

**Shodex™**

Capture the Essence

禹重科技® ÜZONGLAB

2018-2019

# 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

<http://www.shodexHPLC.com/>



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[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.

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# 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-50, ODP-40	Polyvinyl alcohol	Octadecyl	10
	Asahipak C8P-50	Polyvinyl alcohol	Octyl	10
	Asahipak C4P-50	Polyvinyl alcohol	Butyl	10
	RSpak RP18-415, DS	Styrene divinylbenzene copolymer	—	12
	RSpak DE	Polymethacrylate	—	12
	RSpak DM-614	Polyhydroxymethacrylate	—	12
	RSpak NN	Polyhydroxymethacrylate	Sulfo	12
	RSpak JJ-50	Polyvinyl alcohol	Quaternary ammonium	12
	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	Polyvinyl alcohol	Amino	20
Reversed Phase, Normal Phase & HILIC (Silica-based)	ET-RP1	Polyvinyl alcohol	Octadecyl	74
	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
	Silica 5PYE	Silica	Pyrenylethyl	22
	Silica 5SIL	Silica	—	23
Ligand Exchange	Silica 5NH	Silica	Aminopropyl	23
	SUGAR SC	Styrene divinylbenzene copolymer	Sulfo (Ca <sup>2+</sup> )	26
	SUGAR SP0810	Styrene divinylbenzene copolymer	Sulfo (Pb <sup>2+</sup> )	26
	SUGAR KS-800	Styrene divinylbenzene copolymer	Sulfo (Na <sup>+</sup> )	26
	RSpak DC-613	Styrene divinylbenzene copolymer	Sulfo (Na <sup>+</sup> )	26
	SUGAR SZ5532	Styrene divinylbenzene copolymer	Sulfo (Zn <sup>2+</sup> )	26
	EP SC1011-7F	Styrene divinylbenzene copolymer	Sulfo (Ca <sup>2+</sup> )	27
Ion Exclusion	USPpak MN-431	Styrene divinylbenzene copolymer	Sulfo (Ca <sup>2+</sup> )	27
	SUGAR SH	Styrene divinylbenzene copolymer	Sulfo	30
Ion Chromatography	RSpak KC-811	Styrene divinylbenzene copolymer	Sulfo	30
	IC NI-424, I-524A	Polyhydroxymethacrylate	Quaternary ammonium	32
	IC SI	Polyvinyl alcohol	Quaternary ammonium	32
	IC YS-50	Polyvinyl alcohol	Carboxyl	34
	IC YK-421	Silica	Carboxyl	34
Aqueous SEC (GFC)	IC Y-521, T-521	Styrene divinylbenzene copolymer	Sulfo	34
	PROTEIN KW-800	Silica	Hydrophilic polymer	38
	PROTEIN LW-803	Silica	Hydrophilic polymer	38
	KW400	Silica	Hydrophilic polymer	38
Multimode	OHpak SB-800 HQ	Polyhydroxymethacrylate	—	42
	OHpak LB-800	Polyhydroxymethacrylate	—	42
Aqueous/Organic SEC	Asahipak GS-HQ	Polyvinyl alcohol	—	46
	MSPak GF-310	Polyvinyl alcohol	—	48
Organic SEC (GPC)	Asahipak GF-HQ	Polyvinyl alcohol	—	48
Ion Exchange	MSPak GF-310	Polyvinyl alcohol	—	48
	GPC	Styrene divinylbenzene copolymer	—	50, 52, 54, 56, 58, 62, 64, 66
	IEC QA-825	Polyhydroxymethacrylate	Quaternary ammonium	70
	IEC DEAE-825	Polyhydroxymethacrylate	Diethylaminoethyl	70
	IEC DEAE3N	Polyhydroxymethacrylate	Diethylaminoethyl	70
	PIKESS DEAE-2B	Polyhydroxymethacrylate	Diethylaminoethyl	70
	Asahipak ES-502N	Polyvinyl alcohol	Diethylaminoethyl	70
	AXpak WA-624	Polyhydroxymethacrylate	Diethylaminoethyl	70
	IEC SP-825	Polyhydroxymethacrylate	Sulfopropyl	72
	IEC SP-420N	Polyhydroxymethacrylate	Sulfopropyl	72
	IEC SP-FT 4A	Polyhydroxymethacrylate	Sulfopropyl	72
	PIKESS SP-2B	Polyhydroxymethacrylate	Sulfopropyl	72
	IEC CM-825	Polyhydroxymethacrylate	Carboxymethyl	72
	Asahipak ES-502C	Polyvinyl alcohol	Carboxymethyl	72
	CXpak P-421S	Styrene divinylbenzene copolymer	Sulfo (Na <sup>+</sup> )	72
Hydrophobic Interaction	HIC PH-814	Polyhydroxymethacrylate	Phenyl	74
	AFpak APA-894	Polyhydroxymethacrylate	Protein A	74
Affinity	AFpak ACH-494	Polyhydroxymethacrylate	Choline oxydase, Acetylcholine esterase	74
	ORpak CDBS-453	Silica	β-Cyclodextrin derivative	74
Chiral Separation	ORpak CRX-853	Polyhydroxymethacrylate	L-Amino acid derivative	74
	MSPak GF-4A	Polyvinyl alcohol	—	74
Column Switching Pretreatment	CLNpak EV	Styrene divinylbenzene copolymer	—	76
GPC Clean-up	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
<b>Reversed Phase Chromatography (RPC)</b>	<ul style="list-style-type: none"> <li>Separation is based on the partition equilibrium between stationary phase and mobile phase.</li> <li>The polarity of the stationary phase is lower than that of the mobile phase.</li> <li>Typically the mobile phase contains a mixture of organic solvents (methanol, acetonitrile, or THF) and aqueous solvents (water or buffer).</li> <li>Use of lower polarity mobile phases fasten the elution.</li> </ul>
<b>Hydrophilic Interaction Chromatography (HILIC)</b>	<ul style="list-style-type: none"> <li>Separation is based on hydrophilic interaction.</li> <li>A high polarity stationary phase is used.</li> <li>Typically the mobile phase contains a mixture of organic solvents such as acetonitrile and aqueous solvents (water or buffer).</li> <li>Using the higher polarity mobile phase causes a faster elution.</li> <li>Applicable for the analysis of high polar substances.</li> </ul>
<b>Normal Phase Chromatography (NPC)</b>	<ul style="list-style-type: none"> <li>Separation is based on the partition equilibrium between the stationary phase and the mobile phase.</li> <li>The polarity of the stationary phase is higher than that of the mobile phase.</li> <li>Typically the mobile phase contains a mixture of organic solvents with different polarities such as hexane and isopropanol.</li> <li>Using the higher polarity mobile phase causes a faster elution.</li> </ul>
<b>Ligand Exchange Chromatography (LEX)</b>	<ul style="list-style-type: none"> <li>Separation is based on differences in analytes' coordination complex.</li> <li>Stationary phase modified with metal sulfonate complex ion.</li> <li>Works in combination with size exclusion or HILIC modes.</li> </ul>
<b>Ion Exclusion Chromatography (IEX)</b>	<ul style="list-style-type: none"> <li>Separation is based on electrostatic interaction (repulsion) between the ion exchanger and ionic solutes.</li> <li>Dissociated ionic molecules elute faster than non-dissociated forms.</li> <li>Used mainly for the analysis of organic acids.</li> </ul>
<b>Ion Chromatography (IC)</b>	<ul style="list-style-type: none"> <li>Separation is based on electrostatic interaction (bonding) between the ion exchanger and ionic solutes.</li> <li>Electrical conductivity detector can be used with a mobile phase with low-salt concentration.</li> <li>Used mainly for the analysis of inorganic compounds.</li> </ul>
<b>Size Exclusion Chromatography (SEC)</b>	<ul style="list-style-type: none"> <li>Network or pores on the surface of the packing material works as molecular sieve to separate molecules based on their sizes.</li> <li>To separate molecules solely based on their sizes, it requires an analytical condition without any analyte and packing gel interaction.</li> <li>The bigger the molecule size, the faster the elution sequence.</li> <li>Used for molecular weight or molecular distribution determination of macromolecules and qualification of oligomers.</li> </ul>
<b>Ion Exchange Chromatography (IEC)</b>	<ul style="list-style-type: none"> <li>Separation is based on electrostatic interactions between the ion exchanger and ionic solutes.</li> <li>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.</li> <li>The elution position is optimized by varying the pH, salt concentration, and/or ionic strength of the mobile phase.</li> </ul>
<b>Hydrophobic Interaction Chromatography (HIC)</b>	<ul style="list-style-type: none"> <li>Separation is based on hydrophobic interaction.</li> <li>Hydrophobic functional group is modified on the stationary phase.</li> <li>Adsorption of analytes generally occurs at a high salt concentration and they are released by lowering the salt concentration.</li> <li>Used mainly for the analysis of proteins.</li> </ul>
<b>Affinity Chromatography (AFC)</b>	<ul style="list-style-type: none"> <li>Separation is based on adsorption of the analyte to the specific biologically derived ligand pair.</li> <li>Highly selective.</li> <li>A buffer solution with the appropriate pH and ionic strength is selected based on the type of ligand, analytes, and their interaction.</li> <li>Used mainly for the purification and concentration of biologically active substances.</li> </ul>
<b>Chiral Separation Chromatography (CS)</b>	<ul style="list-style-type: none"> <li>Separation of optical isomers using chiral selectors.</li> <li>Highly selective.</li> </ul>
<b>Multimode Chromatography</b>	<ul style="list-style-type: none"> <li>Separation is based on the combination of different modes.</li> </ul>

## Column Selection by Sample Character and Separation Mode

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

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, 62	
Moisturizers	Polyalcohols	RPC	12
		LEX+SEC	26
		LEX+HILIC	26
		SEC	42, 48
	Protein hydrolysates	RPC	10, 12
		SEC	38
Mucopolysaccharides	SEC	42	
Emulsifiers	Surfactants	SEC+RPC	48
		SEC	50, 56, 58
Preservatives	Paraben Dehydroacetic acid	RPC	10, 12, 22
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
		IEC+RPC	30
IC		32	
Water-soluble vitamins	RPC	8, 10, 12	
	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+IEC+RPC	12	
	HILIC	16	
	IC	34	
	IEC	72	
Food additives	RPC	10, 12, 74	
	HILIC	16, 20	
Food safety	Pesticides	RPC	12
		IEC+RPC	12
		HILIC	16
	IC	32	
Mycotoxin	RPC	22	
Pretreatment of residual pesticides	SEC GPC (clean-up)	76	

### Separation Mode (Page 4 and Page 5)

RPC : Reversed Phase Chromatography

HILIC : Hydrophilic Interaction Chromatography

NPC : Normal Phase Chromatography

LEX : Ligand Exchange Chromatography

IEC : 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

## New Materials

		Separation Mode	Page
Synthetic polymers	Organic solvent soluble	SEC	48, 50, 52, 54, 56, 58
	Polar organic solvent soluble		42, 48, 54, 56, 58, 62
	High temperature/ Ultra high temperature		64
	Water-soluble		38, 42, 46, 48
Additives Oligomers		RPC	10, 12, 22
	Organic solvent soluble	SEC	48, 50, 52, 56, 58
	Polar organic solvent soluble		42, 48, 54, 56, 58
	Water-soluble		38, 42, 46, 48

## 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	
		SEC	38, 42, 46, 48	
		IEC	70, 72	
		HIC	74	
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	
		SEC+RPC	48	
	Pesticides	RPC	12, 22	
		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	
		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
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

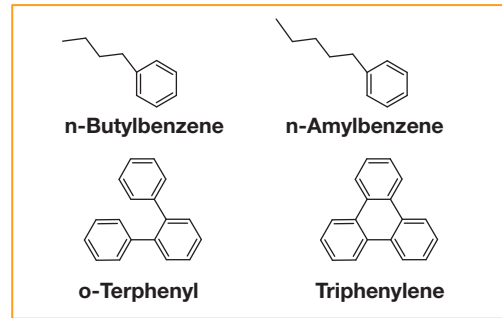
ODS columns are the most popular reversed phase columns that are packed with silica-based octadecyl group. Shodex provides not only ODS columns but also polymer-based reversed phase columns with different functional groups. Please use following descriptions about the column features as guidelines to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

## Features

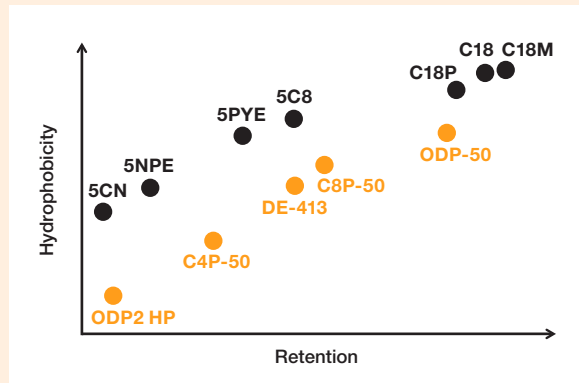
- 
- |   |  |
|---|--|
| <b>ODP2 HP</b>                                  | <ul style="list-style-type: none"><li>• Provides a large theoretical plate number nearly twice as much as generally available polymer-based reversed phase columns do</li><li>• Offers enhanced retention of high polar substances compared to ODS columns</li><li>• Suitable for the analysis of small molecules such as pharmaceuticals in the presence of protein matrix</li><li>• Ideal for LC/MS analysis of high polar compounds</li><li>• Fulfills USP L39 requirements</li></ul> |
| <b>ODP-50</b><br><b>C8P-50</b><br><b>C4P-50</b> | <ul style="list-style-type: none"><li>• Relatively large pore size is suitable for the analysis of amino acids, peptides, and proteins</li><li>• Usable in a wide pH range from pH 2 to 13</li><li>• Usable in 100% water and buffer solution</li><li>• Best used for the analysis of basic substances</li><li>• ODP-50 fulfills USP L67 requirements</li></ul>  |
| <b>ODP-40</b>                                   | <ul style="list-style-type: none"><li>• Higher performance type of ODP-50 series</li><li>• Fulfills USP L67 requirements</li></ul>   |
| <b>RP18-415</b>                                 | <ul style="list-style-type: none"><li>• Large pore size is suitable for the analysis of proteins and peptides</li><li>• Fulfills USP L21 requirements</li></ul>  |
| <b>DS-613</b><br><b>DS-413</b>                  | <ul style="list-style-type: none"><li>• Suitable for reversed phase analysis of highly hydrophilic substances that are not well retained by ODS columns</li><li>• Fulfill USP L21 requirements</li></ul>   |
| <b>DE</b>                                       | <ul style="list-style-type: none"><li>• General purpose polymer-based column having similar polarity as ODS columns</li><li>• Wide working pH range (from pH 2 to 12), usable in 100% water and buffer solutions</li><li>• Fulfills USP L71 requirements</li></ul>   |
| <b>DM-614</b>                                   | <ul style="list-style-type: none"><li>• Suitable for the analysis of amino acids and water-soluble vitamins</li><li>• Fulfills USP L39 requirements</li></ul>  |
| <b>NN</b>                                       | <ul style="list-style-type: none"><li>• The packing material modified with sulfo groups supports multimode (reversed phase and cation exchange) analysis</li><li>• Ideal for the analysis of complex samples containing neutral and ionic substances</li></ul>   |
| <b>JJ-50</b>                                    | <ul style="list-style-type: none"><li>• The packing material is modified with trace amounts of quaternary ammonium groups, and supports multimode (reversed phase and anion exchange) analysis</li><li>• Ideal for analysis of complex samples containing neutral and ionic substances</li></ul>   |
| <b>C18</b>                                      | <ul style="list-style-type: none"><li>• Fully end capped ODS column available at very reasonable price</li><li>• Fulfills USP L1 requirements</li></ul>  |
| <b>C18M</b>                                     | <ul style="list-style-type: none"><li>• Monomeric type ODS column fully end capped high purity silica (99.99% or higher)</li><li>• Fulfills USP L1 requirements</li></ul>  |
| <b>C18P</b>                                     | <ul style="list-style-type: none"><li>• Polymeric type ODS column fully end capped high purity silica (99.99% or higher)</li><li>• Excellent acid tolerance</li><li>• Advantageous for separating planar and nonplanar compounds from each other</li><li>• Fulfills USP L1 requirements</li></ul>  |
| <b>5C8</b>                                      | <ul style="list-style-type: none"><li>• Use when the retention capacity of C18 is too strong</li><li>• Rapid mass transfer and fast equilibration allow its use as an ion-pair chromatography</li><li>• Fulfills USP L7 requirements</li></ul>   |
| <b>5CN</b>                                      | <ul style="list-style-type: none"><li>• Utilizes reversed phase interaction and <math>\pi</math>-electron interaction to separate regioisomers, which typically cannot be separated with ODS or C8 columns</li><li>• Fulfills USP L10 requirements</li></ul>   |
| <b>5NPE</b><br><b>5PYE</b>                      | <ul style="list-style-type: none"><li>• Utilizes several types of interactions based on <math>\pi</math>-electrons to separate structural isomers</li><li>• 5NPE fulfills USP L11 requirements</li></ul>   |
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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 ( $\alpha$ ) between n-butylbenzene and n-amylbenzene was used as the hydrophobicity. The separation factor between o-terphenil and triphenylene was used as the steric recognition. Lager separation factor means higher hydrophobicity and higher steric selectivity.

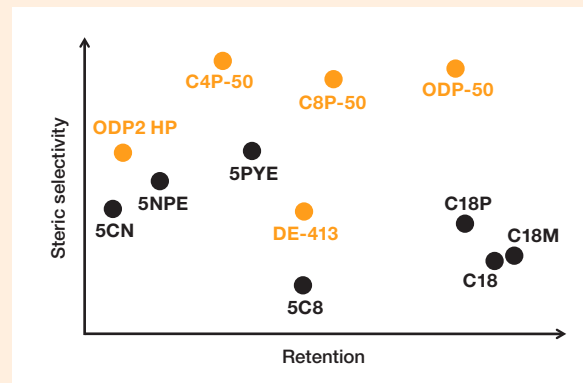


### Hydrophobicity differences among Shodex RPCs



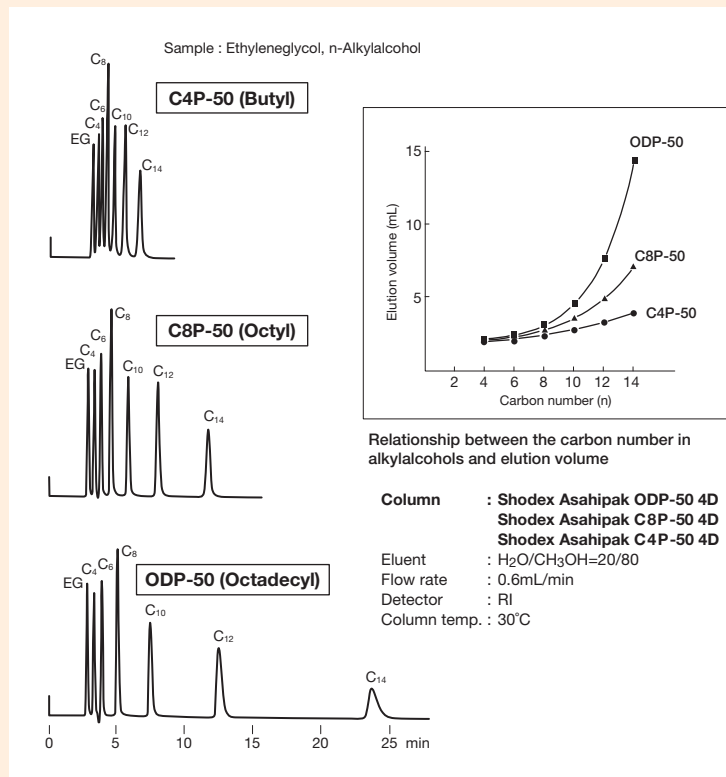
Column size : 4.6mm I.D. x 150mm each  
 Eluent : H<sub>2</sub>O/CH<sub>3</sub>OH=20/80  
 Flow rate : 1.0mL/min  
 Detector : UV (254nm)  
 Column temp. : 40°C

### Steric selectivity differences among Shodex RPCs

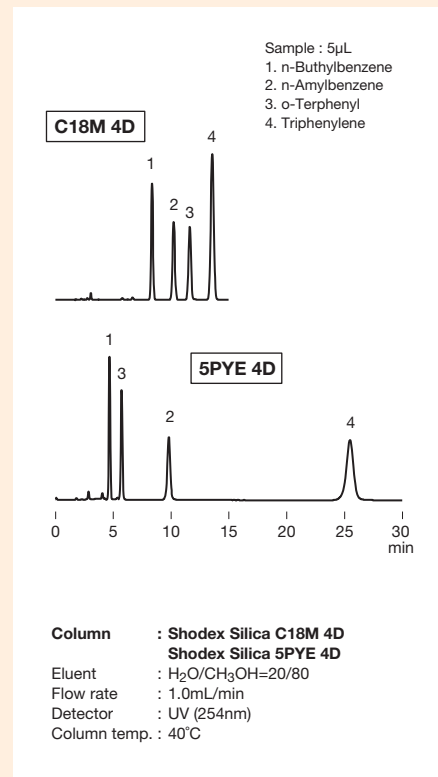


Column size : 4.6mm I.D. x 150mm each  
 Eluent : H<sub>2</sub>O/CH<sub>3</sub>OH=20/80  
 Flow rate : 1.0mL/min  
 Detector : UV (254nm)  
 Column temp. : 40°C

### Comparison of different functional groups on the separation of alkylalcohols



### Effects of steric selectivity differences



# 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	<b>ODP2 HP-4B</b>	≥ 3,500	–	5	40	<b>4.6 × 50</b>	H <sub>2</sub> O/CH <sub>3</sub> CN=55/45
F7622002	<b>ODP2 HP-4D</b>	≥ 13,000	–	5	40	<b>4.6 × 150</b>	H <sub>2</sub> O/CH <sub>3</sub> CN=55/45
F7622003	<b>ODP2 HP-4E</b>	≥ 17,000	–	5	40	<b>4.6 × 250</b>	H <sub>2</sub> O/CH <sub>3</sub> CN=55/45
F6714010	<b>ODP2 HPG-4A</b>	(guard column)	–	5	–	<b>4.6 × 10</b>	H <sub>2</sub> O/CH <sub>3</sub> CN=55/45
F7622004	<b>ODP2 HP-2B</b>	≥ 3,000	–	5	40	<b>2.0 × 50</b>	H <sub>2</sub> O/CH <sub>3</sub> CN=55/45
F7622005	<b>ODP2 HP-2D</b>	≥ 7,000	–	5	40	<b>2.0 × 150</b>	H <sub>2</sub> O/CH <sub>3</sub> CN=55/45
F6714011	<b>ODP2 HPG-2A</b>	(guard column)	–	5	–	<b>2.0 × 10</b>	H <sub>2</sub> O/CH <sub>3</sub> CN=55/45

Base Material: Polyhydroxymethacrylate

## 3mm I.D. columns [Customized columns]

Product Code	Product Name	Functional Group	Particle Size (µm)	Pore Size (Å)	Column Size (mm) I.D. x Length
F7622006	<b>ODP2 HP-3B</b>	–	5	40	<b>3.0 × 50</b>
F7622007	<b>ODP2 HP-3D</b>	–	5	40	<b>3.0 × 150</b>
F6714014	<b>ODP2 HPG-3A (guard column)</b>	–	5	–	<b>3.0 × 10</b>

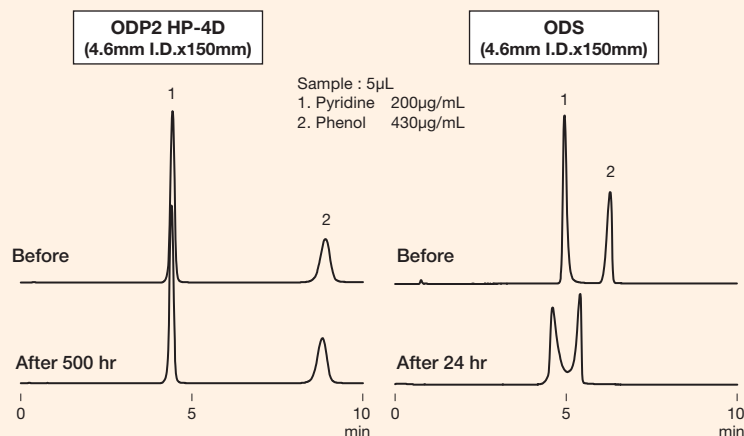
Base Material: Polyhydroxymethacrylate

## 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	<b>ODP2 HP-10E</b>	≥ 9,500	6	<b>10.0 × 250</b>	ODP2 HP
F6714015	<b>ODP2 HPG-7B</b>	(guard column)	6	<b>7.5 × 50</b>	(guard column)

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

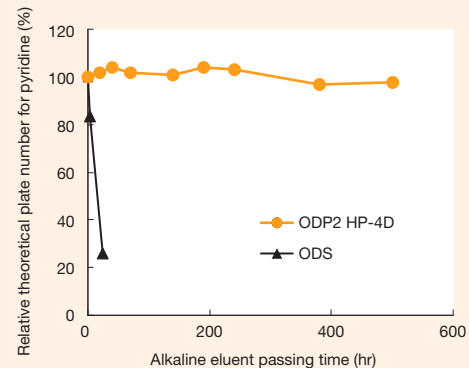
### Chromatograms obtained before and after passing alkaline eluent



#### Analysis condition

**Column** : Shodex ODP2 HP-4D  
 ODS from other manufacturer  
**Eluent** : H<sub>2</sub>O/CH<sub>3</sub>OH=70/30  
**Flow rate** : 1.0mL/min  
**Detector** : UV (254nm)  
**Column temp.** : 40°C

### Correlation between alkaline eluent passing time and relative theoretical plate number

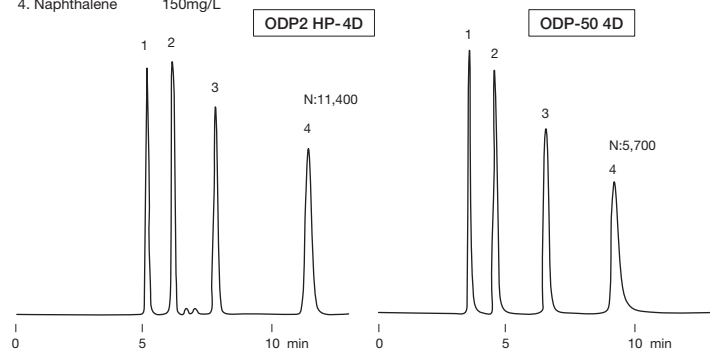


#### Eluent passing conditions for alkali tolerance test

**Column** : Shodex ODP2 HP-4D  
 ODS from other manufacturer  
**Eluent** : 10mM Sodium phosphate buffer (pH12)  
 /CH<sub>3</sub>CN=45/55  
**Flow rate** : 0.6mL/min  
**Column temp.** : 30°C

### Comparison between ODP2 HP and ODP-50

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

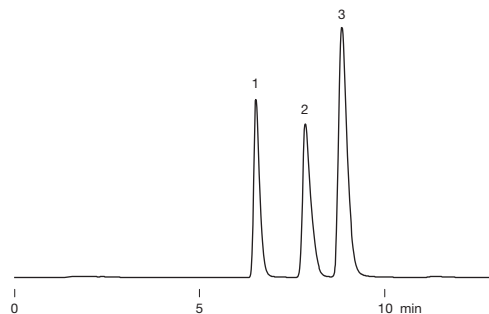


**Column** : Shodex ODP2 HP-4D  
**Eluent** : H<sub>2</sub>O/CH<sub>3</sub>CN=55/45  
**Flow rate** : 0.6mL/min  
**Detector** : UV (254nm)  
**Column temp.** : 40°C

**Column** : Shodex Asahipak ODP-50 4D  
**Eluent** : H<sub>2</sub>O/CH<sub>3</sub>CN=35/65  
**Flow rate** : 0.6mL/min  
**Detector** : UV (254nm)  
**Column temp.** : 40°C

### Imidazoles

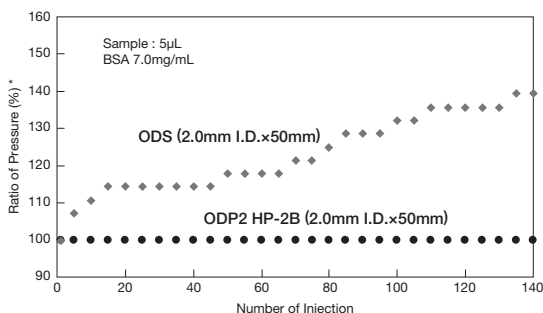
Sample : 0.1% each, 10µL  
 1. Imidazole  
 2. 2-Methylimidazole  
 3. 4-Methylimidazole



**Column** : Shodex ODP2 HP-4E  
**Eluent** : 10mM Na<sub>2</sub>HPO<sub>4</sub> aq./CH<sub>3</sub>CN=90/10  
**Flow rate** : 0.8mL/min  
**Detector** : UV (220nm)  
**Column temp.** : 40°C

### 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.

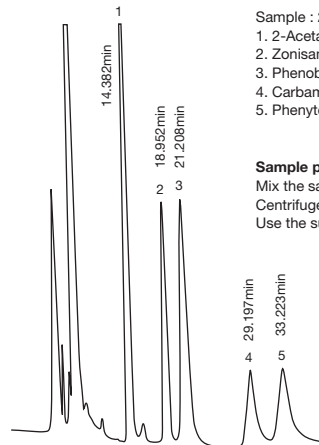


**Column** : Shodex ODP2 HP-2B  
**ODS from other manufacturer**  
**Eluent** : 1mM CH<sub>3</sub>COONH<sub>4</sub> aq./CH<sub>3</sub>CN=90/10  
**Flow rate** : 0.2mL/min  
**Detector** : UV (220nm)  
**Column temp.** : 30°C

\*Considering original pressure as 100%

### Anticonvulsant in serum

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

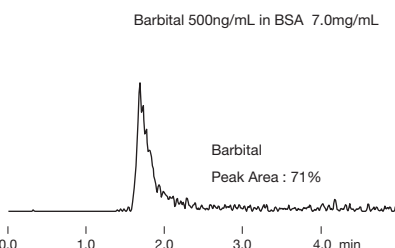
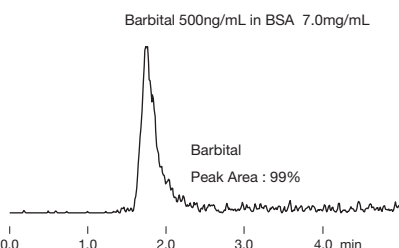
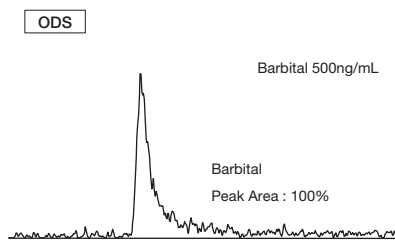
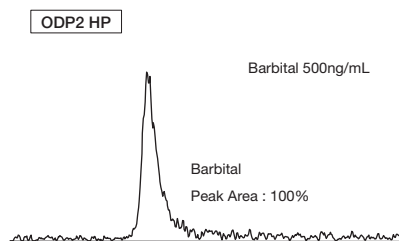


**Sample pretreatment:**  
 Mix the same volumes of serum and acetonitrile. Centrifuge the mixture at 6000g for 5minutes. Use the supernatant as sample.

Data courtesy of Katsuko Hara.MT  
 Yutaka Komiya.Ph.D.,  
 Department of Clinical Sciences  
 and Laboratory Medicine,  
 Kansai Medical University.

**Column** : Shodex ODP2 HP-4E  
**Eluent** : 25mM Sodium phosphate buffer (pH5.2)/CH<sub>3</sub>CN=680/320  
**Flow rate** : 0.35mL/min  
**Detector** : UV (210nm)  
**Column temp.** : 40°C

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



The ODP2 HP column showed less matrix effect (ion suppression) than the ODS column during LC/MS analysis of samples containing the protein matrix. This shows that the ODP2 HP column does not retain proteins and elute them as a void.

**Column** : Shodex ODP2 HP-2B  
**ODS from other manufacturer**  
**Eluent** : 10mM Ammonium acetate aq./CH<sub>3</sub>CN=70/30  
**Flow rate** : 0.2mL/min  
**Detector** : ESI-MS (SIM Negative : m/z 183)  
**Column temp.** : 30°C  
**Injection vol.** : 10µL

# 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 <sub>2</sub> O/CH <sub>3</sub> CN=35/65
F7621002	Asahipak ODP-40 4E	≥ 17,000	Octadecyl	4	250	4.6 x 250	H <sub>2</sub> O/CH <sub>3</sub> CN=35/65
F7620002	Asahipak ODP-50 6D	≥ 9,000	Octadecyl	5	250	6.0 x 150	H <sub>2</sub> O/CH <sub>3</sub> CN=35/65
F7620001	Asahipak ODP-50 6E	≥ 14,000	Octadecyl	5	250	6.0 x 250	H <sub>2</sub> O/CH <sub>3</sub> CN=35/65
F6710001	Asahipak ODP-50G 6A	(guard column)	Octadecyl	5	–	6.0 x 10	H <sub>2</sub> O/CH <sub>3</sub> CN=35/65
F6710023	Asahipak ODP-50 4B	≥ 2,500	Octadecyl	5	250	4.6 x 50	H <sub>2</sub> O/CH <sub>3</sub> CN=35/65
F7620004	Asahipak ODP-50 4D	≥ 9,000	Octadecyl	5	250	4.6 x 150	H <sub>2</sub> O/CH <sub>3</sub> CN=35/65
F7620003	Asahipak ODP-50 4E	≥ 14,000	Octadecyl	5	250	4.6 x 250	H <sub>2</sub> O/CH <sub>3</sub> CN=35/65
F6710022	Asahipak ODP-50G 4A	(guard column)	Octadecyl	5	–	4.6 x 10	H <sub>2</sub> O/CH <sub>3</sub> CN=35/65
F7620009	Asahipak ODP-50 2D	≥ 5,000	Octadecyl	5	250	2.0 x 150	H <sub>2</sub> O/CH <sub>3</sub> CN=35/65
F6713001	Asahipak ODP-50G 2A	(guard column)	Octadecyl	5	–	2.0 x 10	H <sub>2</sub> O/CH <sub>3</sub> CN=35/65
F7620006	Asahipak C8P-50 4D	≥ 7,000	Octyl	5	250	4.6 x 150	H <sub>2</sub> O/CH <sub>3</sub> CN=35/65
F7620005	Asahipak C8P-50 4E	≥ 11,000	Octyl	5	250	4.6 x 250	H <sub>2</sub> O/CH <sub>3</sub> CN=35/65
F6710002	Asahipak C8P-50G 4A	(guard column)	Octyl	5	–	4.6 x 10	H <sub>2</sub> O/CH <sub>3</sub> CN=35/65
F7620008	Asahipak C4P-50 4D	≥ 6,000	Butyl	5	250	4.6 x 150	H <sub>2</sub> O/CH <sub>3</sub> CN=35/65
F7620007	Asahipak C4P-50 4E	≥ 9,000	Butyl	5	250	4.6 x 250	H <sub>2</sub> O/CH <sub>3</sub> CN=35/65
F6710003	Asahipak C4P-50G 4A	(guard column)	Butyl	5	–	4.6 x 10	H <sub>2</sub> O/CH <sub>3</sub> CN=35/65

Base Material: Polyvinyl alcohol

## 3mm I.D columns [Customized columns]

Product Code	Product Name	Functional Group	Particle Size (µm)	Pore Size (Å)	Column Size (mm) I.D. x Length
F7621101	Asahipak ODP-40 3B	Octadecyl	4	250	3.0 x 50
F7621102	Asahipak ODP-40 3D	Octadecyl	4	250	3.0 x 150
F6714013	Asahipak ODP-40G 3A (guard column)	Octadecyl	4	250	3.0 x 10

Base Material: Polyvinyl alcohol

## Semi-micro columns \*The following semi-micro columns are made to order.

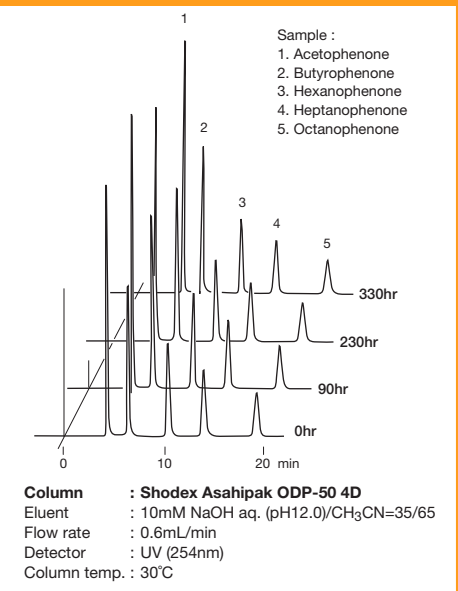
Product Code	Product Name	Functional Group	Particle Size (µm)	Pore Size (Å)	Column Size (mm) I.D. x Length
F7838023	ODP40-2B	Octadecyl	4	250	2.0 x 50
F7838022	ODP40-2D	Octadecyl	4	250	2.0 x 150

Base Material: Polyvinyl alcohol

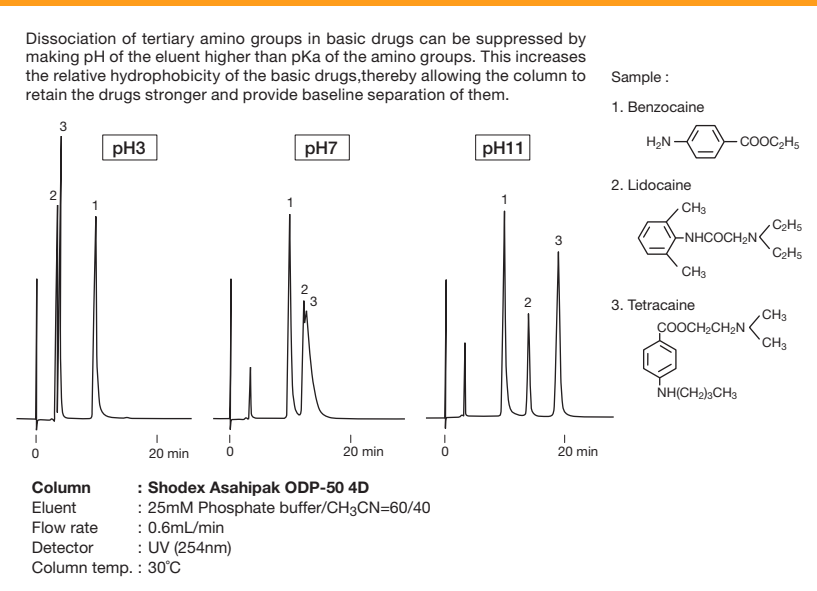
## Preparative columns \*Preparative columns are made to order.

Product Code	Product Name	Plate Number (TP/column)	Particle Size (µm)	Column Size (mm) I.D. x Length	Standard Column
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)
F6820003	Asahipak C8P-50 10E	≥ 8,000	5	10.0 x 250	C8P-50
F6714004	Asahipak C8P-50G 7B	(guard column)	5	7.5 x 50	(guard column)
F6820005	Asahipak C4P-50 10E	≥ 7,000	5	10.0 x 250	C4P-50
F6714005	Asahipak C4P-50G 7B	(guard column)	5	7.5 x 50	(guard column)

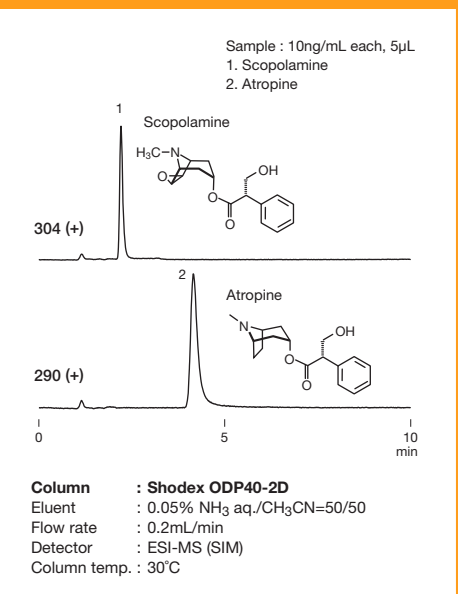
### Alkaline tolerance of ODP-50



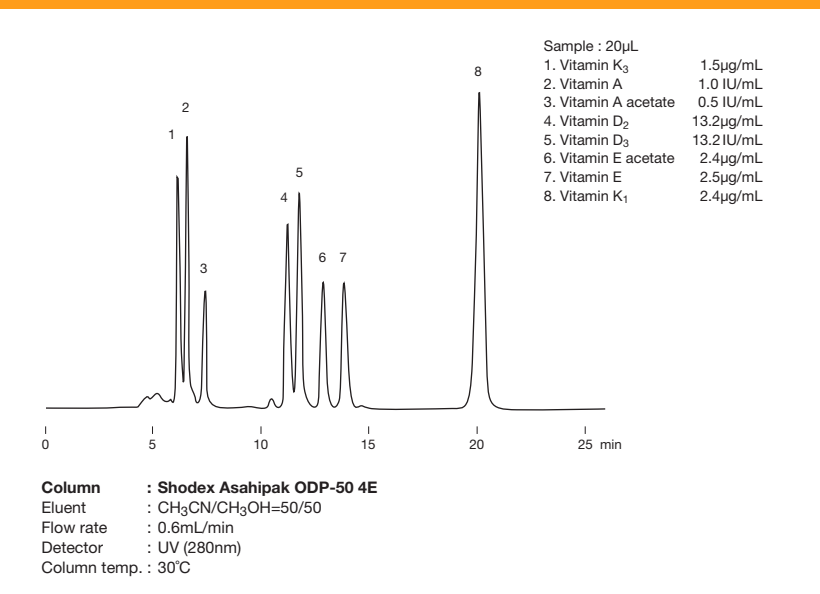
### Local anesthetics



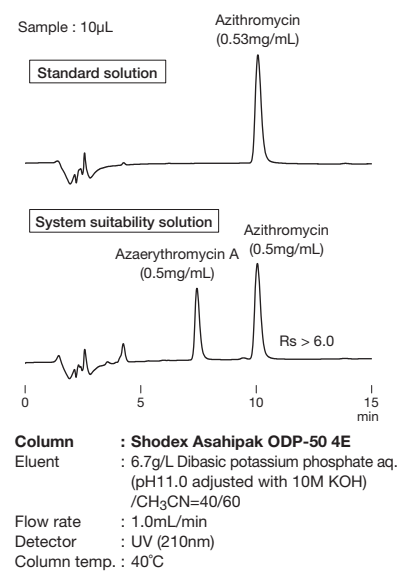
### LC/MS analysis of basic drugs



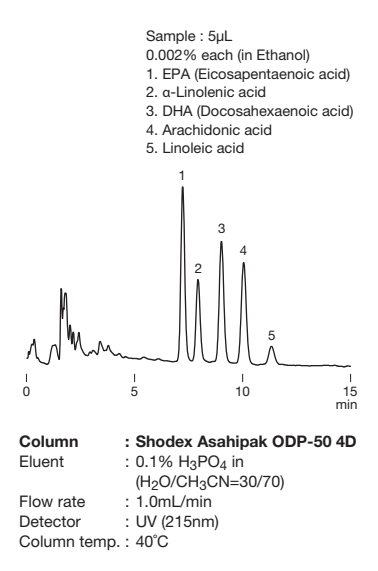
### Fat-soluble vitamins



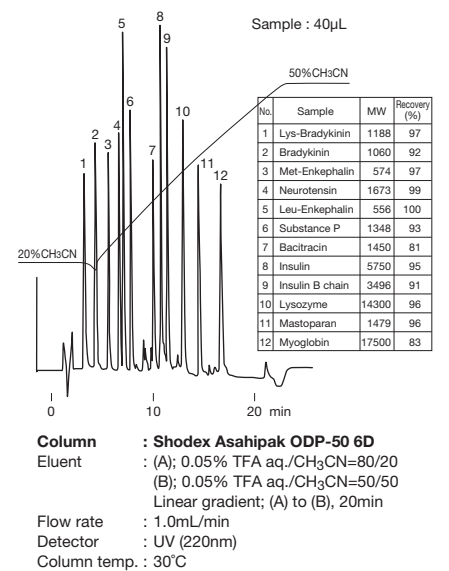
### Analysis of azithromycin following USP method



### Unsaturated fatty acids



### Gradient analysis of proteins and peptides



# 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)	Functional Group	Base Material	Particle Size (µm)	Pore Size (Å)	Column Size (mm) I.D. x Length	Shipping Solvent
F7009000	<b>RSpak RP18-415</b>	≥ 5,000	-	Styrene divinylbenzene copolymer	6	450	<b>4.6 x 150</b>	H <sub>2</sub> O/CH <sub>3</sub> CN=5/95
F6709558	<b>RSpak RP18-G</b>	(guard column)	-	Styrene divinylbenzene copolymer	6	-	<b>4.6 x 10</b>	H <sub>2</sub> O/CH <sub>3</sub> CN/THF=40/30/30
F7001001	<b>RSpak DS-613</b>	≥ 6,500	-	Styrene divinylbenzene copolymer	6	200	<b>6.0 x 150</b>	H <sub>2</sub> O/CH <sub>3</sub> CN/THF=30/40/30
F7001012	<b>RSpak DS-413</b>	≥ 11,000	-	Styrene divinylbenzene copolymer	3.5	200	<b>4.6 x 150</b>	H <sub>2</sub> O/CH <sub>3</sub> CN/THF=40/30/30
F6700140	<b>RSpak DS-G</b>	(guard column)	-	Styrene divinylbenzene copolymer	10	-	<b>4.6 x 10</b>	H <sub>2</sub> O/CH <sub>3</sub> CN/THF=30/40/30
F7001004	<b>RSpak DE-613</b>	≥ 7,000	-	Polymethacrylate	6	25	<b>6.0 x 150</b>	H <sub>2</sub> O
F7001005	<b>RSpak DE-413</b>	≥ 11,000	-	Polymethacrylate	4	25	<b>4.6 x 150</b>	H <sub>2</sub> O/CH <sub>3</sub> CN=50/50
F7009030	<b>RSpak DE-413L</b>	≥ 17,000	-	Polymethacrylate	4	25	<b>4.6 x 250</b>	H <sub>2</sub> O/CH <sub>3</sub> CN=50/50
F6700150	<b>RSpak DE-G 4A (RSpak DE-G)</b>	(guard column)	-	Polymethacrylate	10	-	<b>4.6 x 10</b>	H <sub>2</sub> O
F7001007	<b>RSpak DE-213</b>	≥ 8,000	-	Polymethacrylate	4	25	<b>2.0 x 150</b>	H <sub>2</sub> O/CH <sub>3</sub> CN=50/50
F6700151	<b>RSpak DE-G 2A (RSpak DE-SG)</b>	(guard column)	-	Polymethacrylate	6	-	<b>2.0 x 10</b>	H <sub>2</sub> O/CH <sub>3</sub> CN=50/50
F7001002	<b>RSpak DM-614</b>	≥ 4,500	-	Polyhydroxymethacrylate	10	200	<b>6.0 x 150</b>	5mM H <sub>3</sub> PO <sub>4</sub> aq.
F6700160	<b>RSpak DM-G 4A (RSpak DM-G)</b>	(guard column)	-	Polyhydroxymethacrylate	12	-	<b>4.6 x 10</b>	5mM H <sub>3</sub> PO <sub>4</sub> aq.
F7008140	<b>RSpak NN-814</b>	≥ 9,000	Sulfo	Polyhydroxymethacrylate	10	200	<b>8.0 x 250</b>	0.1M Sodium phosphate buffer (pH3.0)
F7008150	<b>RSpak NN-614</b>	≥ 4,000	Sulfo	Polyhydroxymethacrylate	10	200	<b>6.0 x 150</b>	0.1M Sodium phosphate buffer (pH3.0)
F6700510	<b>RSpak NN-G</b>	(guard column)	Sulfo	Polyhydroxymethacrylate	10	-	<b>6.0 x 50</b>	0.1M Sodium phosphate buffer (pH3.0)
F7008160	<b>RSpak NN-414</b>	≥ 6,000	Sulfo	Polyhydroxymethacrylate	10	200	<b>4.6 x 150</b>	0.1M Sodium phosphate buffer (pH3.0)
F7008240	<b>RSpak JJ-50 4D</b>	≥ 4,500	Quaternary ammonium	Polyvinyl alcohol	5	100	<b>4.6 x 150</b>	H <sub>2</sub> O/CH <sub>3</sub> CN=40/60
F7008220	<b>RSpak JJ-50 2D</b>	≥ 3,500	Quaternary ammonium	Polyvinyl alcohol	5	100	<b>2.0 x 150</b>	H <sub>2</sub> O/CH <sub>3</sub> CN=40/60

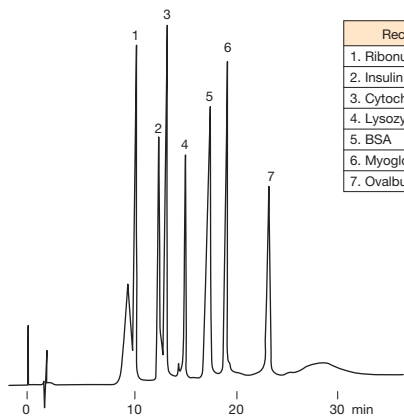
■ **Semi-micro columns** \*The following semi-micro columns are made to order.

Product Code	Product Name	Functional Group	Base Material	Particle Size (µm)	Pore Size (Å)	Column Size (mm) I.D. x Length
F7840123	<b>DE413-2B</b>	-	Polymethacrylate	4	25	<b>2.0 x 50</b>
F7840121	<b>DE413-2E</b>	-	Polymethacrylate	4	25	<b>2.0 x 250</b>
F7860122	<b>NN414-2D</b>	Sulfo	Polyhydroxymethacrylate	10	200	<b>2.0 x 150</b>

■ **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
F6513013	<b>RSpak DE-2013</b>	≥ 10,000	12	<b>20.0 x 300</b>	DE-413, DE-613
F6700190	<b>RSpak DE-G 8B (RSpak DE-LG)</b>	(guard column)	12	<b>8.0 x 50</b>	DE-413, DE-613
F6514014	<b>RSpak DM-2014</b>	≥ 5,000	12	<b>20.0 x 300</b>	DM-614
F6700404	<b>RSpak DM-G 8B (RSpak DM-LG)</b>	(guard column)	12	<b>8.0 x 50</b>	(guard column)

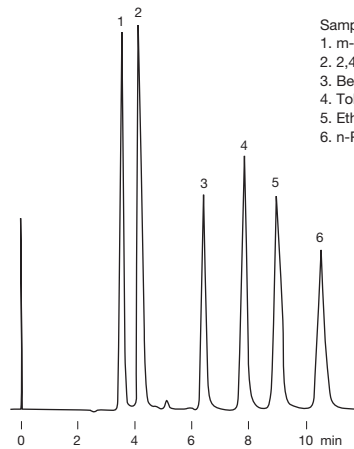
### Separation and recovery rate of standard proteins



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<sub>3</sub>CN=99/1  
 (B); 0.1% TFA aq./CH<sub>3</sub>CN=5/95  
 Linear gradient; (B%) 20% to 60%, 20min  
**Flow rate** : 1.0mL/min  
**Detector** : UV (220nm)  
**Column temp.** : Room temp.

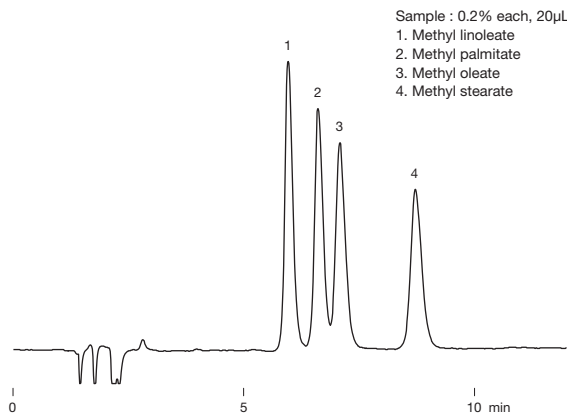
### Alkylbenzenes



Sample : 5µL  
 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<sub>2</sub>O/CH<sub>3</sub>CN/THF=30/40/30  
**Flow rate** : 1.0mL/min  
**Detector** : UV (254nm)  
**Column temp.** : 40°C

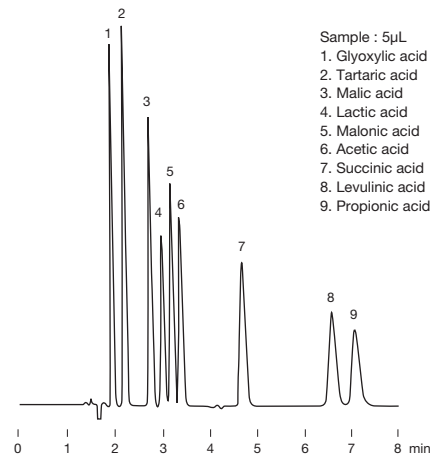
### Fatty acid methyl esters



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

**Column** : Shodex RSpak DS-413  
**Eluent** : H<sub>2</sub>O/CH<sub>3</sub>CN/THF=25/45/30  
**Flow rate** : 1.0mL/min  
**Detector** : RI  
**Column temp.** : 40°C

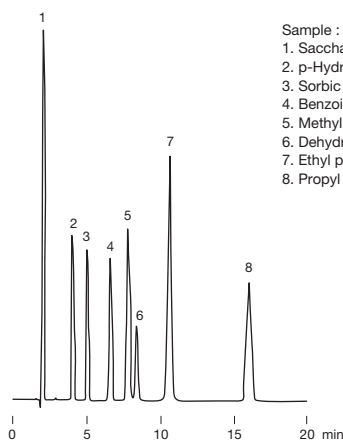
### Organic acids



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

**Column** : Shodex RSpak DE-413  
**Eluent** : 10mM H<sub>3</sub>PO<sub>4</sub> aq.  
**Flow rate** : 1.0mL/min  
**Detector** : RI  
**Column temp.** : 50°C

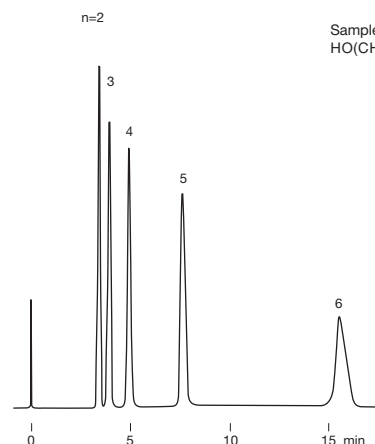
### Food additives (Preservatives)



Sample : 10µL  
 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** : 50mM KH<sub>2</sub>PO<sub>4</sub> + 0.1% H<sub>3</sub>PO<sub>4</sub> aq./CH<sub>3</sub>CN=65/35  
**Flow rate** : 1.0mL/min  
**Detector** : UV (210nm)  
**Column temp.** : 40°C

### Diols

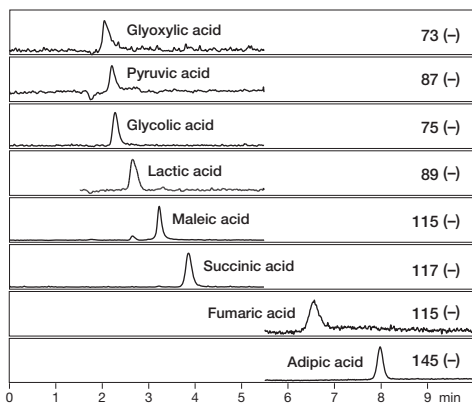


Sample : 1% each, 7.5µL  
 HO(CH<sub>2</sub>)<sub>n</sub>OH

**Column** : Shodex RSpak DE-613  
**Eluent** : H<sub>2</sub>O  
**Flow rate** : 1.0mL/min  
**Detector** : RI  
**Column temp.** : 60°C



### LC/MS analysis of organic acids

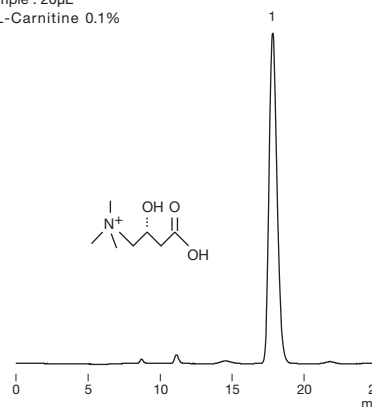
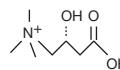


Sample : 50ng/mL each, 10µL

**Column** : Shodex RSpak DE-213  
**Eluent** : (A); 0.1% (v/v) Formic acid aq./ (B); CH<sub>3</sub>CN  
 Linear gradient; (B%) 5% (0min) → 5% (2min) → 15% (2.5min) → 15% (10min)  
**Flow rate** : 0.2mL/min  
**Detector** : ESI-MS (SIM)  
**Column temp.** : 30°C

### Carnitine

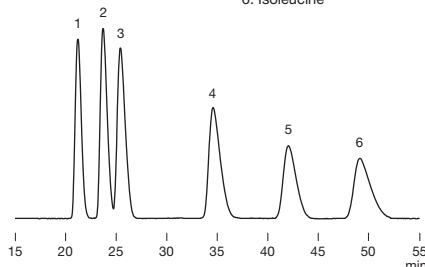
Sample : 20µL  
 1. L-Carnitine 0.1%



**Column** : Shodex RSpak NN-814  
**Eluent** : 0.1M H<sub>3</sub>PO<sub>4</sub> aq.  
**Flow rate** : 1.0mL/min  
**Detector** : UV (210nm)  
**Column temp.** : 25°C

### Amino acids

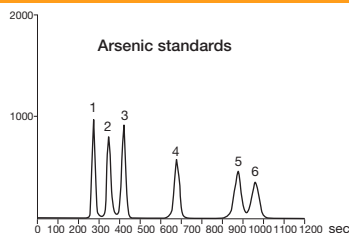
Sample : 0.1% each, 20µL  
 1. Aspartic acid  
 2. Glycine  
 3. Alanine  
 4. Valine  
 5. Methionine  
 6. Isoleucine



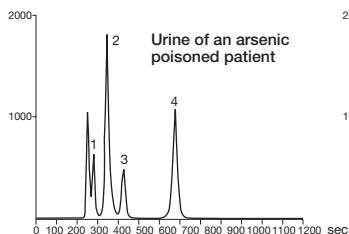
**Column** : Shodex RSpak NN-814  
**Eluent** : 40mM H<sub>3</sub>PO<sub>4</sub> aq.  
**Flow rate** : 1.0mL/min  
**Detector** : RI  
**Column temp.** : 40°C

### Speciation of arsenic

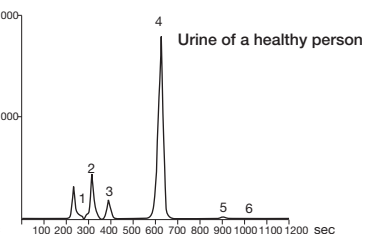
#### Arsenic standards



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



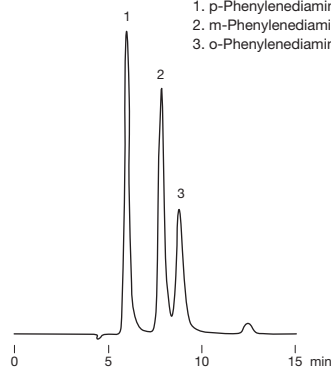
**Column** : Shodex RSpak NN-614  
**Eluent** : 5mM HNO<sub>3</sub>/8mM NH<sub>4</sub>NO<sub>3</sub> aq.  
**Flow rate** : 0.8mL/min  
**Detector** : ICP-MS (SIM m/z 75)



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

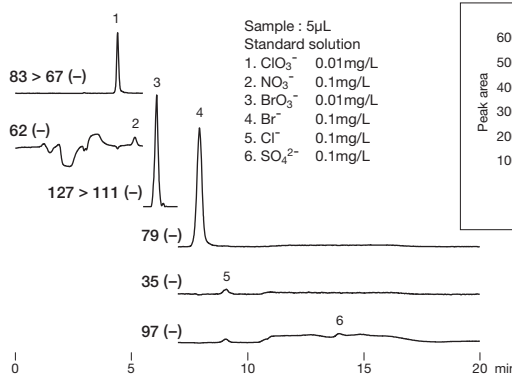
### Phenylenediamine isomers

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

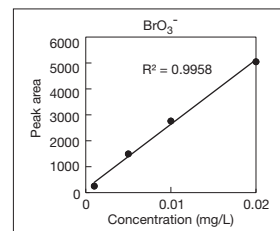


**Column** : Shodex RSpak JJ-50 4D  
**Eluent** : 25mM Ammonium acetate buffer  
 (pH9.2)/CH<sub>3</sub>CN=70/30  
**Flow rate** : 0.4mL/min  
**Detector** : UV (254nm)  
**Column temp.** : 30°C

### High sensitive analysis of bromate by LC/MS/MS



Sample : 5µL  
 Standard solution  
 1. ClO<sub>3</sub><sup>-</sup> 0.01mg/L  
 2. NO<sub>3</sub><sup>-</sup> 0.1mg/L  
 3. BrO<sub>3</sub><sup>-</sup> 0.01mg/L  
 4. Br<sup>-</sup> 0.1mg/L  
 5. Cl<sup>-</sup> 0.1mg/L  
 6. SO<sub>4</sub><sup>2-</sup> 0.1mg/L



**Column** : Shodex RSpak JJ-50 2D  
**Eluent** : (A); 200mM HCOONH<sub>4</sub> aq./ (B); CH<sub>3</sub>CN  
 Linear gradient (High pressure);  
 (B%) 85% (0min) → 85% (8min) → 50% (9min) → 50% (14min) → 85% (15min) → 85% (20min)  
**Flow rate** : 0.3mL/min  
**Detector** : ESI-MS/MS (MRM) for ClO<sub>3</sub><sup>-</sup>, BrO<sub>3</sub><sup>-</sup>  
 ESI-MS (SIM) for NO<sub>3</sub><sup>-</sup>, Br<sup>-</sup>, Cl<sup>-</sup>, SO<sub>4</sub><sup>2-</sup>  
**Column temp.** : 50°C

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

## Features

- VG-50**
- Suitable for saccharides and polar sample 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**
- Multimodal - combines HILIC with anion exchange
  - Suitable for analysis of anionic substances including phosphorylated saccharides and metabolites
  - Use of some eluents add ion exchange mode
  - Polymer-based packing material provides excellent chemical stability and minimum deterioration over an extended time period
  - Packed in PEEK and suitable for LC/MS analysis

- New VC-50**
- Modified carboxyl group is suitable for cationic substance analysis including amines, amino acids and sugars
  - The dominant separation mode is RP using HILIC mode as secondary- least polar column of HILICpak
  - Polymer-based packing material provides stability and minimal deterioration over time

- New VN-50**
- The modified diol groups on the packing material create the HILIC mode suitable for polar compounds
  - Targeted for oligosaccharide and oligonucleotide analysis which is not possible by SEC column or conventional HILIC columns

## Standard columns

### VG-50

(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	<b>HILICpak VG-50 4D</b>	≥ 5,500	Amino	5	100	<b>4.6 × 150</b>	H <sub>2</sub> O/CH <sub>3</sub> CN=20/80
F7630100	<b>HILICpak VG-50 4E</b>	≥ 7,500	Amino	5	100	<b>4.6 × 250</b>	H <sub>2</sub> O/CH <sub>3</sub> CN=20/80
F6711100	<b>HILICpak VG-50G 4A</b>	(guard column)	Amino	5	100	<b>4.6 × 10</b>	H <sub>2</sub> O/CH <sub>3</sub> CN=20/80

(Housing Material: PEEK)

Base Material: Polyvinyl alcohol

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	<b>HILICpak VG-50 2D</b>	≥ 3,500	Amino	5	100	<b>2.0 × 150</b>	H <sub>2</sub> O/CH <sub>3</sub> CN=15/85
F6711200	<b>HILICpak VG-50G 2A</b>	(guard column)	Amino	5	100	<b>2.0 × 10</b>	H <sub>2</sub> O/CH <sub>3</sub> CN=15/85

### VT-50

(Housing Material: PEEK)

Base Material: Polyvinyl alcohol

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	<b>HILICpak VT-50 2D</b>	≥ 4,500	Quaternary ammonium	5	100	<b>2.0 × 150</b>	25mM HCOONH <sub>4</sub> aq. /CH <sub>3</sub> CN=15/85
F6711300	<b>HILICpak VT-50G 2A</b>	(guard column)	Quaternary ammonium	5	100	<b>2.0 × 10</b>	25mM HCOONH <sub>4</sub> aq. /CH <sub>3</sub> CN=15/85

### VC-50

(Housing Material: PEEK)

Base Material: Polyvinyl alcohol

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	<b>New HILICpak VC-50 2D</b>	≥ 3,500	Carboxyl	5	100	<b>2.0 × 150</b>	H <sub>2</sub> O
F6711600	<b>New HILICpak VC-50G 2A</b>	(guard column)	Carboxyl	5	100	<b>2.0 × 10</b>	H <sub>2</sub> O

### VN-50

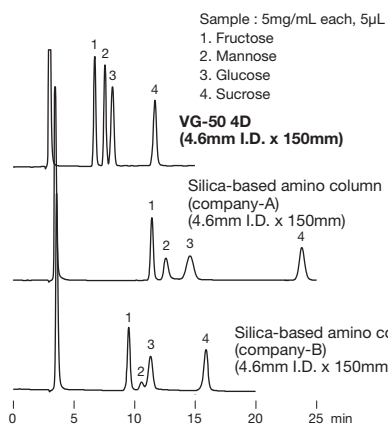
(Housing Material: PEEK)

Base Material: Polyvinyl alcohol

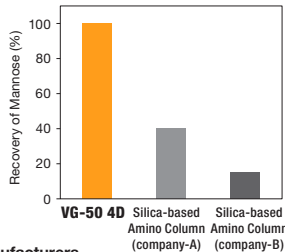
Product Code	Product Name	Plate Number (TP/column)	Functional Group	Particle Size (µm)	Pore Size (Å)	Column Size (mm) I.D. x Length	Shipping Solvent
F7630600	<b>New HILICpak VN-50 2D</b>	≥ 3,500	Diol	5	100	<b>2.0 × 150</b>	H <sub>2</sub> O/CH <sub>3</sub> CN=25/75
F6711500	<b>New HILICpak VN-50G 2A</b>	(guard column)	Diol	5	100	<b>2.0 × 10</b>	H <sub>2</sub> O/CH <sub>3</sub> CN=25/75
F7630500	<b>New HILICpak VN-50 4D</b>	≥ 10,000	Diol	5	100	<b>4.6 × 150</b>	H <sub>2</sub> O/CH <sub>3</sub> CN=25/75
F6711400	<b>New HILICpak VN-50G 4A</b>	(guard column)	Diol	5	100	<b>4.6 × 10</b>	H <sub>2</sub> O/CH <sub>3</sub> CN=25/75

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

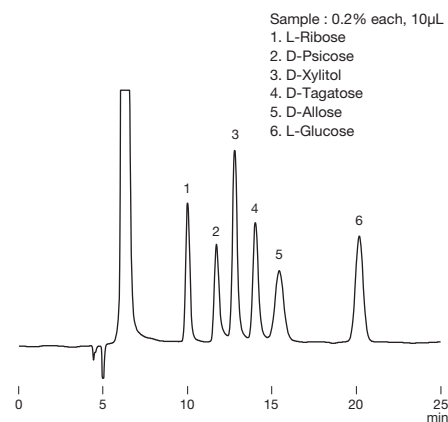
**Eluent** : H<sub>2</sub>O/CH<sub>3</sub>CN=20/80

**Flow rate** : 0.6mL/min (VG-50 4D)  
1.0mL/min (Silica based amino column)

**Detector** : RI

**Column temp.** : 40°C

### Rare sugar



**Column** : Shodex HILICpak VG-50 4E

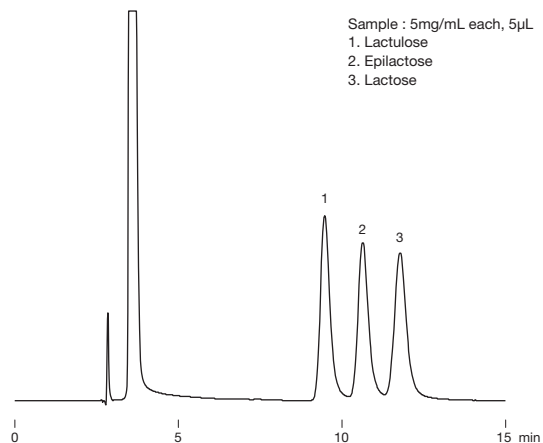
**Eluent** : H<sub>2</sub>O/CH<sub>3</sub>CN/CH<sub>3</sub>OH=5/85/10

**Flow rate** : 0.6mL/min

**Detector** : RI

**Column temp.** : 50°C

### Lactose, epilactose, and lactulose



**Column** : Shodex HILICpak VG-50 4E

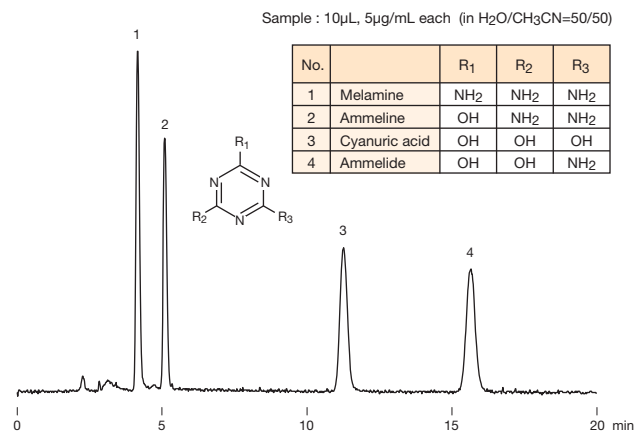
**Eluent** : H<sub>2</sub>O/CH<sub>3</sub>CN/CH<sub>3</sub>OH=5/75/20

**Flow rate** : 1.0mL/min

**Detector** : RI

**Column temp.** : 40°C

### Melamine and related substances



**Column** : Shodex HILICpak VG-50 4D

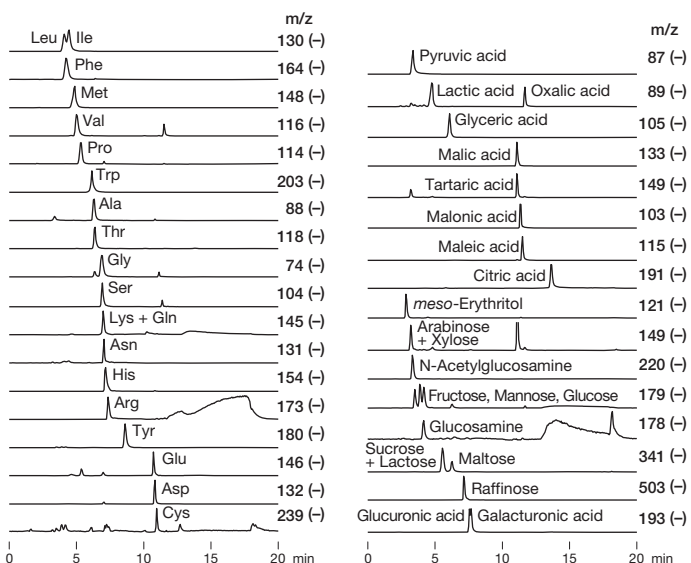
**Eluent** : 30mM HCOONH<sub>4</sub> aq./CH<sub>3</sub>CN=35/65

**Flow rate** : 0.6mL/min

**Detector** : Corona charged aerosol

**Column temp.** : 40°C

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



Sample : 1µg/mL each (in H<sub>2</sub>O/CH<sub>3</sub>CN=1/4), 5µL

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

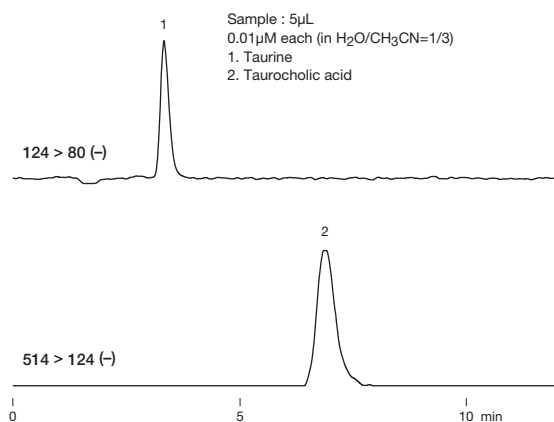
**Eluent** : (A); 0.5% NH<sub>3</sub> aq./ (B); CH<sub>3</sub>CN  
Linear gradient (High pressure);  
(B%) 80% (0 to 2min), 80% to 10% (2 to 12min),  
10% (12 to 15min), 80% (15 to 20min)

**Flow rate** : 0.2mL/min

**Detector** : ESI-MS (SIM)

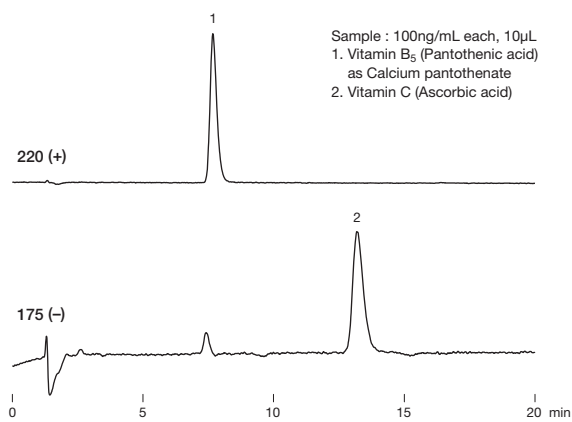
**Column temp.** : 40°C

### LC/MS/MS analysis of organic sulfonic acids



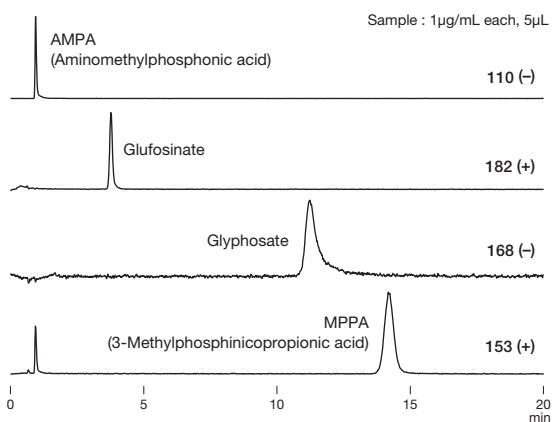
**Column** : Shodex HILICpak VT-50 2D  
**Eluent** : 50mM HCOONH<sub>4</sub> aq./CH<sub>3</sub>CN=20/80  
**Flow rate** : 0.3mL/min  
**Detector** : ESI-MS/MS (MRM)  
**Column temp.** : 30°C

### LC/MS analysis of pantothenic acid and vitamin C



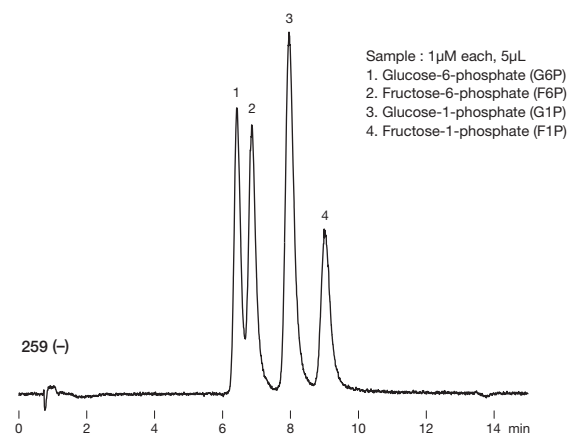
**Column** : Shodex HILICpak VT-50 2D  
**Eluent** : 50mM HCOONH<sub>4</sub> aq./CH<sub>3</sub>CN=30/70  
**Flow rate** : 0.2mL/min  
**Detector** : ESI-MS (SIM)  
**Column temp.** : 30°C

### LC/MS analysis of glyphosate and glufosinate



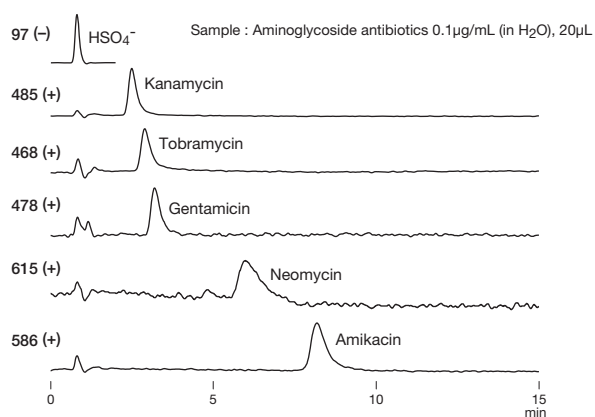
**Column** : Shodex HILICpak VT-50 2D  
**Eluent** : H<sub>2</sub>O/1% HCOOH aq./CH<sub>3</sub>CN=70/20/10  
**Flow rate** : 0.3mL/min  
**Detector** : ESI-MS (SIM)  
**Column temp.** : 40°C

### LC/MS analysis of phosphorylated saccharides



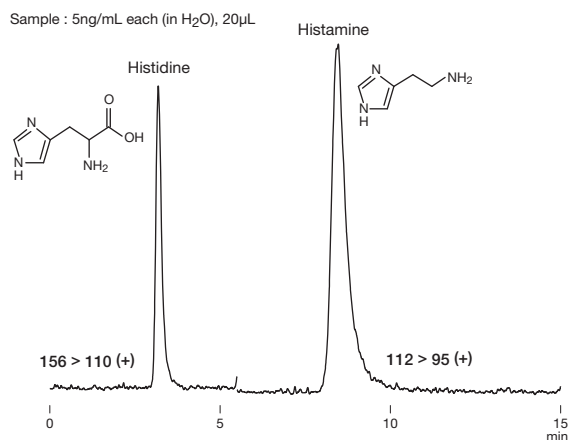
**Column** : Shodex HILICpak VT-50 2D  
**Eluent** : 25mM HCOONH<sub>4</sub> aq./CH<sub>3</sub>CN=80/20  
**Flow rate** : 0.3mL/min  
**Detector** : ESI-MS (SIM)  
**Column temp.** : 60°C

### LC/MS analysis of aminoglycoside antibiotics



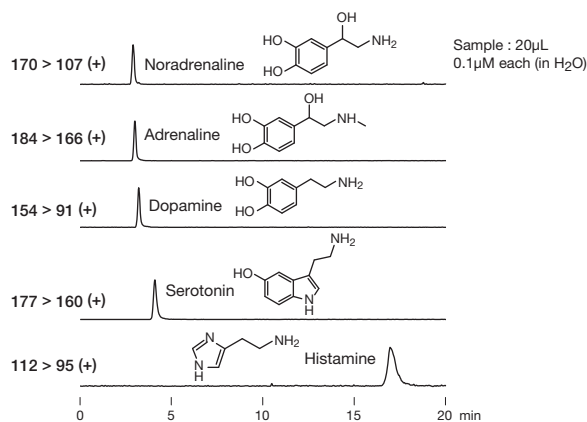
**Column** : Shodex HILICpak VC-50 2D  
**Eluent** : (A); 1.5% NH<sub>3</sub> aq./ (B); CH<sub>3</sub>CN  
Linear gradient (High pressure);  
(B%) 30% to 10% (0 to 5min), 10% (5 to 15min)  
**Flow rate** : 0.3mL/min  
**Detector** : ESI-MS (SIM)  
**Column temp.** : 40°C

### LC/MS/MS analysis of histamine and histidine



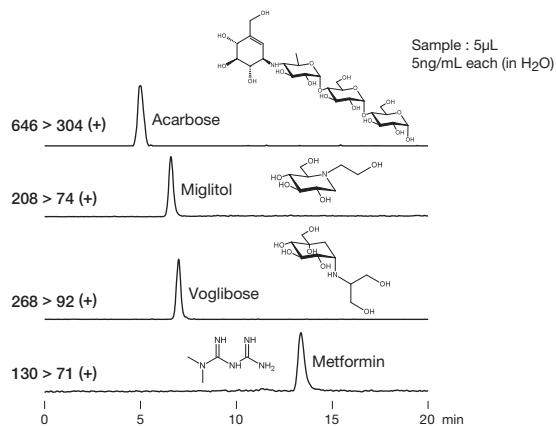
**Column** : Shodex HILICpak VC-50 2D  
**Eluent** : 250mM HCOOH aq./CH<sub>3</sub>CN=70/30  
**Flow rate** : 0.3mL/min  
**Detector** : ESI-MS/MS (MRM)  
**Column temp.** : 40°C

### LC/MS/MS analysis of monoamine neurotransmitters



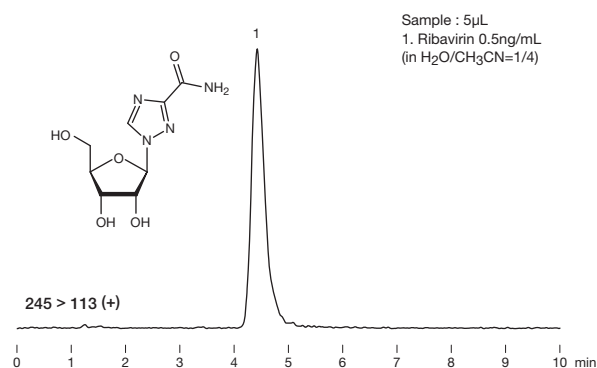
**Column** : Shodex HILICpak VC-50 2D  
**Eluent** : (A); 200mM HCOOH aq./ (B); CH<sub>3</sub>CN  
 Linear gradient (High pressure);  
 (B%) 60% (0 to 5min), 60% to 10% (5 to 6min), 10% (6 to 20min)  
**Flow rate** : 0.3mL/min  
**Detector** : ESI-MS/MS (MRM)  
**Column temp.** : 40°C

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



**Column** : Shodex HILICpak VC-50 2D  
**Eluent** : (A); 200mM HCOOH aq./ (B); CH<sub>3</sub>CN  
 Linear gradient (High pressure);  
 (B%) 60% (0 to 5min), 60% to 20% (5 to 6min), 20% (6 to 20min)  
**Flow rate** : 0.3mL/min  
**Detector** : ESI-MS/MS (MRM)  
**Column temp.** : 40°C

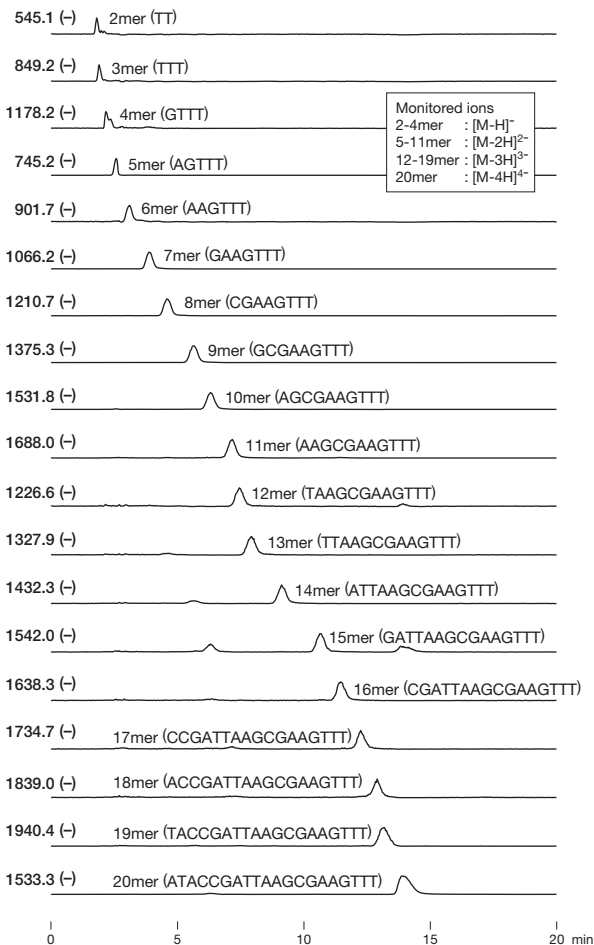
### LC/MS/MS analysis of ribavirin



**Column** : Shodex HILICpak VC-50 2D  
**Eluent** : 50mM HCOOH aq./CH<sub>3</sub>CN=10/90  
**Flow rate** : 0.25mL/min  
**Detector** : ESI-MS/MS (MRM)  
**Column temp.** : 40°C

### LC/MS analysis of oligo DNA

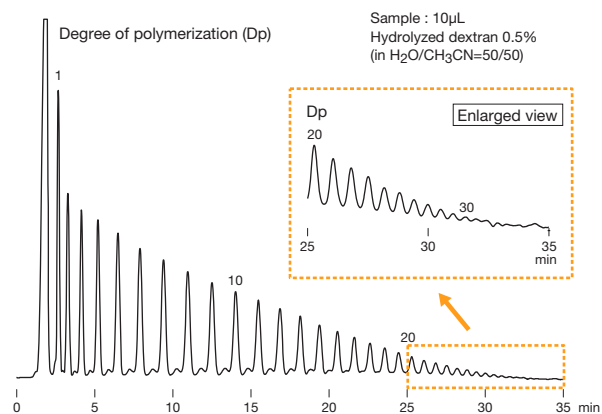
Sample : 1µL  
 Synthesized oligo DNA 20mer (ATACCGATTAAGCGAAGTTT; crude)  
 2.2mg/mL (in H<sub>2</sub>O)



Monitored ions  
 2-4mer : [M-H]<sup>-</sup>  
 5-11mer : [M-2H]<sup>2-</sup>  
 12-19mer : [M-3H]<sup>3-</sup>  
 20mer : [M-4H]<sup>4-</sup>

**Column** : Shodex HILICpak VN-50 2D  
**Eluent** : (A); 50mM HCOONH<sub>4</sub> aq./ (B); CH<sub>3</sub>CN  
 Linear gradient ;  
 (B%) 60% (0 to 10min), 60% to 55% (10 to 15min),  
 60% (15 to 20min)  
**Flow rate** : 0.2mL/min  
**Detector** : ESI-MS (SIM)  
**Column temp.** : 40°C

### Hydrolyzed dextran



**Column** : Shodex HILICpak VN-50 4D  
**Eluent** : (A); H<sub>2</sub>O/ (B); CH<sub>3</sub>CN  
 Linear gradient ; (B) 70% to 50% (0 to 40min)  
**Flow rate** : 1.0mL/min  
**Detector** : Corona charged aerosol  
**Column temp.** : 40°C

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

## Features

- NH2P**
- 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	<b>Asahipak NH2P-50 4B</b>	≥ 1,500	Amino	5	100	<b>4.6 x 50</b>	CH <sub>3</sub> CN
F7630002	<b>Asahipak NH2P-50 4D</b>	≥ 5,500	Amino	5	100	<b>4.6 x 150</b>	CH <sub>3</sub> CN
F7630001	<b>Asahipak NH2P-50 4E</b>	≥ 7,500	Amino	5	100	<b>4.6 x 250</b>	CH <sub>3</sub> CN
F6710016	<b>Asahipak NH2P-50G 4A</b>	(guard column)	Amino	5	–	<b>4.6 x 10</b>	CH <sub>3</sub> CN
F7630006	<b>Asahipak NH2P-50 2D</b>	≥ 3,500	Amino	5	100	<b>2.0 x 150</b>	CH <sub>3</sub> CN
F6713000	<b>Asahipak NH2P-50G 2A</b>	(guard column)	Amino	5	–	<b>2.0 x 10</b>	CH <sub>3</sub> CN
F7630007	<b>Asahipak NH2P-40 3E</b>	≥ 8,500	Amino	4	100	<b>3.0 x 250</b>	CH <sub>3</sub> CN
F6710030	<b>Asahipak NH2P-50G 3A</b>	(guard column)	Amino	5	–	<b>3.0 x 10</b>	CH <sub>3</sub> CN
F7630008	<b>Asahipak NH2P-40 2B</b>	≥ 2,000	Amino	4	100	<b>2.0 x 50</b>	CH <sub>3</sub> CN
F7630009	<b>Asahipak NH2P-40 2D</b>	≥ 5,500	Amino	4	100	<b>2.0 x 150</b>	CH <sub>3</sub> CN
F7630010	<b>Asahipak NH2P-40 2E</b>	≥ 7,000	Amino	4	100	<b>2.0 x 250</b>	CH <sub>3</sub> CN
F6710100	<b>Asahipak NH2P-LF</b>	(line filter)	Amino	–	–	<b>8.0 x 75</b>	CH <sub>3</sub> CN

Base Material: Polyvinyl alcohol

## 3mm I.D columns [Customized columns]

Product Code	Product Name	Functional Group	Particle Size (µm)	Pore Size (Å)	Column Size (mm) I.D. x Length
F7630011	<b>Asahipak NH2P-40 3B</b>	Amino	4	100	<b>3.0 x 50</b>
F7630012	<b>Asahipak NH2P-40 3D</b>	Amino	4	100	<b>3.0 x 150</b>

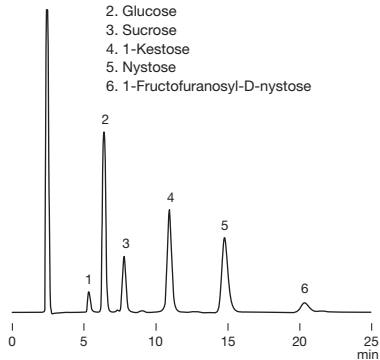
Base Material: Polyvinyl alcohol

## 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
F6830001	<b>Asahipak NH2P-50 10E</b>	≥ 10,000	5	<b>10.0 x 250</b>	NH2P-50
F6710016	<b>Asahipak NH2P-50G 4A</b>	(guard column)	5	<b>4.6 x 10</b>	(guard column)
F6830031	<b>Asahipak NH2P-90 20F</b>	≥ 10,000	9	<b>20.0 x 300</b>	NH2P-50
F6710017	<b>Asahipak NH2P-130G 7B</b>	(guard column)	13	<b>7.5 x 50</b>	(guard column)

### Fructooligosaccharide syrup

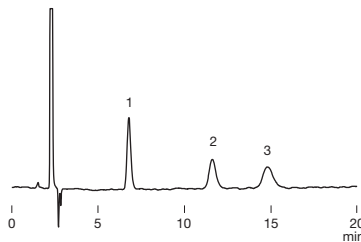
Sample : Fructooligosaccharide syrup, 2.5%, 20 $\mu$ L  
 1. Fructose  
 2. Glucose  
 3. Sucrose  
 4. 1-Kestose  
 5. Nystose  
 6. 1-Fructofuranosyl-D-nystose



Column : Shodex Asahipak NH2P-50 4E  
 Eluent : H<sub>2</sub>O/CH<sub>3</sub>CN=30/70  
 Flow rate : 1.0mL/min  
 Detector : RI  
 Column temp. : 25°C

### Cyclodextrins

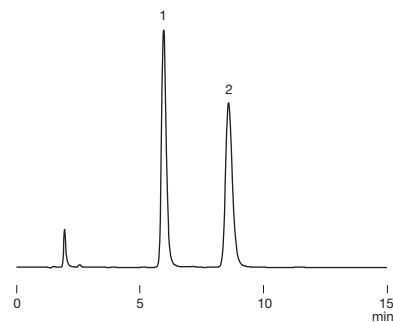
Sample : 250 $\mu$ g/mL each, 20 $\mu$ L  
 1.  $\alpha$ -Cyclodextrin  
 2.  $\gamma$ -Cyclodextrin  
 3.  $\beta$ -Cyclodextrin



Column : Shodex Asahipak NH2P-50 4E  
 Eluent : H<sub>2</sub>O/CH<sub>3</sub>CN=40/60  
 Flow rate : 1.0mL/min  
 Detector : RI  
 Column temp. : 40°C

### Stevioside and rebaudioside A

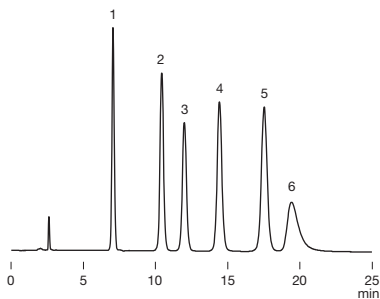
Sample : 0.05% each, 20 $\mu$ L  
 1. Stevioside  
 2. Rebaudioside A



Column : Shodex Asahipak NH2P-50 4E  
 Eluent : H<sub>2</sub>O/CH<sub>3</sub>CN=25/75  
 Flow rate : 1.0mL/min  
 Detector : UV (210nm)  
 Column temp. : 30°C

### Imidazole dipeptides

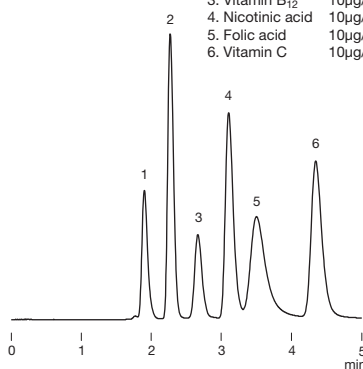
Sample : 20 $\mu$ L  
 1.  $\beta$ -Alanine 200 $\mu$ g/mL  
 2. 1-Methyl-L-histidine 2 $\mu$ g/mL  
 3. L-Anserine 5 $\mu$ g/mL  
 4. Histidine 5 $\mu$ g/mL  
 5. L-Carnosine 5 $\mu$ g/mL  
 6. Nitrate (derived from L-Anserine Nitrate)



Column : Shodex Asahipak NH2P-50 4E  
 Eluent : 50mM NaH<sub>2</sub>PO<sub>4</sub> aq./CH<sub>3</sub>CN=40/60  
 Flow rate : 1.0mL/min  
 Detector : UV (210nm)  
 Column temp. : 40°C

### Simultaneous analysis of water-soluble vitamins

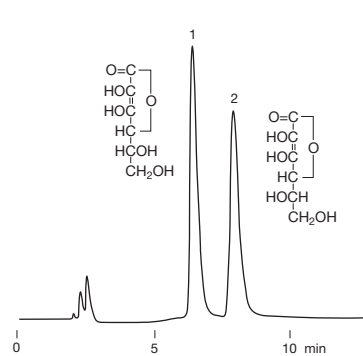
Sample : 20 $\mu$ L  
 1. Vitamin B<sub>6</sub> 50 $\mu$ g/mL  
 2. Nicotinamide 10 $\mu$ g/mL  
 3. Vitamin B<sub>12</sub> 10 $\mu$ g/mL  
 4. Nicotinic acid 10 $\mu$ g/mL  
 5. Folic acid 10 $\mu$ g/mL  
 6. Vitamin C 10 $\mu$ g/mL



Column : Shodex Asahipak NH2P-50 4E  
 Eluent : 40mM H<sub>3</sub>PO<sub>4</sub> aq./CH<sub>3</sub>CN=45/55  
 Flow rate : 1.0mL/min  
 Detector : UV (254nm)  
 Column temp. : 40°C

### Ascorbic acid and erythorbic acid

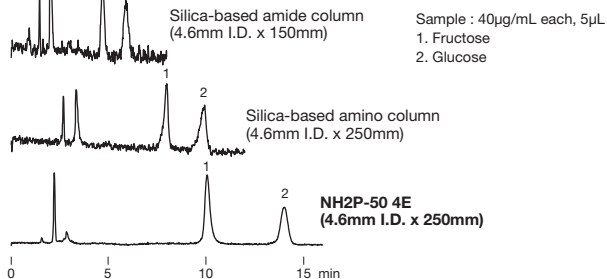
Sample : 5 $\mu$ g/mL each, 10 $\mu$ L  
 1. Erythorbic acid  
 2. L-Ascorbic acid



Column : Shodex Asahipak NH2P-50 4E  
 Eluent : 20mM NaH<sub>2</sub>PO<sub>4</sub> + 30mM H<sub>3</sub>PO<sub>4</sub> aq./CH<sub>3</sub>CN=20/80  
 Flow rate : 1.0mL/min  
 Detector : UV (254nm)  
 Column temp. : 30°C

### Comparison of saccharide analysis using corona charged aerosol detector

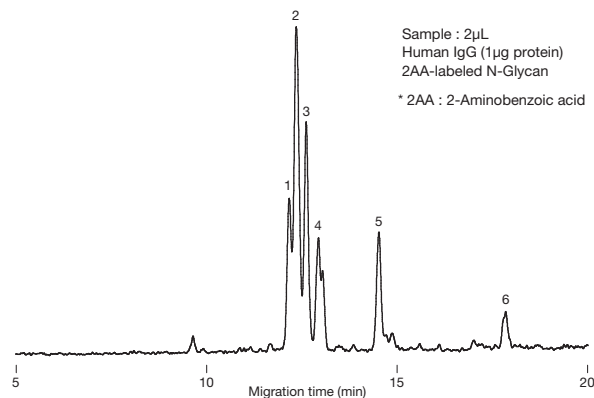
A corona charged aerosol detector measures effluents as particles. Thus, the baseline is significantly affected by all components eluted from the column. The NH2P series polymer-based amino column eliminates insignificant amount of interfering components from the column. This results in providing stable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



Column : Shodex Asahipak NH2P-50 4E  
 Silica based amino column from other manufacturer  
 Silica based amide column from other manufacturer  
 Eluent : H<sub>2</sub>O/CH<sub>3</sub>CN=20/80  
 Flow rate : 1.0mL/min  
 Detector : Corona charged aerosol  
 Column temp : 30°C (NH2P-50 4E, Silica based amino column)  
 80°C (Silica based amide column)

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

Sample : 2 $\mu$ L  
 Human IgG (1 $\mu$ g protein)  
 2AA-labeled N-Glycan  
 \* 2AA : 2-Aminobenzoic acid



Column : Shodex Asahipak NH2P-40 2D  
 Eluent : (A); 95% CH<sub>3</sub>CN/0.1% Formic acid aq.  
 (B); 5% CH<sub>3</sub>CN/0.1% Formic acid aq.  
 Linear gradient; (B%) 30% (0-2.5min), 30-95% (2.5-20min)  
 Flow rate : 0.2mL/min  
 Detector : ESI-TOF MS (Polarity : Negative, Full MS range : 2000)  
 Column temp. : 45°C

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	<b>C18-4D</b>	≥ 13,000	Octadecyl	5	17	120	<b>4.6 x 150</b>	H <sub>2</sub> O/CH <sub>3</sub> OH=25/75
F6651011	<b>C18-4E</b>	≥ 21,000	Octadecyl	5	17	120	<b>4.6 x 250</b>	H <sub>2</sub> O/CH <sub>3</sub> OH=25/75
F6650040	<b>Silica C18M 4D</b>	≥ 10,000	Octadecyl	5	16	100	<b>4.6 x 150</b>	H <sub>2</sub> O/CH <sub>3</sub> OH=30/70
F6650041	<b>Silica C18M 4E</b>	≥ 16,000	Octadecyl	5	16	100	<b>4.6 x 250</b>	H <sub>2</sub> O/CH <sub>3</sub> OH=30/70
F6650042	<b>Silica C18M 2D</b>	≥ 9,000	Octadecyl	5	16	100	<b>2.0 x 150</b>	H <sub>2</sub> O/CH <sub>3</sub> CN=40/60
F6650045	<b>Silica C18P 4D</b>	≥ 10,000	Octadecyl	5	17	100	<b>4.6 x 150</b>	H <sub>2</sub> O/CH <sub>3</sub> OH=30/70
F6650046	<b>Silica C18P 4E</b>	≥ 16,000	Octadecyl	5	17	100	<b>4.6 x 250</b>	H <sub>2</sub> O/CH <sub>3</sub> OH=30/70
F6650047	<b>Silica C18P 2D</b>	≥ 9,000	Octadecyl	5	17	100	<b>2.0 x 150</b>	H <sub>2</sub> O/CH <sub>3</sub> CN=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	<b>Silica C18M 10E</b>	≥ 16,000	5	<b>10.0 x 250</b>	C18M
F7560041	<b>Silica C18M 20E</b>	≥ 16,000	5	<b>20.0 x 250</b>	C18M

# 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	<b>Silica 5C8 4D</b>	≥ 9,000	Octyl	5	10	100	<b>4.6 x 150</b>	H <sub>2</sub> O/CH <sub>3</sub> OH=34/66
F6650053	<b>Silica 5C8 4E</b>	≥ 15,000	Octyl	5	10	100	<b>4.6 x 250</b>	H <sub>2</sub> O/CH <sub>3</sub> OH=34/66
F6650058	<b>Silica 5CN 4D</b>	≥ 7,000	Cyanopropyl	5	–	100	<b>4.6 x 150</b>	H <sub>2</sub> O/CH <sub>3</sub> OH=60/40
F6650059	<b>Silica 5CN 4E</b>	≥ 12,000	Cyanopropyl	5	–	100	<b>4.6 x 250</b>	H <sub>2</sub> O/CH <sub>3</sub> OH=60/40
F6650062	<b>Silica 5NPE 4D</b>	≥ 8,000	Nitrophenylethyl	5	–	100	<b>4.6 x 150</b>	H <sub>2</sub> O/CH <sub>3</sub> OH=45/55
F6650063	<b>Silica 5PYE 4D</b>	≥ 7,000	Pyrenylethyl	5	–	100	<b>4.6 x 150</b>	H <sub>2</sub> O/CH <sub>3</sub> OH=30/70

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
F7560062	<b>Silica 5C8 10E</b>	≥ 15,000	5	<b>10.0 x 250</b>	5C8
F7560063	<b>Silica 5C8 20E</b>	≥ 15,000	5	<b>20.0 x 250</b>	5C8



# 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

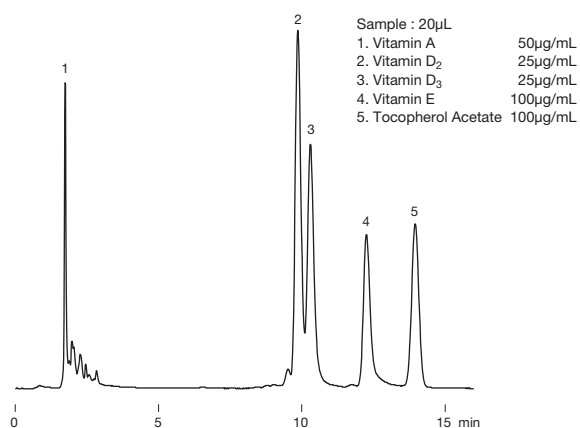
Product Code	Product Name	Plate Number (TP/column)	Functional Group	Particle Size (µm)	Carbon Load (%)	Pore Size (Å)	Column Size (mm) I.D. x Length	Shipping Solvent
F6650050	<b>Silica 5SIL 4D</b>	≥ 9,000	–	5	–	100	<b>4.6 x 150</b>	C <sub>6</sub> H <sub>14</sub> /C <sub>2</sub> H <sub>5</sub> OH=95/5
F6650051	<b>Silica 5SIL 4E</b>	≥ 15,000	–	5	–	100	<b>4.6 x 250</b>	C <sub>6</sub> H <sub>14</sub> /C <sub>2</sub> H <sub>5</sub> OH=95/5
F6650060	<b>Silica 5NH 4D</b>	≥ 5,000	Aminopropyl	5	–	100	<b>4.6 x 150</b>	H <sub>2</sub> O/CH <sub>3</sub> CN=5/95
F6650061	<b>Silica 5NH 4E</b>	≥ 8,000	Aminopropyl	5	–	100	<b>4.6 x 250</b>	H <sub>2</sub> O/CH <sub>3</sub> CN=5/95

Base Material: Silica

## Preparative columns \*Preparative columns are made to order.

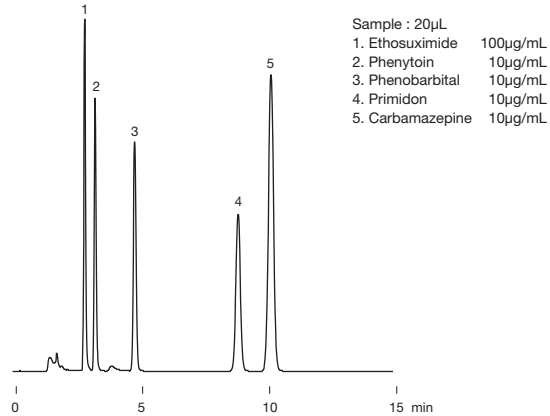
Product Code	Product Name	Plate Number (TP/column)	Particle Size (µm)	Column Size (mm) I.D. x Length	Standard Column
F7560050	<b>Silica 5SIL 10E</b>	≥ 15,000	5	<b>10.0 x 250</b>	5SIL
F7560051	<b>Silica 5SIL 20E</b>	≥ 15,000	5	<b>20.0 x 250</b>	5SIL
F7560060	<b>Silica 5NH 10E</b>	≥ 8,000	5	<b>10.0 x 250</b>	5NH
F7560061	<b>Silica 5NH 20E</b>	≥ 8,000	5	<b>20.0 x 250</b>	5NH

### Fat-soluble vitamins



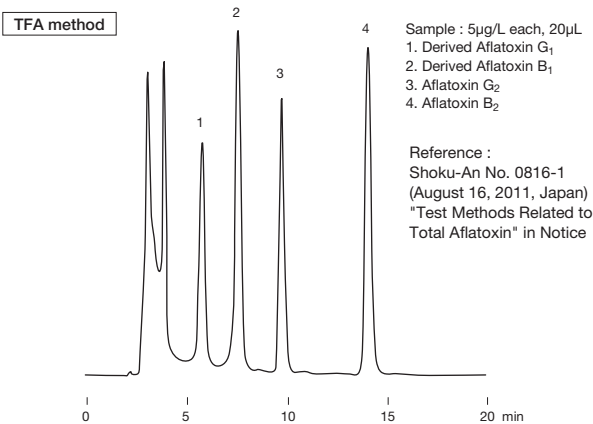
Column : Shodex C18-4D  
 Eluent : CH<sub>3</sub>CN  
 Flow rate : 1.0mL/min  
 Detector : UV (280nm)  
 Column temp. : 40°C

### Anticonvulsant



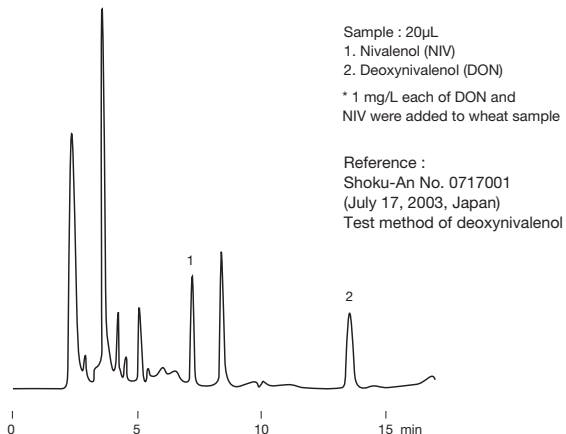
Column : Shodex C18-4D  
 Eluent : 100mM Phosphate buffer(pH2.1)  
 /CH<sub>3</sub>OH/CH<sub>3</sub>CN=4/2/1  
 Flow rate : 1.0mL/min  
 Detector : UV (210nm)  
 Column temp. : 40°C

### Aflatoxins



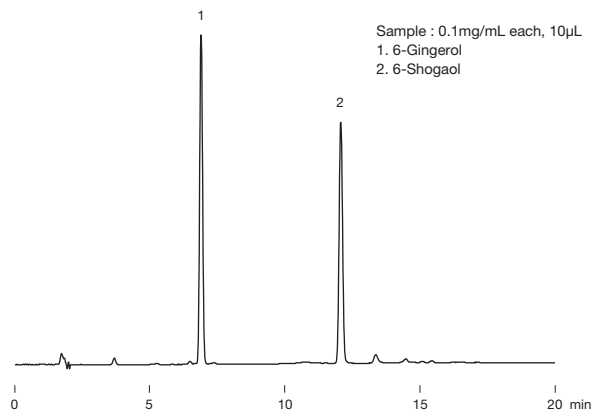
Column : Shodex Silica C18M 4E  
 Eluent : H<sub>2</sub>O/CH<sub>3</sub>CN/CH<sub>3</sub>OH=60/10/30  
 Flow rate : 1.0mL/min  
 Detector : Fluorescence (Ex. : 365nm, Em. : 450nm)  
 Column temp. : 40°C

### Trichothecene mycotoxins



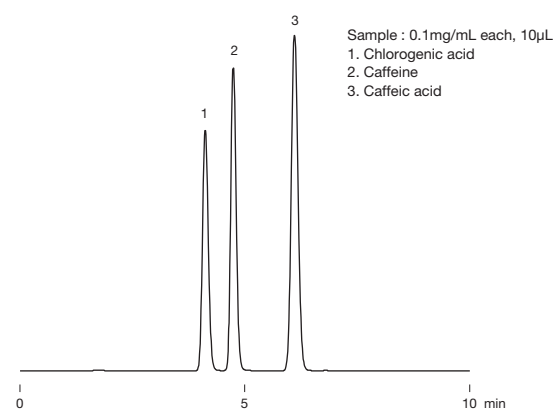
Column : Shodex Silica C18M 4E  
 Eluent : H<sub>2</sub>O/CH<sub>3</sub>CN/CH<sub>3</sub>OH=90/5/5  
 Flow rate : 1.0mL/min  
 Detector : UV (220nm)  
 Column temp. : 40°C

### Gingerol and shogaol



Column : Shodex Silica C18M 4D  
 Eluent : (A) ; H<sub>2</sub>O (B) ; CH<sub>3</sub>CN  
 Linear gradient : (B%) 40% to 70% (15min)  
 Flow rate : 1.0mL/min  
 Detector : UV (280nm)  
 Column temp. : 40°C

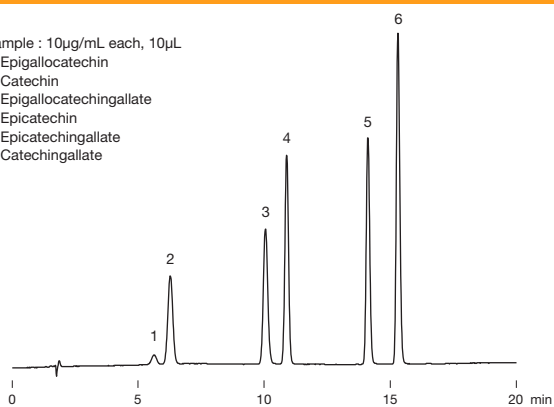
### Chlorogenic acid



Column : Shodex Silica C18M 4D  
 Eluent : 20mM H<sub>3</sub>PO<sub>4</sub> aq. /CH<sub>3</sub>OH=70/30  
 Flow rate : 1.0mL/min  
 Detector : UV (280nm)  
 Column temp. : 30°C

### Catechins

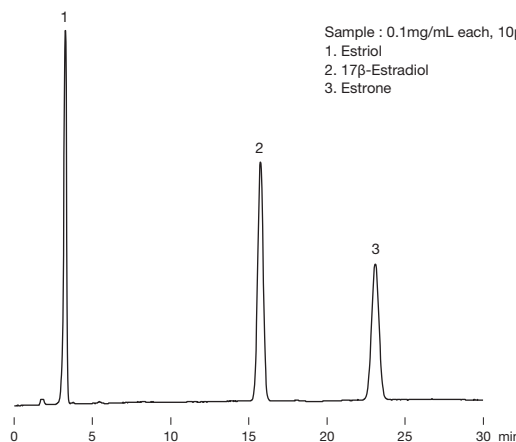
Sample : 10µg/mL each, 10µL  
 1. Epigallocatechin  
 2. Catechin  
 3. Epigallocatechingallate  
 4. Epicatechin  
 5. Epicatechingallate  
 6. Catechingallate



**Column** : Shodex Silica C18P 4D  
**Eluent** : (A) ; 20mM H<sub>3</sub>PO<sub>4</sub> aq./ (B) ; CH<sub>3</sub>CN  
 Linear gradient:  
 (B%) 20% (0 to 5min), 20 to 40% (5 to 15min),  
 40% (15 to 20min)  
**Flow rate** : 1.0mL/min  
**Detector** : UV (280nm)  
**Column temp.** : 30°C

### Estrogens

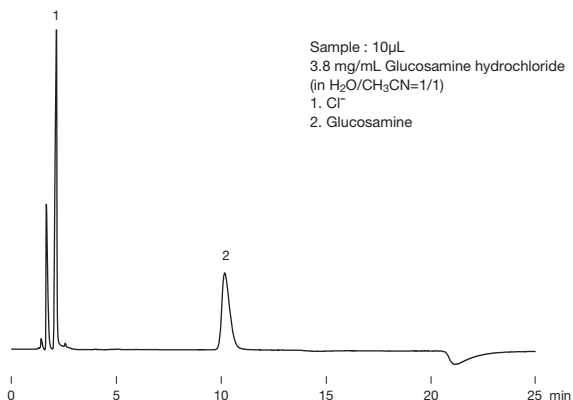
Sample : 0.1mg/mL each, 10µL  
 1. Estriol  
 2. 17β-Estradiol  
 3. Estrone



**Column** : Shodex Silica C18P 4D  
**Eluent** : H<sub>2</sub>O/CH<sub>3</sub>CN=65/35  
**Flow rate** : 1.0mL/min  
**Detector** : UV (280nm)  
**Column temp.** : 30°C

### Analysis of glucosamine following USP method

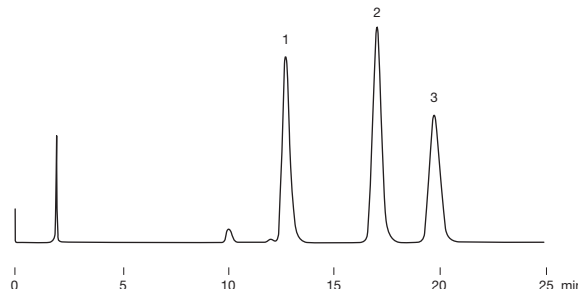
Sample : 10µL  
 3.8 mg/mL Glucosamine hydrochloride  
 (in H<sub>2</sub>O/CH<sub>3</sub>CN=1/1)  
 1. Cl<sup>-</sup>  
 2. Glucosamine



**Column** : Shodex Silica 5NH 4D  
**Eluent** : \*Buffer(pH7.5)/CH<sub>3</sub>CN=30/70  
 \*Buffer ; in a 1-L volumetric flask, dissolve 3.5g K<sub>2</sub>HPO<sub>4</sub> in water.  
 Add 0.25mL Ammonium hydroxide (25%), dilute with water to  
 volume, and mix. Adjusted with H<sub>3</sub>PO<sub>4</sub> to a pH7.5  
**Flow rate** : 1.1mL/min  
**Detector** : UV (195nm)  
**Column temp.** : 35°C

### Benzylpyridine isomers

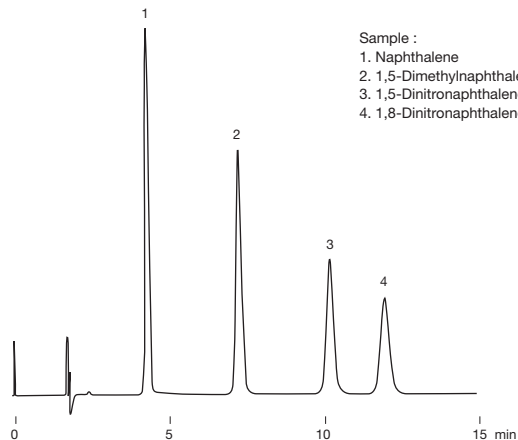
Sample :  
 1. 2-Benzylpyridine  
 2. 3-Benzylpyridine  
 3. 4-Benzylpyridine



**Column** : Shodex Silica 5PYE 4D  
**Eluent** : 20mM KH<sub>2</sub>PO<sub>4</sub> aq./CH<sub>3</sub>OH=40/60  
**Flow rate** : 1.0mL/min  
**Detector** : UV (254nm)  
**Column temp.** : 30°C

### Dinitronaphthalene isomers

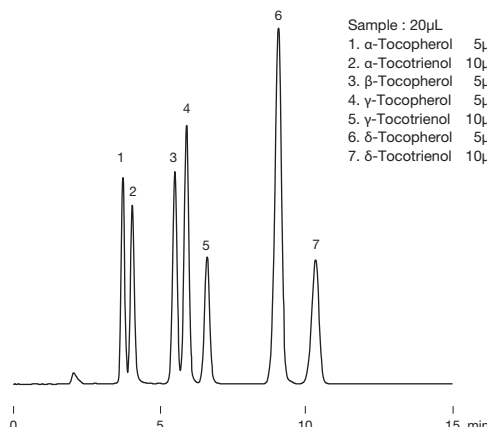
Sample :  
 1. Naphthalene  
 2. 1,5-Dimethylnaphthalene  
 3. 1,5-Dinitronaphthalene  
 4. 1,8-Dinitronaphthalene



**Column** : Shodex Silica 5NPE 4D  
**Eluent** : H<sub>2</sub>O/CH<sub>3</sub>OH=30/70  
**Flow rate** : 1.0mL/min  
**Detector** : UV (254nm)  
**Column temp.** : 30°C

### Simultaneous analysis of vitamin E homologs

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



**Column** : Shodex Silica 5SIL 4D  
**Eluent** : n-Hexane/Isopropanol/CH<sub>3</sub>COOH=1000/6/5  
**Flow rate** : 1.0mL/min  
**Detector** : Fluorescence (Ex. : 298nm, Em. : 325nm)  
**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 (<http://www.shodex.com/en/>) or technical notebook (No.2 and 3).

## Features

- SC1011**
  - SC1821**
  - SP0810**
  - KS-801 to 802**
- Separates saccharides by combination of ligand exchange and size exclusion modes
  - Three types of counter ions are available: Ca<sup>2+</sup>, Pb<sup>2+</sup> and Na<sup>+</sup>
  - 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
  - Fulfills 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<sup>2+</sup> 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	<b>SUGAR SC1011</b>	≥ 13,000	Sulfo (Ca <sup>2+</sup> )	1,000	6	<b>8.0 x 300</b>	H <sub>2</sub> O
F6378103	<b>SUGAR SC1821</b>	≥ 13,000	Sulfo (Ca <sup>2+</sup> )	10,000	6	<b>8.0 x 300</b>	H <sub>2</sub> O
F6700090	<b>SUGAR SC-G 6B (SUGAR SC-LG)</b>	(guard column)	Sulfo (Ca <sup>2+</sup> )	–	10	<b>6.0 x 50</b>	H <sub>2</sub> O
F6378105	<b>SUGAR SP0810</b>	≥ 11,000	Sulfo (Pb <sup>2+</sup> )	1,000	7	<b>8.0 x 300</b>	H <sub>2</sub> O
F6700081	<b>SUGAR SP-G 6B (SUGAR SP-G)</b>	(guard column)	Sulfo (Pb <sup>2+</sup> )	–	10	<b>6.0 x 50</b>	H <sub>2</sub> O
F6378010	<b>SUGAR KS-801</b>	≥ 17,000	Sulfo (Na <sup>+</sup> )	1,000	6	<b>8.0 x 300</b>	H <sub>2</sub> O
F6378020	<b>SUGAR KS-802</b>	≥ 17,000	Sulfo (Na <sup>+</sup> )	10,000	6	<b>8.0 x 300</b>	H <sub>2</sub> O
F6378025	<b>SUGAR KS-803</b>	≥ 17,000	Sulfo (Na <sup>+</sup> )	50,000	6	<b>8.0 x 300</b>	H <sub>2</sub> O
F6378035	<b>SUGAR KS-804</b>	≥ 17,000	Sulfo (Na <sup>+</sup> )	400,000	7	<b>8.0 x 300</b>	H <sub>2</sub> O
F6378050	<b>SUGAR KS-805</b>	≥ 9,000	Sulfo (Na <sup>+</sup> )	5,000,000	17	<b>8.0 x 300</b>	H <sub>2</sub> O
F6378060	<b>SUGAR KS-806</b>	≥ 9,000	Sulfo (Na <sup>+</sup> )	*(50,000,000)	17	<b>8.0 x 300</b>	H <sub>2</sub> O
F6700020	<b>SUGAR KS-G 6B (SUGAR KS-G)</b>	(guard column)	Sulfo (Na <sup>+</sup> )	–	10	<b>6.0 x 50</b>	H <sub>2</sub> O

\*( ) 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	<b>RSpak DC-613</b>	≥ 5,500	Sulfo (Na <sup>+</sup> )	6	100	<b>6.0 x 150</b>	H <sub>2</sub> O/CH <sub>3</sub> CN=30/70
F6700170	<b>RSpak DC-G 4A (RSpak DC-G)</b>	(guard column)	Sulfo (Na <sup>+</sup> )	10	–	<b>4.6 x 10</b>	H <sub>2</sub> O/CH <sub>3</sub> CN=30/70
F7001300	<b>SUGAR SZ5532</b>	≥ 5,500	Sulfo (Zn <sup>2+</sup> )	6	–	<b>6.0 x 150</b>	H <sub>2</sub> O/CH <sub>3</sub> CN=30/70
F6700110	<b>SUGAR SZ-G</b>	(guard column)	Sulfo (Zn <sup>2+</sup> )	6	–	<b>4.6 x 10</b>	H <sub>2</sub> O/CH <sub>3</sub> CN=30/70
F7001400	<b>SUGAR SC1211</b>	≥ 5,500	Sulfo (Ca <sup>2+</sup> )	6	50	<b>6.0 x 250</b>	H <sub>2</sub> O/CH <sub>3</sub> CN=75/25
F6700120	<b>SUGAR SC1211G 4A (SUGAR SC-G)</b>	(guard column)	Sulfo (Ca <sup>2+</sup> )	10	–	<b>4.6 x 10</b>	H <sub>2</sub> O/CH <sub>3</sub> CN=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	<b>EP SC1011-7F</b>	Sulfo (Ca <sup>2+</sup> )	8	<b>7.8 × 300</b>	H <sub>2</sub> O
F6700090	<b>SUGAR SC-G 6B (SUGAR SC-LG)</b> (guard column)	Sulfo (Ca <sup>2+</sup> )	10	<b>6.0 × 50</b>	H <sub>2</sub> O
F6379230	<b>USPpak MN-431</b>	Sulfo (Ca <sup>2+</sup> )	8	<b>4.0 × 250</b>	H <sub>2</sub> O

\*See page 79 for USP40-NF35 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	<b>SUGAR KS-2001</b>	≥ 7,000	13	<b>20.0 × 300</b>	KS-801
F6502008	<b>SUGAR KS-2002</b>	≥ 7,000	13	<b>20.0 × 300</b>	KS-802
F6502009	<b>SUGAR KS-2003</b>	≥ 8,000	13	<b>20.0 × 300</b>	KS-803
F6502010	<b>SUGAR KS-2004</b>	≥ 6,000	18	<b>20.0 × 300</b>	KS-804
F6502011	<b>SUGAR KS-2005</b>	≥ 6,000	18	<b>20.0 × 300</b>	KS-805
F6502012	<b>SUGAR KS-2006</b>	≥ 6,000	18	<b>20.0 × 300</b>	KS-806
F6700002	<b>SUGAR KS-G 8B (SUGAR KS-LG)</b>	(guard column)	13	<b>8.0 × 50</b>	(guard column)

[Ligand exchange and HILIC]

Product Code	Product Name	Plate Number (TP/column)	Particle Size (µm)	Column Size (mm) I.D. x Length	Standard Column
F6514013	<b>RSpak DC-2013</b>	≥ 6,000	10	<b>20.0 × 300</b>	DC-613
F6700402	<b>RSpak DC-G 8B (RSpak DC-LG)</b>	(guard column)	10	<b>8.0 × 50</b>	(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	*
Palatinin	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<sub>2</sub>O  
 Flow rate : 1.0mL/min  
 Detector : RI  
 Column temp. : 80°C

Column : SUGAR SC1211  
 Eluent : H<sub>2</sub>O/CH<sub>3</sub>CN=65/35  
 Flow rate : 1.0mL/min  
 Detector : RI  
 Column temp. : 70°C

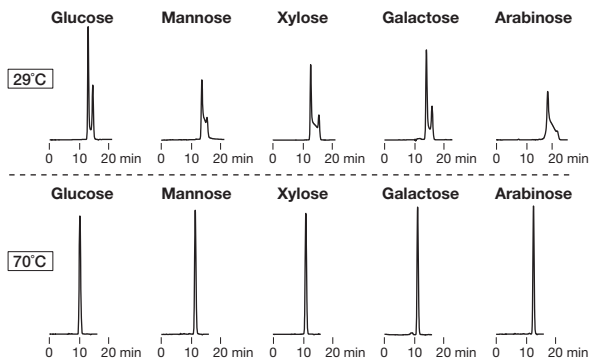
Column : SUGAR SZ5532  
 Eluent : H<sub>2</sub>O/CH<sub>3</sub>CN=25/75  
 Flow rate : 1.0mL/min  
 Detector : RI  
 Column temp. : 60°C

Column : Asahipak NH2P-50 4E  
 Eluent : H<sub>2</sub>O/CH<sub>3</sub>CN=25/75  
 Flow rate : 1.0mL/min  
 Detector : RI  
 Column temp. : 30°C

## Saccharides anomer separation

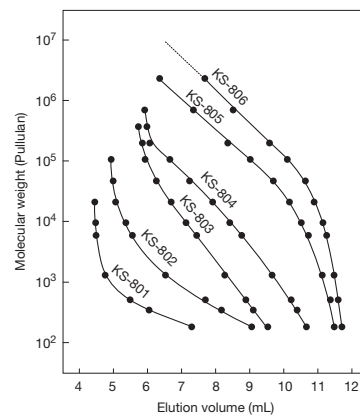
Saccharides may present their anomers at lower temperatures. By setting the SUGAR series columns at higher temperatures will prevent the anomer separation and this results in providing better chromatograms of each saccharide.

Sample :  
0.5% each, 10 $\mu$ L



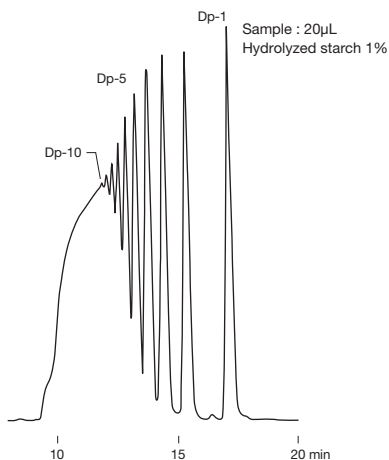
Column : Shodex SUGAR SC1011  
Eluent : H<sub>2</sub>O  
Flow rate : 0.7mL/min  
Detector : RI  
Column temp. : 29°C, 70°C

## Calibration curves for KS-800 series using pullulan



Column : Shodex SUGAR KS-800 series  
Eluent : H<sub>2</sub>O  
Detector : RI  
Column temp. : 80°C

## Hydrolyzed starch

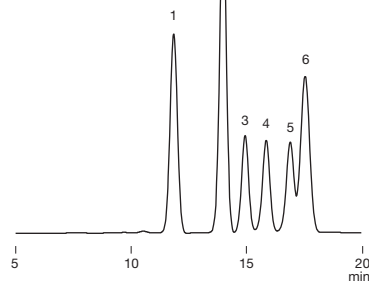


Sample : 20 $\mu$ L  
Hydrolyzed starch 1%

Column : Shodex SUGAR KS-802 x 2  
Eluent : H<sub>2</sub>O  
Flow rate : 1.0mL/min  
Detector : RI  
Column temp. : 80°C

## Biomass sugars

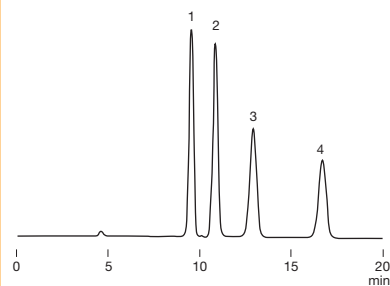
Sample : 5 $\mu$ L  
1. Cellobiose 1.0%  
2. Glucose 1.5%  
3. Xylose 0.5%  
4. Galactose 0.5%  
5. Arabinose 0.5%  
6. Mannose 1.0%



Column : Shodex SUGAR SP0810  
Eluent : H<sub>2</sub>O  
Flow rate : 0.6mL/min  
Detector : RI  
Column temp. : 85°C

## Ketohexoses

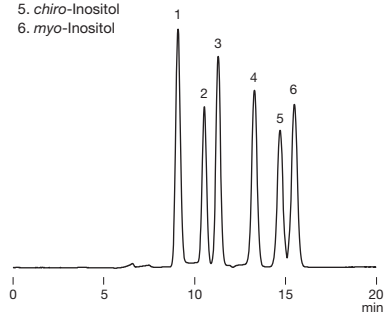
Sample : 0.025% each, 10 $\mu$ L  
1. Sorbose  
2. Fructose  
3. Tagatose  
4. Psicose



Column : Shodex SUGAR SP0810  
Eluent : H<sub>2</sub>O  
Flow rate : 1.0mL/min  
Detector : RI  
Column temp. : 80°C

## Pinitol

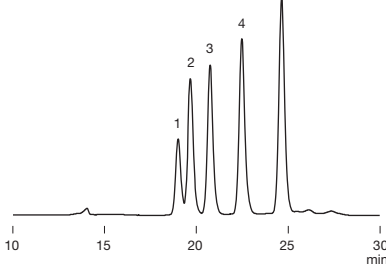
Sample : 0.1% each, 20 $\mu$ L  
1. Sucrose  
2. Glucose  
3. Pinitol  
4. Fructose  
5. *chiro*-Inositol  
6. *myo*-Inositol



Column : Shodex SUGAR SP0810  
Eluent : H<sub>2</sub>O  
Flow rate : 0.8mL/min  
Detector : RI  
Column temp. : 85°C

## Oligosaccharides in soybean

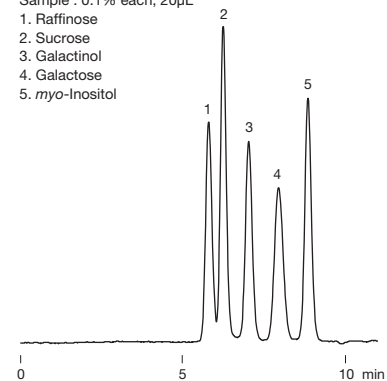
Sample : 0.1% each, 20 $\mu$ L  
1. Verbascose  
2. Stachyose  
3. Raffinose  
4. Sucrose  
5. Pinitol



Column : Shodex SUGAR KS-802 + KS-801  
Eluent : H<sub>2</sub>O  
Flow rate : 0.6mL/min  
Detector : RI  
Column temp. : 85°C

## Saccharides related to raffinose biosynthesis

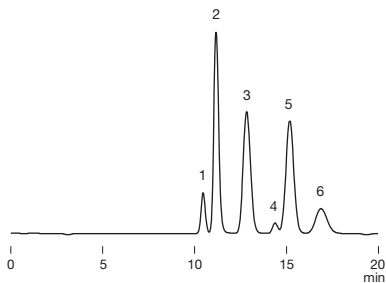
Sample : 0.1% each, 20 $\mu$ L  
1. Raffinose  
2. Sucrose  
3. Galactinol  
4. Galactose  
5. *myo*-Inositol



Column : Shodex SUGAR SC1011  
Eluent : H<sub>2</sub>O  
Flow rate : 1.0mL/min  
Detector : RI  
Column temp. : 80°C

### Acesulfame K and sucralose

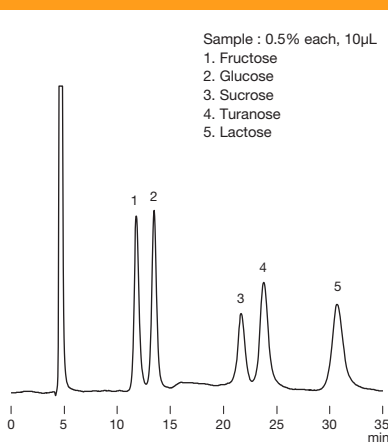
Sample : 20 $\mu$ L  
 1. Acesulfame K 0.1%  
 2. Sucrose 0.5%  
 3. Glucose 0.5%  
 4. Unknown from Acesulfame K  
 5. Fructose 0.5%  
 6. Sucralose 0.1%



**Column** : Shodex SUGAR SC1011  
 Eluent : 10mM CaSO<sub>4</sub> aq.  
 Flow rate : 0.6mL/min  
 Detector : RI  
 Column temp. : 80°C

### Sucrose and turanose

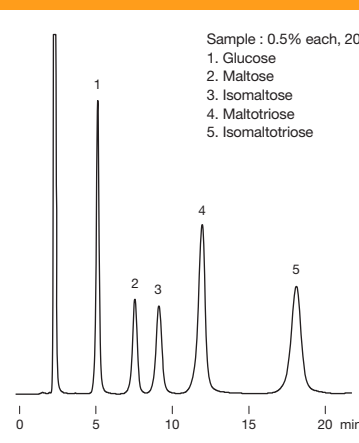
Sample : 0.5% each, 10 $\mu$ L  
 1. Fructose  
 2. Glucose  
 3. Sucrose  
 4. Turanose  
 5. Lactose



**Column** : Shodex SUGAR SZ5532  
 Eluent : H<sub>2</sub>O/CH<sub>3</sub>CN=20/80  
 Flow rate : 0.6mL/min  
 Detector : RI  
 Column temp. : 60°C

### Maltose and isomaltose

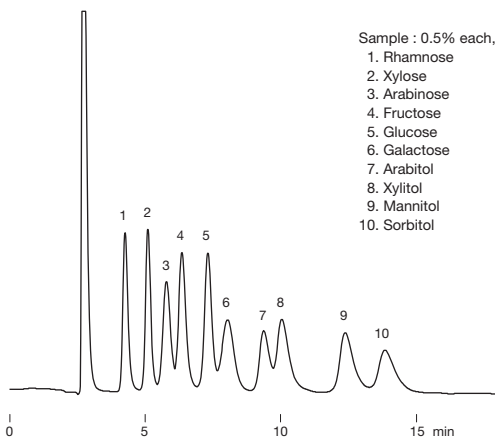
Sample : 0.5% each, 20 $\mu$ L  
 1. Glucose  
 2. Maltose  
 3. Isomaltose  
 4. Maltotriose  
 5. Isomaltotriose



**Column** : Shodex SUGAR SZ5532  
 Eluent : H<sub>2</sub>O/CH<sub>3</sub>CN=25/75  
 Flow rate : 1.0mL/min  
 Detector : RI  
 Column temp. : 60°C

### Saccharides and sugar alcohols

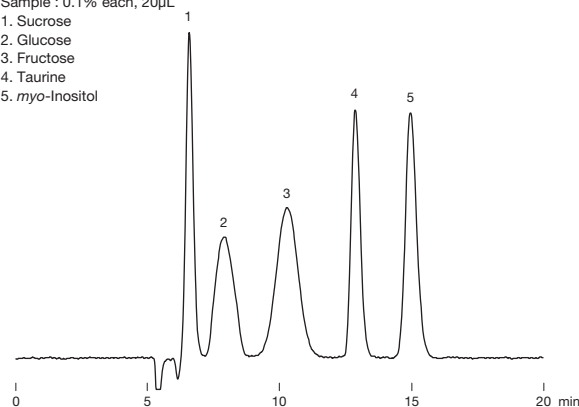
Sample : 0.5% each, 20 $\mu$ L  
 1. Rhamnose  
 2. Xylose  
 3. Arabinose  
 4. Fructose  
 5. Glucose  
 6. Galactose  
 7. Arabitol  
 8. Xylitol  
 9. Mannitol  
 10. Sorbitol



**Column** : Shodex SUGAR SZ5532  
 Eluent : H<sub>2</sub>O/CH<sub>3</sub>CN=20/80  
 Flow rate : 1.0mL/min  
 Detector : RI  
 Column temp. : 65°C

### Saccharides and taurine

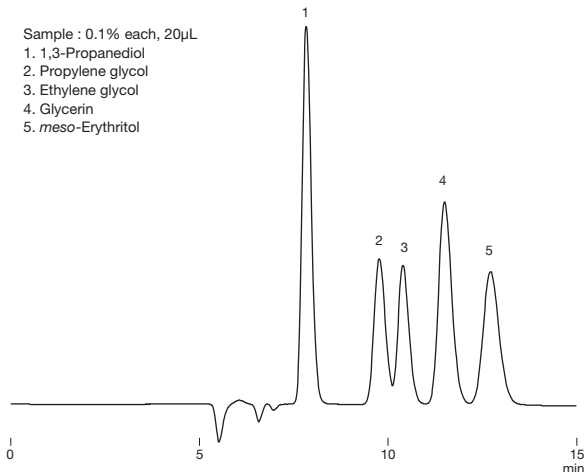
Sample : 0.1% each, 20 $\mu$ L  
 1. Sucrose  
 2. Glucose  
 3. Fructose  
 4. Taurine  
 5. myo-Inositol



**Column** : Shodex SUGAR SC1211  
 Eluent : H<sub>2</sub>O/CH<sub>3</sub>CN=60/40  
 Flow rate : 0.6mL/min  
 Detector : RI  
 Column temp. : 70°C

### Moisturizing components

Sample : 0.1% each, 20 $\mu$ L  
 1. 1,3-Propanediol  
 2. Propylene glycol  
 3. Ethylene glycol  
 4. Glycerin  
 5. meso-Erythritol

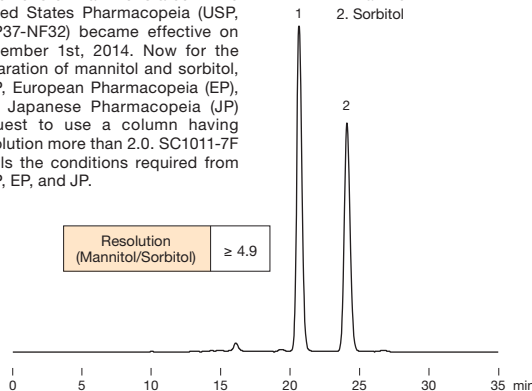


**Column** : Shodex SUGAR SC1211  
 Eluent : H<sub>2</sub>O/CH<sub>3</sub>CN=60/40  
 Flow rate : 0.6mL/min  
 Detector : RI  
 Column temp. : 40°C

### 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.

Sample : 25mg/mL each, 20 $\mu$ L  
 1. Mannitol  
 2. Sorbitol



**Column** : Shodex EP SC1011-7F  
 Eluent : H<sub>2</sub>O  
 Flow rate : 0.5mL/min  
 Detector : RI  
 Column temp. : 85°C

# ● Ion Exclusion Chromatography Columns

## Features

- SH1011** • Columns for simultaneous analysis of saccharides and organic acids
- SH1821** • Separates neutral sugars in size exclusion mode and organic acids in ion exclusion mode
- Suitable for the analysis of uronic and aldonic acids
  - Fulfills 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	<b>SUGAR SH1011</b>	≥ 17,000	Sulfo	1,000	6	<b>8.0 × 300</b>	H <sub>2</sub> O
F6378101	<b>SUGAR SH1821</b>	≥ 17,000	Sulfo	10,000	6	<b>8.0 × 300</b>	H <sub>2</sub> O
F6700080	<b>SUGAR SH-G</b>	(guard column)	Sulfo	–	10	<b>6.0 × 50</b>	H <sub>2</sub> O

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	<b>RSpak KC-811</b>	≥ 17,000	Sulfo	6	<b>8.0 × 300</b>	0.1% H <sub>3</sub> PO <sub>4</sub> aq.
F6378033	<b>RSpak KC-811 6E</b>	≥ 13,000	Sulfo	6	<b>6.0 × 250</b>	0.1% H <sub>3</sub> PO <sub>4</sub> aq.
F6700030	<b>RSpak KC-G 6B (RSpak KC-G)</b>	(guard column)	Sulfo	10	<b>6.0 × 50</b>	0.1% H <sub>3</sub> PO <sub>4</sub> aq.
F6700010	<b>RSpak KC-G 8B (RSpak KC-LG)</b>	(guard column)	Sulfo	13	<b>8.0 × 50</b>	0.1% H <sub>3</sub> PO <sub>4</sub> 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

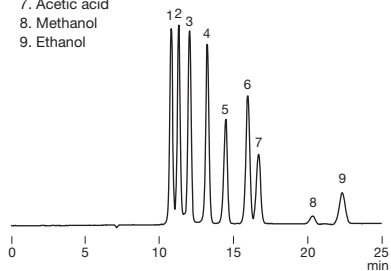
## ■ Preparative columns \*Preparative columns are made to order.

Product Code	Product Name	Plate Number (TP/column)	Particle Size (µm)	Column Size (mm) I.D. x Length	Standard Column
F6505012	<b>RSpak KC-2011</b>	≥ 8,000	13	<b>20.0 × 300</b>	KC-811
F6700010	<b>RSpak KC-G 8B (RSpak KC-LG)</b>	(guard column)	13	<b>8.0 × 50</b>	(guard column)



### Maltooligosaccharides, organic acids and ethanol

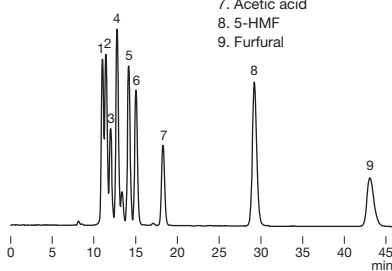
Sample : 0.05% each, 20 $\mu$ L  
 1. Maltotetraose  
 2. Maltotriose  
 3. Maltose  
 4. Glucose  
 5. Lactic acid  
 6. Glycerol  
 7. Acetic acid  
 8. Methanol  
 9. Ethanol



Column : Shodex SUGAR SH1821  
 Eluent : 0.5mM H<sub>2</sub>SO<sub>4</sub> aq.  
 Flow rate : 0.6mL/min  
 Detector : RI  
 Column temp. : 75°C

### Cello-oligosaccharides and furfurals

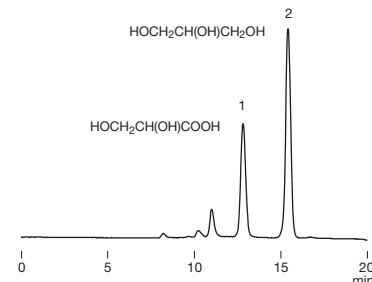
Sample : 0.1% each, 10 $\mu$ L  
 1. Cellopentaose  
 2. Cellotetraose  
 3. Cellotriose  
 4. Cellobiose  
 5. Glucose  
 6. Glyceric acid  
 7. Acetic acid  
 8. 5-HMF  
 9. Furfural



Column : Shodex SUGAR SH1821  
 Eluent : 2mM H<sub>2</sub>SO<sub>4</sub> aq.  
 Flow rate : 0.6mL/min  
 Detector : RI  
 Column temp. : 60°C

### Glycerin and glyceric acid

Sample : 0.1% each, 10 $\mu$ L  
 1. Glyceric acid  
 2. Glycerin

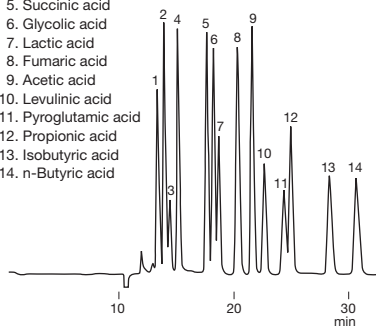


Column : Shodex SUGAR SH1011  
 Eluent : 2mM H<sub>2</sub>SO<sub>4</sub> aq.  
 Flow rate : 0.6mL/min  
 Detector : RI  
 Column temp. : 60°C

### Common organic acids

Sample :

- Citric acid
- Tartaric acid
- Pyruvic acid
- Malic acid
- Succinic acid
- Glycolic acid
- Lactic acid
- Fumaric acid
- Acetic acid
- Levulinic acid
- Pyroglutamic acid
- Propionic acid
- Isobutyric acid
- n-Butyric acid

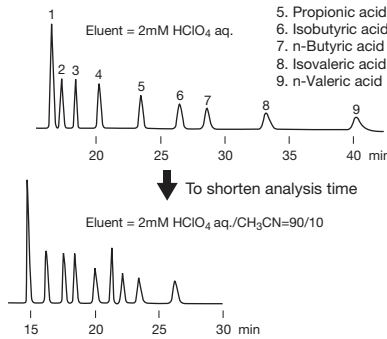


Column : Shodex RSpak KC-811 x 2  
 Eluent : 6mM HClO<sub>4</sub> aq.  
 Flow rate : 1.0mL/min  
 Detector : VIS (430nm)  
 post column method  
 Column temp. : 50°C

### Hydrophobic organic acids

Sample :

- Succinic acid
- Lactic acid
- Formic acid
- Acetic acid
- Propionic acid
- Isobutyric acid
- n-Butyric acid
- Isovaleric acid
- n-Valeric acid

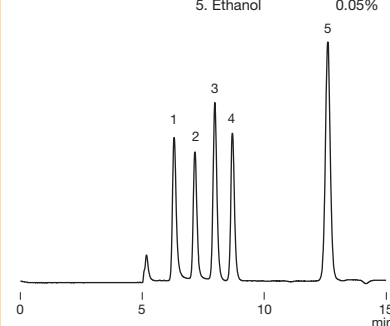


Column : Shodex RSpak KC-LG + KC-811 x 2  
 Flow rate : 1.0mL/min  
 Detector : VIS (430nm)  
 post column method  
 Column temp. : 47°C

### Glucronolactone and organic acids

Sample : 20 $\mu$ L

- Citric acid 0.01%
- Malic acid 0.01%
- Glucronolactone 0.01%
- Glycerin 0.01%
- Ethanol 0.05%

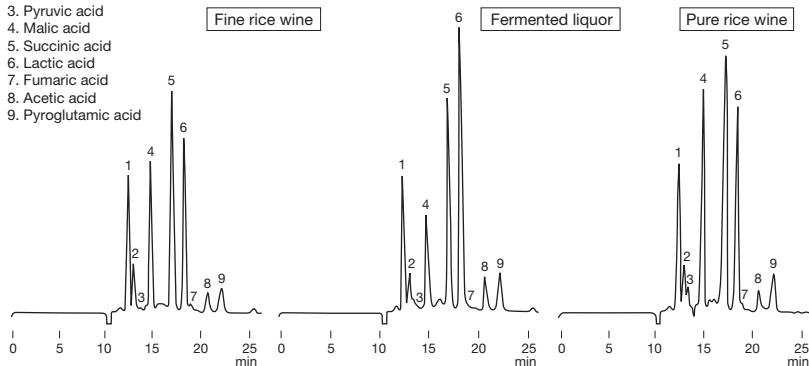


Column : Shodex RSpak KC-811  
 Eluent : 3mM HClO<sub>4</sub> aq.  
 Flow rate : 1.0mL/min  
 Detector : RI  
 Column temp. : 40°C

### Organic acids in sake

Sample : 100 $\mu$ L

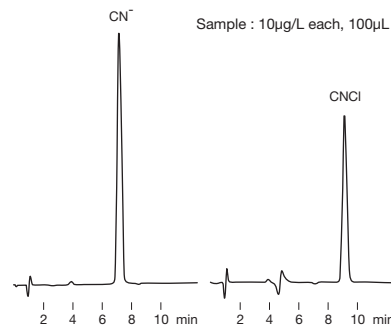
- Phosphoric acid etc.
- Citric acid
- Pyruvic acid
- Malic acid
- Succinic acid
- Lactic acid
- Fumaric acid
- Acetic acid
- Pyroglutamic acid



Column : Shodex RSpak KC-LG + KC-811 x 2  
 Eluent : 4.8mM HClO<sub>4</sub> aq.  
 Flow rate : 1.0mL/min  
 Detector : VIS (430nm)  
 post column method  
 Column temp. : 63°C

### Analysis of Cyanide ion and cyanogen chloride with post column method

Sample : 10 $\mu$ g/L each, 100 $\mu$ L



Column : Shodex RSpak KC-811 6E  
 Eluent : 1.0mM H<sub>2</sub>SO<sub>4</sub> aq.  
 Reagent A : Chloramine T solution  
 Reagent B : 4-Pyridinecarboxylic acid-Pyrazolone solution  
 Flow rate : (Eluent) 1.0mL/min  
 (Reagent) 0.5mL/min each  
 Detector : VIS (638nm)  
 Column temp. : 40°C  
 Reaction temp. : (Reagent A) 40°C  
 (Reagent B) 80°C

# Ion Chromatography Columns (Anion Analysis)

## Features

- NI-424**
  - Columns for anion analysis with non-suppressor method
- NI-524A**
  - NI-424 provides simultaneous analysis of fluoride and phosphate ions
- SI-90 4E**
  - Columns for anion analysis with suppressor method
- SI-50 4E**
  - Suitable for the quantitative analysis of fluoride ion
  - SI-50 separates target inorganic anions from organic acids
  - Not interfered by the system peak derived from carbonate
- SI-52 4E**
  - Column for the analysis of oxyhalides with suppressor method
  - Provides simultaneous analysis of oxyhalides and general inorganic ions
- 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

## Standard columns

### [For anion non-suppressor method]

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

Base Material: Polyhydroxymethacrylate Housing Material: SUS

### [For anion suppressor method]

Product Code	Product Name	Plate Number (TP/column)	Functional Group	Particle Size (µm)	Column Size (mm) I.D. x Length	Shipping Solvent
F6995244	<b>IC SI-90 4E</b>	≥ 5,000	Quaternary ammonium	9	<b>4.0 × 250</b>	1.8mM Na <sub>2</sub> CO <sub>3</sub> + 1.7mM NaHCO <sub>3</sub> aq.
F6709620	<b>IC SI-90G</b>	(guard column)	Quaternary ammonium	9	<b>4.6 × 10</b>	1.8mM Na <sub>2</sub> CO <sub>3</sub> + 1.7mM NaHCO <sub>3</sub> aq.
F6995245	<b>IC SI-50 4E</b>	≥ 10,000	Quaternary ammonium	5	<b>4.0 × 250</b>	3.2mM Na <sub>2</sub> CO <sub>3</sub> + 1.0mM NaHCO <sub>3</sub> aq.
F6709625	<b>IC SI-50G</b>	(guard column)	Quaternary ammonium	5	<b>4.6 × 10</b>	3.2mM Na <sub>2</sub> CO <sub>3</sub> + 1.0mM NaHCO <sub>3</sub> 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	<b>IC SI-52 4E</b>	≥ 14,000	Quaternary ammonium	5	<b>4.0 × 250</b>	3.6mM Na <sub>2</sub> CO <sub>3</sub> aq.
F6709626	<b>IC SI-92G</b>	(guard column)	Quaternary ammonium	9	<b>4.6 × 10</b>	3.6mM Na <sub>2</sub> CO <sub>3</sub> aq.

Base Material: Polyvinyl alcohol Housing Material: PEEK

### [For rapid suppressor method]

Product Code	Product Name	Plate Number (TP/column)	Functional Group	Particle Size (µm)	Column Size (mm) I.D. x Length	Shipping Solvent
F6995290	<b>IC SI-35 4D</b>	≥ 13,000	Quaternary ammonium	3.5	<b>4.0 × 150</b>	3.6mM Na <sub>2</sub> CO <sub>3</sub> aq.
F6709627	<b>IC SI-95G</b>	(guard column)	Quaternary ammonium	9	<b>4.6 × 10</b>	3.6mM Na <sub>2</sub> CO <sub>3</sub> aq.
F6995291	<b>IC SI-35 2B</b>	≥ 4,000	Quaternary ammonium	3.5	<b>2.0 × 50</b>	1.0mM Na <sub>2</sub> CO <sub>3</sub> + 2.0mM NaHCO <sub>3</sub> aq.

Base Material: Polyvinyl alcohol Housing Material: PEEK

## Guard filter for SI-35 2B

Product Code	Product Name	Contents
F6709720	<b>IC SI-2GF</b>	One holder and one filter
F6709730	<b>IC SI-2GF filter</b>	3 filters

Removes insoluble components in the sample

## Line filters for IC

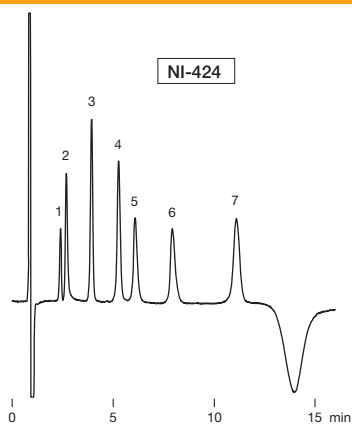
Product Code	Product Name	Contents
F8500630	<b>IC FL-1</b>	One holder and one filter
F8500640	<b>IC FL-1 filter</b>	5 filters



\*Attach directly to analysis column

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

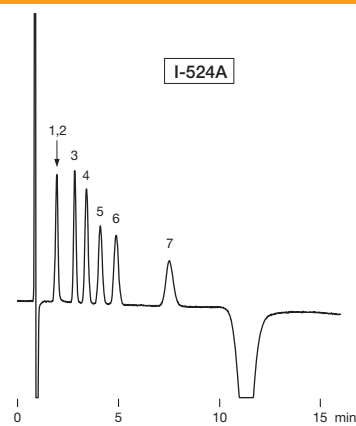
Anion analysis using NI-424 and I-524A (non-suppressor methods)



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

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

Sample : 20µL  
 1. H<sub>2</sub>PO<sub>4</sub><sup>-</sup> 10mg/L  
 2. F<sup>-</sup> 1mg/L  
 3. Cl<sup>-</sup> 1mg/L  
 4. NO<sub>2</sub><sup>-</sup> 5mg/L  
 5. Br<sup>-</sup> 5mg/L  
 6. NO<sub>3</sub><sup>-</sup> 5mg/L  
 7. SO<sub>4</sub><sup>2-</sup> 5mg/L



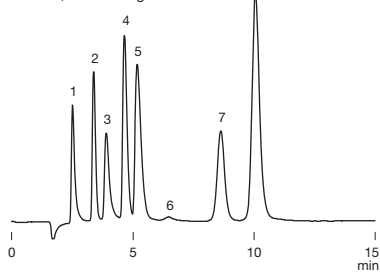
**Column** : Shodex IC I-524A  
**Eluent** : 2.5mM Phthalic acid + 2.3mM Tris(hydroxymethyl)aminomethane aq.  
**Flow rate** : 1.2mL/min  
**Detector** : Non-suppressed conductivity  
**Column temp.** : 40°C

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<sub>2</sub>PO<sub>4</sub><sup>-</sup> and F<sup>-</sup> 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<sup>-</sup> and NO<sub>2</sub><sup>-</sup> is improved.

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

Sample : 20µL  
 1. F<sup>-</sup> 2mg/L  
 2. Cl<sup>-</sup> 3mg/L  
 3. NO<sub>2</sub><sup>-</sup> 5mg/L  
 4. Br<sup>-</sup> 10mg/L  
 5. NO<sub>3</sub><sup>-</sup> 10mg/L  
 6. HCO<sub>3</sub><sup>-</sup> 300mg/L  
 7. PO<sub>4</sub><sup>3-</sup> 15mg/L  
 8. SO<sub>4</sub><sup>2-</sup> 15mg/L

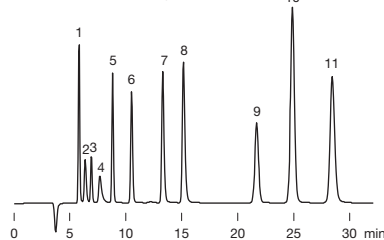


**Column** : Shodex IC SI-90 4E  
**Eluent** : 1.8mM Na<sub>2</sub>CO<sub>3</sub> + 1.7mM NaHCO<sub>3</sub> aq.  
**Flow rate** : 1.5mL/min  
**Detector** : Suppressed conductivity  
**Column temp.** : Room temp. (25°C)

Anion analysis using SI-50 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<sup>-</sup> and Cl<sup>-</sup>. The carbonate system peak appears between NO<sub>2</sub><sup>-</sup> and Br<sup>-</sup> peaks.

Sample : 20µL  
 1. F<sup>-</sup> 2mg/L  
 2. Acetic acid 10mg/L  
 3. Formic acid 2mg/L  
 4. Methacrylic acid 10mg/L  
 5. Cl<sup>-</sup> 3mg/L  
 6. NO<sub>2</sub><sup>-</sup> 5mg/L  
 7. Br<sup>-</sup> 10mg/L  
 8. NO<sub>3</sub><sup>-</sup> 10mg/L  
 9. PO<sub>4</sub><sup>3-</sup> 15mg/L  
 10. SO<sub>4</sub><sup>2-</sup> 15mg/L  
 11. Oxalic acid 15mg/L

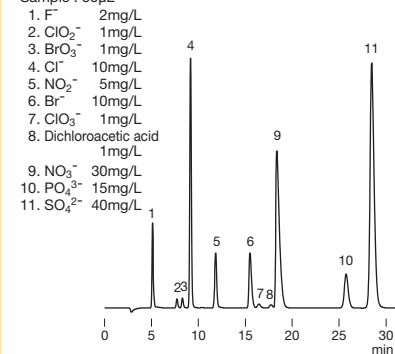


**Column** : Shodex IC SI-50 4E  
**Eluent** : 3.2mM Na<sub>2</sub>CO<sub>3</sub> + 1.0mM NaHCO<sub>3</sub> aq.  
**Flow rate** : 0.7mL/min  
**Detector** : Suppressed conductivity  
**Column temp.** : 25°C

Oxyhalides and anion 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.

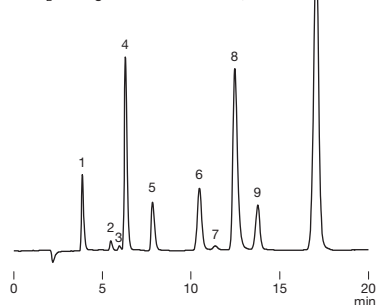
Sample : 50µL  
 1. F<sup>-</sup> 2mg/L  
 2. ClO<sub>2</sub><sup>-</sup> 1mg/L  
 3. BrO<sub>3</sub><sup>-</sup> 1mg/L  
 4. Cl<sup>-</sup> 10mg/L  
 5. NO<sub>2</sub><sup>-</sup> 5mg/L  
 6. Br<sup>-</sup> 10mg/L  
 7. ClO<sub>3</sub><sup>-</sup> 1mg/L  
 8. Dichloroacetic acid 1mg/L  
 9. NO<sub>3</sub><sup>-</sup> 30mg/L  
 10. PO<sub>4</sub><sup>3-</sup> 15mg/L  
 11. SO<sub>4</sub><sup>2-</sup> 40mg/L



**Column** : Shodex IC SI-52 4E  
**Eluent** : 3.6mM Na<sub>2</sub>CO<sub>3</sub> aq.  
**Flow rate** : 0.8mL/min  
**Detector** : Suppressed conductivity  
**Column temp.** : 45°C

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

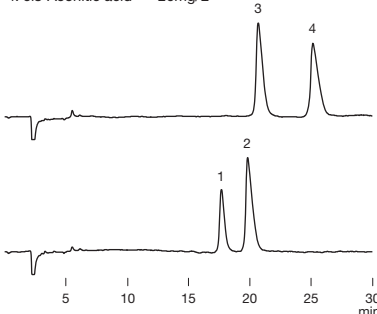
Sample : 20µL  
 1. F<sup>-</sup> 2mg/L  
 2. ClO<sub>2</sub><sup>-</sup> 1mg/L  
 3. BrO<sub>3</sub><sup>-</sup> 1mg/L  
 4. Cl<sup>-</sup> 10mg/L  
 5. NO<sub>2</sub><sup>-</sup> 5mg/L  
 6. Br<sup>-</sup> 10mg/L  
 7. ClO<sub>3</sub><sup>-</sup> 1mg/L  
 8. NO<sub>3</sub><sup>-</sup> 30mg/L  
 9. PO<sub>4</sub><sup>3-</sup> 15mg/L  
 10. SO<sub>4</sub><sup>2-</sup> 40mg/L



**Column** : Shodex IC SI-35 4D  
**Eluent** : 2.0mM Na<sub>2</sub>CO<sub>3</sub> + 4.5mM NaHCO<sub>3</sub> aq.  
**Flow rate** : 0.6mL/min  
**Detector** : Suppressed conductivity  
**Column temp.** : 45°C

Tricarboxylic acids analysis (suppressor method)

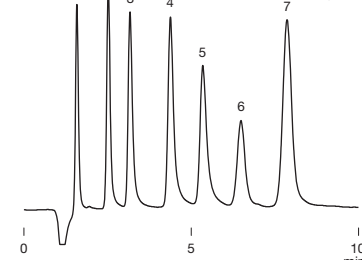
Sample : 20µL  
 1. Citric acid 10mg/L  
 2. Isocitric acid 50mg/L  
 3. trans-Aconitic acid 20mg/L  
 4. cis-Aconitic acid 20mg/L



**Column** : Shodex IC SI-35 4D  
**Eluent** : 9.0mM Na<sub>2</sub>CO<sub>3</sub> aq.  
**Flow rate** : 0.6mL/min  
**Detector** : Suppressed conductivity  
**Column temp.** : 45°C

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

Sample : 2µL  
 1. F<sup>-</sup> 1mg/L  
 2. Cl<sup>-</sup> 2mg/L  
 3. NO<sub>2</sub><sup>-</sup> 3mg/L  
 4. Br<sup>-</sup> 5mg/L  
 5. NO<sub>3</sub><sup>-</sup> 5mg/L  
 6. PO<sub>4</sub><sup>3-</sup> 8mg/L  
 7. SO<sub>4</sub><sup>2-</sup> 6mg/L



**Column** : Shodex IC SI-35 2B  
**Eluent** : 1.0mM Na<sub>2</sub>CO<sub>3</sub> + 2.0mM NaHCO<sub>3</sub> aq.  
**Flow rate** : 0.2mL/min  
**Detector** : Suppressed conductivity  
**Column temp.** : 30°C

# 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

## 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	<b>IC YS-50</b>	≥ 5,500	Carboxyl	Polyvinyl alcohol	5	<b>4.6 x 125</b>	H <sub>2</sub> O
F6700530	<b>IC YS-G</b>	(guard column)	Carboxyl	Polyvinyl alcohol	5	<b>4.6 x 10</b>	H <sub>2</sub> O
F7120012	<b>IC YK-421</b>	≥ 2,800	Carboxyl	Silica	5	<b>4.6 x 125</b>	5mM Tartaric acid + 1mM Dipicolinic acid + 1.5g/L Boric acid aq.
F6709608	<b>IC YK-G</b>	(guard column)	Carboxyl	Silica	5	<b>4.6 x 10</b>	5mM Tartaric acid + 1mM Dipicolinic acid + 1.5g/L Boric acid aq.
F6995210	<b>IC Y-521</b>	≥ 3,000	Sulfo	Styrene divinylbenzene copolymer	12	<b>4.6 x 150</b>	4mM HNO <sub>3</sub> aq.
F6700230	<b>IC Y-G</b>	(guard column)	Sulfo	Styrene divinylbenzene copolymer	12	<b>4.6 x 10</b>	4mM HNO <sub>3</sub> aq.

Housing Material: SUS

### [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	<b>IC T-521</b>	≥ 3,000	Sulfo	12	<b>4.6 x 150</b>	3mM HNO <sub>3</sub> aq.
F6700412	<b>IC T-G</b>	(guard column)	Sulfo	12	<b>4.6 x 10</b>	3mM HNO <sub>3</sub> aq.

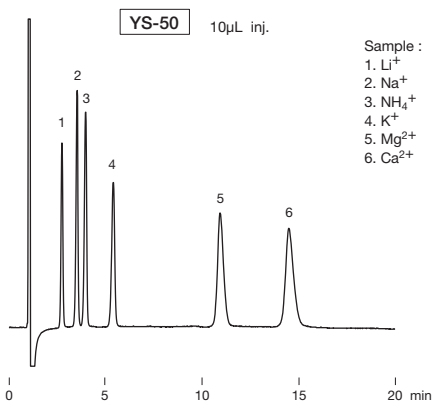
Base Material: Styrene divinylbenzene copolymer  
Housing Material: PEEK

## Line filters for IC

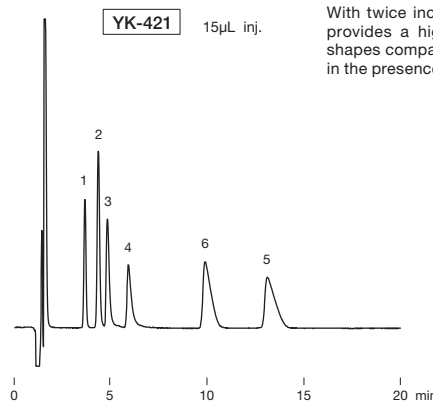
Product Code	Product Name	Contents
F8500630	<b>IC FL-1</b>	One holder and one filter
F8500640	<b>IC FL-1 filter</b>	5 filters

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

### Common cations (YS-50 and YK-421)



Sample :  
 1. Li<sup>+</sup> 2mg/L  
 2. Na<sup>+</sup> 10mg/L  
 3. NH<sub>4</sub><sup>+</sup> 10mg/L  
 4. K<sup>+</sup> 20mg/L  
 5. Mg<sup>2+</sup> 10mg/L  
 6. Ca<sup>2+</sup> 20mg/L



With twice increased theoretical plate number, YS-50 provides a higher performance with improved peak shapes compared to YK-421. The quantitation of NH<sub>4</sub><sup>+</sup> in the presence of high Na<sup>+</sup> content is also improved.

Resolution (Na <sup>+</sup> and NH <sub>4</sub> <sup>+</sup> )	YS-50	YK-421
	2.5	2.1

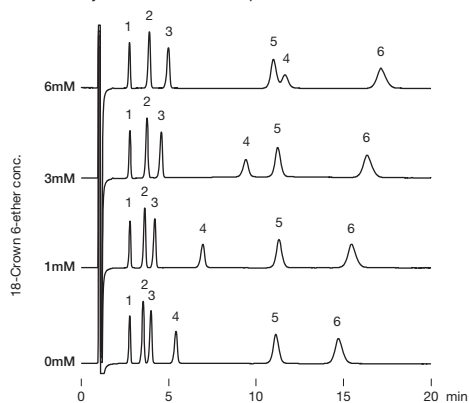
TP	YS-50	YK-421
Mg <sup>2+</sup>	6,900	3,000
Ca <sup>2+</sup>	6,600	3,000

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

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

### Effects of added crown ether in the eluent

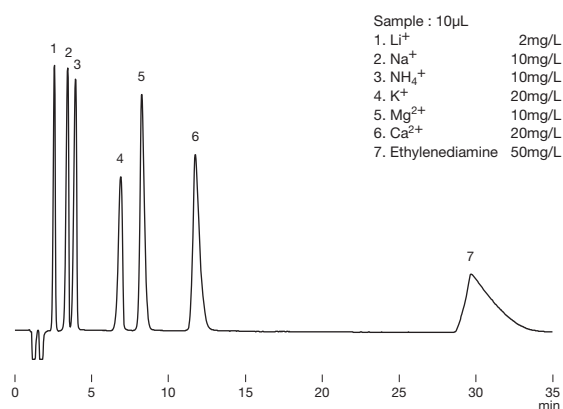
Crown ether forms complex with cations. The elution of cations (particularly K<sup>+</sup>) can be well controlled by the difference in complex formation rate.



Sample : 10μL  
 1. Li<sup>+</sup> 2mg/L  
 2. Na<sup>+</sup> 10mg/L  
 3. NH<sub>4</sub><sup>+</sup> 10mg/L  
 4. K<sup>+</sup> 20mg/L  
 5. Mg<sup>2+</sup> 10mg/L  
 6. Ca<sup>2+</sup> 20mg/L

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

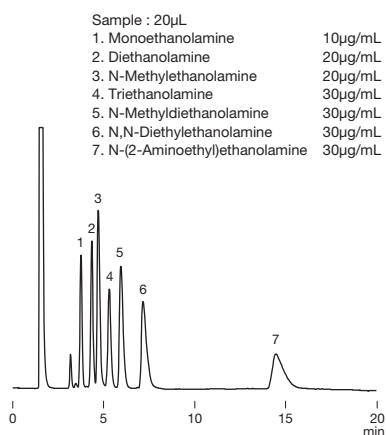
### Simultaneous analysis of cations and ethylenediamine



Sample : 10μL  
 1. Li<sup>+</sup> 2mg/L  
 2. Na<sup>+</sup> 10mg/L  
 3. NH<sub>4</sub><sup>+</sup> 10mg/L  
 4. K<sup>+</sup> 20mg/L  
 5. Mg<sup>2+</sup> 10mg/L  
 6. Ca<sup>2+</sup> 20mg/L  
 7. Ethylenediamine 50mg/L

**Column** : Shodex IC YS-50  
**Eluent** : 4mM HNO<sub>3</sub> + 1.5mM 18-Crown 6-ether aq. / CH<sub>3</sub>CN=90/10  
**Flow rate** : 1.0mL/min  
**Detector** : Non-suppressed conductivity  
**Column temp.** : 40°C

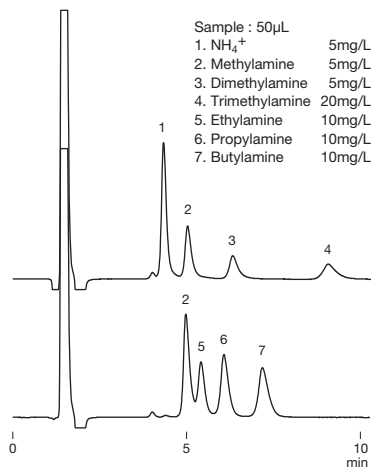
### Amino alcohols



Sample : 20μL  
 1. Monoethanolamine 10μg/mL  
 2. Diethanolamine 20μg/mL  
 3. N-Methylethanolamine 20μg/mL  
 4. Triethanolamine 30μg/mL  
 5. N-Methyldiethanolamine 30μg/mL  
 6. N,N-Diethylethanolamine 30μg/mL  
 7. N-(2-Aminoethyl)ethanolamine 30μg/mL

**Column** : Shodex IC YK-421  
**Eluent** : 4mM HNO<sub>3</sub> aq.  
**Flow rate** : 1.0mL/min  
**Detector** : Non-suppressed conductivity  
**Column temp.** : 40°C

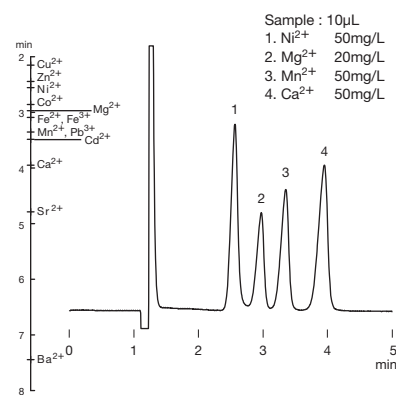
### Alkylamines



Sample : 50μL  
 1. NH<sub>4</sub><sup>+</sup> 5mg/L  
 2. Methylamine 5mg/L  
 3. Dimethylamine 5mg/L  
 4. Trimethylamine 20mg/L  
 5. Ethylamine 10mg/L  
 6. Propylamine 10mg/L  
 7. Butylamine 10mg/L

**Column** : Shodex IC YK-421  
**Eluent** : 4mM H<sub>3</sub>PO<sub>4</sub> aq. / CH<sub>3</sub>CN=90/10  
**Flow rate** : 1.0mL/min  
**Detector** : Non-suppressed conductivity  
**Column temp.** : 25°C

### Alkaline earth metal ions



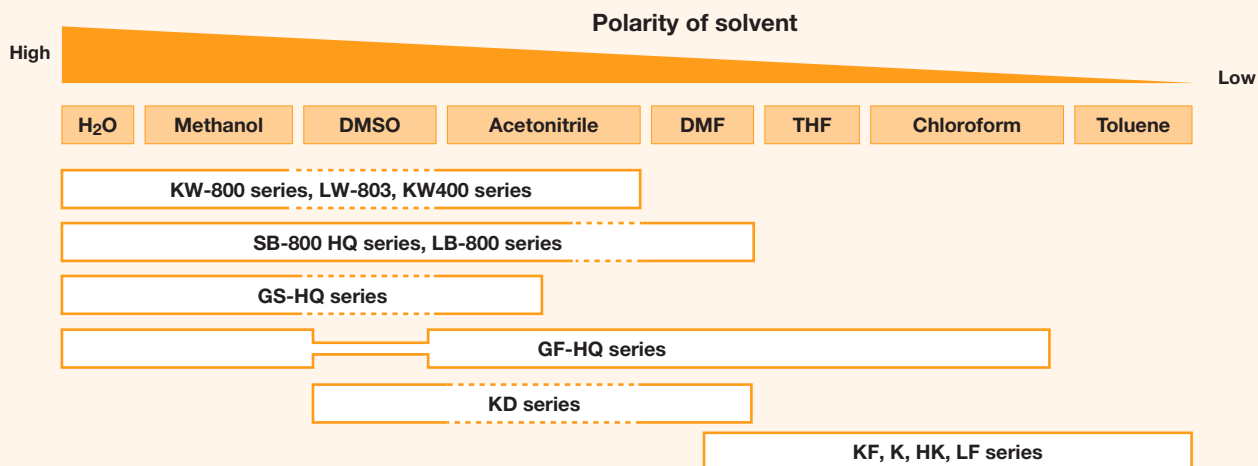
Sample : 10μL  
 1. Ni<sup>2+</sup> 50mg/L  
 2. Mg<sup>2+</sup> 20mg/L  
 3. Mn<sup>2+</sup> 50mg/L  
 4. Ca<sup>2+</sup> 50mg/L

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

# Column Selection for Size Exclusion Chromatography (SEC)

	Application	Solvent	Column	Page
Aqueous SEC (GPC)	Biological macromolecules (proteins, peptides, nucleic acids, etc.)	Buffer etc.	KW-800 series	38
			LW-803 High performance	38
			KW400 series High performance (solvent-saving)	38
	Biological macromolecules (high MW range)	Buffer etc.	SB-800 HQ series	42
			LB-800 series	42
	Water-soluble polymers (polyacrylamide, polyethylenimine, etc.) Polysaccharides	Water, Buffer, Aqueous solution, etc.	SB-800 HQ series	42
			LB-800 series	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	62
			K-800 series	52
	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	62
			SB-800 HQ series	42
			LB-800 series	42
	Analysis at high temperature (polyethylene, polypropylene etc.)	ODCB etc.	HT-800 series	64
			UT-800 series	64
			AT-806MS	64
	Engineering resin analysis at room temperature [polyamide (Nylon), polyethylene terephthalate (PET) etc.]	HFIP	HFIP-800 series	66
HFIP-600 series Rapid analysis (solvent-saving)			66	
HK-HFIP404L Ultra-rapid Analysis (solvent-saving)			58	
LF series High-linear calibration curves			62	
Aqueous/Organic SEC			GF-HQ series	48

## Solvent usability guideline for the Shodex SEC columns



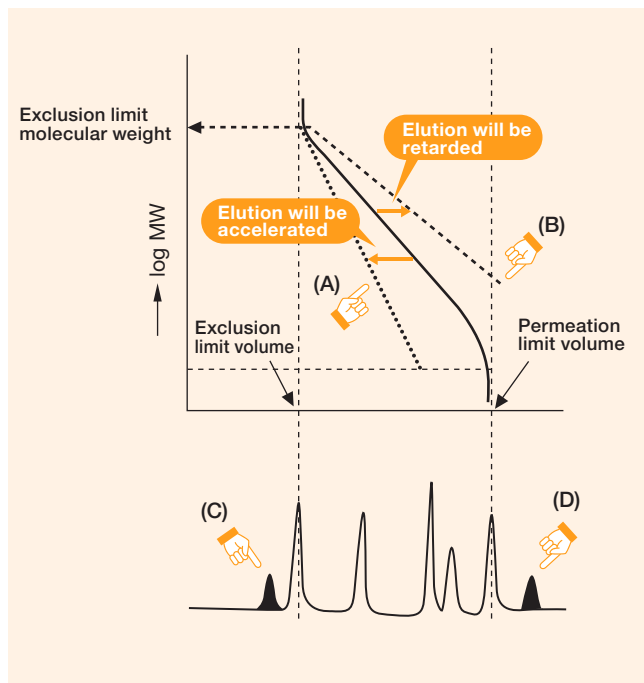
# ● Precautions for Polar Polymer Analysis

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 solvent SEC (GPC)

#### Ionic Interaction

- Add salt  
(Example) Add LiBr to DMF  
Add CF<sub>3</sub>COONa to HFIP

#### Hydrophobic interaction

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

#### Hydrophillic 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
- 
- New LW-803**
- Pore size specifically controlled for analyzing proteins with molecular weights of several hundred thousand Daltons; optimized for light scattering detection
  - High performance analysis of antibody drugs and various proteins
  - High lot-to-lot reproducibility
  - 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

## ■ Standard columns

Product Code	Product Name	<sup>1)</sup> Plate Number (TP/column)	Particle Size (µm)	Pore Size (Å)	Column Size (mm) I.D. x Length	Shipping Solvent
F6989000	<b>PROTEIN KW-802.5</b>	≥ 21,000	5	400	<b>8.0 x 300</b>	H <sub>2</sub> O
F6989103	<b>PROTEIN KW-803</b>	≥ 21,000	5	1,000	<b>8.0 x 300</b>	H <sub>2</sub> O
F6989104	<b>PROTEIN KW-804</b>	≥ 16,000	7	1,500	<b>8.0 x 300</b>	H <sub>2</sub> O
F6700131	<b>PROTEIN KW-G 6B (PROTEIN KW-G)</b>	(guard column)	7	–	<b>6.0 x 50</b>	H <sub>2</sub> O

1) Measured with ethylene glycol

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

## ■ Standard columns

Product Code	Product Name	<sup>2)</sup> Plate Number (TP/column)	Particle Size (µm)	Pore Size (Å)	Column Size (mm) I.D. x Length	Shipping Solvent
F6989303	<b>New</b> <b>PROTEIN LW-803</b>	≥ 12,000	3	1,000	<b>8.0 x 300</b>	H <sub>2</sub> O
F6700133	<b>New</b> <b>PROTEIN LW-G 6B</b>	(guard column)	3	–	<b>6.0 x 50</b>	H <sub>2</sub> O

2) Measured with BSA

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

3) Measured with uridine

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

4) Measured with ethylene glycol

**Target molecular weight range and exclusion limit**

● **Measured with protein (eluent: phosphate buffer)**

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

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

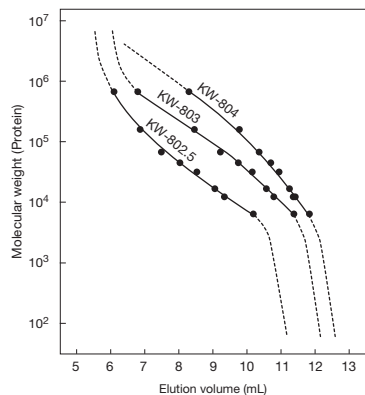
\*( ) Estimated value

● **Measured with pullulan (eluent: ultrapure water)**

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

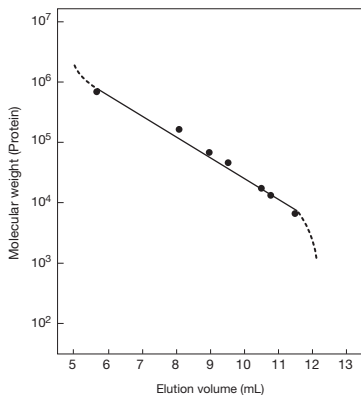
\*Please use the above table for reference purposes only when selecting columns.

### Calibration curves for KW-800 series using protein



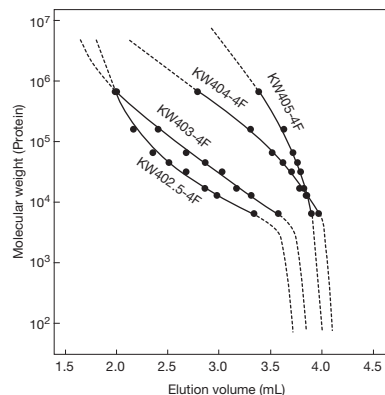
**Column** : Shodex PROTEIN KW-800 series  
**Eluent** : 50mM Sodium phosphate buffer (pH7.0) + 0.3M NaCl  
**Flow rate** : 1.0mL/min  
**Detector** : UV (280nm)  
**Column temp.** : 30°C

### Calibration curve for LW-803 using protein



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

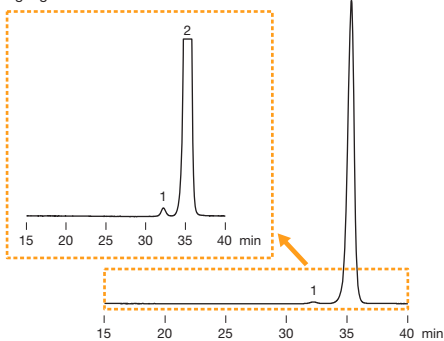
### Calibration curves for KW400 series using protein



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

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

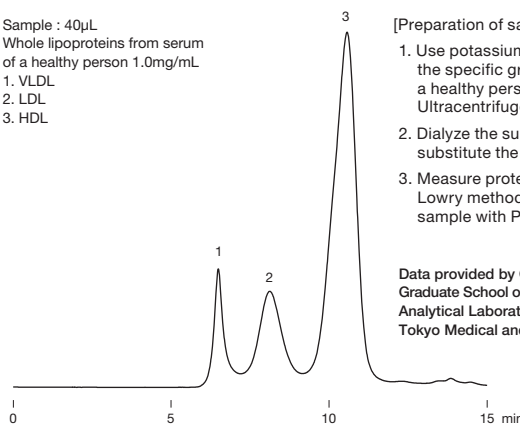
Sample : 100µL  
 System suitability solution (prepared following USP method)  
 1. High molecular weight proteins  
 2. Insulin glargine



**Column** : Shodex PROTEIN KW-802.5 x 2  
**Eluent** : CH<sub>3</sub>COOH/CH<sub>3</sub>CN/H<sub>2</sub>O=20/30/50 (pH to 3.0 adjusted with 25% NH<sub>3</sub> aq.)  
**Flow rate** : 0.5mL/min  
**Detector** : UV (276nm)  
**Column temp.** : Ambient

### Lipoproteins in serum

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

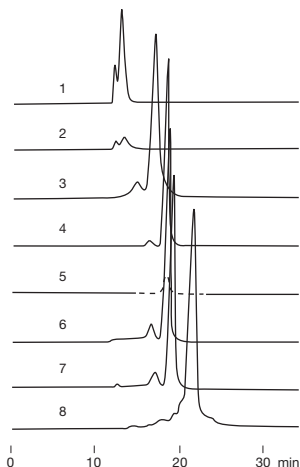


[Preparation of sample]  
 1. Use potassium bromide to adjust the specific gravity of serum from a healthy person to 1.210g/mL. Ultracentrifuge for 24 hours.  
 2. Dialyze the supernatant and then substitute the solvent with PBS\*.  
 3. Measure protein concentration by Lowry method and dilute the sample with PBS\* to 1.0mg/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<sub>2</sub>O  
**Flow rate** : 1.0mL/min  
**Detector** : UV (280nm)  
**Column temp.** : 30°C  
 x10 PBS\* : 80g NaCl + 29g Na<sub>2</sub>HPO<sub>4</sub> · 12H<sub>2</sub>O + 2g KCl + 2g KH<sub>2</sub>PO<sub>4</sub> in 1000mL of H<sub>2</sub>O

### Proteins in human blood serum

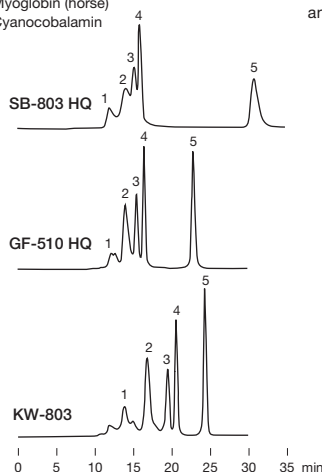


Sample : 0.1% each  
 1. Fibrinogen 50µL  
 2. α<sub>2</sub>-Macroglobulin 50µL  
 3. IgG 50µL  
 4. Transferrin 50µL  
 5. Plasminogen 50µL  
 6. Albumin 100µL  
 7. Antitrypsin 100µL  
 8. Hemoglobin 100µL

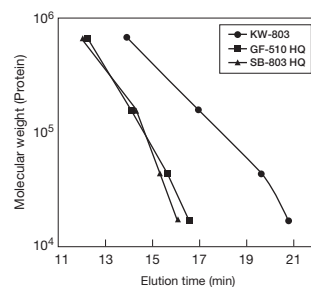
**Column** : Shodex PROTEIN KW-803  
**Eluent** : 50mM Sodium phosphate buffer (pH7.0) + 0.3M NaCl  
**Flow rate** : 1.0mL/min  
**Detector** : UV (280nm)  
**Column temp.** : Room temp.

### 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



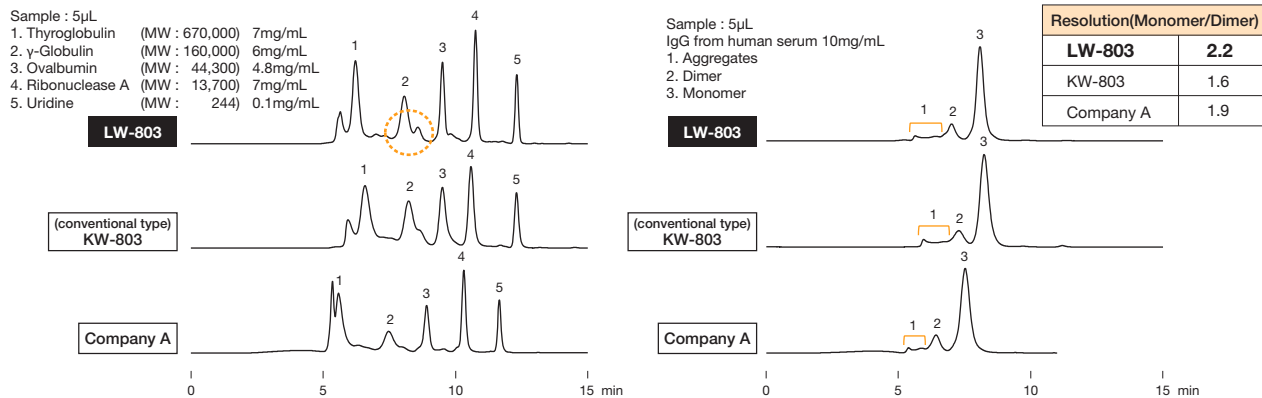
Separation performances of three aqueous SEC columns (SB-803 HQ, GF-510 HQ, and KW-803) were compared. KW-803, silica-based column, showed the best separation performance for the analysis of protein standards.



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

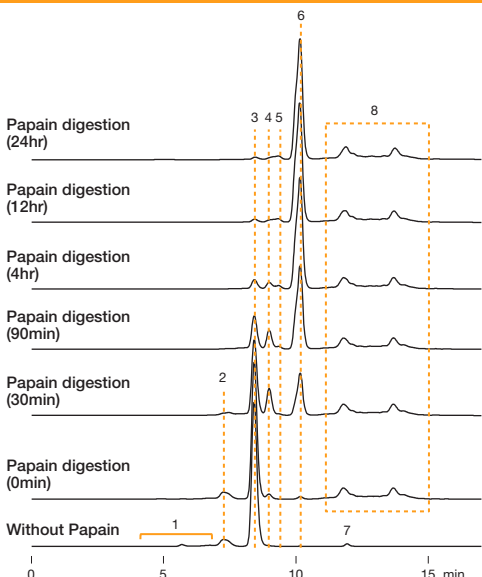
### Comparison of LW-803, conventional column, and other manufacturer's column

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  $\gamma$ -Globulin). This improvement is advantageous for the separation of monomer and dimer of IgG which is a mainstream antibody drug.



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

### Monitoring papain digestion of humanized monoclonal IgG



Sample : 10 $\mu$ L  
 Humanized monoclonal IgG  
 1. Aggregates of IgG  
 2. Dimer of IgG  
 3. Monomer of IgG  
 4, 5, 6. Fragments of IgG from papain digestion  
 7. Citric acid  
 8. Papain

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.

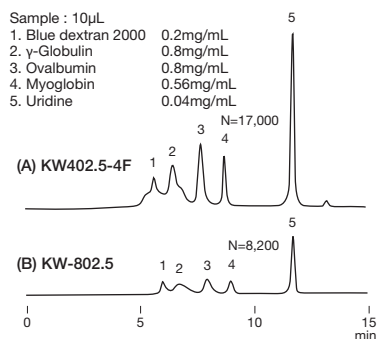
[Procedure of papain digestion]

- (1) Dissolve 3mg of humanized monoclonal IgG in 500 $\mu$ L of the eluent. (6mg/mL conc.)
- (2) Dissolve 1mg of papain in 500 $\mu$ L of the eluent. (1mg/mL conc.)
- (3) Pass (1) and (2) through 0.2 $\mu$ m membrane filter.
- (4) Mix each solution in equal amounts.
- (5) Keep temperature at 25 $^{\circ}$ C.
- (6) Takes a sample with time and analyze it by HPLC.

Column : Shodex PROTEIN LW-803  
 Eluent : 0.1M Sodium phosphate buffer (pH7.0) + 0.3M NaCl  
 Flow rate : 1.0mL/min  
 Detector : UV (280nm)  
 Column temp. : 25 $^{\circ}$ C

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

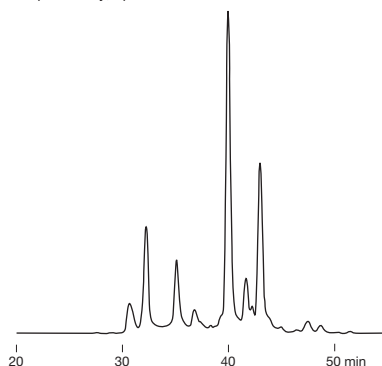
KW400 series is a high performance type of semi-micro columns. It offers approximately 1.5 times larger theoretical plate number and 3 to 4 times higher detection sensitivity (peak height) than KW-800 series columns do.



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

### Whey in yogurt

Sample : Whey, 5 $\mu$ L

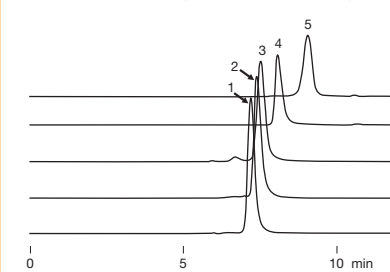


Column : Shodex KW402.5-4F + KW403-4F  
 Eluent : 50mM Sodium phosphate buffer (pH7.0) + 0.3M NaCl  
 Flow rate : 0.20mL/min  
 Detector : UV (280nm) (small cell volume)  
 Column temp. : 30 $^{\circ}$ C

### Lectins

Sample : 5 $\mu$ L

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



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

# 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 and 802.5 HQ fulfill USP L25 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-805 (exclusion limit: about 4,000,000) newly added to the series
  - Fulfills USP L38 and L39 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	<b>OHpak SB-802 HQ</b>	≥ 12,000	8	100	<b>8.0 × 300</b>	0.02% NaN <sub>3</sub> aq.
F6429101	<b>OHpak SB-802.5 HQ</b>	≥ 16,000	6	200	<b>8.0 × 300</b>	0.02% NaN <sub>3</sub> aq.
F6429102	<b>OHpak SB-803 HQ</b>	≥ 16,000	6	800	<b>8.0 × 300</b>	0.02% NaN <sub>3</sub> aq.
F6429103	<b>OHpak SB-804 HQ</b>	≥ 16,000	10	2,000	<b>8.0 × 300</b>	0.02% NaN <sub>3</sub> aq.
F6429104	<b>OHpak SB-805 HQ</b>	≥ 12,000	13	7,000	<b>8.0 × 300</b>	0.02% NaN <sub>3</sub> aq.
F6429105	<b>OHpak SB-806 HQ</b>	≥ 12,000	13	15,000	<b>8.0 × 300</b>	0.02% NaN <sub>3</sub> aq.
F6429106	<b>OHpak SB-806M HQ</b>	≥ 12,000	13	15,000	<b>8.0 × 300</b>	0.02% NaN <sub>3</sub> aq.
F6709430	<b>OHpak SB-G 6B (OHpak SB-G)</b>	(guard column)	10	-	<b>6.0 × 50</b>	0.02% NaN <sub>3</sub> 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	<b>OHpak SB-807 HQ</b>	≥ 1,500	35	30,000	<b>8.0 × 300</b>	H <sub>2</sub> O
F6709431	<b>OHpak SB-807G</b>	(guard column)	35	-	<b>8.0 × 50</b>	H <sub>2</sub> O

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	<b>OHpak LB-803</b>	≥ 16,000	6	800	<b>8.0 × 300</b>	H <sub>2</sub> O
F6429203	<b>New OHpak LB-805</b>	≥ 12,000	13	7,000	<b>8.0 × 300</b>	H <sub>2</sub> O
F6429202	<b>OHpak LB-806M</b>	≥ 12,000	13	15,000	<b>8.0 × 300</b>	H <sub>2</sub> O
F6709434	<b>OHpak LB-G 6B</b>	(guard column)	13	-	<b>6.0 × 50</b>	H <sub>2</sub> O

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	<b>OHpak SB-2002</b>	≥ 9,000	15	<b>20.0 × 300</b>	SB-802 HQ
F6516012	<b>OHpak SB-2002.5</b>	≥ 12,000	10	<b>20.0 × 300</b>	SB-802.5 HQ
F6516013	<b>OHpak SB-2003</b>	≥ 12,000	10	<b>20.0 × 300</b>	SB-803 HQ
F6516014	<b>OHpak SB-2004</b>	≥ 12,000	18	<b>20.0 × 300</b>	SB-804 HQ
F6516015	<b>OHpak SB-2005</b>	≥ 12,000	20	<b>20.0 × 300</b>	SB-805 HQ
F6516016	<b>OHpak SB-2006</b>	≥ 12,000	20	<b>20.0 × 300</b>	SB-806 HQ
F6516017	<b>OHpak SB-2006M</b>	≥ 12,000	20	<b>20.0 × 300</b>	SB-806M HQ
F6709555	<b>OHpak SB-G 8B (OHpak SB-LG)</b>	(guard column)	18	<b>8.0 × 50</b>	(guard column)

■ **Usable concentration of organic solvents**

Product Code	The maximum usable concentration (%)		
	Methanol	Acetonitrile	DMF
<b>SB-802 HQ</b>	0	0	0
<b>SB-802.5 HQ, SB-803 HQ</b>	100	75	100
<b>SB-804 HQ~SB-806M HQ</b>	75	75	100
<b>SB-G 6B</b>	75	75	100
<b>SB-807 HQ, SB-807G</b>	30	30	0
<b>LB-803, LB-805, LB-806M, LB-G 6B</b>	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
<b>SB-802 HQ</b>	200 – 1,000	1,000
<b>SB-802.5 HQ</b>	500 – 10,000	10,000
<b>SB-803 HQ</b>	1,000 – 100,000	100,000
<b>SB-804 HQ</b>	5,000 – 400,000	1,000,000
<b>SB-805 HQ</b>	100,000 – 1,000,000	*(4,000,000)
<b>SB-806 HQ</b>	100,000 – *(20,000,000)	*(20,000,000)
<b>SB-806M HQ</b>	500 – *(20,000,000)	*(20,000,000)
<b>SB-807 HQ</b>	500,000 – *(500,000,000)	*(500,000,000)
<b>LB-803</b>	1,000 – 100,000	100,000
<b>LB-805</b>	100,000 – 1,000,000	*(4,000,000)
<b>LB-806M</b>	500 – *(20,000,000)	*(20,000,000)

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

\*( ) Estimated value

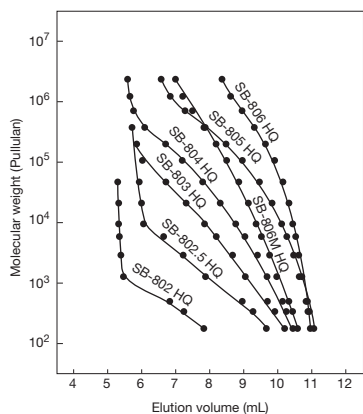
● **Measured with \*PEG/PEO (eluent: DMF)**

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

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

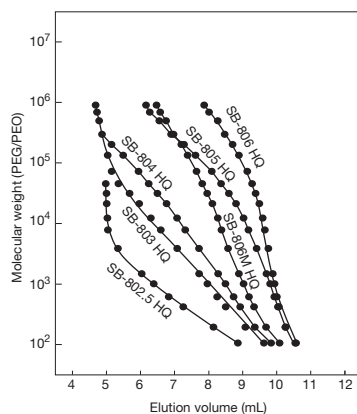
\*PEG: polyethylene glycol  
\*PEO: polyethylene oxide  
\*\* ( ) Estimated value

### Calibration curves for SB-800 HQ series using pullulan (eluent: H<sub>2</sub>O)



**Column** : Shodex OHpak SB-800 HQ series  
**Eluent** : H<sub>2</sub>O  
**Flow rate** : 1.0mL/min  
**Detector** : RI  
**Column temp.** : 30°C

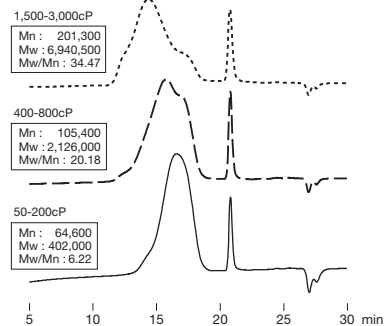
### Calibration curves for SB-800 HQ series using PEG/PEO (eluent: DMF)



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

### Carboxymethylcellulose

Sample : Carboxymethylcellulose 0.1% each, 50μL



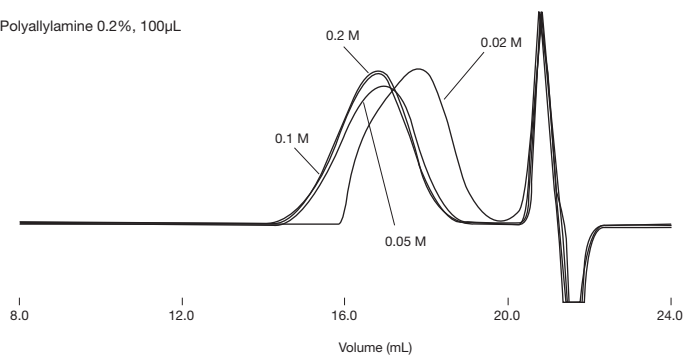
\*Molecular weight was determined from the calibration curve of pullulan.

**Column** : Shodex OHpak SB-806M HQ x 2  
**Eluent** : 0.1M NaCl aq.  
**Flow rate** : 1.0mL/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 polyallylamine, undesired adsorption of the polymer is observed when low (0.02M) sodium nitrate eluent was used. By using higher concentration (> 0.1M) salt, it suppresses the sample adsorption and enables to obtain accurate chromatograms.

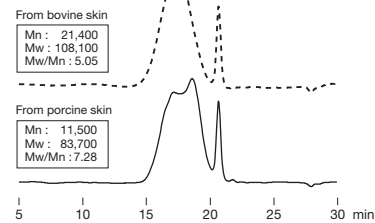
Sample : Polyallylamine 0.2%, 100μL



**Column** : Shodex OHpak SB-806M HQ x 2  
**Eluent** : 0.5M CH<sub>3</sub>COOH + NaNO<sub>3</sub> aq.  
**Flow rate** : 1.0mL/min  
**Detector** : RI  
**Column temp.** : 40°C

### Gelatin

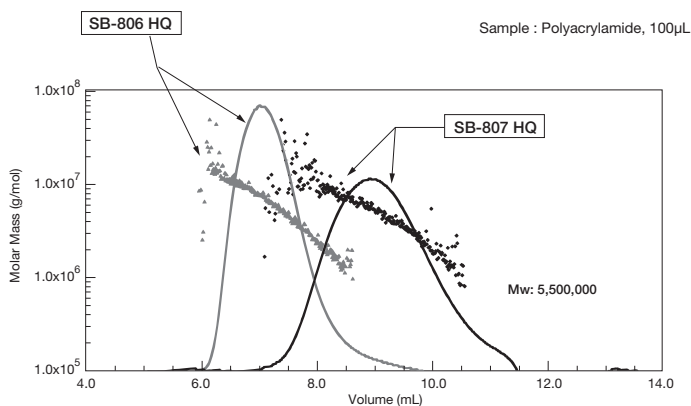
Sample : 0.1% each, 100μL  
 Gelatin from bovine skin (Acid treatment, Gel strength : 225g)  
 Gelatin from porcine skin (Alkali treatment, Gel strength : 90-100g)



\*Molecular weight was determined from the calibration curve of pullulan.

**Column** : Shodex OHpak SB-806M HQ x 2  
**Eluent** : 0.1M KH<sub>2</sub>PO<sub>4</sub> aq./  
 0.1M Na<sub>2</sub>HPO<sub>4</sub> aq.=50/50  
**Flow rate** : 1.0mL/min  
**Detector** : RI  
**Column temp.** : 40°C

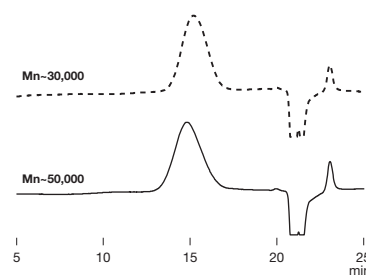
### Polyacrylamide



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

### Cellulose acetate

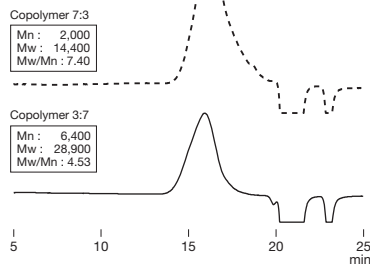
Sample : Cellulose acetate 0.1% each, 100μL



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

### Copovidones

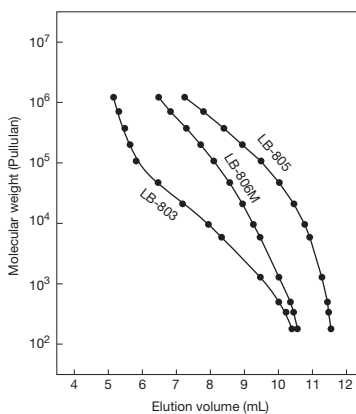
Sample : 100 $\mu$ L  
Poly(1-vinylpyrrolidone-co-vinyl acetate) 0.1% each



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

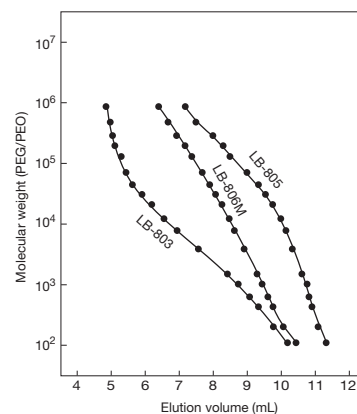
**Column** : Shodex OHpak SB-806M HQ x 2  
**Eluent** : 20mM LiBr in DMF  
**Flow rate** : 1.0mL/min  
**Detector** : RI  
**Column temp.** : 40°C

### Calibration curves for LB-800 series using pullulan (eluent: H<sub>2</sub>O)



**Column** : Shodex OHpak LB-800 series  
**Eluent** : H<sub>2</sub>O  
**Flow rate** : 1.0mL/min  
**Detector** : RI  
**Column temp.** : 30°C

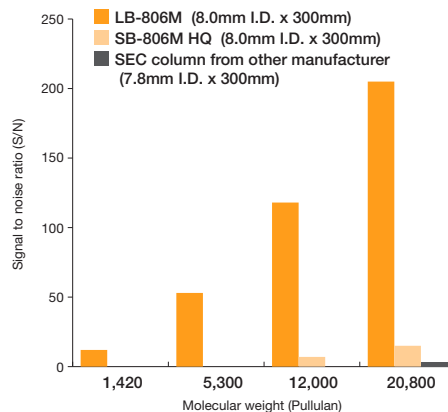
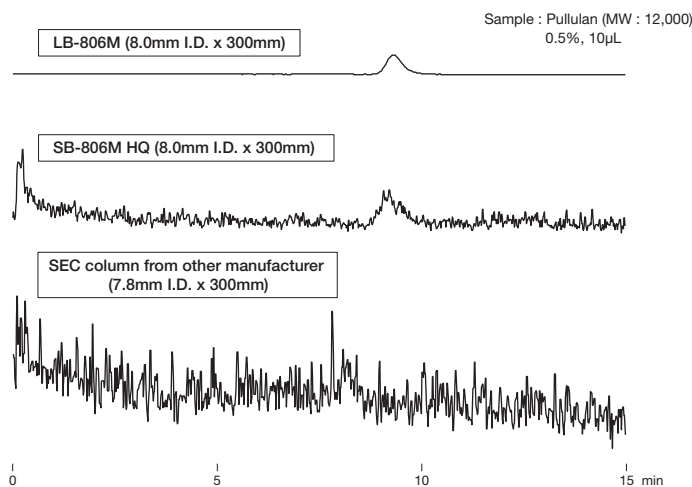
### Calibration curves for LB-800 series using PEG/PEO (eluent: DMF)



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

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

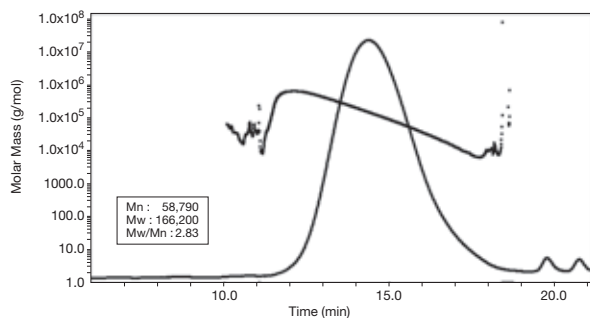
The new OHpak LB-800 series is able to detect low molecular weight substances owing to its improved low baseline noise level while using it with a multiangle light scattering detector. This cannot be achieved with other manufacturer's SEC column.



**Column** : Shodex OHpak LB-806M  
Shodex OHpak SB-806M HQ  
SEC column from other manufacturer  
**Eluent** : 0.1M NaNO<sub>3</sub> aq.  
**Flow rate** : 1.0mL/min  
**Detector** : MALS (Multi angle light scattering) (90°)  
**Column temp.** : 30°C

### Sodium alginate

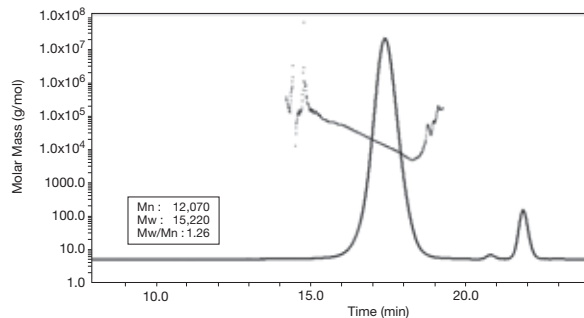
Sample : Sodium alginate 0.1%, 100 $\mu$ L



**Column** : Shodex OHpak LB-806M x 2  
**Eluent** : 0.1M NaNO<sub>3</sub> aq.  
**Flow rate** : 1.0mL/min  
**Detector** : RI  
MALS (Multi angle light scattering)  
**Column temp.** : 30°C

### Sodium heparin

Sample : Sodium heparin 0.1%, 100 $\mu$ L



**Column** : Shodex OHpak LB-806M x 2  
**Eluent** : 0.1M NaNO<sub>3</sub> aq.  
**Flow rate** : 1.0mL/min  
**Detector** : RI  
MALS (Multi angle light scattering)  
**Column temp.** : 30°C

# 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	<b>Asahipak GS-220 HQ</b>	≥ 19,000	6	150	<b>7.5 × 300</b>	H <sub>2</sub> O/CH <sub>3</sub> OH=70/30
F7600006	<b>Asahipak GS-320 HQ</b>	≥ 19,000	6	400	<b>7.5 × 300</b>	H <sub>2</sub> O/CH <sub>3</sub> OH=70/30
F7600007	<b>Asahipak GS-520 HQ</b>	≥ 18,000	7	2,000	<b>7.5 × 300</b>	H <sub>2</sub> O/CH <sub>3</sub> OH=70/30
F7600008	<b>Asahipak GS-620 HQ</b>	≥ 18,000	7	7,000	<b>7.5 × 300</b>	H <sub>2</sub> O/CH <sub>3</sub> OH=70/30
F6710019	<b>Asahipak GS-2G 7B</b>	(guard column)	9	–	<b>7.5 × 50</b>	H <sub>2</sub> O/CH <sub>3</sub> OH=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	<b>GS320A-4D</b>	6	400	<b>4.6 × 150</b>
F7750311	<b>GS320A-4E</b>	6	400	<b>4.6 × 250</b>

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	<b>Asahipak GS-220 20F</b>	≥ 8,000	13	<b>20.0 × 300</b>	GS-220 HQ
F6810018	<b>Asahipak GS-320 20F</b>	≥ 8,000	13	<b>20.0 × 300</b>	GS-320 HQ
F6810019	<b>Asahipak GS-520 20F</b>	≥ 8,000	13	<b>20.0 × 300</b>	GS-520 HQ
F6810020	<b>Asahipak GS-620 20F</b>	≥ 8,000	13	<b>20.0 × 300</b>	GS-620 HQ
F6810034	<b>Asahipak GS-220 20G</b>	≥ 14,000	13	<b>20.0 × 500</b>	GS-220 HQ
F6810035	<b>Asahipak GS-320 20G</b>	≥ 14,000	13	<b>20.0 × 500</b>	GS-320 HQ
F6810036	<b>Asahipak GS-520 20G</b>	≥ 14,000	13	<b>20.0 × 500</b>	GS-520 HQ
F6810037	<b>Asahipak GS-620 20G</b>	≥ 14,000	13	<b>20.0 × 500</b>	GS-620 HQ
F6710021	<b>Asahipak GS-20G 7B</b>	(guard column)	20	<b>7.5 × 50</b>	(guard column)

## Target molecular weight range and exclusion limit

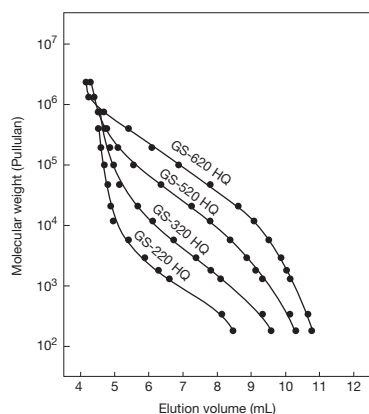
● Measured with pullulan (eluent: ultrapure water)

Product Name	Target Molecular Weight Range	Exclusion Limit
<b>GS-220</b>	300 – 3,000	7,000
<b>GS-320</b>	300 – 20,000	40,000
<b>GS-520</b>	5,000 – 200,000	300,000
<b>GS-620</b>	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<sub>2</sub>O  
**Flow rate** : 0.6mL/min  
**Detector** : RI  
**Column temp.** : 30°C

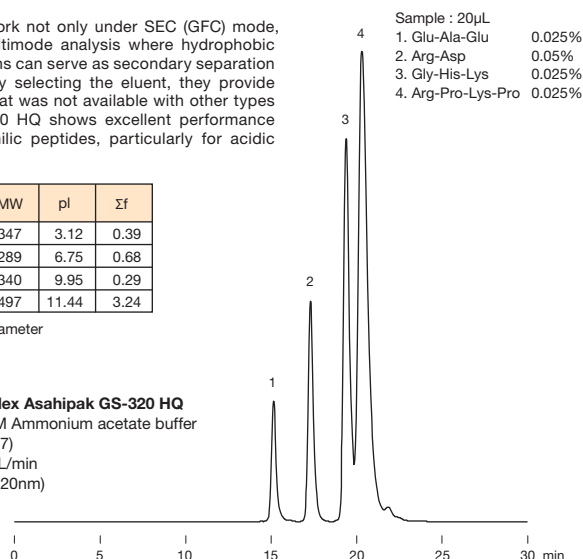
### Peptides

GS-HQ columns work not only under SEC (GFC) mode, but also under multimode analysis where hydrophobic and ionic interactions can serve as secondary separation modes. 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

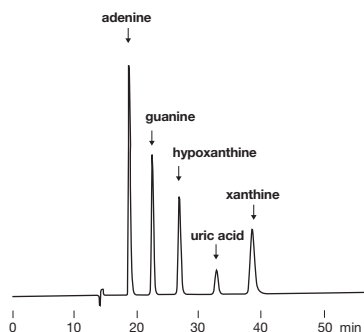
**Column** : Shodex Asahipak GS-320 HQ  
**Eluent** : 30mM Ammonium acetate buffer (pH6.7)  
**Flow rate** : 0.5mL/min  
**Detector** : UV (220nm)  
**Column temp.** : 30°C



### Analysis of purine bases in beer

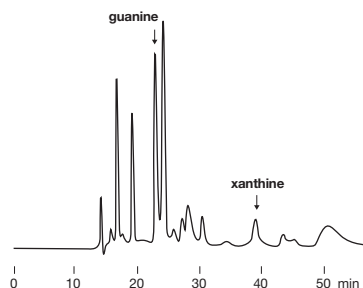
Purine present in food is detected as its purine base form after sample preparation including: homogenization, freeze drying, hydrolyzation with 70% perchloric acid, and neutralization. The example below shows the analysis of purine in regular beer and beer treated with guanase (an enzyme that degrades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

#### Purine bases in beer

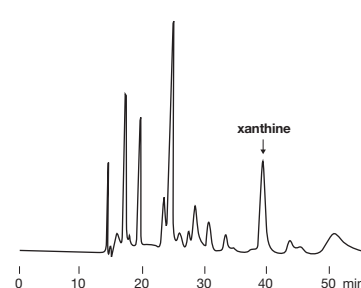


**Column** : Shodex Asahipak GS-320 HQ  
**Eluent** : 150mM Sodium phosphate buffer (pH2.5)  
**Flow rate** : 0.6mL/min  
**Detector** : UV (260nm)  
**Column temp.** : 35°C

#### Normal beer



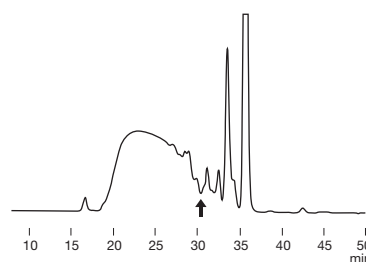
#### Guanase treated beer



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

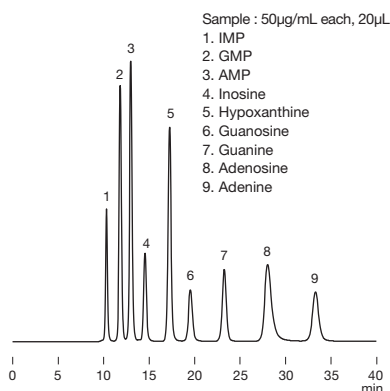
### Low molecular weight water-soluble dietary fiber

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



**Column** : Shodex Asahipak GS-220 HQ x 2  
**Eluent** : H<sub>2</sub>O  
**Flow rate** : 0.5mL/min  
**Detector** : RI  
**Column temp.** : 60°C

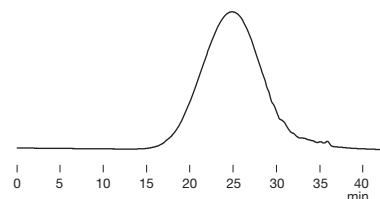
### “Umami”



**Column** : Shodex Asahipak GS-320 HQ  
**Eluent** : 10mM NaH<sub>2</sub>PO<sub>4</sub> aq./10mM Na<sub>2</sub>HPO<sub>4</sub> aq. =1000/31  
**Flow rate** : 1.0mL/min  
**Detector** : UV (260nm)  
**Column temp.** : 40°C

### Lignosulfonic acid

Sample : 100µL  
 Lignosulfonic acid sodium salt 0.1%



**Column** : Shodex Asahipak GS-520 HQ x 2  
**Eluent** : 20mM Na<sub>2</sub>HPO<sub>4</sub> aq.  
**Flow rate** : 0.6mL/min  
**Detector** : UV (254nm)  
**Column temp.** : 40°C

# 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	<b>Asahipak GF-210 HQ</b>	≥ 19,000	5	180	<b>7.5 x 300</b>	H <sub>2</sub> O
F7600001	<b>Asahipak GF-310 HQ</b>	≥ 19,000	5	400	<b>7.5 x 300</b>	H <sub>2</sub> O/CH <sub>3</sub> OH=70/30
F7600002	<b>Asahipak GF-510 HQ</b>	≥ 19,000	5	2,000	<b>7.5 x 300</b>	H <sub>2</sub> O/CH <sub>3</sub> OH=70/30
F7600003	<b>Asahipak GF-710 HQ</b>	≥ 11,000	9	10,000	<b>7.5 x 300</b>	H <sub>2</sub> O/CH <sub>3</sub> OH=70/30
F7600004	<b>Asahipak GF-7M HQ</b>	≥ 13,000	9	10,000	<b>7.5 x 300</b>	H <sub>2</sub> O/CH <sub>3</sub> OH=70/30
F6710018	<b>Asahipak GF-1G 7B</b>	(guard column)	9	–	<b>7.5 x 50</b>	H <sub>2</sub> O/CH <sub>3</sub> OH=70/30
F7600100	<b>MSPak GF-310 4B</b>	≥ 3,000	5	400	<b>4.6 x 50</b>	H <sub>2</sub> O
F7600110	<b>MSPak GF-310 4D</b>	≥ 10,000	5	400	<b>4.6 x 150</b>	H <sub>2</sub> O
F7600024	<b>MSPak GF-310 4E</b>	≥ 16,000	5	400	<b>4.6 x 250</b>	H <sub>2</sub> O
F7600120	<b>MSPak GF-310 2D</b>	≥ 5,500	5	400	<b>2.0 x 150</b>	H <sub>2</sub> O

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	<b>Asahipak GF-210 4D</b>	5	180	<b>4.6 x 150</b>
F7600201	<b>Asahipak GF-210 4E</b>	5	180	<b>4.6 x 250</b>
F7760512	<b>GF510A-4D</b>	5	2,000	<b>4.6 x 150</b>
F7760511	<b>GF510A-4E</b>	5	2,000	<b>4.6 x 250</b>

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	<b>Asahipak GS-310 20F</b>	≥ 8,000	13	<b>20.0 x 300</b>	GF-310 HQ
F6810031	<b>Asahipak GS-510 20F</b>	≥ 8,000	13	<b>20.0 x 300</b>	GF-510 HQ
F6810032	<b>Asahipak GS-710 20F</b>	≥ 8,000	13	<b>20.0 x 300</b>	GF-710 HQ
F6810033	<b>Asahipak GSM-700 20F</b>	≥ 8,000	13	<b>20.0 x 300</b>	GF-7M HQ
F6810038	<b>Asahipak GS-310 20G</b>	≥ 14,000	13	<b>20.0 x 500</b>	GF-310 HQ
F6810039	<b>Asahipak GS-510 20G</b>	≥ 14,000	13	<b>20.0 x 500</b>	GF-510 HQ
F6810040	<b>Asahipak GS-710 20G</b>	≥ 14,000	13	<b>20.0 x 500</b>	GF-710 HQ
F6810041	<b>Asahipak GSM-700 20G</b>	≥ 14,000	13	<b>20.0 x 500</b>	GF-7M HQ
F6710020	<b>Asahipak GS-10G 7B</b>	(guard column)	20	<b>7.5 x 50</b>	(guard column)

## Target molecular weight range and exclusion limit

### Measured with pullulan (eluent: ultrapure water)

Product Name	Target Molecular Weight Range	Exclusion Limit
<b>GF-210</b>	300 – 4,000	9,000
<b>GF-310</b>	300 – 30,000	40,000
<b>GF-510</b>	5,000 – 200,000	300,000
<b>GF-710</b>	100,000 – *(10,000,000)	*(10,000,000)
<b>GF-7M</b>	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
<b>GF-210</b>	100 – 2,000
<b>GF-310</b>	200 – 4,000
<b>GF-510</b>	2,000 – 200,000
<b>GF-710</b>	20,000 – *(10,000,000)
<b>GF-7M</b>	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 - 0.5M sodium concentration)	○	○
Methanol	○	○
Ethanol	○	○
Acetonitrile	○*	○
THF	○	○
DMF	○	○
Acetone	○	○
Chloroform	○*	○
Ethylacetate	○*	○
DMSO	○	○~50%

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

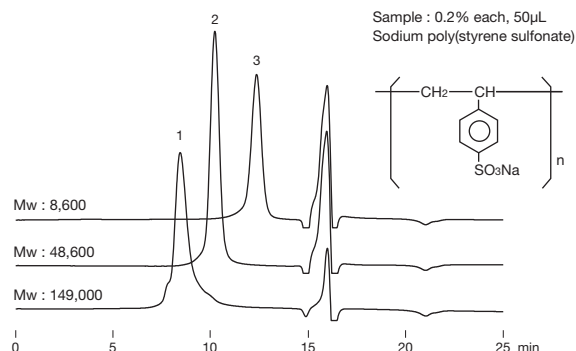
\*When replacing water with ethyl acetate or chloroform, replace with methanol first and then replace with the required eluent condition.

(Note)

The usable solvents for preparative columns of GF-710 HQ, GS-710 20F and 20G, are water and methanol. Use of GSM-700 20F or 20G is recommended when other solvents are required.

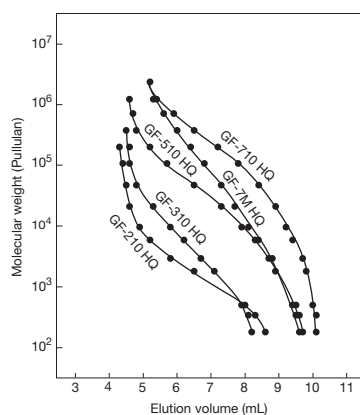
### Sodium polystyrene sulfonates

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.



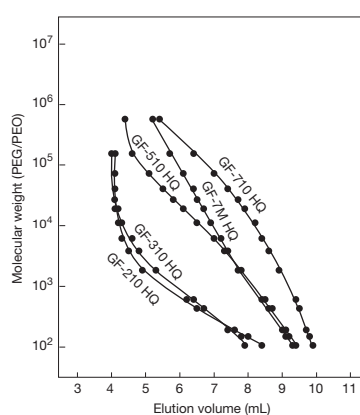
Column : Shodex Asahipak GF-510 HQ  
 Eluent : 50mM LiCl aq./CH<sub>3</sub>CN=60/40  
 Flow rate : 0.6mL/min  
 Detector : UV (254nm)  
 Column temp. : 30°C

### Calibration curves for GF-HQ series using pullulan (eluent: H<sub>2</sub>O)



Column : Shodex Asahipak GF-HQ series  
 Eluent : H<sub>2</sub>O  
 Flow rate : 0.6mL/min  
 Detector : RI  
 Column temp. : 30°C

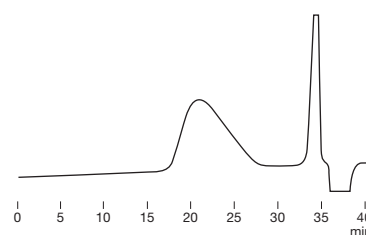
### Calibration curves for GF-HQ series using PEG/PEO (eluent: DMF)



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

### Polyacrylonitrile

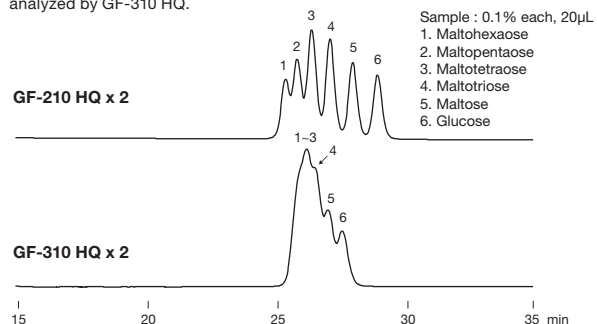
Sample : Polyacrylonitrile 0.1%, 100µL



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

### Comparison of two GF column performances for the separation of maltooligosaccharides

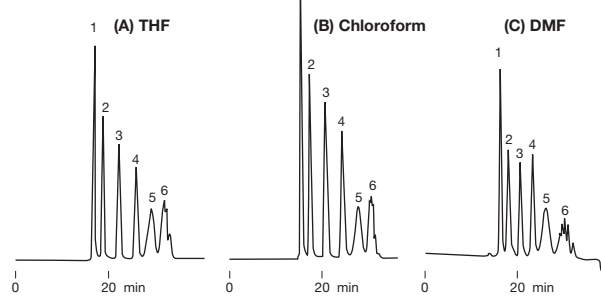
GF-210 HQ demonstrates an improved separation of low molecular substances. The chromatograms below show that the peaks obtained by GF-210 HQ are separated with deeper notches compared to peaks obtained by GF-310 HQ. GF-210 HQ is capable of separating oligosaccharides (trisaccharides to hexasaccharides) 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<sub>2</sub>O  
 Flow rate : 0.6mL/min  
 Detector : RI  
 Column temp. : 50°C

### Comparison of polystyrene separation under three different solvent conditions

Sample : Polystyrene 1mg/mL each, 50µL  
 1. Mw : 1,090,000  
 2. Mw : 190,000  
 3. Mw : 37,900  
 4. Mw : 9,100  
 5. Mw : 2,980  
 6. Mw : 500



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

# 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 (GPC KF-G)	(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 pages 60 and 61 for details preparative columns.

\*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)

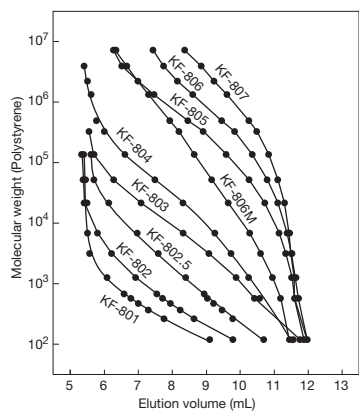
Product Name	Target Molecular Weight Range	Exclusion Limit
<b>KF-801</b>	100 – 700	1,500
<b>KF-802</b>	300 – 3,000	5,000
<b>KF-802.5</b>	300 – 8,000	20,000
<b>KF-803</b>	1,000 – 50,000	70,000
<b>KF-803L</b>	100 – 50,000	70,000
<b>KF-804</b>	7,000 – 300,000	400,000
<b>KF-804L</b>	100 – 300,000	400,000

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

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

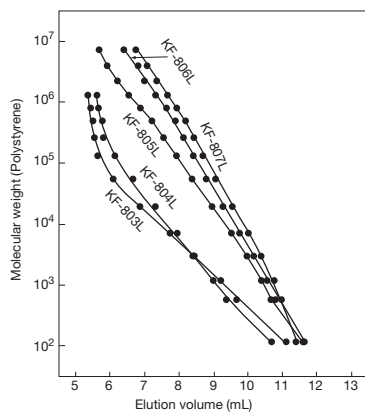
\*( ) Estimated value

Calibration curves for KF-800 series using polystyrene



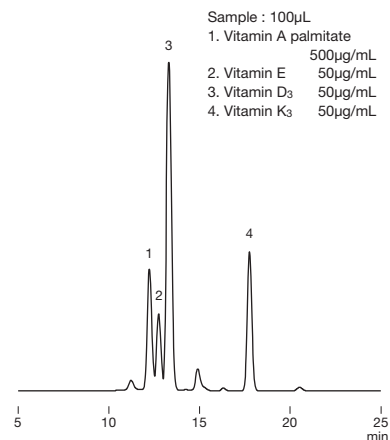
Column : Shodex GPC KF-800 series  
 Eluent : THF  
 Flow rate : 1.0mL/min  
 Detector : RI  
 Column temp. : 40°C

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



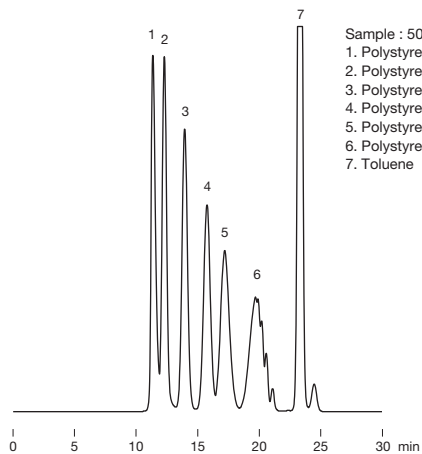
Column : Shodex GPC KF-800L series  
 Eluent : THF  
 Flow rate : 1.0mL/min  
 Detector : RI  
 Column temp. : 40°C

Fat-soluble vitamins



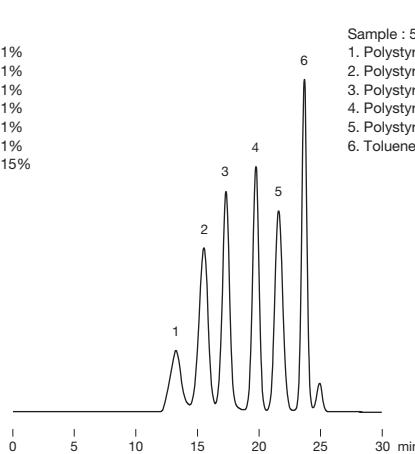
Column : Shodex GPC KF-801 x 2  
 Eluent : THF  
 Flow rate : 1.0mL/min  
 Detector : UV (280nm)  
 Column temp. : 40°C

Polystyrene standards



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

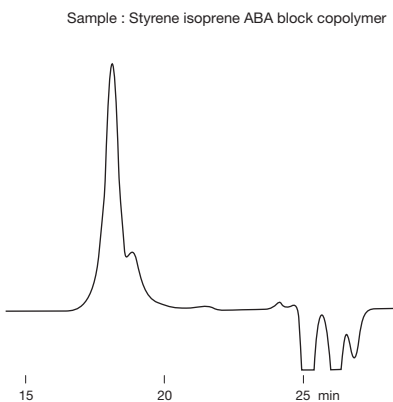
Sample : 50µL  
 1. Polystyrene (Mw : 133,000) 0.1%  
 2. Polystyrene (Mw : 55,100) 0.1%  
 3. Polystyrene (Mw : 19,600) 0.1%  
 4. Polystyrene (Mw : 7,210) 0.1%  
 5. Polystyrene (Mw : 3,070) 0.1%  
 6. Polystyrene (Mw : 580) 0.1%  
 7. Toluene (Mw : 92) 0.15%



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

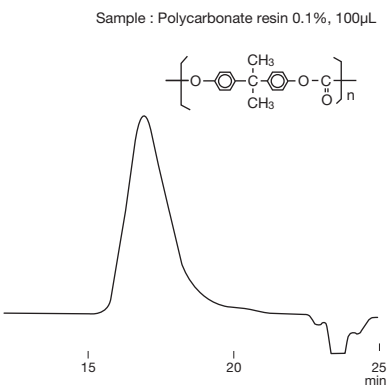
Sample : 50µL  
 1. Polystyrene (Mw : 19,825,000) 0.05%  
 2. Polystyrene (Mw : 1,320,000) 0.1%  
 3. Polystyrene (Mw : 133,000) 0.1%  
 4. Polystyrene (Mw : 7,210) 0.1%  
 5. Polystyrene (Mw : 580) 0.1%  
 6. Toluene (Mw : 92) 0.1%

Styrene isoprene ABA block copolymer



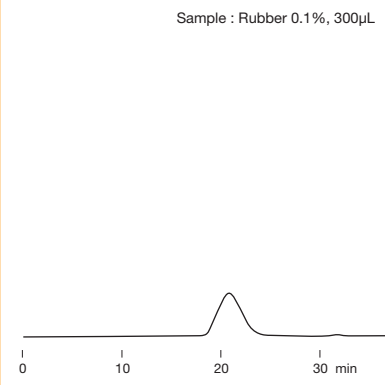
Column : Shodex GPC KF-806M x 2  
 Eluent : THF  
 Flow rate : 1.0mL/min  
 Detector : RI  
 Column temp. : 30°C

Polycarbonate resin



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

Raw rubber



Column : Shodex GPC KF-806M x 2 + KF-802  
 Eluent : Toluene  
 Flow rate : 1.0mL/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	<b>GPC K-801</b>	≥ 18,000	6	50	<b>8.0 x 300</b>
F6028120	<b>GPC K-802</b>	≥ 18,000	6	150	<b>8.0 x 300</b>
F6028125	<b>GPC K-802.5</b>	≥ 18,000	6	300	<b>8.0 x 300</b>
F6028130	<b>GPC K-803</b>	≥ 18,000	6	500	<b>8.0 x 300</b>
F6028194	<b>GPC K-803L</b>	≥ 18,000	6	500	<b>8.0 x 300</b>
F6028140	<b>GPC K-804</b>	≥ 18,000	7	1,500	<b>8.0 x 300</b>
F6028195	<b>GPC K-804L</b>	≥ 18,000	7	1,500	<b>8.0 x 300</b>
F6028150	<b>GPC K-805</b>	≥ 11,000	10	5,000	<b>8.0 x 300</b>
F6028196	<b>GPC K-805L</b>	≥ 11,000	10	5,000	<b>8.0 x 300</b>
F6028160	<b>GPC K-806</b>	≥ 11,000	10	10,000	<b>8.0 x 300</b>
F6028190	<b>GPC K-806M</b>	≥ 13,000	10	10,000	<b>8.0 x 300</b>
F6028197	<b>GPC K-806L</b>	≥ 11,000	10	10,000	<b>8.0 x 300</b>
F6028170	<b>GPC K-807</b>	≥ 6,000	18	20,000	<b>8.0 x 300</b>
F6028198	<b>GPC K-807L</b>	≥ 6,000	18	20,000	<b>8.0 x 300</b>
F6700401	<b>GPC K-G 4A (GPC K-G)</b>	(guard column)	8	–	<b>4.6 x 10</b>
F6709450	<b>GPC K-800D</b>	( solvent-peak separation column )	10	–	<b>8.0 x 100</b>

\*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 pages 60 and 61 for details preparative columns.

\*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: Chloroform)

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

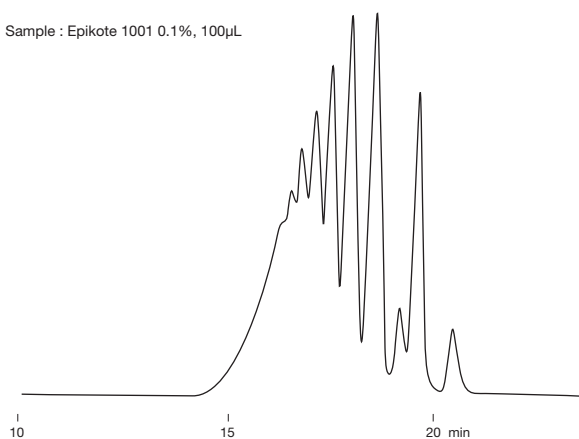
Product Name	Target Molecular Weight Range	Exclusion Limit
<b>K-805</b>	50,000 – 2,000,000	4,000,000
<b>K-805L</b>	300 – 2,000,000	4,000,000
<b>K-806</b>	150,000 – *(20,000,000)	*(20,000,000)
<b>K-806M</b>	1,000 – *(20,000,000)	*(20,000,000)
<b>K-806L</b>	300 – *(20,000,000)	*(20,000,000)
<b>K-807</b>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

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

\*( ) Estimated value

### Epoxy resin

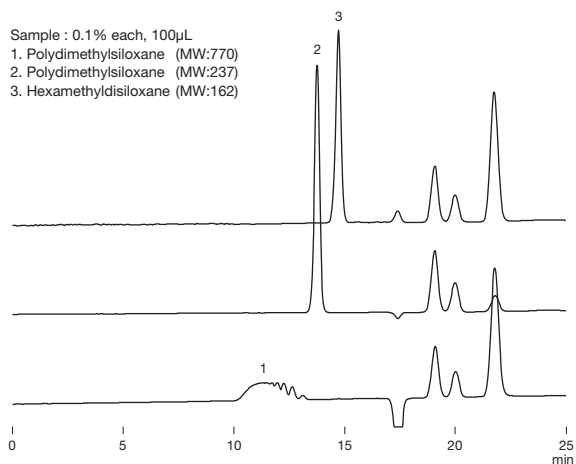
Sample : Epikote 1001 0.1%, 100µL



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

### Low molecular polydimethylsiloxanes

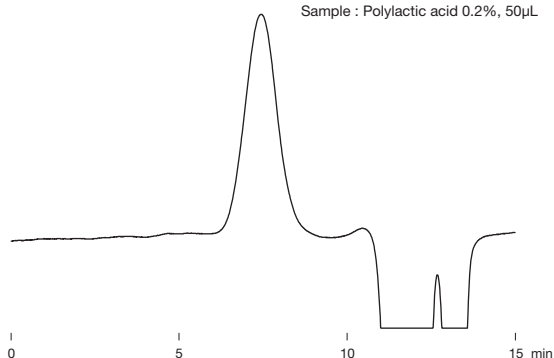
Sample : 0.1% each, 100µL  
 1. Polydimethylsiloxane (MW:770)  
 2. Polydimethylsiloxane (MW:237)  
 3. Hexamethyldisiloxane (MW:162)



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

### Polylactic acid

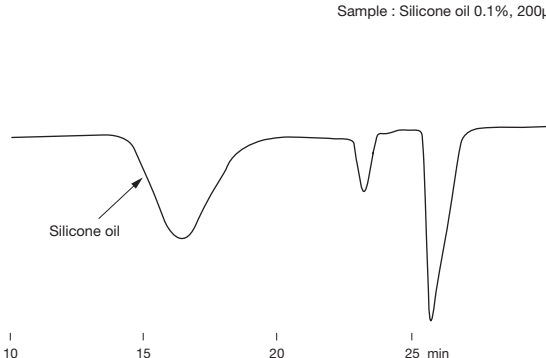
Sample : Polylactic acid 0.2%, 50µL



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

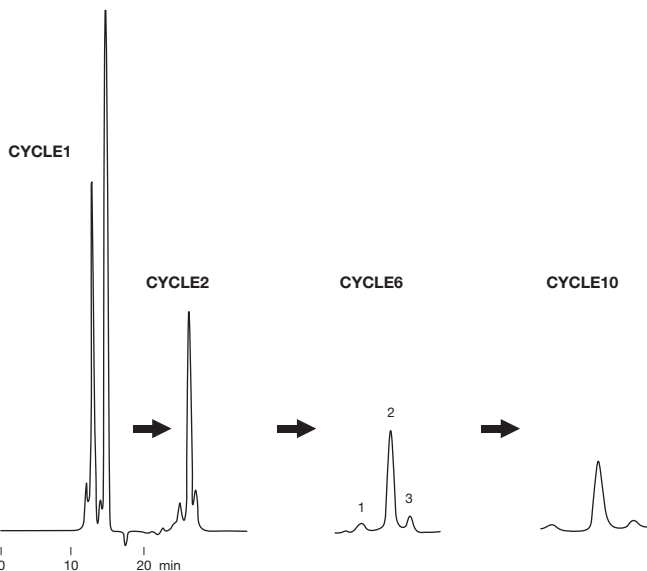
### Silicone oil

Sample : Silicone oil 0.1%, 200µL



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

### Recycling preparative chromatography of lauryl stearyl thiodipropionate



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

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

\*See page 60 for K-2001

# 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	<b>GPC KD-801</b>	≥ 17,000	6	50	<b>8.0 x 300</b>
F6028220	<b>GPC KD-802</b>	≥ 17,000	6	150	<b>8.0 x 300</b>
F6028225	<b>GPC KD-802.5</b>	≥ 17,000	6	300	<b>8.0 x 300</b>
F6028230	<b>GPC KD-803</b>	≥ 17,000	6	500	<b>8.0 x 300</b>
F6028240	<b>GPC KD-804</b>	≥ 17,000	7	1,500	<b>8.0 x 300</b>
F6028250	<b>GPC KD-805</b>	≥ 11,000	10	5,000	<b>8.0 x 300</b>
F6028260	<b>GPC KD-806</b>	≥ 11,000	10	10,000	<b>8.0 x 300</b>
F6028290	<b>GPC KD-806M</b>	≥ 13,000	10	10,000	<b>8.0 x 300</b>
F6028270	<b>GPC KD-807</b>	≥ 6,000	18	20,000	<b>8.0 x 300</b>
F6700411	<b>GPC KD-G 4A (GPC KD-G)</b>	(guard column)	8	–	<b>4.6 x 10</b>

\*The column with 'M' at the end of column names 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
<b>KD-801</b>	100 – 1,500	2,500
<b>KD-802</b>	200 – 4,000	7,000
<b>KD-802.5</b>	400 – 10,000	20,000
<b>KD-803</b>	1,000 – 50,000	70,000
<b>KD-804</b>	4,000 – 200,000	200,000

Product Name	Target Molecular Weight Range	Exclusion Limit
<b>KD-805</b>	30,000 – *(4,000,000)	*(4,000,000)
<b>KD-806</b>	30,000 – *(40,000,000)	*(40,000,000)
<b>KD-806M</b>	1,000 – *(40,000,000)	*(40,000,000)
<b>KD-807</b>	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**
  - Use this column in combination with a linear column
- K-800D**
  - 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

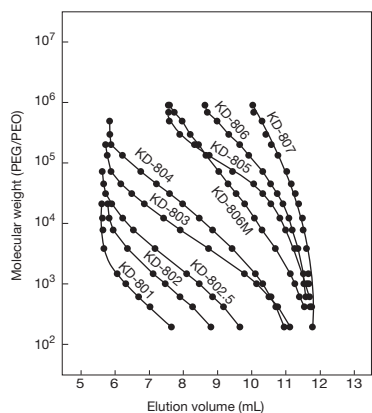
## Solvent-peak separation columns

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

Base Material: Styrene divinylbenzene copolymer



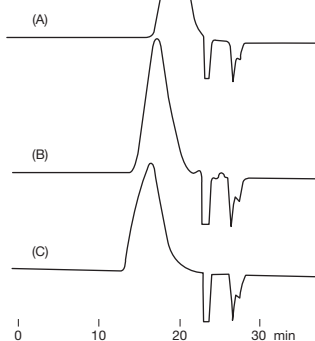
### Calibration curves for KD-800 series using PEG/PEO



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

### Polyvinylpyrrolidones

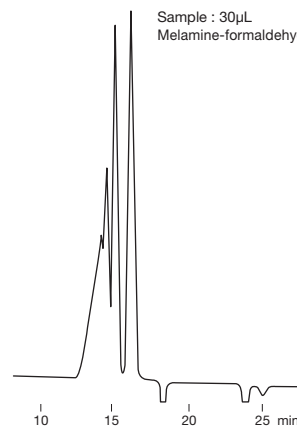
Sample : Polyvinylpyrrolidone 0.2% each  
 (A) K-30 400 $\mu$ L  
 (B) K-60 500 $\mu$ L  
 (C) K-90 500 $\mu$ L



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

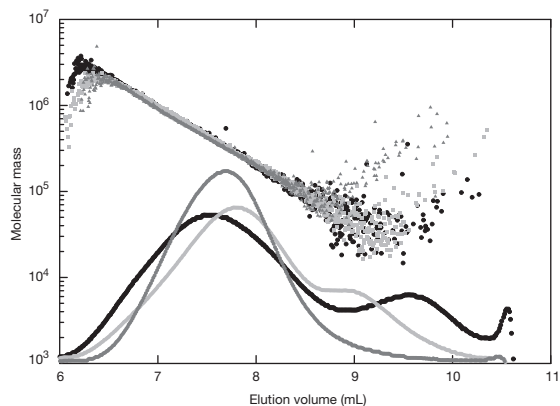
### Melamine formaldehyde resin

Sample : 30 $\mu$ L  
 Melamine-formaldehyde resin 1%



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

### Celluloses



Sample : 100 $\mu$ L  
 Cellulose ca. 0.05% each

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.

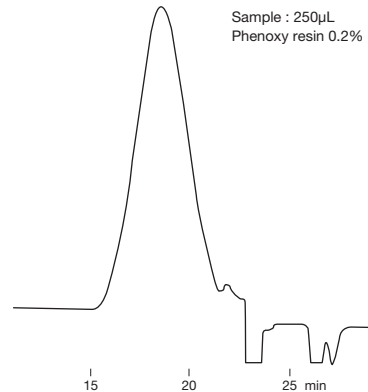
**Column** : Shodex GPC KD-806M  
**Eluent** : 1% LiCl in \*DMI  
**Flow rate** : 0.5mL/min  
**Detector** : RI, MALS (Multi angle light scattering)  
**Column temp.** : 60°C

\*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

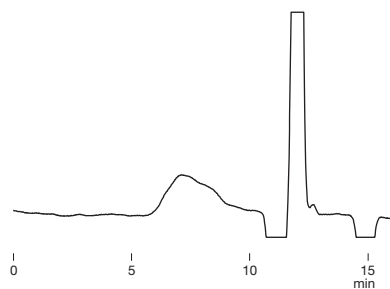
Sample : 250 $\mu$ L  
 Phenoxy resin 0.2%



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

### Potato starch

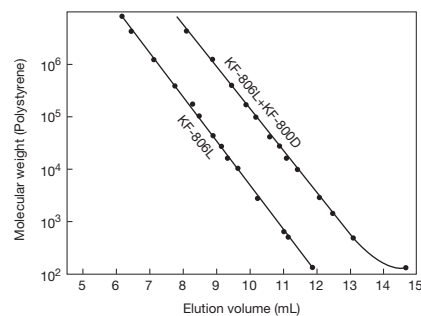
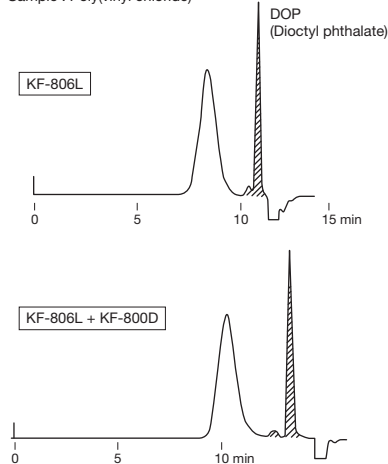
Sample : 100 $\mu$ L  
 Potato starch in DMSO 0.1%  
 \*solved at 80°C



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

### 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** : 1.0mL/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]

© 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	<b>GPC KF-601</b>	≥ 17,000	3	50	<b>6.0 x 150</b>
F6028092	<b>GPC KF-602</b>	≥ 17,000	3	150	<b>6.0 x 150</b>
F6028093	<b>GPC KF-602.5</b>	≥ 17,000	3	300	<b>6.0 x 150</b>
F6028094	<b>GPC KF-603</b>	≥ 17,000	3	500	<b>6.0 x 150</b>
F6028095	<b>GPC KF-604</b>	≥ 16,000	3	1,500	<b>6.0 x 150</b>
F6028096	<b>GPC KF-605</b>	≥ 7,000	10	5,000	<b>6.0 x 150</b>
F6028097	<b>GPC KF-606</b>	≥ 7,000	10	10,000	<b>6.0 x 150</b>
F6028098	<b>GPC KF-606M</b>	≥ 8,000	10	10,000	<b>6.0 x 150</b>
F6028099	<b>GPC KF-607</b>	≥ 5,000	18	20,000	<b>6.0 x 150</b>
F6700300	<b>GPC KF-G 4A (GPC KF-G)</b>	(guard column)	8	-	<b>4.6 x 10</b>

## High performance semi-micro columns

### [KF-400HQ series]

© 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	<b>GPC KF-401HQ</b>	≥ 25,000	3	50	<b>4.6 x 250</b>
F6028112	<b>GPC KF-402HQ</b>	≥ 25,000	3	150	<b>4.6 x 250</b>
F6028114	<b>GPC KF-402.5HQ</b>	≥ 25,000	3	300	<b>4.6 x 250</b>
F6028116	<b>GPC KF-403HQ</b>	≥ 25,000	3	500	<b>4.6 x 250</b>
F6028118	<b>GPC KF-404HQ</b>	≥ 25,000	3	1,500	<b>4.6 x 250</b>
F6028119	<b>GPC KF-405LHQ</b>	≥ 10,000	10	5,000	<b>4.6 x 250</b>
F6028122	<b>GPC KF-406LHQ</b>	≥ 10,000	10	10,000	<b>4.6 x 250</b>
F6700300	<b>GPC KF-G 4A (GPC KF-G)</b>	(guard column)	8	-	<b>4.6 x 10</b>

#### [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  
Shipping Solvent: Tetrahydrofuran (THF)

## Target molecular weight range and exclusion limit

### Measured with polystyrene (eluent: THF)

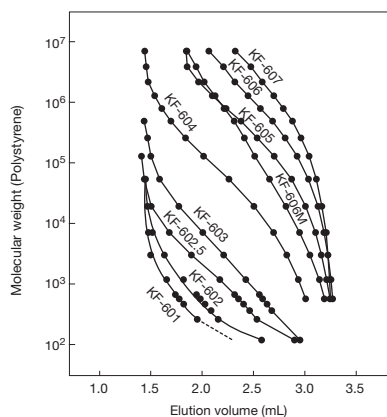
Product Name	Target Molecular Weight Range	Exclusion Limit
<b>KF-601</b>	100 – 700	1,500
<b>KF-602</b>	200 – 1,500	4,000
<b>KF-602.5</b>	300 – 10,000	20,000
<b>KF-603</b>	600 – 50,000	70,000
<b>KF-604</b>	7,000 – 500,000	1,000,000
<b>KF-605</b>	50,000 – 2,000,000	4,000,000
<b>KF-606</b>	150,000 – *(20,000,000)	*(20,000,000)
<b>KF-606M</b>	1,000 – *(20,000,000)	*(20,000,000)
<b>KF-607</b>	300,000 – *(20,000,000)	*(20,000,000)

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

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

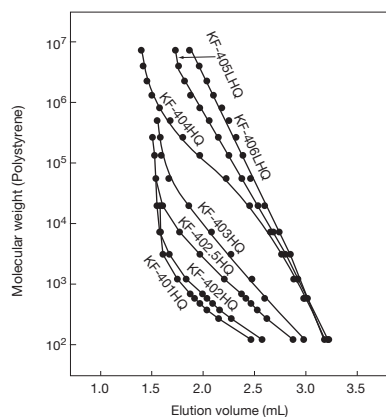
\*( ) Estimated value

Calibration curves for KF-600 series using polystyrene



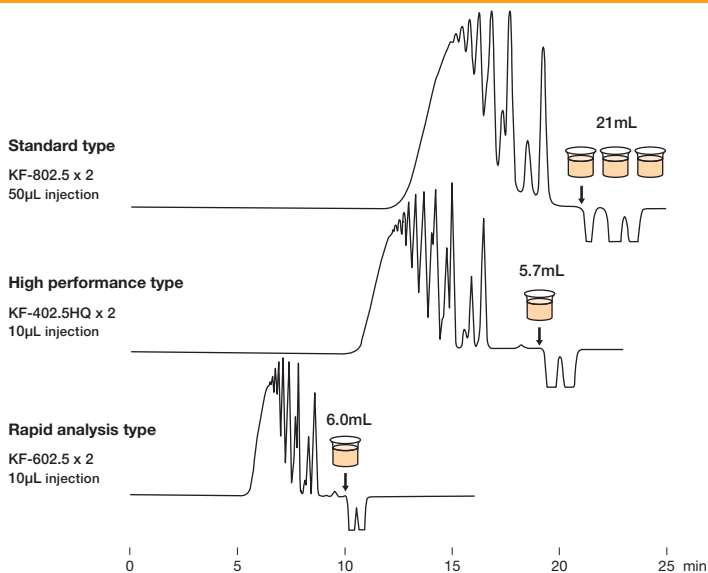
Column : Shodex GPC KF-600 series  
 Eluent : THF  
 Flow rate : 0.5mL/min  
 Detector : RI (small cell volume)  
 Column temp. : 40°C

Calibration curves for KF-400HQ series using polystyrene



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

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



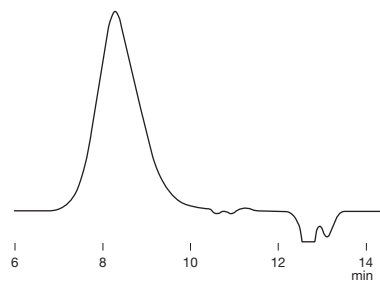
Sample : EPON1001 0.2%

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 and high performance type columns use less than one third of solvent 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 : 1.0mL/min (KF-802.5)  
 0.3mL/min (KF-402.5HQ)  
 0.6mL/min (KF-602.5)  
 Detector : RI (conventional type) (KF-802.5)  
 RI (small cell volume) (KF-402.5HQ, KF-602.5)  
 Column temp. : 40°C

Styrene acrylonitrile copolymer

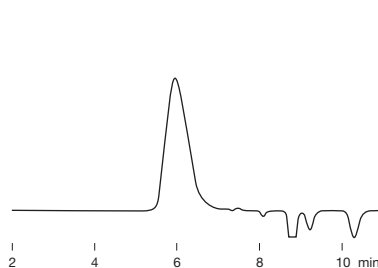
Sample : Styrene-Acrylonitrile (30:70) copolymer



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

Liquid paraffin

Sample : Liquid paraffin 1%, 5µL

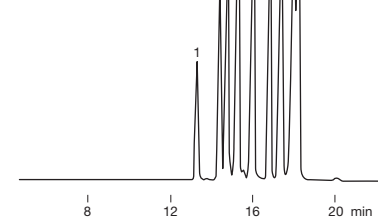


Column : Shodex GPC KF-401HQ  
 Eluent : Chloroform  
 Flow rate : 0.3mL/min  
 Detector : RI (small cell volume)  
 Column temp. : 40°C

Phthalates

Sample : 10µL

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 : 0.3mL/min  
 Detector : UV (254nm) (small cell volume)  
 Column temp. : 40°C

# Organic SEC (GPC) Columns: Ultra-Rapid Analysis

## Features

- New HK-400**
  - Newly developed styrene divinylbenzene copolymer mono-dispersed particle packing material
  - Analysis time reduced to about one 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-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	<b>New</b> GPC HK-401	≥ 9,000	3	50	4.6 x 150
F6026040	<b>New</b> GPC HK-404L	≥ 9,000	3.5	2,000	4.6 x 150
F6025050	<b>New</b> GPC HK-405	≥ 7,000	3	5,000	4.6 x 150

\*The column with 'L' at the end of column names 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	<b>New</b> GPC HK-HFIP404L	≥ 9,000	3.5	800	4.6 x 150

\*The column with 'L' at the end of column names is mixed-gel column capable of analyzing samples over a wide range of molecular weight distribution.

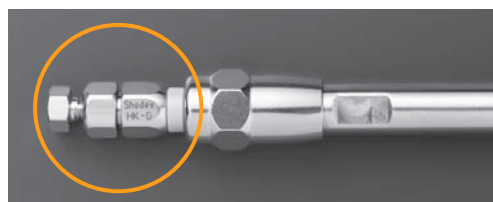
Base Material: Styrene divinylbenzene copolymer

\*See page 66 for details of other columns filled with HFIP.

## Guard filter for HK series

Product Code	Product Name	Contents
F6700200	<b>New</b> GPC HK-G	One holder and one filter
F6700100	<b>New</b> 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
<b>HK-401</b>	100 – 1,500	2,000
<b>HK-404L</b>	100 – 1,000,000	1,000,000
<b>HK-405</b>	10,000 – 2,500,000	4,000,000

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

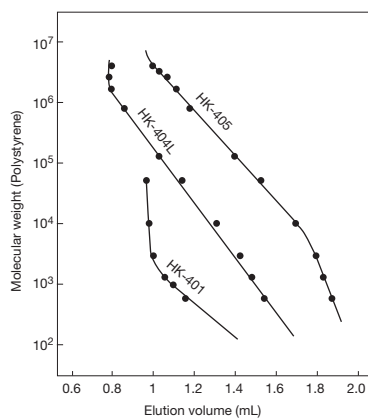
### Measured with \*PMMA (eluent: HFIP)

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

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

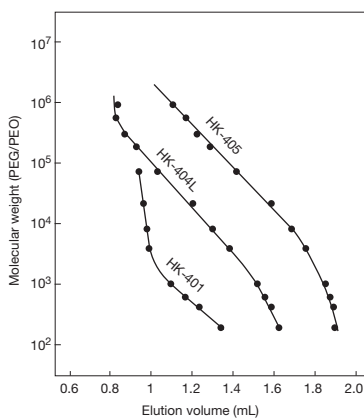
\*PMMA: Polymethylmethacrylate

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



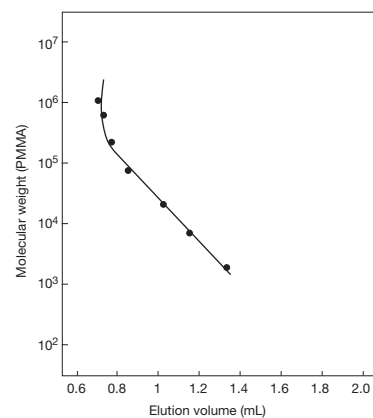
Column : Shodex GPC HK-400 series  
 Eluent : THF  
 Flow rate : 1.0mL/min  
 Detector : RI (small cell volume)  
 Column temp. : 40°C

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



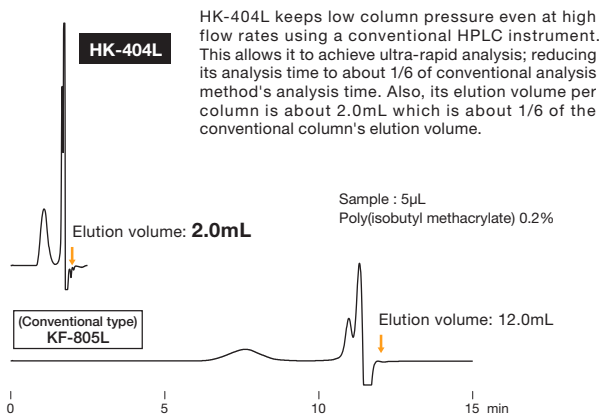
Column : Shodex GPC HK-400 series  
 Eluent : DMF  
 Flow rate : 1.0mL/min  
 Detector : RI (small cell volume)  
 Column temp. : 40°C

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



Column : Shodex GPC HK-HFIP404L  
 Eluent : 5mM CF<sub>3</sub>COONa in HFIP  
 Flow rate : 0.3mL/min  
 Detector : RI (small cell volume)  
 Column temp. : 40°C

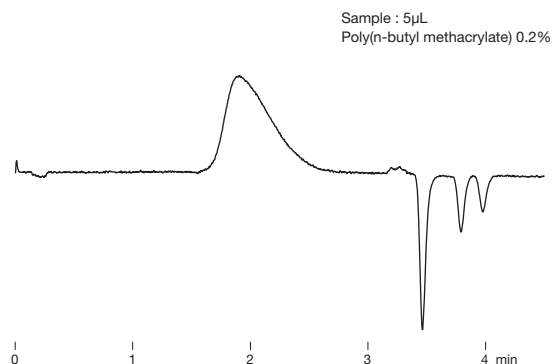
Comparison of HK-404L and conventional column (KF-805L)



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 2.0mL which is about 1/6 of the conventional column's elution volume.

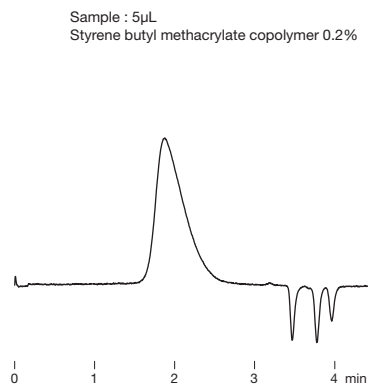
Column : Shodex GPC HK-404L, KF-805L  
 Eluent : THF  
 Flow rate : 1.0mL/min  
 Detector : RI (small cell volume)  
 Column temp. : 40°C

Poly(butyl methacrylate)



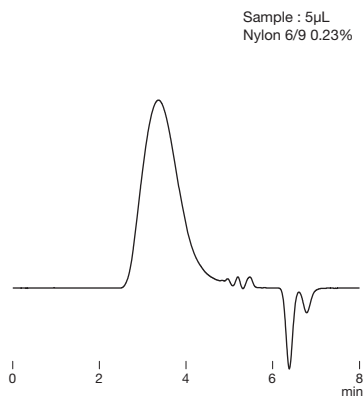
Column : Shodex GPC HK-404L x 2  
 Eluent : THF  
 Flow rate : 1.0mL/min  
 Detector : RI (small cell volume)  
 Column temp. : 40°C

Styrene butyl methacrylate copolymer



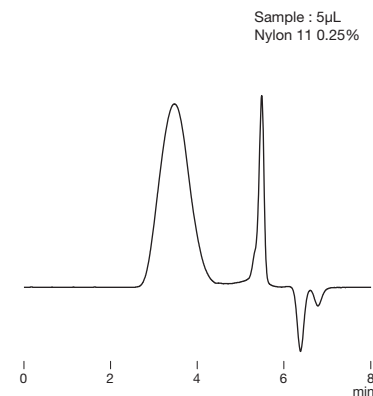
Column : Shodex GPC HK-404L x 2  
 Eluent : THF  
 Flow rate : 1.0mL/min  
 Detector : RI (small cell volume)  
 Column temp. : 40°C

Polyamide (Nylon 6/9)



Column : Shodex GPC HK-HFIP404L  
 Eluent : 5mM CF<sub>3</sub>COONa in HFIP  
 Flow rate : 0.3mL/min  
 Detector : RI (small cell volume)  
 Column temp. : 40°C

Polyamide (Nylon 11)



Column : Shodex GPC HK-HFIP404L  
 Eluent : 5mM CF<sub>3</sub>COONa in HFIP  
 Flow rate : 0.3mL/min  
 Detector : RI (small cell volume)  
 Column temp. : 40°C

# Organic SEC (GPC) Columns: Preparative Columns

■ Preparative columns \*Preparative columns are made to order.

## [KF-2000 series: Shipping solvent Tetrahydrofuran (THF)]

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 (GPC KF-LG)	(guard column)	15	8.0 x 50	(guard column)

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

Base Material: Styrene divinylbenzene copolymer

## [K-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
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 (GPC K-LG)	(guard column)	15	8.0 x 50	(guard column)

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

Base Material: Styrene divinylbenzene copolymer

**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	<b>GPC H-2001</b>	≥ 13,000	15	<b>20.0 × 500</b>	K-801
F6102002	<b>GPC H-2002</b>	≥ 13,000	15	<b>20.0 × 500</b>	K-802
F6102025	<b>GPC H-2002.5</b>	≥ 13,000	15	<b>20.0 × 500</b>	K-802.5
F6102003	<b>GPC H-2003</b>	≥ 13,000	15	<b>20.0 × 500</b>	K-803
F6102004	<b>GPC H-2004</b>	≥ 13,000	15	<b>20.0 × 500</b>	K-804
F6102005	<b>GPC H-2005</b>	≥ 13,000	15	<b>20.0 × 500</b>	K-805
F6102006	<b>GPC H-2006</b>	≥ 13,000	15	<b>20.0 × 500</b>	K-806
F6102009	<b>GPC H-2006M</b>	≥ 12,000	15	<b>20.0 × 500</b>	K-806M
F6700310	<b>GPC H-G 8B (GPC H-G)</b>	(guard column)	15	<b>8.0 × 50</b>	(guard column)

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

Base Material: Styrene divinylbenzene copolymer

\*\*H-2002 can be used for the EPA 36 40 method (pesticide analysis)

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

**[Customized columns]**

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

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

Base Material: Styrene divinylbenzene copolymer

**[K-5000 series: Shipping solvent Chloroform]**

**[Customized columns]**

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

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

Base Material: Styrene divinylbenzene copolymer

# 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
  - 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 columns

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

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

Base Material: Styrene divinylbenzene copolymer  
Shipping Solvent: Tetrahydrofuran (THF)

## Rapid analysis downsized column

⊙ 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	<b>GPC LF-604</b>	≥ 9,000	6	3,000	<b>6.0 x 150</b>
F6709621	<b>GPC LF-G</b>	(guard column)	6	–	<b>4.6 x 10</b>

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

Base Material: Styrene divinylbenzene copolymer  
Shipping Solvent: Tetrahydrofuran (THF)

## High performance semi-micro column

⊙ 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	<b>GPC LF-404</b>	≥ 14,000	6	3,000	<b>4.6 x 250</b>
F6709621	<b>GPC LF-G</b>	(guard column)	6	–	<b>4.6 x 10</b>

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

Base Material: Styrene divinylbenzene copolymer  
Shipping Solvent: Tetrahydrofuran (THF)

## Target molecular weight range and exclusion limit

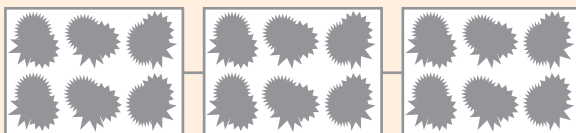
### Measured with polystyrene (eluent: THF)

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

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

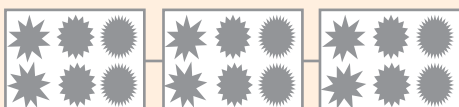
## Schematic diagram of linear calibration type packing

### 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.)

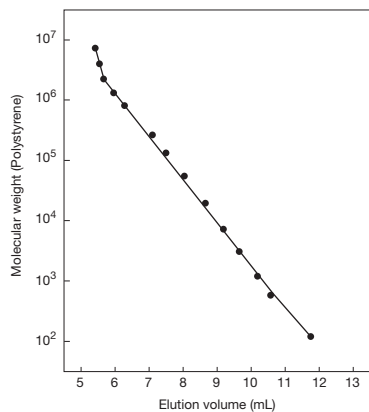


### Connecting different single pore-size columns (KF-804 + KF-803 + KF-802, etc.)



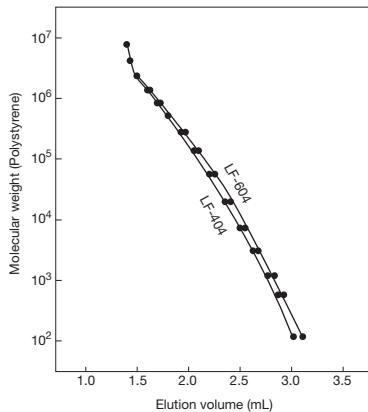


**Calibration curve for LF-804 using polystyrene**



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

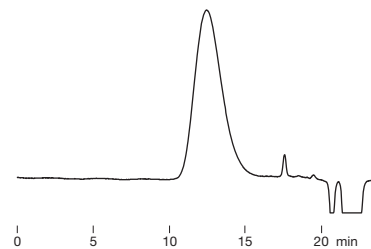
**Calibration curves for LF-604 and LF-404 using polystyrene**



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

**Polyurethane**

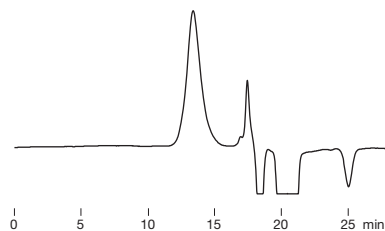
Sample : Polyurethane 0.1%, 20µL



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

**Xylan**

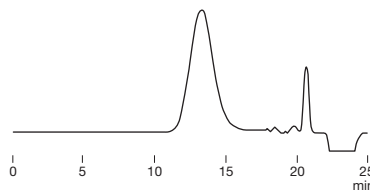
Sample : Xylan 0.1%, 100µL



**Column** : Shodex GPC LF-804  
**Eluent** : 20mM H<sub>3</sub>PO<sub>4</sub> + 20mM LiBr  
 in DMSO/DMF=80/20  
**Flow rate** : 0.6mL/min  
**Detector** : RI  
**Column temp.** : 50°C

**Polyamide (Nylon6/6)**

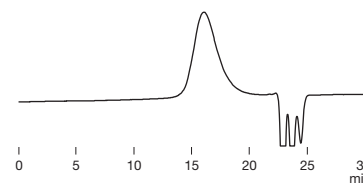
Sample : Nylon 6/6 0.1%, 20µL



**Column** : Shodex GPC LF-404  
**Eluent** : 5mM CF<sub>3</sub>COONa in HFIP  
**Flow rate** : 0.15mL/min  
**Detector** : RI (small cell volume)  
**Column temp.** : 40°C

**Polymethyl methacrylate**

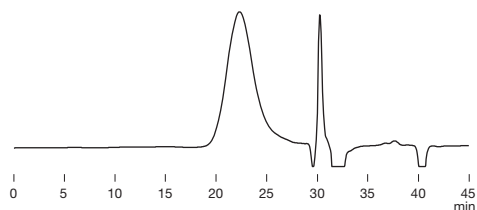
Sample : 100µL  
 Polymethyl methacrylate



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

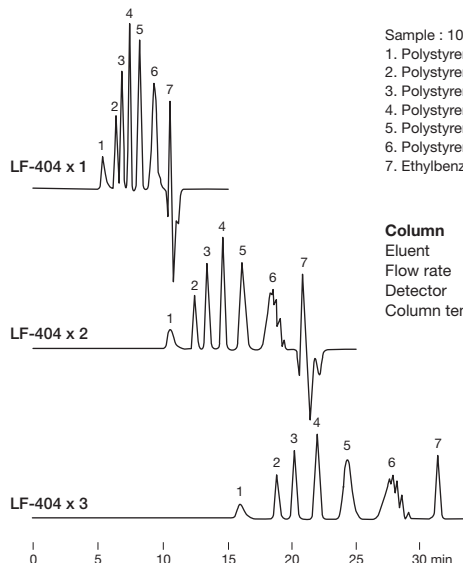
**Polyamic acid**

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



**Column** : Shodex GPC LF-804 x 2  
**Eluent** : 30mM LiBr + 30mM H<sub>3</sub>PO<sub>4</sub> in NMP  
**Flow rate** : 0.7mL/min  
**Detector** : RI  
**Column temp.** : 50°C

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



Sample : 10µL  
 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** : 0.3mL/min  
**Detector** : RI (small cell volume)  
**Column temp.** : 40°C

# 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

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	<b>GPC HT-803</b>	≥ 7,000	100 ~ 150	13	500	<b>8.0 x 300</b>
F6208710	<b>GPC HT-804</b>	≥ 7,000	100 ~ 150	13	1,500	<b>8.0 x 300</b>
F6208720	<b>GPC HT-805</b>	≥ 7,000	100 ~ 150	13	5,000	<b>8.0 x 300</b>
F6208730	<b>GPC HT-806</b>	≥ 7,000	100 ~ 150	13	10,000	<b>8.0 x 300</b>
F6208740	<b>GPC HT-806M</b>	≥ 7,000	100 ~ 150	13	10,000	<b>8.0 x 300</b>
F6208770	<b>GPC HT-807</b>	≥ 4,000	100 ~ 150	18	20,000	<b>8.0 x 300</b>
F6709410	<b>GPC HT-G</b>	(guard column)	100 ~ 150	13	–	<b>8.0 x 50</b>
F6208600	<b>GPC UT-802.5</b>	≥ 4,400	100 ~ 210	30	300	<b>8.0 x 300</b>
F6208610	<b>GPC UT-806M</b>	≥ 4,400	100 ~ 210	30	10,000	<b>8.0 x 300</b>
F6208620	<b>GPC UT-807</b>	≥ 3,300	100 ~ 210	30	20,000	<b>8.0 x 300</b>
F6709400	<b>GPC UT-G</b>	(guard column)	100 ~ 210	30	–	<b>8.0 x 50</b>
F6208390	<b>GPC AT-806MS</b>	≥ 6,000	*Ta ~ 150	12	10,000	<b>8.0 x 250</b>
F6700280	<b>GPC AT-G</b>	(guard column)	*Ta ~ 150	15	–	<b>8.0 x 50</b>

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

Base Material: Styrene divinylbenzene copolymer  
Shipping Solvent: Toluene  
\*Ta: Ambient temperature

## Target molecular weight range and exclusion limit

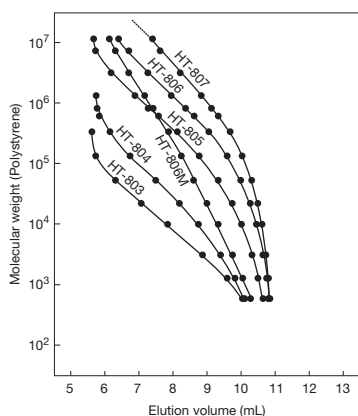
### Measured with polystyrene (eluent: o-Dichlorobenzene (ODCB))

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

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

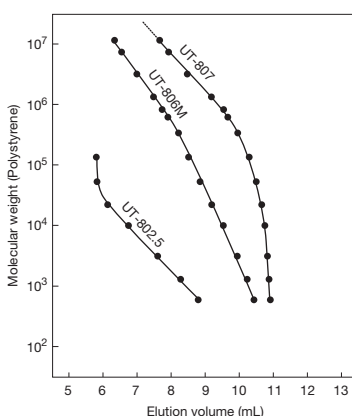
( ) Estimated value

Calibration curves for HT-800 series using polystyrene



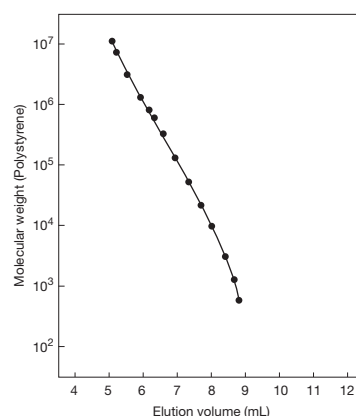
Column : Shodex GPC HT-800 series  
 Eluent : 0.1% BHT in ODCB  
 Flow rate : 1.0mL/min  
 Detector : RI  
 Column temp. : 140°C

Calibration curves for UT-800 series using polystyrene



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

Calibration curve for AT-806MS using polystyrene

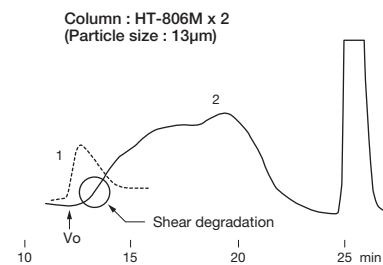
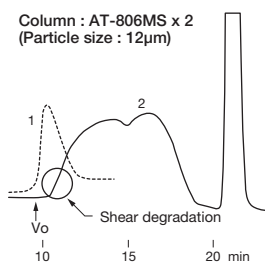
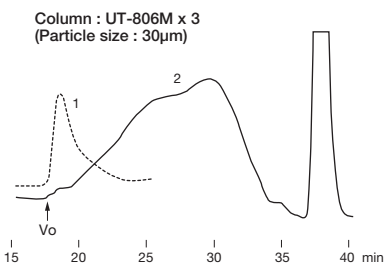


Column : Shodex GPC AT-806MS  
 Eluent : 0.1% BHT in ODCB  
 Flow rate : 1.0mL/min  
 Detector : RI  
 Column temp. : 140°C

Effects of gel particle size in high temperature GPC columns

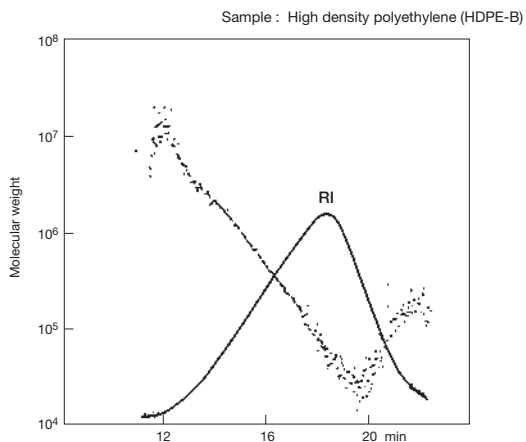
High temperature GPC columns are suitable for the analysis of high molecular weight polymers that are difficult to be dissolved in ambient temperature solvents; examples of such polymers are polyethylene and polypropylene. The GPC UT-800 series packed with large particle size (30µm) are recommended for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



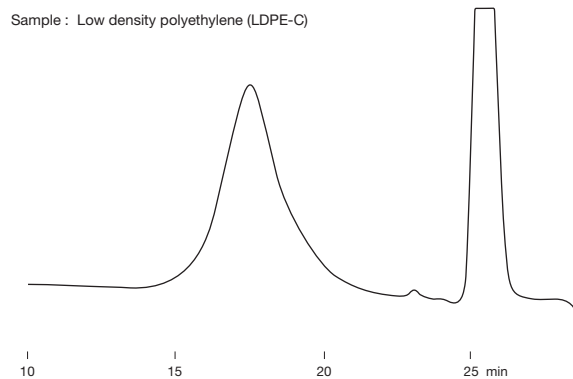
Column : Shodex GPC UT-806M  
 Shodex GPC HT-806M  
 Shodex GPC AT-806MS  
 Eluent : 0.1% BHT in ODCB  
 Flow rate : 1.0mL/min  
 Detector : RI  
 Column temp. : 140°C

High density polyethylene



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

Low density polyethylene



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

# 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]

Product Code	Product Name	Plate Number (TP/column)	Particle Size (µm)	Pore Size (Å)	Column Size (mm) I.D. x Length
F6028530	<b>GPC HFIP-803</b>	≥ 12,000	10	500	<b>8.0 x 300</b>
F6028540	<b>GPC HFIP-804</b>	≥ 12,000	7	1,500	<b>8.0 x 300</b>
F6028550	<b>GPC HFIP-805</b>	≥ 10,000	10	5,000	<b>8.0 x 300</b>
F6028560	<b>GPC HFIP-806</b>	≥ 10,000	10	10,000	<b>8.0 x 300</b>
F6028590	<b>GPC HFIP-806M</b>	≥ 10,000	10	10,000	<b>8.0 x 300</b>
F6028570	<b>GPC HFIP-807</b>	≥ 4,000	18	20,000	<b>8.0 x 300</b>
F6700500	<b>GPC HFIP-G 8B (GPC HFIP-LG)</b>	(guard column)	15	–	<b>8.0 x 50</b>

\*The columns with 'M' at the end of column names 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)

## Rapid analysis downsized columns

### [HFIP-600 series]

© 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	<b>GPC HFIP-603</b>	≥ 12,000	3	500	<b>6.0 x 150</b>
F6021040	<b>GPC HFIP-604</b>	≥ 12,000	3	1,500	<b>6.0 x 150</b>
F6021050	<b>GPC HFIP-605</b>	≥ 5,000	10	5,000	<b>6.0 x 150</b>
F6021060	<b>GPC HFIP-606</b>	≥ 5,000	10	10,000	<b>6.0 x 150</b>
F6021080	<b>GPC HFIP-606M</b>	≥ 6,000	10	10,000	<b>6.0 x 150</b>
F6021070	<b>GPC HFIP-607</b>	≥ 3,000	18	20,000	<b>6.0 x 150</b>
F6700511	<b>GPC HFIP-G 4A (GPC HFIP-G)</b>	(guard column)	8	–	<b>4.6 x 10</b>

\*The columns with 'M' at the end of column names 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)

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

## Target molecular weight range and exclusion limit

### Measured with \*PMMA (eluent: HFIP)

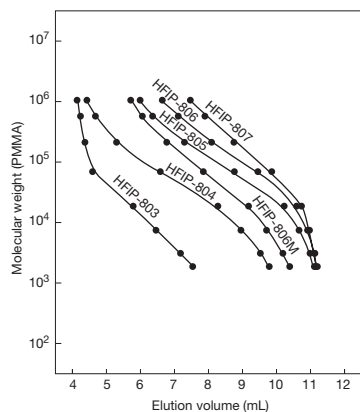
Product Name	Target Molecular Weight Range	Exclusion Limit
<b>HFIP-803</b>	1,000 – 30,000	60,000
<b>HFIP-804</b>	20,000 – 200,000	300,000
<b>HFIP-805</b>	20,000 – 600,000	1,000,000
<b>HFIP-806</b>	70,000 – *(8,000,000)	*(8,000,000)
<b>HFIP-806M</b>	1,000 – *(8,000,000)	*(8,000,000)
<b>HFIP-807</b>	70,000 – *(50,000,000)	*(50,000,000)

Product Name	Target Molecular Weight Range	Exclusion Limit
<b>HFIP-603</b>	1,000 – 30,000	60,000
<b>HFIP-604</b>	20,000 – 200,000	300,000
<b>HFIP-605</b>	20,000 – 600,000	1,000,000
<b>HFIP-606</b>	70,000 – *(8,000,000)	*(8,000,000)
<b>HFIP-606M</b>	1,000 – *(8,000,000)	*(8,000,000)
<b>HFIP-607</b>	70,000 – *(50,000,000)	*(50,000,000)

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

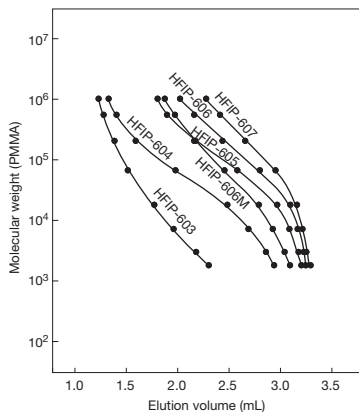
\*PMMA: Polymethylmethacrylate  
\*( ) Estimated value

Calibration curves for HFIP-800 series using PMMA



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

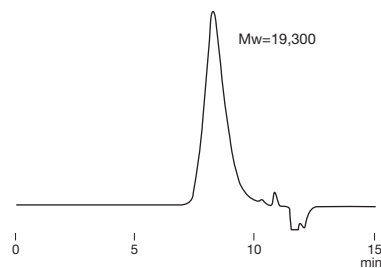
Calibration curves for HFIP-600 series using PMMA



Column : Shodex GPC HFIP-600 series  
 Eluent : HFIP  
 Flow rate : 0.3mL/min (HFIP-603, 604)  
 0.5mL/min (HFIP-605, 606, 606M, 607)  
 Detector : RI (small cell volume)  
 Column temp. : 40°C

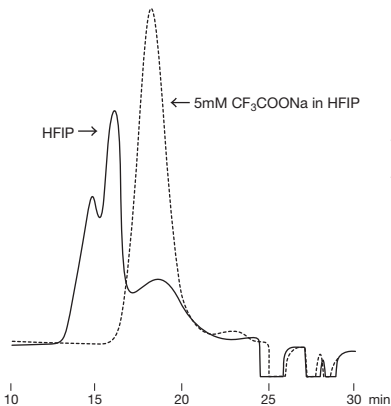
Polyethylene terephthalate (PET)

Sample : Polyethylene terephthalate 0.2%, 20µL



Column : Shodex GPC HFIP-606M x 2  
 Eluent : 5mM CF<sub>3</sub>COONa in HFIP  
 Flow rate : 0.6mL/min  
 Detector : RI (small cell volume)  
 Column temp. : 40°C

Polyamide (effects of added salt)



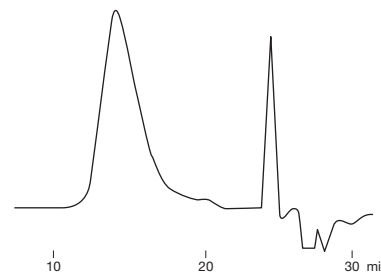
Sample : Polycaprolactone (Nylon 6)

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), 5mM CF<sub>3</sub>COONa in HFIP (broken line)  
 Flow rate : 1.0mL/min  
 Detector : RI  
 Column temp. : 40°C

Polybutylene terephthalate (PBT)

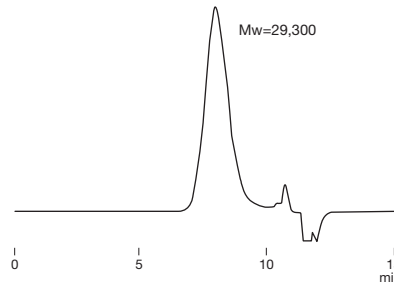
Sample : Polybutylene terephthalate 0.05%, 500µL



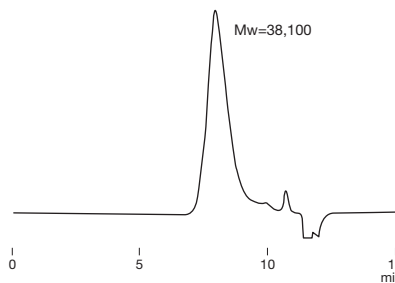
Column : Shodex GPC HFIP-805 + HFIP-803  
 Eluent : 5mM CF<sub>3</sub>COONa in HFIP  
 Flow rate : 1.0mL/min  
 Detector : RI  
 Column temp. : 40°C

Polyamides (Nylon 6/10 and Nylon 6)

Sample : Nylon 6/10 0.2%, 20µL

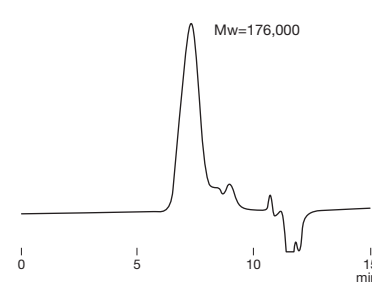


Sample : Nylon 6 0.2%, 20µL



Column : Shodex GPC HFIP-606M x 2  
 Eluent : 5mM CF<sub>3</sub>COONa in HFIP  
 Flow rate : 0.6mL/min  
 Detector : RI (small cell volume)  
 Column temp. : 40°C

Sample : Polyacetal 0.2%, 20µL



Column : Shodex GPC HFIP-606M x 2  
 Eluent : 5mM CF<sub>3</sub>COONa in HFIP  
 Flow rate : 0.6mL/min  
 Detector : RI (small cell volume)  
 Column temp. : 40°C

# 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-607 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-807 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	×	×	○	○				×	○	○
Quinolin	×	×	○	○				×	○	○
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)]

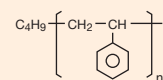
### Features

- 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	MW Range
F8601105	<b>STANDARD SL-105</b>	0.5g x 10 kinds	580 – 19,900
F8602105	<b>STANDARD SM-105</b>	0.5g x 10 kinds	1,150 – 2,380,000
F8603075	<b>STANDARD SH-75</b>	0.5g x 7 kinds	508,000 – 6,870,000

### Structural formula of S series



### SL-105

Std. No.	Mp	Mw/Mn
S-20	19,900	1.03
S-13	13,000	1.02
S-9.6	9,590	1.02
S-7.6	7,640	1.02
S-4.7	4,730	1.03
S-3.0	2,970	1.04
S-1.9	1,920	1.04
S-1.4	1,440	1.05
S-0.9	860	1.07
S-0.6	580	1.11

### SM-105

Std. No.	Mp	Mw/Mn
S-2380	2,380,000	1.08
S-1390	1,390,000	1.05
S-730	730,000	1.05
S-270	270,000	1.02
S-139	139,000	1.03
S-45	45,100	1.02
S-20	19,500	1.02
S-6.3	6,320	1.03
S-3.0	2,970	1.04
S-1.2	1,150	1.08

### 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	MW Range
F8604075	<b>STANDARD M-75</b>	0.5g x 7 kinds	2,880 – 1,020,000

(Note)

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

Std. No.	Mp	Mw/Mn
M-1020	1,020,000	1.04
M-505	505,000	1.02
M-224	224,000	1.02
M-67	66,700	1.03
M-18	17,800	1.04
M-6.1	6,140	1.11
M-2.9	2,880	1.08

## [Pullulan]

### Features

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

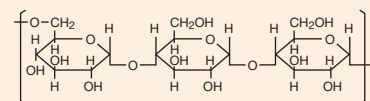
### Standard kit

Product Code	Product Name	Contents	MW Range
F8400000	<b>STANDARD P-82</b>	0.2g x 8 kinds	6,100 – 642,000

### Single type

Product Code	Product Name	Contents	Mp	Mw/Mn
F8400800	<b>STD P-800</b>	0.5g	642,000	1.23
F8400400	<b>STD P-400</b>	0.5g	337,000	1.12
F8400200	<b>STD P-200</b>	0.5g	194,000	1.09
F8400100	<b>STD P-100</b>	0.5g	107,000	1.13
F8400050	<b>STD P-50</b>	0.5g	47,100	1.07
F8400020	<b>STD P-20</b>	0.5g	22,000	1.08
F8400010	<b>STD P-10</b>	0.5g	9,600	1.09
F8400005	<b>STD P-5</b>	0.5g	6,100	1.05

### Structural formula of P series



Std. No.	Mp	Mw/Mn
STD P-800	642,000	1.23
STD P-400	337,000	1.12
STD P-200	194,000	1.09
STD P-100	107,000	1.13
STD P-50	47,100	1.07
STD P-20	22,000	1.08
STD P-10	9,600	1.09
STD P-5	6,100	1.05

(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

<b>QA-825</b>	• Suitable for analyzing relatively high molecular weight compounds: proteins, peptides, DNA, and RNA
<b>DEAE-825</b>	• Usable in a wide pH range from pH 2 to 12 • QA-825 fulfills USP L23 requirements
<b>DEAE3N-4T</b>	• Non-porous base material • For rapid analysis
<b>DEAE-2B</b>	• Non-porous base material • Can be used with UHPLC (available under hyperbaric conditions up to 30 MPa)
<b>ES-502N 7C</b>	• 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
<b>WA-624</b>	• 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	<b>IEC QA-825</b>	0.45	Polyhydroxymethacrylate	12	5,000	<b>8.0 × 75</b>	50mM Na <sub>2</sub> SO <sub>4</sub> 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	<b>IEC DEAE-825</b>	0.6	Polyhydroxymethacrylate	8	5,000	<b>8.0 × 75</b>	50mM Na <sub>2</sub> SO <sub>4</sub> aq.
F6112100	<b>IEC DEAE3N-4T</b>	0.4	Polyhydroxymethacrylate	2.5	–	<b>4.6 × 35</b>	H <sub>2</sub> O
F7640002	<b>Asahipak ES-502N 7C</b>	0.55	Polyvinyl alcohol	9	2,000	<b>7.5 × 100</b>	50mM 1,3-Diaminopropane + 50mM NaCl (pH10.0)
F6356240	<b>AXpak WA-624</b>	1.2	Polyhydroxymethacrylate	10	2,000	<b>6.0 × 150</b>	0.1M Sodium phosphate buffer (pH3.0)/CH <sub>3</sub> CN =80/20
F6700245	<b>AXpak WA-G</b> (guard column)	–	Polyhydroxymethacrylate	10	–	<b>4.6 × 10</b>	0.1M Sodium phosphate buffer (pH3.0)/CH <sub>3</sub> CN =80/20

### [Weak anion exchange resin] Functional Group: Diethylaminoethyl (UHPLC column)

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
F6112110	<b>PIKESS DEAE-2B</b>	0.4	Polyhydroxymethacrylate	2.5	–	<b>2.0 × 50</b>	H <sub>2</sub> O

## ■ Preparative columns \*Preparative columns are made to order.

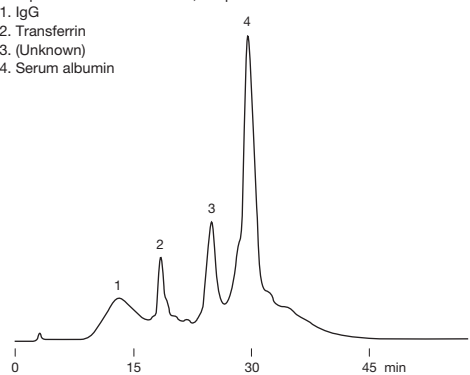
Product Code	Product Name	Particle Size (µm)	Column Size (mm) I.D. x Length	Standard column
F6548000	<b>IEC QA-2025</b>	20	<b>20.0 × 150</b>	QA-825
F6709602	<b>IEC QA-G 8B</b> (IEC QA-LG)	20	<b>8.0 × 50</b>	(guard column)
F6548001	<b>IEC DEAE-2025</b>	20	<b>20.0 × 150</b>	DEAE-825
F6709603	<b>IEC DEAE-G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



### Proteins in human serum

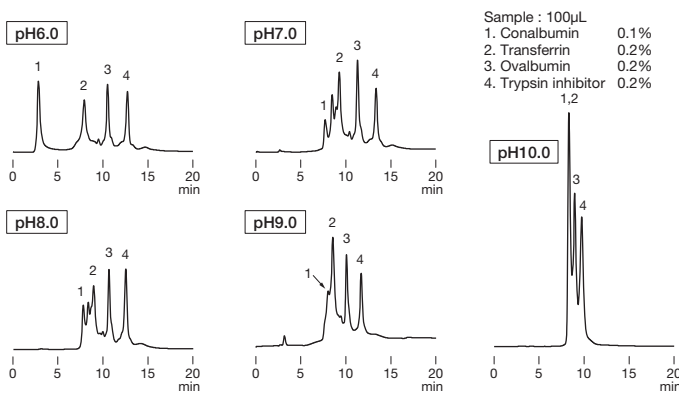
Sample : Human serum 0.5%, 200 $\mu$ L

1. IgG
2. Transferrin
3. (Unknown)
4. Serum albumin



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

### Effects of eluent pH on DEAE-825 analysis

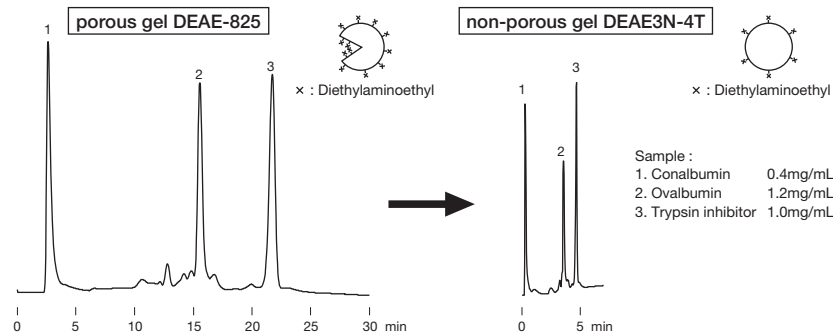


Sample : 100 $\mu$ L  
 1. Conalbumin 0.1%  
 2. Transferrin 0.2%  
 3. Ovalbumin 0.2%  
 4. Trypsin inhibitor 0.2%

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

### Comparison of porous DEAE-825 and non-porous DEAE3N-4T for protein separation

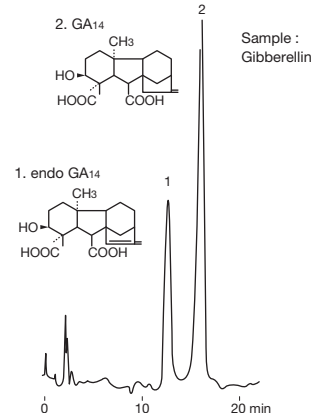
IEC DEAE3N-4T is a weak anion exchange column, having diethylaminoethyl functional group modified on non-porous gel. The non-porous gel enables rapid analysis of proteins and peptides. DEAE3N-4T is also suitable for the analysis of small-volume samples, as it provides sharp peaks even with small injection volume.



**Column** : Shodex IEC DEAE-825  
**Eluent** : (A); 20mM Piperazine-HCl buffer (pH6.0)  
 (B); (A) + 0.5M NaCl  
 Linear gradient; (A) to (B), 60min  
**Flow rate** : 1.0mL/min  
**Detector** : UV (280nm)  
**Column temp.** : Room temp.  
**Injection vol.** : 100 $\mu$ L

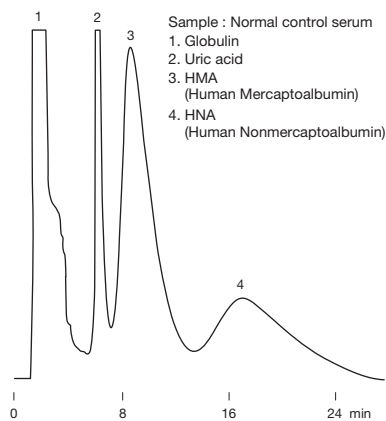
**Column** : Shodex IEC DEAE3N-4T  
**Eluent** : (A); 25mM Piperazine-HCl buffer (pH6.0)  
 (B); (A) + 0.5M NaCl  
 Linear gradient; (A) to (B), 10min  
**Flow rate** : 1.5mL/min  
**Detector** : UV (280nm)  
**Column temp.** : Room temp.  
**Injection vol.** : 20 $\mu$ L

### Gibberellin Isomers



**Column** : Shodex Asahipak ES-502N 7C  
**Eluent** : CH<sub>3</sub>COOH/H<sub>2</sub>O/CH<sub>3</sub>OH  
 =0.1/0.4/99.5  
**Flow rate** : 1.5mL/min  
**Detector** : UV (210nm)  
**Column temp.** : 50°C  
 Data was provided by Prof. Yamaguchi,  
 Faculty of Agriculture, University of Tokyo.

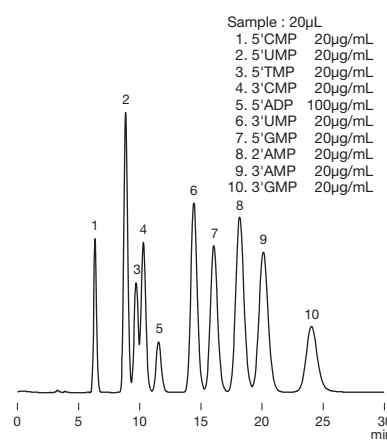
### Mercaptoalbumin and non-mercaptoalbumin



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

**Column** : Shodex Asahipak ES-502N 7C  
**Eluent** : 50mM N-methylpiperazine-HCl  
 buffer (pH4.8) + 400mM Na<sub>2</sub>SO<sub>4</sub>  
 + 0.3% C<sub>2</sub>H<sub>5</sub>OH  
**Flow rate** : 1.0mL/min  
**Detector** : UV (280nm)  
**Column temp.** : 35°C

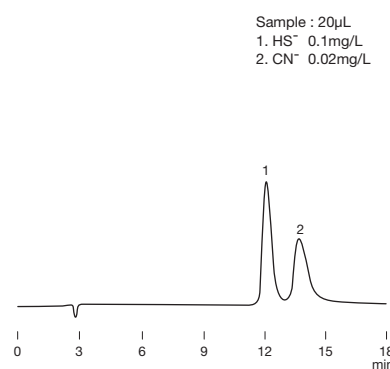
### Nucleotides



Sample : 20 $\mu$ L  
 1. 5'CMP 20 $\mu$ g/mL  
 2. 5'UMP 20 $\mu$ g/mL  
 3. 5'TMP 20 $\mu$ g/mL  
 4. 3'CMP 20 $\mu$ g/mL  
 5. 5'ADP 100 $\mu$ g/mL  
 6. 3'UMP 20 $\mu$ g/mL  
 7. 5'GMP 20 $\mu$ g/mL  
 8. 2'AMP 20 $\mu$ g/mL  
 9. 3'AMP 20 $\mu$ g/mL  
 10. 3'GMP 20 $\mu$ g/mL

**Column** : Shodex AXPak WA-624  
**Eluent** : 0.35M CH<sub>3</sub>COOH aq.  
 /0.35M CH<sub>3</sub>COONH<sub>4</sub> aq.=240/100  
**Flow rate** : 1.0mL/min  
**Detector** : UV (260nm)  
**Column temp.** : 60°C

### Sulfide ion and cyanide ion



Sample : 20 $\mu$ L  
 1. HS<sup>-</sup> 0.1mg/L  
 2. CN<sup>-</sup> 0.02mg/L

**Column** : Shodex IEC DEAE-825  
**Eluent** : 10mM Na<sub>2</sub>CO<sub>3</sub>  
 + 1mM Ethylenediamine aq.  
 + 10% CH<sub>3</sub>OH  
**Flow rate** : 1.0mL/min  
**Detector** : Electrochemical  
 (Electrode; Silver, 0mV SCE)  
**Column temp.** : 25°C

# Cation Exchange Chromatography Columns

## Features

<b>SP-825</b>	• Suitable for analyzing relatively high molecular weight compounds: proteins, peptides, DNA, and RNA
<b>CM-825</b>	• Usable in a wide pH range from pH 2 to 12
<b>SP-420N</b>	• Non-porous base material • For rapid analysis
<b>New SP-FT 4A</b>	• Non-porous base material • Provides ultra-rapid analysis using conventional devices
<b>SP-2B</b>	• Non-porous base material • Can be used with UHPLC (available under hyperbaric conditions for up to 30 MPa)
<b>ES-502C 7C</b>	• 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
<b>P-421S</b>	• 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	<b>IEC SP-825</b>	0.4	Polyhydroxymethacrylate	8	5,000	<b>8.0 × 75</b>	50mM Na <sub>2</sub> SO <sub>4</sub> aq.
F6113000	<b>IEC SP-420N</b>	0.3	Polyhydroxymethacrylate	2.5	–	<b>4.6 × 35</b>	20mM Sodium acetate buffer + 0.5M Na <sub>2</sub> SO <sub>4</sub> (pH5.0)
F6113100	<b>New IEC SP-FT 4A</b>	0.2	Polyhydroxymethacrylate	2.7	–	<b>4.6 × 10</b>	20mM *MES buffer (pH5.6)

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

### [Strong cation exchange resin] Functional Group: Sulfopropyl (UHPLC column)

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
F6113110	<b>PIKESS SP-2B</b>	0.3	Polyhydroxymethacrylate	2.5	–	<b>2.0 × 50</b>	20mM Sodium acetate buffer + 0.5M Na <sub>2</sub> SO <sub>4</sub> (pH5.0)

### [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	<b>IEC CM-825</b>	0.4	Polyhydroxymethacrylate	8	5,000	<b>8.0 × 75</b>	50mM Na <sub>2</sub> SO <sub>4</sub> aq.
F7640001	<b>Asahipak ES-502C 7C</b>	0.55	Polyvinyl alcohol	9	2,000	<b>7.5 × 100</b>	0.1M Sodium phosphate buffer (pH4.4)

### [For amino acid analysis] Functional Group: Sulfo (Na<sup>+</sup>)

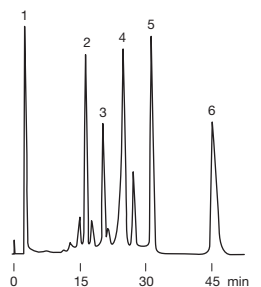
Product Code	Product Name	Plate Number (TP/column)	Base Material	Particle Size (µm)	Column Size (mm) I.D. x Length	Shipping Solvent
F6354211	<b>CXpak P-421S</b>	≥ 3,500	Styrene divinylbenzene copolymer	6	<b>4.6 × 150</b>	H <sub>2</sub> O
F6700210	<b>CXpak P-G</b>	(guard column)	Styrene divinylbenzene copolymer	6	<b>4.6 × 10</b>	H <sub>2</sub> O

## Preparative columns \*Preparative columns are made to order.

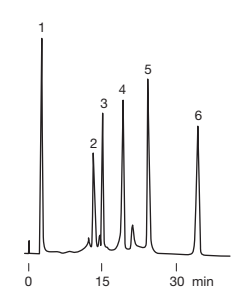
Product Code	Product Name	Particle Size (µm)	Column Size (mm) I.D. x Length	Standard column
F6548002	<b>IEC SP-2025</b>	20	<b>20.0 × 150</b>	SP-825
F6709604	<b>IEC SP-G 8B (IEC SP-LG)</b>	20	<b>8.0 × 50</b>	(guard column)
F6548003	<b>IEC CM-2025</b>	20	<b>20.0 × 150</b>	CM-825
F6709605	<b>IEC CM-G 8B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

### Protein separation using cation exchange columns

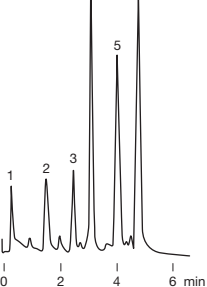
(I) CM-825  
(Weak cation exchange)  
90µL injection



(II) SP-825  
(Strong cation exchange)  
30µL injection



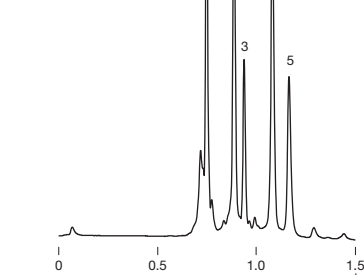
(III) SP-420N  
(Strong cation exchange)  
non-porous type gel



**Column** : (I) Shodex IEC CM-825, (II) Shodex IEC SP-825, (III) Shodex IEC SP-420N  
**Eluent** : (A); 20mM Sodium phosphate buffer (pH7.0)  
 (B); (A) + 0.5M NaCl  
 (I,II) Linear gradient; (A) to (B), 60min (III) Linear gradient; (A) to (B), 10min  
**Flow rate** : (I,II) 1.0mL/min (III) 1.5mL/min  
**Detector** : UV (280nm)  
**Column temp.** : Room temp.

### Ultra-rapid analysis of protein standards

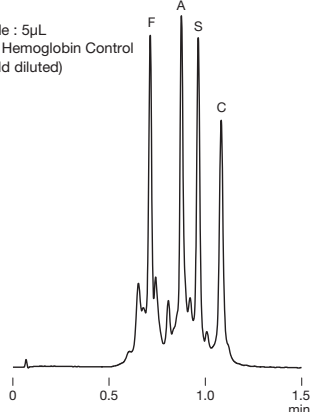
Sample : 5µL  
 1. Trypsinogen 0.16%  
 2. α-Chymotrypsinogen A 0.08%  
 3. Ribonuclease A 0.12%  
 4. Cytochrome c 0.12%  
 5. Lysozyme 0.06%



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

### Ultra-rapid analysis of hemoglobins

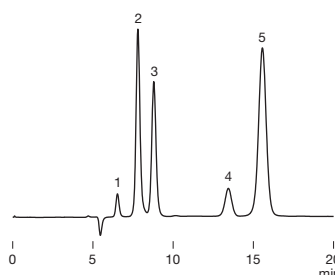
Sample : 5µL  
 AFSC Hemoglobin Control  
 (51-fold diluted)



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

### Analysis of nitrogen compounds following the testing methods for fertilizers

Sample : 10µg/mL each, 10µL  
 1. Urea  
 2. Biuret  
 3. Dicyandiamide  
 4. Guanidine  
 5. Guanylurea

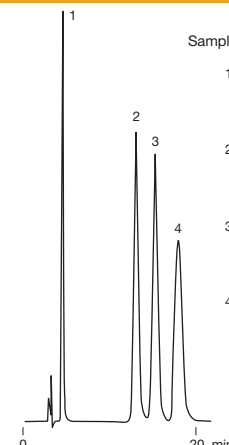


**Column** : Shodex Asahipak ES-502C 7C  
**Eluent** : 3.92g KH<sub>2</sub>PO<sub>4</sub> + 0.12g H<sub>3</sub>PO<sub>4</sub>  
 in 1000mL of H<sub>2</sub>O  
**Flow rate** : 0.6mL/min  
**Detector** : UV (190nm)  
**Column temp.** : 40°C

### Catecholamines

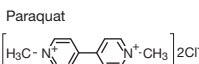
Sample : 300µg/mL each, 10µL

1. DOPA  
Oc1ccc(O)cc1CC(N)C(=O)O
2. Adrenaline  
Oc1ccc(O)cc1CC(N)C(O)C
3. Noradrenaline  
Oc1ccc(O)cc1CC(N)C(O)
4. Dopamine  
Oc1ccc(O)cc1CCN

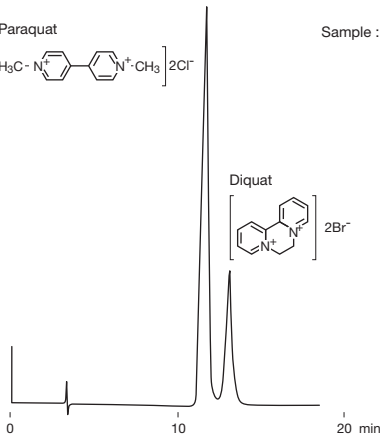
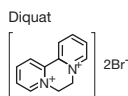


**Column** : Shodex Asahipak ES-502C 7C  
**Eluent** : 20mM Sodium malonate buffer (pH6.0)  
 + 0.5M NaCl  
**Flow rate** : 1.0mL/min  
**Detector** : UV (280nm)  
**Column temp.** : 30°C

### Paraquat and diquat



Sample : 20µL

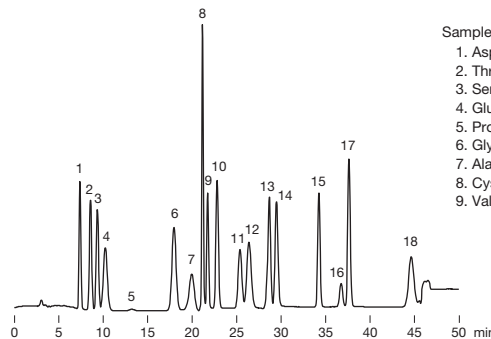


**Column** : Shodex Asahipak ES-502C 7C  
**Eluent** : 50mM Sodium phosphate buffer (pH7.0)  
 + 150mM NaCl  
**Flow rate** : 1.0mL/min  
**Detector** : UV (288nm)  
**Column temp.** : 30°C

### Standard amino acids

Sample : 0.1µM each, 100µL

1. Asp
2. Thr
3. Ser
4. Glu
5. Pro
6. Gly
7. Ala
8. Cys
9. Val
10. Met
11. Ile
12. Leu
13. Tyr
14. Phe
15. Lys
16. NH<sub>3</sub>
17. His
18. Arg



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

# 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 columns

Product Code	Product Name	Functional Group	Particle Size (µm)	Pore Size (Å)	Column Size (mm) I.D. x Length	Shipping Solvent
F6110003	<b>HIC PH-814</b>	Phenyl	10	2,000	<b>8.0 x 75</b>	H <sub>2</sub> O

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	<b>AFpak APA-894</b>	Protein A	4mg	18	<b>8.0 x 50</b>	0.1M Sodium phosphate buffer + 0.5M NaCl + 0.02% NaN <sub>3</sub> (pH7.0)
F7118964	<b>AFpak ACH-494</b>	Choline oxydase, Acetylcholine esterase	-	18	<b>4.6 x 10</b>	10mM Sodium Phosphate buffer + 1.0M 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	<b>ORpak CDBS-453</b>	β-Cyclodextrin derivative	Silica	3	<b>4.6 x 150</b>	1.0% CH <sub>3</sub> COOH + 0.2M NaCl aq. /CH <sub>3</sub> CN=70/30
F7140040	<b>ORpak CRX-853</b>	L-Amino acid derivative	Polyhydroxymethacrylate	6	<b>8.0 x 50</b>	0.25mM CuSO <sub>4</sub> aq.
F6709300	<b>ORpak CRX-G</b>	(guard column)	Polyhydroxymethacrylate	6	<b>4.6 x 10</b>	0.25mM CuSO <sub>4</sub> 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 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
F7623001	<b>ET-RP1 4D</b>	≥ 11,000	Octadecyl	4	250	<b>4.6 x 150</b>	H <sub>2</sub> O/CH <sub>3</sub> CN=35/65

Base Material: Polyvinyl alcohol

## Pretreatment Column for Column Switching Method

### Feature

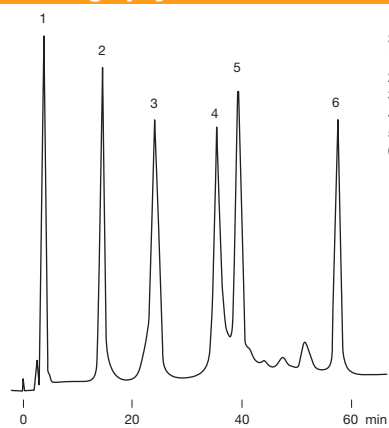
- GF-4A**
- Higher protein removal rate than the discontinued PK columns. Removes surfactants and proteins/peptides well but is not suitable for trapping hydrophilic substances.

### 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	<b>MSPak GF-4A</b>	9	400	<b>4.6 x 10</b>	H <sub>2</sub> O

Base Material: Polyvinyl alcohol

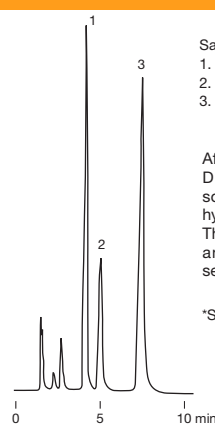
**Protein separation by hydrophobic interaction chromatography**



Sample : 370µL  
 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); 1.8M Ammonium sulfate + (B)  
 (B); 0.1M Phosphate buffer (pH7.0)  
 Linear gradient; (A) to (B), 60min  
**Flow rate** : 1.0mL/min  
**Detector** : UV (280nm)  
**Column temp.** : Room temp.

**Choline and acetylcholine**



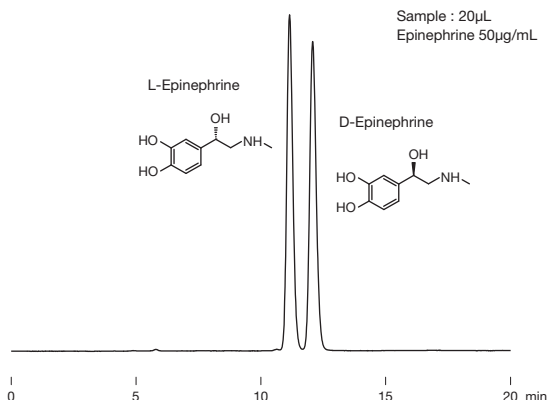
Sample : 10µL  
 1. Choline 5mg/L  
 2. Ethylhomocholine 10mg/L  
 3. Acetylcholine 10mg/L

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** : 0.1M H<sub>3</sub>PO<sub>4</sub> + 300mg/L Sodium 1-decansulfonate + 65mg/L Tetramethylammonium chloride (pH8.0 adjusted by 1.0M NaOH)  
**Flow rate** : 1.0mL/min  
**Detector** : Electrochemical (Electrode : Pt, 350mV SCE)  
**Column temp.** : 37°C

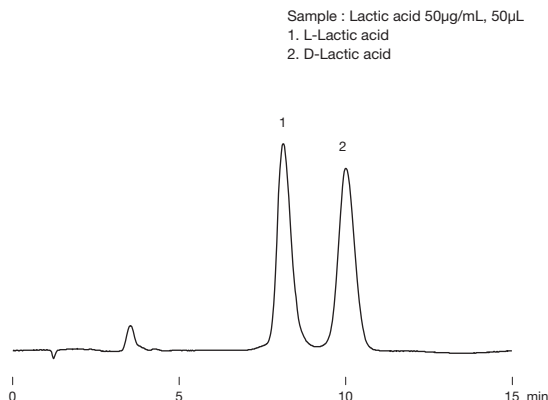
**Chiral separation of epinephrines**



Sample : 20µL  
 Epinephrine 50µg/mL

**Column** : Shodex ORpak CDBS-453  
**Eluent** : (0.05%(w/v) CH<sub>3</sub>COOH + 0.2M NaCl) aq./CH<sub>3</sub>CN=95/5  
**Flow rate** : 0.5mL/min  
**Detector** : UV (280nm)  
**Column temp.** : 10°C

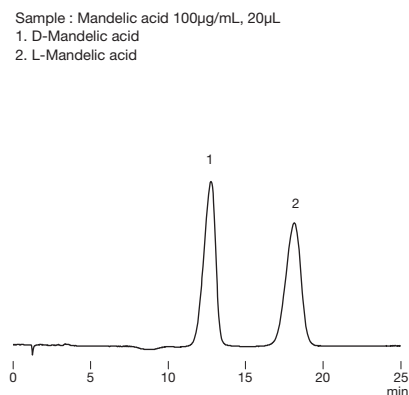
**Chiral separation of lactic acids**



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

**Column** : Shodex ORpak CRX-853  
**Eluent** : 0.5mM CuSO<sub>4</sub> aq.  
**Flow rate** : 1.0mL/min  
**Detector** : UV (230nm)  
**Column temp.** : 50°C

**Chiral separation of mandelic acids**



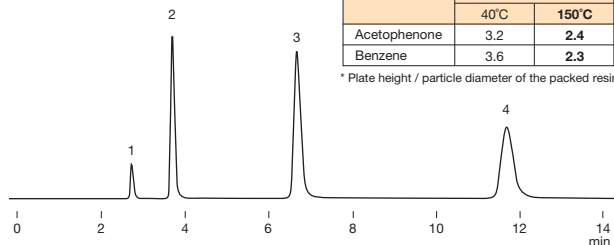
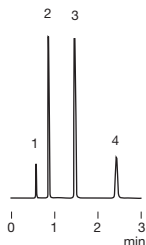
Sample : Mandelic acid 100µg/mL, 20µL  
 1. D-Mandelic acid  
 2. L-Mandelic acid

**Column** : Shodex ORpak CRX-853  
**Eluent** : 0.25mM CuSO<sub>4</sub> aq.  
**Flow rate** : 1.0mL/min  
**Detector** : UV (230nm)  
**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)**  
 2.4mL/min

**normal temp. (40°C)**  
 0.5mL/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<sub>2</sub>O/CH<sub>3</sub>CN=50/50 (Right) H<sub>2</sub>O/CH<sub>3</sub>CN=75/25  
**Detector** : Photodiode array (210nm)  
**Column Oven** : Polartherm 9000 Series (SandraSelerity Technologies, Inc)

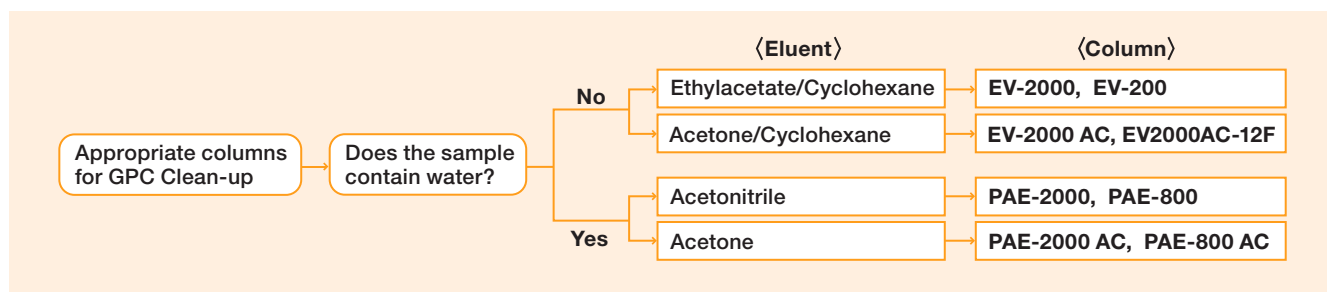
**Note:**  
 The eluent was introduced into the column after being preheated and was cooled after column elution, then introduced into the detector.

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. 1003001 (October 3rd, 2006, 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

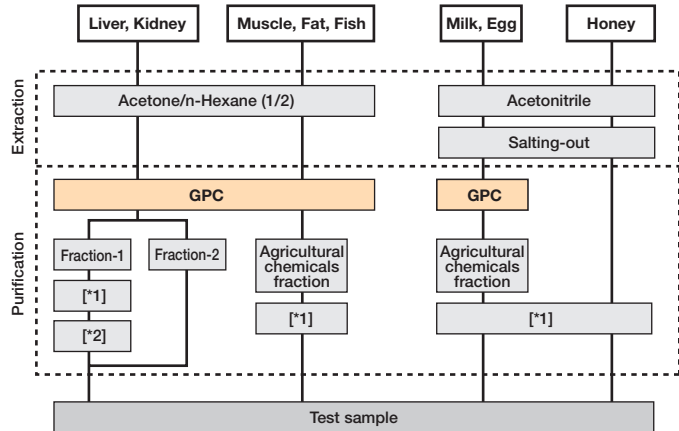
### ■ GPC Clean-up for phthalic acid esters in sediments, biological samples, blood, etc.

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

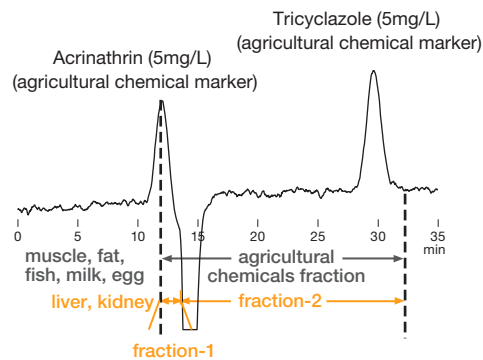
**Sample preparation outline for simultaneous GC/MS and LC/MS analysis of agricultural chemicals in livestock and marine products (part 1)**

**[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

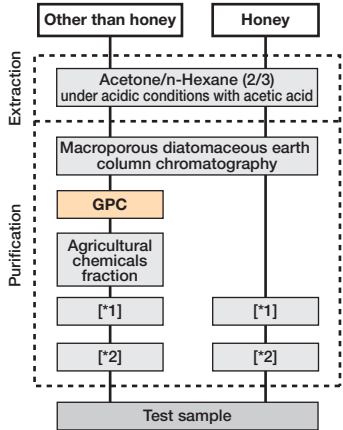
**Preparation range of agricultural chemicals using EV-2000 AC**



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

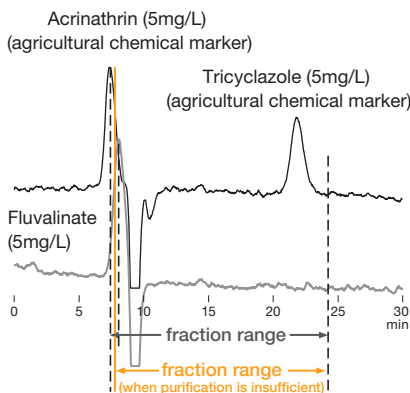
**Sample preparation outline for simultaneous LC/MS analysis of agricultural chemicals in livestock and marine products (part 2)**

**[Outline]**



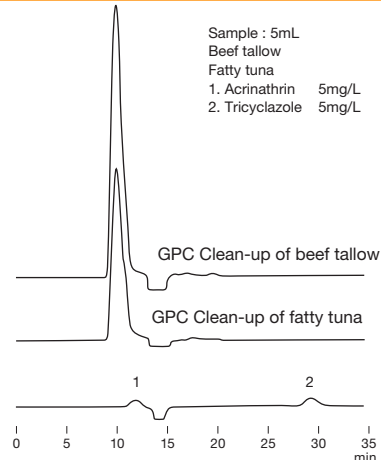
GPC column : Shodex CLNpak EV2000AC-12F + EV-G AC12C  
 \*1 Purification with trimethyl aminopropylsilyled silica gel mini-column  
 \*2 Purification with ethylenediamine-N-propylsilyled silica gel mini-column

**Preparation range of agricultural chemicals using EV2000AC-12F**



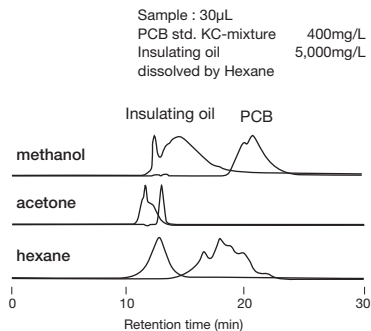
Column : Shodex CLNpak EV-G AC12C + EV2000AC-12F  
 Eluent : Acetone/Cyclohexane=3/17  
 Flow rate : 3.0mL/min  
 Detector : UV (254nm)  
 Column temp. : 45°C  
 Injection vol. : 2mL

**GPC Clean-up of fatty tuna and beef tallow**



Sample : 5mL  
 Beef tallow  
 Fatty tuna  
 1. Acrinathrin 5mg/L  
 2. Tricyclazole 5mg/L  
 Column : Shodex CLNpak EV-G AC + EV-2000 AC  
 Eluent : Acetone/Cyclohexane=1/4  
 Flow rate : 5.0mL/min  
 Detector : UV (254nm)  
 Column temp. : 40°C  
 Injection vol. : 5mL

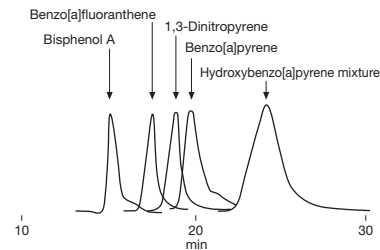
**Separation of PSB and insulating oil using PAE-800**



Sample : 30μL  
 PCB std. KC-mixture 400mg/L  
 Insulating oil 5,000mg/L dissolved by Hexane  
 Column : Shodex CLNpak PAE-800  
 Eluent : Methanol, Acetone, Hexane  
 Flow rate : 0.8mL/min  
 Detector : Photodiode array (209nm)  
 Column temp. : 40°C

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**

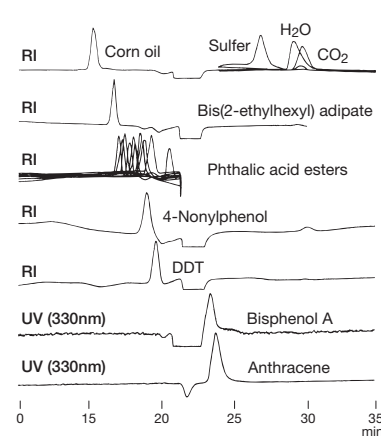


Compound	Rt(min)	Compound	Rt(min)
Anthracene	16.6	Benzo[a]pyrene	19.9
Chrysene	18.0	Hydroxybenzo[a]pyrene	23.0
Fluoranthene	17.1	compound	
Benzo[a]fluoranthene	17.7	Bisphenol A	16.1
Benzo[b]fluoranthene	18.6	1,3-Dinitronaphthalene	16.2
Benzo[k]fluoranthene	18.4	1-Nitropyrene	18.6
Pyrene	17.9	1,3-Dinitropyrene	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 : 0.8mL/min  
 Detector : UV (210nm)  
 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 : 0.5mL/min  
 Detector : UV (330nm), RI  
 Column temp. : Room temp.

# Product Name Changes Notices

Some Shodex guard columns have been renamed.  
There is no change in their product codes.

## Renamed products list

Page	New Product Name	Former Product Name	Product Code
12	<b>RSpak DE-G 4A</b>	<b>RSpak DE-G</b>	F6700150
12	<b>RSpak DE-G 2A</b>	<b>RSpak DE-SG</b>	F6700151
12	<b>RSpak DM-G 4A</b>	<b>RSpak DM-G</b>	F6700160
13	<b>RSpak DE-G 8B</b>	<b>RSpak DE-LG</b>	F6700190
13	<b>RSpak DM-G 8B</b>	<b>RSpak DM-LG</b>	F6700404
26	<b>SUGAR SC-G 6B</b>	<b>SUGAR SC-LG</b>	F6700090
26	<b>SUGAR SP-G 6B</b>	<b>SUGAR SP-G</b>	F6700081
26	<b>SUGAR KS-G 6B</b>	<b>SUGAR KS-G</b>	F6700020
26	<b>RSpak DC-G 4A</b>	<b>RSpak DC-G</b>	F6700170
26	<b>SUGAR SC1211G 4A</b>	<b>SUGAR SC-G</b>	F6700120
27	<b>SUGAR KS-G 8B</b>	<b>SUGAR KS-LG</b>	F6700002
27	<b>RSpak DC-G 8B</b>	<b>RSpak DC-LG</b>	F6700402
30	<b>RSpak KC-G 6B</b>	<b>RSpak KC-G</b>	F6700030
30	<b>RSpak KC-G 8B</b>	<b>RSpak KC-LG</b>	F6700010
38	<b>PROTEIN KW-G 6B</b>	<b>PROTEIN KW-G</b>	F6700131
39	<b>PROTEIN KW-G 8B</b>	<b>PROTEIN KW-LG</b>	F6709556
42	<b>OHpak SB-G 6B</b>	<b>OHpak SB-G</b>	F6709430
43	<b>OHpak SB-G 8B</b>	<b>OHpak SB-LG</b>	F6709555
50, 56	<b>GPC KF-G 4A</b>	<b>GPC KF-G</b>	F6700300
52	<b>GPC K-G 4A</b>	<b>GPC K-G</b>	F6700401
54	<b>GPC KD-G 4A</b>	<b>GPC KD-G</b>	F6700411
60	<b>GPC KF-G 8B</b>	<b>GPC KF-LG</b>	F6700406
60	<b>GPC K-G 8B</b>	<b>GPC K-LG</b>	F6700407
61	<b>GPC H-G 8B</b>	<b>GPC H-G</b>	F6700310
61	<b>GPC KF-G 20C</b>	<b>GPC KF-LLG</b>	F6700408
61	<b>GPC K-G 20C</b>	<b>GPC K-LLG</b>	F6700409
68	<b>GPC HFIP-G 8B</b>	<b>GPC HFIP-LG</b>	F6700500
68	<b>GPC HFIP-G 4A</b>	<b>GPC HFIP-G</b>	F6700511
70	<b>IEC QA-G 8B</b>	<b>IEC QA-LG</b>	F6709602
70	<b>IEC DEAE-G 8B</b>	<b>IEC DEAE-LG</b>	F6709603
72	<b>IEC SP-G 8B</b>	<b>IEC SP-LG</b>	F6709604
72	<b>IEC CM-G 8B</b>	<b>IEC CM-LG</b>	F6709605



# USP40-NF35 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 10µm in diameter, or a monolithic rod.	C18	22
		Silica C18M	22
		Silica C18P	22
L3	Porous silica particles, 1.5 to 10µm in diameter, or a monolithic silica rod.	Silica 5SIL	23
L7	Octylsilane chemically bonded to totally or superficially porous silica particles, 1.5 to 10µm 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, 1.5-10µm in diameter, or a monolithic silica rod.	Silica 5NH	23
L10	Nitrile groups chemically bonded to porous silica particles, 1.5-10µm in diameter, or a monolithic silica rod.	Silica 5CN	22
L11	Phenyl groups chemically bonded to porous silica particles, 1.5-10µm in diameter, or a monolithic silica rod.	Silica 5NPE	22
L17	Strong cation-exchange resin consisting of sulfonated cross-linked styrene-divinylbenzene copolymer in the hydrogen form, 6 to 12µm in diameter.	SUGAR SH1011	30
		SUGAR SH1821	30
		RSpak KC-811	30
		IC Y-521	34
L19	Strong cation-exchange resin consisting of sulfonated cross-linked styrene-divinylbenzene copolymer in the calcium form, about 5-15µm in diameter.	SUGAR SC1011	26
		SUGAR SC1821	26
		SUGAR SC1211	26
		EP SC1011-7F	27
		USPpak MN-431	27
		PROTEIN KW-800 series	38
L20	Dihydroxypropane groups chemically bonded to porous silica or hybrid particles, 1.5-10µm in diameter, or a monolithic silica rod.	PROTEIN LW-803	38
		KW400 series	38
		RSpak RP18-415	12
L21	A rigid, spherical styrene-divinylbenzene copolymer, 3 to 30µm in diameter.	RSpak DS-613	12
		RSpak DS-413	12
		GPC KF, K, KD, HK, LF, HT, UT, AT, HFIP series	50,52,54,56 58,62,64,66
L22	A cation-exchange resin made of porous polystyrene gel with sulfonic acid groups, about 5-15µm 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
L23	An anion-exchange resin made of porous polymethacrylate or polyacrylate gel with quaternary ammonium groups, 7-12µm in size.	IC Y-521	34
		CXpak P-421S	72
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.	IEC QA-825	70
		OHpak SB-802 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.	OHpak SB-802.5 HQ	42
		PROTEIN KW-800 series	38
L34	Strong cation-exchange resin consisting of sulfonated cross-linked styrene-divinylbenzene copolymer in the lead form, about 7 to 9µm in diameter.	PROTEIN LW-803	38
		KW400 series	38
		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, 3-10µm 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 30µm 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 a spherical 1.5- to 10-µm, silica or hybrid packing with a hydrophilic coating.	PROTEIN KW-800 series	38
		PROTEIN LW-803	38
		KW400 series	38
L67	Porous vinyl alcohol copolymer with a C18 alkyl group attached to the hydroxyl group of the polymer, 2 to 10µm in diameter.	Asahipak ODP-40	10
		Asahipak ODP-50	10
		ET-RP1	74
L71	A rigid, spherical polymethacrylate, 4 to 6µm 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 29µEq/column.	IC YK-421	34
L82	Polyamine chemically bonded to cross-linked polyvinyl alcohol polymer, 5µm in diameter.	Asahipak NH2P-50	20

# 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 to 1/3 of the regular flow.

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	<p><b>[Ligand exchange columns (SUGAR series)]</b></p> <ul style="list-style-type: none"> <li>• <b>In case of counter ion detachment</b> Flush or inject solvent containing the salt corresponding to the modified counter-ligand.</li> </ul> <p><b>[Polymer-base amino columns (NH2P series)]</b></p> <ul style="list-style-type: none"> <li>• <b>In cases where an acidic substance has been bound to the amino functional group</b> Flush with solvents in the following sequence: water, 0.1M perchloric acid (aq.), water, 0.1M NaOH (aq.), water, and mobile phase.</li> </ul>
Aqueous SEC (GFC) chromatography columns	<ul style="list-style-type: none"> <li>• <b>In cases where an ionic substance has been adsorbed</b> Use a solvent with higher salt concentration or solvent with different pH from the mobile phase.</li> <li>• <b>In cases where a hydrophobic substance has been adsorbed</b> 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)</li> </ul>
Ion exchange chromatography columns	<ul style="list-style-type: none"> <li>• <b>In cases where an ionic substance has been adsorbed</b> Use a solvent with higher salt concentration or solvent with different pH from the mobile phase.</li> <li>• <b>In cases where a hydrophobic substance has been adsorbed</b> 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)</li> </ul> <hr/> <ul style="list-style-type: none"> <li>• <b>In cases where protein have been adsorbed</b> Inject 1-2 mL of 0.1 M NaOH (aq.) or 30% (v/v) acetic acid (aq.) several times.</li> </ul>
Hydrophobic interaction chromatography columns	<ul style="list-style-type: none"> <li>• <b>In cases where protein have been adsorbed</b> Inject 1-2 mL of 0.1 M NaOH (aq.) or 30% (v/v) acetic acid (aq.) several times.</li> </ul>

\*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

One typical cause of the column pressure elevation is the solid substance being clogged at the inlet filter of the column. In this case, reverse the direction and reduce the flow to 1/3 of the regular flow rate. This may remove the solid substance 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, replace the solvent with shipping solvent and securely tighten the end caps.
- Store the column in a location with stable temperature.
- For long-term storage of SEC columns, immersion method is recommended. \*Please refer to the immersion method on the operation manual.

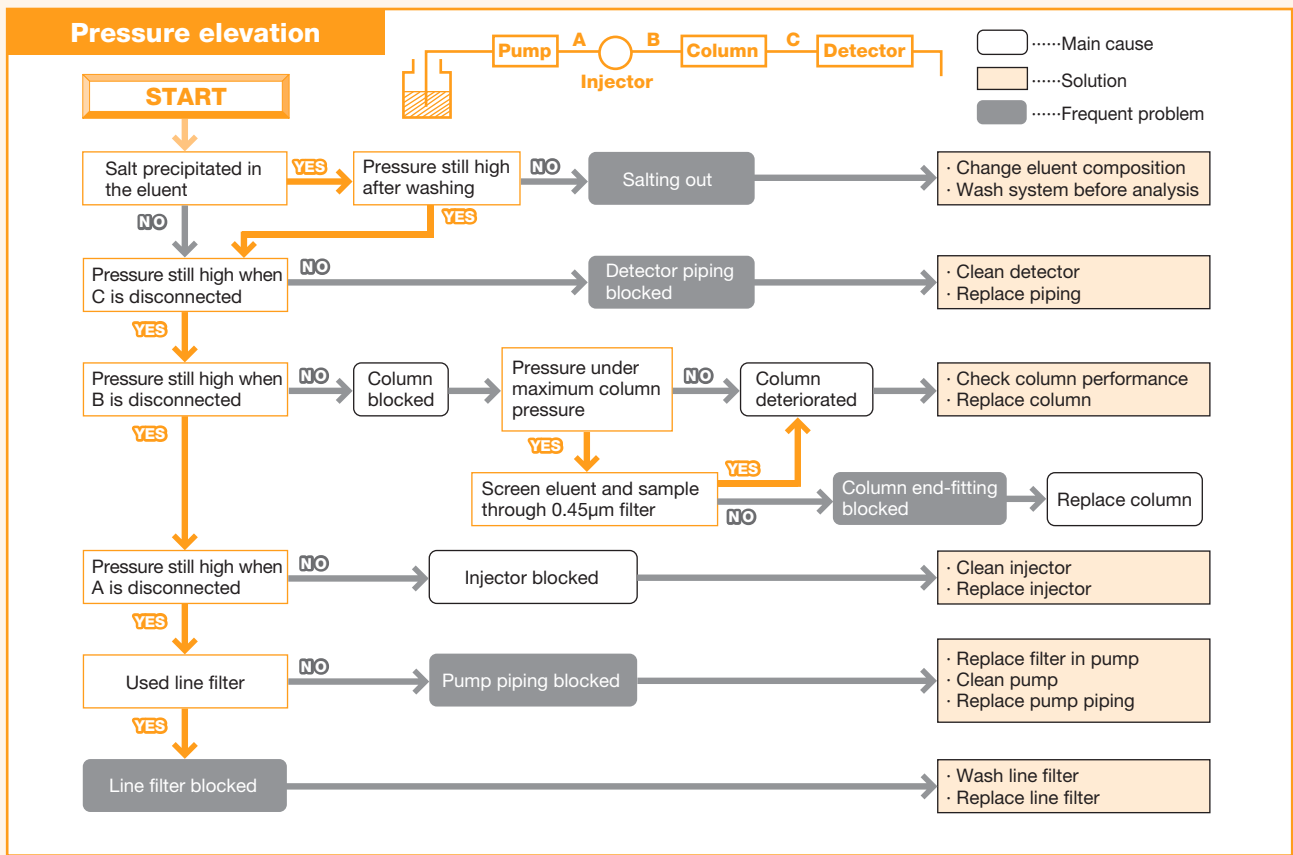
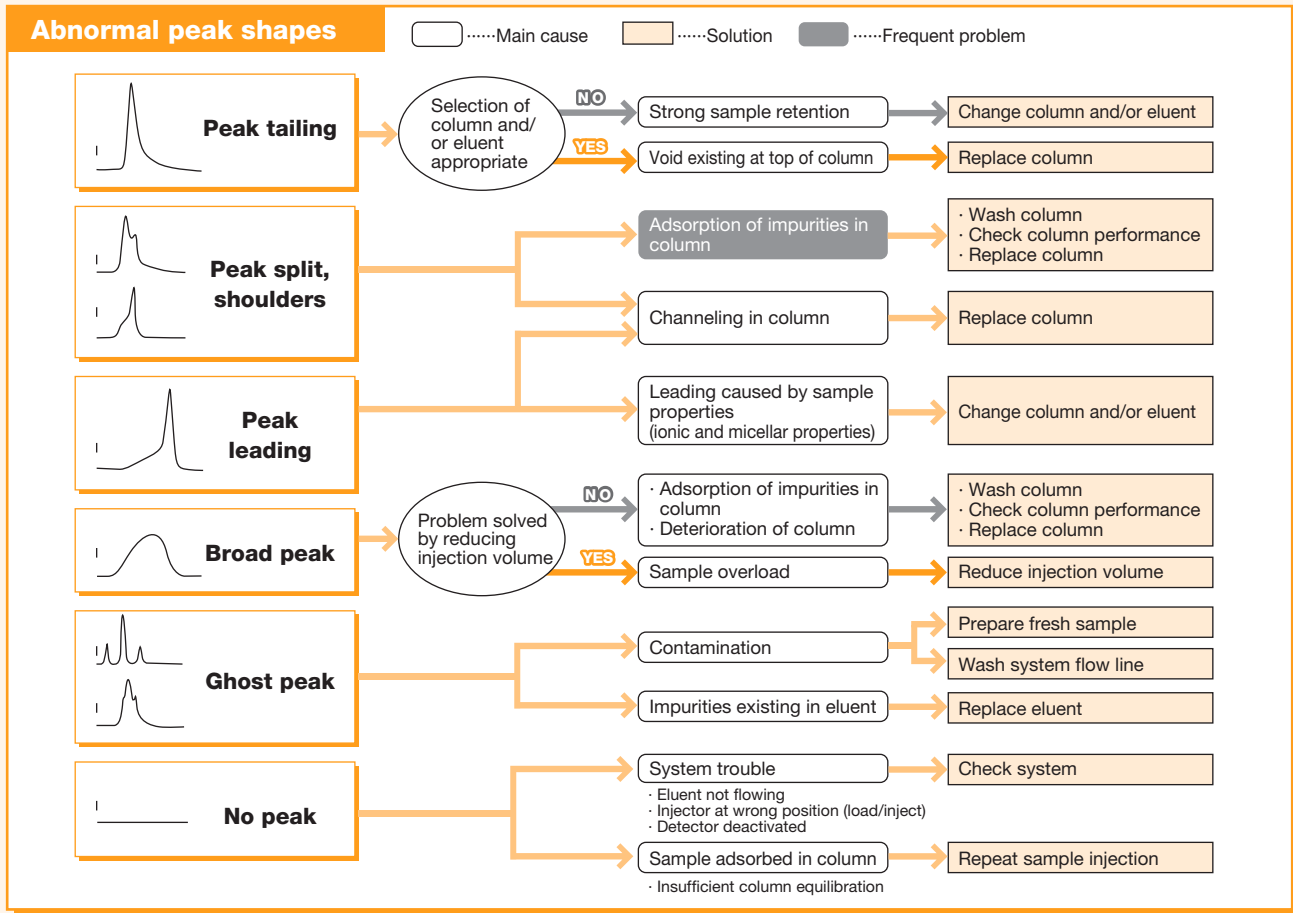
## Other

- Avoid physical shock on the column. Be cautious not to drop the column from a high position.
- Do not bend the column.
- Avoid opening the column's end-fitting, it can cause alteration of column's performance.

\*Read the operation manual before using the column.

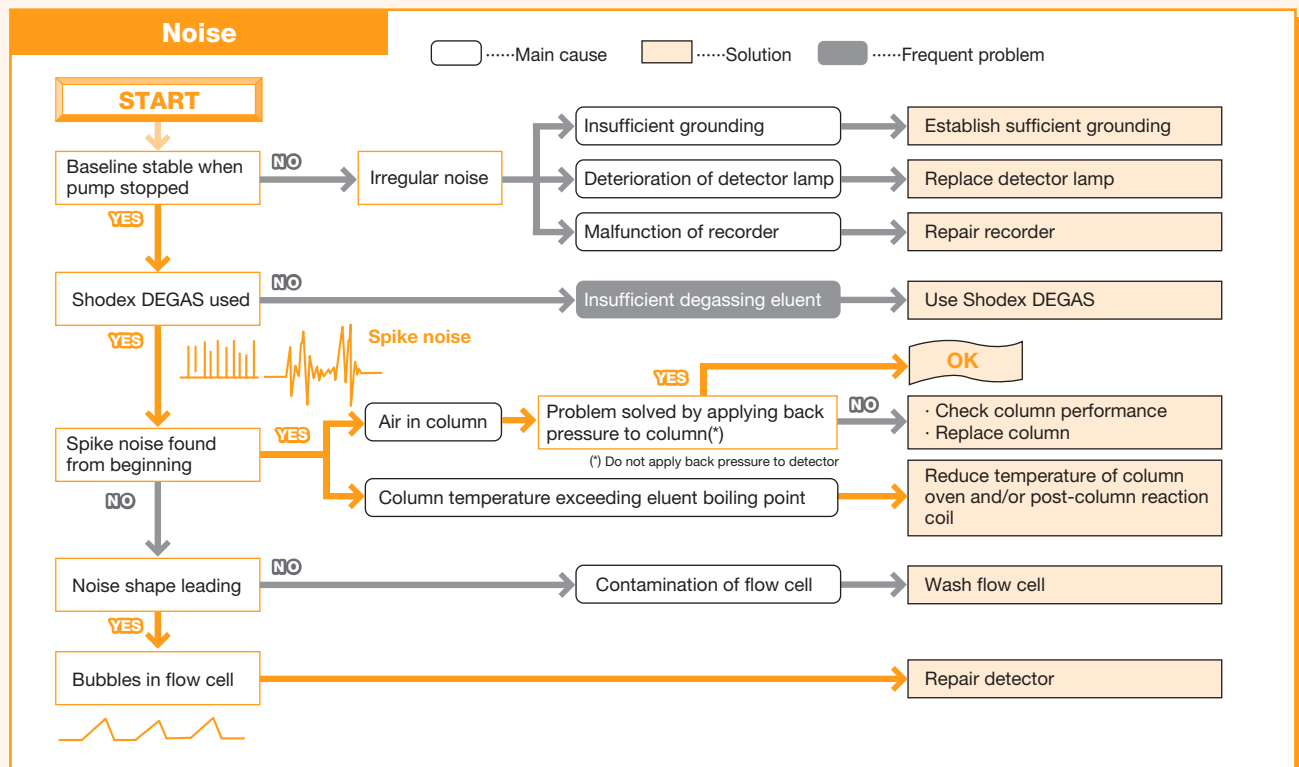
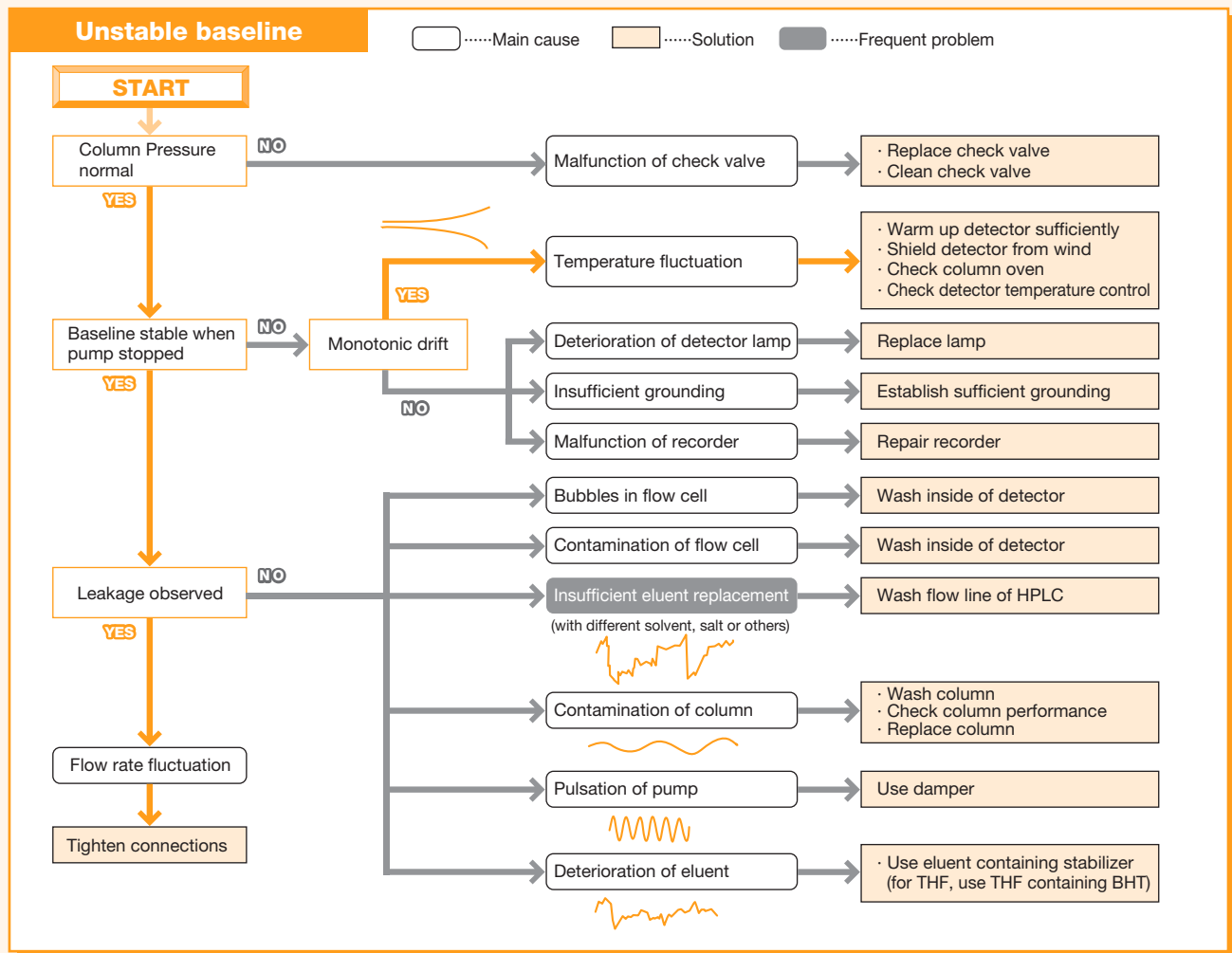
# Column Trouble Shooting

Common causes for abnormal chromatograms



# HPLC System Trouble Shooting

Common causes for abnormal chromatograms



# 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	PIKESS	PROTEIN
RSPak	Silica	STANDARD	STD	SUGAR	USPpak		

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C8P-50	10
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ES-502N	70
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GF-710	48
GF-7M HQ	48
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GS-310	48
GS-320	46
GS-510	48
GS-520	46
GS-620	46
GS-710	48
GSM-700	48

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HFIP-800	66
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HK-HFIP404L	58
HT-800	64

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VG-50	16
VN-50	16
VT-50	16

## W

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## Y

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YK-421	34
YS-50	34

# Index by Product Code

Product Code	Product Name	Page
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F6021040	HFIP-604	66
F6021041	LF-804	62
F6021042	LF-604	62
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## Please contact a Shodex support office near you

### Support office

**North America**  
**Latin America**

**Showa Denko America, Inc.**  
420 Lexington Avenue Suite 2335A, New York, NY 10170 USA  
Tel: +1 212 370 0033 Fax: +1 212 370 4566  
E-mail: sales@shodexhplc.com  
**URL: <http://www.shodexhplc.com/>**

**Europe**  
**Africa**  
**Middle East**  
**Russia**

**Showa Denko Europe GmbH**  
Konrad-Zuse-Platz 3 D-81829 Munich, Germany  
Tel: +49 (0)89 93 99 62-37 Fax: +49 (0)89 93 99 62-7734  
E-mail: order@shodex.de  
**URL: <http://www.shodex.de/>**

**Southeast Asia**  
**India**  
**Oceania**

**Showa Denko Singapore (Pte) Ltd.**  
2 Shenton Way #15-03/04, SGX Centre 1, Singapore 068804  
Tel: +65-6223-1889  
E-mail: sds-admi@sds.com.sg  
**URL: <http://www.sds.com.sg/>**

**Taiwan**

**Showa Denko K.K.**  
13-9 Shiba Daimon 1-chome, Minato-ku, Tokyo 105-8518, Japan  
Tel: +81 (0)3 6402 5140 Fax: +81 (0)3 5403 5730  
E-mail: Sdk\_shodex@showadenko.com  
**URL: <http://www.shodex.com/en/>**

**China**  
**Hong Kong**  
**Macau**

**Shodex China Co., Ltd.**  
18F, No.211 Shi Men Yi Road, Jing An, Shanghai, 200041, China  
Tel: +86 (0)21 6217-6111 Fax: +86 (0)21 6217-9879  
E-mail: sales@shodexchina.com  
**URL: <http://www.shodex.com/cn/>**

**Korea**

**Shoko Korea Co., Ltd.**  
#322, Chungjeong Rizion, 27, Seosomun-ro, Seodaemun-gu, Seoul 03741, Korea  
Tel: +82 (0)2 784 5111 Fax: +82 (0)2 784 5125  
E-mail: shoko.korea@shokokorea.com  
**URL: <http://www.shodex.com/kr/>**

**Japan**

**SHOKO SCIENCE Co., Ltd.**  
4-1, Shibakoen 2-chome, Minato-ku, Tokyo, 105-8432, Japan  
Tel: +81 3 3459 5104 Fax: +81 3 3459 5081  
E-mail: shodex.tokyo@shoko.co.jp  
**URL: <http://www.shodex.com/ja/>**

**<http://www.shodexHPLC.com/>**

Manufactured by



**SHOWA DENKO K.K.**

**Shodex (Separation & HPLC) Group**

13-9 Shiba Daimon 1-chome, Minato-ku, Tokyo 105-8518, Japan  
Tel: +81 (0)3 6402 5140 Fax: +81 (0)3 5403 5730