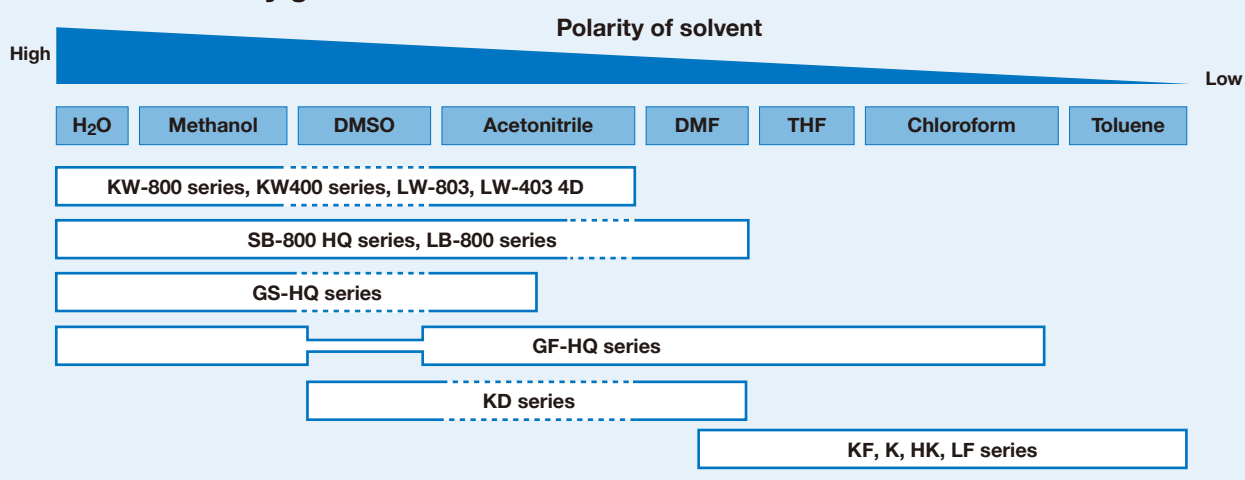


Column Selection for Size Exclusion Chromatography (SEC)

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

Solvent usability guideline for the Shodex SEC columns



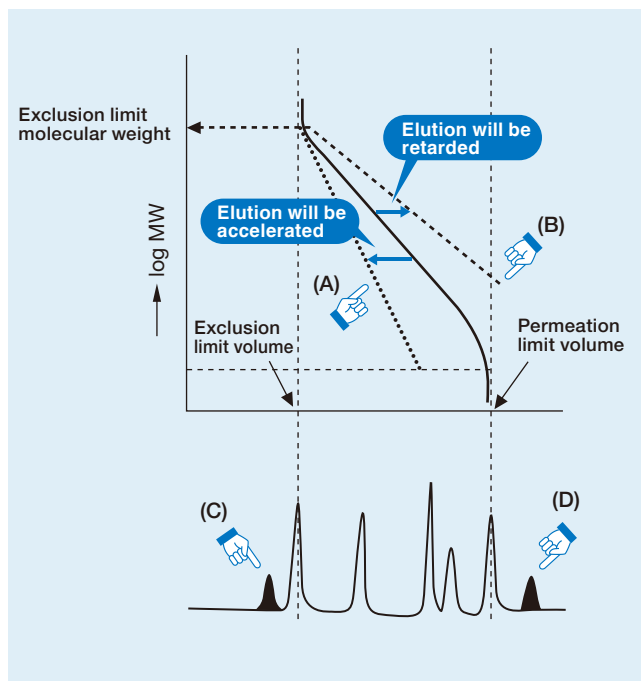
Precautions for Polar Polymer Analysis

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 CF₃COONa 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

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

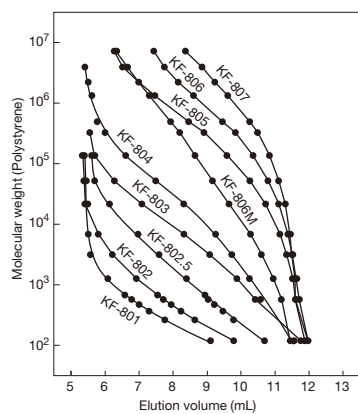
● Measured with polystyrene (eluent: THF)

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.

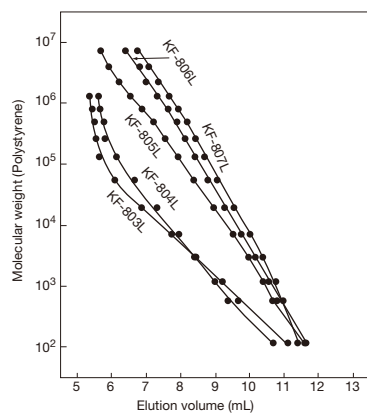
*() Estimated value

Calibration curves for KF-800 series using polystyrene



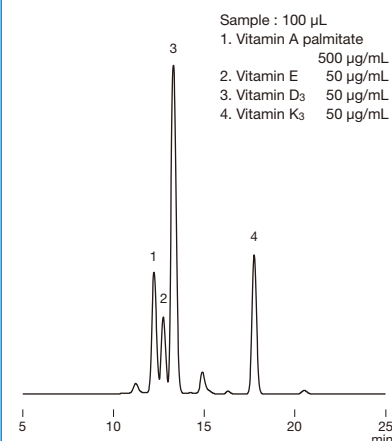
Column : Shodex GPC KF-800 series
 Eluent : THF
 Flow rate : 1.0 mL/min
 Detector : RI
 Column temp. : 40 °C

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



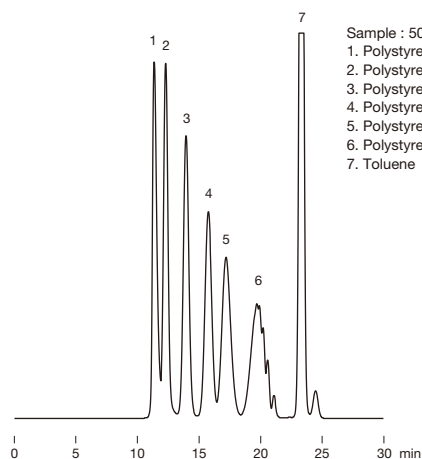
Column : Shodex GPC KF-800L series
 Eluent : THF
 Flow rate : 1.0 mL/min
 Detector : RI
 Column temp. : 40 °C

Fat-soluble vitamins

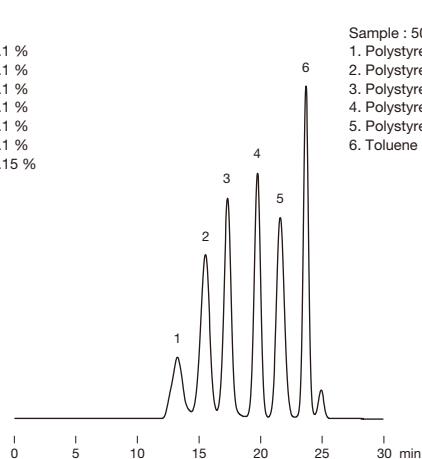


Column : Shodex GPC KF-801 x 2
 Eluent : THF
 Flow rate : 1.0 mL/min
 Detector : UV (280 nm)
 Column temp. : 40 °C

Polystyrene standards



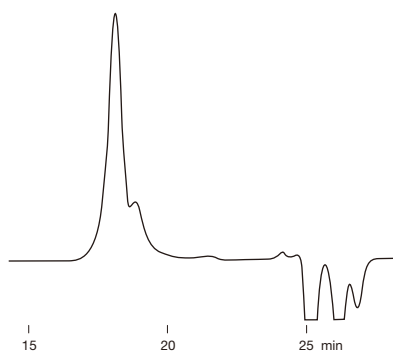
Column : Shodex GPC KF-803L x 2
 Eluent : THF
 Flow rate : 1.0 mL/min
 Detector : UV (254 nm)
 Column temp. : 40 °C



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

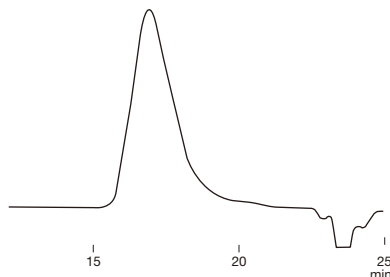
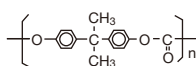
Sample : Styrene isoprene ABA block copolymer



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

Polycarbonate resin

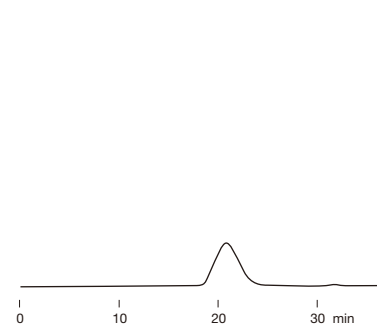
Sample : Polycarbonate resin 0.1 %, 100 µL



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

Raw rubber

Sample : Rubber 0.1 %, 300 µL



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 in chloroform.

Base Material: Styrene divinylbenzene copolymer

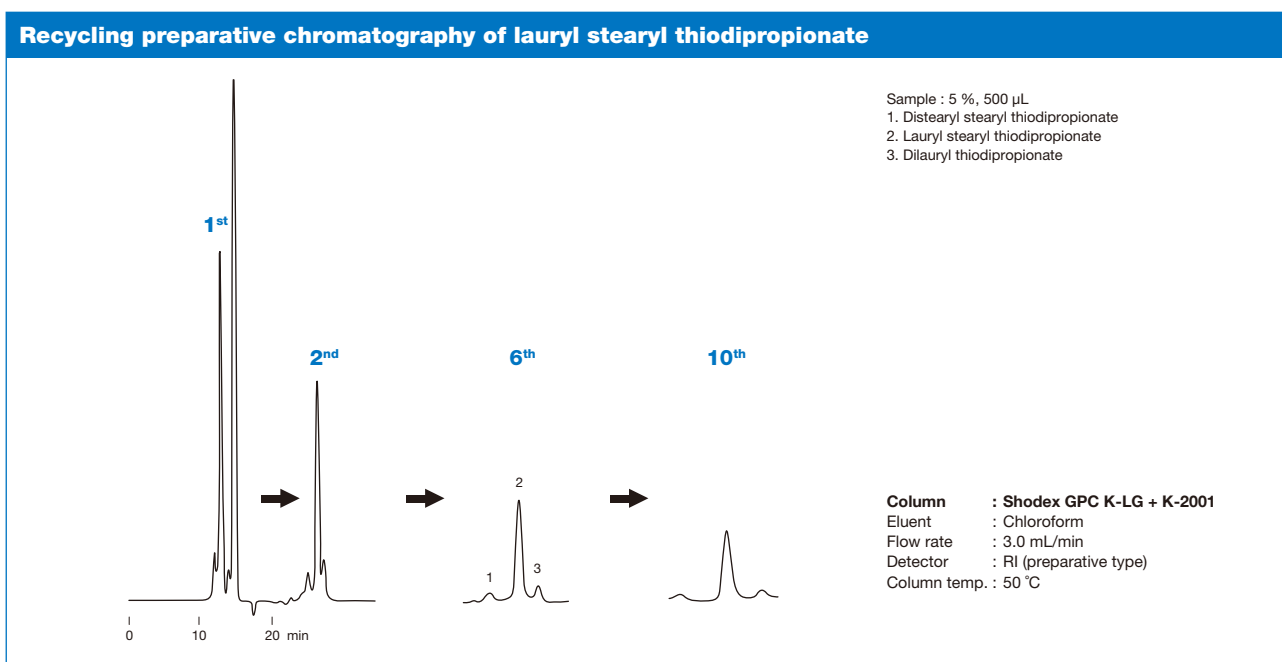
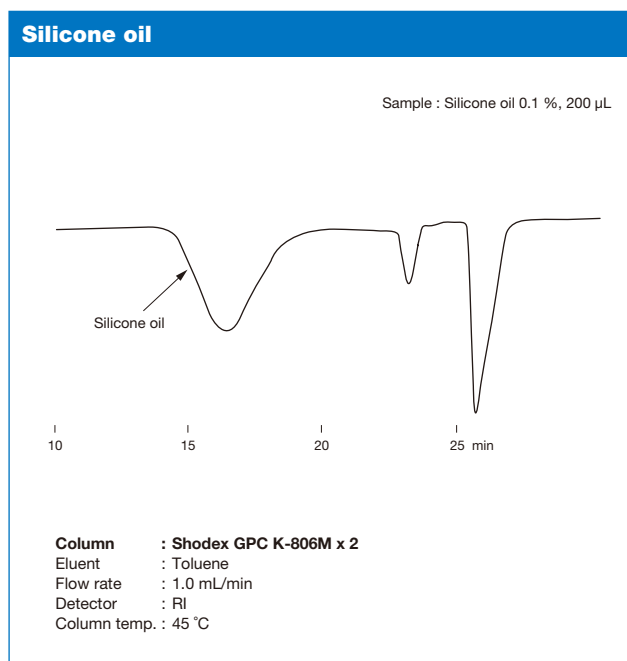
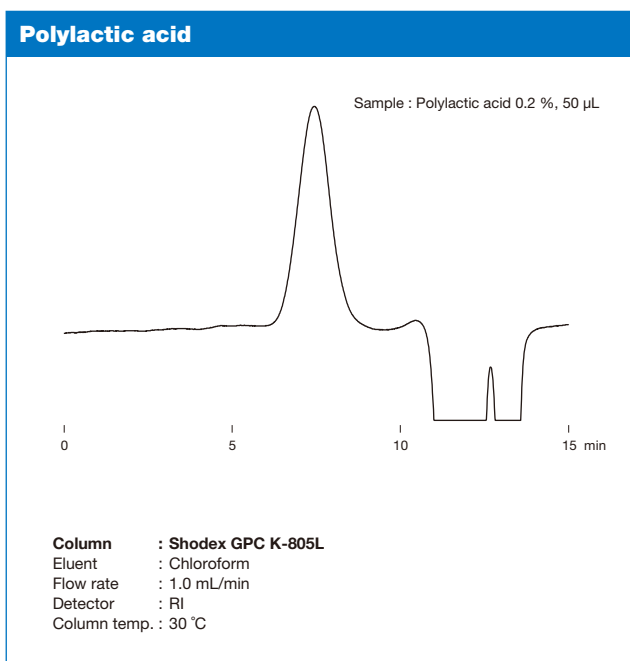
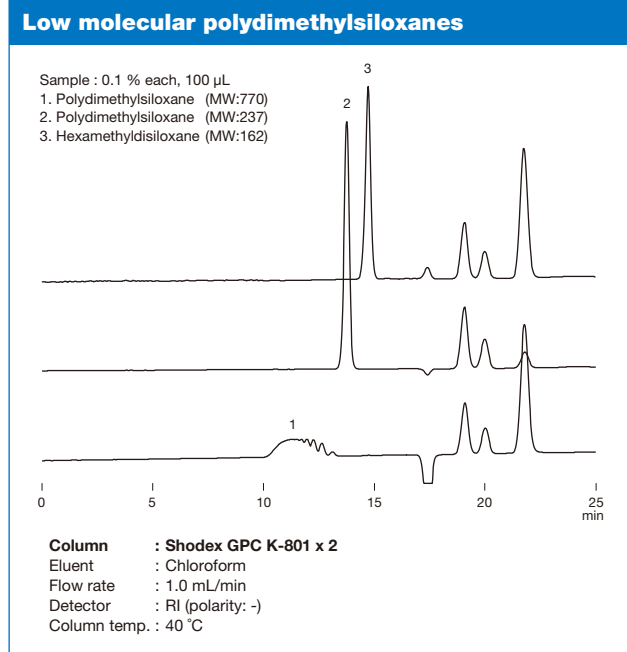
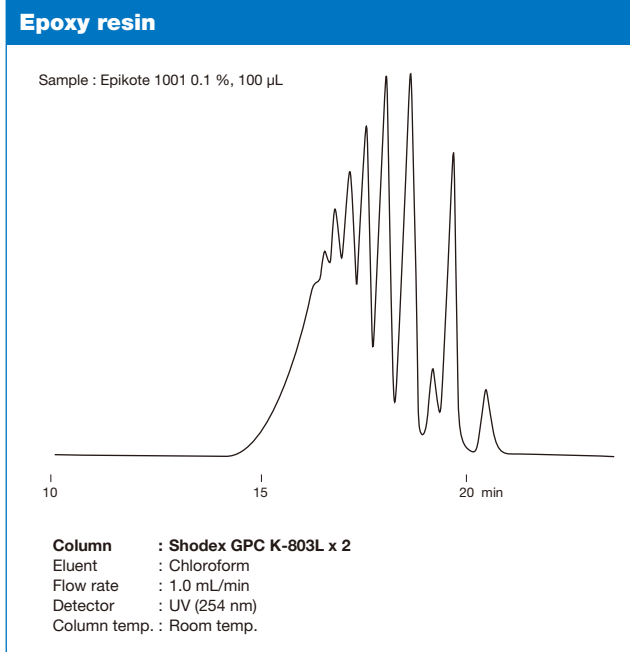
Target molecular weight range and exclusion limit

● 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



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

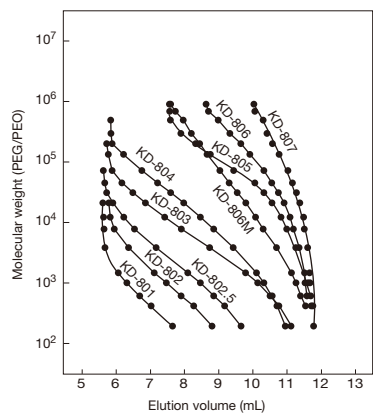
- KF-800D**
- Use this column in combination with a linear column
- K-800D**
- Accurate molecular weight distribution of polymers and oligomers are achieved by shifting the elutions of monomers, polymer additives, and solvent-peak in the lower molecular region

● 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

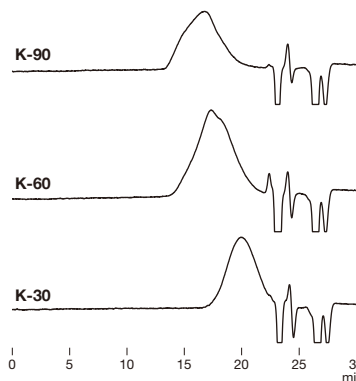
Calibration curves for KD-800 series using PEG/PEO



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

Polyvinylpyrrolidones

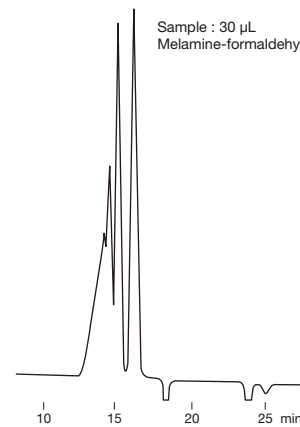
Sample : Polyvinylpyrrolidone 0.1 % each, 100 μ L



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

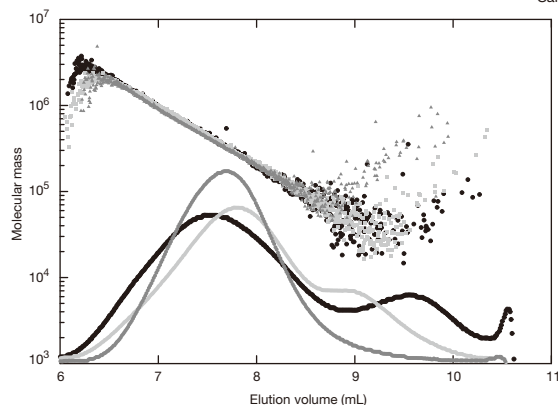
Sample : 30 μ L
 Melamine-formaldehyde resin 1 %



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

Celluloses

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



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

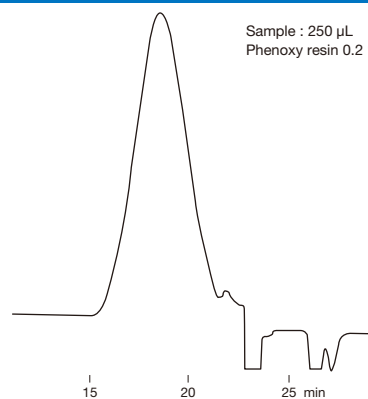
Column : Shodex GPC KD-806M
Eluent : 1 % LiCl in DMI*
Flow rate : 0.5 mL/min
Detector : RI, MALS (Multi angle light scattering)
Column temp. : 60 °C

*DMI 1,3-dimethyl-2-imidazolidinone

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

Phenoxy resin

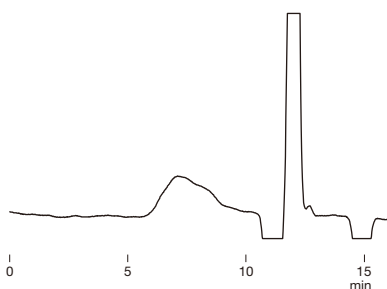
Sample : 250 μ L
 Phenoxy resin 0.2 %



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

Potato starch

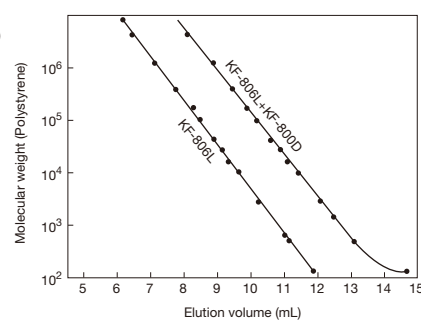
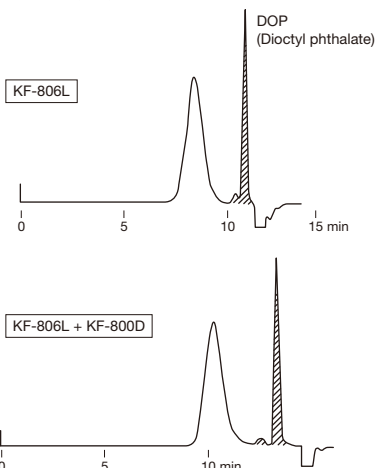
Sample : 100 μ L
 Potato starch in DMSO 0.1 %
 (dissolved at 80 °C)



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 half the 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

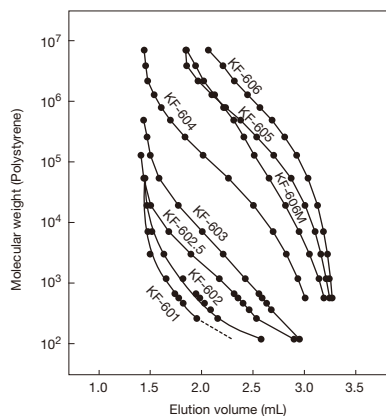
● Measured with polystyrene (eluent: THF)

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.

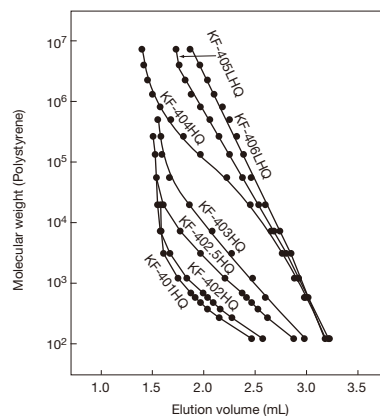
*() Estimated value

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

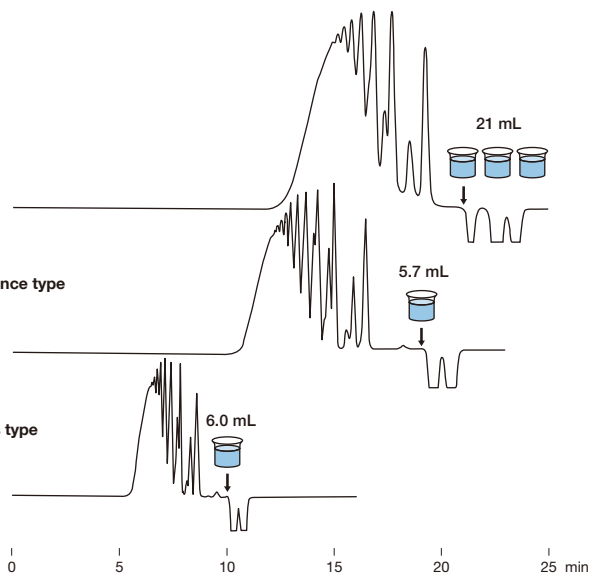
KF-802.5 x 2
 50 μ L injection

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.

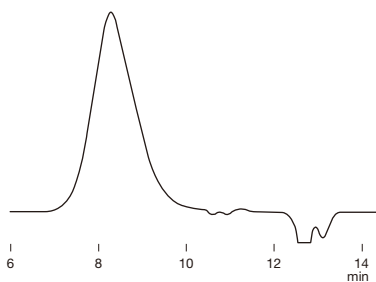
Column : Shodex GPC KF-802.5 x 2
 Shodex GPC KF-402.5HQ x 2
 Shodex GPC KF-602.5 x 2

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

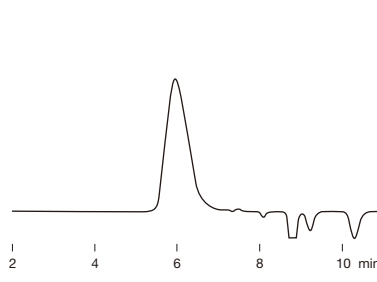
Sample : Styrene-Acrylonitrile (30:70) copolymer



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

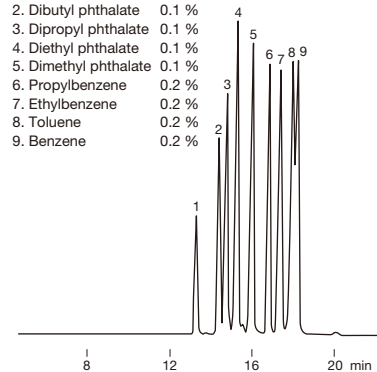


Column : Shodex GPC KF-401HQ
 Eluent : Chloroform
 Flow rate : 0.3 mL/min
 Detector : RI (small cell volume)
 Column temp. : 40 °C

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

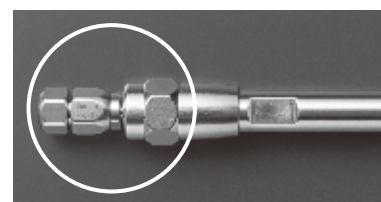
HK-HFIP404L is mixed-gel column capable of analyzing samples over a wide range of molecular weight distribution.
See page 64 for details of other columns filled with HFIP.

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.

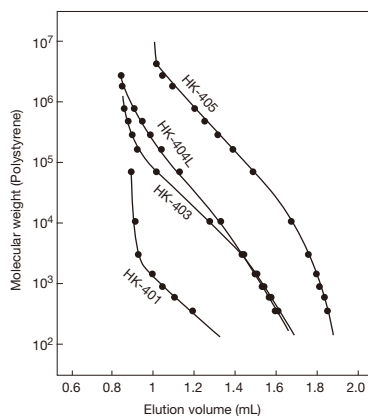
● Measured with PMMA (eluent: HFIP)

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.

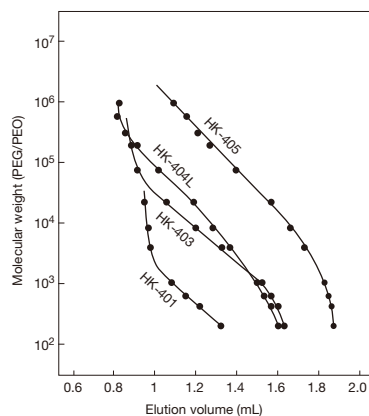
PMMA: Polymethylmethacrylate

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



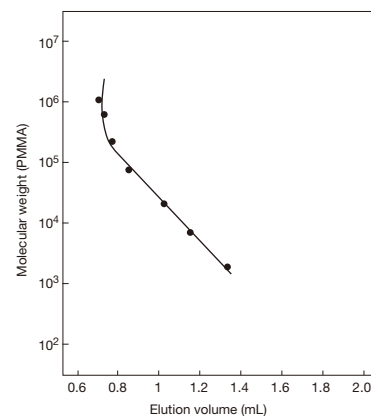
Column : Shodex GPC HK-400 series
 Eluent : THF
 Flow rate : 1.0 mL/min
 Detector : RI (small cell volume)
 Column temp. : 40 °C

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



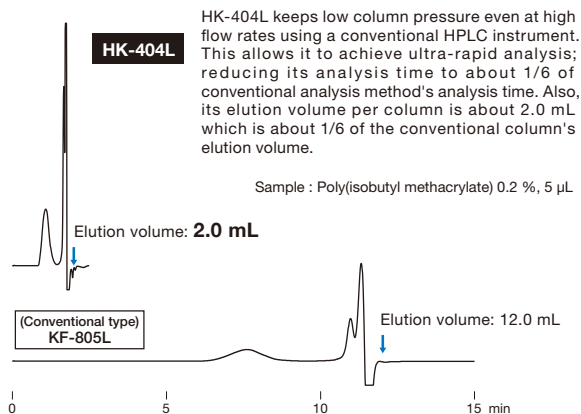
Column : Shodex GPC HK-400 series
 Eluent : DMF
 Flow rate : 1.0 mL/min
 Detector : RI (small cell volume)
 Column temp. : 40 °C

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



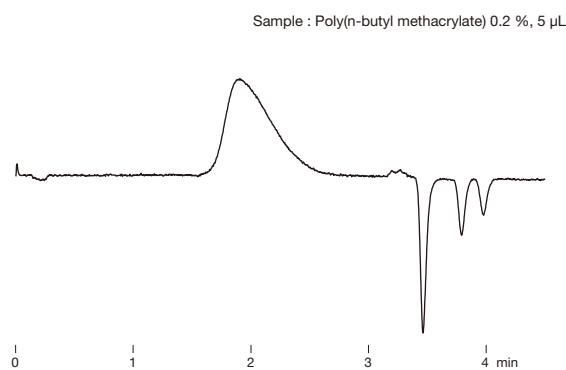
Column : Shodex GPC HK-HFIP404L
 Eluent : 5 mM CF₃COONa in HFIP
 Flow rate : 0.3 mL/min
 Detector : RI (small cell volume)
 Column temp. : 40 °C

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

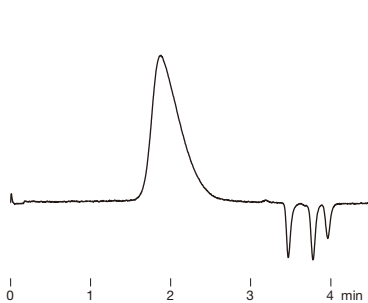
Poly(butyl methacrylate)



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

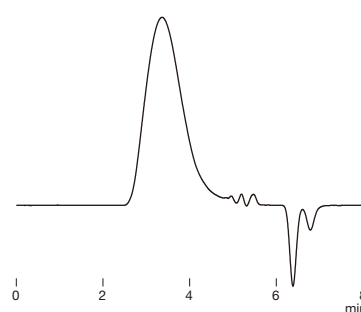
Sample : Styrene butyl methacrylate copolymer 0.2 %, 5 µL



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)

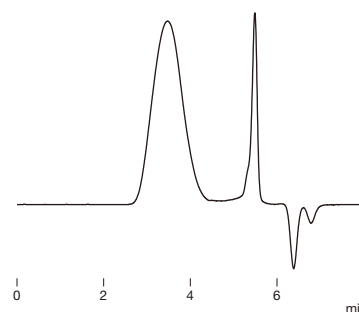
Sample : Nylon 6/9 0.23 %, 5 µL



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

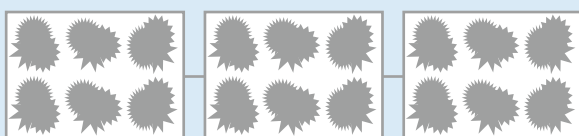
● Measured with polystyrene (eluent: THF)

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)



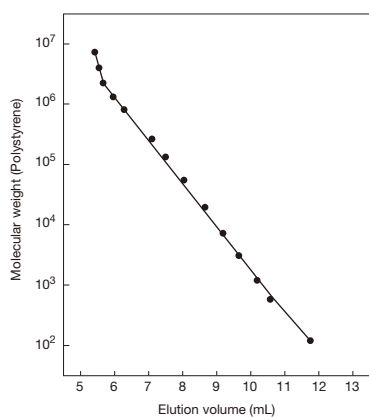
The linear calibration type column covers a broad range of molecular weights with only one kind of packing material.

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

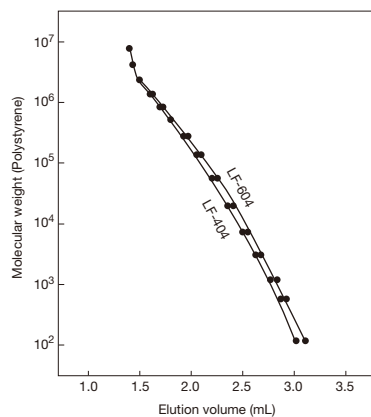


Connecting different single pore-size columns (KF-804 + KF-803 + KF-802, etc.)

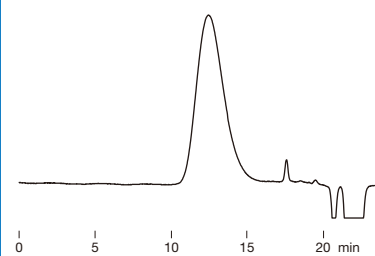


Calibration curve for LF-804 using polystyrene

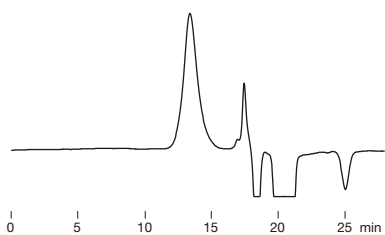
Column : Shodex GPC LF-804
 Eluent : THF
 Flow rate : 1.0 mL/min
 Detector : RI
 Column temp. : 40 °C

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

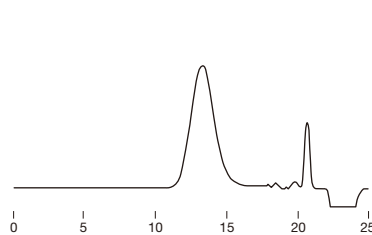
Column : Shodex GPC LF-604, LF-404
 Eluent : THF
 Flow rate : 0.5 mL/min (LF-604)
 0.3 mL/min (LF-404)
 Detector : RI (small cell volume)
 Column temp. : 40 °C

PolyurethaneSample : Polyurethane 0.1 %, 20 μ L

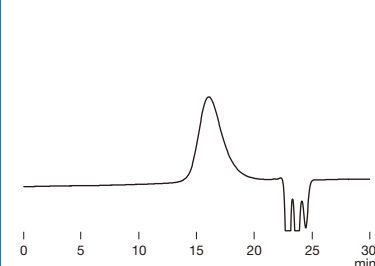
Column : Shodex GPC LF-404 x 2
 Eluent : THF
 Flow rate : 0.3 mL/min
 Detector : RI (small cell volume)
 Column temp. : 40 °C

XylanSample : Xylan 0.1 %, 100 μ L

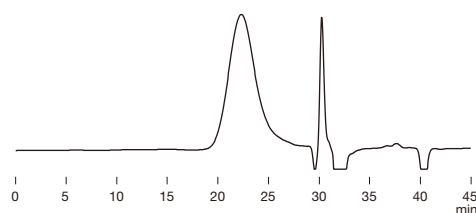
Column : Shodex GPC LF-804
 Eluent : 20 mM H₃PO₄ + 20 mM LiBr
 in DMSO/DMF=80/20
 Flow rate : 0.6 mL/min
 Detector : RI
 Column temp. : 50 °C

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

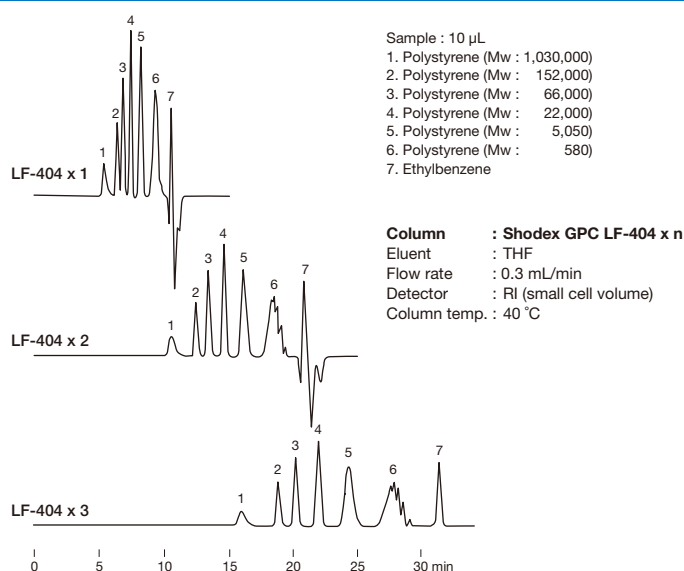
Column : Shodex GPC LF-404
 Eluent : 5 mM CF₃COONa in HFIP
 Flow rate : 0.15 mL/min
 Detector : RI (small cell volume)
 Column temp. : 40 °C

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

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	RT ~ 150	12	10,000	8.0 x 250
F6700280	GPC AT-G	(guard column)	RT ~ 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
RT: Ambient room temperature

Target molecular weight range and exclusion limit

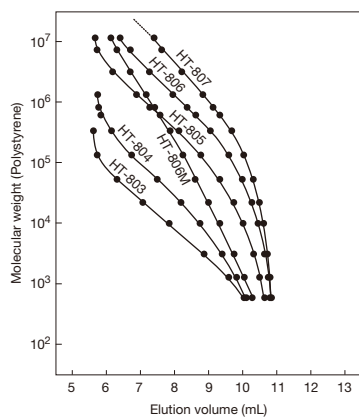
● Measured with polystyrene (eluent: o-Dichlorobenzene (ODCB))

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.

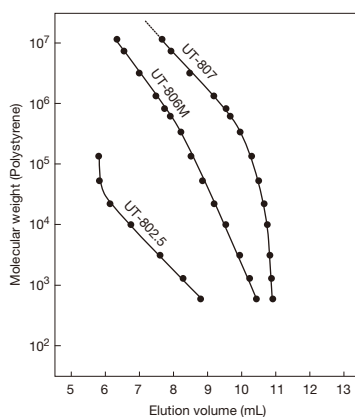
*() Estimated value

Calibration curves for HT-800 series using polystyrene



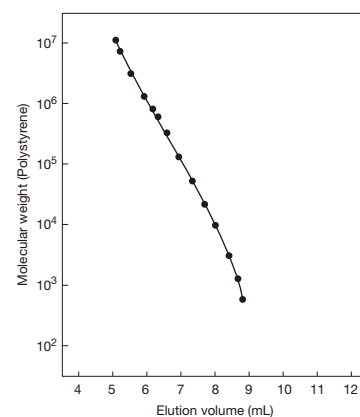
Column : Shodex GPC HT-800 series
 Eluent : 0.1 % BHT in ODCB
 Flow rate : 1.0 mL/min
 Detector : RI
 Column temp. : 140 °C

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

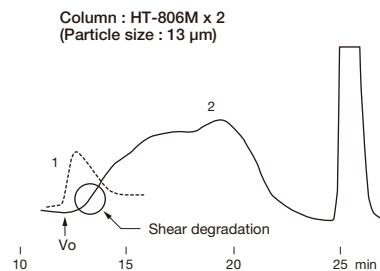
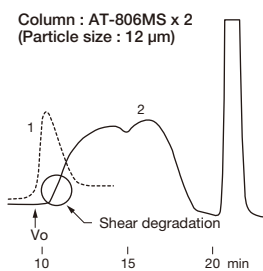
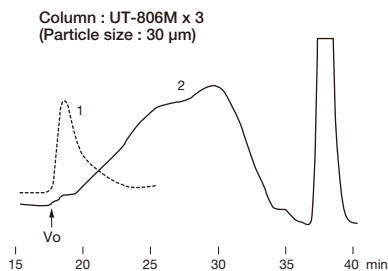


Column : Shodex GPC AT-806MS
 Eluent : 0.1 % BHT in ODCB
 Flow rate : 1.0 mL/min
 Detector : RI
 Column temp. : 140 °C

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 μm) are recommended for the analysis of macromolecules. The large particle size prevents potential molecular shear degradation of the sample.

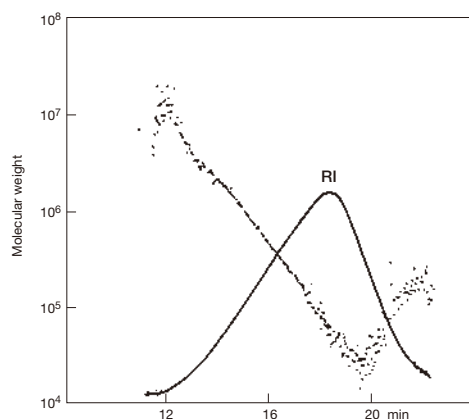
Sample :
 1. Polystyrene (MW : 20,000,000)
 2. High density polyethylene (HDPE-A)



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

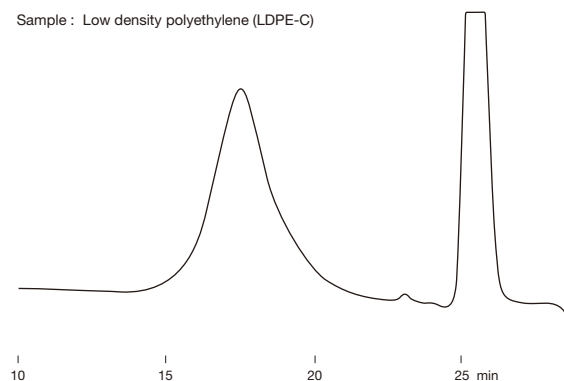
Sample : High density polyethylene (HDPE-B)



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

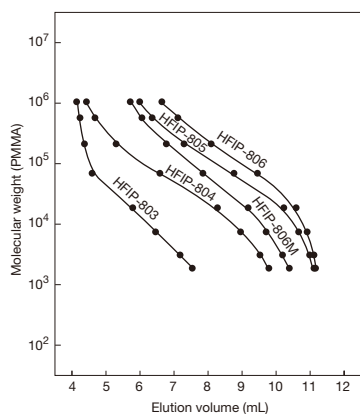
Measured with PMMA (eluent: HFIP)

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.

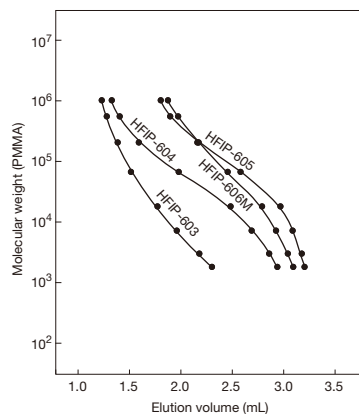
PMMA: Polymethylmethacrylate
*() Estimated value

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

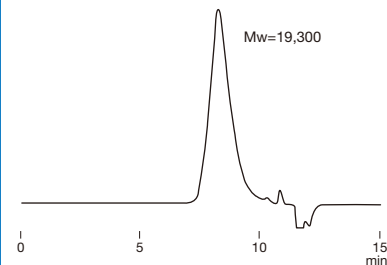
Calibration curves for HFIP-600 series using PMMA



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)

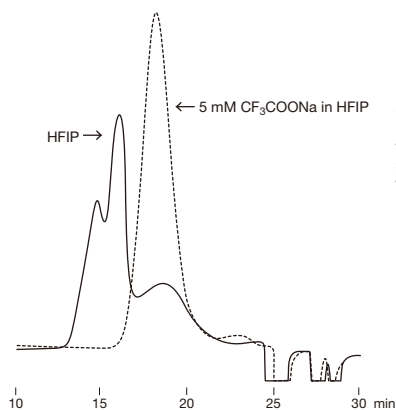
Sample : Polyethylene terephthalate 0.2 %, 20 μ L



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)

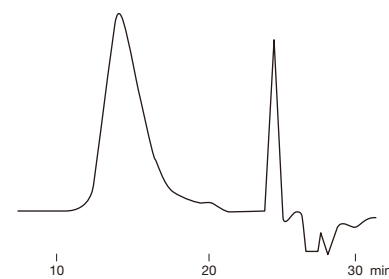


Some samples analyzed under SEC mode with HFIP solvent may show abnormal peaks resulting from the ionic interaction. This interaction can be suppressed by adding sodium trifluoroacetate to the HFIP eluent.

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

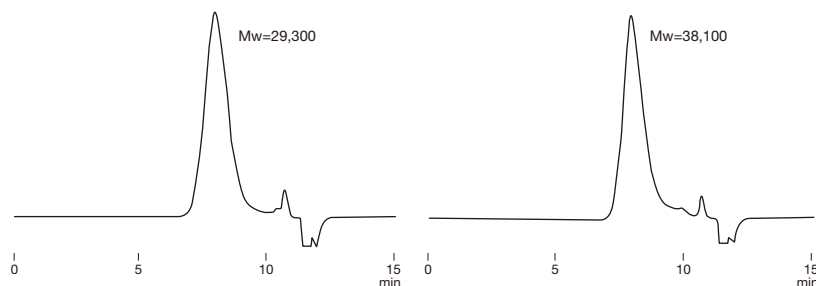


Column : Shodex GPC HFIP-805 + HFIP-803
 Eluent : 5 mM CF₃COONa in HFIP
 Flow rate : 1.0 mL/min
 Detector : RI
 Column temp. : 40 °C

Polyamides (Nylon 6/10 and Nylon 6)

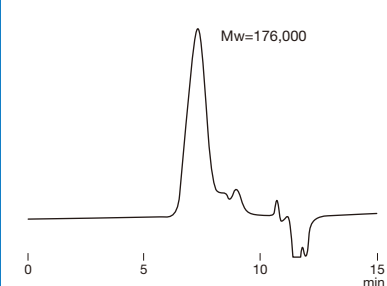
Sample : Nylon 6/10 0.2 %, 20 μ L

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

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

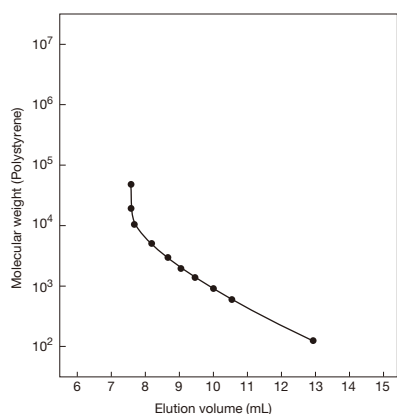
Target molecular weight range and exclusion limit

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

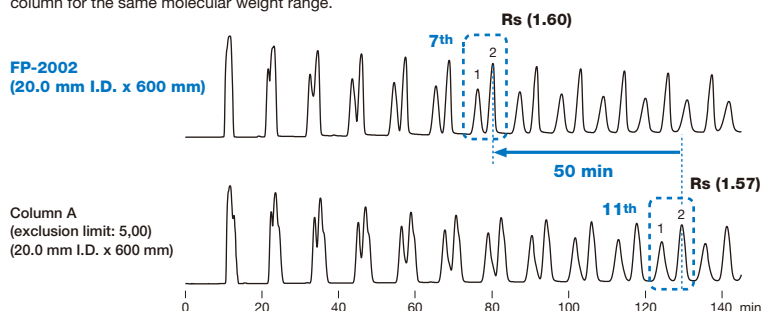


Column : Shodex GPC FP-2002
 Eluent : Chloroform
 Flow rate : 10 mL/min
 Detector : UV (254 nm)
 (preparative type)
 Column temp. : 30 °C

Comparison of recycling separation

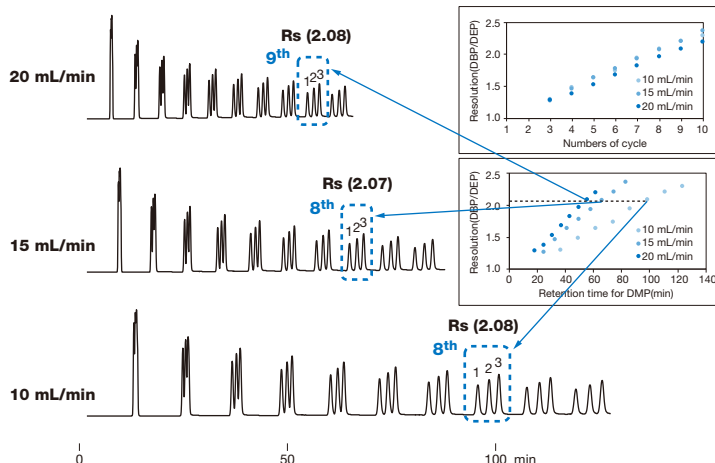
GPC FP-2002 is a column suitable for rapid organic solvent SEC (GPC) separation. Phthalate esters were used to compare recycled separations with other manufacturer's rapid preparative column (exclusion limit: 5,000). The recycling separation using FP-2002 can be made faster than other column for the 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	≥ 13,000	15	20.0 x 500	K-801
F6102002	GPC H-2002	≥ 13,000	15	20.0 x 500	K-802
F6102025	GPC H-2002.5	≥ 13,000	15	20.0 x 500	K-802.5
F6102003	GPC H-2003	≥ 13,000	15	20.0 x 500	K-803
F6102004	GPC H-2004	≥ 13,000	15	20.0 x 500	K-804
F6102005	GPC H-2005	≥ 13,000	15	20.0 x 500	K-805
F6102006	GPC H-2006	≥ 13,000	15	20.0 x 500	K-806
F6102009	GPC H-2006M	≥ 12,000	15	20.0 x 500	K-806M
F6700310	GPC H-G 8B	(guard column)	15	8.0 x 50	(guard column)

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

Base Material: Styrene divinylbenzene copolymer

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

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

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

Base Material: Styrene divinylbenzene copolymer

[K-5000 series] Shipping Solvent: Chloroform

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

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

Base Material: Styrene divinylbenzene copolymer

Solvent Replacement Applicability of SEC (GPC) Columns

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

○: Solvent replacement possible

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

*: Usable at 40 °C or higher

×: Solvent replacement not possible

Calibration Standards for SEC

[Polystyrene (PS)]

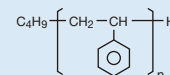
Features

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

Standard kit

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

Structural formula of S series



SL-105

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

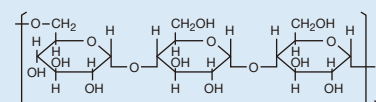
Features

- 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

Structural formula of P series



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

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.