, 60, 62, 64
L22	A cation-exchange resin made of porous polystyrene gel with sulfonic acid groups, 5 - 15 µm in diameter.	SUGAR SC1011	26
		SUGAR SC1821	26
		SUGAR SP0810	26
		SUGAR KS-800 series	26
		RSpak DC-613	26
		SUGAR SZ5532	26
		SUGAR SC1211	26
		EP SC1011-7F	27
		USPpak MN-431	27
		SUGAR SH1011	30
		SUGAR SH1821	30
		RSpak KC-811	30
		IC Y-521	34
		IC T-521	34
		CXpak P-421S	72
L23	An anion-exchange resin made of porous polymethacrylate or polyacrylate gel with quartenary ammonium groups, 7 - 12 µm in size.	IEC QA-825	70
L25	Packing having the capacity to separate compounds with a molecular weight range from 100-5000 (as determined by polyethylene oxide), applied to neutral, anionic, and cationic water-soluble polymers. A polymethacrylate resin base, cross-linked with polyhydroxylated ether (surface contained some residual carboxyl functional groups) was found suitable.	OHpak SB-802 HQ	42
		OHpak SB-802.5 HQ	42
L33	Packing having the capacity to separate dextrans by molecular size over a range of 4,000 to 500,000 Da. It is spherical, silica-based, and processed to provide pH stability.	PROTEIN KW-800 series	38
		KW400 series	38
		PROTEIN LW-803	39
		PROTEIN LW-403 4D	39
L34	Strong cation-exchange resin consisting of sulfonated cross-linked styrene-divinylbenzene copolymer in the lead form, 7 to 9 µm in diameter	SUGAR SP0810	26
L37	Packing having the capacity to separate proteins by molecular size over a range of 2,000 to 40,000 Da. It is a polymethacrylate gel.	OHpak SB-803 HQ	42
		OHpak LB-803	42
L38	A methacrylate-based size-exclusion packing for water-soluble samples.	OHpak SB-800 HQ series	42
		OHpak LB-800 series	42
L39	A hydrophilic polyhydroxymethacrylate gel of totally porous spherical resin.	ODP2 HP	8
		RSpak DM-614	12
		OHpak SB-800 HQ series	42
		OHpak LB-800 series	42
L45	Beta cyclodextrin, R,S-hydroxypropyl ether derivative, bonded to porous silica particles, 3 to 10 µm in diameter.	ORpak CDBS-453	74
L58	Strong cation-exchange resin consisting of sulfonated cross-linked styrene-divinylbenzene copolymer in the sodium form, about 6 to 30 µm in diameter.	RSpak DC-613	26
		SUGAR KS-800 series	26
		CXpak P-421S	72
L59	Packing for the size-exclusion separations of proteins (separation by molecular weight) over the range of 5 to 7000 kDa. The packing is spherical 1.5 - 10 µm, silica or hybrid packing with a hydrophilic coating.	PROTEIN KW-800 series	38
		KW400 series	38
		PROTEIN LW-803	39
		PROTEIN LW-403 4D	39
L67	Porous vinyl alcohol copolymer with a C18 alkyl group attached to the hydroxyl group of the polymer, 2 to 10 µm in diameter.	Asahipak ODP-40	10
		Asahipak ODP-50	10
		ET-RP1	74
L71	A rigid, spherical polymetacrylate, 4 to 6 µm in diameter.	RSpak DE-613	12
		RSpak DE-413	12
		RSpak DE-213	12
L76	Silica based, weak cation-exchange material, 5 µm in diameter. Substrate is surface polymerized polybutadiene-maleic acid to provide carboxylic acid functionalities. Capacity not less than 29 µEq/column.	IC YK-421	34
L82	Polyamine chemically bonded to cross-linked polyvinyl alcohol polymer, 4 - 5 µm in diameter.	Asahipak NH2P-50	20
		Asahipak NH2P-40	20
L89	Packing having the capacity to separate compounds with a molecular weight range from 100 - 3000 (as determined by polyethylene oxide), applied to neutral and anionic water-soluble polymers. A polymethacrylate resin base, cross-linked with polyhydroxylate ether (surface contains some residual cationic functional groups).	OHpak SB-802.5 HQ	42

Index by Product Name

Columns are listed in alphabetical order without their series names.

[Series name]

AFpak	Asahipak	AXpak	CLNpak	CXpak	EP	GPC	HIC
HILICpak	IC	IEC	MSpak	OHpak	ORpak	PROTEIN	RSpak
Silica	STANDARD	STD	SUGAR	USPpak			

Index by Product Code

Product Code	Product Name	Page
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F6548001	DEAE-2025	70
F6548002	SP-2025	72
F6548003	CM-2025	72
F6650040	C18M 4D	22
F6650041	C18M 4E	22
F6650042	C18M 2D	22
F6650045	C18P 4D	22
F6650046	C18P 4E	22
F6650050	5SIL 4D	23
F6650051	5SIL 4E	23
F6650052	5C8 4D	22
F6650053	5C8 4E	22
F6650058	5CN 4D	22
F6650059	5CN 4E	22
F6650060	5NH 4D	23
F6650061	5NH 4E	23
F6650062	5NPE 4D	22
F6651010	C18-4D	22
F6651011	C18-4E	22
F6654011	C18U 2B	23
F6654012	C18U 2D	23
F6700002	KS-G 8B	27
F6700010	KC-G 8B	30
F6700020	KS-G 6B	26
F6700030	KC-G 6B	30
F6700080	SH-G	30
F6700081	SP-G 6B	26
F6700090	SC-G 6B	26,27
F6700100	HK-G filter	58
F6700110	SZ-G	26
F6700120	SC1211G 4A	26
F6700131	KW-G 6B	38
F6700132	KW400G-4A	38
F6700133	LW-G 6B	39
F6700134	LS-G 4J	39
F6700140	DS-G	12
F6700150	DE-G 4A	12
F6700151	DE-G 2A	12
F6700160	DM-G 4A	12
F6700170	DC-G 4A	26
F6700200	HK-G	58
F6700210	P-G	72
F6700230	Y-G	34
F6700245	WA-G	70
F6700280	AT-G	62
F6700300	KF-G 4A	50,56
F6700310	H-G 8B	67
F6700340	FP-G 8B	66
F6700400	IA-G	32
F6700401	K-G 4A	52
F6700406	KF-G 8B	50
F6700407	K-G 8B	52
F6700408	KF-G 20C	67
F6700409	K-G 20C	67
F6700411	KD-G 4A	54
F6700412	T-G	34
F6700500	HFIP-G 8B	64
F6700510	NN-G	13
F6700511	HFIP-G 4A	64
F6700530	YS-G	34
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F6709431	SB-807G	42
F6709434	LB-G 6B	42
F6709450	K-800D	52,54
F6709555	SB-G 8B	43
F6709556	KW-G 8B	39
F6709558	RP18-G	12
F6709602	QA-G 8B	70
F6709603	DEAE-G 8B	70
F6709604	SP-G 8B	72
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F6709626	SI-92G	32
F6709627	SI-95G	32
F6709720	SI-2GF	32
F6709730	SI-2GF filter	32
F6709801	EXP® cartridges	23
F6709802	EXP® direct connect holder	23
F6710001	ODP-50G 6A	10
F6710002	C8P-50G 4A	10
F6710003	C4P-50G 4A	10
F6710004	ODP-130G 7B	10
F6710016	NH2P-50G 4A	20
F6710017	NH2P-130G 7B	20
F6710018	GF-1G 7B	48
F6710019	GS-2G 7B	46
F6710020	GS-10G 7B	48
F6710021	GS-20G 7B	46,70, 72
F6710022	ODP-50G 4A	10
F6710023	ODP-50 4B	10
F6710030	NH2P-50G 3A	20
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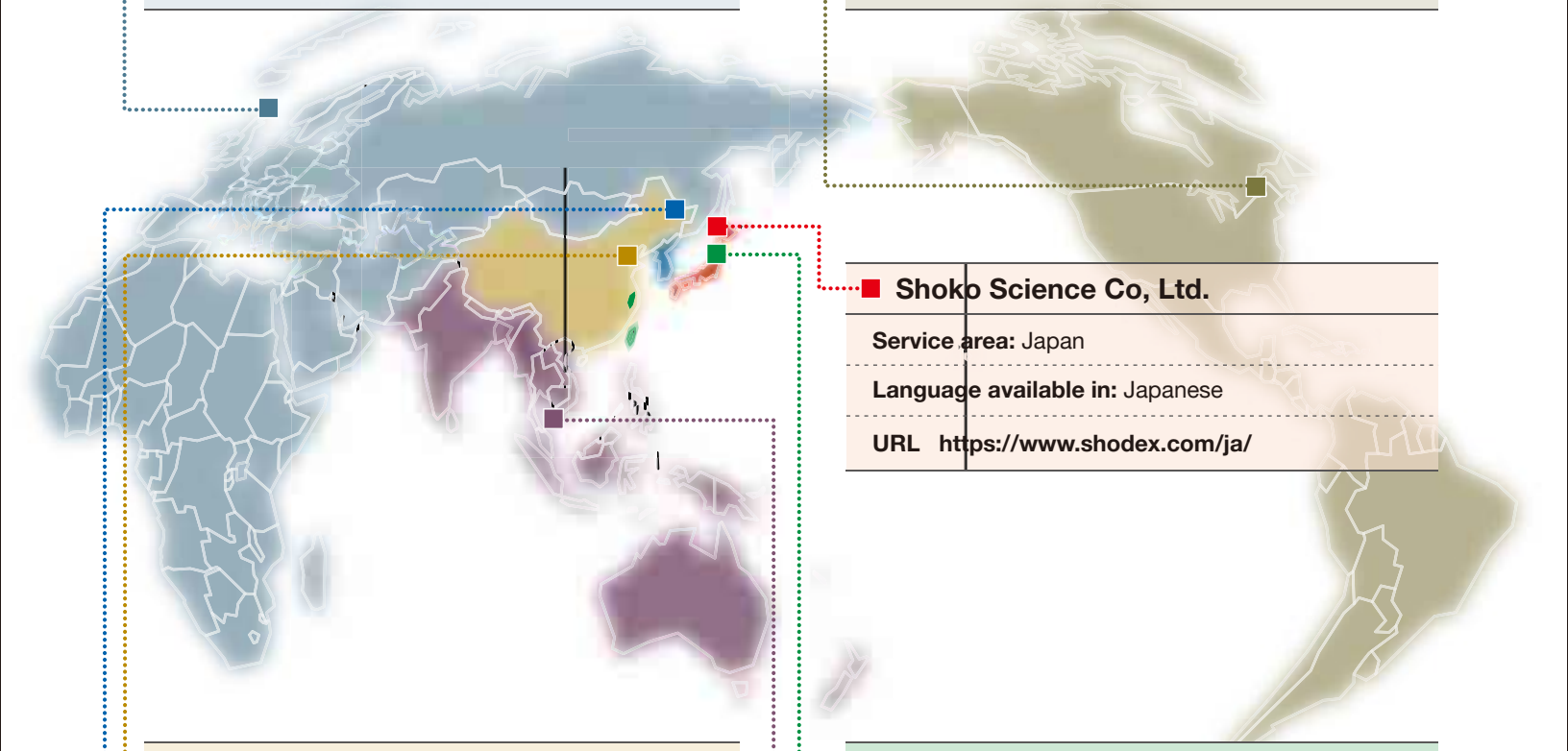

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