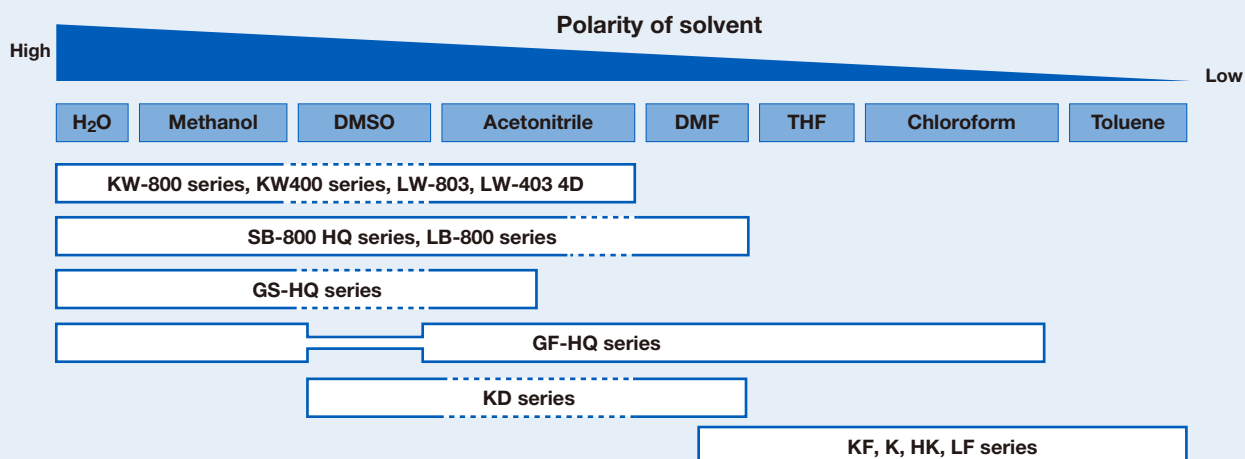


Column Selection for Size Exclusion Chromatography (SEC)

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

Solvent usability guideline for the Shodex SEC columns



Precautions for Polar Polymer Analysis

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

Interfering interactions likely to be observed

Interactions between the analyte and the packing materials

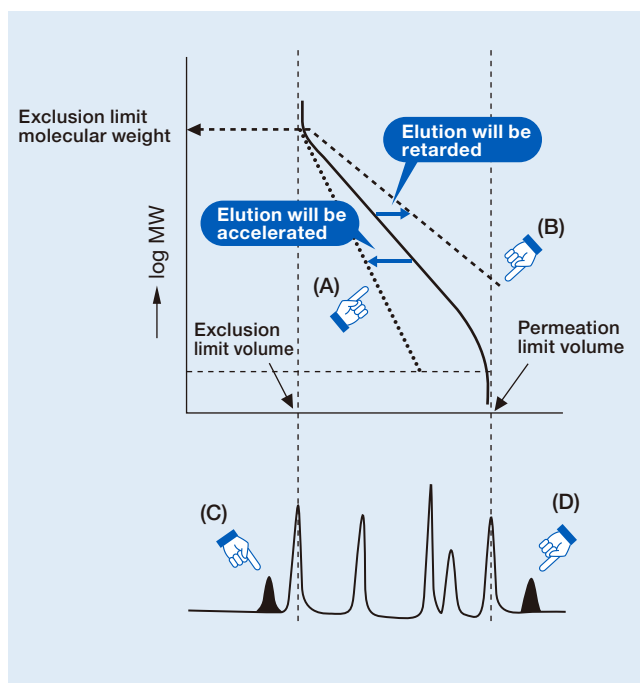
- **Hydrophobic interaction**
 - The analyte is adsorbed on the packing material. This delays the analyte elution and results in under estimating the analyte's molecular weight. See (B) and (D).
- **Ionic interaction**
 - (1) Ion Exclusion
 - The analyte is repelled from the packing material. This accelerates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

Interaction within and between the analyte

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

Interactions between the analyte and the solvent

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



Methods to reduce interactions

Aqueous SEC (GFC)

Ionic interaction

- Add salt

Hydrophobic interaction

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

Organic SEC (GPC)

Ionic interaction

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

Hydrophobic interaction

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

Hydrophilic interaction

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

Aqueous SEC (GFC) Columns: Silica-based

Features

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

● Standard columns

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

*Measured with ethylene glycol

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

● High performance semi-micro columns ◎ KW400 series is recommended to be used with semi-micro type devices.

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

*Measured with uridine

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

For antibody drugs analysis

● Standard columns

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

*Measured with bovine serum albumin

Base Material: Silica

Usable pH range: pH3.0 - 7.5

Usable concentration of methanol and acetonitrile is up to 100 %

● Semi-micro columns

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

Product Code	Product Name	* Plate Number (TP/column)	Particle Size (μm)	Pore Size (Å)	Column Size (mm) I.D. x Length	Shipping Solvent
F6989403	New PROTEIN LW-403 4D	≥ 11,000	1.9	1,000	4.6 x 150	H ₂ O
F6700134	New PROTEIN LS-G 4J	(guard column)	1.9	–	4.6 x 20	H ₂ O

*Measured with bovine serum albumin

Base Material: Silica

Usable pH range: pH3.0 - 7.5

Usable concentration of methanol and acetonitrile is up to 100 %

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

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

*Measured with ethylene glycol

Base Material: Silica

Target molecular weight range and exclusion limit

● Measured with protein (eluent: phosphate buffer)

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

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

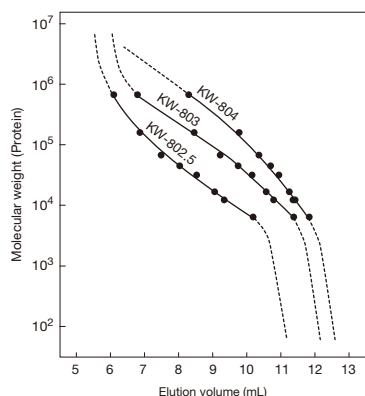
*() Estimated value

● Measured with pullulan (eluent: ultrapure water)

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

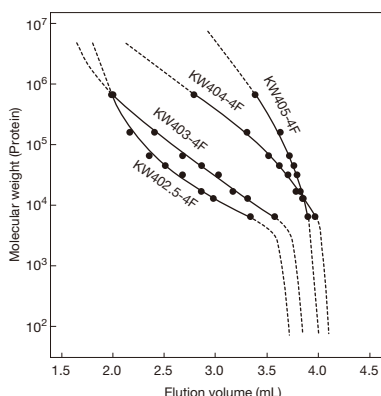
Please use the above table for reference purposes only when selecting columns.

Calibration curves for KW-800 series using protein



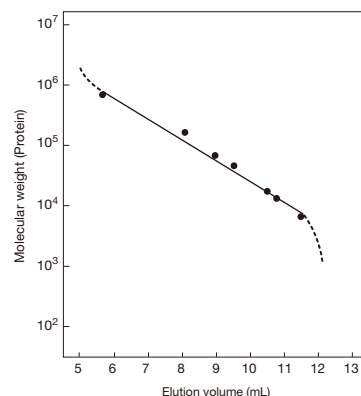
Column : Shodex PROTEIN KW-800 series
Eluent : 50 mM Sodium phosphate buffer (pH7.0) + 0.3 M NaCl
Flow rate : 1.0 mL/min
Detector : UV (280 nm)
Column temp. : 30 °C

Calibration curves for KW400 series using protein



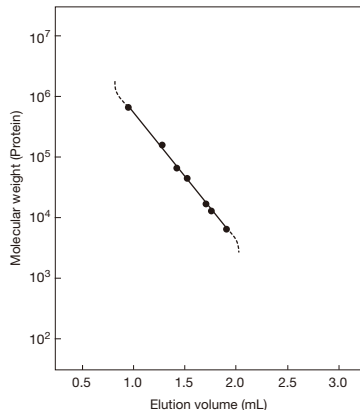
Column : Shodex KW400-4F series
Eluent : 50 mM Sodium phosphate buffer (pH7.0) + 0.3 M NaCl
Flow rate : 0.33 mL/min
Detector : UV (280 nm) (small cell volume)
Column temp. : 30 °C

Calibration curve for LW-803 using protein



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

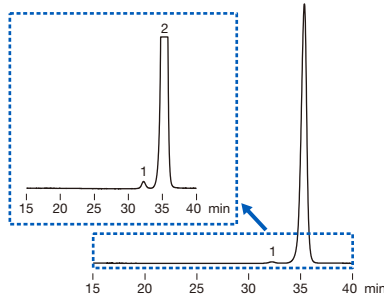
Calibration curve for LW-403 4D using protein



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

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

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



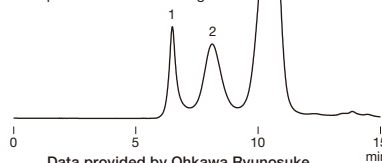
Column : Shodex PROTEIN KW-802.5 x 2
Eluent : CH₃COOH/CH₃CN/H₂O=20/30/50 (pH to 3.0 adjusted with 25 % NH₃ aq.)
Flow rate : 0.5 mL/min
Detector : UV (276 nm)
Column temp. : Ambient

Lipoproteins in serum

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

[Preparation of sample]

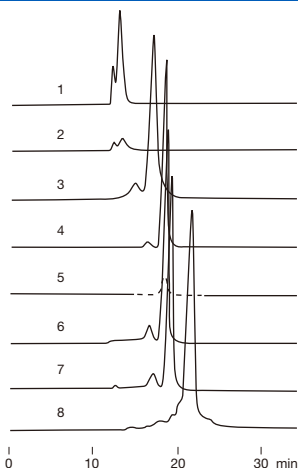
1. Use potassium bromide to adjust the specific gravity of serum from a healthy person to 1.210 g/mL. Ultracentrifuge for 24 hours.
2. Dialyze the supernatant and then substitute the solvent with *PBS.
3. Measure protein concentration by Lowry method and dilute the sample with *PBS to 1.0 mg/mL.



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

Column : Shodex PROTEIN KW-G + KW-804
Eluent : 10-fold diluted x 10 *PBS with H₂O
Flow rate : 1.0 mL/min
Detector : UV (280 nm)
Column temp. : 30 °C
 x 10 *PBS : 80 g NaCl + 29 g Na₂HPO₄·12H₂O + 2 g KCl + 2 g KH₂PO₄ in 1000 mL of H₂O

Proteins in human blood serum

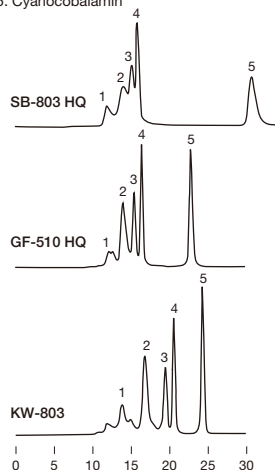


Sample : 0.1 % each
 1. Fibrinogen 50 µL
 2. α₂-Macroglobulin 50 µL
 3. IgG 50 µL
 4. Transferrin 50 µL
 5. Plasminogen 50 µL
 6. Albumin 100 µL
 7. Antitrypsin 100 µL
 8. Hemoglobin 100 µL

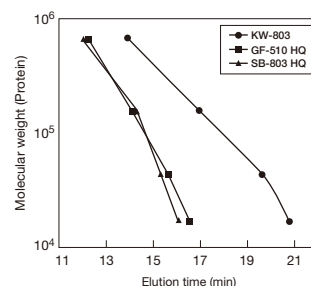
Column : Shodex PROTEIN KW-803
Eluent : 50 mM Sodium phosphate buffer (pH7.0) + 0.3 M NaCl
Flow rate : 1.0 mL/min
Detector : UV (280 nm)
Column temp. : Room temp.

Comparing three GFC columns for the separation of common proteins

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



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

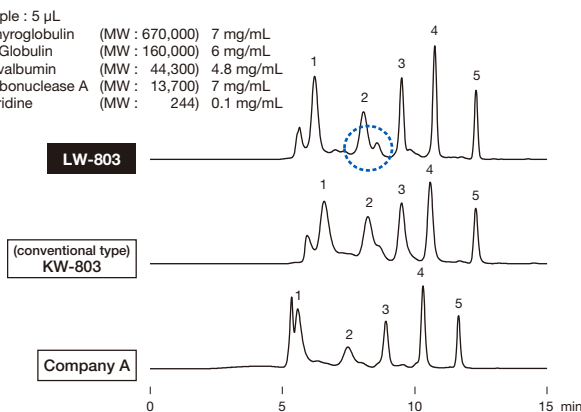


Column : Shodex OHpak SB-803 HQ
 Shodex Asahipak GF-510 HQ
 Shodex PROTEIN KW-803
Eluent : 0.2 M Phosphate buffer (pH6.9)
Flow rate : 0.5 mL/min
Detector : UV (280 nm)
Column temp. : 30 °C

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

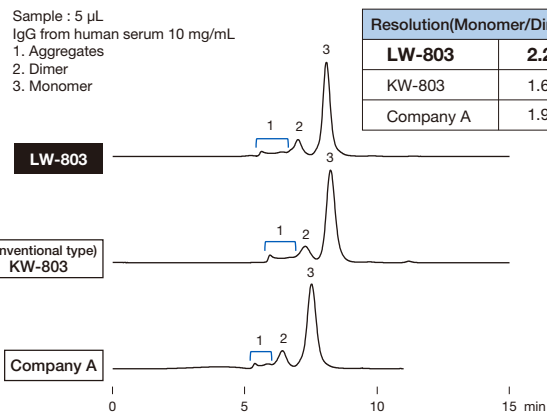
PROTEIN LW-803 is suitable for analyzing proteins with molecular weight of several hundreds of thousands. Compared to our conventional columns and other manufacturer's columns, LW-803 has improved separation performance in the molecular weight range around 160,000 (about the size of γ -Globulin). This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

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



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

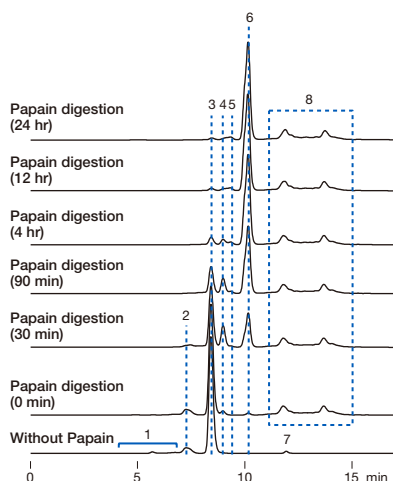
Resolution(Monomer/Dimer)	
LW-803	2.2
KW-803	1.6
Company A	1.9



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

Monitoring papain digestion of humanized monoclonal IgG

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



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

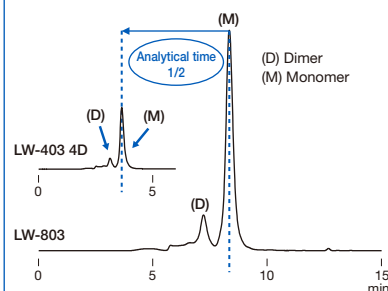
[Procedure of papain digestion]

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

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

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

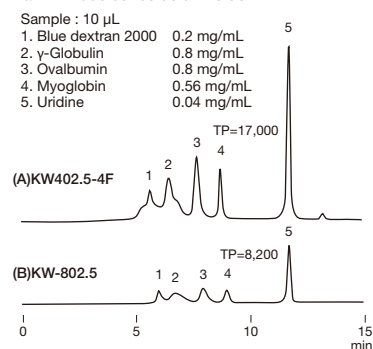
Sample : IgG from human serum 10 mg/mL
 (LW-403 4D) 0.5 μ L
 (LW-803) 5 μ L



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

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

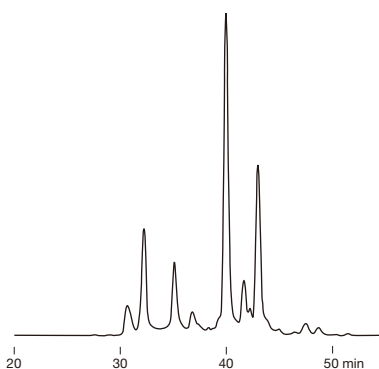
KW400 series is a high performance type of semi-micro columns. It offers approximately 1.5 times larger theoretical plate number and 3 to 4 times higher detection sensitivity (peak height) than KW-800 series columns do.



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

Whey in yogurt

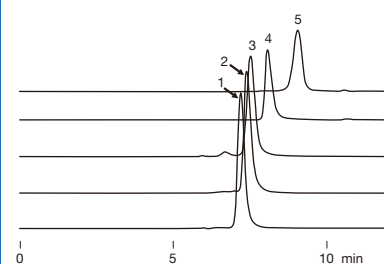
Sample : Whey, 5 μ L



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

Lectins

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



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

Aqueous SEC (GFC) Columns: Polymer-based

Features

- SB-800 HQ**
- Polymer-based packed columns for aqueous SEC (GFC) analysis
 - Supports a wide range of molecular weight sample analysis
 - The eluent can be replaced with DMF (except SB-802 HQ and SB-807 HQ), enabling the analysis of polar polymers
 - Method using SB-804 HQ or SB-805 HQ for gelatin's mean molecular weight determination is comparable with PAGI method (Ver. 10, Japan)
 - Fulfills USP L38 and L39 requirements
 - SB-802 HQ fulfills USP L25 requirements
 - SB-802.5 HQ fulfills USP L25 and L89 requirements
 - SB-803 HQ fulfills USP L37 requirements

- SB-807 HQ**
- Column for the analysis of water-soluble ultra high molecular weight polymers
 - Large particle-size gel prevents shear degradation of polymers
 - Fulfills USP L38 and L39 requirements

- LB-800**
- Polymer-based packed columns for aqueous SEC (GFC) analysis
 - Low column bleeding allows its use with light scattering detectors
 - The eluent can be replaced with DMF enabling the analysis of polar polymers
 - LB-804 (exclusion limit: about 1,000,000) and LB-806 (exclusion limit: about 20,000,000) newly added to the series
 - Fulfills USP L38 and L39 requirements
 - LB-803 fulfills USP L37 requirements

● Standard columns

Product Code	Product Name	Plate Number (TP/column)	Particle Size (μm)	Pore Size (Å)	Column Size (mm) I.D. x Length	Shipping Solvent
F6429100	OHpak SB-802 HQ	≥ 12,000	8	100	8.0 x 300	0.02 % NaN ₃ aq.
F6429101	OHpak SB-802.5 HQ	≥ 16,000	6	200	8.0 x 300	0.02 % NaN ₃ aq.
F6429102	OHpak SB-803 HQ	≥ 16,000	6	800	8.0 x 300	0.02 % NaN ₃ aq.
F6429103	OHpak SB-804 HQ	≥ 16,000	10	2,000	8.0 x 300	0.02 % NaN ₃ aq.
F6429104	OHpak SB-805 HQ	≥ 12,000	13	7,000	8.0 x 300	0.02 % NaN ₃ aq.
F6429105	OHpak SB-806 HQ	≥ 12,000	13	15,000	8.0 x 300	0.02 % NaN ₃ aq.
F6429106	OHpak SB-806M HQ	≥ 12,000	13	15,000	8.0 x 300	0.02 % NaN ₃ aq.
F6709430	OHpak SB-G 6B	(guard column)	10	–	6.0 x 50	0.02 % NaN ₃ aq.

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

Base Material: Polyhydroxymethacrylate
Usable pH range: pH3 - 10

[Aqueous high molecular weight analysis column]

Product Code	Product Name	Plate Number (TP/column)	Particle Size (μm)	Pore Size (Å)	Column Size (mm) I.D. x Length	Shipping Solvent
F6429108	OHpak SB-807 HQ	≥ 1,500	35	30,000	8.0 x 300	H ₂ O
F6709431	OHpak SB-807G	(guard column)	35	–	8.0 x 50	H ₂ O

Base Material: Polyhydroxymethacrylate
Usable pH range: pH3 - 10

[GFC columns to be used with light scattering detector]

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

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

Base Material: Polyhydroxymethacrylate
Usable pH range: pH3 - 10

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

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

Base Material: Polyhydroxymethacrylate

● Usable concentration of organic solvents

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

(Note)

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

Target molecular weight range and exclusion limit

● Measured with pullulan (eluent: ultrapure water)

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

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

*() Estimated value

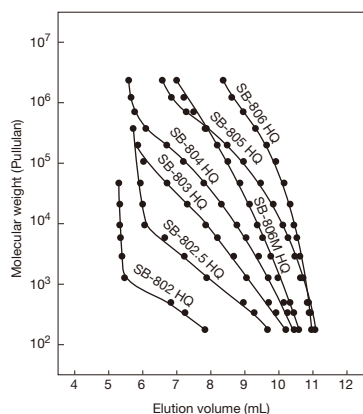
● Measured with *PEG/PEO (eluent: DMF)

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

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

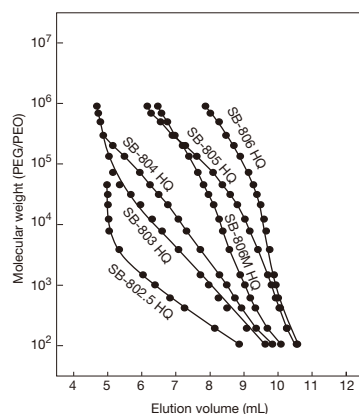
*PEG: polyethylene glycol
*PEO: polyethylene oxide
** () Estimated value

Calibration curves for SB-800 HQ series using pullulan (eluent: H₂O)



Column : Shodex OHPak SB-800 HQ series
Eluent : H₂O
Flow rate : 1.0 mL/min
Detector : RI
Column temp. : 30 °C

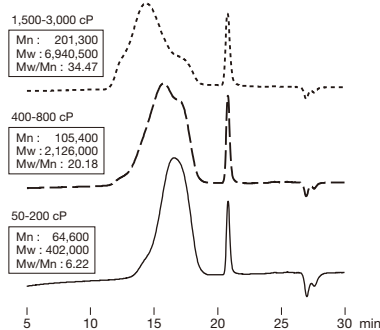
Calibration curves for SB-800 HQ series using PEG/PEO (eluent: DMF)



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

Carboxymethylcellulose

Sample : Carboxymethylcellulose 0.1 % each, 50 µL



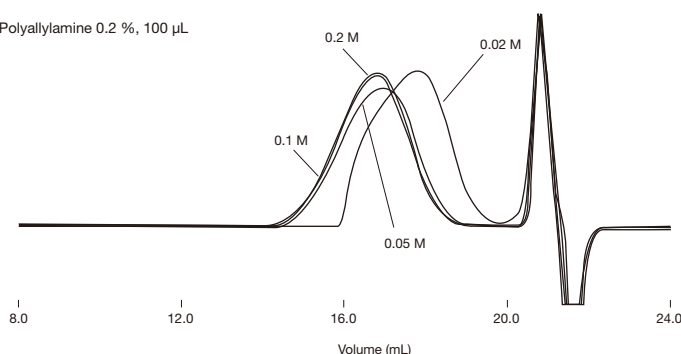
Molecular weight was determined from the calibration curve of pullulan.

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

Effects of sodium nitrate in eluent on the analysis of polyallylamine

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

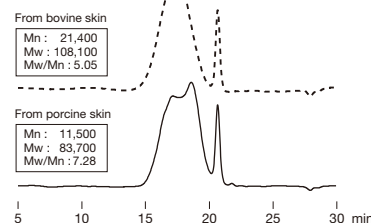
Sample : Polyallylamine 0.2 %, 100 µL



Column : Shodex OHPak SB-806M HQ x 2
Eluent : 0.5 M CH₃COOH + NaNO₃ aq.
Flow rate : 1.0 mL/min
Detector : RI
Column temp. : 40 °C

Gelatin

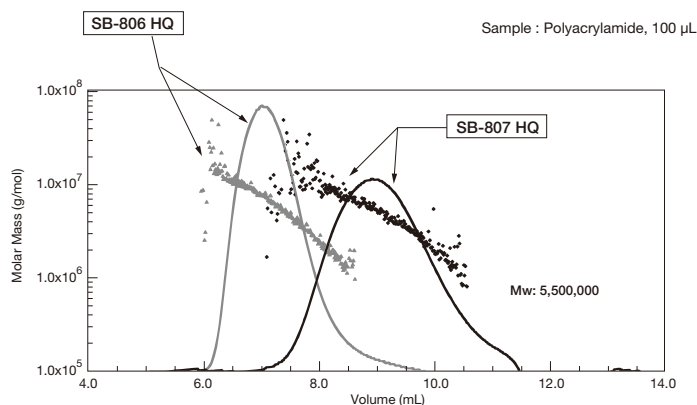
Sample : 0.1 % each, 100 µL
Gelatin from bovine skin
(Acid treatment, Gel strength : 225 g)
Gelatin from porcine skin
(Alkali treatment, Gel strength : 90-100 g)



Molecular weight was determined from the calibration curve of pullulan.

Column : Shodex OHPak SB-806M HQ x 2
Eluent : 0.1 M KH₂PO₄ aq./
0.1 M Na₂HPO₄ aq.=50/50
Flow rate : 1.0 mL/min
Detector : RI
Column temp. : 40 °C

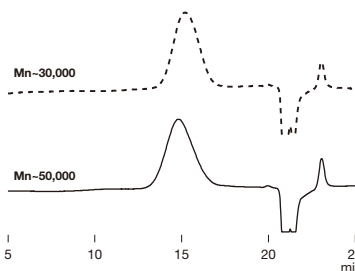
Polyacrylamide



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

Cellulose acetate

Sample : Cellulose acetate 0.1 % each, 100 µL



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

Copovidones

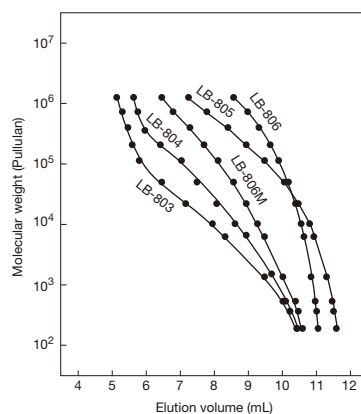
Sample : 100 μ L
Poly(1-vinylpyrrolidone-co-vinyl acetate) 0.1 % each

Copolymer 7:3
Mn : 2,000
Mw : 14,400
Mw/Mn : 7.40

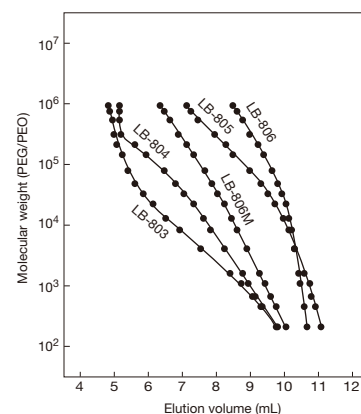
Copolymer 3:7
Mn : 6,400
Mw : 28,900
Mw/Mn : 4.53

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

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

Calibration curves for LB-800 series using pullulan (eluent: H₂O)

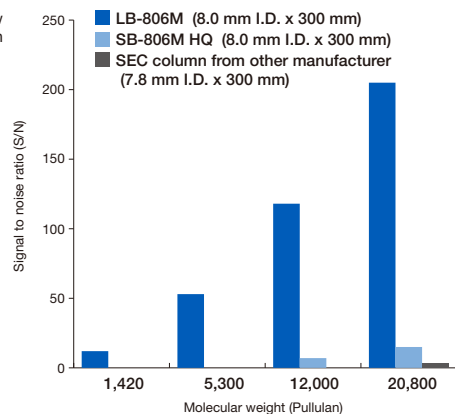
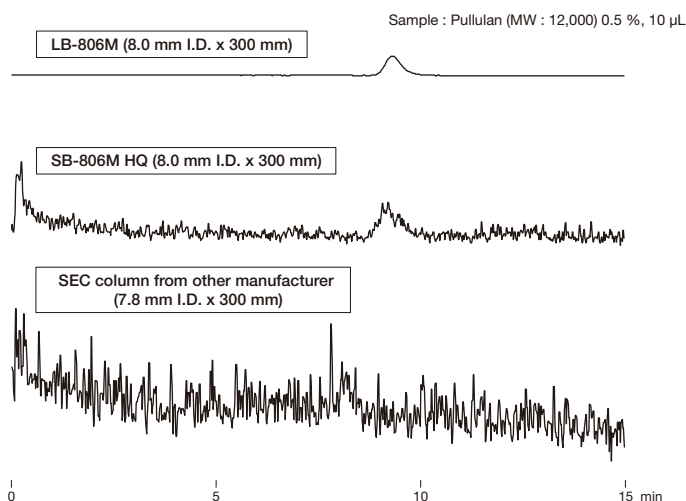
Column : Shodex OHpak LB-800 series
Eluent : H₂O
Flow rate : 1.0 mL/min
Detector : RI
Column temp. : 30 °C

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

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

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

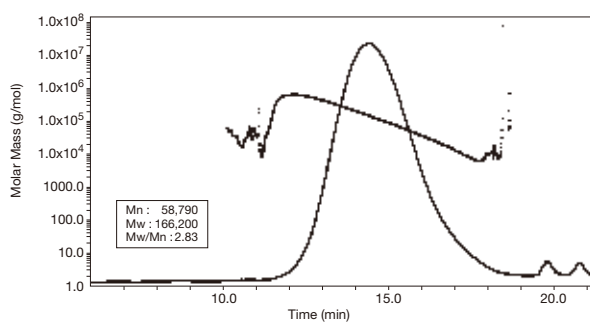
The OHpak LB-800 series is able to detect low molecular weight substances owing to its improved low baseline noise level while using it with a multiangle light scattering detector. This cannot be achieved with other manufacturer's SEC column.



Column : Shodex OHpak LB-806M
Shodex OHpak SB-806M HQ
SEC column from other manufacturer
Eluent : 0.1 M NaNO₃ aq.
Flow rate : 1.0 mL/min
Detector : MALS (Multi angle light scattering) (90 °)
Column temp. : 30 °C

Sodium alginate

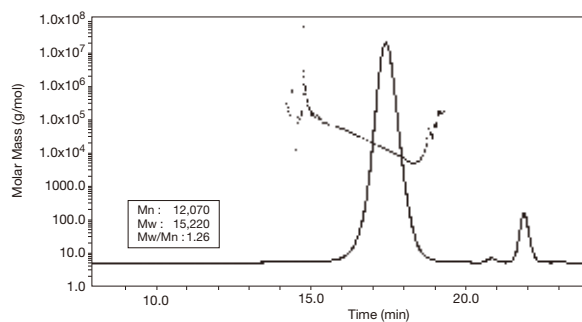
Sample : Sodium alginate 0.1 %, 100 μ L



Column : Shodex OHpak LB-806M x 2
Eluent : 0.1 M NaNO₃ aq.
Flow rate : 1.0 mL/min
Detector : RI
MALS (Multi angle light scattering)
Column temp. : 30 °C

Sodium heparin

Sample : Sodium heparin 0.1 %, 100 μ L



Column : Shodex OHpak LB-806M x 2
Eluent : 0.1 M NaNO₃ aq.
Flow rate : 1.0 mL/min
Detector : RI
MALS (Multi angle light scattering)
Column temp. : 30 °C

Multimode Columns

Features

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

● Standard columns

Product Code	Product Name	Plate Number (TP/column)	Particle Size (μm)	Pore Size (Å)	Column Size (mm) I.D. x Length	Shipping Solvent
F7600005	Asahipak GS-220 HQ	≥ 19,000	6	150	7.5 x 300	H ₂ O/CH ₃ OH=70/30
F7600006	Asahipak GS-320 HQ	≥ 19,000	6	400	7.5 x 300	H ₂ O/CH ₃ OH=70/30
F7600007	Asahipak GS-520 HQ	≥ 18,000	7	2,000	7.5 x 300	H ₂ O/CH ₃ OH=70/30
F7600008	Asahipak GS-620 HQ	≥ 18,000	7	7,000	7.5 x 300	H ₂ O/CH ₃ OH=70/30
F6710019	Asahipak GS-2G 7B	(guard column)	9	–	7.5 x 50	H ₂ O/CH ₃ 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	GS320A-4D	6	400	4.6 x 150
F7750311	GS320A-4E	6	400	4.6 x 250

Base Material: Polyvinyl alcohol

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

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

Base Material: Polyvinyl alcohol

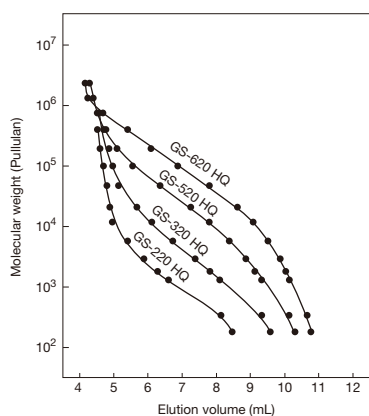
Target molecular weight range and exclusion limit

● Measured with pullulan (eluent: ultrapure water)

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

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

Calibration curves for GS-HQ series using pullulan



Column : Shodex Asahipak GS-HQ series
Eluent : H₂O
Flow rate : 0.6 mL/min
Detector : RI
Column temp. : 30 °C

Peptides

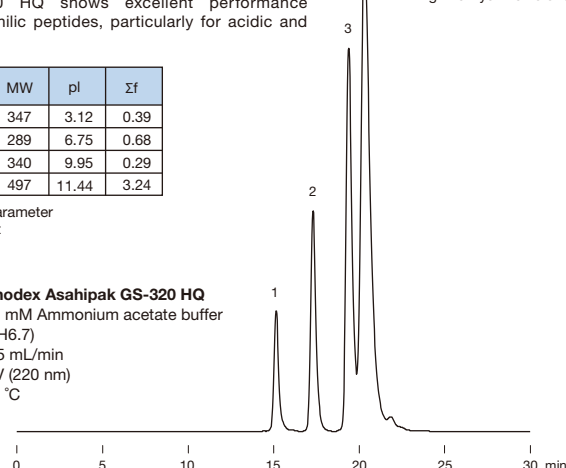
GS-HQ columns work not only under SEC (GFC) mode, but also under multimode, adding hydrophobic and ionic interactions. By carefully selecting the eluent, they provide separation mode that was not available with other types of columns. GS-320 HQ shows excellent performance separating hydrophilic peptides,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

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

Σf: Hydrophobic parameter
 pI: Isoelectric point

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

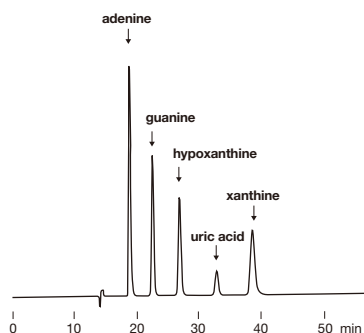
Sample : 20 µL
 1. Glu-Ala-Glu 0.025 %
 2. Arg-Asp 0.05 %
 3. Gly-His-Lys 0.025 %
 4. Arg-Pro-Lys-Pro 0.025 %



Purine bases in beer

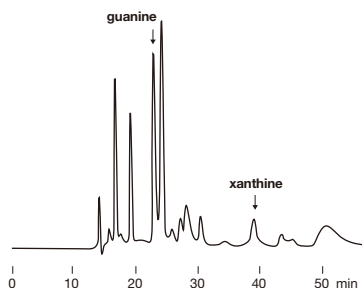
Purine present in food is detected as its purine base form after sample preparation including: homogenization, freeze drying, hydrolyzation with 70 % perchloric acid, and neutralization. The example below shows the analysis of purine in regular beer and beer treated with guanase (an enzyme that degrades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

Purine bases in beer

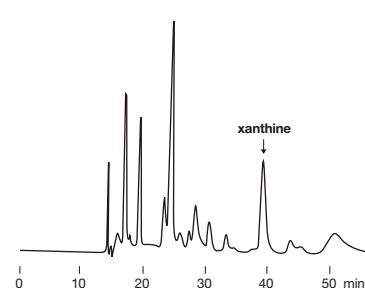


Column : Shodex Asahipak GS-320 HQ
Eluent : 150 mM Sodium phosphate buffer (pH2.5)
Flow rate : 0.6 mL/min
Detector : UV (260 nm)
Column temp. : 35 °C

Normal beer



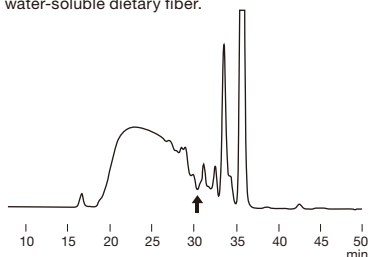
Guanase treated beer



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

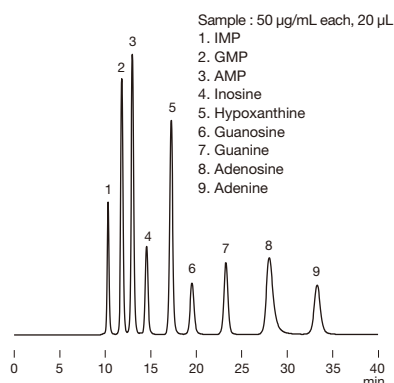
Low molecular weight water-soluble dietary fiber

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



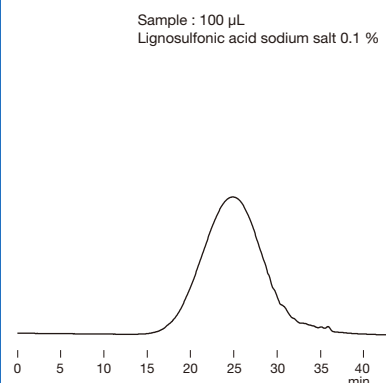
Column : Shodex Asahipak GS-220 HQ x 2
Eluent : H₂O
Flow rate : 0.5 mL/min
Detector : RI
Column temp. : 60 °C

"Umami"



Column : Shodex Asahipak GS-320 HQ
Eluent : 10 mM NaH₂PO₄ aq./10 mM Na₂HPO₄ aq. =1000/31
Flow rate : 1.0 mL/min
Detector : UV (260 nm)
Column temp. : 40 °C

Lignosulfonic acid



Column : Shodex Asahipak GS-520 HQ x 2
Eluent : 20 mM Na₂HPO₄ aq.
Flow rate : 0.6 mL/min
Detector : UV (254 nm)
Column temp. : 40 °C

Aqueous/Organic SEC Columns

Features

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

● Standard columns

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

Base Material: Polyvinyl alcohol

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

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

Base Material: Polyvinyl alcohol

Target molecular weight range and exclusion limit

● Measured with pullulan (eluent: ultrapure water)

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

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

*() Estimated value

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

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

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

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

Usable solvents

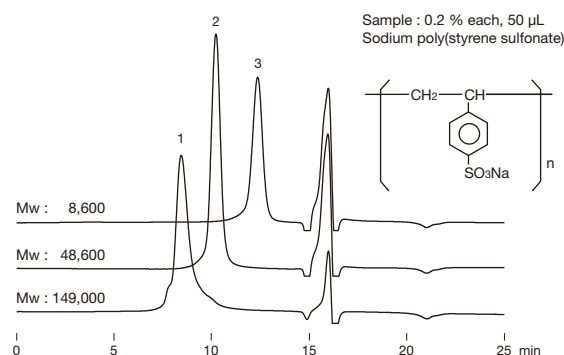
Solvent	GF-210	GF-310 GF-510 GF-710 GF-7M
Water (0 - 0.5 M sodium concentration)	○	○
Methanol	○	○
Ethanol	○	○
Acetonitrile	*○	○
THF	○	○
DMF	○	○
Acetone	○	○
Chloroform	*○	○
Ethylacetate	*○	○
DMSO	○	(0 ~ 50 %) ○

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

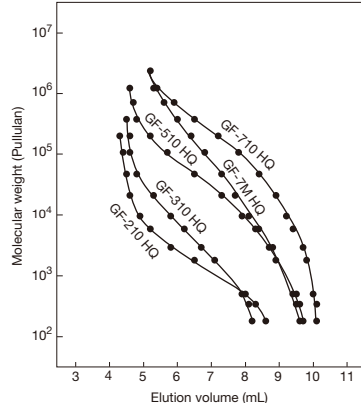
*When replacing water with ethyl acetate or chloroform, replace with methanol first and then replace with the required eluent condition.

Sodium polystyrene sulfonates

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

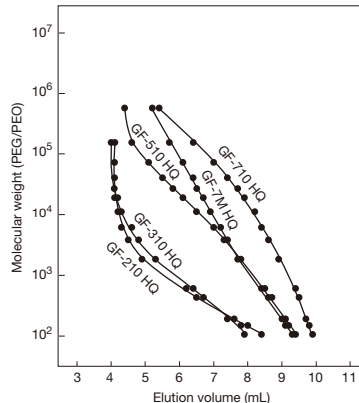


Column : Shodex Asahipak GF-510 HQ
Eluent : 50 mM LiCl aq./CH₃CN=60/40
Flow rate : 0.6 mL/min
Detector : UV (254 nm)
Column temp. : 30 °C

Calibration curves for GF-HQ series using pullulan (eluent: H₂O)

Column : Shodex Asahipak GF-HQ series
Eluent : H₂O
Flow rate : 0.6 mL/min
Detector : RI
Column temp. : 30 °C

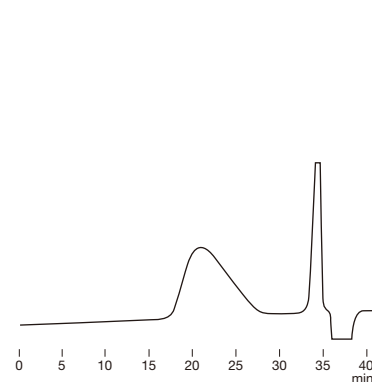
Calibration curves for GF-HQ series using PEG/PEO (eluent: DMF)



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

Polyacrylonitrile

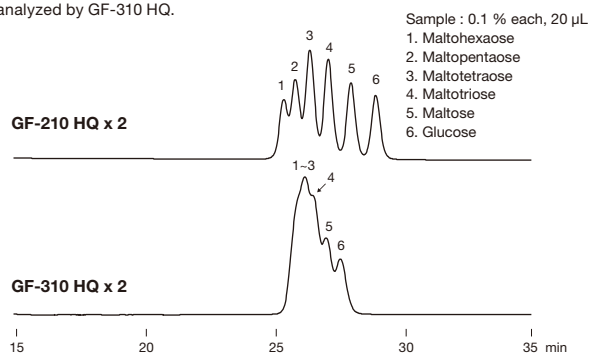
Sample : Polyacrylonitrile 0.1 %, 100 μ L



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

Comparison of two GF column performances for the separation of maltooligosaccharides

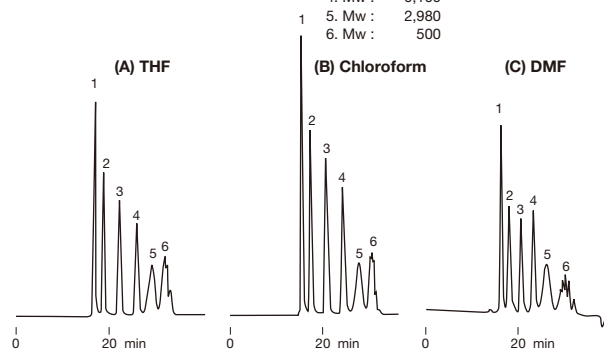
GF-210 HQ demonstrates an improved separation of low molecular substances. The chromatograms below show that the peaks obtained by GF-210 HQ are separated with deeper notches compared to peaks obtained by GF-310 HQ. GF-210 HQ is capable of separating oligosaccharides (trisaccharides to hexasaccharides)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



Column : Shodex Asahipak GF-210 HQ x 2
Shodex Asahipak GF-310 HQ x 2
Eluent : H₂O
Flow rate : 0.6 mL/min
Detector : RI
Column temp. : 50 °C

Comparison of polystyrene separation under three different solvent conditions

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



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

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

Features

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

● Standard columns

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

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

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

Base Material: Styrene divinylbenzene copolymer

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

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

See page 67 for other preparative columns.

Base Material: Styrene divinylbenzene copolymer

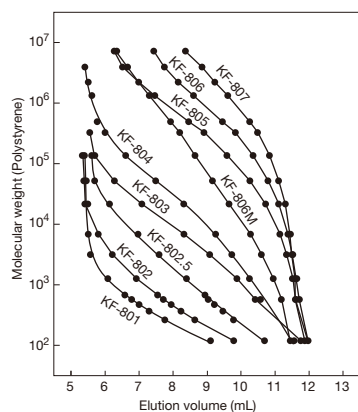
Target molecular weight range and exclusion limit

● Measured with polystyrene (eluent: THF)

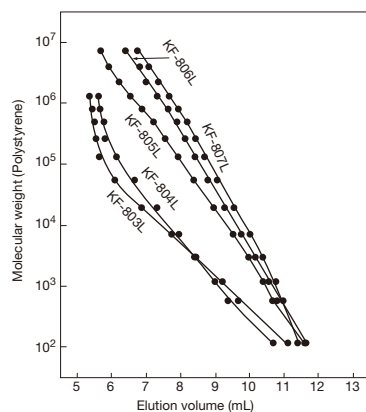
Product Name	Target Molecular Weight Range	Exclusion Limit	Product Name	Target Molecular Weight Range	Exclusion Limit
KF-801	100 – 700	1,500	KF-805	50,000 – 2,000,000	4,000,000
KF-802	300 – 3,000	5,000	KF-805L	300 – 2,000,000	4,000,000
KF-802.5	300 – 8,000	20,000	KF-806	150,000 – *(20,000,000)	*(20,000,000)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

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

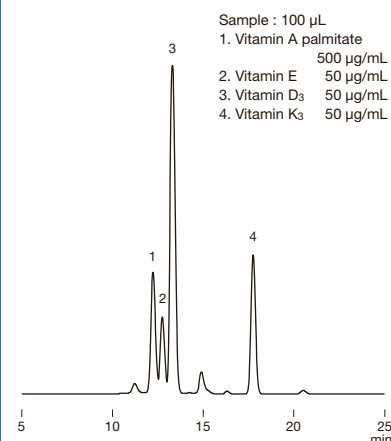
*() Estimated value

Calibration curves for KF-800 series using polystyrene

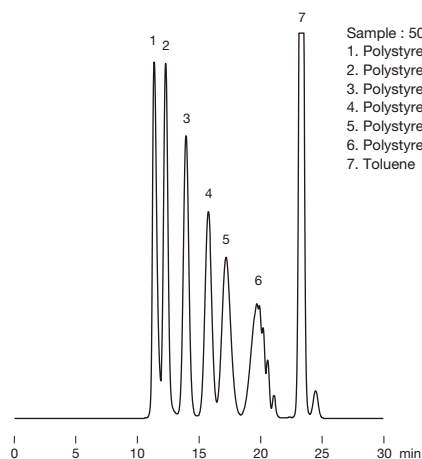
Column : Shodex GPC KF-800 series
Eluent : THF
Flow rate : 1.0 mL/min
Detector : RI
Column temp. : 40 °C

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

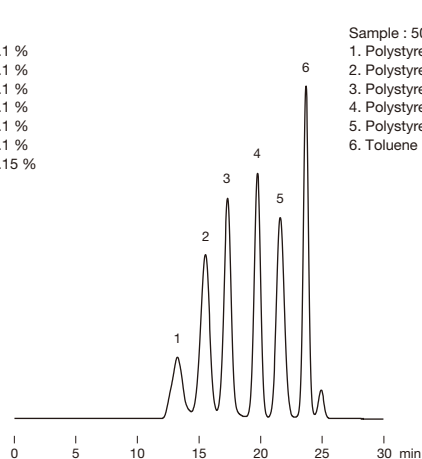
Column : Shodex GPC KF-800L series
Eluent : THF
Flow rate : 1.0 mL/min
Detector : RI
Column temp. : 40 °C

Fat-soluble vitamins

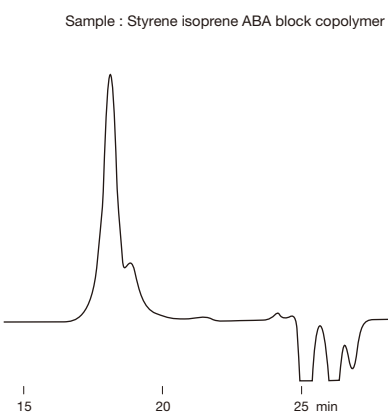
Column : Shodex GPC KF-801 x 2
Eluent : THF
Flow rate : 1.0 mL/min
Detector : UV (280 nm)
Column temp. : 40 °C

Polystyrene standards

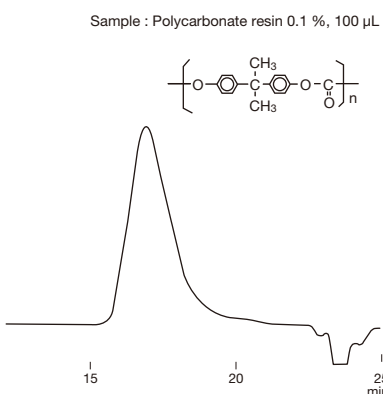
Column : Shodex GPC KF-803L x 2
Eluent : THF
Flow rate : 1.0 mL/min
Detector : UV (254 nm)
Column temp. : 40 °C



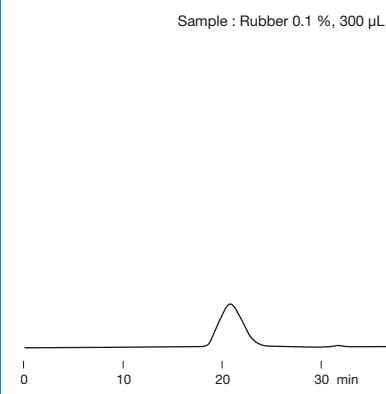
Column : Shodex GPC KF-807L x 2
Eluent : THF
Flow rate : 1.0 mL/min
Detector : UV (254 nm)
Column temp. : 40 °C

Styrene isoprene ABA block copolymer

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

Polycarbonate resin

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

Raw rubber

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

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

Features

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

● Standard columns

[K-800 series] Shipping Solvent: Chloroform

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

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

Base Material: Styrene divinylbenzene copolymer

See page 54 for details of the solvent-peak separation columns.

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

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

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

See page 66 and 67 for other preparative columns.

Base Material: Styrene divinylbenzene copolymer

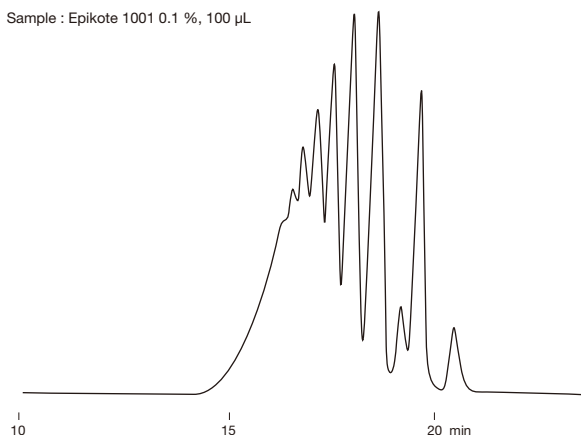
Target molecular weight range and exclusion limit

● Measured with polystyrene (eluent: Chloroform)

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

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

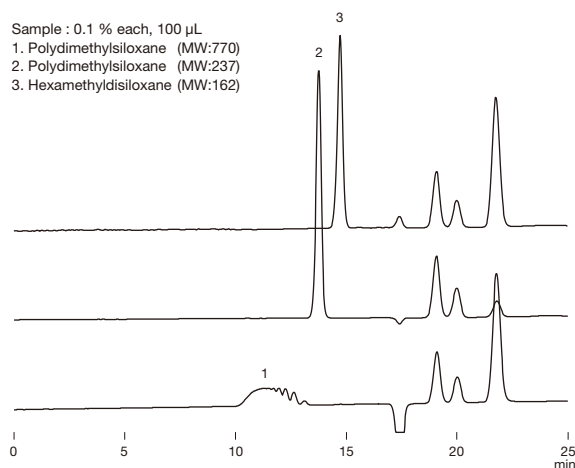
*() Estimated value

Epoxy resinSample : Epikote 1001 0.1 %, 100 μ L

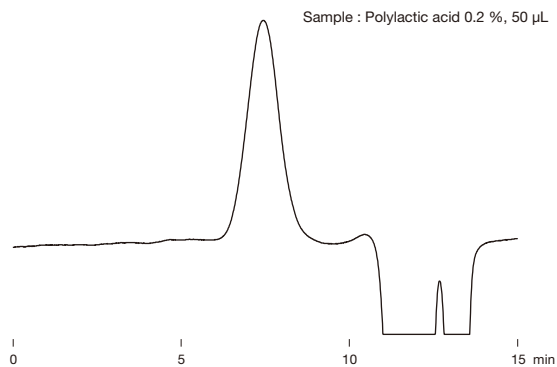
Column : Shodex GPC K-803L x 2
 Eluent : Chloroform
 Flow rate : 1.0 mL/min
 Detector : UV (254 nm)
 Column temp. : Room temp.

Low molecular polydimethylsiloxanes

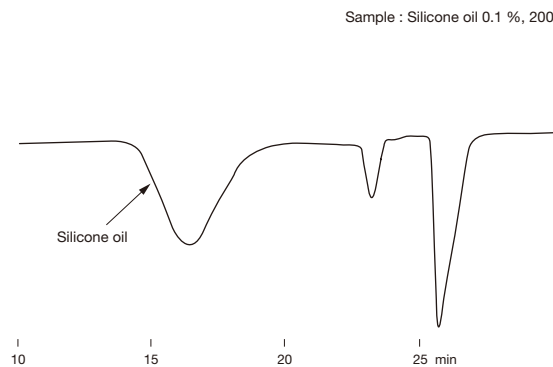
Sample : 0.1 % each, 100 μ L
 1. Polydimethylsiloxane (MW:770)
 2. Polydimethylsiloxane (MW:237)
 3. Hexamethyldisiloxane (MW:162)



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

Polylactic acidSample : Polylactic acid 0.2 %, 50 μ L

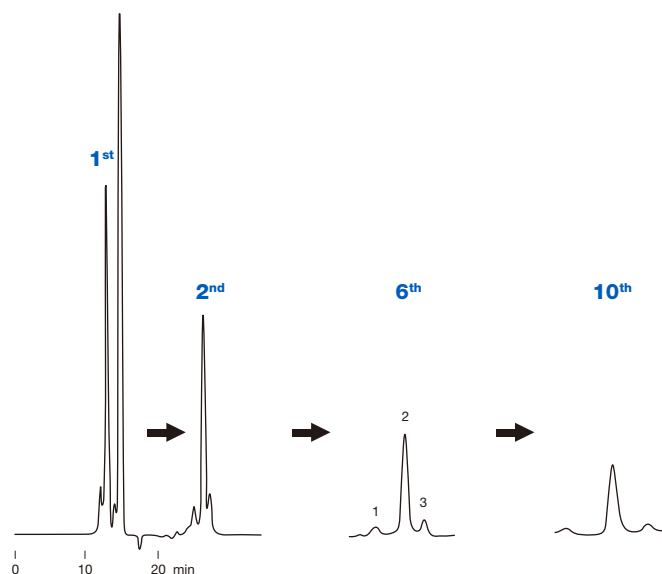
Column : Shodex GPC K-805L
 Eluent : Chloroform
 Flow rate : 1.0 mL/min
 Detector : RI
 Column temp. : 30 °C

Silicone oilSample : Silicone oil 0.1 %, 200 μ L

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

Recycling preparative chromatography of lauryl stearyl thiodipropionate

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



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

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

Features

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

● Standard columns

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

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

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

Base Material: Styrene divinylbenzene copolymer

Target molecular weight range and exclusion limit

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

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

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

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

Solvent-peak Separation Columns for Organic SEC (GPC)

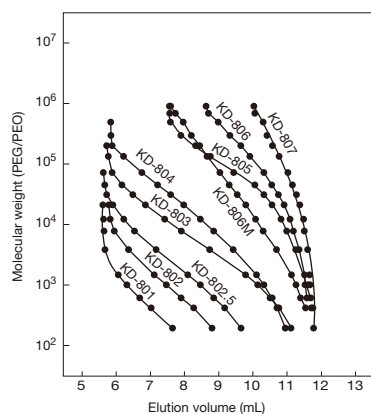
Features

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

● Solvent-peak separation columns

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

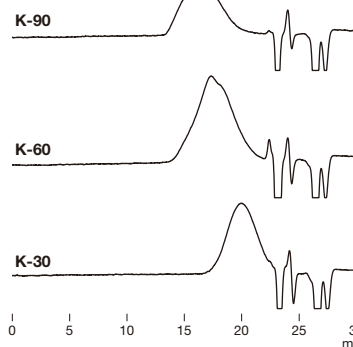
Base Material: Styrene divinylbenzene copolymer

Calibration curves for KD-800 series using PEG/PEO

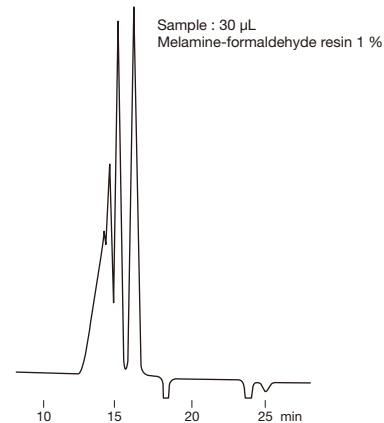
Column : Shodex GPC KD-800 series
Eluent : DMF
Flow rate : 1.0 mL/min
Detector : RI
Column temp. : 40 °C

Polyvinylpyrrolidones

Sample : Polyvinylpyrrolidone 0.1 % each, 100 μ L



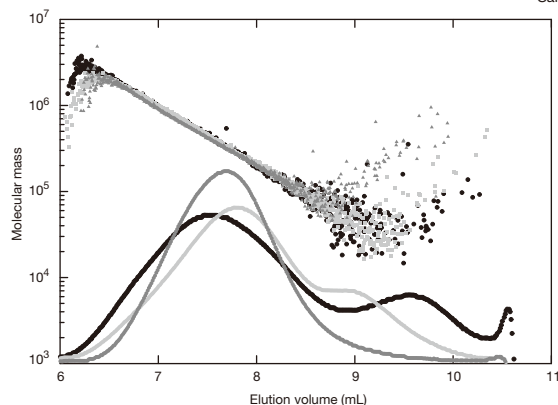
Column : Shodex GPC KD-806M x 2
Eluent : 10 mM LiBr in DMF
Flow rate : 1.0 mL/min
Detector : RI
Column temp. : 50 °C

Melamine formaldehyde resin

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

Celluloses

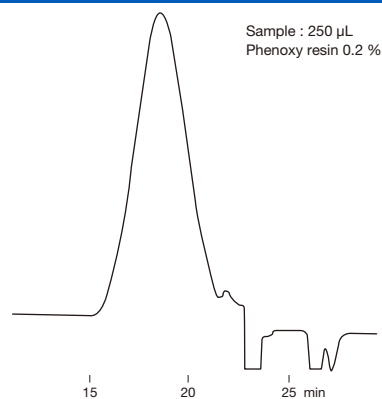
Sample : Cellulose ca. 0.05 % each, 100 μ L



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

*DMI 1,3-dimethyl-2-imidazolidinone

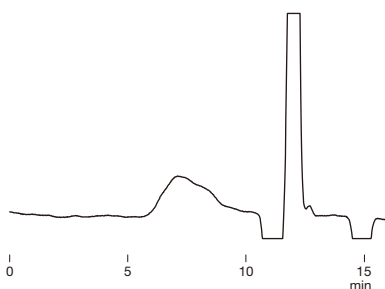
Data provided by Dr. Masahiko Yanagisawa,
 Isogai group, Graduate School of Agricultural and
 Life Sciences, The University of Tokyo

Phenoxy resin

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

Potato starch

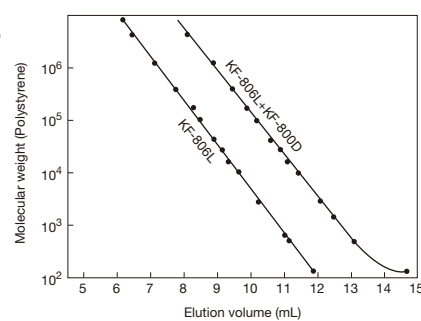
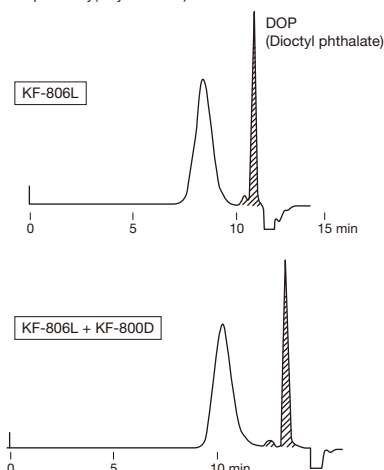
Sample : 100 μ L
 Potato starch in DMSO 0.1 %
 (solved at 80 °C)



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

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

Features

- KF-600**
- Achieves approximately halved analysis time compared with standard columns
 - The amount of solvent used is reduced to about a third
 - Improved applicability of solvent replacement
 - Fulfills USP L21 requirements
-
- KF-400HQ**
- About 1.5 times better separation performance than standard columns, obtains higher resolution
 - About 4 times better sensitivity than that of standard columns, supports high sensitivity analysis
 - The amount of solvent used is reduced to about a third
 - Improved applicability of solvent replacement
 - Fulfills USP L21 requirements

● Rapid analysis downsized columns

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

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

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

● High performance semi-micro columns

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

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

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

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

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

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

Base Material: Styrene divinylbenzene copolymer

Target molecular weight range and exclusion limit

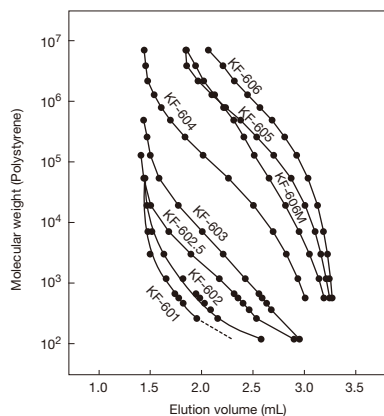
● Measured with polystyrene (eluent: THF)

Product Name	Target Molecular Weight Range	Exclusion Limit	Product Name	Target Molecular Weight Range	Exclusion Limit
KF-601	100 – 700	1,500	KF-401HQ	100 – 700	1,500
KF-602	200 – 1,500	4,000	KF-402HQ	200 – 1,500	4,000
KF-602.5	300 – 10,000	20,000	KF-402.5HQ	300 – 10,000	20,000
KF-603	600 – 50,000	70,000	KF-403HQ	600 – 50,000	70,000
KF-604	7,000 – 500,000	1,000,000	KF-404HQ	7,000 – 500,000	1,000,000
KF-605	50,000 – 2,000,000	4,000,000	KF-405LHQ	300 – 2,000,000	4,000,000
KF-606	150,000 – *(20,000,000)	*(20,000,000)	KF-406LHQ	300 – *(20,000,000)	*(20,000,000)
KF-606M	1,000 – *(20,000,000)	*(20,000,000)			

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

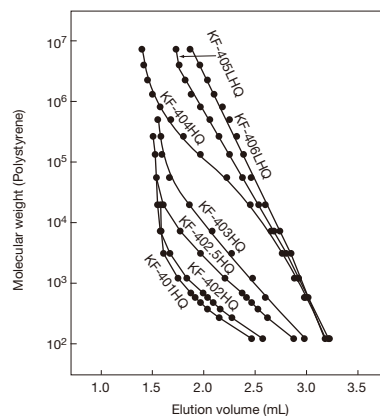
*() Estimated value

Calibration curves for KF-600 series using polystyrene



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

Calibration curves for KF-400HQ series using polystyrene



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

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

Standard type

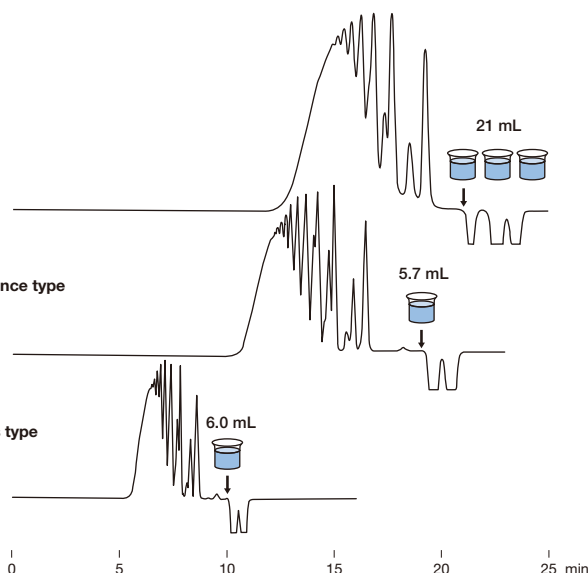
KF-802.5 x 2
 50 μ L injection

High performance type

KF-402.5HQ x 2
 10 μ L injection

Rapid analysis type

KF-602.5 x 2
 10 μ L injection



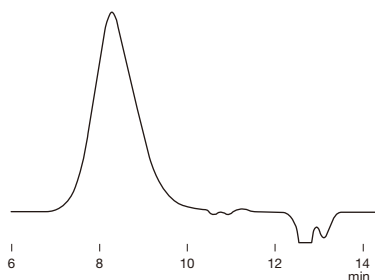
Sample : EPON1001 0.2 %

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

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

Styrene acrylonitrile copolymer

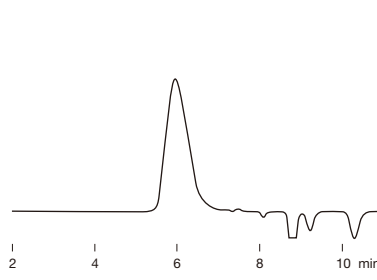
Sample : Styrene-Acrylonitrile (30:70) copolymer



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

Liquid paraffin

Sample : Liquid paraffin 1 %, 5 μ L

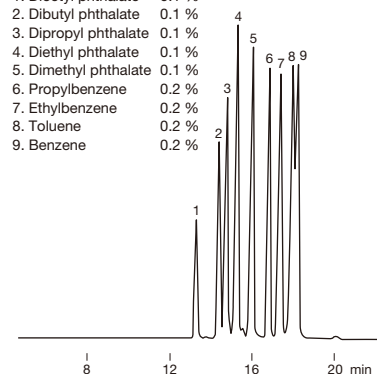


Column : Shodex GPC KF-401HQ
 Eluent : Chloroform
 Flow rate : 0.3 mL/min
 Detector : RI (small cell volume)
 Column temp. : 40 °C

Phthalates

Sample : 10 μ 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 : 0.3 mL/min
 Detector : UV (254 nm) (small cell volume)
 Column temp. : 40 °C

Organic SEC (GPC) Columns: Ultra-Rapid Analysis

Features

- HK-400**
- Newly developed styrene divinylbenzene copolymer monodisperse particles
 - Analysis time is reduced to about a sixth of conventional column's analysis time
 - Low column pressure even under high flow rate does not require a UHPLC system
 - The amount of solvent used is reduced to about a sixth
 - HK-403 (exclusion limit: 100,000) newly added to the series
 - HK-HFIP404L is filled with HFIP
 - Fulfills USP L21 requirements

● Ultra-Rapid analysis semi-micro columns

Shipping Solvent: Tetrahydrofuran (THF)

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

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

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

Base Material: Styrene divinylbenzene copolymer

Shipping Solvent: hexafluoroisopropanol (HFIP)

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

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

HK-HFIP404L is mixed-gel column capable of analyzing samples over a wide range of molecular weight distribution.
See page 64 for details of other columns filled with HFIP.

Base Material: Styrene divinylbenzene copolymer

● Guard filter for HK series

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

Removes insoluble components in the sample



Allows direct attachment to the analytical column

Target molecular weight range and exclusion limit

● Measured with polystyrene (eluent: THF)

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

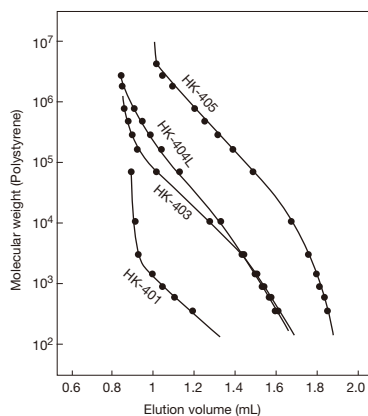
Please use the above table for reference purposes only when selecting columns.

● Measured with *PMMA (eluent: HFIP)

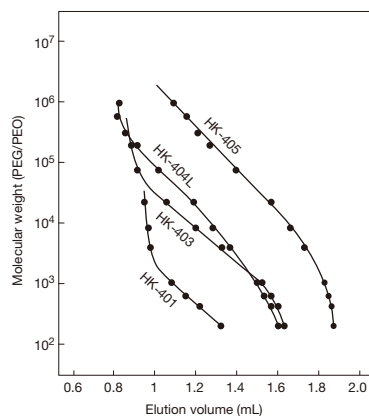
Product Name	Target Molecular Weight Range	Exclusion Limit
HK-HFIP404L	5,000 – 200,000	200,000

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

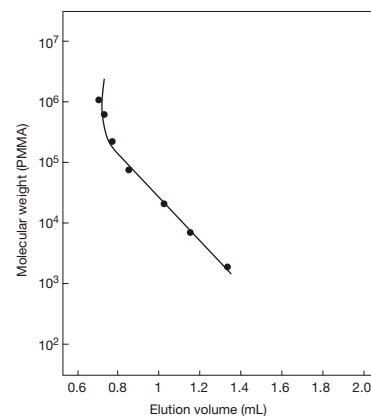
*PMMA: Polymethylmethacrylate

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

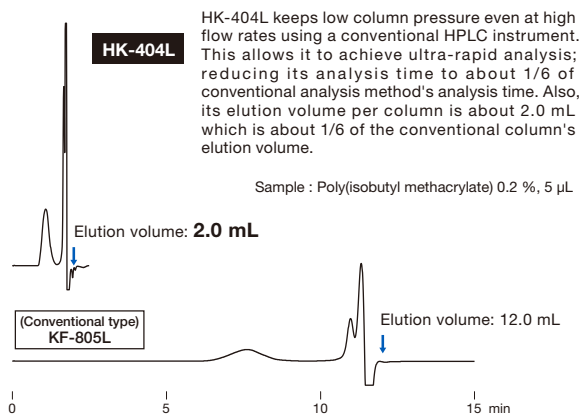
Column : Shodex GPC HK-400 series
Eluent : THF
Flow rate : 1.0 mL/min
Detector : RI (small cell volume)
Column temp. : 40 °C

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

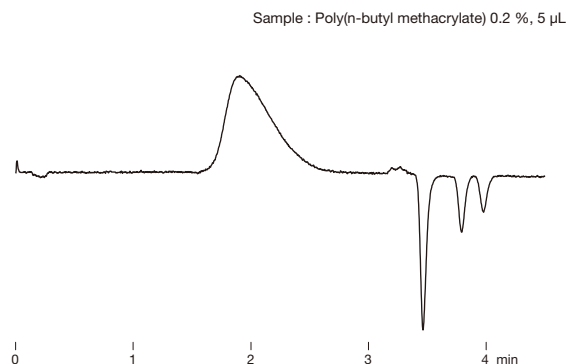
Column : Shodex GPC HK-400 series
Eluent : DMF
Flow rate : 1.0 mL/min
Detector : RI (small cell volume)
Column temp. : 40 °C

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

Column : Shodex GPC HK-HFIP404L
Eluent : 5 mM CF₃COONa in HFIP
Flow rate : 0.3 mL/min
Detector : RI (small cell volume)
Column temp. : 40 °C

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

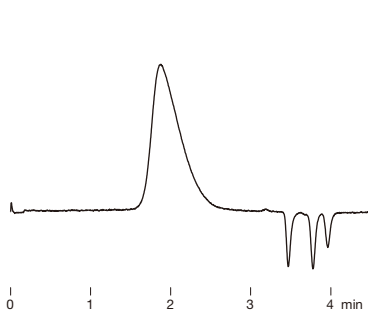
Column : Shodex GPC HK-404L, KF-805L
Eluent : THF
Flow rate : 1.0 mL/min
Detector : RI (small cell volume)
Column temp. : 40 °C

Poly(butyl methacrylate)

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

Styrene butyl methacrylate copolymer

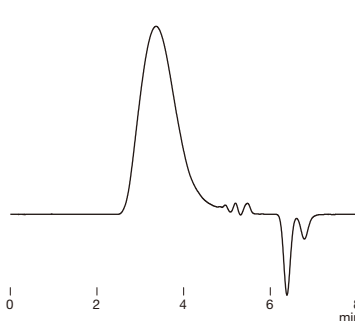
Sample : Styrene butyl methacrylate copolymer 0.2 %, 5 µL



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

Polyamide (Nylon 6/9)

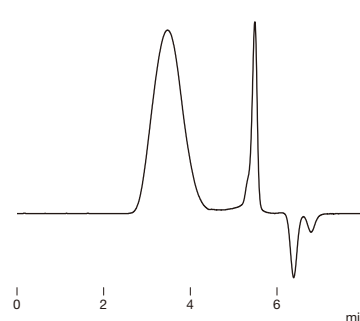
Sample : Nylon 6/9 0.23 %, 5 µL



Column : Shodex GPC HK-HFIP404L
Eluent : 5 mM CF₃COONa in HFIP
Flow rate : 0.3 mL/min
Detector : RI (small cell volume)
Column temp. : 40 °C

Polyamide (Nylon 11)

Sample : Nylon 11 0.25 %, 5 µL



Column : Shodex GPC HK-HFIP404L
Eluent : 5 mM CF₃COONa in HFIP
Flow rate : 0.3 mL/min
Detector : RI (small cell volume)
Column temp. : 40 °C

Organic SEC (GPC) Columns: Linear Calibration Type

Features

LF

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

● Standard column

Shipping Solvent: Tetrahydrofuran (THF)

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

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

Base Material: Styrene divinylbenzene copolymer

● Rapid analysis downsized column

Shipping Solvent: Tetrahydrofuran (THF)

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

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

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

Base Material: Styrene divinylbenzene copolymer

● High performance semi-micro column

Shipping Solvent: Tetrahydrofuran (THF)

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

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

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

Base Material: Styrene divinylbenzene copolymer

Target molecular weight range and exclusion limit

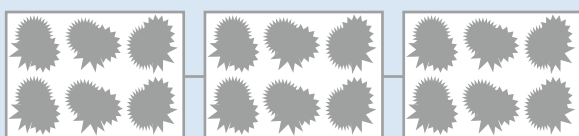
● Measured with polystyrene (eluent: THF)

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

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

Schematic diagram of linear calibration type packing

Connecting linear calibration type columns (LF series)



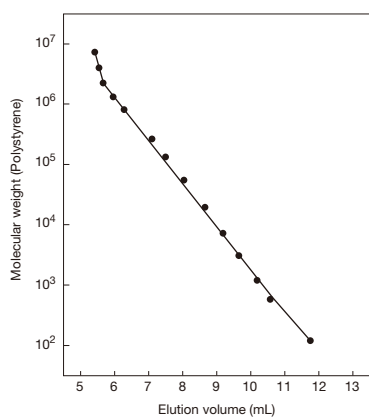
The linear calibration type column covers a broad range of molecular weights with only one kind of packing material.

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

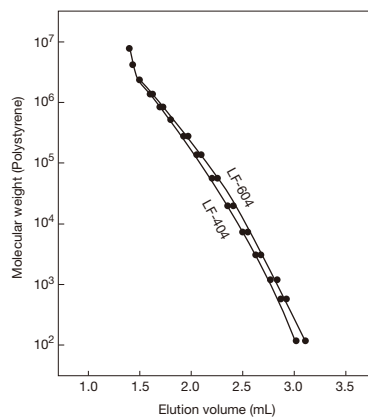


Connecting different single pore-size columns (KF-804 + KF-803 + KF-802, etc.)

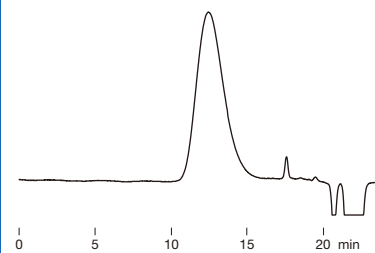


Calibration curve for LF-804 using polystyrene

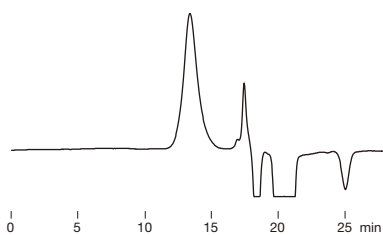
Column : Shodex GPC LF-804
 Eluent : THF
 Flow rate : 1.0 mL/min
 Detector : RI
 Column temp. : 40 °C

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

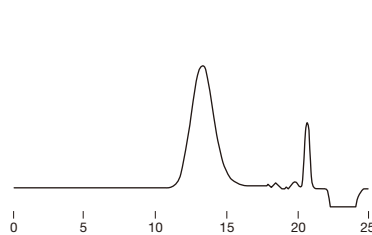
Column : Shodex GPC LF-604, LF-404
 Eluent : THF
 Flow rate : 0.5 mL/min (LF-604)
 0.3 mL/min (LF-404)
 Detector : RI (small cell volume)
 Column temp. : 40 °C

PolyurethaneSample : Polyurethane 0.1 %, 20 μ L

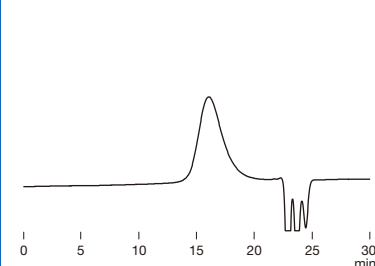
Column : Shodex GPC LF-404 x 2
 Eluent : THF
 Flow rate : 0.3 mL/min
 Detector : RI (small cell volume)
 Column temp. : 40 °C

XylanSample : Xylan 0.1 %, 100 μ L

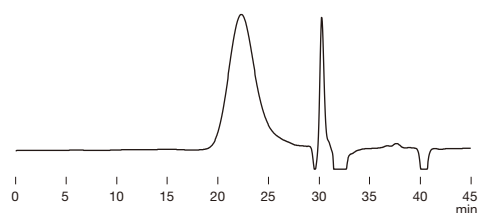
Column : Shodex GPC LF-804
 Eluent : 20 mM H₃PO₄ + 20 mM LiBr
 in DMSO/DMF=80/20
 Flow rate : 0.6 mL/min
 Detector : RI
 Column temp. : 50 °C

Polyamide (Nylon 6/6)Sample : Nylon 6/6 0.1 %, 20 μ L

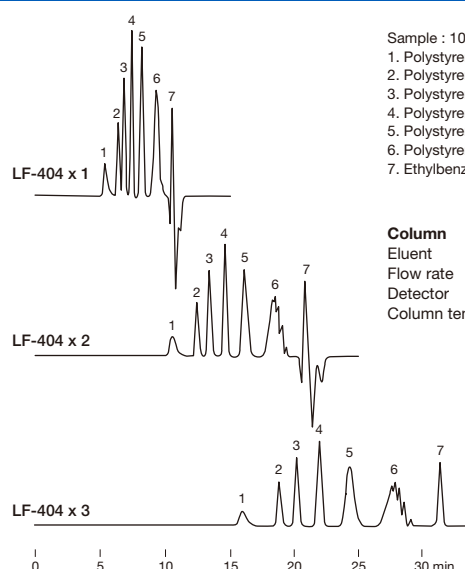
Column : Shodex GPC LF-404
 Eluent : 5 mM CF₃COONa in HFIP
 Flow rate : 0.15 mL/min
 Detector : RI (small cell volume)
 Column temp. : 40 °C

Polymethyl methacrylateSample : Polymethyl methacrylate, 100 μ L

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

Polyamic acidSample : Poly(pyromellitic dianhydride-co-4,4'-oxydianiline), 100 μ L

Column : Shodex GPC LF-804 x 2
 Eluent : 30 mM LiBr + 30 mM H₃PO₄ in NMP
 Flow rate : 0.7 mL/min
 Detector : RI
 Column temp. : 50 °C

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

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

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

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

Features

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

● Standard columns

Shipping Solvent: Toluene

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

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

Base Material: Styrene divinylbenzene copolymer
*Ta: Ambient temperature

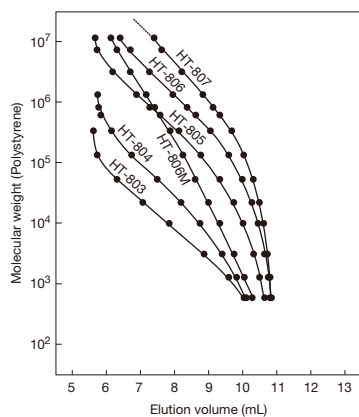
Target molecular weight range and exclusion limit

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

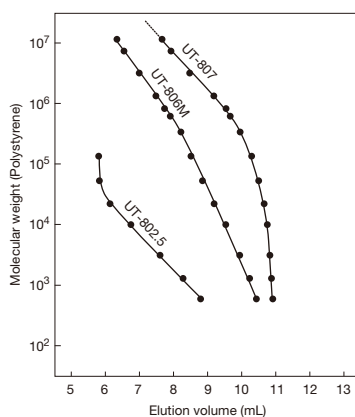
Product Name	Target Molecular Weight Range	Exclusion Limit
HT-803	1,000 – 50,000	70,000
HT-804	7,000 – 300,000	400,000
HT-805	50,000 – 2,000,000	4,000,000
HT-806	150,000 – *(20,000,000)	*(20,000,000)
HT-806M	1,000 – *(20,000,000).	*(20,000,000)
HT-807	300,000 – *(200,000,000)	*(200,000,000)
UT-802.5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

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

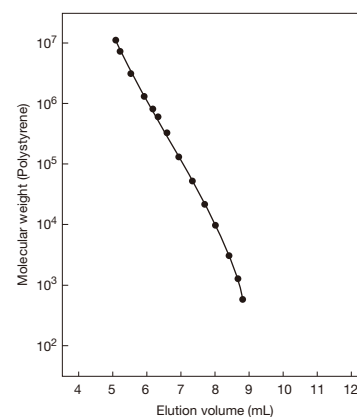
*() Estimated value

Calibration curves for HT-800 series using polystyrene

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

Calibration curves for UT-800 series using polystyrene

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

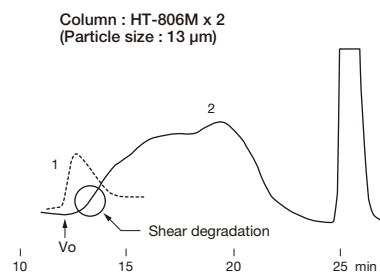
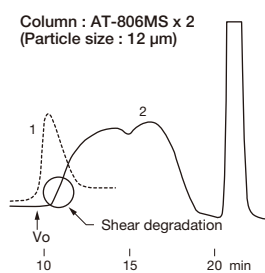
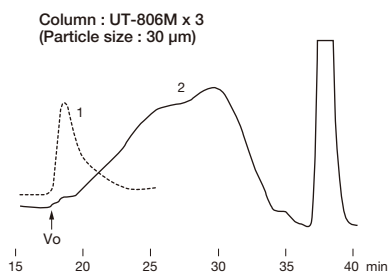
Calibration curve for AT-806MS using polystyrene

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

Effects of gel particle size in high temperature GPC columns

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

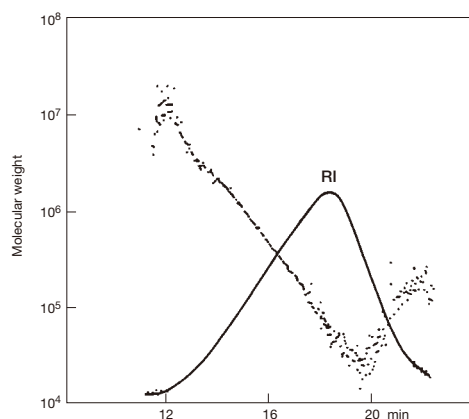
Sample :
 1. Polystyrene (MW : 20,000,000)
 2. High density polyethylene (HDPE-A)



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

High density polyethylene

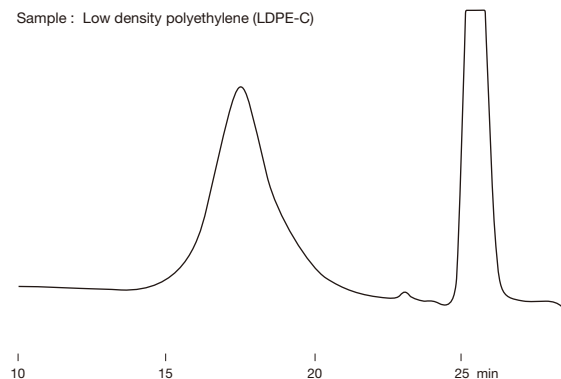
Sample : High density polyethylene (HDPE-B)



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

Low density polyethylene

Sample : Low density polyethylene (LDPE-C)



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

Organic SEC (GPC) Columns: HFIP

Features

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

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

Standard columns

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

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

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

Base Material: Styrene divinylbenzene copolymer

Rapid analysis downsized columns

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

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

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

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

Base Material: Styrene divinylbenzene copolymer

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

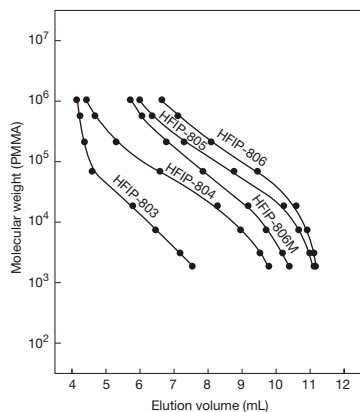
Target molecular weight range and exclusion limit

Measured with *PMMA (eluent: HFIP)

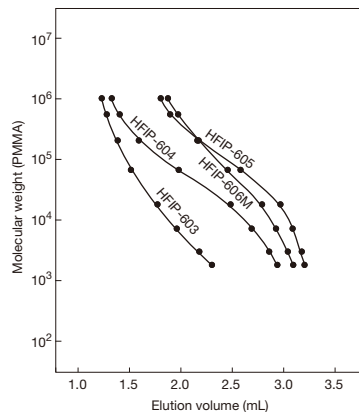
Product Name	Target Molecular Weight Range	Exclusion Limit	Product Name	Target Molecular Weight Range	Exclusion Limit
HFIP-803	1,000 – 30,000	60,000	HFIP-603	1,000 – 30,000	60,000
HFIP-804	20,000 – 200,000	300,000	HFIP-604	20,000 – 200,000	300,000
HFIP-805	20,000 – 600,000	1,000,000	HFIP-605	20,000 –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

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

*PMMA: Polymethylmethacrylate
 ** () Estimated value

Calibration curves for HFIP-800 series using PMMA

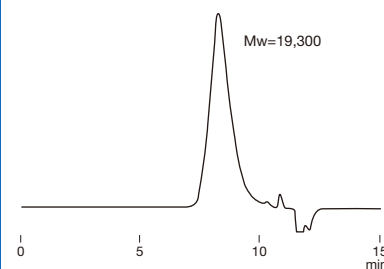
Column : Shodex GPC HFIP-800 series
Eluent : HFIP
Flow rate : 1.0 mL/min
Detector : RI
Column temp. : 40 °C

Calibration curves for HFIP-600 series using PMMA

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

Polyethylene terephthalate (PET)

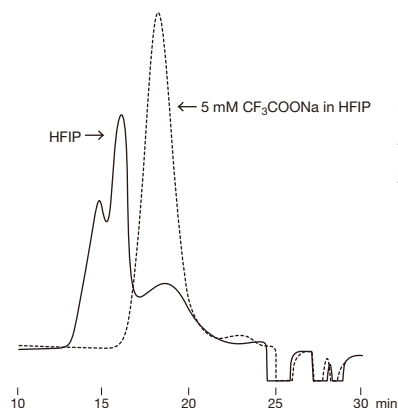
Sample : Polyethylene terephthalate 0.2 %, 20 μ L



Column : Shodex GPC HFIP-606M x 2
Eluent : 5 mM CF₃COONa in HFIP
Flow rate : 0.6 mL/min
Detector : RI (small cell volume)
Column temp. : 40 °C

Polyamide (added salt)

Sample : Polycaprolactum (Nylon 6)

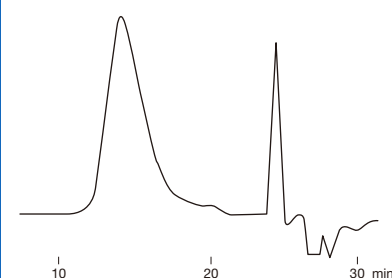


Some samples analyzed under SEC mode with HFIP solvent may show abnormal peaks resulting from the ionic interaction. This interaction can be suppressed by adding sodium trifluoroacetate to the HFIP eluent.

Column : Shodex GPC HFIP-806M x 2
Eluent : HFIP (solid line), 5 mM CF₃COONa in HFIP (broken line)
Flow rate : 1.0 mL/min
Detector : RI
Column temp. : 40 °C

Polybutylene terephthalate (PBT)

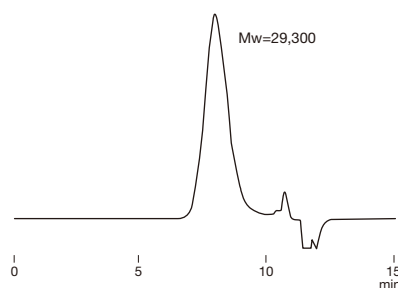
Sample : Polybutylene terephthalate 0.05 %, 500 μ L



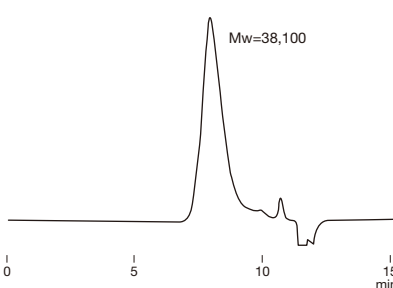
Column : Shodex GPC HFIP-805 + HFIP-803
Eluent : 5 mM CF₃COONa in HFIP
Flow rate : 1.0 mL/min
Detector : RI
Column temp. : 40 °C

Polyamides (Nylon 6/10 and Nylon 6)

Sample : Nylon 6/10 0.2 %, 20 μ L



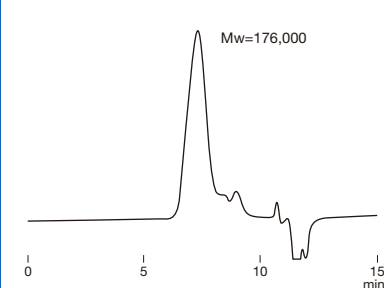
Sample : Nylon 6 0.2 %, 20 μ L



Column : Shodex GPC HFIP-606M x 2
Eluent : 5 mM CF₃COONa in HFIP
Flow rate : 0.6 mL/min
Detector : RI (small cell volume)
Column temp. : 40 °C

Polyacetal

Sample : Polyacetal 0.2 %, 20 μ L



Column : Shodex GPC HFIP-606M x 2
Eluent : 5 mM CF₃COONa in HFIP
Flow rate : 0.6 mL/min
Detector : RI (small cell volume)
Column temp. : 40 °C

Organic SEC (GPC) Column: Rapid Preparation

Features

New

FP-2002

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

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

Shipping Solvent: Chloroform

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

Base Material: Styrene divinylbenzene copolymer

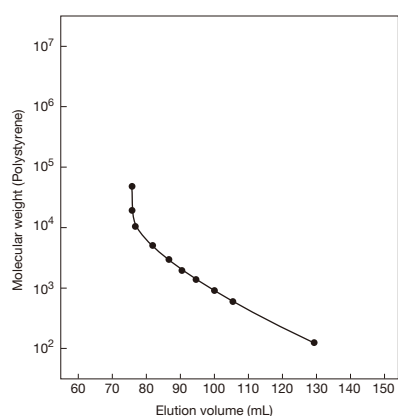
Target molecular weight range and exclusion limit

● Measured with polystyrene (eluent: Chloroform)

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

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

Calibration curve for FP-2002 using polystyrene

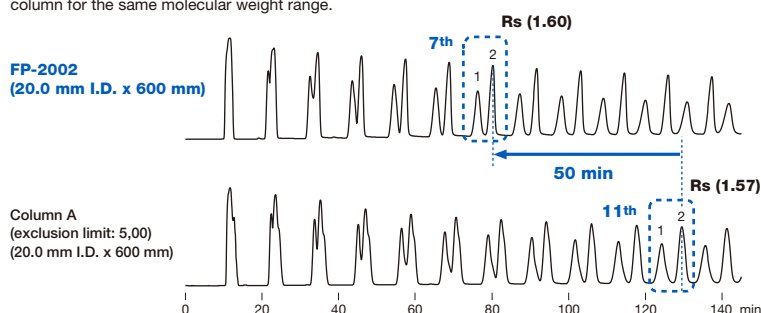


Column : Shodex GPC FP-2002
Eluent : Chloroform
Flow rate : 10 mL/min
Detector : UV (254 nm)
 (preparative type)
Column temp. : 30 °C

Comparison of recycling separation

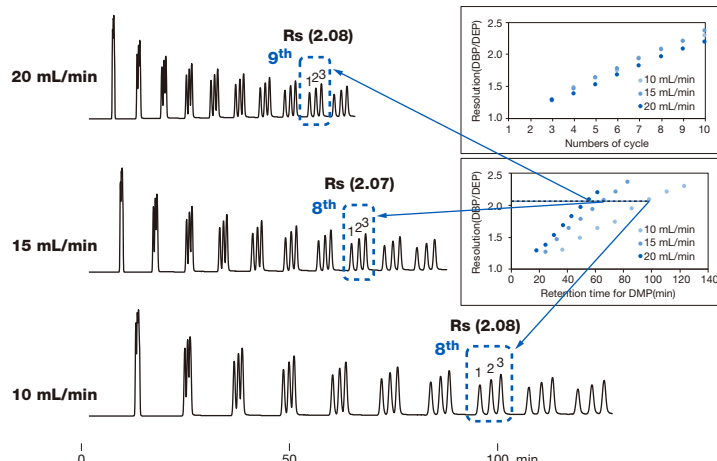
GPC FP-2002 is a column suitable for rapid organic solvent SEC(GPC) separation. Phthalate esters were used to compare recycled separations with other manufacturer's rapid preparative column (exclusion limit: 5,000). The recycling separation using FP-2002 can be made faster than other column for the same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

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



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

Effects of flow rate for recycling separation



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

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

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

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

Organic SEC (GPC) Columns: [Customized columns]

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

[H-2000 series] Shipping Solvent: Chloroform

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

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

Base Material: Styrene divinylbenzene copolymer

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

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

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

Base Material: Styrene divinylbenzene copolymer

[K-5000 series] Shipping Solvent: Chloroform

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

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

Base Material: Styrene divinylbenzene copolymer

Solvent Replacement Applicability of SEC (GPC) Columns

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

○: Solvent replacement possible

△: Solvent replacement possible, but this may cause column performance to deteriorate slightly

*: Usable at 40 °C or higher

×: Solvent replacement not possible

Calibration Standards for SEC

[Polystyrene (PS)]

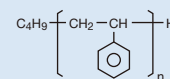
Features

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

Standard kit

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

Structural formula of S series



SL-105

Std. No.	Mp	Mw/Mn
S-18	18,000	1.02
S-13	13,000	1.02
S-9.8	9,820	1.02
S-6.7	6,660	1.03
S-4.9	4,910	1.03
S-2.8	2,790	1.04
S-1.9	1,890	1.05
S-1.3	1,300	1.06
S-1.1	1,140	1.06
S-0.6	580	1.18

SM-105

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

SH-75

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

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

[Polymethylmethacrylate (PMMA)]

Features

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

Standard kit

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

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

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

[Pullulan]

Features

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

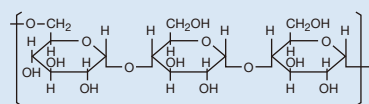
Standard kit

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

Single type

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

Structural formula of P series



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

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