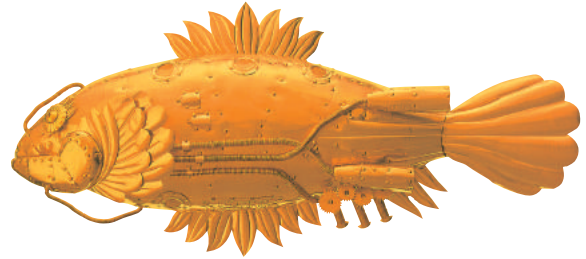
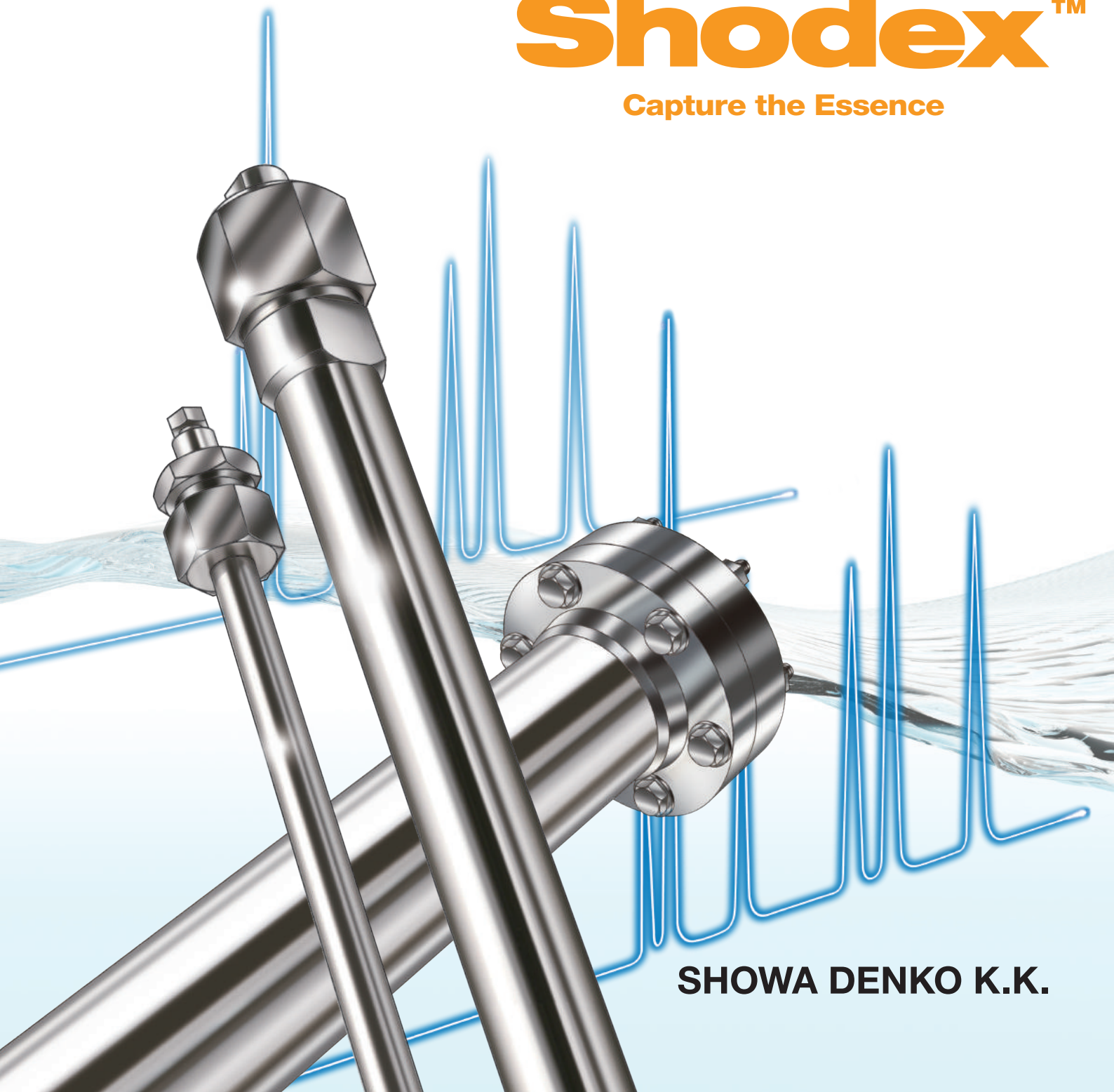


**HPLC Columns**  
**2016–2017**



**Shodex™**

**Capture the Essence**



**SHOWA DENKO K.K.**

# Shodex™



## HPLC Columns

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HPLC columns made in Japan

## Why to buy polymer-based columns?

- \* The great chemical stability leads to an extended pH range (2 to 13).
- \* The low bleeding allows the use of sensitive detection.
- \* The large variety of material properties creates a higher resolution.
- \* They are available for almost all separation techniques.
- \* The price per injection is cheaper than in silica-based columns due to their extended lifetime (2 to 3 times longer than silica-based).

## Why to choose Shodex as supplier?

- \* We offer a comprehensive and high standard technical support (pre- and after-sales).
- \* We provide 50 years of experience.
- \* Our experience leads to a great knowledge and a huge application database.
- \* Full production control: own production of polymer gels & own column packing.
- \* Strong partnership with customers and distributors.
- \* We offer you demo columns for free during 30 days.

Register on our new website and get  
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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	20
	HILICpak	VT-50	Polyvinyl alcohol	Quaternary ammonium	20
	Asahipak	NH2P	Polyvinyl alcohol	Amino	22
		ET-RP1	Polyvinyl alcohol	Octadecyl	68
Reversed Phase & HILIC & Normal Phase (Silica-based)	Silica	C18M, C18P	Silica	Octadecyl	16
	Silica	5C8	Silica	Octyl	17
	Silica	5C4	Silica	Butyl	17
	Silica	5CN	Silica	Cyanopropyl	17
	Silica	5NPE	Silica	Nitrophenylethyl	17
	Silica	5PYE	Silica	Pyrenylethyl	17
	Silica	5SIL	Silica	—	17
	Silica	5NH	Silica	Aminopropyl	17
Ligand Exchange	SUGAR	SC	Styrene divinylbenzene copolymer	Sulfo(Ca <sup>2+</sup> )	24
	SUGAR	SP0810	Styrene divinylbenzene copolymer	Sulfo(Pb <sup>2+</sup> )	24
	SUGAR	KS-800	Styrene divinylbenzene copolymer	Sulfo(Na <sup>+</sup> )	24
	RSpak	DC-613	Styrene divinylbenzene copolymer	Sulfo(Na <sup>+</sup> )	24
	SUGAR	SZ5532	Styrene divinylbenzene copolymer	Sulfo(Zn <sup>2+</sup> )	24
	EP	SC1011-7F	Styrene divinylbenzene copolymer	Sulfo(Ca <sup>2+</sup> )	25
	USPpak	MN-431	Styrene divinylbenzene copolymer	Sulfo(Ca <sup>2+</sup> )	25
Ion Exclusion	SUGAR	SH	Styrene divinylbenzene copolymer	Sulfo	28
	RSpak	KC-811	Styrene divinylbenzene copolymer	Sulfo	28
Ion Chromatography	IC	NI-424, I-524A	Polyhydroxymethacrylate	Quaternary ammonium	30
	IC	SI	Polyvinyl alcohol	Quaternary ammonium	30
	IC	YS-50	Polyvinyl alcohol	Carboxyl	32
	IC	YK-421	Silica	Carboxyl	32
	IC	Y-521, T-521	Styrene divinylbenzene copolymer	Sulfo	32
Aqueous SEC (GFC)	PROTEIN	KW-800	Silica	Hydrophilic polymer	36
		KW400	Silica	Hydrophilic polymer	36
	OHpak	SB-800 HQ	Polyhydroxymethacrylate	—	38
	OHpak	LB-800	Polyhydroxymethacrylate	—	38
Multimode	Asahipak	GS-HQ	Polyvinyl alcohol	—	42
Aqueous/Organic SEC	Asahipak	GF-HQ	Polyvinyl alcohol	—	44
	MSPak	GF-310	Polyvinyl alcohol	—	44
Organic SEC (GPC)		KF-800, K-800, KD-800, KF-600, KF-400HQ, LF, HT-800, UT-800, AT-806MS HFIP-800, HFIP-600	Styrene divinylbenzene copolymer	—	46, 48, 50, 52, 56, 58, 60
Ion Exchange	IEC	QA-825	Polyhydroxymethacrylate	Quaternary ammonium	64
	IEC	DEAE-825	Polyhydroxymethacrylate	Diethylaminoethyl	64
	IEC	DEAE3N	Polyhydroxymethacrylate	Diethylaminoethyl	64
	PIKESS	DEAE-2B	Polyhydroxymethacrylate	Diethylaminoethyl	64
	Asahipak	ES-502N	Polyvinyl alcohol	Diethylaminoethyl	64
	AXpak	WA-624	Polyhydroxymethacrylate	Diethylaminoethyl	64
	IEC	SP-825	Polyhydroxymethacrylate	Sulfopropyl	66
	IEC	SP-420N	Polyhydroxymethacrylate	Sulfopropyl	66
	PIKESS	SP-2B	Polyhydroxymethacrylate	Sulfopropyl	66
	IEC	CM-825	Polyhydroxymethacrylate	Carboxymethyl	66
	Asahipak	ES-502C	Polyvinyl alcohol	Carboxymethyl	66
	CXpak	P-421S	Styrene divinylbenzene copolymer	Sulfo(Na <sup>+</sup> )	66
Hydrophobic Interaction	HIC	PH-814	Polyhydroxymethacrylate	Phenyl	68
Affinity	AFpak	Various	Polyhydroxymethacrylate	Various ligand	68
Chiral Separation	ORpak	CDBS-453	Silica	β-Cyclodextrin derivative	68
	ORpak	CRX-853	Polyhydroxymethacrylate	L-Amino acid derivative	68
GPC Clean-up	CLNpak	EV	Styrene divinylbenzene copolymer	—	70
	CLNpak	PAE	Polyvinyl alcohol	—	70
Column Switching Pretreatment	MSPak	PK	Hydrophilic copolymers containing N-vinyl acetamide	—	72
	MSPak	GF-4A	Polyvinyl alcohol	—	72

# 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>Using the lower polarity mobile phase causes a faster 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>Has a relatively small ion exchange capacity.</li> <li>Electrical conductivity detector can be used with low-salt concentration mobile phase.</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 (IEX)</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 biological 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	AFC		≤ 2,000	RPC
		RPC			
		HILIC			
		LEX			
		IEX			NPC
		IC			
		SEC			
		IEC			
AFC	SEC				
CS					

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, 16, 17
	Hydrophilic substances	HILIC	20, 22
		IEC+RPC	12
		LEX+SEC	24, 25
	Substances in bio-fluid (serum-plasma-urine)	RPC	8
		SEC+RPC	42, 44, 72
Polymer	SEC	38, 44, 50, 56	
Moisturizers	Polyalcohols	RPC	12
		LEX+SEC	24
		LEX+HILIC	24
		SEC	38, 44
	Protein hydrolysates	RPC	10, 12
		SEC	36
Mucopolysaccharides	SEC	38	
Emulsifiers	Surfactants	SEC+RPC	44
		SEC	46, 52
Preservatives	Paraben Dehydroacetic acid	RPC	10, 12, 16, 17
Optical active materials		CS	68

## Foods

		Separation Mode	Page
Nutritional ingredients	Monosaccharides Disaccharides Sugar alcohols	HILIC	20, 22
		LEX+SEC	24
		LEX+HILIC	24
	Oligosaccharides	HILIC	20, 22
		LEX+HILIC	24
		SEC	24, 38, 42
	Low molecular water-soluble dietary fiber	SEC	42
	Polysaccharides	SEC	24, 38
	Organic acids	RPC	8, 12
		IEC+RPC	28
		IC	30
		RPC	8, 10, 12
	Water-soluble vitamins	IEC+RPC	12
		HILIC	20, 22
	Fat-soluble vitamins	RPC	10
		NPC	17
		SEC	46, 52
	Fatty acids	RPC	12, 16, 17
SEC		44, 46, 48, 52	
Nucleic acids (umami)	IEC+SEC	42	
Amino acids	IEC+IEC+RPC	12	
	IC	32	
	IEC	66	
Food safety	Food additives	RPC	10, 12, 68
		HILIC	20, 22
	Pesticides	RPC	12
		IEC+RPC	12
		HILIC	20
		IC	30
	Mycotoxin	RPC	16
	Pretreatment of residual pesticides	SEC GPC (Clean-up)	70

### 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	44, 46, 48, 52, 56
	Polar organic solvent soluble		38, 44, 50, 52, 56
	High temperature/ Ultra high temperature		58
	Water-soluble		36, 38, 42, 44
Additives Oligomers		RPC	10, 12, 16, 17
	Organic solvent soluble	SEC	44, 46, 48, 52
	Polar organic solvent soluble		38, 44, 50, 52
	Water-soluble		36, 38, 42, 44

## Biotechnology

		Separation Mode	Page
Genomics	Nucleobases Nucleotides Nucleosides	RPC	12
		IEC+SEC	12, 42
		IEC	64
	Oligo nucleic acids	RPC	12
		IEC+SEC	42
		IEC	64
	DNA/RNA	SEC	38, 44
Proteomics	Amino acids	RPC	10
		IEC+IEX+RPC	12
		IEC	66
		IEC+SEC	42
	Peptides Proteins	RPC	10, 12
		SEC	36, 38, 42, 44
		IEC	64, 66
		HIC	68
Glycomics	Glycoproteins	RPC	10, 12
		SEC	36, 38, 42, 44
		IEC	64, 66
		HIC	68
		AFC	68
	Sugar chains	HILIC	20, 22
		AFC	68
	Monosaccharides	HILIC	20, 22
		LEX+SEC	24
		LEX+HILIC	24
Sialic acids Uronic acids Aldonic acids	IEX+RPC	28	
Hormones	Amines	RPC	8, 10, 12
		IEC	66
	Steroids	RPC	10
		HILIC	20, 22
		SEC	38, 44
Lipids	Phospholipids	NPC	17
		SEC	44, 46, 52
	Lipoproteins	SEC	38
		AFC	68

## Environment

		Separation Mode	Page
Water quality	Anions	IC	30
	Oxyhalides	IC	30
		IEX+HILIC	20
	Cyanide Cyanogen chloride	IEX	28
	Cations	IC	32
	Surfactants	RPC	10, 16
		SEC+RPC	44
	Perchloric acids	IC	30
		IEX+HILIC	20
	Pesticides	RPC	12, 16, 17
		IEX+RPC	12
		HILIC	20
			IC
Soil	Anions	IC	30
	Heavy metals	IC	32
	Humic substances	SEC	38
	Organic arsenic	IEX+RPC	12
	Pesticides	RPC	12, 16, 17
		IEX+RPC	12
		HILIC	20
IC		30	
Environmental hormones	Pretreatment of Phthalates PCBs Benzo [a] pyrene	SEC GPC (Clean-up)	70
Bioethanols	Monosaccharides Oligosaccharides	HILIC	20, 22
		LEX+SEC	24
	Oligosaccharides Alcohols Furfural	LEX+SEC	24
	Saccharides Organic acids Alcohols Furfural	IEX+RPC+SEC	28
	Hemicelluloses Celluloses	SEC	50, 56
Biodiesels	Cations	IC	32
	Fatty acid glycerides	SEC	44
	Fatty acid methyl esters	RPC	12
	Organic acids	IC	30

# Comparison of the Features Among Shodex Reverse Phase Chromatography (RPC) Columns

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. You can choose a suitable column for your application based on the features listed below.

## Features

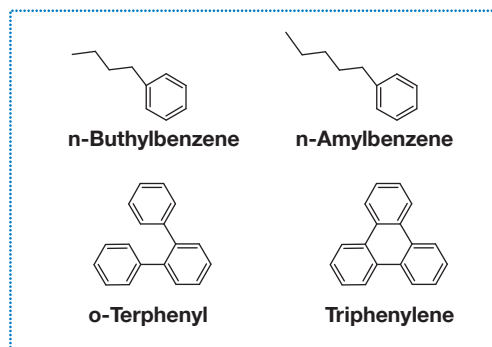
<b>ODP2 HP</b>	<ul style="list-style-type: none"><li>• Provides a large theoretical plate number nearly twice as much as generally available polymer-based reversed phase columns</li><li>• Offers enhanced retention of high polar substances compared to ODS columns</li><li>• Suitable for the analysis of small molecules such as pharmaceuticals in the presence of protein matrix</li><li>• Ideal for LC/MS analysis of high polar compounds</li><li>• Corresponds to USP L39</li></ul>
<b>ODP-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></ul>
<b>C8P-50</b>	<ul style="list-style-type: none"><li>• Usable in a wide pH range from pH 2 to 13</li></ul>
<b>C4P-50</b>	<ul style="list-style-type: none"><li>• Usable in 100% water or buffer solution</li><li>• Best used for the analysis of basic substances</li><li>• ODP-50 corresponds to USP L67</li></ul>
<b>ODP-40</b>	<ul style="list-style-type: none"><li>• Higher performance type of ODP-50 series</li><li>• Corresponds to USP L67</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>• Corresponds to USP L21</li></ul>
<b>DS-613</b> <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>• Corresponds to USP L21</li></ul>
<b>DE</b>	<ul style="list-style-type: none"><li>• Polymer-based columns, with similar polarity to that of ODS columns, can be used in general purposes</li><li>• Wide working pH range (from pH 2 to 12), usable in 100% water and buffer solutions</li><li>• Corresponds to USP L71</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>• Corresponds to USP L39</li></ul>
<b>NN</b>	<ul style="list-style-type: none"><li>• The packing material contains sulfo groups, and 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 contains 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>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>• Corresponds to USP L1</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>• Corresponds to USP L1</li></ul>
<b>5C8</b>	<ul style="list-style-type: none"><li>• Use when the retention capacity of C18 is too strong or that of C4 is too weak</li><li>• Applicable to ion pair chromatography, because of its rapid mass transfer and equilibrium</li><li>• Corresponds to USP L7</li></ul>
<b>5C4</b>	<ul style="list-style-type: none"><li>• Use when the retention capacity of C18 or C8 is too strong</li><li>• Corresponds to USP L26</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, C8, or C4 columns</li><li>• Corresponds to USP L10</li></ul>
<b>5NPE</b> <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 corresponds to USP L67</li></ul>



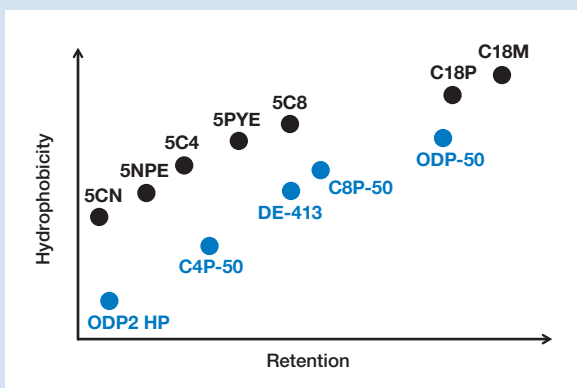
The interrelation between hydrophobicity and retention, and the interrelation between steric selectivity and retention were compared among Shodex columns for reversed phase chromatography.

The retention factor ( $k'$ ) of amylbenzene was used as the retention, the separation factor ( $\alpha$ ) between n-butylbenzene and n-amino benzene was used as the hydrophobicity. The separation factor between o-terphenil and triphenylene was used as the steric recognition.

Larger separation factor means higher hydrophobicity and higher steric selectivity.

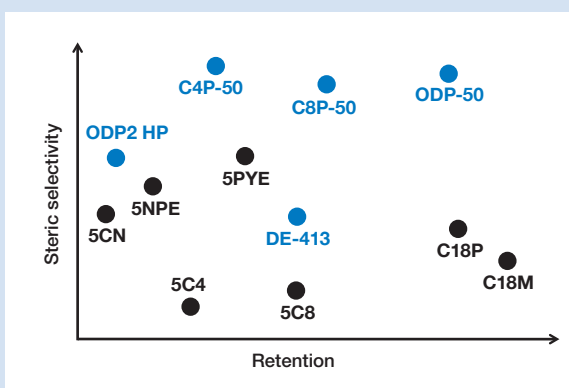


### Interrelation between hydrophobicity and retention



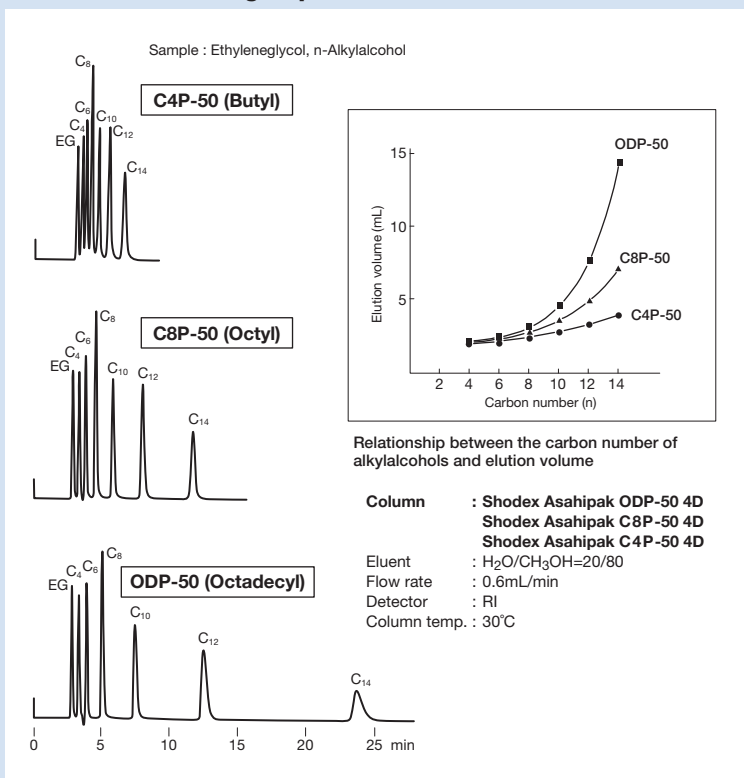
Column size : 4.6mm I.D. x 150mm each  
 Eluent : H<sub>2</sub>O/CH<sub>3</sub>OH=20/80  
 Flow rate : 1.0mL/min  
 Detector : UV (254nm)  
 Column temp. : 40°C

### Interrelation between steric selectivity and retention

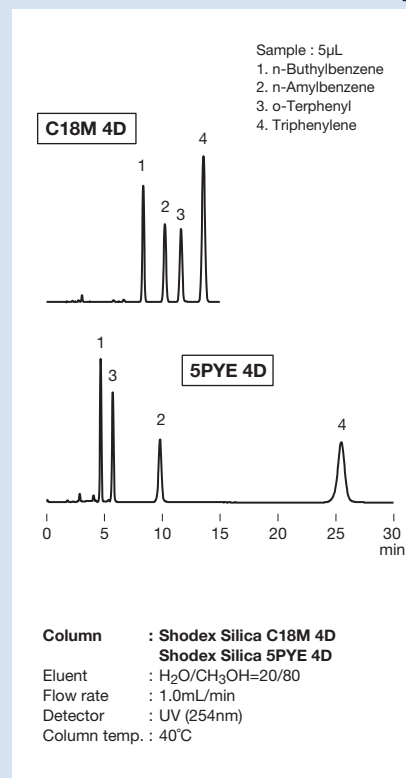


Column size : 4.6mm I.D. x 150mm each  
 Eluent : H<sub>2</sub>O/CH<sub>3</sub>OH=20/80  
 Flow rate : 1.0mL/min  
 Detector : UV (254nm)  
 Column temp. : 40°C

### Comparison of separation of alkylalcohol due to different functional groups



### Comparison of separation due to the difference in steric selectivity



# Columns for Polymer-based Reversed Phase Chromatography (ODP2 HP)

Please refer to “Comparison of the Features Among Shodex Reverse Phase Chromatography (RPC) Columns” 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 x 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 x 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 x 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 x 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 x 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 x 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 x 10</b>	H <sub>2</sub> O/CH <sub>3</sub> CN=55/45

Base Material : Polyhydroxymethacrylate

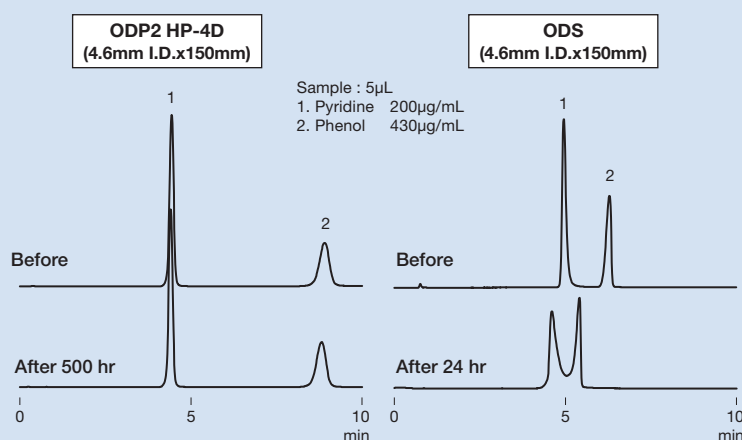
## 3mm I.D columns [Customized columns]

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 x 50</b>
F7622007	<b>ODP2 HP-3D</b>	-	5	40	<b>3.0 x 150</b>
F6714014	<b>ODP2 HPG-3A (guard column)</b>	-	5	-	<b>3.0 x 10</b>

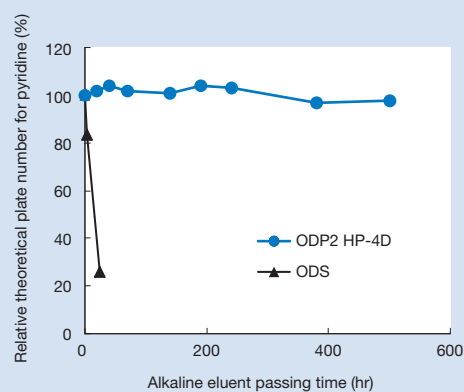
Base Material : Polyhydroxymethacrylate

## Tolerance of ODP2 HP for alkaline condition

### Comparison between the chromatograms obtained before and after passing alkaline eluent



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



#### Analysis condition

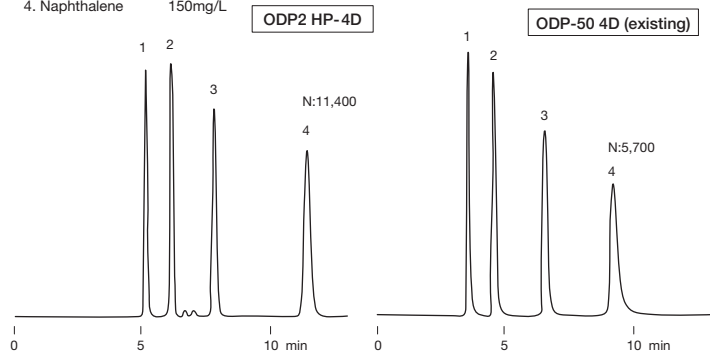
Column : Shodex ODP2 HP-4D  
 ODS from other manufacturer  
 Eluent : H<sub>2</sub>O/CH<sub>3</sub>OH=70/30  
 Flow rate : 1.0mL/min  
 Detector : UV (254nm)  
 Column temp. : 40°C

#### 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 (existing)**

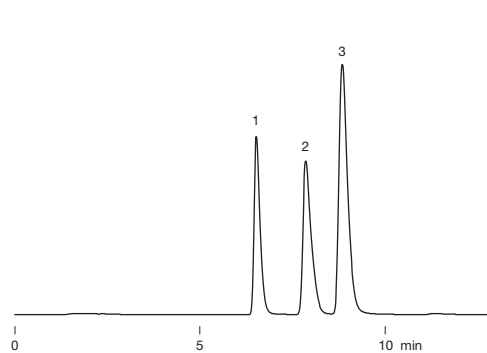
Sample : 5µL  
 1. Phenol 300mg/L  
 2. Methyl benzoate 350mg/L  
 3. Toluene 1000mg/L  
 4. Naphthalene 150mg/L



<b>Column</b> : Shodex ODP2 HP-4D	<b>Column</b> : Shodex Asahipak ODP-50 4D
<b>Eluent</b> : H <sub>2</sub> O/CH <sub>3</sub> CN=55/45	<b>Eluent</b> : H <sub>2</sub> O/CH <sub>3</sub> CN=35/65
<b>Flow rate</b> : 0.6mL/min	<b>Flow rate</b> : 0.6mL/min
<b>Detector</b> : UV (254nm)	<b>Detector</b> : UV (254nm)
<b>Column temp.</b> : 40°C	<b>Column temp.</b> : 40°C

**Imidazoles**

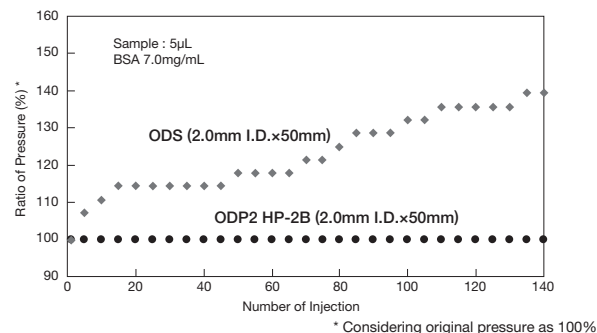
Sample : 0.1% each, 10µL  
 1. Imidazole  
 2. 2-Methylimidazole  
 3. 4-Methylimidazole



**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**

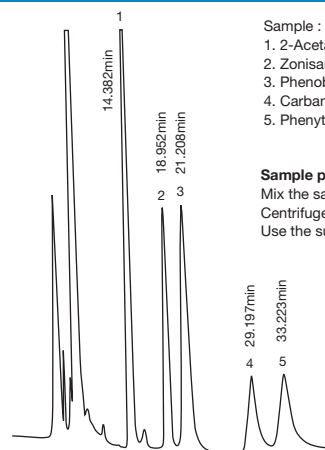
ODP2 HP columns are packed with gels with increased surface polarity and smaller pore size which prevent the adsorption of proteins. BSA was injected multiple times to both ODS and ODP2 HP columns. A significant column pressure increase was observed for the ODS column, while no considerable change was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



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

**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

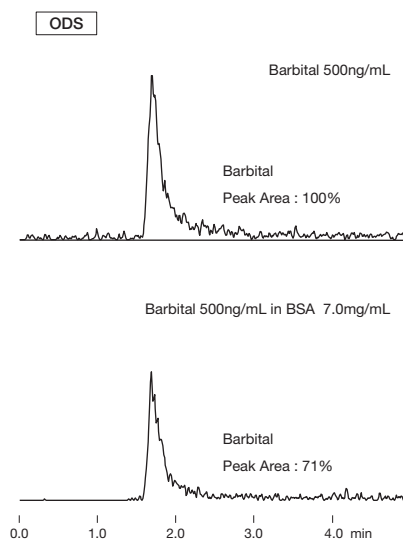
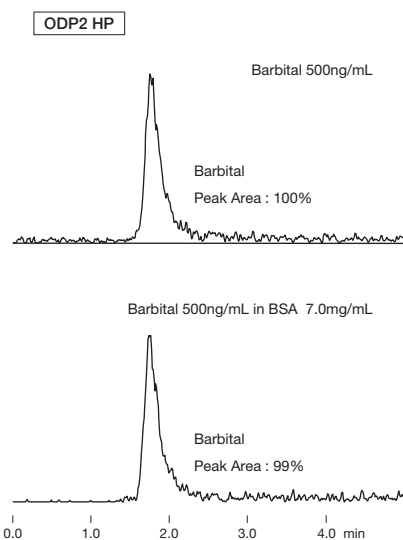


**Sample pretreatment :**  
 Mix the same volumes of serum and acetonitrile.  
 Centrifuge the mixture at 6000g for 5minutes.  
 Use the supernatant as sample.

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

**Barbital recovery rate comparison of ODP2 HP-2B and ODS in the presence of BSA**



For the analysis of drugs in samples containing proteins in matrix using LC/MS, ODP2 HP columns show less matrix effects (ion suppression in this case) compared to ODS columns due to fact that proteins can not be retained on ODP2 HP columns and are eluted 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

# Columns for Polymer-based Reversed Phase Chromatography (Asahipak)

Please refer to “Comparison of the Features Among Shodex Reverse Phase Chromatography (RPC) Columns” 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	<b>Asahipak ODP-40 4D</b>	≥ 11,000	Octadecyl	4	250	<b>4.6 × 150</b>	H <sub>2</sub> O/CH <sub>3</sub> CN=35/65
F7621002	<b>Asahipak ODP-40 4E</b>	≥ 17,000	Octadecyl	4	250	<b>4.6 × 250</b>	H <sub>2</sub> O/CH <sub>3</sub> CN=35/65
F7620002	<b>Asahipak ODP-50 6D</b>	≥ 9,000	Octadecyl	5	250	<b>6.0 × 150</b>	H <sub>2</sub> O/CH <sub>3</sub> CN=35/65
F7620001	<b>Asahipak ODP-50 6E</b>	≥ 14,000	Octadecyl	5	250	<b>6.0 × 250</b>	H <sub>2</sub> O/CH <sub>3</sub> CN=35/65
F6710001	<b>Asahipak ODP-50G 6A</b>	(guard column)	Octadecyl	5	–	<b>6.0 × 10</b>	H <sub>2</sub> O/CH <sub>3</sub> CN=35/65
F6710023	<b>Asahipak ODP-50 4B</b>	≥ 2,500	Octadecyl	5	250	<b>4.6 × 50</b>	H <sub>2</sub> O/CH <sub>3</sub> CN=35/65
F7620004	<b>Asahipak ODP-50 4D</b>	≥ 9,000	Octadecyl	5	250	<b>4.6 × 150</b>	H <sub>2</sub> O/CH <sub>3</sub> CN=35/65
F7620003	<b>Asahipak ODP-50 4E</b>	≥ 14,000	Octadecyl	5	250	<b>4.6 × 250</b>	H <sub>2</sub> O/CH <sub>3</sub> CN=35/65
F6710022	<b>Asahipak ODP-50G 4A</b>	(guard column)	Octadecyl	5	–	<b>4.6 × 10</b>	H <sub>2</sub> O/CH <sub>3</sub> CN=35/65
F7620009	<b>Asahipak ODP-50 2D</b>	≥ 5,000	Octadecyl	5	250	<b>2.0 × 150</b>	H <sub>2</sub> O/CH <sub>3</sub> CN=35/65
F6713001	<b>Asahipak ODP-50G 2A</b>	(guard column)	Octadecyl	5	–	<b>2.0 × 10</b>	H <sub>2</sub> O/CH <sub>3</sub> CN=35/65
F7620006	<b>Asahipak C8P-50 4D</b>	≥ 7,000	Octyl	5	250	<b>4.6 × 150</b>	H <sub>2</sub> O/CH <sub>3</sub> CN=35/65
F7620005	<b>Asahipak C8P-50 4E</b>	≥ 11,000	Octyl	5	250	<b>4.6 × 250</b>	H <sub>2</sub> O/CH <sub>3</sub> CN=35/65
F6710002	<b>Asahipak C8P-50G 4A</b>	(guard column)	Octyl	5	–	<b>4.6 × 10</b>	H <sub>2</sub> O/CH <sub>3</sub> CN=35/65
F7620008	<b>Asahipak C4P-50 4D</b>	≥ 6,000	Butyl	5	250	<b>4.6 × 150</b>	H <sub>2</sub> O/CH <sub>3</sub> CN=35/65
F7620007	<b>Asahipak C4P-50 4E</b>	≥ 9,000	Butyl	5	250	<b>4.6 × 250</b>	H <sub>2</sub> O/CH <sub>3</sub> CN=35/65
F6710003	<b>Asahipak C4P-50G 4A</b>	(guard column)	Butyl	5	–	<b>4.6 × 10</b>	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	<b>Asahipak ODP-40 3B</b>	Octadecyl	4	250	<b>3.0 × 50</b>
F7621102	<b>Asahipak ODP-40 3D</b>	Octadecyl	4	250	<b>3.0 × 150</b>
F6714013	<b>Asahipak ODP-40G 3A (guard column)</b>	Octadecyl	4	250	<b>3.0 × 10</b>

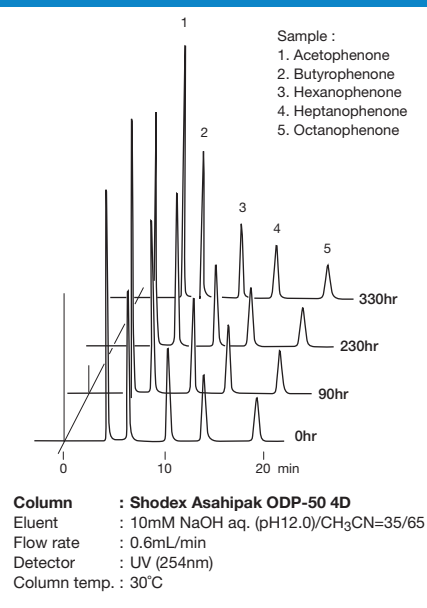
## Semi-micro columns \* The following semi-micro columns are made to order.

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

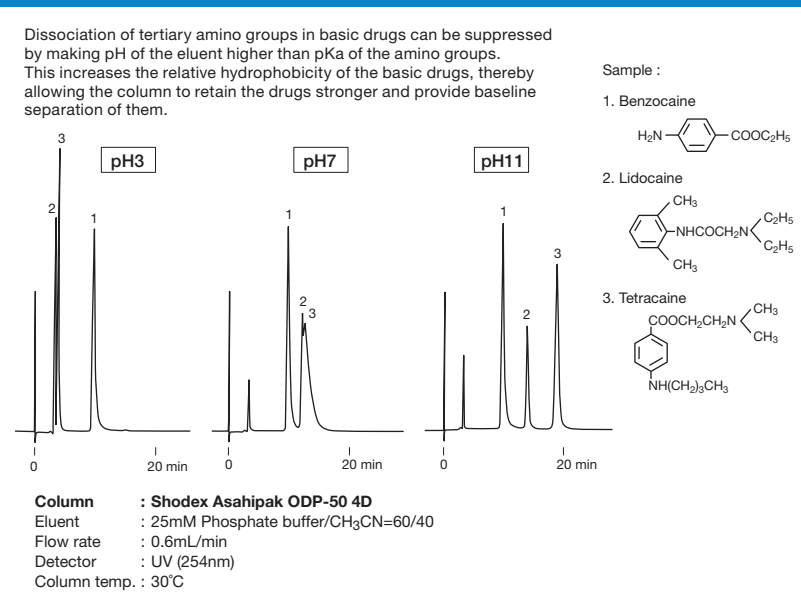
## Preparative columns \* Preparative columns are made to order.

Product Code	Product Name	Plate Number (TP/column)	Particle Size (μm)	Column Size (mm) I.D. x Length	Standard Column
F6820001	<b>Asahipak ODP-50 10E</b>	≥ 10,000	5	<b>10.0 × 250</b>	ODP-40, ODP-50
F6820035	<b>Asahipak ODP-90 20F</b>	≥ 9,000	9	<b>20.0 × 300</b>	ODP-40, ODP-50
F6710004	<b>Asahipak ODP-130G 7B</b>	(guard column)	13	<b>7.5 × 50</b>	(guard column)
F6820003	<b>Asahipak C8P-50 10E</b>	≥ 8,000	5	<b>10.0 × 250</b>	C8P-50
F6714004	<b>Asahipak C8P-50G 7B</b>	(guard column)	5	<b>7.5 × 50</b>	(guard column)
F6820005	<b>Asahipak C4P-50 10E</b>	≥ 7,000	5	<b>10.0 × 250</b>	C4P-50
F6714005	<b>Asahipak C4P-50G 7B</b>	(guard column)	5	<b>7.5 × 50</b>	(guard column)

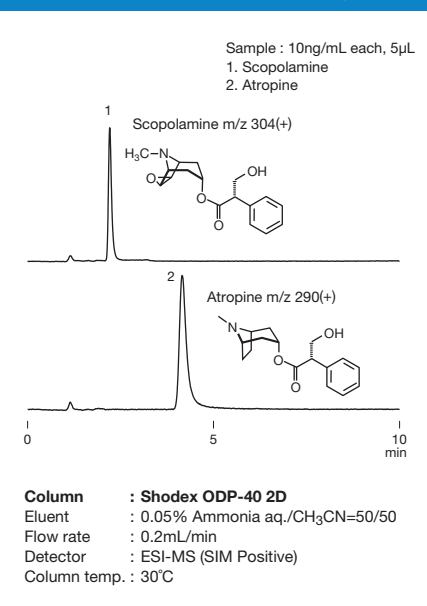
### Tolerance of ODP-50 for alkaline condition



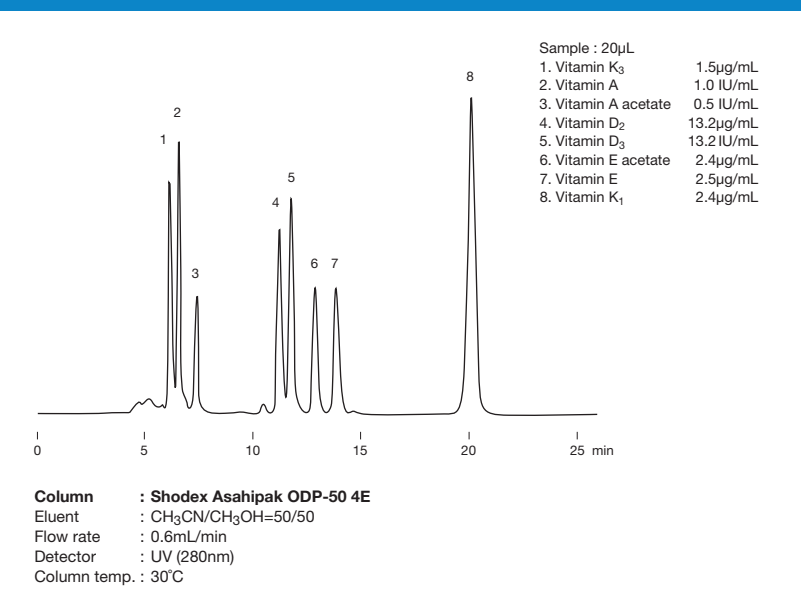
### Local anesthetics



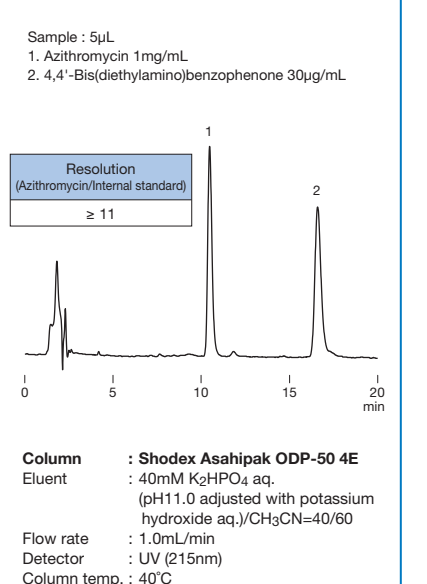
### LC/MS analysis of basic drugs



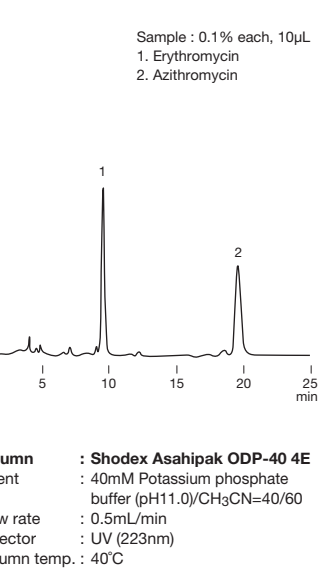
### Fat-soluble vitamins



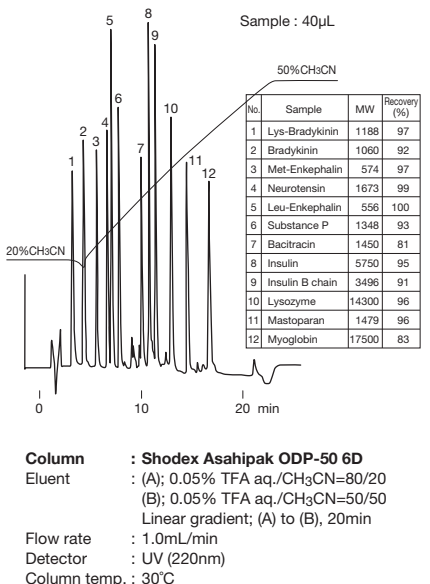
### Analysis of azithromycin according to JP method



### Macrolide antibiotics



### Gradient analysis of proteins and peptides



# Columns for Polymer-based Reversed Phase Chromatography (RSpak)

Please refer to “Comparison of the Features Among Shodex Reverse Phase Chromatography (RPC) Columns” 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

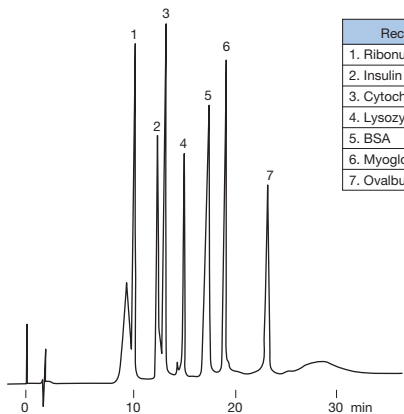
**Semi-micro columns** \* The following semi-micro columns are made to order.

Product Code	Product Name	Functional Group	Base Material	Particle Size ( $\mu\text{m}$ )	Pore Size ( $\text{\AA}$ )	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 ( $\mu\text{m}$ )	Column Size (mm) I.D. x Length	Standard Column
F6513013	<b>RSpak DE-2013</b>	$\geq 10,000$	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
F6513015	<b>RSpak DE-5013</b>	–	12	<b>50.0 x 300</b>	DE-413, DE-613
F6700191	<b>RSpak DE-G 20C (RSpak DE-LLG)</b>	(guard column)	12	<b>20.0 x 100</b>	(guard column)
F6514014	<b>RSpak DM-2014</b>	$\geq 5,000$	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)
F6514022	<b>RSpak DM-5014</b>	–	12	<b>50.0 x 300</b>	DM-614
F6700162	<b>RSpak DM-G 20C (RSpak DM-LLG)</b>	(guard column)	12	<b>20.0 x 100</b>	(guard column)

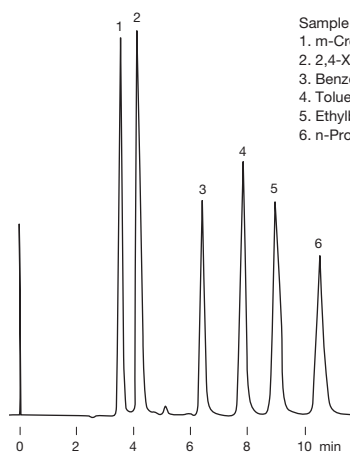
### Separation and recovery rate of standard proteins



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

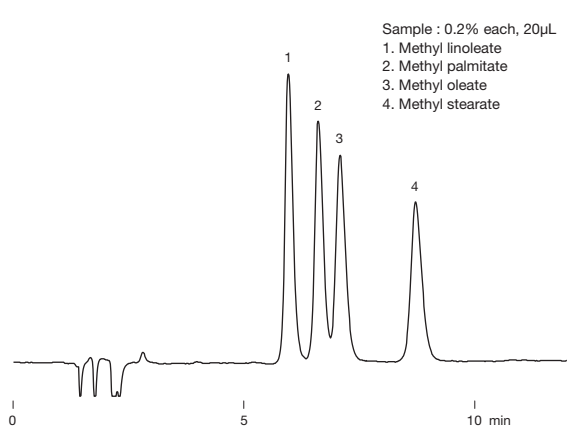


Sample : 5µL

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

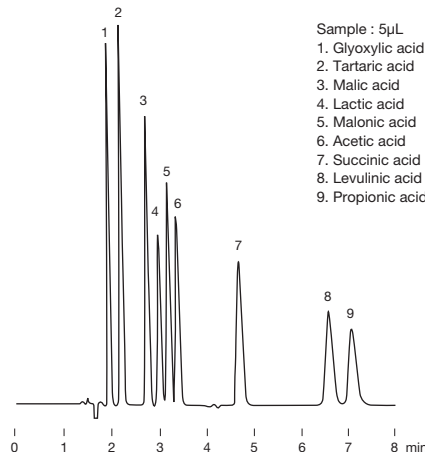


Sample : 0.2% each, 20µL

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

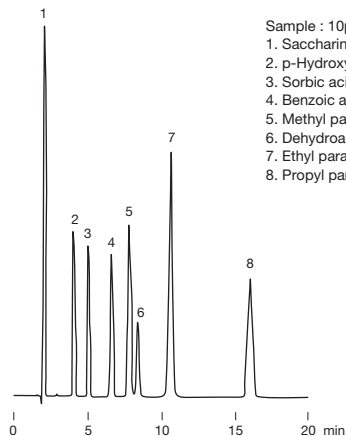


Sample : 5µL

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)

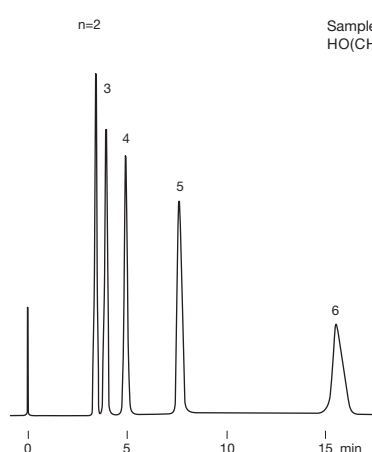


Sample : 10µL

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

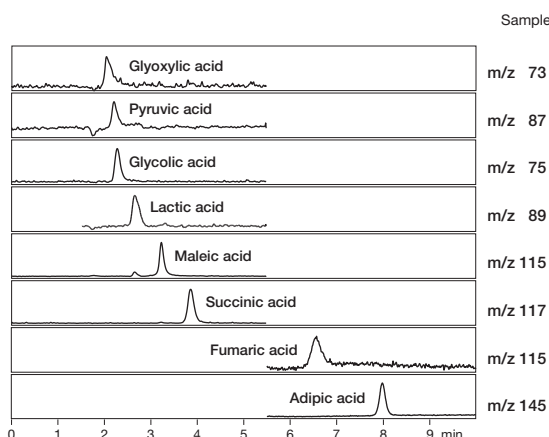


Sample : 1% each, 7.5µL  
HO(CH<sub>2</sub>)<sub>n</sub>OH

**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

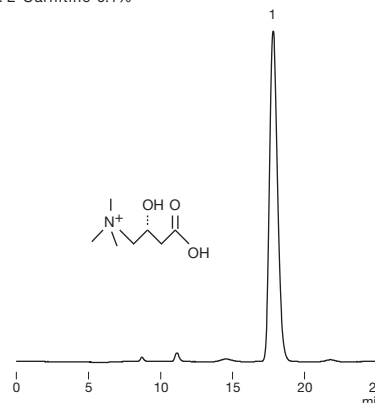


Sample : 50ng/mL each, 10µL

**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 Negative)  
**Column temp.** : 30°C

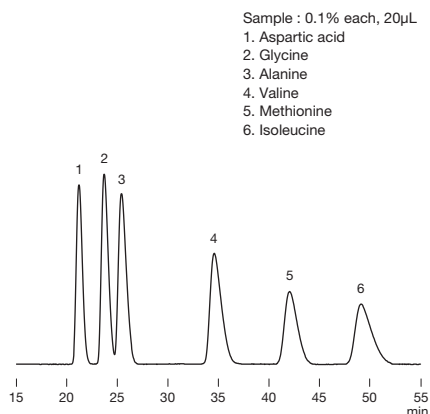
### Carnitine

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

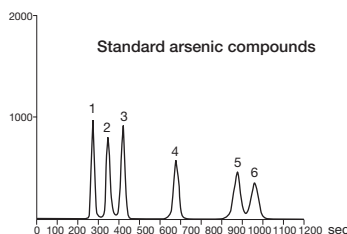
### Amino acids



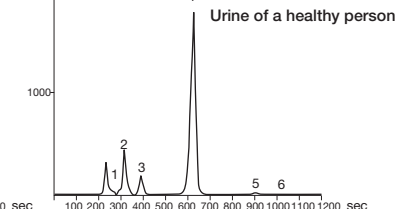
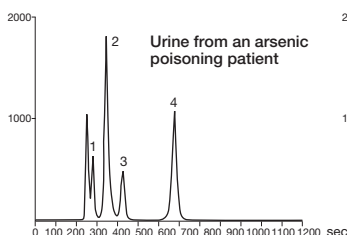
Sample : 0.1% each, 20µL  
 1. Aspartic acid  
 2. Glycine  
 3. Alanine  
 4. Valine  
 5. Methionine  
 6. Isoleucine

**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



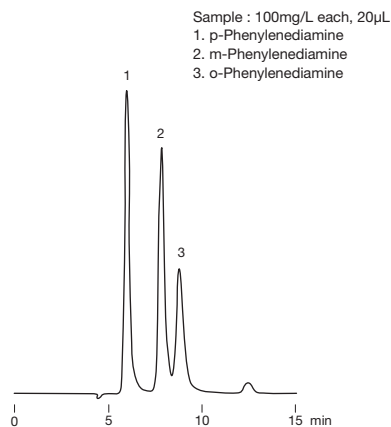
Sample : Arsenic compounds, 50µL  
 1. Monomethylarsinic acid  
 2. Arsinic acid  
 3. Dimethylarsinic acid  
 4. Arsenobetaine  
 5. Tetramethylarsonium  
 6. Trimethylarsine oxide



**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

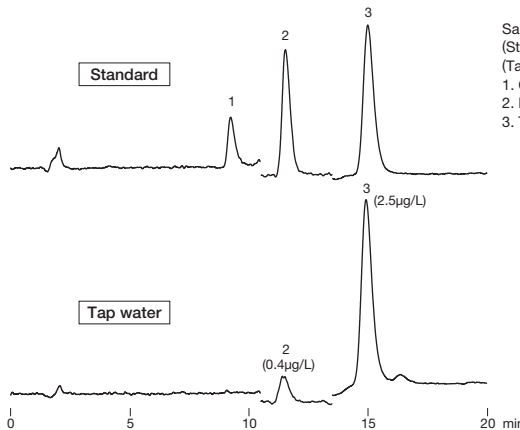
### Phenylenediamine isomers



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

### LC/MS analysis of haloacetic acids



Sample : 50µL each  
 (Standard) 2ng/mL each  
 (Tap water)  
 1. Chloroacetic acid  
 2. Dichloroacetic acid  
 3. Trichloroacetic acid

**Column** : Shodex RSPak JJ-50 2D  
**Eluent** : 25mM Ammonium acetate aq. (pH9.2)/CH<sub>3</sub>CN=50/50  
**Flow rate** : 0.2mL/min  
**Detector** : Chloroacetic acid : ESI-MS (SIM Negative : m/z 93)  
 Dichloroacetic acid : ESI-MS/MS (MRM Negative : m/z 127→83)  
 Trichloroacetic acid : ESI-MS (SIM Negative : m/z 161)  
**Column temp.** : 40°C

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

Please refer to “Comparison of the Features Among Shodex Reverse Phase Chromatography (RPC) Columns” 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
F6650040	<b>Silica C18M 4D</b>	≥ 10,000	Octadecyl	5	16	100	<b>4.6 × 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 × 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 × 150</b>	H <sub>2</sub> O/CH <sub>3</sub> OH=40/60
F6650045	<b>Silica C18P 4D</b>	≥ 10,000	Octadecyl	5	17	100	<b>4.6 × 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 × 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 × 150</b>	H <sub>2</sub> O/CH <sub>3</sub> OH=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 × 250</b>	C18M
F7560041	<b>Silica C18M 20E</b>	≥ 16,000	5	<b>20.0 × 250</b>	C18M

# Columns for Silica-based Reversed Phase Chromatography (Other Columns)

Please refer to “Comparison of the Features Among Shodex Reverse Phase Chromatography (RPC) Columns” 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 × 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 × 250</b>	H <sub>2</sub> O/CH <sub>3</sub> OH=34/66
F6650054	<b>Silica 5C4 4D</b>	≥ 9,000	Butyl	5	7	100	<b>4.6 × 150</b>	H <sub>2</sub> O/CH <sub>3</sub> OH=45/55
F6650055	<b>Silica 5C4 4E</b>	≥ 15,000	Butyl	5	7	100	<b>4.6 × 250</b>	H <sub>2</sub> O/CH <sub>3</sub> OH=45/55
F6650058	<b>Silica 5CN 4D</b>	≥ 7,000	Cyanopropyl	5	–	100	<b>4.6 × 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 × 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 × 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 × 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 × 250</b>	5C8
F7560063	<b>Silica 5C8 20E</b>	≥ 15,000	5	<b>20.0 × 250</b>	5C8
F7560054	<b>Silica 5C4 10E</b>	≥ 15,000	5	<b>10.0 × 250</b>	5C4
F7560055	<b>Silica 5C4 20E</b>	≥ 15,000	5	<b>20.0 × 250</b>	5C4

# Columns for Silica-based HILIC and Normal Phase Chromatography

## Features

- 5SIL**
- Uses high purity silica (99.99% or higher)
  - Suitable for normal phase analysis using a nonpolar organic solvent
  - Corresponds to USP L3

- 5NH**
- Suitable for saccharides analysis by hydrophilic interaction chromatography (HILIC)
  - Corresponds to USP L8

## 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 × 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 × 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 × 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 × 250</b>	H <sub>2</sub> O/CH <sub>3</sub> CN=5/95

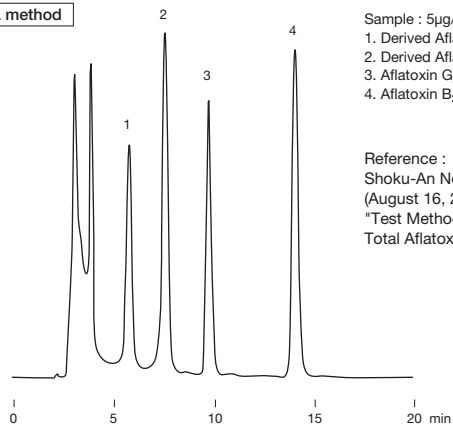
Base Material : Silica

## 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 × 250</b>	5SIL
F7560051	<b>Silica 5SIL 20E</b>	≥ 15,000	5	<b>20.0 × 250</b>	5SIL
F7560060	<b>Silica 5NH 10E</b>	≥ 8,000	5	<b>10.0 × 250</b>	5NH
F7560061	<b>Silica 5NH 20E</b>	≥ 8,000	5	<b>20.0 × 250</b>	5NH

## Aflatoxins

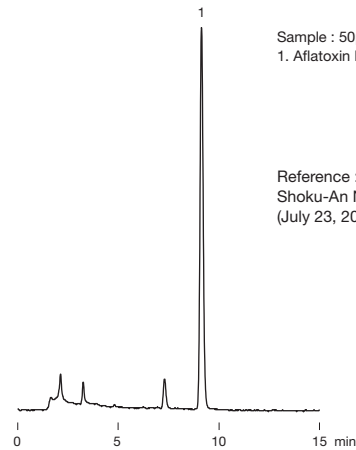
TFA method



Sample : 5µg/L each, 20µL  
 1. Derived Aflatoxin G<sub>1</sub>  
 2. Derived Aflatoxin B<sub>1</sub>  
 3. Aflatoxin G<sub>2</sub>  
 4. Aflatoxin B<sub>2</sub>

Reference :  
 Shoku-An No. 0816-1  
 (August 16, 2011, Japan)  
 "Test Methods Related to  
 Total Aflatoxin" in Notice

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

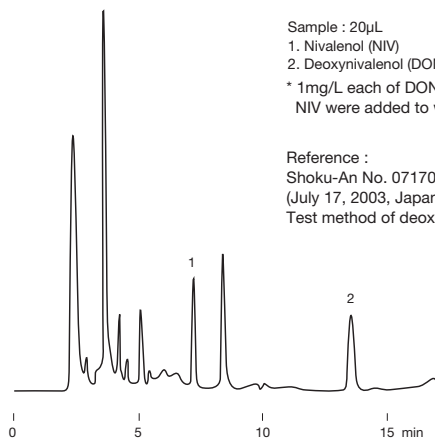


Sample : 50µL  
 1. Aflatoxin M<sub>1</sub> 1µg/L

Reference :  
 Shoku-An No. 0723-5  
 (July 23, 2015, Japan)

Column : Shodex Silica C18M 4E  
 Eluent : H<sub>2</sub>O/CH<sub>3</sub>CN=75/25  
 Flow rate : 1.0mL/min  
 Detector : Fluorescence (Ex. : 365nm, Em. : 435nm)  
 Column temp. : 40°C

## Trichothecene mycotoxins

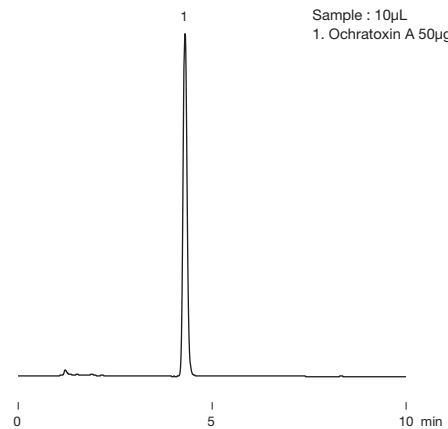


Sample : 20µL  
 1. Nivalenol (NIV)  
 2. Deoxynivalenol (DON)  
 \* 1mg/L each of DON and  
 NIV were added to wheat sample

Reference :  
 Shoku-An No. 0717001  
 (July 17, 2003, Japan)  
 Test method of deoxynivalenol

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

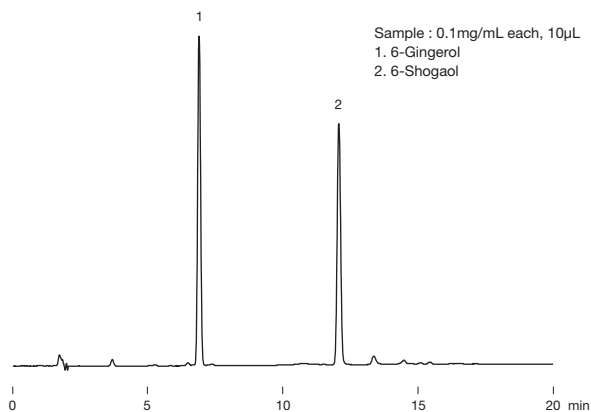
## Ochratoxin



Sample : 10µL  
 1. Ochratoxin A 50µg/L

Column : Shodex Silica C18M 4D  
 Eluent : H<sub>2</sub>O/CH<sub>3</sub>COOH/CH<sub>3</sub>CN=43/2/55  
 Flow rate : 1.0mL/min  
 Detector : Fluorescence (Ex. : 333nm, Em. : 460nm)  
 Column temp. : 40°C

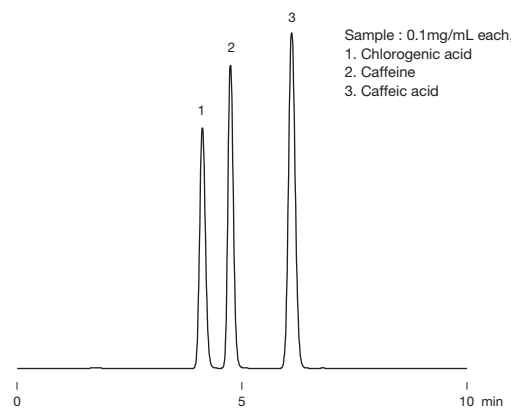
## Gingerol and shogaol



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

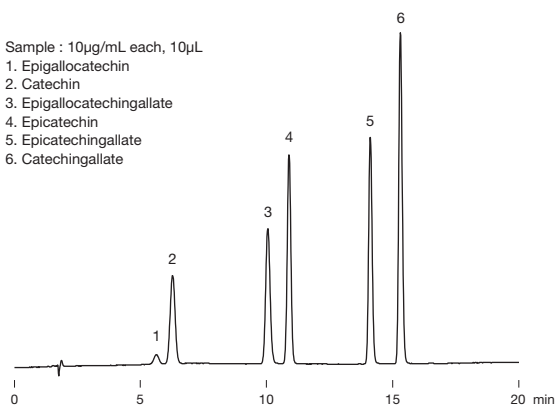


Sample : 0.1mg/mL each, 10µL  
 1. Chlorogenic acid  
 2. Caffeine  
 3. Caffeic acid

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

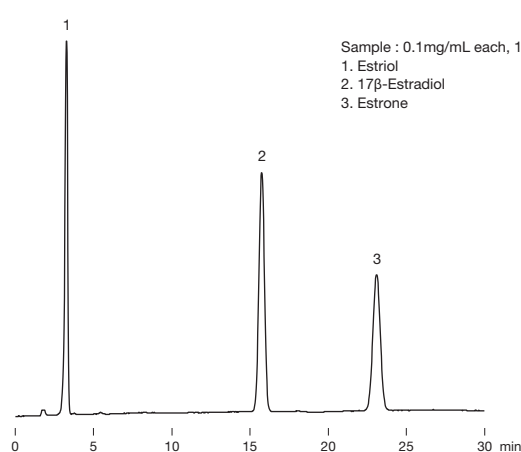
Sample : 10 $\mu$ g/mL each, 10 $\mu$ L  
 1. Epigallocatechin  
 2. Catechin  
 3. Epigallocatechingallate  
 4. Epicatechin  
 5. Epicatechingallate  
 6. Catechingallate



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

## Estradiols

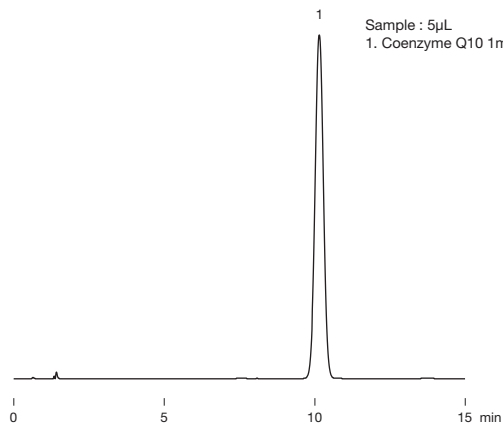
Sample : 0.1mg/mL each, 10 $\mu$ L  
 1. Estriol  
 2. 17 $\beta$ -Estradiol  
 3. Estrone



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

## Coenzyme Q10

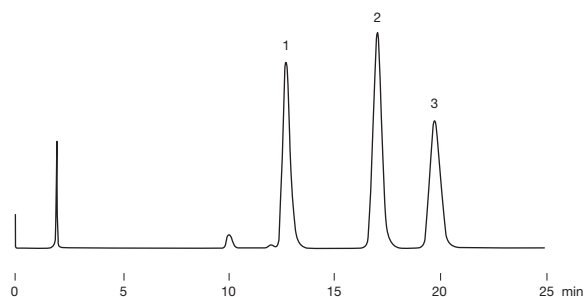
Sample : 5 $\mu$ L  
 1. Coenzyme Q10 1mg/mL



Column : Shodex Silica C18P 4D  
 Eluent : CH<sub>3</sub>OH/C<sub>2</sub>H<sub>5</sub>OH=13/7  
 Flow rate : 1.2mL/min  
 Detector : UV (275nm)  
 Column temp. : 35°C

## Benzylpyridine isomers

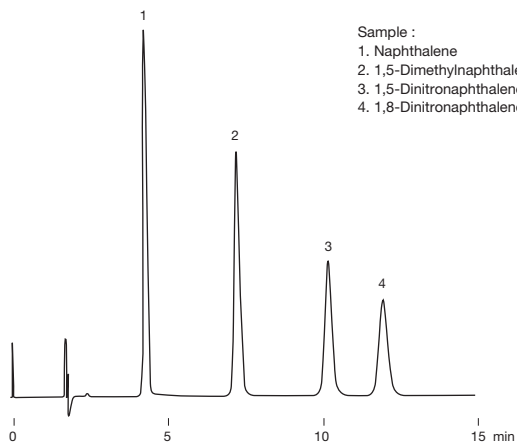
Sample :  
 1. 2-Benzylpyridine  
 2. 3-Benzylpyridine  
 3. 4-Benzylpyridine



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

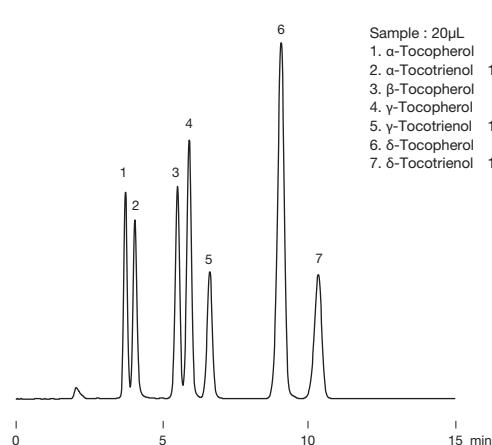
Sample :  
 1. Naphthalene  
 2. 1,5-Dimethylnaphthalene  
 3. 1,5-Dinitronaphthalene  
 4. 1,8-Dinitronaphthalene



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 : 20 $\mu$ L  
 1.  $\alpha$ -Tocopherol 5 $\mu$ g/mL  
 2.  $\alpha$ -Tocotrienol 10 $\mu$ g/mL  
 3.  $\beta$ -Tocopherol 5 $\mu$ g/mL  
 4.  $\gamma$ -Tocopherol 5 $\mu$ g/mL  
 5.  $\gamma$ -Tocotrienol 10 $\mu$ g/mL  
 6.  $\delta$ -Tocopherol 5 $\mu$ g/mL  
 7.  $\delta$ -Tocotrienol 10 $\mu$ g/mL



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

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

## Features

- New VG-50**
- Suitable for saccharides analysis by hydrophilic interaction chromatography (HILIC)
  - High recovery ratio of reducing saccharides
  - Polymer-based packing material provides excellent chemical stability and minimum deterioration over extended time period
  - Easily regenerated by washing in a alkaline solution
  - Also suitable for evaporative light scattering detector, corona charged aerosol detector, and LC/MS
- 
- New VT-50**
- Suitable for anionic substances analysis by hydrophilic interaction chromatography (HILIC)
  - Depends on the eluent selected, the column adds ion exchange mode
  - Polymer-based packing material provides excellent chemical stability and minimum deterioration over extended time period
  - Suitable for LC/MS

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

Base Material : Polyvinyl alcohol

(Housing Material : PEEK)

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

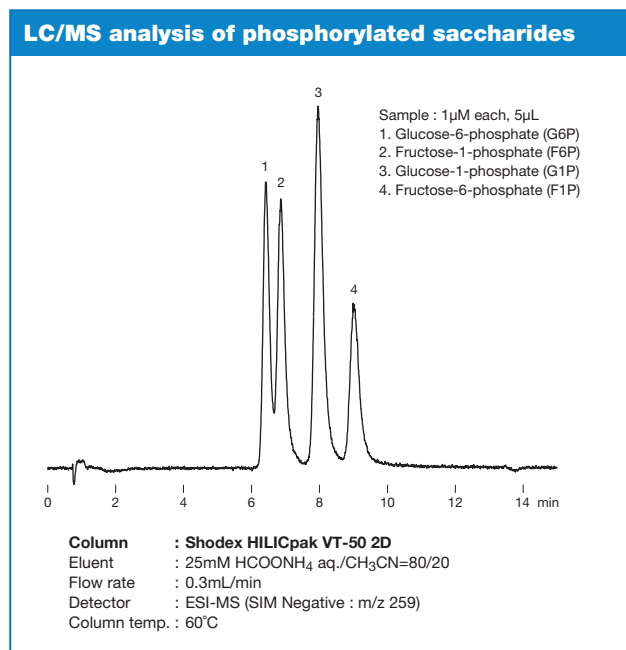
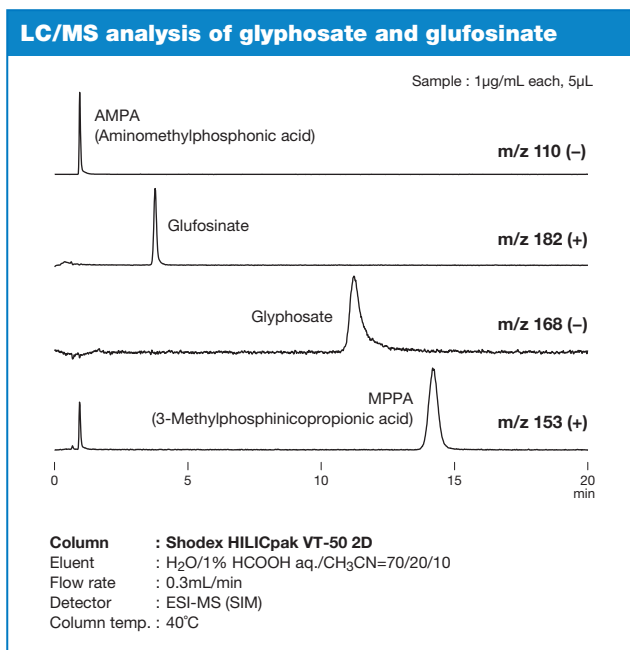
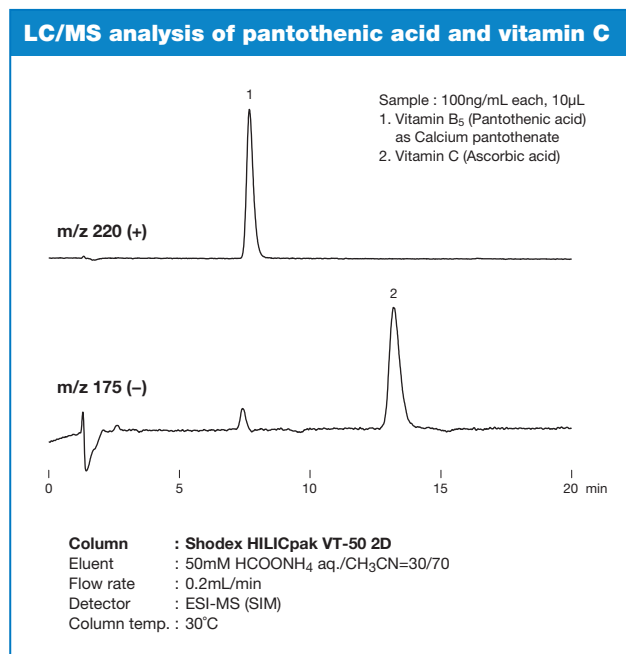
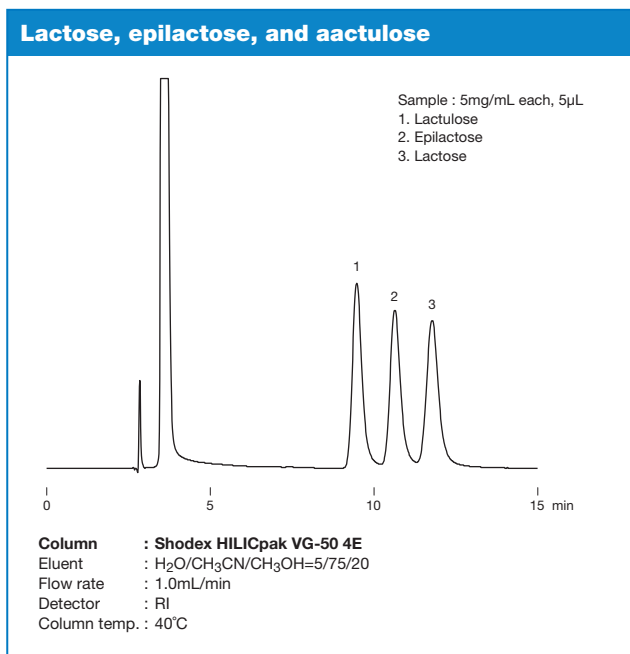
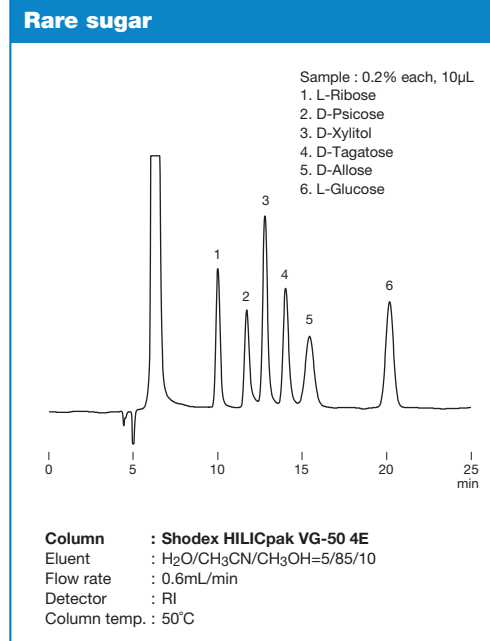
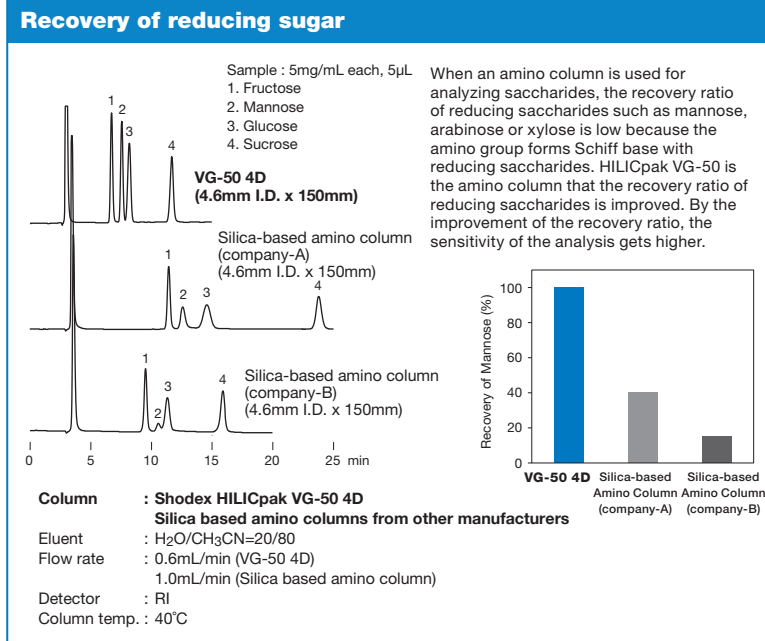
Base Material : Polyvinyl alcohol

### ● VT-50

(Housing Material : PEEK)

Product Code	Product Name	Plate Number (TP/column)	Functional Group	Particle Size (μm)	Pore Size (Å)	Column Size (mm) I.D. x Length	Shipping Solvent
F7630400	<b>New</b> HILICpak VT-50 2D	≥ 4,500	Quaternary ammonium	5	100	2.0 x 150	25mM HCOONH <sub>4</sub> aq. /CH <sub>3</sub> CN=15/85
F6711300	<b>New</b> HILICpak VT-50G 2A	(guard column)	Quaternary ammonium	5	100	2.0 x 10	25mM HCOONH <sub>4</sub> aq. /CH <sub>3</sub> CN=15/85

Base Material : Polyvinyl alcohol



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

## Features

- NH2P**
- Suitable for saccharides analysis by hydrophilic interaction chromatography (HILIC)
  - Polymer-based packing material provides excellent chemical stability and minimum deterioration over extended time period
  - Easily regenerated by washing in a alkaline solution
  - Also suitable for evaporative light scattering detector, corona charged aerosol detector, and LC/MS
  - Corresponds to USP L82
- 
- NH2P-40**
- Provides higher theoretical plate number compared to NH2P-50 series
  - Corresponds to USP L82

## 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

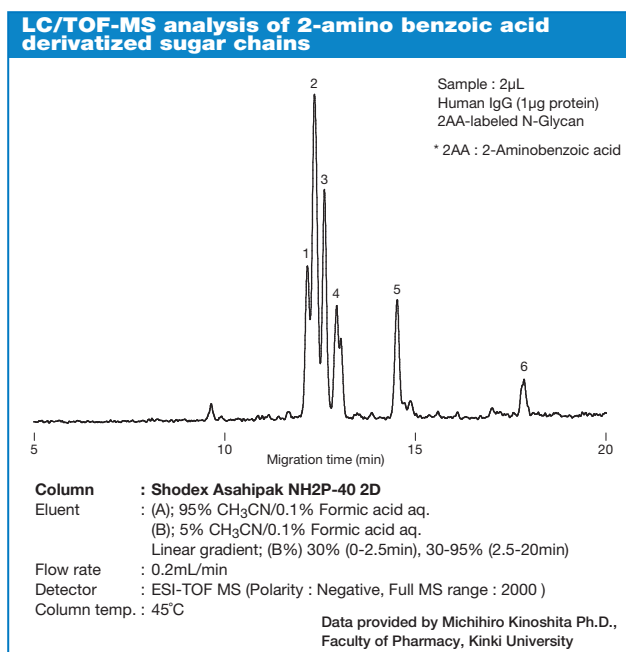
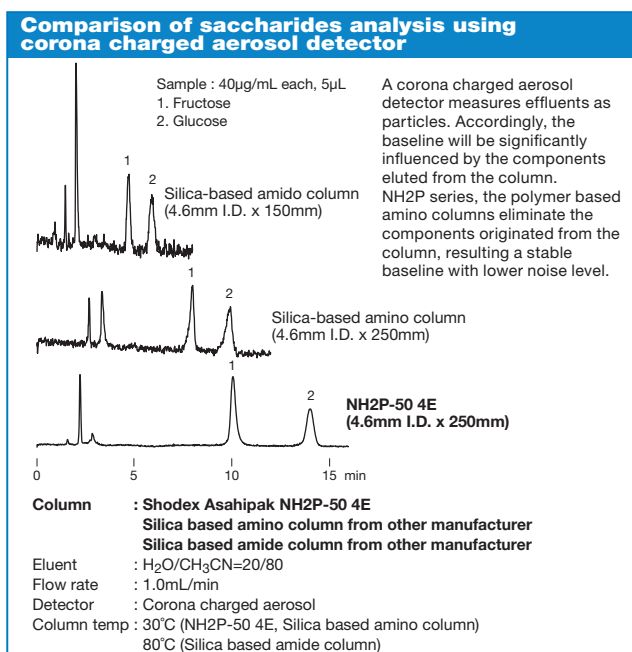
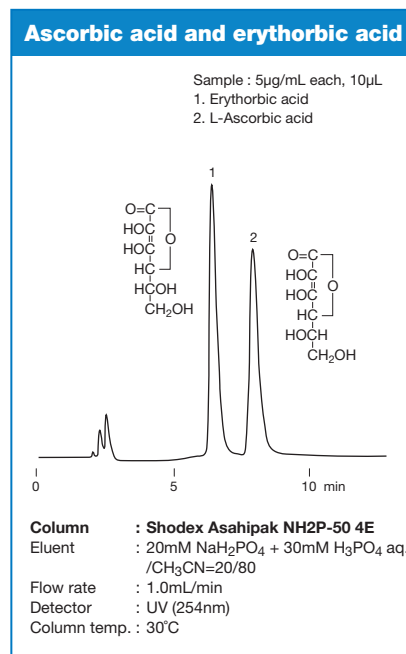
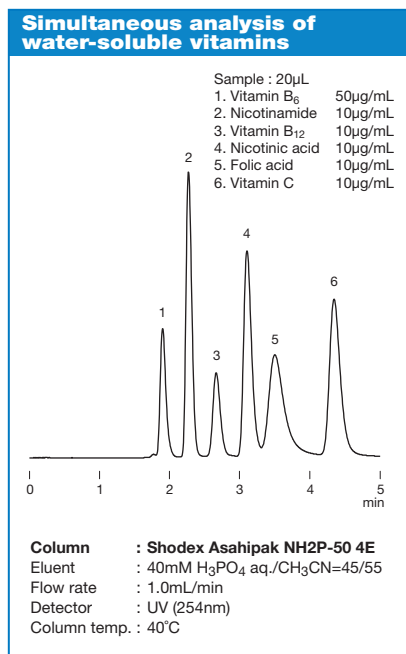
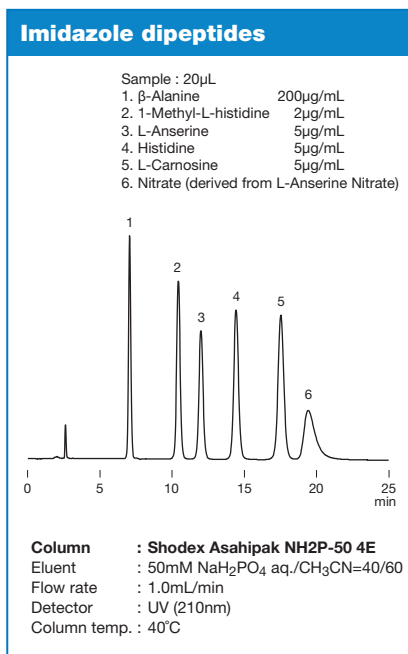
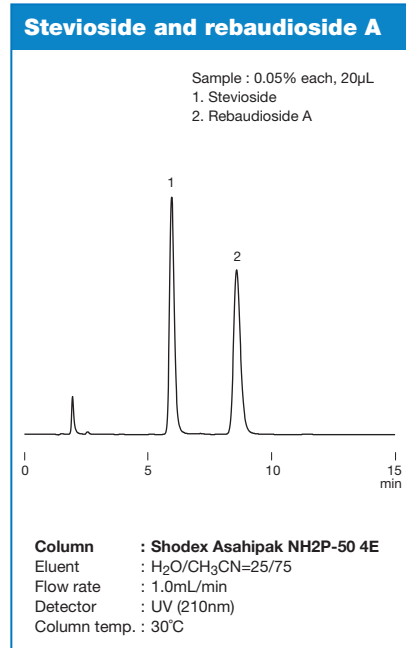
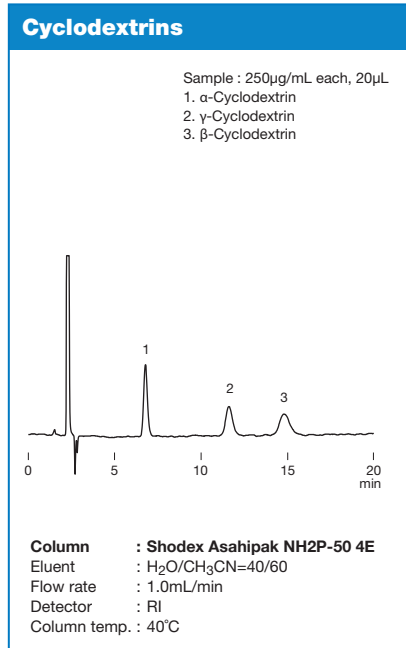
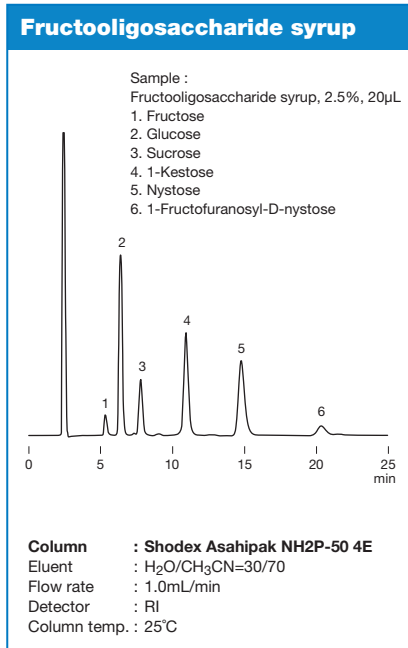
## 3mm I.D columns [Customized columns]

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>

## 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
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)





# Columns for Ligand Exchange Chromatography

\* A list of elution volume of saccharides for Shodex columns is available.  
Please refer to our website ([www.shodex.de](http://www.shodex.de)) or technical notebook (No.2 and 3).

## Features

- |  |   |
|--|---|
| <p><b>SC1011</b></p> <p><b>SC1821</b></p> <p><b>SP0810</b></p> <p><b>KS-801 to 802</b></p> | <ul style="list-style-type: none"> <li>• Separates saccharides by the combination of ligand exchange and size exclusion modes</li> <li>• Three types of counter ions are available: Ca<sup>2+</sup>, Pb<sup>2+</sup>, and Na<sup>+</sup></li> <li>• Only water is required for the analysis of neutral sugars</li> <li>• SC1011 and SC1821 correspond to USP L19 and L22</li> <li>• SP0810 corresponds to USP L22 and L34</li> <li>• KS-801 and KS-802 correspond to USP L22 and L58</li> </ul>       |
| <p><b>KS-803 to 807</b></p>  | <ul style="list-style-type: none"> <li>• Suitable for separation of polysaccharides by size exclusion mode</li> <li>• Can be used in combination with other columns e.g., KS-802 and KS-801</li> <li>• Only water is required for the analysis of neutral sugars</li> <li>• Corresponds to USP L22 and L58</li> </ul>   |
| <p><b>DC-613</b></p> <p><b>SZ5532</b></p> <p><b>SC1211</b></p>                             | <ul style="list-style-type: none"> <li>• Separates by the combination of ligand exchange and HILIC modes</li> <li>• DC-613 can analyze sugars without removing sodium salts in the sample</li> <li>• SZ5532 is recommended for the separation of disaccharides or trisaccharides</li> <li>• SC1211 is suitable for separation of sugar alcohols</li> <li>• DC-613 corresponds to USP L22 and L58</li> <li>• SZ5532 corresponds to USP L22</li> <li>• SC1211 corresponds to USP L19 and L22</li> </ul> |
| <p><b>SC1011-7F</b></p>  | <ul style="list-style-type: none"> <li>• For the analysis of mannitol under the method of JP, USP and EP</li> <li>• Ca-type ligand exchange chromatography column</li> <li>• Only water is required for the analysis of neutral sugars</li> <li>• Corresponds to USP L19 and L22</li> </ul>   |

## 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
F6378070	<b>SUGAR KS-807</b>	≥ 4,000	Sulfo (Na <sup>+</sup> )	*(200,000,000)	30	<b>8.0 x 300</b>	H <sub>2</sub> O
F6700021	<b>SUGAR KS-807G</b>	(guard column)	Sulfo (Na <sup>+</sup> )	–	30	<b>8.0 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 the analysis of mannitol in conformity with JP and USP

Product Code	Product Name	Functional Group (Counter Ion)	Particle Size (µm)	Column Size (mm) I.D. x Length	Shipping Solvent
F6379300	EP SC1011-7F	Sulfo (Ca <sup>2+</sup> )	8	7.8 x 300	H <sub>2</sub> O
F6379230	USPpak MN-431	Sulfo (Ca <sup>2+</sup> )	8	4.0 x 250	H <sub>2</sub> O

See p.75 for USP (Ver.38) Column List.

Base Material : Styrene divinylbenzene copolymer

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

## ● Ligand exchange and size exclusion

Product Code	Product Name	Plate Number (TP/column)	Particle Size (µm)	Column Size (mm) I.D. x Length	Standard Column
F6502007	SUGAR KS-2001	≥ 7,000	13	20.0 x 300	KS-801
F6502008	SUGAR KS-2002	≥ 7,000	13	20.0 x 300	KS-802
F6502009	SUGAR KS-2003	≥ 8,000	13	20.0 x 300	KS-803
F6502010	SUGAR KS-2004	≥ 6,000	18	20.0 x 300	KS-804
F6502011	SUGAR KS-2005	≥ 6,000	18	20.0 x 300	KS-805
F6502012	SUGAR KS-2006	≥ 6,000	18	20.0 x 300	KS-806
F6700002	SUGAR KS-G 8B (SUGAR KS-LG)	(guard column)	13	8.0 x 50	(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	RSpak DC-2013	≥ 6,000	10	20.0 x 300	DC-613
F6700402	RSpak DC-G 8B (RSpak DC-LG)	(guard column)	10	8.0 x 50	(guard column)
F6514021	RSpak DC-5013	-	10	50.0 x 300	DC-613
F6700172	RSpak DC-G 20C (RSpak DC-LLG)	(guard column)	10	20.0 x 100	(guard column)

## Elution volume of saccharides analysis with various 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

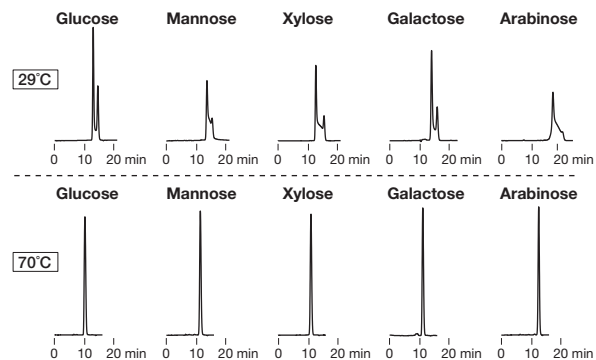
Column : SUGAR SC1211  
 Eluent : H<sub>2</sub>O/CH<sub>3</sub>CN=65/35  
 Flow rate : 1.0mL/min  
 Detector : RI  
 Column temp. : 70°C

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

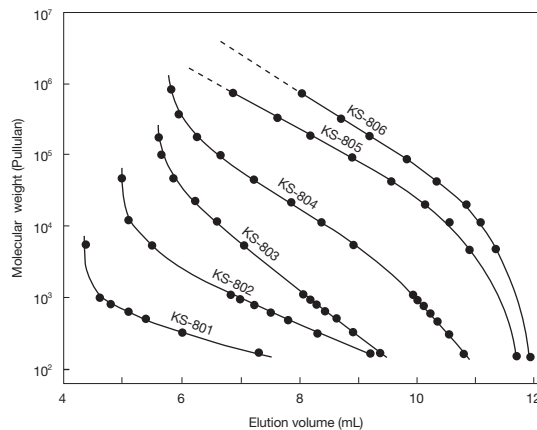
### Anomer separation of saccharides

Temperature can affect chromatograms when separating saccharide anomers. When using a SUGAR column to analyze saccharides, the analysis at high temperatures would suppress the influence of anomer separation, resulting in better chromatograms.



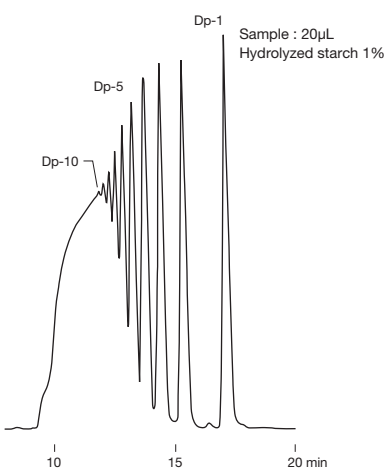
Column : Shodex SUGAR SC1011  
 Eluent : H<sub>2</sub>O  
 Flow rate : 0.7mL/min  
 Detector : RI  
 Column temp. : 29°C, 70°C

### Calibration curves for KS-800 series using pullulan



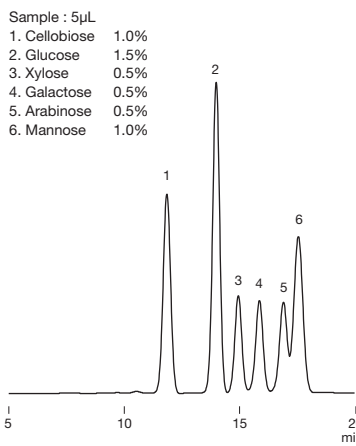
Column : Shodex SUGAR KS-800 series  
 Eluent : H<sub>2</sub>O  
 Detector : RI  
 Column temp. : 80°C

### Hydrolyzed starch



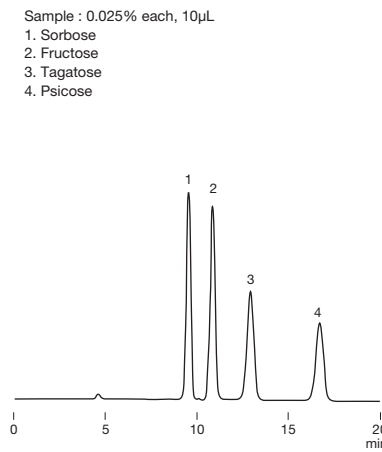
Sample : 20µL  
 Hydrolyzed starch 1%  
 Column : Shodex SUGAR KS-802 x 2  
 Eluent : H<sub>2</sub>O  
 Flow rate : 1.0mL/min  
 Detector : RI  
 Column temp. : 80°C

### Saccharides in wood (model)



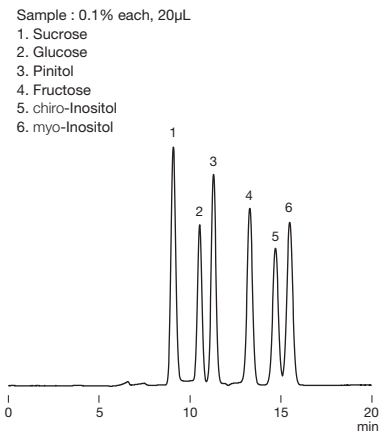
Sample : 5µL  
 1. Cellobiose 1.0%  
 2. Glucose 1.5%  
 3. Xylose 0.5%  
 4. Galactose 0.5%  
 5. Arabinose 0.5%  
 6. Mannose 1.0%  
 Column : Shodex SUGAR SP0810  
 Eluent : H<sub>2</sub>O  
 Flow rate : 0.6mL/min  
 Detector : RI  
 Column temp. : 85°C

### Ketohexoses



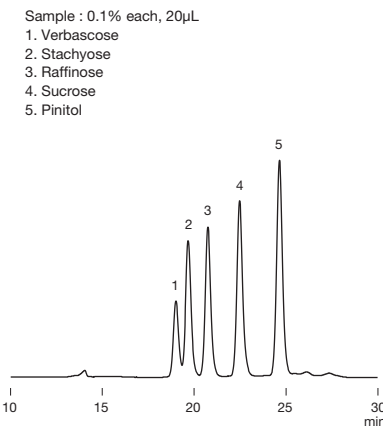
Sample : 0.025% each, 10µL  
 1. Sorbose  
 2. Fructose  
 3. Tagatose  
 4. Psicose  
 Column : Shodex SUGAR SP0810  
 Eluent : H<sub>2</sub>O  
 Flow rate : 1.0mL/min  
 Detector : RI  
 Column temp. : 80°C

### Pinitol



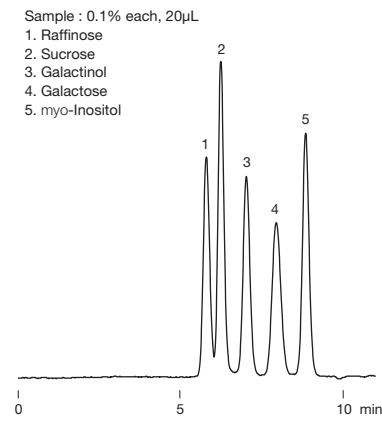
Sample : 0.1% each, 20µL  
 1. Sucrose  
 2. Glucose  
 3. Pinitol  
 4. Fructose  
 5. chiro-Inositol  
 6. myo-Inositol  
 Column : Shodex SUGAR SP0810  
 Eluent : H<sub>2</sub>O  
 Flow rate : 0.8mL/min  
 Detector : RI  
 Column temp. : 85°C

### Oligosaccharides in soybean

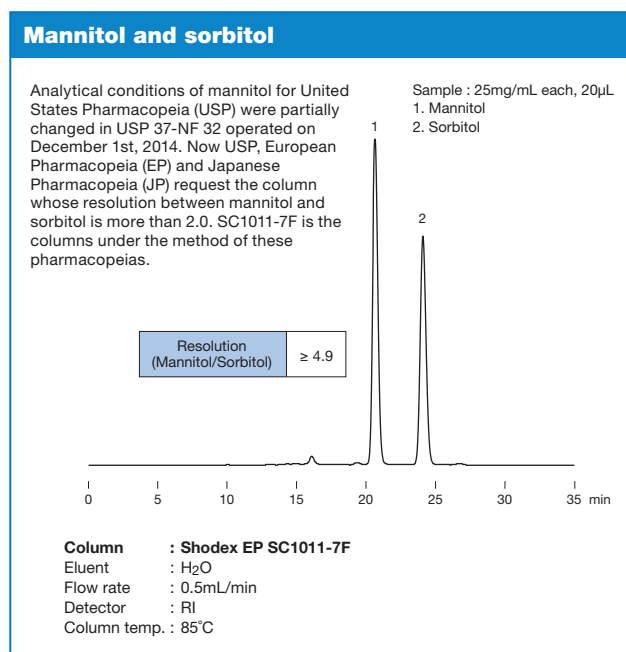
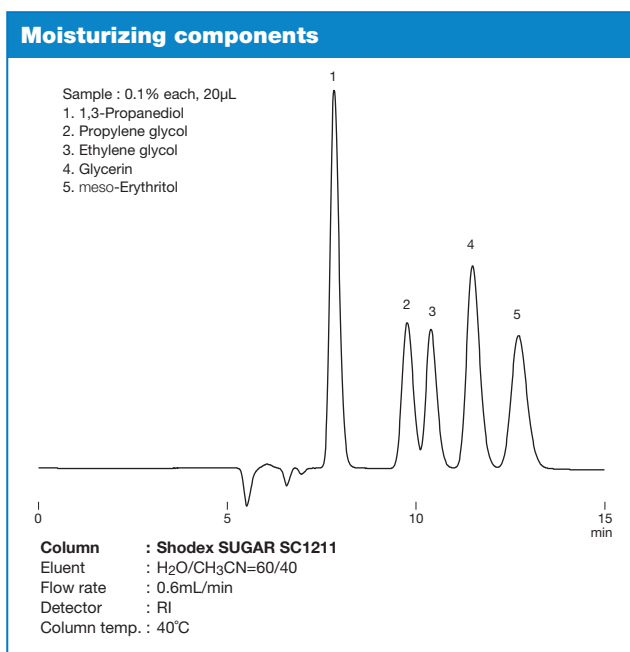
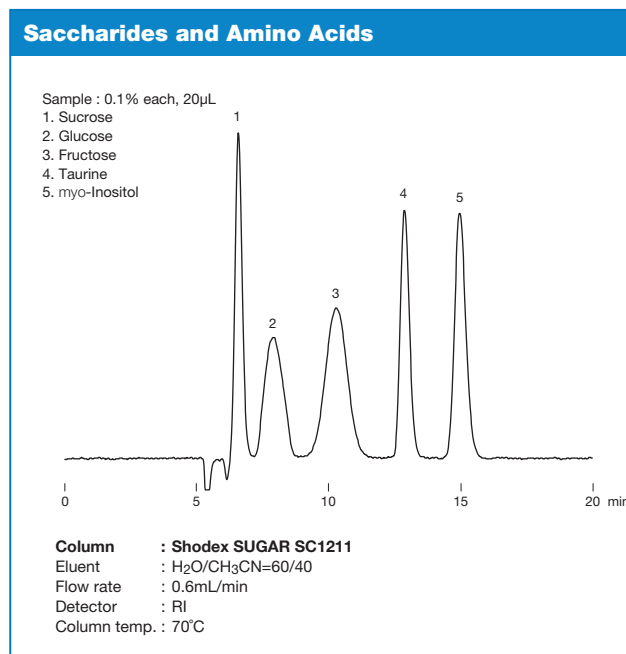
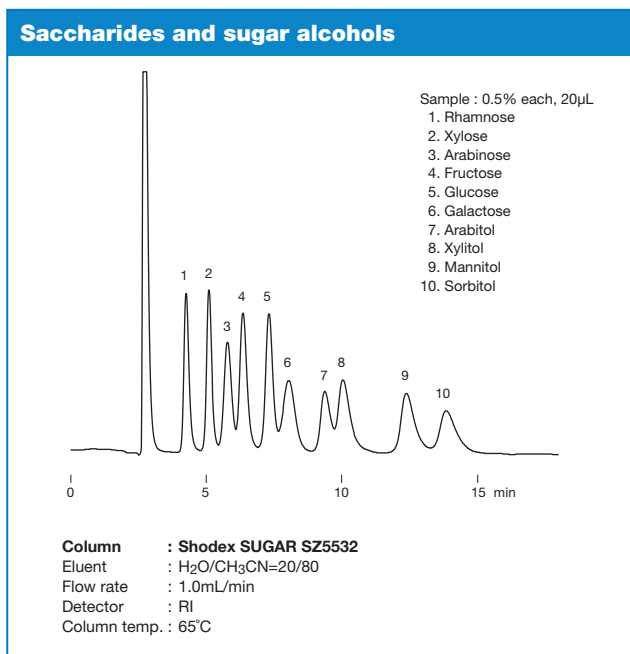
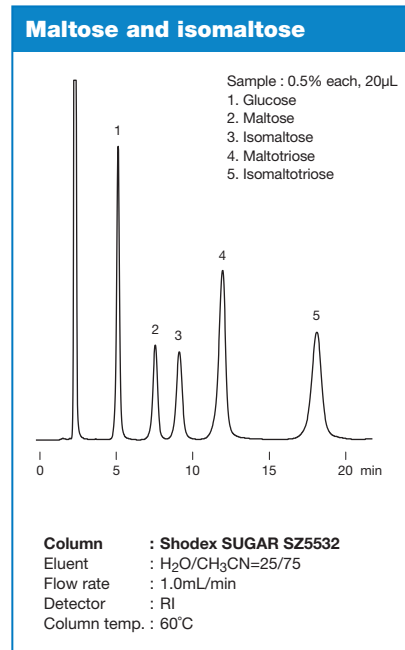
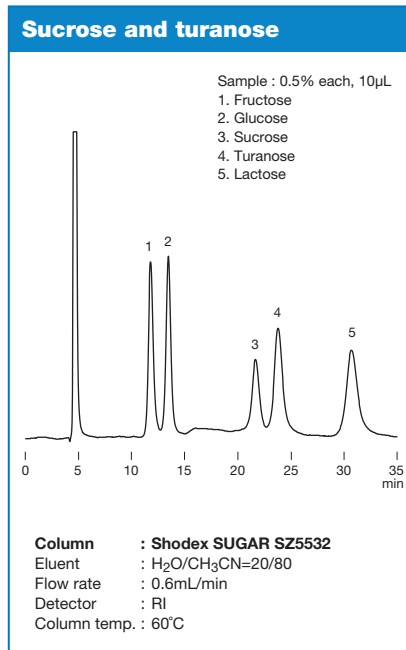
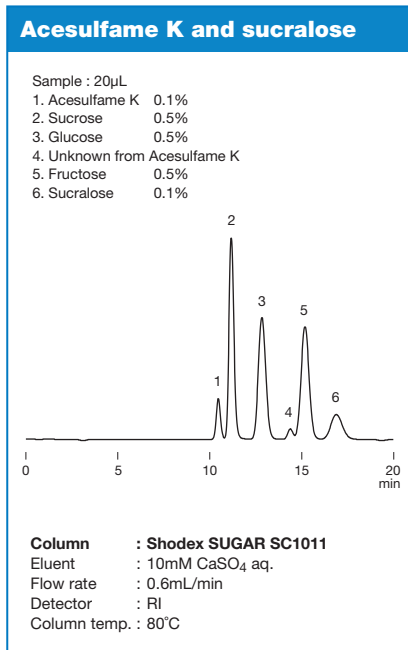


Sample : 0.1% each, 20µL  
 1. Verbascose  
 2. Stachyose  
 3. Raffinose  
 4. Sucrose  
 5. Pinitol  
 Column : Shodex SUGAR KS-802 + KS-801  
 Eluent : H<sub>2</sub>O  
 Flow rate : 0.6mL/min  
 Detector : RI  
 Column temp. : 85°C

### Saccharides related to raffinose biosynthesis



Sample : 0.1% each, 20µL  
 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



# Columns for Ion Exclusion Chromatography

## 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  
 • Corresponds to USP L17 and L22
- 
- KC-811** • Columns for the analysis of organic acids  
 • Ion exclusion mode (+ reversed phase mode)  
 • Highly selective detection 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  
 • Corresponds to USP L17 and L22

## 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 x 300</b>	H <sub>2</sub> O
F6378101	<b>SUGAR SH1821</b>	≥ 17,000	Sulfo	10,000	6	<b>8.0 x 300</b>	H <sub>2</sub> O
F6700080	<b>SUGAR SH-G</b>	(guard column)	Sulfo	–	10	<b>6.0 x 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 x 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 x 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 x 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 x 50</b>	0.1% H <sub>3</sub> PO <sub>4</sub> aq.

\* As a guard column, use KC-G 8B for samples with relatively high impurity and KC-G 6B for samples with relatively low impurity.

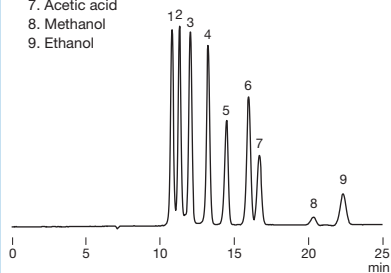
Base Material : Styrene divinylbenzene copolymer

## 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 x 300</b>	KC-811
F6700010	<b>RSpak KC-G 8B (RSpak KC-LG)</b>	(guard column)	13	<b>8.0 x 50</b>	(guard column)

**Maltoligosaccharides, organic acids and ethanol**Sample : 0.05% each, 20 $\mu$ L

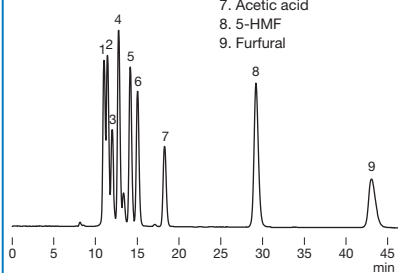
1. Maltotetraose
2. Maltotriose
3. Maltose
4. Glucose
5. Lactic acid
6. Glycerol
7. Acetic acid
8. Methanol
9. Ethanol



**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

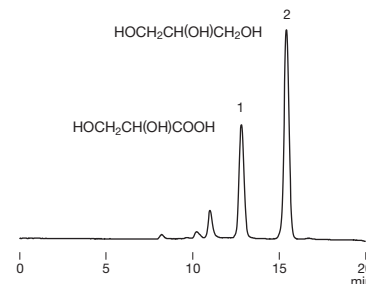
1. Cellopentaose
2. Cellotetraose
3. Cellotriose
4. Cellobiose
5. Glucose
6. Glyceric acid
7. Acetic acid
8. 5-HMF
9. Furfural



**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

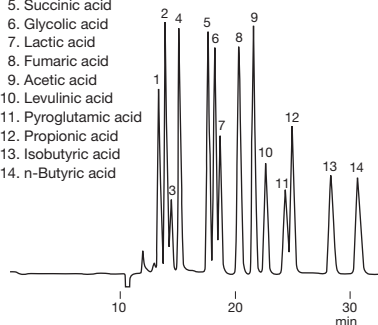


**Column** : Shodex SUGAR SH1011  
**Eluent** : 2mM H<sub>2</sub>SO<sub>4</sub> aq.  
**Flow rate** : 0.6mL/min  
**Detector** : RI  
**Column temp.** : 60°C

**General organic acids**

Sample :

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

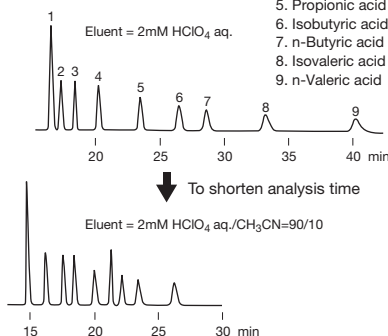


**Column** : Shodex RSPak KC-811 x 2  
**Eluent** : 6mM HClO<sub>4</sub> aq.  
**Flow rate** : 1.0mL/min  
**Detector** : VIS (430nm)  
 post column method  
**Column temp.** : 50°C

**Hydrophobic organic acids**

Sample :

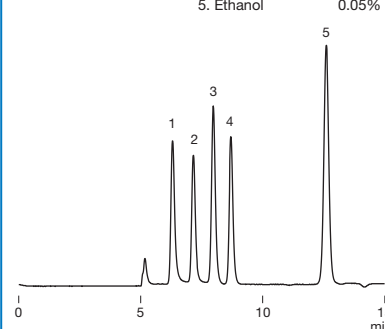
1. Succinic acid
2. Lactic acid
3. Formic acid
4. Acetic acid
5. Propionic acid
6. Isobutyric acid
7. n-Butyric acid
8. Isovaleric acid
9. n-Valeric acid



**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

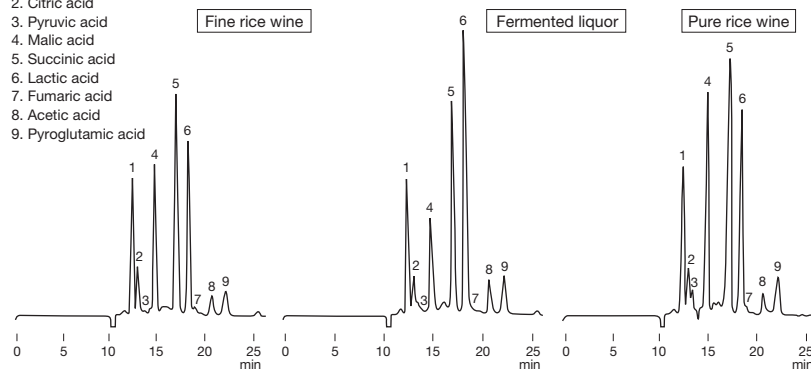
- |                    |       |
|--------------------|-------|
| 1. Citric acid     | 0.01% |
| 2. Malic acid      | 0.01% |
| 3. Glucronolactone | 0.01% |
| 4. Glycerin        | 0.01% |
| 5. Ethanol         | 0.05% |



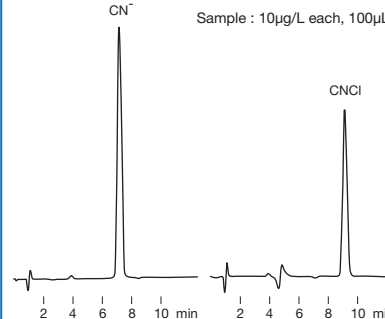
**Column** : Shodex RSPak KC-811  
**Eluent** : 3mM HClO<sub>4</sub> aq.  
**Flow rate** : 1.0mL/min  
**Detector** : RI  
**Column temp.** : 40°C

**Organic acids in sake**Sample : 100 $\mu$ L

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



**Column** : Shodex RSPak KC-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

# Columns for Ion Chromatography (Anion Analysis)

## Features

- NI-424** • Columns for anion analysis with non-suppressor method
- I-524A** • NI-424 supports simultaneous analysis of fluoride and phosphate ions

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- 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

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- SI-35 4D** • Columns for the analysis of oxyhalides with suppressor method
- SI-52 4E** • SI-35 supports rapid analysis of oxyhalides and general inorganic ions
- SI-52 supports simultaneous analysis of oxyhalides and general inorganic ions

## Standard columns

### ● For anions (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 anions (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
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.
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.

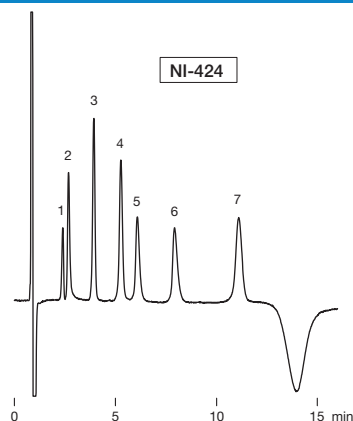
Base Material : Polyvinyl alcohol  
Housing Material : PEEK

## Line filters for IC

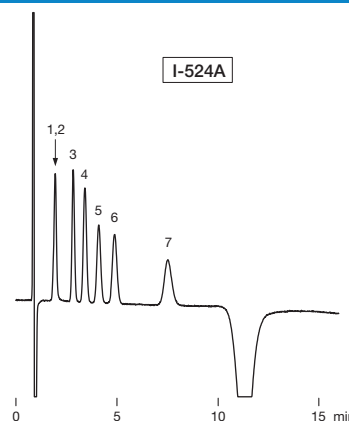
Product Code	Product Name	Contents
F8500630	<b>IC FL-1</b>	One holder and one filter
F8500640	<b>IC FL-1 filter</b>	5 filters



## Anions analysis with non-suppressor method (NI-424 and I-524A)



Sample : 20 $\mu$ L  
 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



NI-424 is a high performance type of column offers an increased theoretical plate number twice as much as 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) The shape of each peak is sharper, and the separation balance is proper. Especially, the separation of Cl<sup>-</sup> and NO<sub>2</sub><sup>-</sup> is improved.

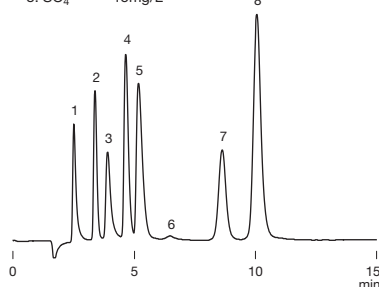
**Column** : Shodex IC NI-424  
**Eluent** : 8mM 4-Hydroxybenzoic acid + 2.8mM Bis-Tris + 2mM Phenylboronic acid + 0.005mM \*CyDTA aq.  
**Flow rate** : 1.0mL/min  
**Detector** : Non-suppressed conductivity  
**Column temp.** : 40°C

**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

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

## Anions analysis using SI-90 4E (suppressor method)

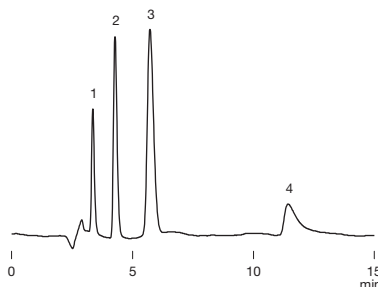
Sample : 20 $\mu$ L  
 1. F<sup>-</sup> 2mg/L  
 2. Cl<sup>-</sup> 3mg/L  
 3. NO<sub>2</sub><sup>-</sup> 5mg/L  
 4. Br<sup>-</sup> 10mg/L  
 5. NO<sub>3</sub><sup>-</sup> 10mg/L  
 6. HCO<sub>3</sub><sup>-</sup> 300mg/L  
 7. PO<sub>4</sub><sup>3-</sup> 15mg/L  
 8. SO<sub>4</sub><sup>2-</sup> 15mg/L



**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)

## Perchloric acid analysis using SI-90 4E (suppressor method)

Sample : 100 $\mu$ L  
 1. Cl<sup>-</sup> 3mg/L  
 2. NO<sub>3</sub><sup>-</sup> 10mg/L  
 3. SO<sub>4</sub><sup>2-</sup> 15mg/L  
 4. ClO<sub>4</sub><sup>-</sup> 10mg/L

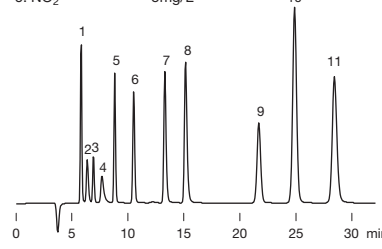


**Column** : Shodex IC SI-90 4E  
**Eluent** : 6mM Na<sub>2</sub>CO<sub>3</sub> aq. + 10% CH<sub>3</sub>CN  
**Flow rate** : 1.0mL/min  
**Detector** : Suppressed conductivity  
**Column temp.** : 25°C

## Anions 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 : 20 $\mu$ L  
 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

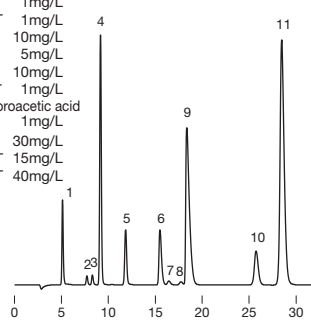


**Column** : Shodex IC SI-50 4E  
**Eluent** : 3.2mM Na<sub>2</sub>CO<sub>3</sub> + 1.0mM NaHCO<sub>3</sub> aq.  
**Flow rate** : 0.7mL/min  
**Detector** : Suppressed conductivity  
**Column temp.** : 25°C

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

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

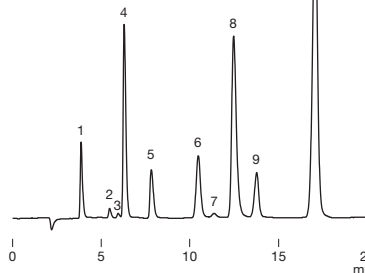
Sample : 50 $\mu$ L  
 1. F<sup>-</sup> 2mg/L  
 2. ClO<sub>2</sub><sup>-</sup> 1mg/L  
 3. BrO<sub>3</sub><sup>-</sup> 1mg/L  
 4. Cl<sup>-</sup> 10mg/L  
 5. NO<sub>2</sub><sup>-</sup> 5mg/L  
 6. Br<sup>-</sup> 10mg/L  
 7. ClO<sub>3</sub><sup>-</sup> 1mg/L  
 8. Dichloroacetic acid 1mg/L  
 9. NO<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

## Oxyhalides and anions analysis using SI-35 4D (suppressor method)

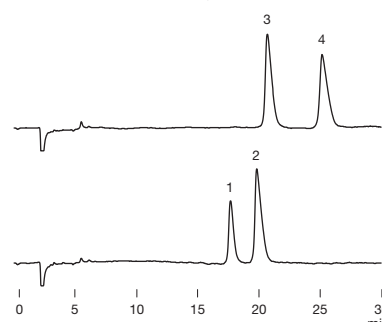
Sample : 20 $\mu$ L  
 1. F<sup>-</sup> 2mg/L  
 2. ClO<sub>2</sub><sup>-</sup> 1mg/L  
 3. BrO<sub>3</sub><sup>-</sup> 1mg/L  
 4. Cl<sup>-</sup> 10mg/L  
 5. NO<sub>2</sub><sup>-</sup> 5mg/L  
 6. Br<sup>-</sup> 10mg/L  
 7. ClO<sub>3</sub><sup>-</sup> 1mg/L  
 8. NO<sub>3</sub><sup>-</sup> 30mg/L  
 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 acid (suppressor method)

Sample : 20 $\mu$ L  
 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

# Columns for Ion Chromatography (Cation Analysis)

## Features

- YS-50**
- High performance type of YK-421
  - Applicable to both suppressor and non-suppressor methods
  - Peak shape is sharper, especially 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 for separation of alkylamines
- 
- Y-521**
- Column for cation analysis with non-suppressor method
  - For the separation of monovalent or divalent cations
  - Corresponds to USP L17 and L22
- 
- T-521**
- Column for transition metal ion analysis
  - Highly sensitive analysis is achieved by 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.

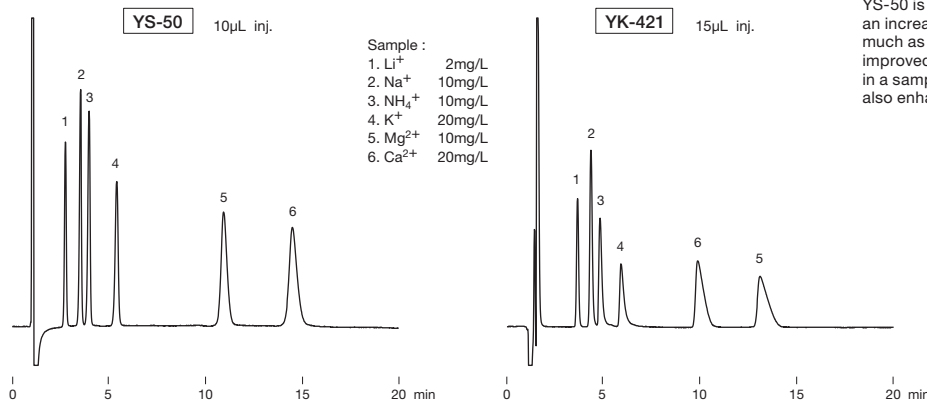
Base Material : Styrene divinylbenzene copolymer

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

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



YS-50 is a high performance type of column offers an increased theoretical plate number twice as much as YK-421. In particular, the peak shape is improved. The quantitative performance for  $\text{NH}_4^+$  in a sample containing high concentration  $\text{Na}^+$  is also enhanced.

Resolution ( $\text{Na}^+$ and $\text{NH}_4^+$ )	YS-50	YK-421
	2.5	2.1

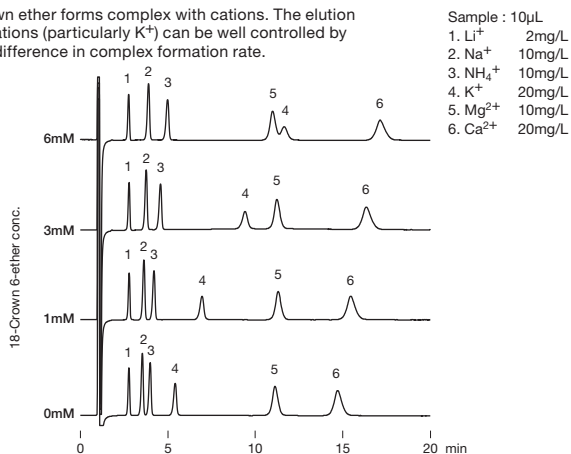
TP	YS-50	YK-421
$\text{Mg}^{2+}$	6,900	3,000
$\text{Ca}^{2+}$	6,600	3,000

**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

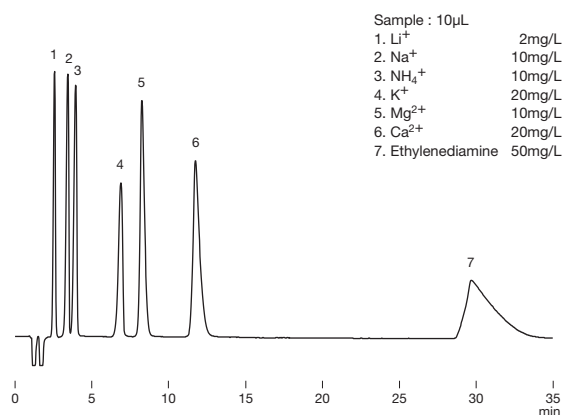
### Effects of crown ether in eluent

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



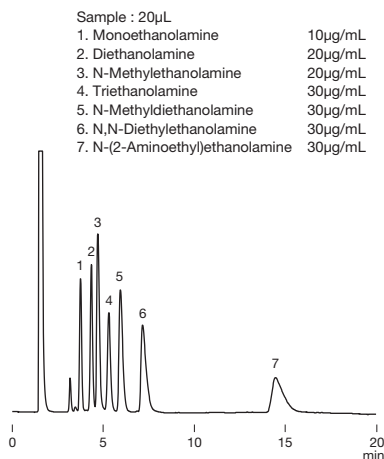
**Column** : Shodex IC YS-50  
**Eluent** : 4mM Methanesulfonic acid + 18-Crown 6-ether aq.  
**Flow rate** : 1.0mL/min  
**Detector** : Non-suppressed conductivity  
**Column temp.** : 40°C

### Simultaneous analysis for cations and ethylenediamine



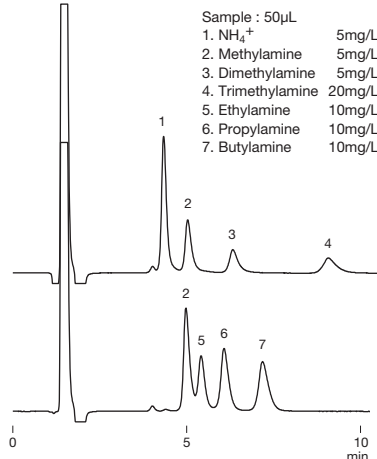
**Column** : Shodex IC YS-50  
**Eluent** : 4mM Nitric acid + 1.5mM 18-Crown 6-ether aq. /  $\text{CH}_3\text{CN}=90/10$   
**Flow rate** : 1.0mL/min  
**Detector** : Non-suppressed conductivity  
**Column temp.** : 40°C

### Amino alcohols



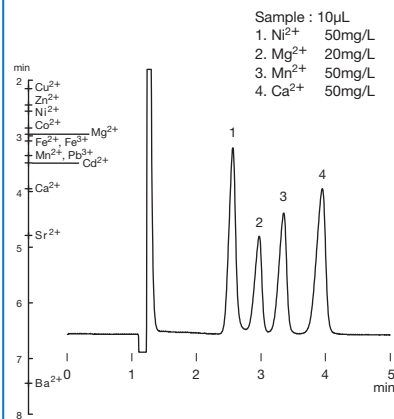
**Column** : Shodex IC YK-421  
**Eluent** : 4mM Nitric acid aq.  
**Flow rate** : 1.0mL/min  
**Detector** : Non-suppressed conductivity  
**Column temp.** : 40°C

### Alkylamines



**Column** : Shodex IC YK-421  
**Eluent** : 4mM  $\text{H}_3\text{PO}_4$  aq. /  $\text{CH}_3\text{CN}=90/10$   
**Flow rate** : 1.0mL/min  
**Detector** : Non-suppressed conductivity  
**Column temp.** : 25°C

### Alkaline earth metal ions

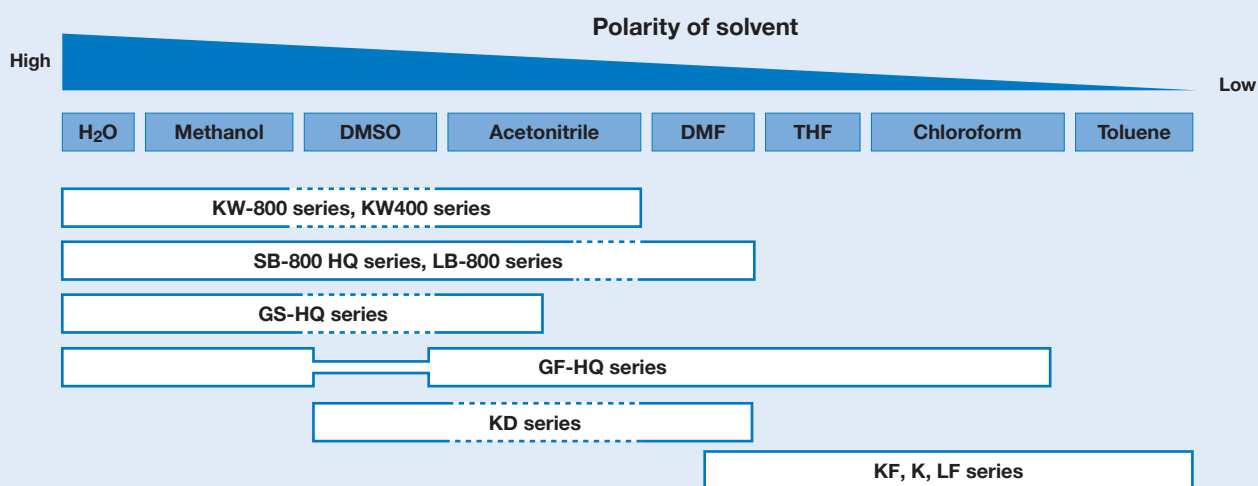


**Column** : Shodex IC Y-521  
**Eluent** : 4mM Tartaric acid + 2mM Ethylenediamine aq.  
**Flow rate** : 1.0mL/min  
**Detector** : Non-suppressed conductivity  
**Column temp.** : 40°C

# Column Selection for Size Exclusion Chromatography (SEC)

	Application	Solvent	Column	Page
Aqueous SEC (GFC)	Biological macromolecules (proteins, peptides, nucleic acids, etc.)	Buffer etc.	KW-800 series	36
			KW400 series <small>High performance (solvent-saving)</small>	36
	Biological macromolecules (high MW range)	Buffer etc.	SB-800 HQ series	38
			LB-800 series	38
	Water-soluble polymers (polyacrylamide, polyethylenimine, etc.) Polysaccharides	H <sub>2</sub> O, Buffer Aqueous solution etc.	SB-800 HQ series	38
			LB-800 series	38
	Oligosaccharide, polysaccharides	H <sub>2</sub> O, Aqueous solution etc.	KS-800 series	24
			GS-HQ series	42
Organic SEC (GPC)	General polymers	THF	KF-800 series	46
			KF-600 series <small>Rapid analysis (solvent-saving)</small>	52
			KF-400HQ series <small>High performance (solvent-saving)</small>	52
			LF series <small>High linearity of calibration curve</small>	56
	Polar polymers (polyimides, polyvinylpyrrolidones etc.)	DMF	K-800 series	48
			KD-800 series	50
			SB-800 HQ series	38
	Analysis at high temperature (polyethylene, polypropylene etc.)	ODCB etc.	LB-800 series	38
			HT-800 series	58
			UT-800 series	58
	Engineering resin analysis at room temperature [polyamide (Nylon), polyethylene terephthalate (PET) etc.]	HFIP	AT-806MS	58
			HFIP-800 series	60
			HFIP-600 series <small>Rapid analysis (solvent-saving)</small>	60
			LF series <small>High linearity of calibration curve</small>	56
Aqueous/Organic SEC			GF-HQ series	44

## Guideline for column solvent usability



\* See page 62 for the solvent replaceability of organic solvent SEC (GPC) packed columns.

# Precautions for Polar Polymer Analysis

Size exclusion chromatography analysis of polar polymers can be influenced by unexpected interactions in the column. These interactions may change elution patterns and results in an invalid molecular weight calculation. It is important to reduce them in order to obtain the accurate molecular weight distribution.

## Interfering interactions likely to be observed

### Interactions between the analyte and the packing materials

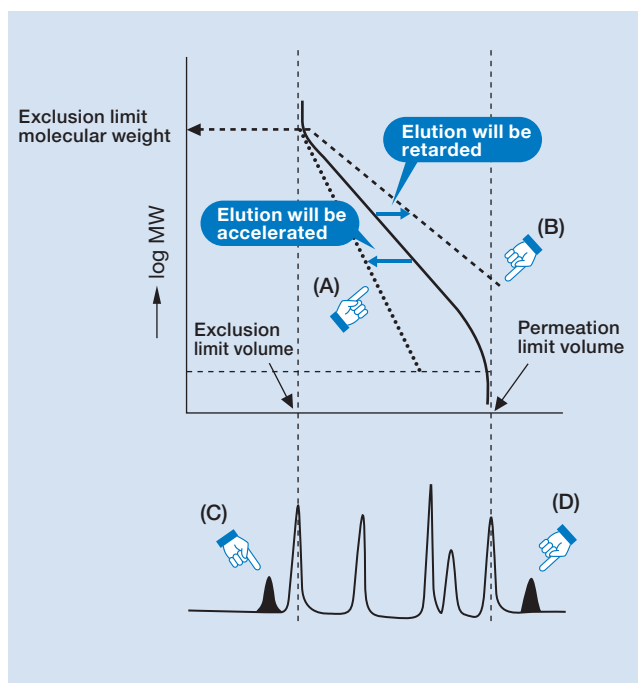
- **Hydrophobic interaction**
  - The analyte is adsorbed into the packing material. This delays the analyte elution, and thus results in under estimation of its molecular weight (Figure B, D).
- **Ionic interaction**
  - (1) Ion Exclusion
    - The analyte is repelled from the packing material. This accelerates the analyte elution, and thus results in over estimation of its molecular weight (Figure A, C).
  - (2) Ion Exchange
    - The analyte is adsorbed onto the packing material. This delays the analyte elution, and thus results in under estimation of its molecular weight (Figure B, D).

### Interaction within and between the analyte

- **Ionic repulsion effects observed within the multivalent macromolecules causes structure expansion**
  - This accelerates the analyte elution, and thus results in over estimation of its molecular weight (Figure A).
- **Association between the molecules**
  - Associated molecule detected as a larger molecule (Figure A).

### Interactions between the analyte and the solvent

- The multivalent ion of 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 dissociation of the analyte
  - 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 polarity of the eluent
  - (Example) Change the eluent from DMF to THF

#### Hydrophillic interaction

- Increase the polarity of the eluent
  - (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
  - Corresponds to USP L20, L33, and L59

- KW400**
- Reducing particle size of the packing material enhances column performance
  - Three- or four-fold higher sensitivity than KW-800 series
  - KW405-4F is applicable to samples with a molecular weight above 1,000,000
  - Corresponds to USP L20, L33, and L59

## Standard columns

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

Base Material : Silica Usable pH range : pH3.0-7.5

## High performance semi-micro columns

◎ Use of the KW400 series with semi-micro type devices is recommended.

Product Code	Product Name	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 × 300</b>	H <sub>2</sub> O
F6989202	<b>KW403-4F</b>	≥ 35,000	3	800	<b>4.6 × 300</b>	H <sub>2</sub> O
F6989203	<b>KW404-4F</b>	≥ 25,000	5	1,500	<b>4.6 × 300</b>	H <sub>2</sub> O
F6989204	<b>KW405-4F</b>	≥ 25,000	5	2,000	<b>4.6 × 300</b>	H <sub>2</sub> O
F6700132	<b>KW400G-4A</b>	(guard column)	5	–	<b>4.6 × 10</b>	H <sub>2</sub> O

Base Material : Silica Usable pH range : pH3.0-7.5

## Semi-micro columns

\* The following semi-micro columns are made to order. ◎ Use of the KW400 series with semi-micro type devices is recommended.

Product Code	Product Name	Particle Size (µm)	Pore Size (Å)	Column Size (mm) I.D. x Length
F7781213	<b>KW402.5-4B</b>	3	400	<b>4.6 × 50</b>
F7781212	<b>KW402.5-4D</b>	3	400	<b>4.6 × 150</b>
F7781313	<b>KW403-4B</b>	3	800	<b>4.6 × 50</b>
F7781312	<b>KW403-4D</b>	3	800	<b>4.6 × 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 Columns
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)

## Target molecular weight range and Exclusion limit

### ● 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</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 as a rough indication for the column selection.

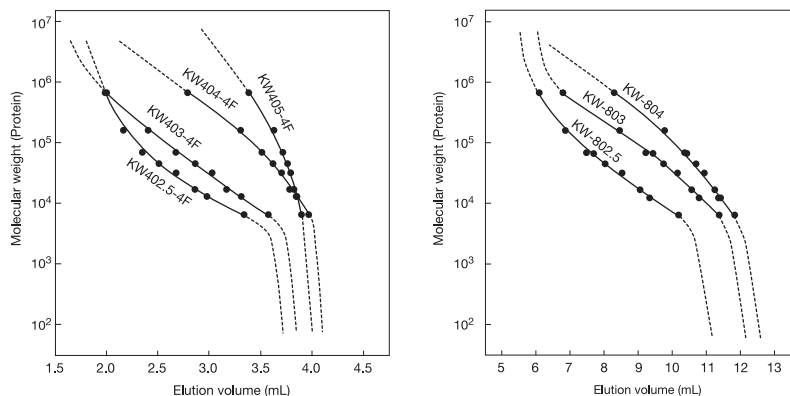
\*( ) Estimated value

### ● 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 as a rough indication for the column selection.

### Calibration curves for KW400 series and KW-800 series using protein



**Column** : Shodex KW400-4F series, Shodex PROTEIN KW-800 series  
**Eluent** : 50mM Sodium phosphate buffer + 0.3M NaCl (pH7.0)  
**Flow rate** : 0.33mL/min (KW400)  
 1.0mL/min (KW-800)  
**Detector** : UV (280nm) (small cell volume) (KW400)  
 UV (280nm) (conventional type) (KW-800)  
**Column temp.** : 30°C

### Recovery rate of proteins

Protein	Recovery (%)	
	KW402.5-4F	KW403-4F
γ - Globulin	98	96
Bovine serum albumin	89	96
Ovalbumin	89	97
Myoglobin	90	89
Cytochrome c	92	92
Lysozyme	87	98
α-Chymotrypsinogen A	95	94

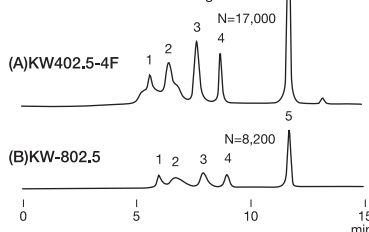
**Column** : Shodex KW402.5-4F  
 Shodex KW403-4F  
**Eluent** : 50mM Sodium phosphate buffer  
 + 0.3M NaCl (pH7.0)  
**Flow rate** : 0.33mL/min  
**Detector** : UV (280nm) (small cell volume)  
**Column temp.** : 25°C

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

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

Sample : 10μL

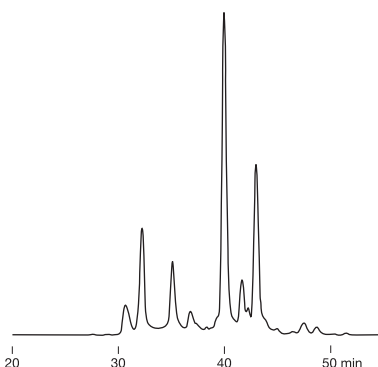
1. Blue dextran 2000 0.2mg/mL
2. γ-Globulin 0.8mg/mL
3. Ovalbumin 0.8mg/mL
4. Myoglobin 0.56mg/mL
5. Uridine 0.04mg/mL



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

### Whey in yogurt

Sample : Whey, 5μL

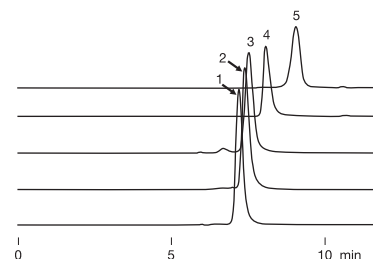


**Column** : Shodex KW402.5-4F + KW403-4F  
**Eluent** : 50mM Sodium phosphate buffer  
 + 0.3M NaCl (pH7.0)  
**Flow rate** : 0.20mL/min  
**Detector** : UV (280nm) (small cell volume)  
**Column temp.** : 30°C

### Lectins

Sample : 5μL

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 vulgare (WGA) 0.8mg/mL



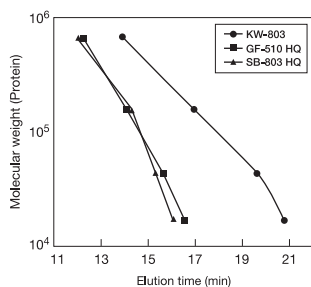
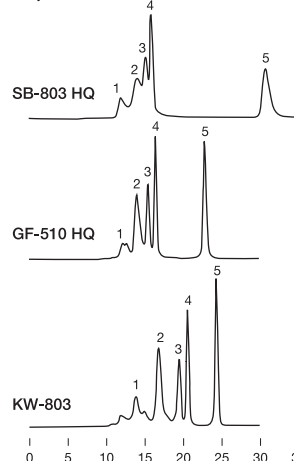
**Column** : Shodex KW402.5-4F  
**Eluent** : 50mM Sodium phosphate buffer  
 + 0.3M NaCl (pH7.0)  
**Flow rate** : 0.33mL/min  
**Detector** : UV (220nm) (small cell volume)  
**Column temp.** : 30°C

### Comparison of various GFC columns for separation of standard proteins

Sample :

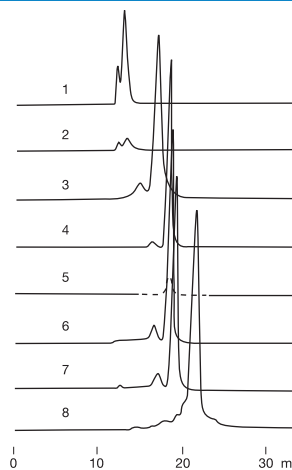
1. Thyroglobulin (bovine)
2. γ-Globulin (bovine)
3. Ovalbumin (chicken)
4. Myoglobin (horse)
5. Cyanocobalamin

Three aqueous SEC columns (SB-803 HQ, GF-510 HQ, and KW-803) were compared for their separation performances. 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

### 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 Phosphate buffer + 0.3M NaCl (pH7.0)  
**Flow rate** : 1.0mL/min  
**Detector** : UV (280nm)  
**Column temp.** : Room temp.

# 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)
  - Corresponds to USP L38 and L39
  - SB-802 HQ corresponds to USP L25
  - SB-802.5 HQ corresponds to USP L25
  - SB-803 HQ corresponds to USP L37

- SB-807 HQ**
- Column for the analysis of water-soluble ultra high molecular weight polymers
  - Large particle size gel is packed to prevent shear degradation of polymers
  - Corresponds to USP L38 and L39

- New LB-800**
- Suitable for light scattering detector because of the controlled column bleed
  - Polymer-based packed columns for aqueous SEC (GFC) analysis
  - The eluent can be replaced with DMF enabling the analysis of polar polymers
  - Corresponds to USP L38 and L39

## 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 x 300</b>	0.02% NaN <sub>3</sub> aq.
F6429101	<b>OHpak SB-802.5 HQ</b>	≥ 16,000	6	200	<b>8.0 x 300</b>	0.02% NaN <sub>3</sub> aq.
F6429102	<b>OHpak SB-803 HQ</b>	≥ 16,000	6	800	<b>8.0 x 300</b>	0.02% NaN <sub>3</sub> aq.
F6429103	<b>OHpak SB-804 HQ</b>	≥ 16,000	10	2,000	<b>8.0 x 300</b>	0.02% NaN <sub>3</sub> aq.
F6429104	<b>OHpak SB-805 HQ</b>	≥ 12,000	13	7,000	<b>8.0 x 300</b>	0.02% NaN <sub>3</sub> aq.
F6429105	<b>OHpak SB-806 HQ</b>	≥ 12,000	13	15,000	<b>8.0 x 300</b>	0.02% NaN <sub>3</sub> aq.
F6429106	<b>OHpak SB-806M HQ</b>	≥ 12,000	13	15,000	<b>8.0 x 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 x 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

## For water-soluble ultra high molecular weight polymers

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 x 300</b>	H <sub>2</sub> O
F6709431	<b>OHpak SB-807G</b>	(guard column)	35	–	<b>8.0 x 50</b>	H <sub>2</sub> O

Base Material : Polyhydroxymethacrylate  
Usable pH range : pH3-10

## For light scattering

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>New OHpak LB-803</b>	≥ 16,000	6	800	<b>8.0 x 300</b>	H <sub>2</sub> O
F6429202	<b>New OHpak LB-806M</b>	≥ 12,000	13	15,000	<b>8.0 x 300</b>	H <sub>2</sub> O
F6709434	<b>New OHpak LB-G 6B</b>	(guard column)	13	–	<b>6.0 x 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 x 300</b>	SB-802 HQ
F6516012	<b>OHpak SB-2002.5</b>	≥ 12,000	10	<b>20.0 x 300</b>	SB-802.5 HQ
F6516013	<b>OHpak SB-2003</b>	≥ 12,000	10	<b>20.0 x 300</b>	SB-803 HQ
F6516014	<b>OHpak SB-2004</b>	≥ 12,000	18	<b>20.0 x 300</b>	SB-804 HQ
F6516015	<b>OHpak SB-2005</b>	≥ 12,000	20	<b>20.0 x 300</b>	SB-805 HQ
F6516016	<b>OHpak SB-2006</b>	≥ 12,000	20	<b>20.0 x 300</b>	SB-806 HQ
F6516017	<b>OHpak SB-2006M</b>	≥ 12,000	20	<b>20.0 x 300</b>	SB-806M HQ
F6709555	<b>OHpak SB-G 8B (OHpak SB-LG)</b>	(guard column)	18	<b>8.0 x 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-806M, LB-G 6B</b>	100	100	100

(Note)  
The maximum solvent tolerance of preparative type SB-800 HQ, SB-2000 series, is 50% of methanol, acetonitrile, and DMF (SB-2002 is not tolerant of organic solvents, similar to SB-802 HQ).

### Target molecular weight range and Exclusion limit

#### ● 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-806M</b>	500 – *(20,000,000)	*(20,000,000)

\* Please use the above table as a rough indication for the column selection.

\*( ) Estimated value

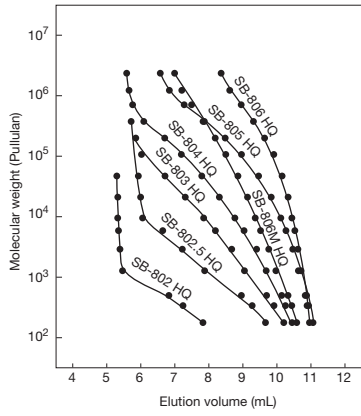
#### ● With \*PEG/PEO (eluent : DMF)

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-806M</b>	200 – *(20,000,000)

\* Please use the above table as a rough indication for the column selection.

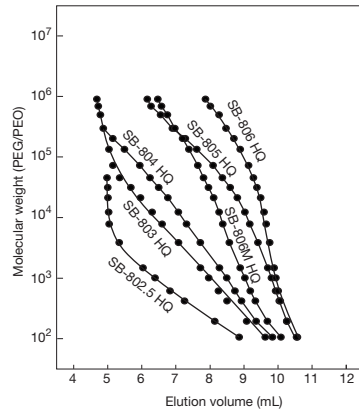
\*PEG : polyethylene glycol  
\*PEO : polyethylene oxide  
\*\* ( ) Estimated value

**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

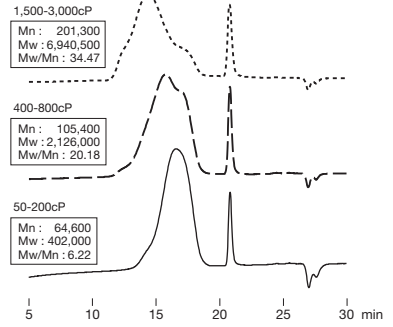
**Calibration curves for SB-800 HQ series using PEG/PEO (eluent : DMF)**



**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



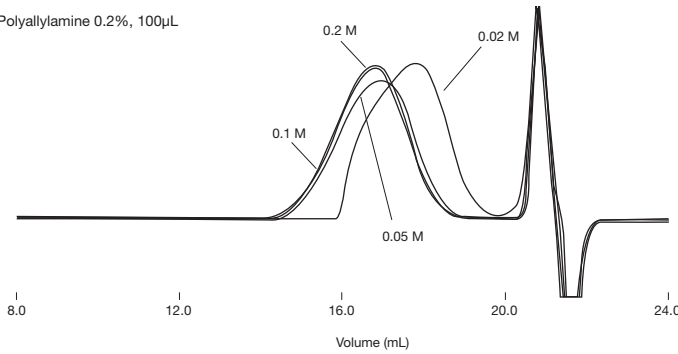
\* Molecular weight was determined from the calibration curve of pullulan.

**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.

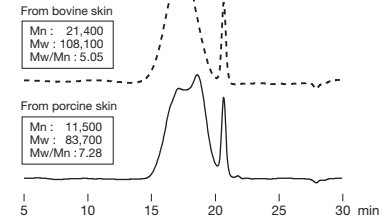
Sample : Polyallylamine 0.2%, 100µL



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

**Gelatin**

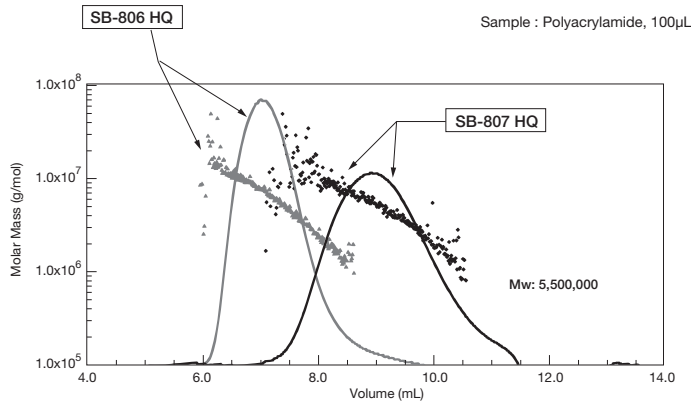
Sample : 0.1% each, 100µL  
 Gelatin from bovine skin (Acid treatment, Gel strength : 225g)  
 Gelatin from porcine skin (Alkali treatment, Gel strength : 90-100g)



\* 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

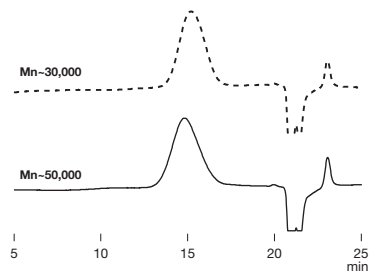
**Polyacrylamide**



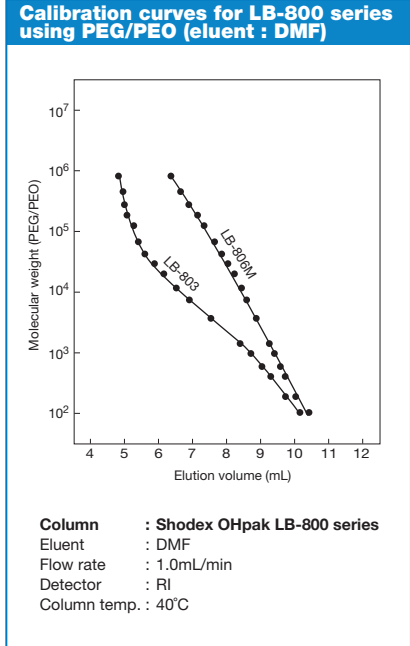
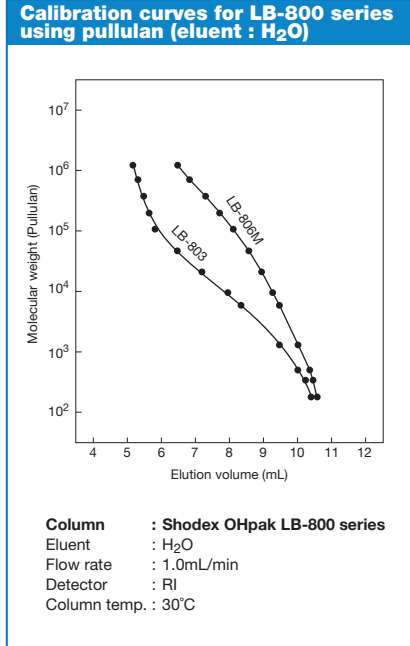
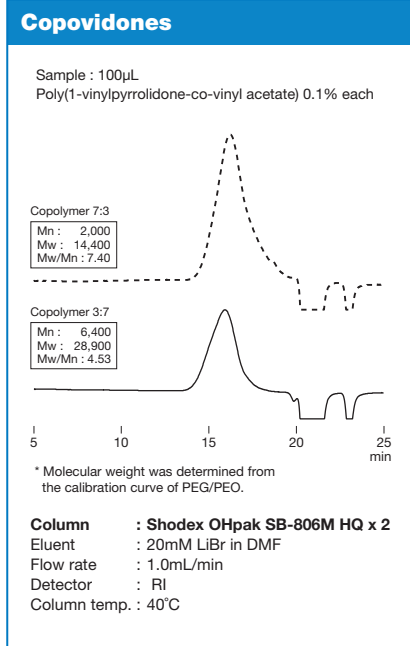
**Column** : Shodex OHpak SB-807 HQ, SB-806 HQ  
**Eluent** : 0.2M NaCl aq.  
**Flow rate** : 0.5mL/min  
**Detector** : RI  
 MALS (Multi angle light scattering)  
**Column temp.** : 30°C

**Cellulose acetate**

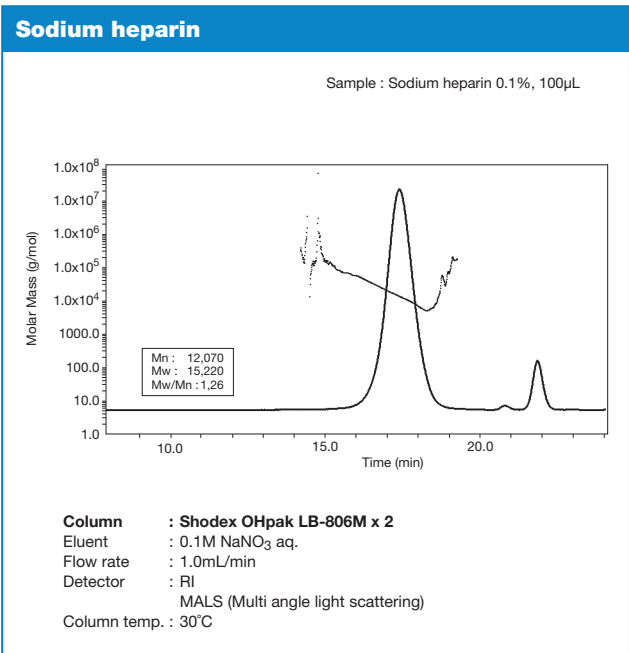
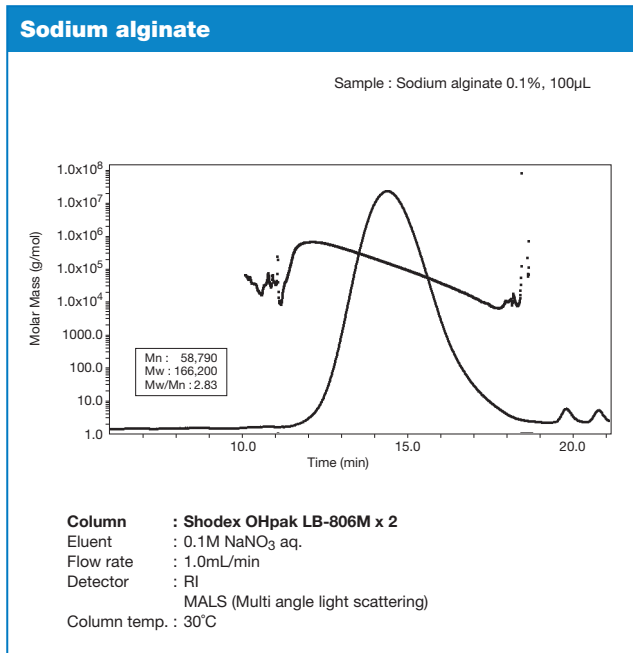
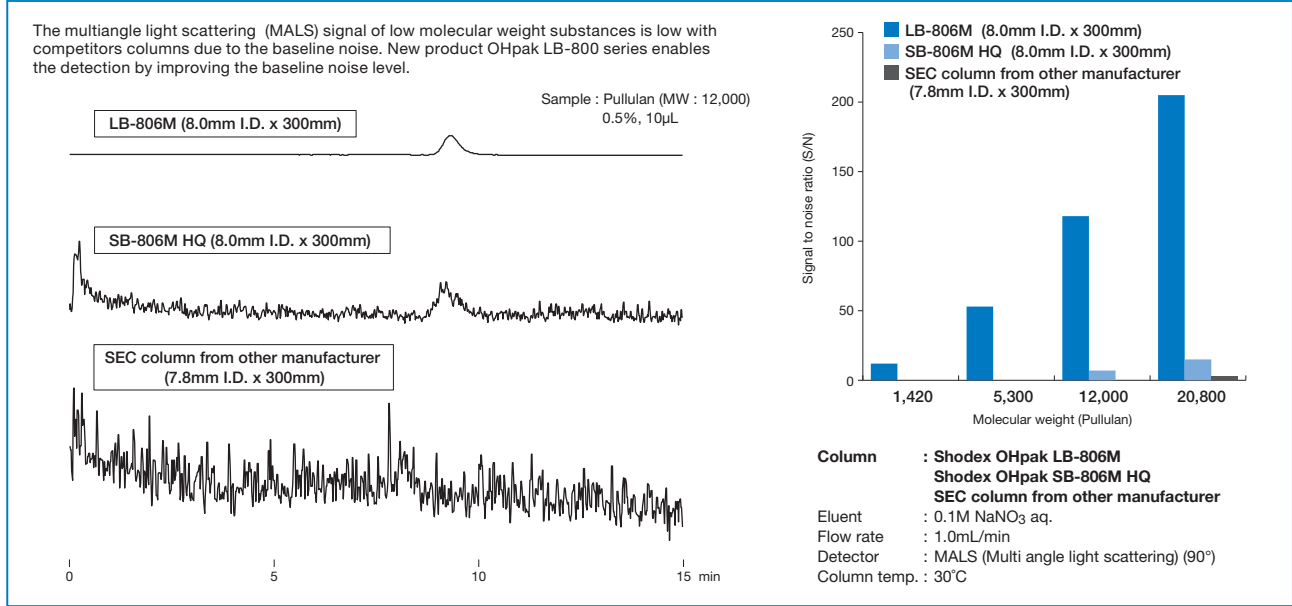
Sample : Cellulose acetate 0.1% each, 100µL



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



### Comparison of the detection of pullulan using multiangle light scattering detector



# Multimode Columns

## Features

- GS-HQ**
  - SEC is the main separation mode
  - Depends on the eluent selected, the column adds 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>
F7750613	<b>GS620A-4B</b>	7	7,000	<b>4.6 × 50</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
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)

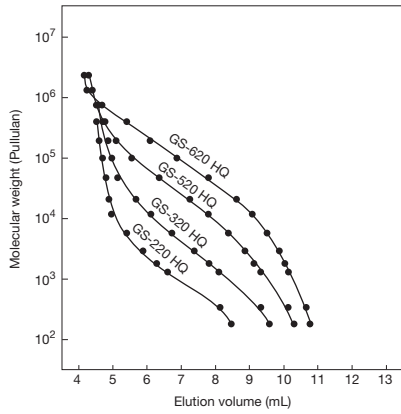
## Target molecular weight range and Exclusion limit

● 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 as a rough indication for the column selection.

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



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

### Peptides

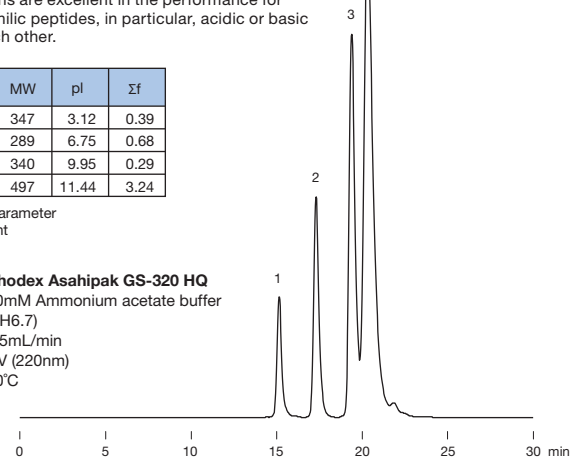
GS-HQ columns can be used not only for SEC (GFC) in an aqueous system, but also for multimodal analysis where hydrophobic interaction and ionic interaction are used together as separation criteria, under certain conditions of the eluent. This results in unprecedented separation analysis. GS-320 HQ columns are excellent in the performance for separating hydrophilic peptides, in particular, acidic or basic peptides, from each other.

	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

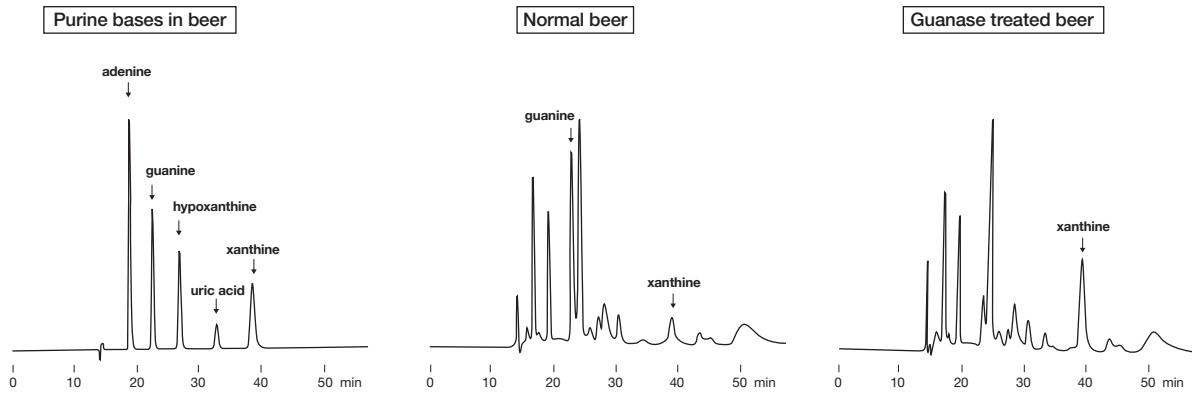
**Column** : Shodex Asahipak GS-320 HQ  
**Eluent** : 30mM Ammonium acetate buffer (pH6.7)  
**Flow rate** : 0.5mL/min  
**Detector** : UV (220nm)  
**Column temp.** : 30°C

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



### Analysis of purine bases in beer

Purine in foods is analyzed as purine base after a step of sample preparation; homogenization, freeze drying, hydrolyzation with 70% perchloric acid, and neutralization. Example below shows the analysis of purin 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.

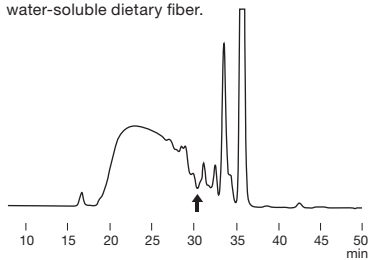


**Column** : Shodex Asahipak GS-320 HQ  
**Eluent** : 150mM Sodium phosphate buffer (pH2.5)  
**Flow rate** : 0.6mL/min  
**Detector** : UV (260nm)  
**Column temp.** : 35°C

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

### Low molecular weight water-soluble dietary fiber

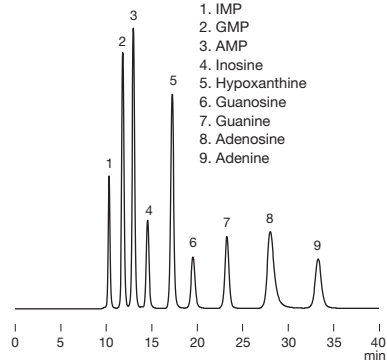
By using GS-220 HQ, monosaccharides, disaccharides, and sugar alcohols elute after indigestible component fraction (indicated by an arrow on the chromatogram). This separation makes the method preferable for the quantification of low molecular weight water-soluble dietary fiber.



**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”

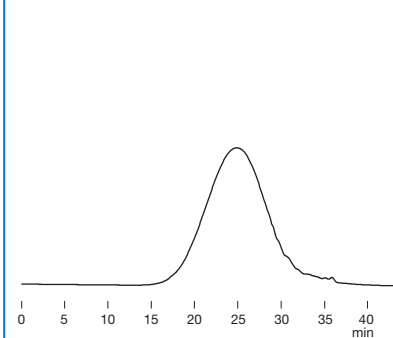
Sample : 50µg/mL each, 20µL  
 1. IMP  
 2. GMP  
 3. AMP  
 4. Inosine  
 5. Hypoxanthine  
 6. Guanosine  
 7. Guanine  
 8. Adenosine  
 9. Adenine



**Column** : Shodex Asahipak GS-320 HQ  
**Eluent** : 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 exhibit high solvent durability
  - Supports 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>
F7760712	<b>GF710A-4D</b>	9	10,000	<b>4.6 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 Columns
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

### ● 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 as a rough indication for the column selection.

\*( ) Estimated value

### ● 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 as a rough indication for the column selection.

\*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	○	0-50% ○

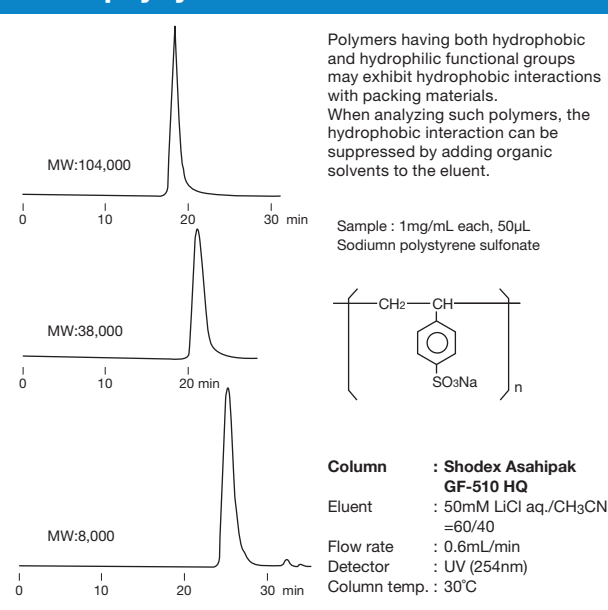
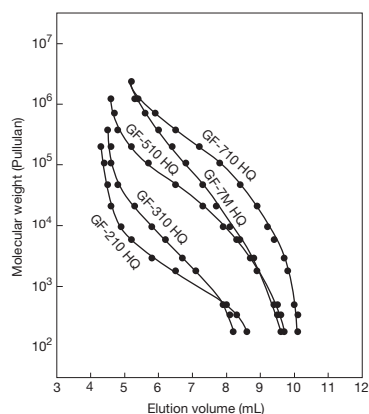
\* When replacing acetonitrile, ethyl acetate or chloroform with water, replace with methanol first and then replace with water.

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

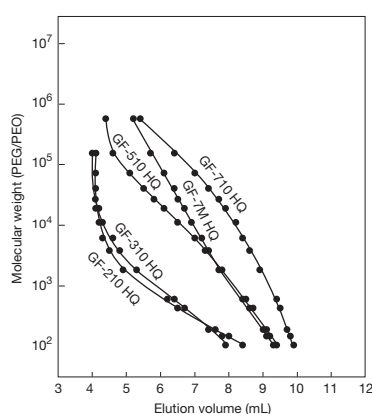
## (Note)

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

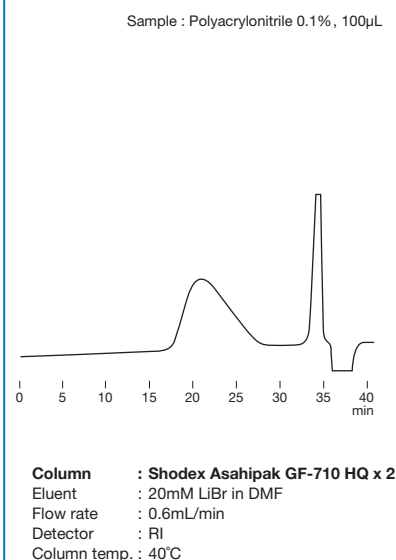
## Sodium polystyrene sulfonates

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

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

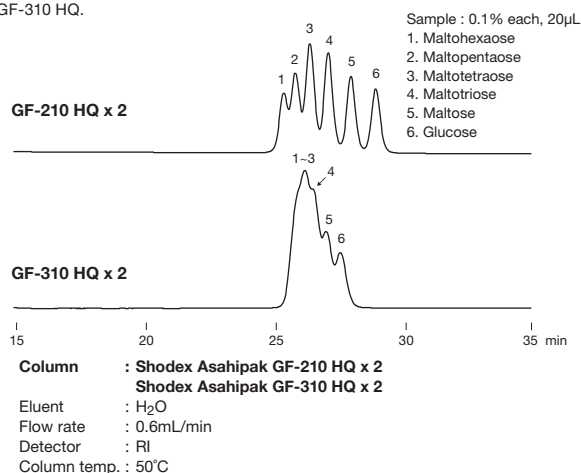


## Polyacrylonitrile

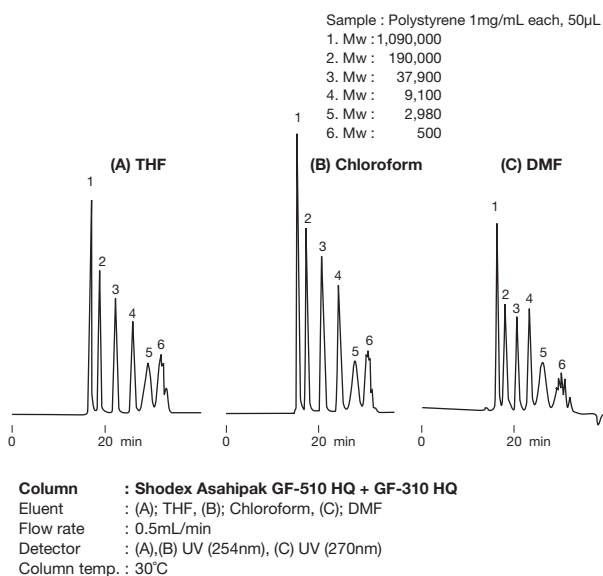


## Comparison of two GF columns for the separation performance of maltooligosaccharides

GF-210 HQ demonstrates an improved separation of low molecular substances. The sample below shows 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.



## Comparison of polystyrenes separation using various solvents



# 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
  - Corresponds to USP L21

## 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	<b>GPC KF-801</b>	≥ 18,000	6	50	<b>8.0 x 300</b>
F6028020	<b>GPC KF-802</b>	≥ 18,000	6	150	<b>8.0 x 300</b>
F6028025	<b>GPC KF-802.5</b>	≥ 18,000	6	300	<b>8.0 x 300</b>
F6028030	<b>GPC KF-803</b>	≥ 18,000	6	500	<b>8.0 x 300</b>
F6027030	<b>GPC KF-803L</b>	≥ 18,000	6	500	<b>8.0 x 300</b>
F6028040	<b>GPC KF-804</b>	≥ 18,000	7	1,500	<b>8.0 x 300</b>
F6027040	<b>GPC KF-804L</b>	≥ 18,000	7	1,500	<b>8.0 x 300</b>
F6028050	<b>GPC KF-805</b>	≥ 11,000	10	5,000	<b>8.0 x 300</b>
F6027050	<b>GPC KF-805L</b>	≥ 11,000	10	5,000	<b>8.0 x 300</b>
F6028060	<b>GPC KF-806</b>	≥ 11,000	10	10,000	<b>8.0 x 300</b>
F6028090	<b>GPC KF-806M</b>	≥ 13,000	10	10,000	<b>8.0 x 300</b>
F6027060	<b>GPC KF-806L</b>	≥ 11,000	10	10,000	<b>8.0 x 300</b>
F6028070	<b>GPC KF-807</b>	≥ 6,000	18	20,000	<b>8.0 x 300</b>
F6027070	<b>GPC KF-807L</b>	≥ 6,000	18	20,000	<b>8.0 x 300</b>
F6700300	<b>GPC KF-G 4A (GPC KF-G)</b>	(guard column)	8	–	<b>4.6 x 10</b>
F6709350	<b>GPC KF-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 50 for details of the solvent-peak separation columns.

\* See pages 54 and 55 for details preparative columns.

\* See page 62 for applicability of SEC (GPC) columns to solvent replacement.

Base Material : Styrene divinylbenzene copolymer

## Target molecular weight range and Exclusion limit

### ● With Polystyrene (eluent : THF)

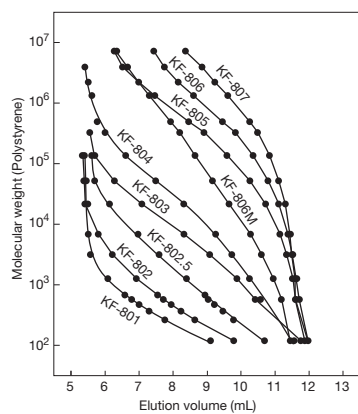
Product Name	Target Molecular Weight Range	Exclusion Limit	Product Name	Target Molecular Weight Range	Exclusion Limit
<b>KF-801</b>	100 – 700	1,500	<b>KF-805</b>	50,000 – 2,000,000	4,000,000
<b>KF-802</b>	300 – 3,000	5,000	<b>KF-805L</b>	300 – 2,000,000	4,000,000
<b>KF-802.5</b>	300 – 8,000	20,000	<b>KF-806</b>	150,000 – *(20,000,000)	*(20,000,000)
<b>KF-803</b>	1,000 – 50,000	70,000	<b>KF-806M</b>	1,000 – *(20,000,000)	*(20,000,000)
<b>KF-803L</b>	100 – 50,000	70,000	<b>KF-806L</b>	300 – *(20,000,000)	*(20,000,000)
<b>KF-804</b>	7,000 – 300,000	400,000	<b>KF-807</b>	300,000 – *(200,000,000)	*(200,000,000)
<b>KF-804L</b>	100 – 300,000	400,000	<b>KF-807L</b>	300 – *(200,000,000)	*(200,000,000)

\* Please use the above table as a rough indication for the column selection.

\*( ) Estimated value

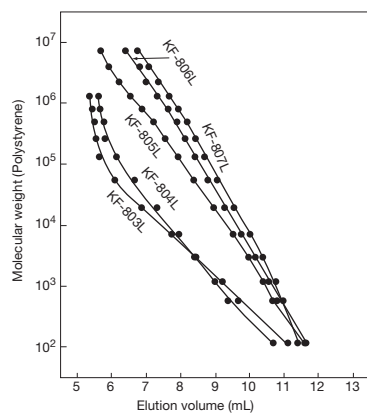


## Calibration curves for KF-800 series using polystyrene



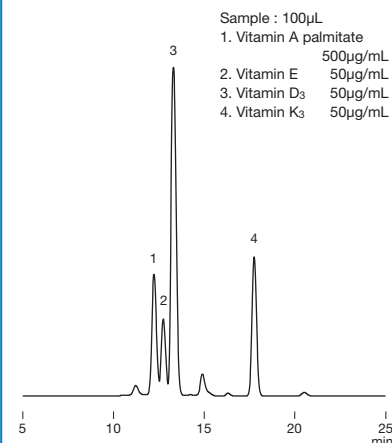
Column : Shodex GPC KF-800 series  
 Eluent : THF  
 Flow rate : 1.0mL/min  
 Detector : RI  
 Column temp. : 40°C

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



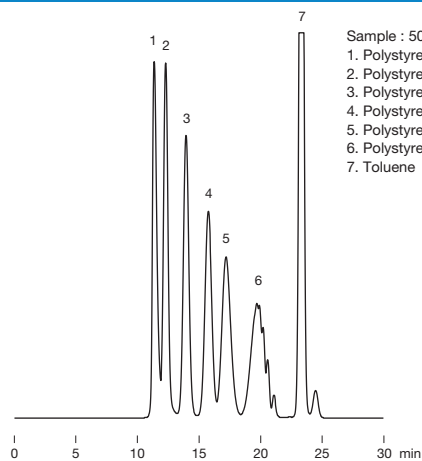
Column : Shodex GPC KF-800L series  
 Eluent : THF  
 Flow rate : 1.0mL/min  
 Detector : RI  
 Column temp. : 40°C

## Fat-soluble vitamins

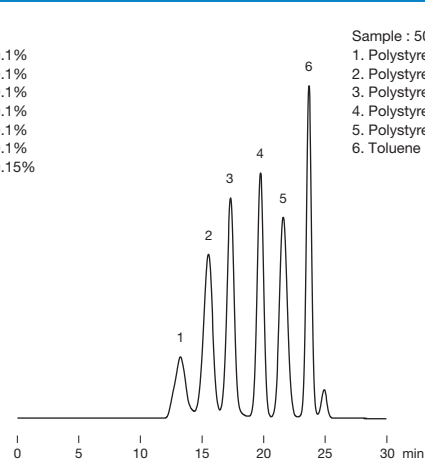


Column : Shodex GPC KF-801 x 2  
 Eluent : THF  
 Flow rate : 1.0mL/min  
 Detector : UV (280nm)  
 Column temp. : 40°C

## Standard polystyrenes



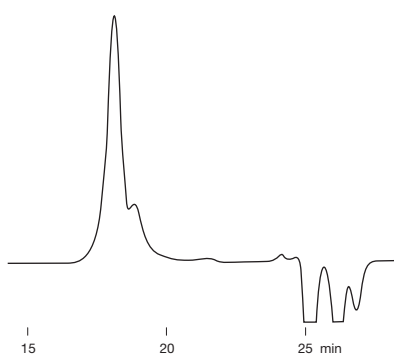
Column : Shodex GPC KF-803L x 2  
 Eluent : THF  
 Flow rate : 1.0mL/min  
 Detector : UV (254nm)  
 Column temp. : 40°C



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

## Styrene isoprene ABA block copolymer

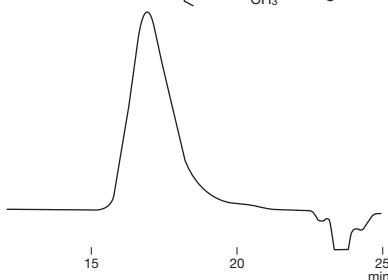
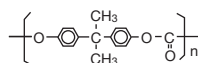
Sample : Styrene isoprene ABA block copolymer



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

## Polycarbonate resin

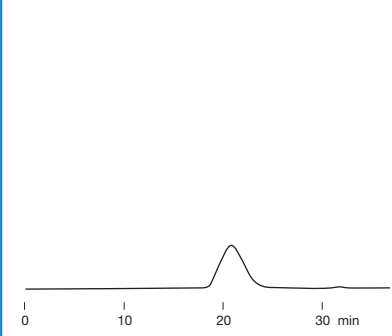
Sample : Polycarbonate resin 0.1%, 100µL



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

## Raw rubber

Sample : Rubber 0.1%, 300µL



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
  - Corresponds to USP L21

## 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	8	50	<b>8.0 × 300</b>
F6028120	<b>GPC K-802</b>	≥ 18,000	6	150	<b>8.0 × 300</b>
F6028125	<b>GPC K-802.5</b>	≥ 18,000	6	300	<b>8.0 × 300</b>
F6028130	<b>GPC K-803</b>	≥ 18,000	6	500	<b>8.0 × 300</b>
F6028194	<b>GPC K-803L</b>	≥ 18,000	6	500	<b>8.0 × 300</b>
F6028140	<b>GPC K-804</b>	≥ 18,000	7	1,500	<b>8.0 × 300</b>
F6028195	<b>GPC K-804L</b>	≥ 18,000	7	1,500	<b>8.0 × 300</b>
F6028150	<b>GPC K-805</b>	≥ 11,000	10	5,000	<b>8.0 × 300</b>
F6028196	<b>GPC K-805L</b>	≥ 11,000	10	5,000	<b>8.0 × 300</b>
F6028160	<b>GPC K-806</b>	≥ 11,000	10	10,000	<b>8.0 × 300</b>
F6028190	<b>GPC K-806M</b>	≥ 13,000	10	10,000	<b>8.0 × 300</b>
F6028197	<b>GPC K-806L</b>	≥ 11,000	10	10,000	<b>8.0 × 300</b>
F6028170	<b>GPC K-807</b>	≥ 6,000	18	20,000	<b>8.0 × 300</b>
F6028198	<b>GPC K-807L</b>	≥ 6,000	18	20,000	<b>8.0 × 300</b>
F6700401	<b>GPC K-G 4A (GPC K-G)</b>	(guard column)	8	–	<b>4.6 × 10</b>
F6709450	<b>GPC K-800D</b>	( solvent-peak separation column )	10	–	<b>8.0 × 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 50 for details of the solvent-peak separation columns.

\* See pages 54 and 55 for details preparative columns.

\* See page 62 for applicability of SEC (GPC) columns to solvent replacement.

Base Material : Styrene divinylbenzene copolymer

## Target molecular weight range and Exclusion limit

### ● With Polystyrene (eluent : Chloroform)

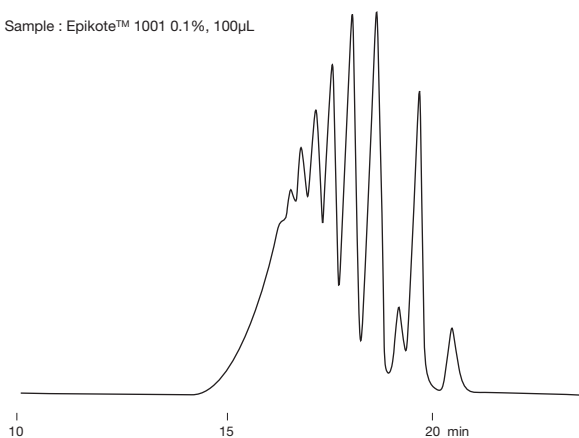
Product Name	Target Molecular Weight Range	Exclusion Limit	Product Name	Target Molecular Weight Range	Exclusion Limit
<b>K-801</b>	100 – 700	1,500	<b>K-805</b>	50,000 – 2,000,000	4,000,000
<b>K-802</b>	300 – 3,000	5,000	<b>K-805L</b>	300 – 2,000,000	4,000,000
<b>K-802.5</b>	300 – 8,000	20,000	<b>K-806</b>	150,000 – *(20,000,000)	*(20,000,000)
<b>K-803</b>	1,000 – 50,000	70,000	<b>K-806M</b>	1,000 – *(20,000,000)	*(20,000,000)
<b>K-803L</b>	100 – 50,000	70,000	<b>K-806L</b>	300 – *(20,000,000)	*(20,000,000)
<b>K-804</b>	7,000 – 300,000	400,000	<b>K-807</b>	300,000 – *(200,000,000)	*(200,000,000)
<b>K-804L</b>	100 – 300,000	400,000	<b>K-807L</b>	300 – *(200,000,000)	*(200,000,000)

\* Please use the above table as a rough indication for the column selection.

\*( ) Estimated value

## Epoxy resin

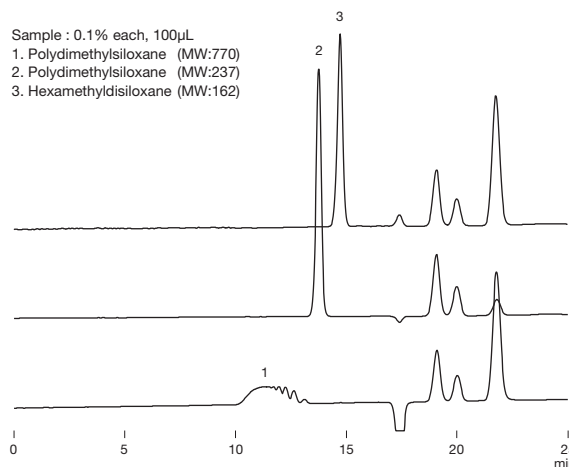
Sample : Epikote™ 1001 0.1%, 100µL



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

## Low molecular polydimethylsiloxanes

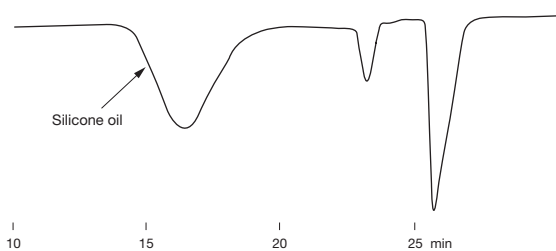
Sample : 0.1% each, 100µL  
 1. Polydimethylsiloxane (MW:770)  
 2. Polydimethylsiloxane (MW:237)  
 3. Hexamethylsiloxane (MW:162)



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

## Silicone oil

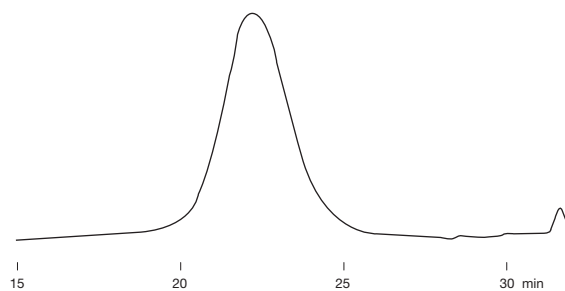
Sample : Silicone oil 0.1%, 200µL



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

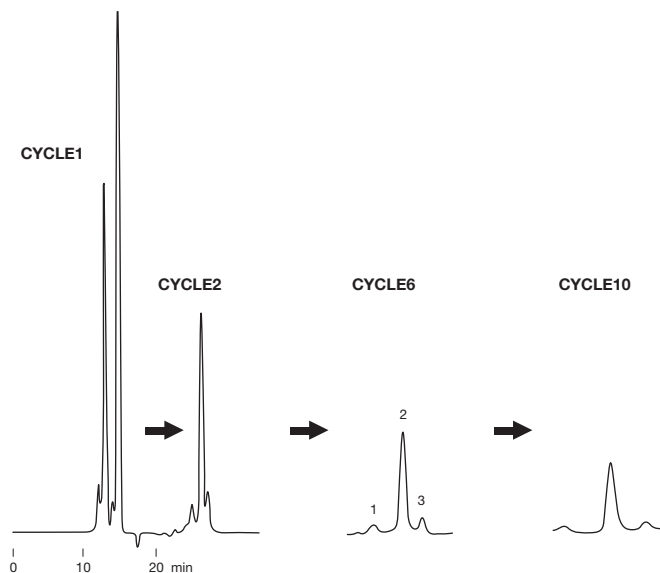
## Bionolle™ (Polybutylene succinate/adipate)

Sample : Polybutylene succinate/adipate 0.2%, 100µL



Column : Shodex GPC K-806M x 2 + K-801  
 Eluent : Chloroform  
 Flow rate : 1.0mL/min  
 Detector : RI  
 Column temp. : 40°C

## Recycling fractionation 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 54 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
  - Corresponds to USP L21

## 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 × 300</b>
F6028220	<b>GPC KD-802</b>	≥ 17,000	6	150	<b>8.0 × 300</b>
F6028225	<b>GPC KD-802.5</b>	≥ 17,000	6	300	<b>8.0 × 300</b>
F6028230	<b>GPC KD-803</b>	≥ 17,000	6	500	<b>8.0 × 300</b>
F6028240	<b>GPC KD-804</b>	≥ 17,000	7	1,500	<b>8.0 × 300</b>
F6028250	<b>GPC KD-805</b>	≥ 11,000	10	5,000	<b>8.0 × 300</b>
F6028260	<b>GPC KD-806</b>	≥ 11,000	10	10,000	<b>8.0 × 300</b>
F6028290	<b>GPC KD-806M</b>	≥ 13,000	10	10,000	<b>8.0 × 300</b>
F6028270	<b>GPC KD-807</b>	≥ 6,000	18	20,000	<b>8.0 × 300</b>
F6700411	<b>GPC KD-G 4A (GPC KD-G)</b>	(guard column)	8	–	<b>4.6 × 10</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 62 for applicability of SEC (GPC) columns to solvent replacement.

Base Material : Styrene divinylbenzene copolymer

## Target molecular weight range and Exclusion limit

### ● With \*PEG/PEO (eluent : DMF)

Product Name	Target Molecular Weight Range	Exclusion Limit	Product Name	Target Molecular Weight Range	Exclusion Limit
<b>KD-801</b>	100 – 1,500	2,500	<b>KD-805</b>	30,000 – *(4,000,000)	*(4,000,000)
<b>KD-802</b>	200 – 4,000	7,000	<b>KD-806</b>	30,000 – *(40,000,000)	*(40,000,000)
<b>KD-802.5</b>	400 – 10,000	20,000	<b>KD-806M</b>	1,000 – *(40,000,000)	*(40,000,000)
<b>KD-803</b>	1,000 – 50,000	70,000	<b>KD-807</b>	50,000 – *(200,000,000)	*(200,000,000)
<b>KD-804</b>	4,000 – 200,000	200,000			

\* Please use the above table as a rough indication for the column selection.

\*PEG : polyethylene glycol

\*PEO : polyethylene oxide

\*( ) Estimated value

# Solvent-peak Separation Columns for Organic SEC (GPC)

## Features

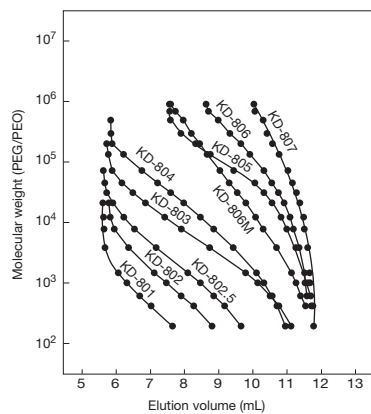
- KF-800D**
- Use this column in combination with a linear column
- K-800D**
- By shifting the elution of monomers, polymer additives, and the solvent-peak in low molecular region, it reduces interferences in the calculation of the molecular weight distribution of polymers and oligomers

## 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 × 100</b>	THF
F6709450	<b>GPC K-800D</b>	K-805L, 806L, 806M, 807L	10	<b>8.0 × 100</b>	Chloroform

Base Material : Styrene divinylbenzene copolymer

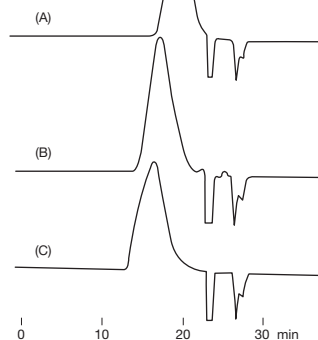
## Calibration curves for KD-800 series using PEG/PEO



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

## Polyvinylpyrrolidones

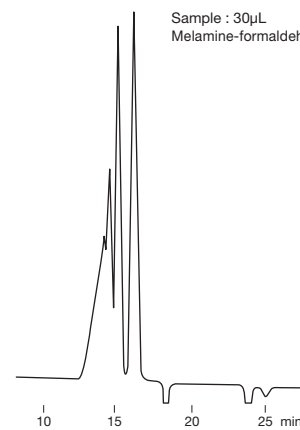
Sample : Polyvinylpyrrolidone 0.2% each  
 (A) K-30 400 $\mu$ L  
 (B) K-60 500 $\mu$ L  
 (C) K-90 500 $\mu$ L



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

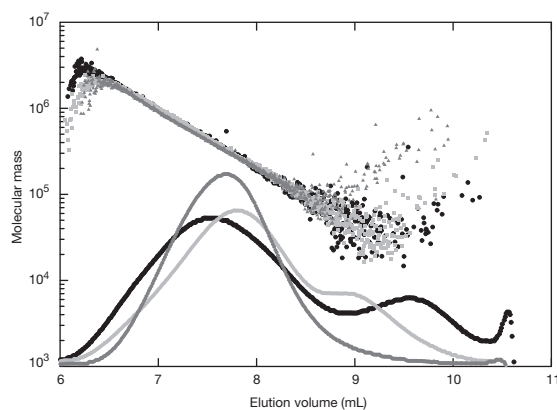
## Melamine formaldehyde resin

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 known to be difficult to dissolve. A cellulose solution is prepared by repeating solvent replacement. It is reported that it requires a long time to dissolve (1 to 60 days), depending on the solvent type, crystallinity and molecular weight.

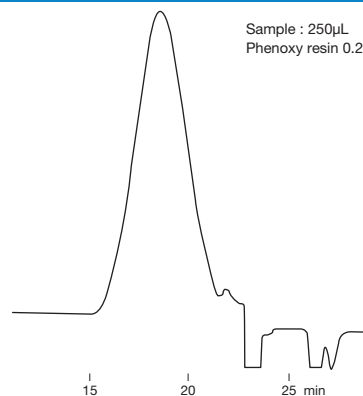
Column : Shodex GPC KD-806M  
 Eluent : 1% LiCl in \*DMI  
 Flow rate : 0.5mL/min  
 Detector : RI, MALS (Multi angle light scattering)  
 Column temp. : 60°C

\* 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

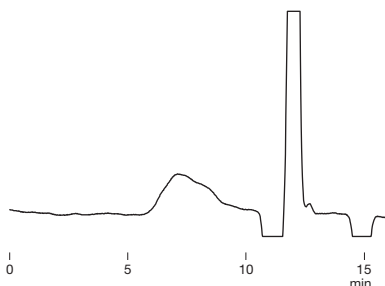
Sample : 250 $\mu$ L  
 Phenoxy resin 0.2%



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

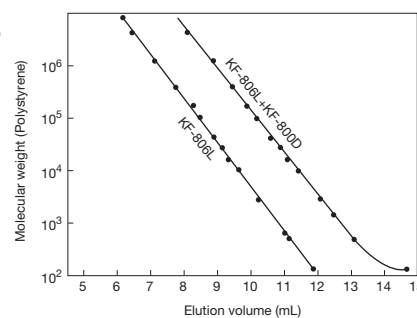
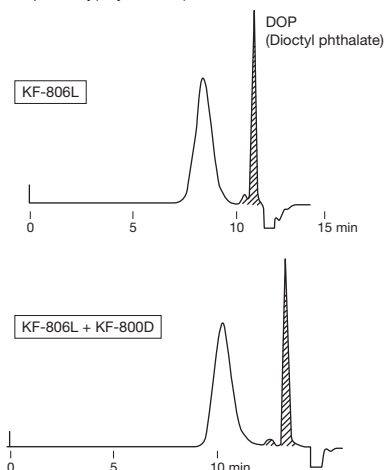
Sample : 100 $\mu$ L  
 Potato starch in DMSO 0.1%  
 \* solved at 80°C



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**
- Approximately half of the analysis time compared with standard columns
  - The amount of solvent used is reduced to about a third
  - Improved applicability of solvent replacement
  - Corresponds to USP L21

- 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
  - Corresponds to USP L21

## Rapid analysis downsized columns

### ● KF-600 series

© Use of the KF-600 series with semi-micro type devices is recommended.

Product Code	Product Name	Plate Number (TP/column)	Particle Size (μm)	Pore Size (Å)	Column Size (mm) I.D. x Length
F6028091	GPC KF-601	≥ 17,000	3	50	6.0 x 150
F6028092	GPC KF-602	≥ 17,000	3	150	6.0 x 150
F6028093	GPC KF-602.5	≥ 17,000	3	300	6.0 x 150
F6028094	GPC KF-603	≥ 17,000	3	500	6.0 x 150
F6028095	GPC KF-604	≥ 16,000	3	1,500	6.0 x 150
F6028096	GPC KF-605	≥ 7,000	10	5,000	6.0 x 150
F6028097	GPC KF-606	≥ 7,000	10	10,000	6.0 x 150
F6028098	GPC KF-606M	≥ 8,000	10	10,000	6.0 x 150
F6028099	GPC KF-607	≥ 5,000	18	20,000	6.0 x 150
F6700300	GPC KF-G 4A (GPC KF-G)	(guard column)	8	-	4.6 x 10

## High performance semi-micro columns

### ● KF-400HQ series

© Use of the KF-400HQ series with semi-micro type devices is recommended.

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

#### [KF-600 series and KF-400HQ series]

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

\* See page 62 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

### ● With Polystyrene (eluent : THF)

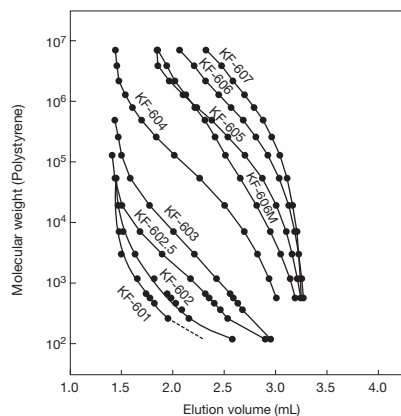
Product Name	Target Molecular Weight Range	Exclusion Limit
KF-601	100 – 700	1,500
KF-602	200 – 1,500	4,000
KF-602.5	300 – 10,000	20,000
KF-603	600 – 50,000	70,000
KF-604	7,000 – 500,000	1,000,000
KF-605	50,000 – 2,000,000	4,000,000
KF-606	150,000 – *(20,000,000)	*(20,000,000)
KF-606M	1,000 – *(20,000,000)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

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

\* Please use the above table as a rough indication for the column selection.

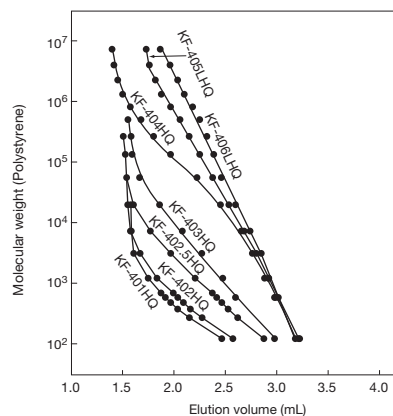
\*( ) Estimated value

## 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

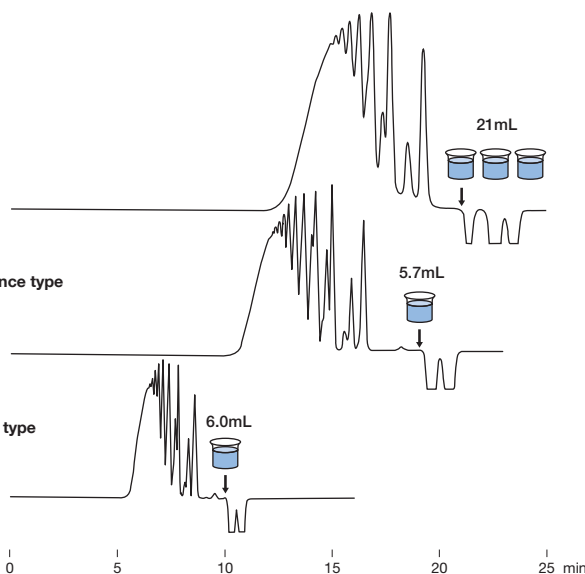


Column : Shodex GPC KF-400HQ series  
 Eluent : THF  
 Flow rate : 0.3mL/min  
 Detector : RI (small cell volume)  
 Column temp. : 40°C

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

## Standard type

KF-802.5 x 2  
 50 $\mu$ L injection



Sample : EPON1001 0.2%

By using KF-602.5, the analysis time is reduced to less than half of that using KF-802.5. Thus KF-600 series enables rapid analysis. On the other hand, KF-402.5HQ has a theoretical plate number 1.5 times more than that of the standard column, thereby improving resolution especially in the analysis of molecules that have a small to medium molecular weight. Rapid analysis and high performance type columns use less than one third of solvent per analysis compared to standard type columns do.

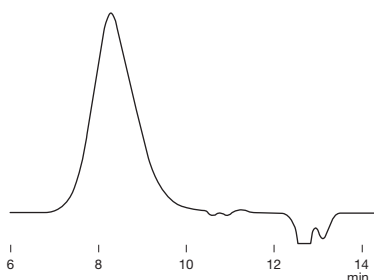
Column : Shodex GPC KF-802.5 x 2  
 Shodex GPC KF-402.5HQ x 2  
 Shodex GPC KF-602.5 x 2

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

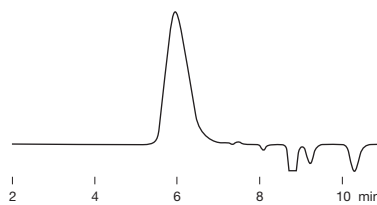
Sample : Styrene-Acrylonitrile (30:70) copolymer



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%, 5 $\mu$ L

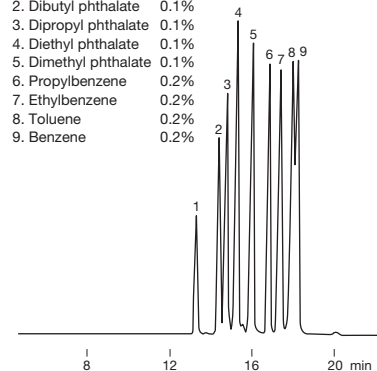


Column : Shodex GPC KF-401HQ  
 Eluent : Chloroform  
 Flow rate : 0.3mL/min  
 Detector : RI (small cell volume)  
 Column temp. : 40°C

## Phthalates

Sample : 10 $\mu$ L

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 : For Preparative

**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 Columns
F6102401	<b>GPC KF-2001</b>	≥ 18,000	6	<b>20.0 x 300</b>	KF-801
F6102402	<b>GPC KF-2002</b>	≥ 18,000	6	<b>20.0 x 300</b>	KF-802
F6102425	<b>GPC KF-2002.5</b>	≥ 18,000	6	<b>20.0 x 300</b>	KF-802.5
F6102403	<b>GPC KF-2003</b>	≥ 18,000	6	<b>20.0 x 300</b>	KF-803
F6102404	<b>GPC KF-2004</b>	≥ 14,000	7	<b>20.0 x 300</b>	KF-804
F6102405	<b>GPC KF-2005</b>	≥ 10,000	10	<b>20.0 x 300</b>	KF-805
F6102406	<b>GPC KF-2006</b>	≥ 10,000	10	<b>20.0 x 300</b>	KF-806
F6102409	<b>GPC KF-2006M</b>	≥ 10,000	10	<b>20.0 x 300</b>	KF-806M
F6700406	<b>GPC KF-G 8B (GPC KF-LG)</b>	(guard column)	15	<b>8.0 x 50</b>	(guard column)

\* See page 46 for 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 Columns
F6102301	<b>GPC K-2001</b>	≥ 18,000	6	<b>20.0 x 300</b>	K-801
F6102312	<b>GPC K-2002</b>	≥ 18,000	6	<b>20.0 x 300</b>	K-802
F6102315	<b>GPC K-2002.5</b>	≥ 18,000	6	<b>20.0 x 300</b>	K-802.5
F6102303	<b>GPC K-2003</b>	≥ 18,000	6	<b>20.0 x 300</b>	K-803
F6102304	<b>GPC K-2004</b>	≥ 14,000	7	<b>20.0 x 300</b>	K-804
F6102305	<b>GPC K-2005</b>	≥ 10,000	10	<b>20.0 x 300</b>	K-805
F6102306	<b>GPC K-2006</b>	≥ 10,000	10	<b>20.0 x 300</b>	K-806
F6102309	<b>GPC K-2006M</b>	≥ 10,000	10	<b>20.0 x 300</b>	K-806M
F6700407	<b>GPC K-G 8B (GPC K-LG)</b>	(guard column)	15	<b>8.0 x 50</b>	(guard column)

\* See page 48 for 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 Columns
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 48 for GPC K-800 series.

Base Material : Styrene divinylbenzene copolymer

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

Product Code	Product Name	Particle Size (µm)	Column Size (mm) I.D. x Length	Standard Columns
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 20B (GPC KF-LLG)</b>	15	<b>20.0 × 100</b>	(guard column)

\* See page 46 for 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 Columns
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 20B (GPC K-LLG)</b>	15	<b>20.0 × 100</b>	(guard column)

\* See page 48 for GPC K-800 series.

Base Material : Styrene divinylbenzene copolymer

# Organic SEC (GPC) Columns : Linear Calibration Type

## Features

- LF**
  - Employs a special packing material with a wide pore size distribution (multi pore type)
  - Highly linear calibration curve without inflection points
  - Molecular weight distribution can be determined with high precision
  - Enables analysis over a broad range of molecular weights
  - Column for rapid analysis (LF-604) and column for high performance analysis (LF-404) enabling reduction in solvent use are also available
  - Corresponds to USP L21

## 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 × 300</b>
F6709621	<b>GPC LF-G</b>	(guard column)	6	–	<b>4.6 × 10</b>

\* See page 62 for applicability of SEC (GPC) columns to solvent replacement.

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

## Rapid analysis downsized column

◎ Use of the LF-604 with semi-micro type devices is recommended.

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 × 150</b>
F6709621	<b>GPC LF-G</b>	(guard column)	6	–	<b>4.6 × 10</b>

\* See page 62 for applicability of SEC (GPC) columns to solvent replacement.

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

## High performance semi-micro column

◎ Use of the LF-404 with semi-micro type devices is recommended.

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 × 250</b>
F6709621	<b>GPC LF-G</b>	(guard column)	6	–	<b>4.6 × 10</b>

\* See page 62 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

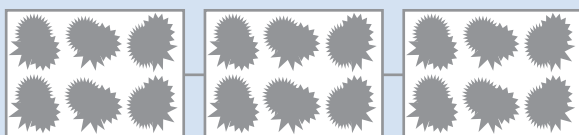
### ● With Polystyrene (eluent : THF)

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 as a rough indication for the column selection.

## 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 (column).

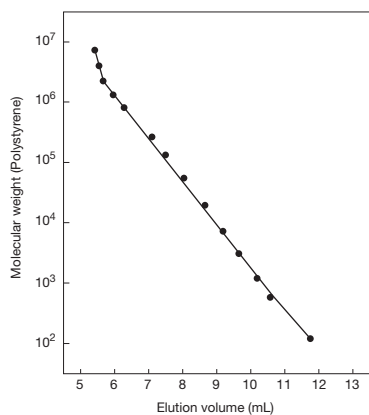
### Connecting mixed-gel columns (KF-804L, etc.)



### Connecting different grades columns (KF-804 + KF-803 + KF-802, etc.)

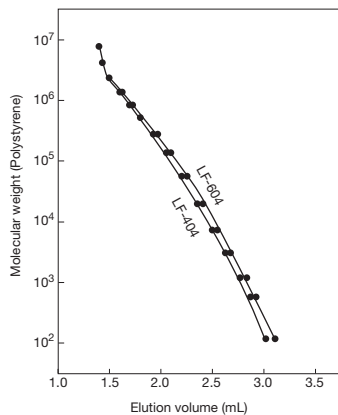


## Calibration curve for LF-804 using polystyrene



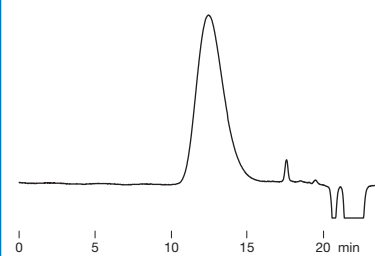
Column : Shodex GPC LF-804  
 Eluent : THF  
 Flow rate : 1.0mL/min  
 Detector : RI  
 Column temp. : 40°C

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



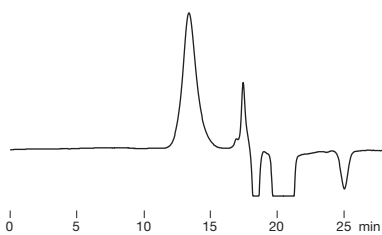
Column : Shodex GPC LF-604, LF-404  
 Eluent : THF  
 Flow rate : 0.5mL/min (LF-604)  
 0.3mL/min (LF-404)  
 Detector : RI (small cell volume)  
 Column temp. : 40°C

## Polyurethane

Sample : Polyurethane 0.1%, 20 $\mu$ L

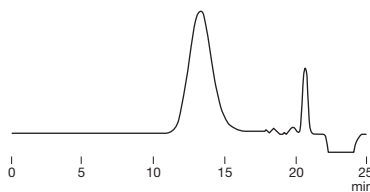
Column : Shodex GPC LF-404 x 2  
 Eluent : THF  
 Flow rate : 0.3mL/min  
 Detector : RI (small cell volume)  
 Column temp. : 40°C

## Xylan

Sample : Xylan 0.1%, 100 $\mu$ L

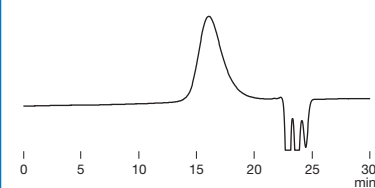
Column : Shodex GPC LF-804  
 Eluent : 20mM H<sub>3</sub>PO<sub>4</sub> + 20mM LiBr in (DMSO/DMF=80/20)  
 Flow rate : 0.6mL/min  
 Detector : RI  
 Column temp. : 50°C

## Polyamide (Nylon6/6)

Sample : Nylon™ 6/6 0.1%, 20 $\mu$ L

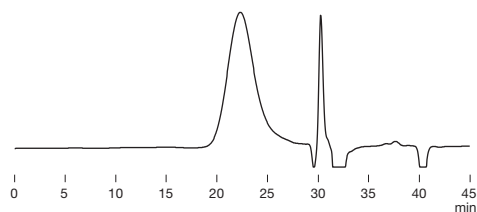
Column : Shodex GPC LF-404  
 Eluent : 5mM CF<sub>3</sub>COONa in HFIP  
 Flow rate : 0.15mL/min  
 Detector : RI (small cell volume)  
 Column temp. : 40°C

## Polymethyl methacrylate

Sample : 100 $\mu$ L  
Polymethyl methacrylate

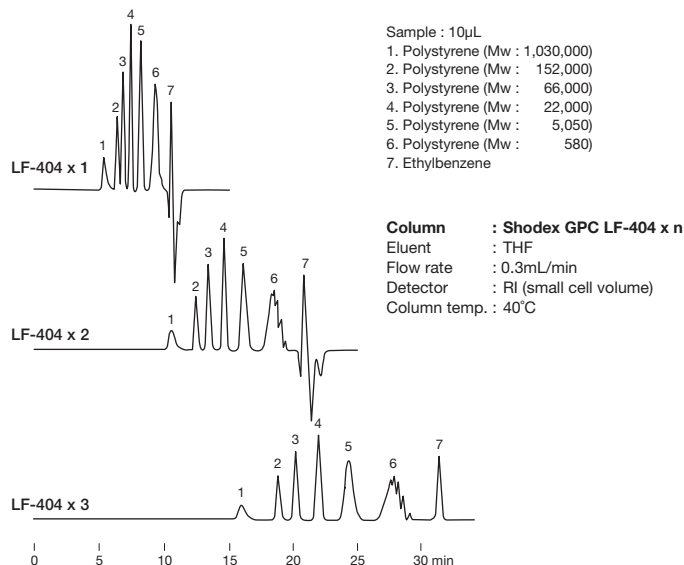
Column : Shodex GPC LF-804 x 2  
 Eluent : Methyl ethyl ketone  
 Flow rate : 1.0mL/min  
 Detector : RI  
 Column temp. : 40°C

## Polyamic acid

Sample : Poly(pyromellitic dianhydride-co-4,4'-oxydianiline), 100 $\mu$ L

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

## Comparison of polystyrenes separation with different numbers of LF-404



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

## Features

- HT-800**
- Varied product lineup to support a wide range of molecular weights
  - Corresponds to USP L21
- 
- 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
  - Corresponds to USP L21

## 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 are 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

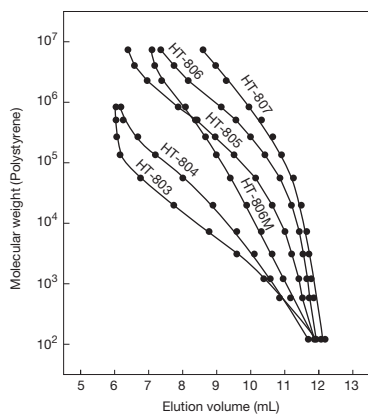
## Target molecular weight range and Exclusion limit

### ● With Polystyrene (eluent : THF)

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)

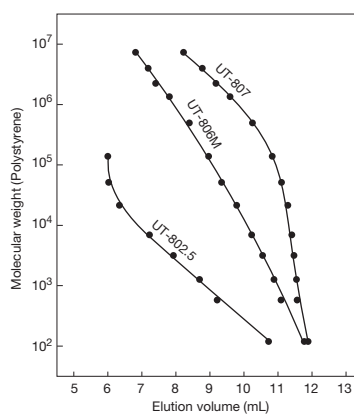
\* Please use the above table as a rough indication for the column selection.   \*( ) Estimated value

## Calibration curves for HT-800 series using polystyrene



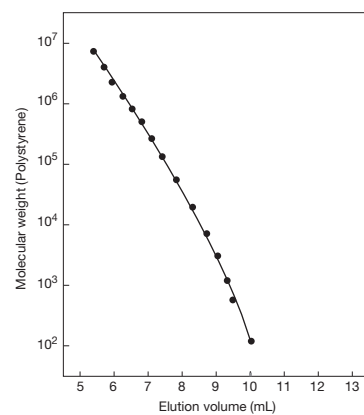
Column : Shodex GPC HT-800 series  
 Eluent : THF  
 Flow rate : 1.0mL/min  
 Detector : RI  
 Column temp. : 40°C

## Calibration curves for UT-800 series using polystyrene



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

## Calibration curve for AT-806MS using polystyrene

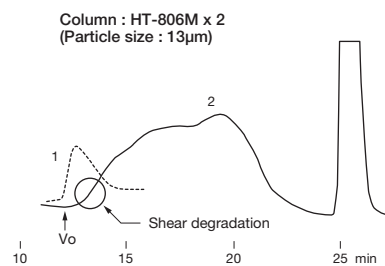
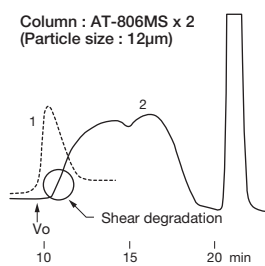
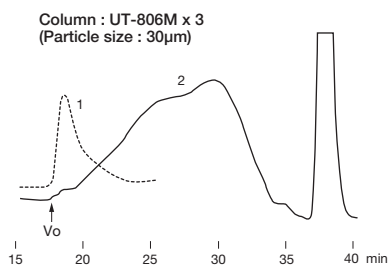


Column : Shodex GPC AT-806MS  
 Eluent : THF  
 Flow rate : 1.0mL/min  
 Detector : RI  
 Column temp. : 40°C

## Effects of gel particle size in high temperature GPC columns

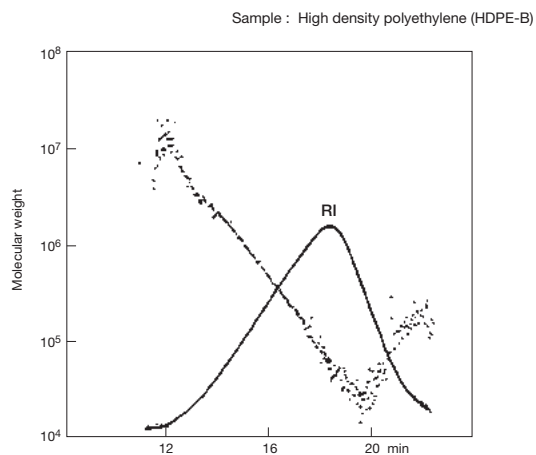
High temperature SEC columns are suitable for the analysis of high molecular weight polymers that are difficult to be dissolved in ambient temperature solvents; examples of such polymers are polyethylene and polypropylene. The GPC UT-800 series packed with large particle size (30  $\mu$ m) are recommended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



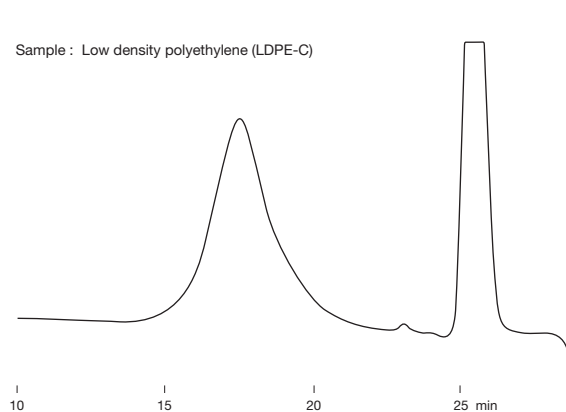
Column : Shodex GPC UT-806M  
 Shodex GPC HT-806M  
 Shodex GPC AT-806MS  
 Eluent : 0.1% BHT in o-Dichlorobenzene  
 Flow rate : 1.0mL/min  
 Detector : RI  
 Column temp. : 140°C

## High density polyethylene



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

# Organic SEC (GPC) Columns : HFIP

## Features

- HFIP-800**
- Columns exclusively for use with hexafluoroisopropanol (HFIP)
  - Corresponds to USP L21

- HFIP-600**
- Rapid analysis, solvent saving type
  - Corresponds to USP L21

## 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 are 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

© Use of the HFIP-600 series with semi-micro type devices is recommended.

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

Base Material : Styrene divinylbenzene copolymer  
Shipping Solvent : Hexafluoroisopropanol (HFIP)

## Target molecular weight range and Exclusion limit

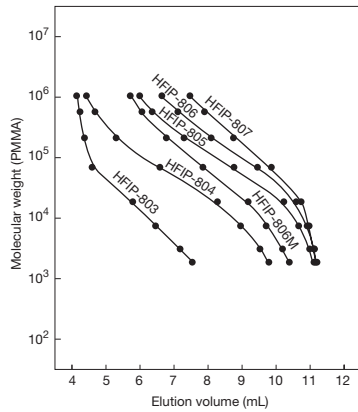
### ● With \*PMMA (eluent : HFIP)

Product Name	Target Molecular Weight Range	Exclusion Limit	Product Name	Target Molecular Weight Range	Exclusion Limit
<b>HFIP-803</b>	1,000 – 30,000	60,000	<b>HFIP-603</b>	1,000 – 30,000	60,000
<b>HFIP-804</b>	20,000 – 200,000	300,000	<b>HFIP-604</b>	20,000 – 200,000	300,000
<b>HFIP-805</b>	20,000 – 600,000	1,000,000	<b>HFIP-605</b>	20,000 – 600,000	1,000,000
<b>HFIP-806</b>	70,000 – *(8,000,000)	*(8,000,000)	<b>HFIP-606</b>	70,000 – *(8,000,000)	*(8,000,000)
<b>HFIP-806M</b>	1,000 – *(8,000,000)	*(8,000,000)	<b>HFIP-606M</b>	1,000 – *(8,000,000)	*(8,000,000)
<b>HFIP-807</b>	70,000 – *(50,000,000)	*(50,000,000)	<b>HFIP-607</b>	70,000 – *(50,000,000)	*(50,000,000)

\* Please use the above table as a rough indication for the column selection.

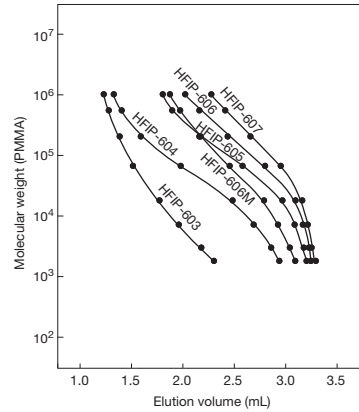
\*PMMA : Polymethylmethacrylate  
\*( ) Estimated value

## 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

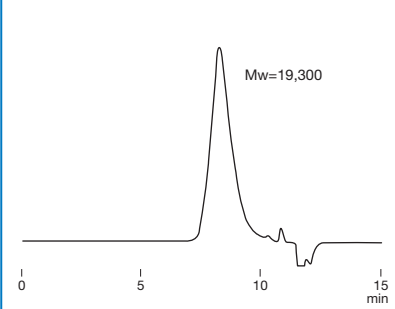
## Calibration curves for HFIP-600 series using PMMA



**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

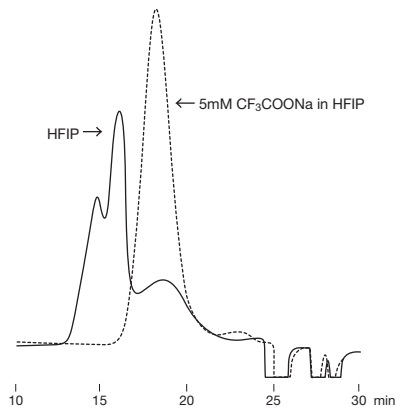
## Polyethylene terephthalate (PET)

Sample : Polyethylene terephthalate 0.2%, 20 $\mu$ L



**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 salt addition)



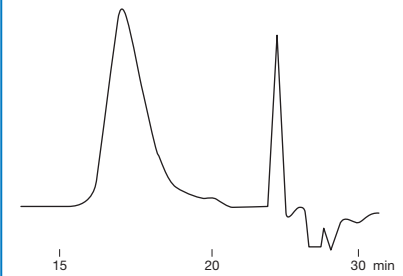
Sample : Polycaprolactum (Nylon® 6)

In SEC analysis using HFIP, some samples may yield abnormal peaks as a result of ionic interaction. In this case, ionic interaction can be suppressed by adding sodium trifluoroacetate to HFIP.

**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%, 500 $\mu$ L

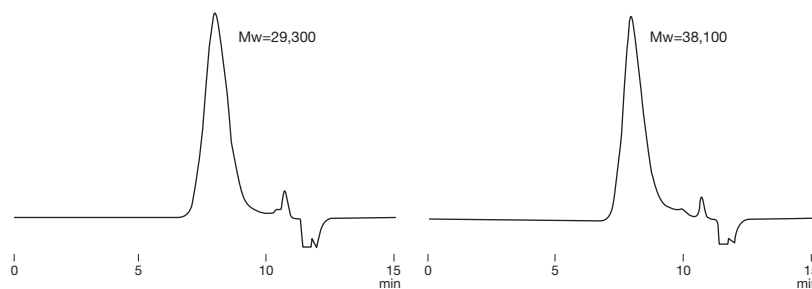


**Column** : Shodex GPC HFIP-805 + HFIP-803  
**Eluent** : 5mM CF<sub>3</sub>COONa in HFIP  
**Flow rate** : 1.0mL/min  
**Detector** : RI  
**Column temp.** : 40°C

## Polyamides (Nylon 610 and Nylon 6)

Sample : Nylon® 610 0.2%, 20 $\mu$ L

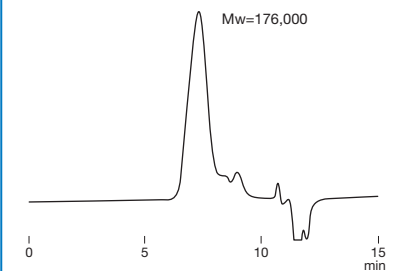
Sample : Nylon® 6 0.2%, 20 $\mu$ L



**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

## Polyacetal

Sample : Polyacetal 0.2%, 20 $\mu$ L



**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

# Applicability of SEC (GPC) Columns to Solvent Replacement

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

×



# Calibration Standards for SEC

## [Polystyrene (PS)]

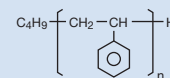
### Features

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

### Kit type

Product Code	Product Name	Contents	MW Range
F8601105	<b>STANDARD SL-105</b>	0.5g x 10 kinds	580 – 19,500
F8602105	<b>STANDARD SM-105</b>	0.5g x 10 kinds	1,220 – 2,700,000
F8603075	<b>STANDARD SH-75</b>	0.5g x 7 kinds	591,000 – 6,870,000

### Structural formula of S series



### SL-105

Std. No.	Mp	Mw/Mn
S-19	19,500	1.03
S-13	13,300	1.02
S-9.9	9,970	1.03
S-6.9	6,940	1.03
S-4.8	4,830	1.04
S-2.7	2,780	1.04
S-1.8	1,860	1.04
S-1.3	1,390	1.05
S-0.8	860	1.07
S-0.5	580	1.11

### SM-105

Std. No.	Mp	Mw/Mn
S-2700	2,700,000	1.07
S-1390	1,390,000	1.06
S-661	661,000	1.04
S-326	326,000	1.02
S-124	124,000	1.03
S-47	47,200	1.03
S-18	18,300	1.03
S-6.9	6,940	1.03
S-3.0	2,980	1.04
S-1.2	1,220	1.06

### SH-75

Std. No.	Mp	Mw/Mn
S-6870	6,870,000	1.09
S-5190	5,190,000	1.03
S-3990	3,990,000	1.05
S-2350	2,350,000	1.04
S-1820	1,820,000	1.04
S-991	991,000	1.05
S-591	591,000	1.02

(Note)  
Molecular weights (Mp, Mw/Mn) of each 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)

### Kit type

Product Code	Product Name	Contents	MW Range
F8604075	<b>STANDARD M-75</b>	0.5g x 7 kinds	2,880 – 1,050,000

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

Std. No.	Mp	Mw/Mn
M-1050	1,050,000	1.07
M-569	569,000	1.04
M-211	211,000	1.02
M-69	68,800	1.02
M-18	17,800	1.04
M-6.8	6,850	1.10
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

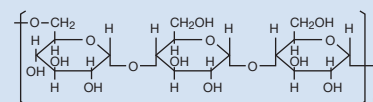
### Kit type

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	21,100	1.09
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	21,100	1.09
STD P-10	9,600	1.09
STD P-5	6,100	1.05

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

# Columns for Anion Exchange Chromatography

## Features

<b>QA-825</b> <b>DEAE-825</b>	<ul style="list-style-type: none"> <li>Suitable for analysis of relatively high molecular weight compounds: proteins, peptides, DNA, and RNA</li> <li>Usable in a wide pH range from pH 2 to 12</li> <li>QA-825 corresponds to USP L23</li> </ul>
<b>DEAE3N-4T</b>	<ul style="list-style-type: none"> <li>Non-porous base material</li> <li>For rapid analysis</li> </ul>
<b>DEAE-2B</b>	<ul style="list-style-type: none"> <li>Non-porous base material</li> <li>Supports UHPLC (available under hyperbaric conditions up to 30 MPa)</li> </ul>
<b>ES-502N 7C</b>	<ul style="list-style-type: none"> <li>Compared to IEC series columns, polyvinyl alcohol is used as base material and this offers different separation pattern</li> <li>Low hydrophobic interaction of proteins allows analysis under mild conditions</li> </ul>
<b>WA-624</b>	<ul style="list-style-type: none"> <li>Suitable for anion exchange analysis of low molecular weight compounds such as nucleotides</li> </ul>

## 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 x 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 x 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 x 35</b>	H <sub>2</sub> O
F7640002	<b>Asahipak ES-502N 7C</b>	0.55	Polyvinyl alcohol	9	2,000	<b>7.5 x 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 x 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 x 10</b>	0.1M Sodium phosphate buffer (pH3.0)/CH <sub>3</sub> CN =80/20

### ● Weak anion exchange resin [Functional Group : Diethylaminoethyl] : For UHPLC column

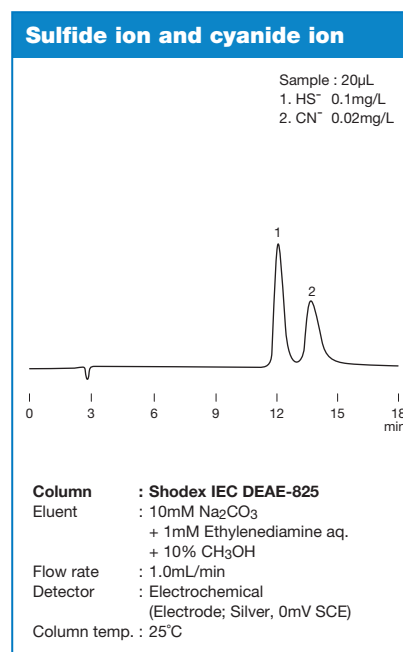
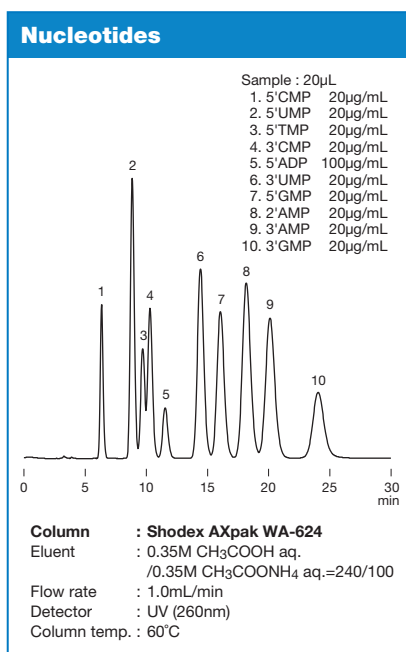
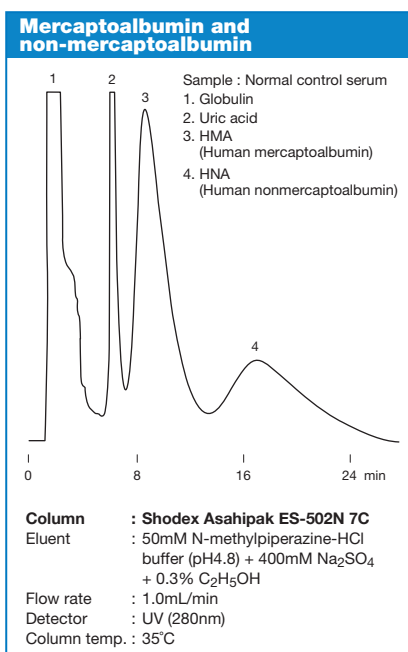
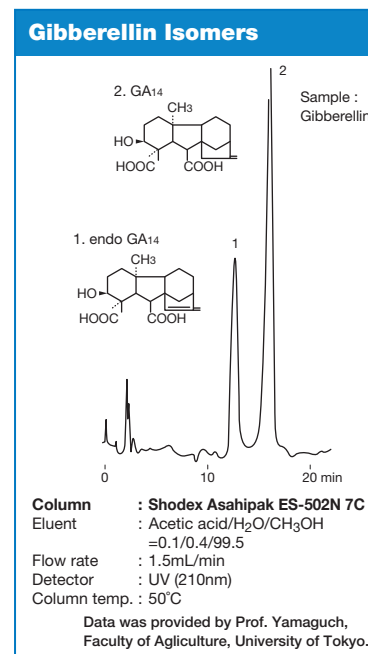
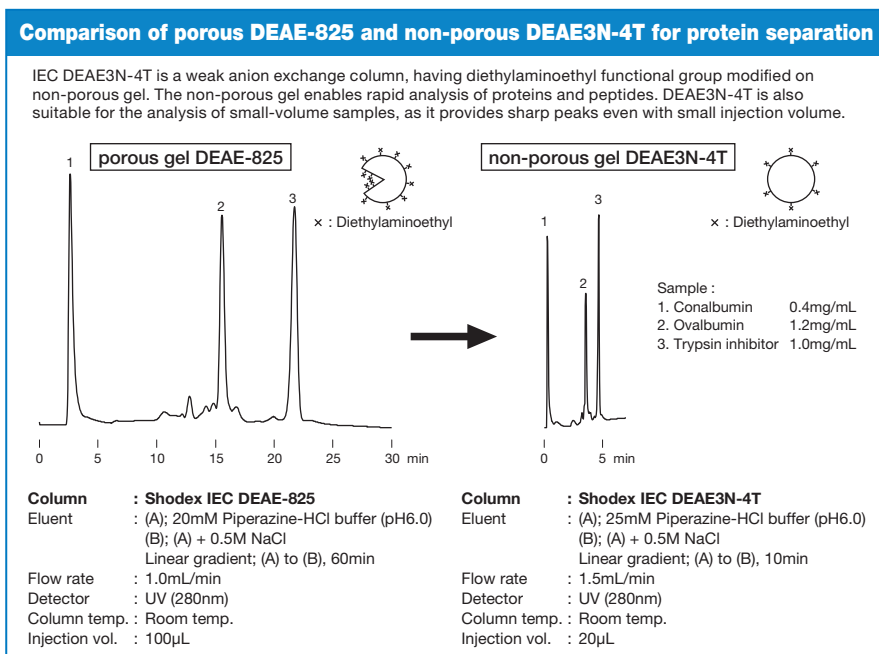
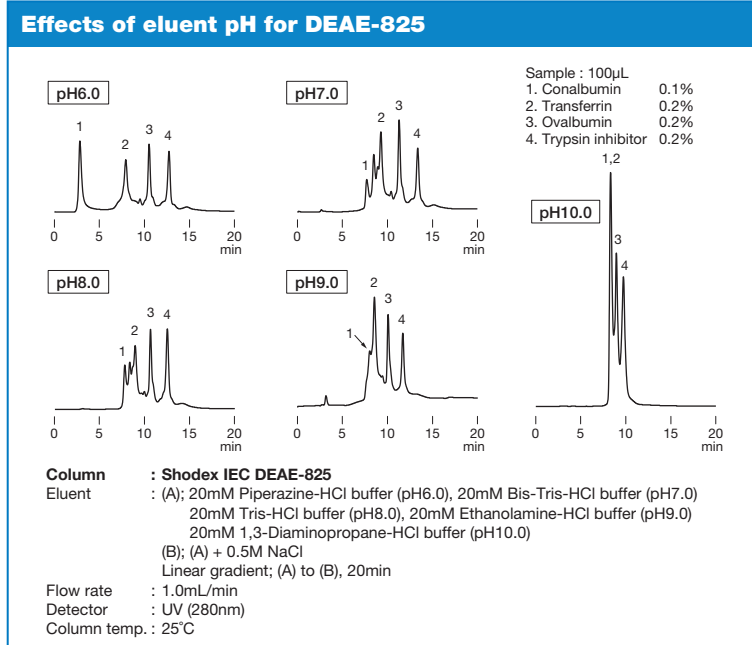
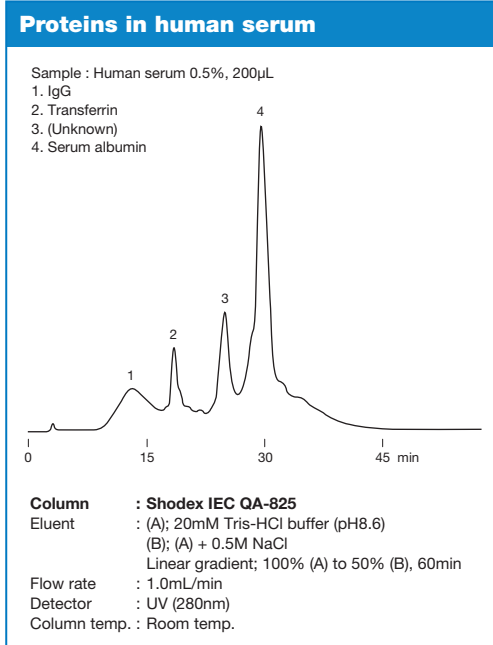
Product Code	Product Name	Ion Exchange Capacity (meq/g)	Base Material	Particle Size (µm)	Pore Size (Å)	Column Size (mm) I.D. x Length	Shipping Solvent
F6112110	<b>PIKESS DEAE-2B</b>	0.4	Polyhydroxymethacrylate	2.5	-	<b>2.0 x 50</b>	H <sub>2</sub> O

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

Product Code	Product Name	Ion Exchange Capacity (meq/g)	Base Material	Particle Size (µm)	Pore Size (Å)	Column Size (mm) I.D. x Length
F7960122	<b>DEAE9A-2D</b>	0.55	Polyvinyl alcohol	9	2,000	<b>2.0 x 150</b>

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

Product Code	Product Name	Particle Size (µm)	Column Size (mm) I.D. x Length	Standard columns
F6548000	<b>IEC QA-2025</b>	20	<b>20.0 x 150</b>	QA-825
F6548050	<b>IEC QA-5025</b>	37	<b>50.0 x 300</b>	QA-825
F6709602	<b>IEC QA-LG</b>	20	<b>8.0 x 50</b>	(guard column)
F6548001	<b>IEC DEAE-2025</b>	20	<b>20.0 x 150</b>	DEAE-825
F6548051	<b>IEC DEAE-5025</b>	37	<b>50.0 x 300</b>	DEAE-825
F6709603	<b>IEC DEAE-LG</b>	20	<b>8.0 x 50</b>	(guard column)
F6840004	<b>Asahipak ES-502N 20C</b>	13	<b>20.0 x 100</b>	ES-502N 7C
F6710021	<b>Asahipak GS-20G 7B</b>	20	<b>7.5 x 50</b>	(guard column)



# Columns for Cation Exchange Chromatography

## Features

<b>SP-825 CM-825</b>	<ul style="list-style-type: none"> <li>Suitable for analysis of relatively high molecular weight compounds: proteins, peptides, DNA, and RNA</li> <li>Usable in a wide pH range from pH 2 to 12</li> </ul>
<b>SP-420N</b>	<ul style="list-style-type: none"> <li>Non-porous base material</li> <li>For rapid analysis</li> </ul>
<b>SP-2B</b>	<ul style="list-style-type: none"> <li>Non-porous base material</li> <li>Supports UHPLC (available under hyperbaric conditions for up to 30 MPa)</li> </ul>
<b>ES-502C 7C</b>	<ul style="list-style-type: none"> <li>Compared to IEC series columns, polyvinyl alcohol is used as base material offering different separation pattern</li> <li>Low hydrophobic interaction with proteins allows analysis under mild conditions</li> </ul>
<b>P-421S</b>	<ul style="list-style-type: none"> <li>Column for amino acids analysis by cation exchange mode</li> <li>Supports simultaneous analysis of different amino acids</li> <li>Corresponds to USP L22 and L58</li> </ul>

## 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 x 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 x 35</b>	20mM Sodium acetate buffer + 0.5M Na <sub>2</sub> SO <sub>4</sub> (pH5.0)

### ● Strong cation exchange resin [Functional Group : Sulfopropyl] : For 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 x 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 x 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 x 100</b>	0.1M Sodium phosphate buffer (pH4.4)

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

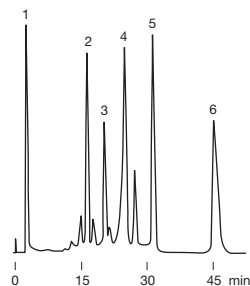
Product Code	Product Name	Plate Number (TP/column)	Base Material	Particle Size (µm)	Column Size (mm) I.D. x Length	Shipping Solvent
F6354211	<b>CXpak P-421S</b>	≥ 3,500	Styrene divinylbenzene copolymer	6	<b>4.6 x 150</b>	H <sub>2</sub> O
F6700210	<b>CXpak P-G</b>	(guard column)	Styrene divinylbenzene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

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

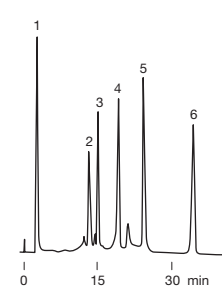
Product Code	Product Name	Particle Size (µm)	Column Size (mm) I.D. x Length	Standard columns
F6548002	<b>IEC SP-2025</b>	20	<b>20.0 x 150</b>	SP-825
F6548052	<b>IEC SP-5025</b>	37	<b>50.0 x 300</b>	SP-825
F6709604	<b>IEC SP-G 8B (IEC SP-LG)</b>	20	<b>8.0 x 50</b>	(guard column)
F6548003	<b>IEC CM-2025</b>	20	<b>20.0 x 150</b>	CM-825
F6548053	<b>IEC CM-5025</b>	37	<b>50.0 x 300</b>	CM-825
F6709605	<b>IEC CM-LG</b>	20	<b>8.0 x 50</b>	(guard column)
F6840003	<b>Asahipak ES-502C 20C</b>	13	<b>20.0 x 100</b>	ES-502C 7C
F6710021	<b>Asahipak GS-20G 7B</b>	20	<b>7.5 x 50</b>	(guard column)

## Protein separation using cation exchange columns

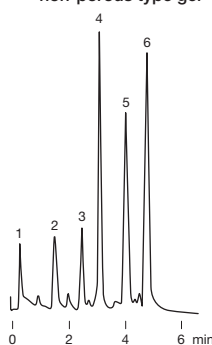
(I) CM-825  
(Weak cation exchange)  
90 $\mu$ L injection



(II) SP-825  
(Strong cation exchange)  
30 $\mu$ L injection



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



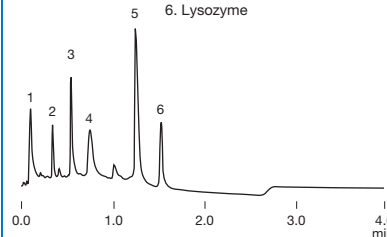
Column : (I) Shodex IEC CM-825, (II) Shodex IEC SP-825,  
(III) Shodex IEC SP-420N

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.

Sample :  
1. Myoglobin  
2. Trypsinogen  
3. Ribonuclease A  
4.  $\alpha$ -Chymotrypsinogen A  
5. Cytochrome c  
6. Lysozyme

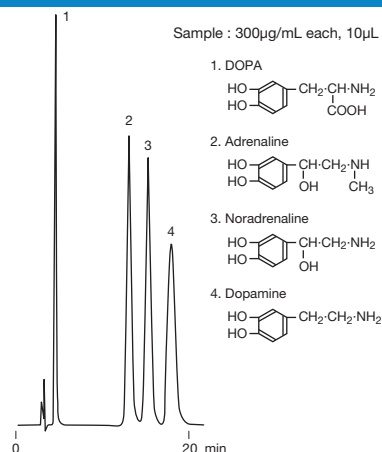
## Rapid analysis of proteins using UHPLC

Sample : 5 $\mu$ L (13mg total protein)  
1. Myoglobin  
2. Trypsinogen  
3. Ribonuclease A  
4.  $\alpha$ -Chymotrypsinogen A  
5. Cytochrome c  
6. Lysozyme



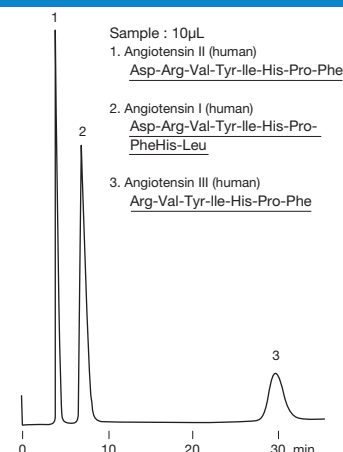
Column : Shodex PIKESS SP-2B  
Eluent : (A); 20mM Sodium phosphate buffer (pH 7.0)  
(B); (A) + 0.5 M NaCl  
Linear gradient; 100% (A) to 50% (B), 2.5min  
Flow rate : 1.2mL/min  
Detector : UV (280nm)  
Column temp. : 25°C

## Catecholamines



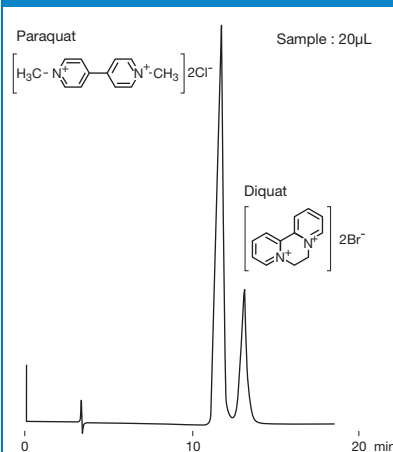
Column : Shodex Asahipak ES-502C 7C  
Eluent : 20mM Sodium malonate buffer + 0.5M NaCl (pH6.0)  
Flow rate : 1.0mL/min  
Detector : UV (280nm)  
Column temp. : 30°C

## Angiotensins



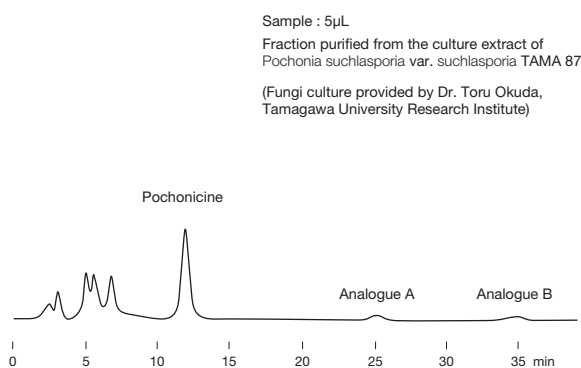
Column : Shodex Asahipak ES-502C 7C  
Eluent : 50mM Sodium malonate buffer (pH6.0) /CH<sub>3</sub>CN=80/20  
Flow rate : 1.0mL/min  
Detector : UV (280nm)  
Column temp. : 30°C

## Paraquat and diquat



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

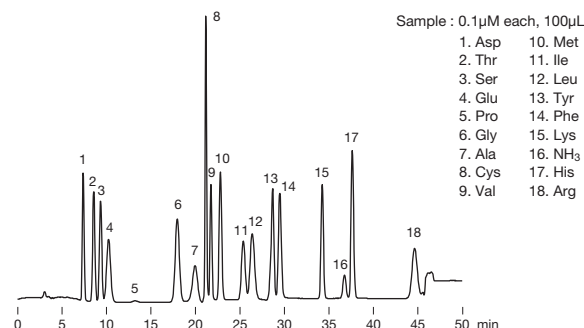
## Analysis of pochonicine and its analogues in filamentous fungi culture extract



Column : Shodex Asahipak ES-502C 7C  
Eluent : 10mM Ammonium bicarbonate aq.  
Flow rate : 0.6mL/min  
Detector : UV (210nm)  
Column temp. : 40°C

Data provided by Dr. Teruhiko Nitoda,  
Faculty of Agriculture, Okayama University.

## Standard amino acids



Column : Shodex CXpak P-421S  
Eluent : MCI 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

# Columns for Special Separation Modes

## Column for Hydrophobic Interaction Chromatography

### 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

## Columns for Affinity Chromatography

### Features

- AFpak**
- Rigid polymer-based packing materials enable high speed analysis
  - Functional group is 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
F7118954	<b>AFpak ADS-894</b>	Dextran sulfate	30mg	18	<b>8.0 x 50</b>	50mM Sodium phosphate buffer + 0.02% NaN <sub>3</sub> (pH7.4)
F7118945	<b>AFpak AHR-894</b>	Heparin	5mg	18	<b>8.0 x 50</b>	10mM Tris-HCl buffer + 10mM NaCl + 0.02% NaN <sub>3</sub> (pH7.4)
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)
F7113050	<b>AFpak APG-894</b>	Protein G	4–5mg	18	<b>8.0 x 50</b>	10mM Sodium phosphate buffer + 0.15M NaCl + 0.02% NaN <sub>3</sub> (pH7.4)
F7118959	<b>AFpak AWG-894</b>	Wheat germ agglutinin (WGA)	14mg	18	<b>8.0 x 50</b>	0.1M Tris-HCl buffer + 0.15M NaCl + 0.2M N-Acetylglucosamine + 0.02% NaN <sub>3</sub> (pH7.4)
F7118964	<b>AFpak ACH-494</b>	Choline oxydase, Acetylcholine esterase	–	18	<b>4.6 x 10</b>	10mM Phosphate buffer + 1.0M NaCl (pH7.4)

Base Material : Polyhydroxymethacrylate

## Columns for Chiral Separation

### Features

- CDBS-453**
- Separates optical isomers by using their conformational compatibility differences
  - Versatile column for chiral separation
  - Corresponds to USP L45
- CRX-853**
- Separates optical isomers by using the differences in metal complex formation capacities of functional group and metal ion in eluent and optical isomers
  - 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% Acetic acid + 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>	L-amino acid derivative	Polyhydroxymethacrylate	6	<b>4.6 x 10</b>	0.25mM CuSO <sub>4</sub> aq.

## Column for High Temperature Reversed Phase Chromatography

### Features

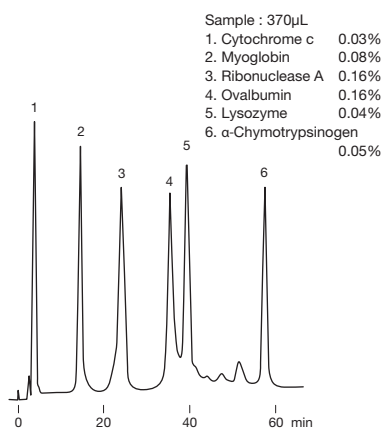
- ET-RP1**
- Capable of high temperature analysis up to 150°C
  - High temperature analysis improves column efficiency and enables rapid analysis
  - Corresponds to USP L67

### 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

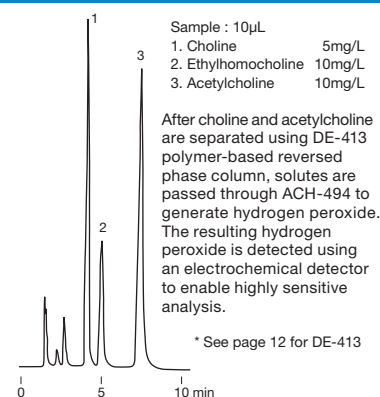
Base Material : Polyvinyl alcohol

## Protein separation by hydrophobic interaction chromatography



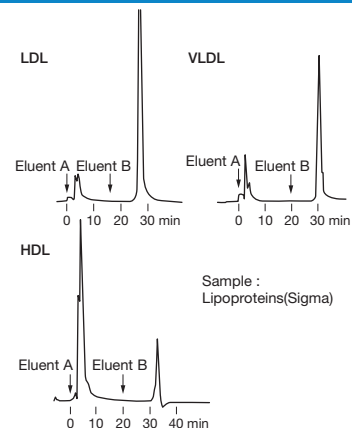
**Column** : Shodex HIC PH-814  
**Eluent** : (A); 1.8M Ammonium sulfate + (B)  
 (B); 0.1M Phosphate buffer (pH7.0)  
 Linear gradient; (A) to (B), 60min  
**Flow rate** : 1.0mL/min  
**Detector** : UV (280nm)  
**Column temp.** : Room temp.

## Choline and acetylcholine



**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

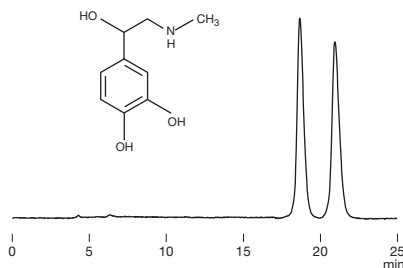
## Lipoproteins in plasma



**Column** : Shodex AFpak ADS-894  
**Eluent** : (A); 50mM Sodium phosphate buffer  
 (pH7.4)  
 (B); (A) + 1.0M NaCl  
 Step gradient; (A) to (B)  
**Flow rate** : 1.0mL/min  
**Detector** : UV (280nm)  
**Column temp.** : Room temp.

## Chiral separation of epinephrines

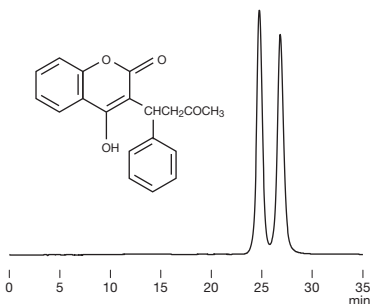
Sample : Epinephrine 50 $\mu$ g/mL, 50 $\mu$ L



**Column** : Shodex ORpak CDBS-453  
**Eluent** : 0.05% Acetic acid + 0.2M NaCl aq.  
 /CH<sub>3</sub>CN=95/5  
**Flow rate** : 0.5mL/min  
**Detector** : UV (254nm)  
**Column temp.** : 10°C

## Chiral separation of warfarin

Sample : Warfarin 20 $\mu$ g/mL, 20 $\mu$ L

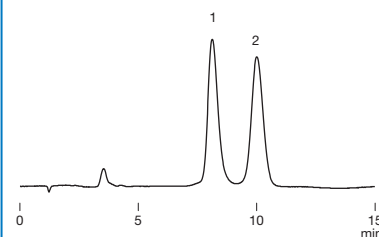


**Column** : Shodex ORpak CDBS-453  
**Eluent** : 1.0% Acetic acid + 0.2M NaCl aq.  
 /CH<sub>3</sub>CN=80/20  
**Flow rate** : 0.6mL/min  
**Detector** : UV (310nm)  
**Column temp.** : 16°C

## Chiral separation of lactic acids

Sample : Lactic acid 50 $\mu$ g/mL, 50 $\mu$ L

1. L-Lactic acid
2. D-Lactic acid

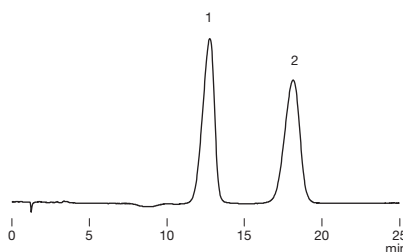


**Column** : Shodex ORpak CRX-853  
**Eluent** : 0.5mM CuSO<sub>4</sub> aq.  
**Flow rate** : 1.0mL/min  
**Detector** : UV (230nm)  
**Column temp.** : 50°C

## Chiral separation of mandelic acids

Sample : Mandelic acid 100 $\mu$ g/mL, 20 $\mu$ L

1. D-Mandelic acid
2. L-Mandelic acid

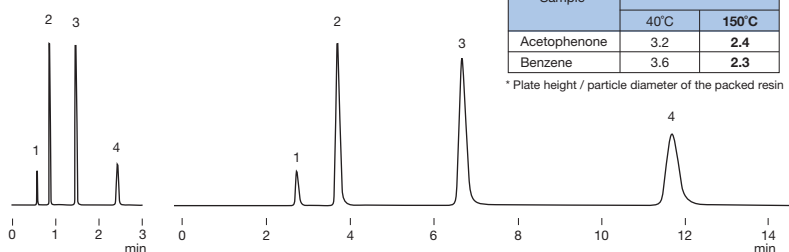


**Column** : Shodex ORpak CRX-853  
**Eluent** : 0.25mM CuSO<sub>4</sub> aq.  
**Flow rate** : 1.0mL/min  
**Detector** : UV (230nm)  
**Column temp.** : 50°C

## 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



**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** : Polaratherm 9000 Series  
 (SandraSelerity Technologies, Inc)

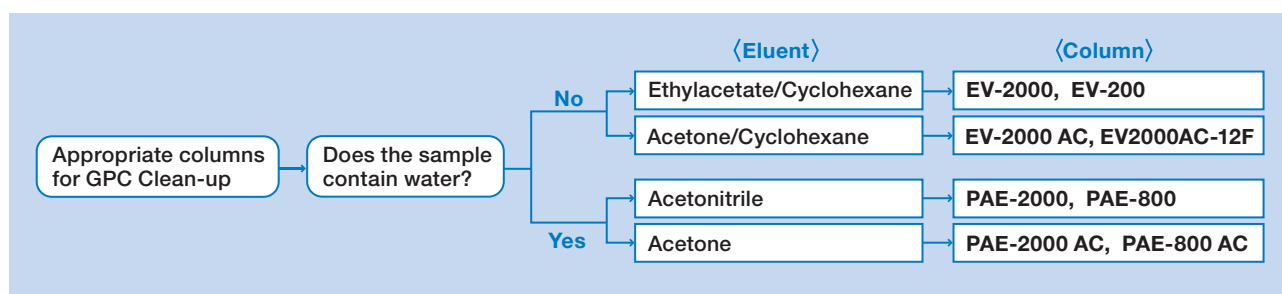
**Note** :  
 The eluent was introduced into the column after being preheated and was cooled after column elution, then introduced into the detector.

Data provided by Research Institute for Chromatography bvba

# Columns for GPC Clean-up

## 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	<b>CLNpak EV2000AC-12F</b>	16	30	<b>12.0 × 300</b>	Acetone/Cyclohexane=3/7
F6090007	<b>CLNpak EV-G AC12C</b>	16	(guard column)	<b>12.0 × 100</b>	Acetone/Cyclohexane=3/7
F6090003	<b>CLNpak EV-2000 AC</b>	16	30	<b>20.0 × 300</b>	Acetone/Cyclohexane=3/7
F6090004	<b>CLNpak EV-G AC</b>	16	(guard column)	<b>20.0 × 100</b>	Acetone/Cyclohexane=3/7
F6090001	<b>CLNpak EV-2000</b>	16	30	<b>20.0 × 300</b>	Ethylacetate/Cyclohexane=3/7
F6090002	<b>CLNpak EV-G</b>	16	(guard column)	<b>20.0 × 100</b>	Ethylacetate/Cyclohexane=3/7
F6090005	<b>CLNpak EV-200</b>	16	30	<b>2.0 × 150</b>	Ethylacetate/Cyclohexane=3/7

Base Material : Styrene divinylbenzene copolymer

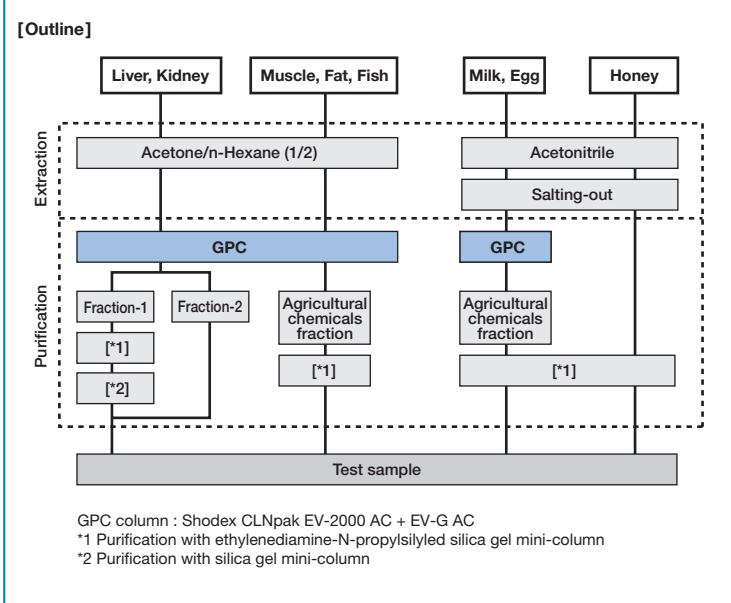
## GPC Clean-up for phthalic acid esters in sediments, biological samples, blood, etc.

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

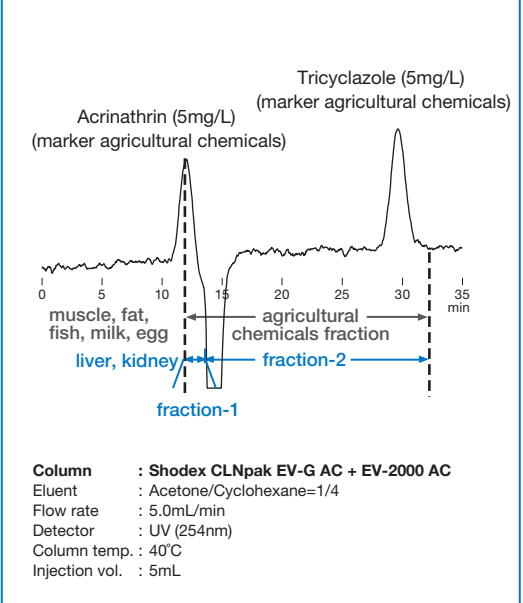
Base Material : Polyvinyl alcohol



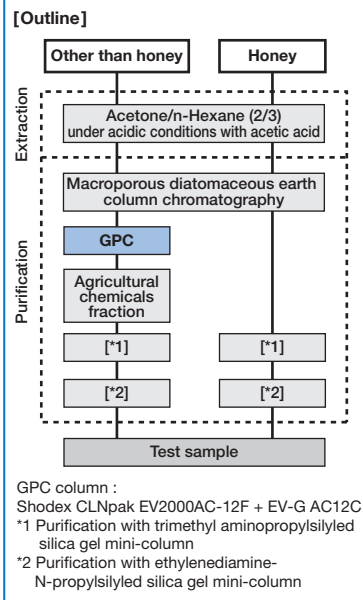
**Sample preparation outline for simultaneous GC/MS and LC/MS analysis of agricultural chemicals in livestock and marine products (part 1)**



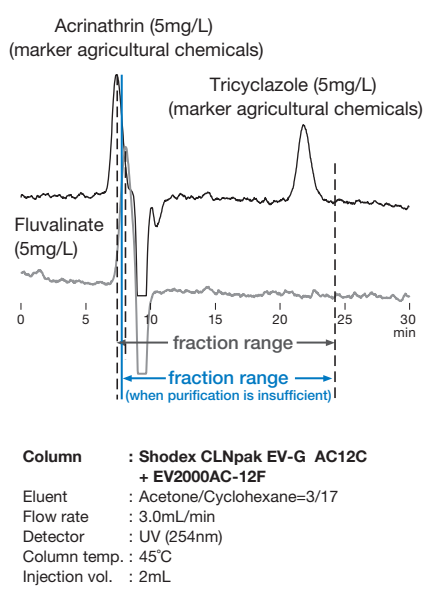
**Preparation range of agricultural chemicals using EV-2000 AC**



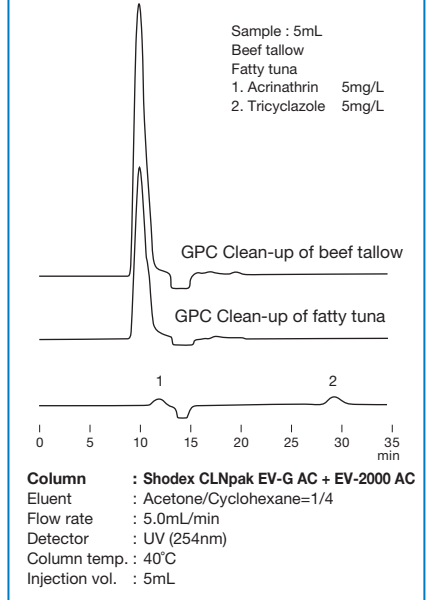
**Sample preparation outline for simultaneous LC/MS analysis of agricultural chemicals in livestock and marine products (part 2)**



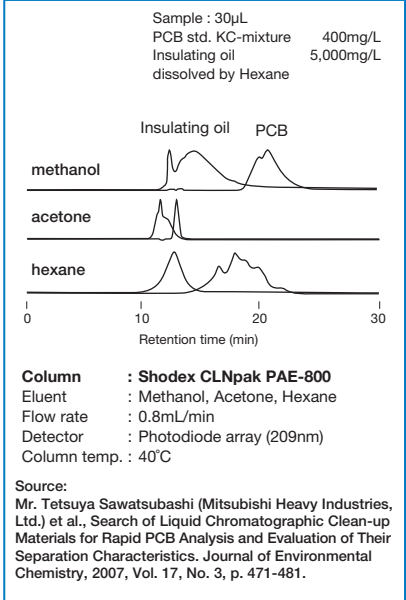
**Preparation range of agricultural chemicals using EV2000AC-12F**



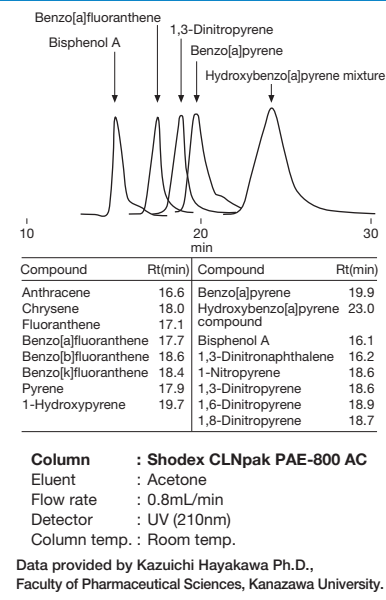
**GPC Clean-up of fatty tuna and beef tallow**



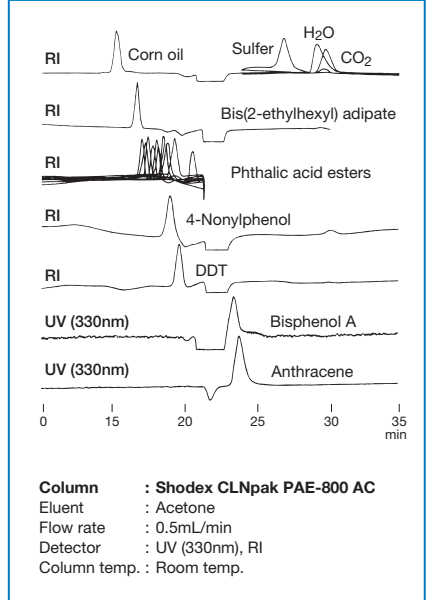
**Separation of PSB and insulating oil using PAE-800**



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



**Elution positions of phthalic acid esters using PAE-800 AC**



# Pretreatment Columns for Column Switching Method

## Features

- PK**
- Effective for both hydrophilic and hydrophobic substances
  - The high protein removal rate enables efficient pretreatment
- 
- GF-4A**
- Higher protein removal rate than PK columns
- \* GF-4A column removes proteins well but is not suitable for trapping hydrophilic substances. Use PK columns for this purpose.

## Cartridge columns and holder for column switching method

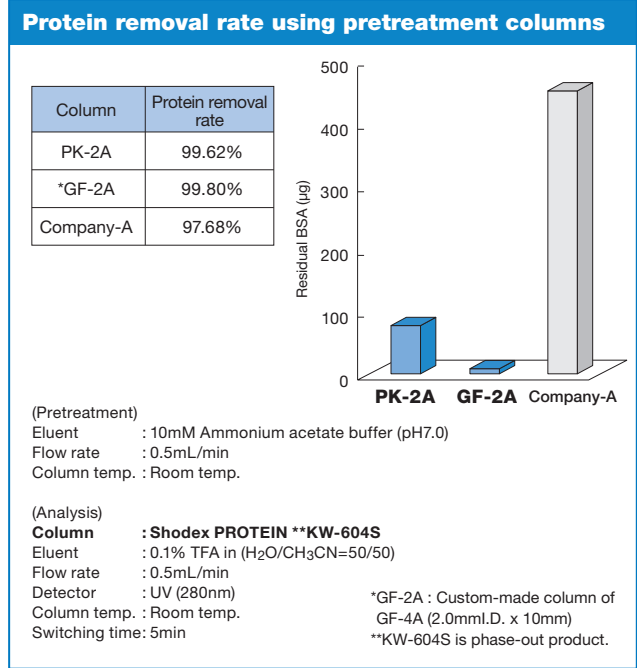
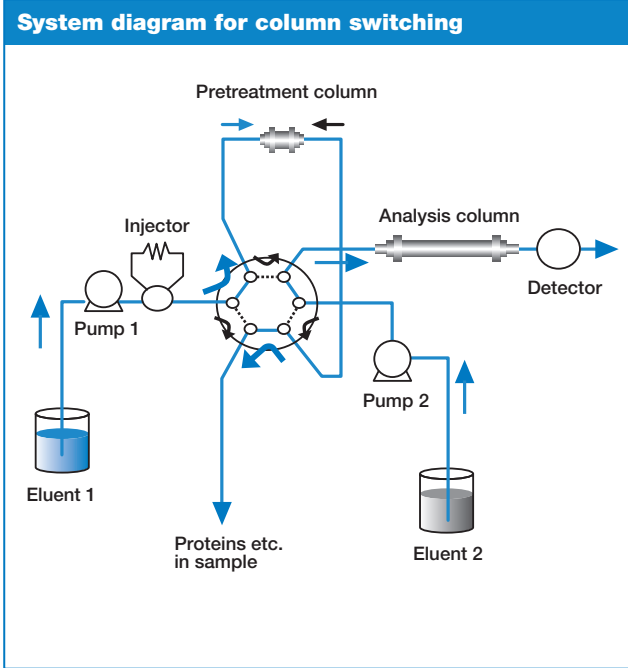
Product Code	Product Name	Particle Size (μm)	Pore Size (Å)	Column Size (mm) I.D. x Length	Shipping Solvent	Pcs/box
F8700000	<b>MSpak PK-2A 2p</b>	30	30	<b>2.0 x 10</b>	H <sub>2</sub> O	2
F8700012	<b>MSpak PK-4A 2p</b>	30	30	<b>4.0 x 10</b>	H <sub>2</sub> O	2
F8700001	<b>MSpak HLD</b>	-	-	<b>(Holder for PK)</b>	-	1

Base Material : Hydrophilic copolymers containing N-vinyl acetoamide  
 \* PK series are cartridge columns and thus should be installed in a column holder "MSpak HLD" before use.

## 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



### Recovery rate of medical compounds using PK-2A

Sample	Recovery (%)	Sample	Recovery (%)	Sample	Recovery (%)
Acetaminophen	115	Cloxacolam	91	Mianserin	92
Acetylpheneturide	92	Desipramine	109	Nimetazepam	90
Aconitine	110	Diazepam	97	Nitrazepam	97
Alprazolam	99	Diphenhydramine	93	Nortriptyline	86
Amitriptyline	93	Estazolam	101	Oxazepam	97
Amobarbital	93	Ethenzamide	98	Oxazolam	99
Barbital	94	Etizolam	105	Pentobarbital	93
Benzoylaconitine	96	Fludiazepam	97	Perfenazine	86
Benzoylhypaconine	83	Flumazenil	93	Phenacetin	108
Biperiden	99	Flunitrazepam	97	Phenobarbital	96
Bromazepam	102	Flurazepam	106	Phenytoin	99
Bromocriptine	80	Glutethimide	93	Primidone	91
Bromperidol	89	Haloperidol	99	Promethazine	92
Bromvalerylurea	94	Haloxazolam	93	Propericiazine	90
Brotizolam	97	1-Hydroxymethyltriazolam	90	Propranolol	97
Caffeine	106	4-Hydroxytriazolam	91	Secobarbital	97
Carbamazepine	97	Hydroxyzine	99	Sildenafil citrate	95
Carpipramine	99	Hypaconitine	97	Thioridazine	97
Chlordiazepoxide	133	Imipramine	97	Timiperone	88
Chlormezanone	92	Indomethacin	93	Triazolam	96
Chlorpheniramine	111	Levomepromazine	96	Trihexyphenidyl	91
Chlorpromazine	77	Lofepamine	65	Trimethadione	137
Clocapramine	95	Maprotyline	90	Trimipramine	107
Clofedanol	91	Medazepam	91	Warfarin	81
Clomipramine	95	Mephobarbital	99	Zotepine	92
Clonazepam	96	Mesaconine	118		
Clotiazepam	96	Metharbital	94		

(Adsorption)  
 Eluent : 10mM Ammonium acetate buffer (pH7.0)  
 Flow rate : 0.5mL/min

(Elution)  
 Eluent : 10mM Ammonium acetate buffer (pH7.0)/CH<sub>3</sub>CN  
 Flow rate : 0.5mL/min  
 Detector : UV (220nm)  
 Switching time: 5min

# Notice of Product Name Changes

Some of Shodex guard columns have been renamed.  
There is no change of product code.

## 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 DE-G 20C</b>	<b>RSpak DE-LLG</b>	F6700191
13	<b>RSpak DM-G 8B</b>	<b>RSpak DM-LG</b>	F6700404
13	<b>RSpak DM-G 20C</b>	<b>RSpak DM-LLG</b>	F6700162
24	<b>SUGAR SC-G 6B</b>	<b>SUGAR SC-LG</b>	F6700090
24	<b>SUGAR SP-G 6B</b>	<b>SUGAR SP-G</b>	F6700081
24	<b>SUGAR KS-G 6B</b>	<b>SUGAR KS-G</b>	F6700020
24	<b>RSpak DC-G 4A</b>	<b>RSpak DC-G</b>	F6700170
24	<b>SUGAR SC1211G 4A</b>	<b>SUGAR SC-G</b>	F6700120
25	<b>SUGAR KS-G 8B</b>	<b>SUGAR KS-LG</b>	F6700002
25	<b>RSpak DC-G 8B</b>	<b>RSpak DC-LG</b>	F6700402
25	<b>RSpak DC-G 20C</b>	<b>RSpak DC-LLG</b>	F6700172
28	<b>RSpak KC-G 6B</b>	<b>RSpak KC-G</b>	F6700030
28	<b>RSpak KC-G 8B</b>	<b>RSpak KC-LG</b>	F6700010
36	<b>PROTEIN KW-G 6B</b>	<b>PROTEIN KW-G</b>	F6700131
36	<b>PROTEIN KW-G 8B</b>	<b>PROTEIN KW-LG</b>	F6709556
38	<b>OHpak SB-G 6B</b>	<b>OHpak SB-G</b>	F6709430
39	<b>OHpak SB-G 8B</b>	<b>OHpak SB-LG</b>	F6709555
46, 52	<b>GPC KF-G 4A</b>	<b>GPC KF-G</b>	F6700300
48	<b>GPC K-G 4A</b>	<b>GPC K-G</b>	F6700401
50	<b>GPC KD-G 4A</b>	<b>GPC KD-G</b>	F6700411
54	<b>GPC KF-G 8B</b>	<b>GPC KF-LG</b>	F6700406
54	<b>GPC K-G 8B</b>	<b>GPC K-LG</b>	F6700407
55	<b>GPC H-G 8B</b>	<b>GPC H-G</b>	F6700310
55	<b>GPC KF-G 20B</b>	<b>GPC KF-LLG</b>	F6700408
55	<b>GPC K-G 20B</b>	<b>GPC K-LLG</b>	F6700409
60	<b>GPC HFIP-G 8B</b>	<b>GPC HFIP-LG</b>	F6700500
60	<b>GPC HFIP-G 4A</b>	<b>GPC HFIP-G</b>	F6700511
66	<b>IEC SP-G 8B</b>	<b>IEC SP-LG</b>	F6709604

# USP (Ver.38) 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	Silica C18M	16
		Silica C18P	16
L3	Porous silica particles, 1.5 to 10µm in diameter, or a monolithic silica rod.	Silica 5SIL	17
L7	Octylsilane chemically bonded to totally or superficially porous silica particles, 1.5 to 10µm in diameter, or a monolithic silica rod.	Silica 5C8	17
L8	An essentially monomolecular layer of aminopropylsilane chemically bonded to totally porous silica gel support, 1.5 to 10µm in diameter	Silica 5NH	17
L10	Nitrile groups chemically bonded to porous silica particles, 1.5 to 10µm in diameter, or a monolithic silica rod.	Silica 5CN	17
L11	Phenyl groups chemically bonded to porous silica particles, 1.5 to 10µm in diameter, or a monolithic silica rod.	Silica 5NPE	17
L17	Strong cation-exchange resin consisting of sulfonated cross-linked styrene-divinylbenzene copolymer in the hydrogen form, 6 to 12µm in diameter	SUGAR SH1011	28
		SUGAR SH1821	28
		RSpak KC-811	28
		IC Y-521	32
L19	Strong cation-exchange resin consisting of sulfonated cross-linked styrene-divinylbenzene copolymer in the calcium form, about 9µm in diameter	SUGAR SC1011	24
		SUGAR SC1821	24
		SUGAR SC1211	24
		EP SC1011-7F	25
		USPpak MN-431	25
L20	Dihydroxypropane groups chemically bonded to porous silica or hybrid particles, 1.5 to 10µm in diameter, or a monolithic silica rod.	PROTEIN KW-800 series	36
		KW400 series	36
L21	A rigid, spherical styrene-divinylbenzene copolymer, 3 to 30µm in diameter	RSpak RP18-415	12
		RSpak DS-613	12
		RSpak DS-413	12
		GPC KF,K,KD,LF,HT,UT,AT,HFIP series	46, 48, 50, 52, 56, 58, 60
L22	A cation-exchange resin made of porous polystyrene gel with sulfonic acid groups, about 10µm in size	SUGAR SC1011	24
		SUGAR SC1821	24
		SUGAR SP0810	24
		SUGAR KS-800 series	24
		RSpak DC-613	24
		SUGAR SZ5532	24
		SUGAR SC1211	24
		EP SC1011-7F	25
		USPpak MN-431	25
		SUGAR SH1011	28
		SUGAR SH1821	28
		RSpak KC-811	28
IC Y-521	32		
CXpak P-421S	66		
L23	An anion-exchange resin made of porous polymethacrylate or polyacrylate gel with quaternary ammonium groups, 7-12µm in size	IEC QA-825	64
L25	Packing having the capacity to separate compounds with a molecular weight range from 100-5000 (as determined by polyethylene oxide), applied to neutral, anionic, and cationic water-soluble polymers. A polymethacrylate resin base, cross-linked with polyhydroxylated ether (surface contained some residual carboxyl functional groups) was found suitable	OHpak SB-802 HQ	38
		OHpak SB-802.5 HQ	38
L26	Butyl silane chemically bonded to totally porous silica particles, 1.5 to 10µm in diameter	Silica 5C4	17
L33	Packing having the capacity to separate dextrans by molecular size over a range of 4,000 to 500,000 Da. It is spherical, silica-based, and processed to provide pH stability	PROTEIN KW-800 series	36
		KW400 series	36
L34	Strong cation-exchange resin consisting of sulfonated cross-linked styrene-divinylbenzene copolymer in the lead form, about 7 to 9µm in diameter	SUGAR SP0810	24
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	38
		OHpak LB-803	38
L38	A methacrylate-based size-exclusion packing for water-soluble samples	OHpak SB-800 HQ series	38
		OHpak LB-800 series	38
L39	A hydrophilic polyhydroxymethacrylate gel of totally porous spherical resin	ODP2 HP	8
		RSpak DM-614	12
		OHpak SB-800 HQ series	38
		OHpak LB-800 series	38
L45	Beta cyclodextrin, R,S-hydroxypropyl ether derivative, bonded to porous silica particles, 5 to 10µm in diameter	ORpak CDBS-453	68
L58	Strong cation-exchange resin consisting of sulfonated cross-linked styrene-divinylbenzene copolymer in the sodium form, about 6 to 30µm diameter	SUGAR KS-800 series	24
		RSpak DC-613	24
		CXpak P-421S	66
L59	Packing for the size-exclusion separations of proteins (separation by molecular weight) over the range of 5 to 7000 kDa. It is spherical (1.5-10µm), silica or hybrid packing with a hydrophilic coating.	PROTEIN KW-800 series	36
		KW400 series	36
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	68
L71	A rigid, spherical polymetacrylate, 4 to 6µm in diameter	RSpak DE-613	12
		RSpak DE-413	12
		RSpak DE-213	12
L82	Polyamine chemically bonded to cross-linked polyvinyl alcohol polymer, 4-5µm in diameter	Asahipak NH2P-50	22
		Asahipak NH2P-40	22

# 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 details of column cleaning procedures, refer to each column's specific operation manual.

## Typical indicators of column deterioration possibility

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

## Selection guide to the cleaning solvent

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.

Columns for reversed phase chromatography	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)
Columns for sugar analysis chromatography	<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>
Columns for aqueous SEC(GFC) chromatography	<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>
Columns for ion exchange chromatography	<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>
Columns for hydrophobic interaction chromatography	<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 clogging of solid substances 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.

# 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.

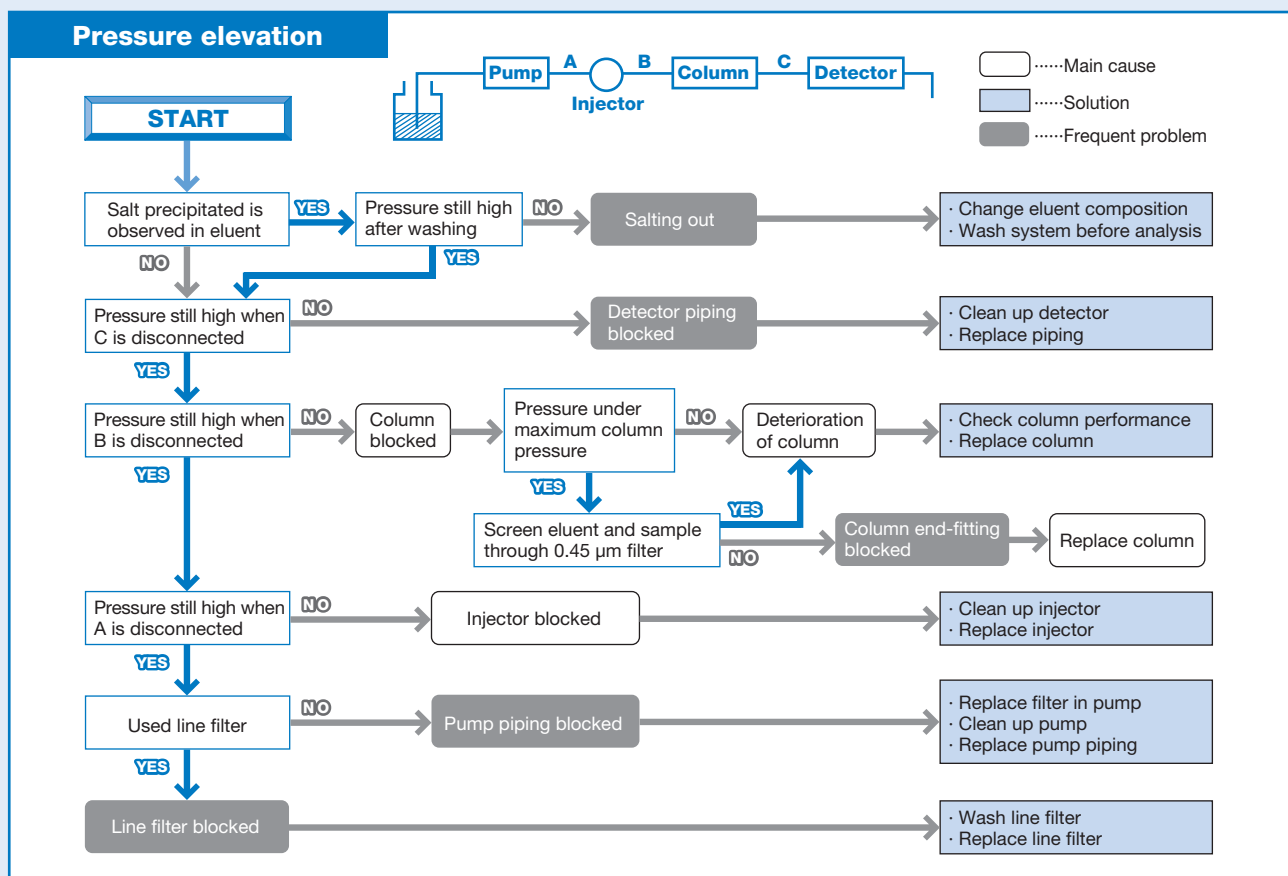
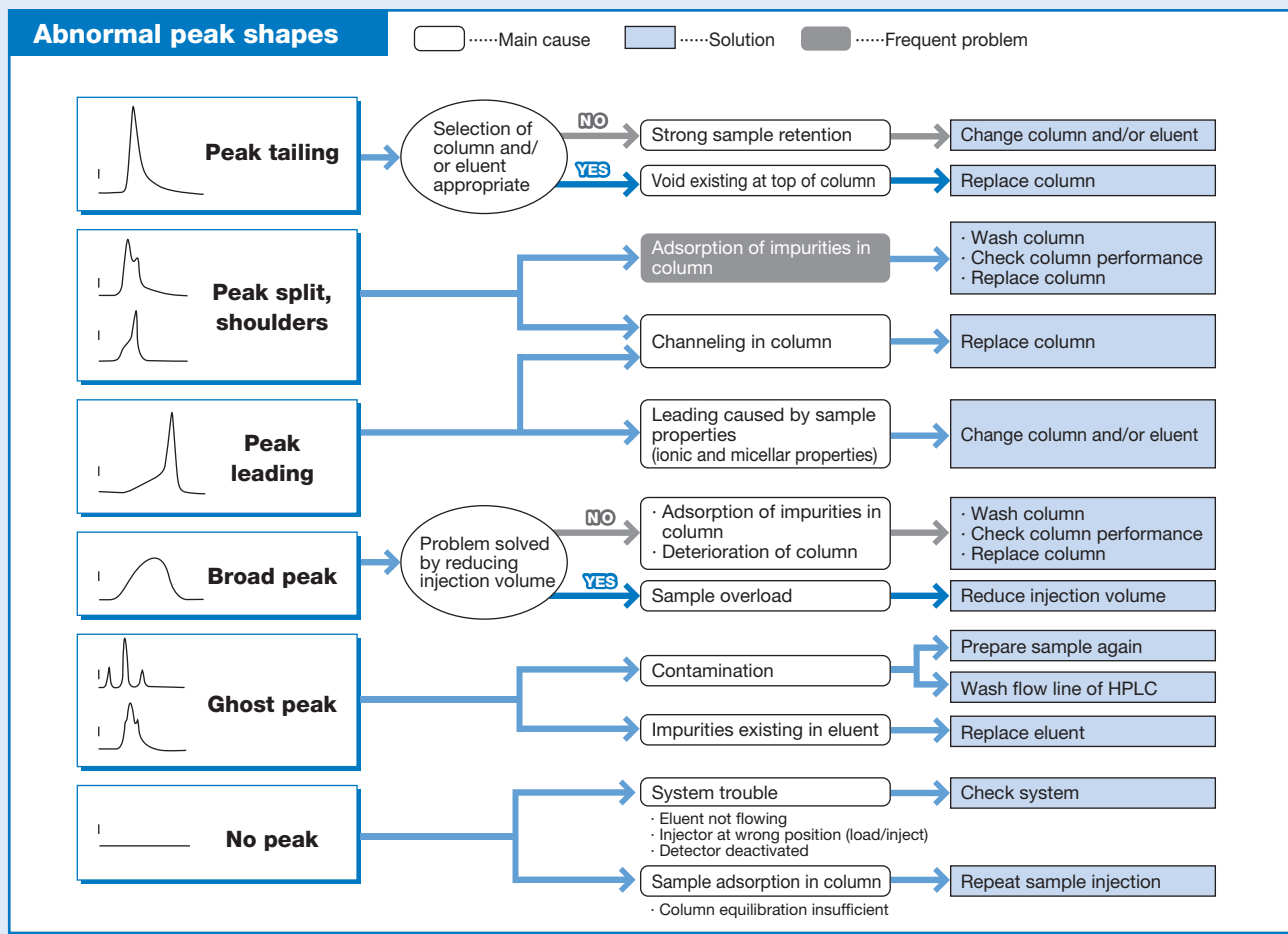
## ■ Other

- 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

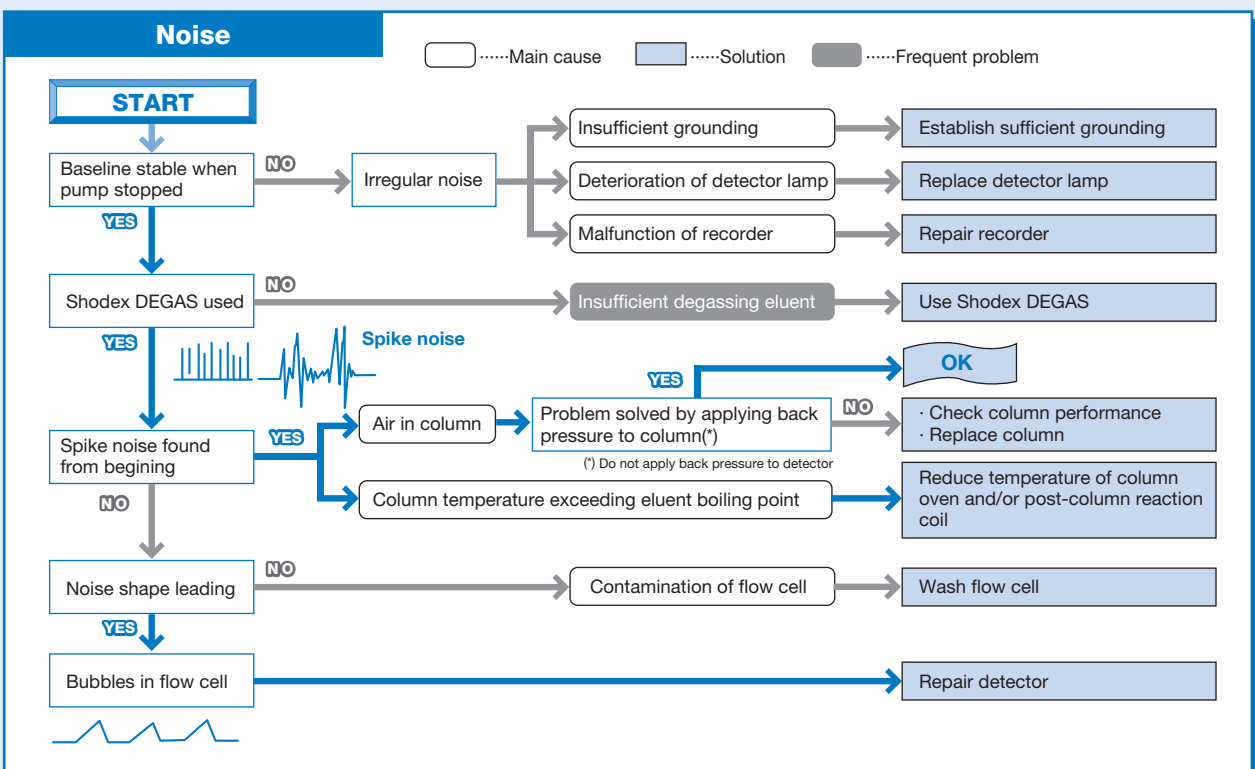
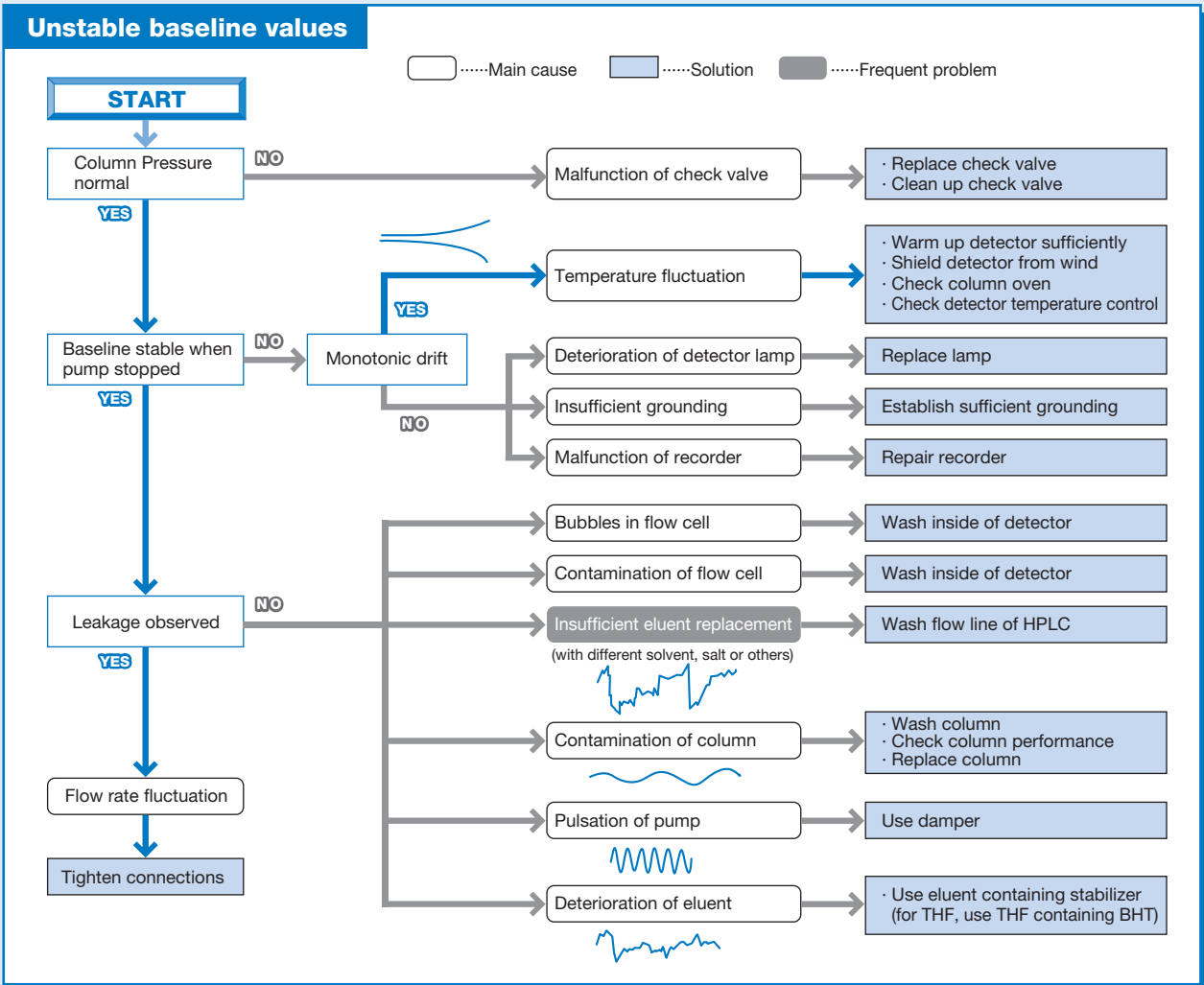
Common causes for abnormal chromatograms





# HPLC System Trouble Shooting

Common causes for abnormal chromatograms



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Columns are listed in alphabetical order under the product name excluding series name.

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F7622003	ODP2 HP-4E	8
F7622004	ODP2 HP-2B	8
F7622005	ODP2 HP-2D	8
F7622006	ODP2 HP-3B	8
F7622007	ODP2 HP-3D	8
F7623001	ET-RP1 4D	68
F7630001	NH2P-50 4E	22
F7630002	NH2P-50 4D	22
F7630005	NH2P-50 4B	22
F7630006	NH2P-50 2D	22
F7630007	NH2P-40 3E	22
F7630008	NH2P-40 2B	22
F7630009	NH2P-40 2D	22
F7630010	NH2P-40 2E	22

Product Code	Product Name	Page
F7630011	NH2P-40 3B	22
F7630012	NH2P-40 3D	22
F7630100	VG-50 4E	20
F7630200	VG-50 4D	20
F7630300	VG-50 2D	20
F7630400	VT-50 2D	20
F7640001	ES-502C 7C	66
F7640002	ES-502N 7C	64
F7750311	GS320A-4E	42
F7750312	GS320A-4D	42
F7750613	GS620A-4B	42
F7760511	GF510A-4E	44
F7760512	GF510A-4D	44
F7760712	GF710A-4D	44
F7781212	KW402.5-4D	36
F7781213	KW402.5-4B	36
F7781312	KW403-4D	36
F7781313	KW403-4B	36
F7838022	ODP40-2D	8
F7838023	ODP40-2B	8
F7840121	DE413-2E	13
F7840123	DE413-2B	13
F7860122	NN414-2D	13
F7960122	DEAE9A-2D	64
F8400000	P-82	63
F8500630	FL-1	30,32
F8500640	FL-1 filter	30,32
F8601105	SL-105	63
F8602105	SM-105	63
F8603075	SH-75	63
F8604075	M-75	63
F8700000	PK-2A 2P	72
F8700001	HLD	82
F8700012	PK-4A 2P	72
F8700015	GF-4A	72

**You can test a Shodex column for free, just contact us!**

**CONGRATS! YOU DID IT TO THE BEST PERFORMANCE!**

Are you already using them?

YES

NO

NO

YES

Do you know the advantages of polymer-based HPLC columns?

These are the advantages of polymer-based columns:

- The great chemical stability leads to an extended pH range (2 to 13).
- The low bleeding allows the use of sensitive detection.
- Large variety of material properties create a higher resolution.
- They are available for almost all separation techniques.
- The price per injection is cheaper than in silica-based columns due to their extended lifetime (2-3 times longer than silica-based).

Still no reason to use them?

## Reversed Phase

### Asahipak ODP-50

- Polymer-based RP C18 column
- better separation of basic substances
- silanol free
- pH stability from 2 to 13
- lower bleeding and higher S/N ratio
- recommended for MS detection
- 100 % water or buffer possible
- 2-3 times longer life time

## HILIC

### Asahipak NH2P-50

- Polymer-based amino column (NH<sub>2</sub>)
- for sugars and polar compounds
- silanol free
- pH stability from 2 to 13
- recommended for MS, CAD, and light scattering detectors
- bestseller column for HILIC
- 2-3 times longer life time

## SUGAR

### SUGAR columns

- ligand exchange with Na<sup>+</sup>, Zn<sup>2+</sup>, Ca<sup>2+</sup> and Pb<sup>2+</sup> as counter ion
- for mono-, di- and oligosaccharides
- cost and eco-friendly: pure water as solvent
- higher exclusion limits for polysaccharides

### Organic acids columns

- ion exclusion with H<sup>+</sup>
- for organic acids or mixtures with sugars and alcohols

## SEC (aqueous GFC)

### PROTEIN KW

- for proteins, peptides, enzymes, antibodies
- silica-based
- for water (buffer, salt) and organic solvents
- many applications for biopolymers

### OHpak SB

- for modified proteins, polysaccharides, water-soluble polymers
- polymer-based
- many exclusion limits available

Pullulan Standard for calibration

## SEC (organic GPC)

### GPC columns

- for (synthetic) polymers, plastics, resins, rubbers, silicones, copolymers
- single pore, linear and mixed-bed columns
- huge variety of exclusion limits
- prefilled with THF, Chloroform, DMF, HFIP
- Special high temperature GPC columns
- Best stability and reproducibility

Polystyrene (PS) and PMMA Standard for calibration

## IC

### Ion Chromatography columns

- for inorganic anions and cations
- for non-suppressed or suppressor methods
- with carbonate buffer (anions and oxyhalides)
- compatible with all instruments

## Company info

Shodex HPLC columns are manufactured by Showa Denko in Japan since 50 years, which leads to a great knowledge, experience and application data base. The European headquarters for Shodex are located in Munich (Germany) and are responsible for Europe, Russia, Africa and Middle East. We offer profound technical support and have a strong partnership with customers and distributors in different countries. Shodex is a specialist for high-quality and long lifetime polymer-based columns.

# Refractive Index Detector

## Shodex RI-501, 502, 504

The Shodex RI-500 series is a versatile and high sensitive RI detectors that can be used with various manufactures' HPLC systems. It consists of an automatic start-up function, a double temperature control and a validation wizard. The detector series are available as Analytic, semi-micro and preparative line up.



### <Features>

- The automatic start-up function controls the complicated operations such as blank substitution and baseline stabilization automatically.
- The validation wizard enables easy component validation.
- Improved double temperature control system shortens the required warm-up time and provides stable background.
- The leak sensor automatically stops the pump in case of solvent leakage.
- External input and output terminals and LAN (RJ45) communication ports can be used to connect various HPLC systems for an advanced automation.
- Usable in UHPLC systems.

Product Code	F4010501	F4010502	F4010504
Model	<b>RI-501</b> <b>Analysis</b>	<b>RI-502</b> <b>Preparative</b>	<b>RI-504</b> <b>Micro</b>
Flow cell type	2 chamber-type		
Measuring method	Deflection type		
Refractive Index range	1.00~1.75		
Measurement range	0.25~512 $\mu$ RIU	2.5~5120 $\mu$ RIU	0.25~512 $\mu$ RIU
Drift *	0.2 $\mu$ RIU/h	2 $\mu$ RIU/h	0.2 $\mu$ RIU/h
Linearity range	$\geq$ 600 $\mu$ RIU	$\geq$ 6000 $\mu$ RIU	$\geq$ 600 $\mu$ RIU
Noise **	$\leq$ 2.5 nRIU	$\leq$ 25 nRIU	$\leq$ 5 nRIU
Response	0.1, 0.25, 0.5, 1, 1.5, 2, 3, 6sec		
Auto zero	Full auto zero		
Auto zero range	All Refractive Index Range		
Recorder output range selection	0.25 - 512 $\mu$ RIU/FS	2.5~5120 $\mu$ RIU	2.5~5120 $\mu$ RIU
Integrator output range selection	128/512 $\mu$ RIU/FS	1280/5120 $\mu$ RIU/FS	128/512 $\mu$ RIU/FS
Integrator output (Sensitivity)	DC 0~1V (2mV/ $\mu$ RIU, 8mV/ $\mu$ RIU)	DC 0~1V (0.2mV/ $\mu$ RIU, 0.8mV/ $\mu$ RIU)	DC 0~1V (2mV/ $\mu$ RIU, 8mV/ $\mu$ RIU)
Cell volume	8 $\mu$ L	8 $\mu$ L	2.5 $\mu$ L
Flow rate (Usual)	0.2~3.0mL/min	1.0~50mL/min	0.2~1.0mL/min
(Max.)	10mL/min (solvent ; pure water)	100mL/min (solvent ; pure water)	1.0mL/min (solvent ; pure water)
Maximum back pressure	50kPa		
Internal volume	IN $\rightarrow$ Cell : ca. 60 $\mu$ L Cell $\rightarrow$ OUT : ca. 630 $\mu$ L All (Cell $\rightarrow$ OUT) : ca. 690 $\mu$ L	IN $\rightarrow$ Cell : ca. 120 $\mu$ L Cell $\rightarrow$ OUT : ca. 540 $\mu$ L All (Cell $\rightarrow$ OUT) : ca. 660 $\mu$ L	IN $\rightarrow$ Cell : ca. 10 $\mu$ L Cell $\rightarrow$ OUT : ca. 385 $\mu$ L All (Cell $\rightarrow$ OUT) : ca. 395 $\mu$ L
Recorder output	0~10mV/FS		
External input	Purge On/Off, Auto Zero, Marker		
External output	① READY (Automatic start-up) ② LEAK ③ ERROR (OVER HEAT/LOW LIGHT INTENSITY/NULL GLASS HOME POSITION/LOST PARAMETERS/OPTICAL BALANCE) (Contact capacity : DC24V 0.1A max.)		
Temperature control	OFF, 30~55 $^{\circ}$ C (double Temperature control)		
Communication port	LAN		
CE / RoHS certificates available	YES		
Wetted materials	Stainless steel 316, Teflon, Quartz glass		
Power source, Power consumption	AC100~240 $\pm$ 10%, 50/60Hz, 150VA max		
Dimensions, Weight	W260 x D420 x H165 (mm), ca.12.5kg		
Accessories	Power cable, signal cable, connector tube, operation manual		

\*Pure water 1mL/min, PURGE OFF

\*\*Pure water, response : 1.5sec



# Electric Conductivity Detector

## Shodex CD-200

The electric conductivity detector is designed for ion chromatography. It is recommended for anion or cation analysis in aqueous solution.

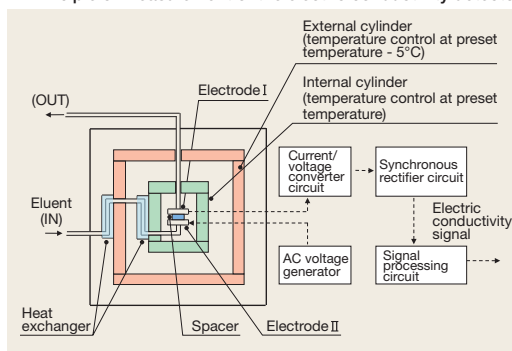
### <Features>

- With use of the built-in double temperature control cell, this detector enables highly sensitive measurement.
- The detector supports a wide range of measurement and is usable for ion chromatography with or without suppressor method.

Product Code	F5515010
Model	CD-200
Measurement method	Two-electrode system
Measurement limit	0~600mS/m (0~6mS/cm)
Measurement range	0.0025~5.12mS/m, 0.025~51.2mS/m, 0.25~512mS/m
Linearity range	600mS/m
Response	0.1, 0.25, 0.5, 1.0, 1.5, 2, 3, 6sec
Auto zero limit	Same as measurement limit
Baseline shift	Range;0~2mS/m, Resolution;0.01mS/m
Integrator output	0~1V (Sensitivity;200, 20, 2mV/mS/m)
Recorder output	0~10mV/FS
External input	① ZERO IN ② MARKER IN
External Output	① READY(TEMPERATURE STABILIZED) ② LEAK ③ ERROR(ROM, RAM, PARAMETER, SENSOR, OVER HEAT, ZERO OVER) ④ MARKER OUT
Cell Temperature control	OFF, 30~50°C (1°C step), 77°C Temp. fuse
Communication port	USB
Cell volume	2.5μL
Pressure rating	1MPa
Wetted materials	Stainless steel 316, Teflon, PEEK
Dimension, Weight	W260 x D400 x H150 (mm), ca. 8kg
Power source, Power consumption	AC 100~240V±10%, 200VA max



■ Principle of measurement of the electric conductivity detector



## Dissolved Gas Removal Devices

# DEGASSER ERC-3215α, 3415α

The ERC-3000α series efficiently remove dissolved gases in the eluent.

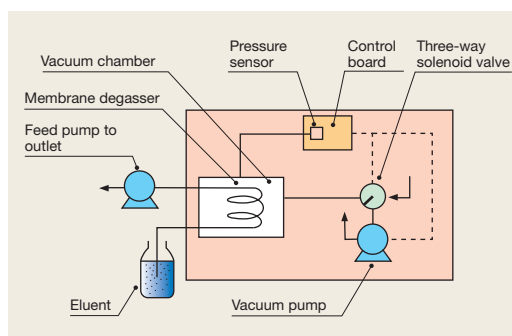
### <Degassing principle>

A special synthetic resin membrane (degassing membrane) is used to selectively remove dissolved gasses; using the characteristics of the small molecular size of the dissolved gas with high mobility and affinity to the membrane.

### <Features>

- Pressure sensor and leak monitor assure a high degree of safety.
- Dead volume is minimized to 7 ml/flow channel.
- Any pump can be used since differential pressure is low.
- Continuous degassing mode aids eluent preparation for high-sensitivity analysis.

Product Code	Y4617000	Y4617004
Model	ERC-3215α	ERC-3415α
Solvent Channels	2 channels	4 channels
Degassing capacity	When ion-exchanged water saturated with air at 25°C is put through at a flow rate of 3 mL/min, no bubble is observed at the outlet of the apparatus. (Measured dissolved oxygen level at the outlet: 2 ppm at flow rate of 3 mL/min)	
Internal volume	7mL/Channel	
Max. Flow Rate	20mL/min for each channel (Eluent : 25°C Pure water)	
External output	An open connector signal is delivered to the external output signal terminal, when "PRES" and "LEAK" LEDs lights are on.	
Dimensions	W71 x D310 x H136 (mm)	
Power source	AC100V~AC240V, 50/60Hz	
Functions, Displays	<ul style="list-style-type: none"> <li>• Power On/Off display : "POWER" LED lights, when the power is supplied.</li> <li>• Status monitoring function : "READY" LED lights, when the internal pressure in the vacuum chamber is below a predetermined limit.</li> <li>• Pressure monitoring function : "PRES" LED lights, when the internal pressure in the vacuum chamber does not reach a predetermined level within a predetermined time.</li> <li>• Leak monitor : "LEAK" LED lights, when the liquid leaks in the apparatus.</li> <li>• Self cleaning : The vacuum line is cleaned by air suction.</li> <li>• Vacuum pump operation switching function: NORM. : Controlled operation in normal run CONT. : Continuous operation in case of high degree of degassing</li> </ul>	
Weight	ca. 5.1kg	ca. 5.5kg



● In addition to this product, various degassers are available including the six-flow channel type and the high flow rate type. For details, please contact Shodex or our distributors near you.

# 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 application data and uses.

Shodex website

[www.shodex.de](http://www.shodex.de)



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[Caution]

1. Please read the operating manual included on the product carefully before use.
2. For improvement purposes, some specifications are subject to change without notice.
3. Provided to help you select the appropriate column, the figures and descriptions in this catalogue are not guaranteed and do not warrant 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 on 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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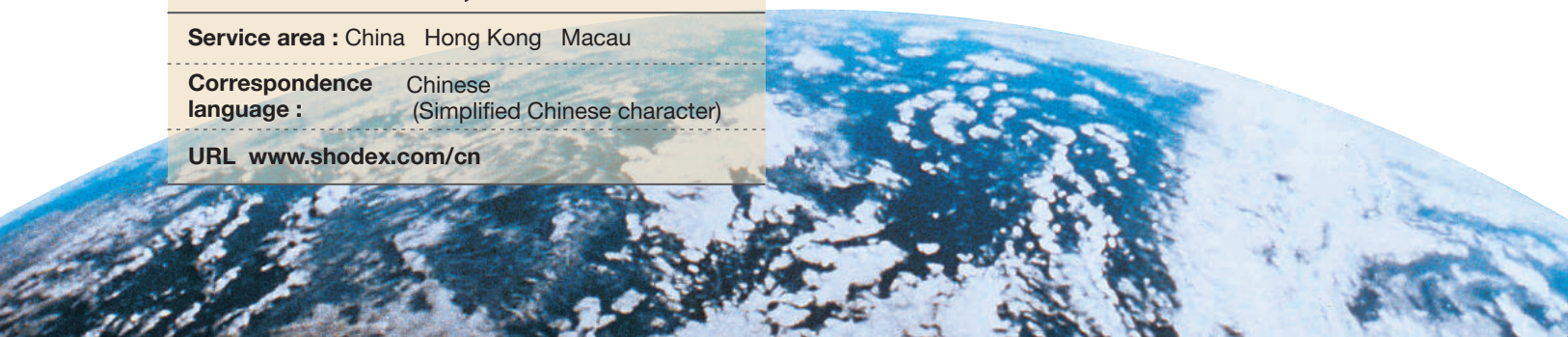
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## Support office

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