

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-NF L21 requirements

• Standard columns

Product Code	Product Name	Plate Number (TP/column)	Particle Size (μm)	Pore Size (Å)	Column Size (mm) I.D. x Length
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
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
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

The columns with 'L' or 'M' at the end of column names are mixed-gel columns capable of analyzing samples over a wide range of molecular weight distribution. See page 60 for solvent replacement applicability of Organic SEC (GPC) columns.

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

Target molecular weight range and exclusion limit

• Measured with polystyrene (eluent: THF)

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

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

* () Estimated value

Organic SEC (GPC) Columns: Solvent-Peak Separation

Features

KF-800D

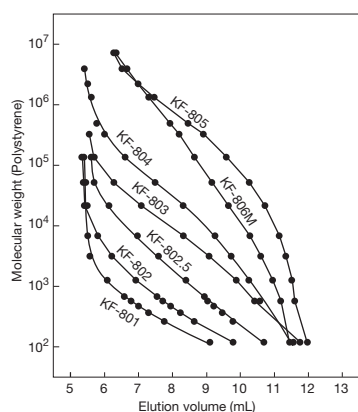
- Use this column in combination with a linear column
- Accurate molecular weight distribution of polymers and oligomers are achieved by shifting the elutions of monomers, polymer additives, and solvent-peak in the lower molecular region

• Solvent-peak separation column

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

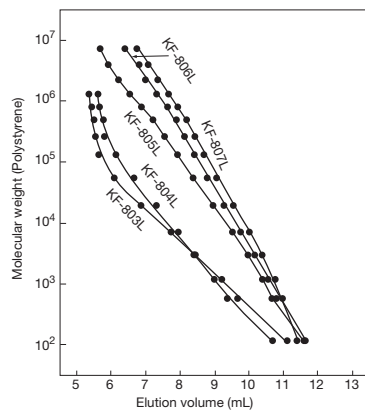
Base Material: Styrene divinylbenzene copolymer
Shipping Solvent: Tetrahydrofuran (THF)

Calibration curves for KF-800 series using polystyrene



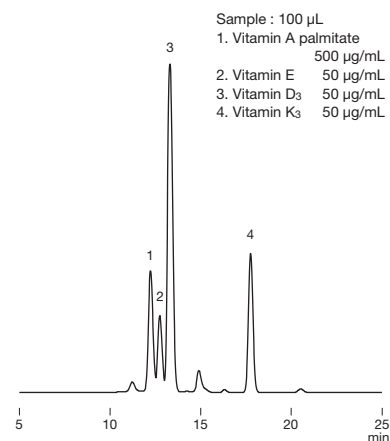
Column : Shodex GPC KF-800 series
 Eluent : THF
 Flow rate : 1.0 mL/min
 Detector : RI
 Column temp. : 40 °C

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



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

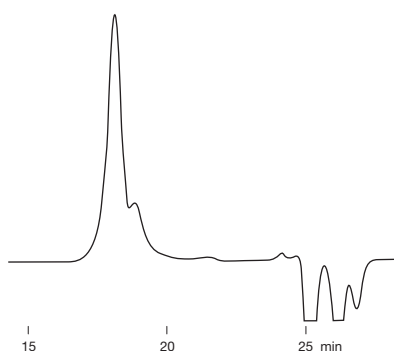
Fat-soluble vitamins



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

Styrene isoprene ABA block copolymer

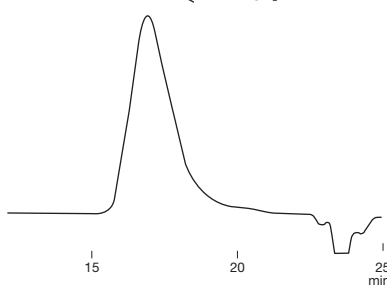
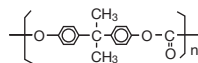
Sample : Styrene isoprene ABA block copolymer



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

Polycarbonate resin

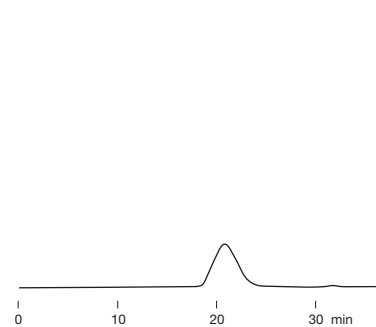
Sample : Polycarbonate resin 0.1 %, 100 µL



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

Raw rubber

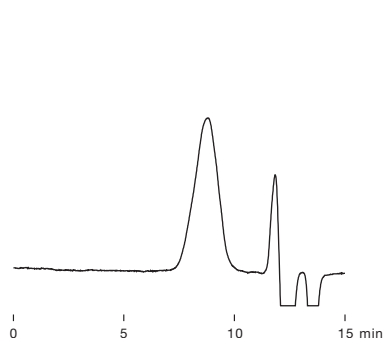
Sample : Rubber 0.1 %, 300 µL



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

Polylactic Acid

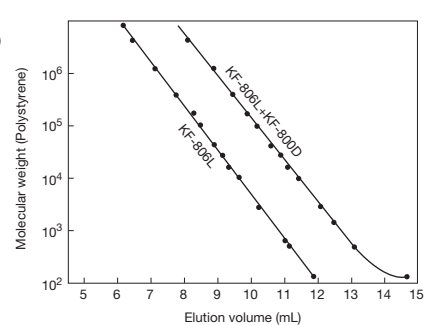
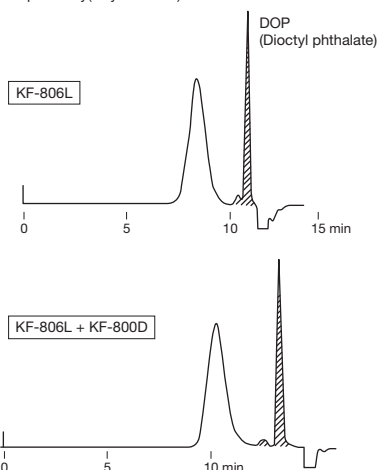
Sample : Polylactic acid 0.2 %, 50 µL



Column : Shodex GPC KF-806M
 Eluent : Chloroform
 Flow rate : 1.0 mL/min
 Detector : RI
 Column temp. : 30 °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: 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-NF L21 requirements

• Standard columns [KD-800 series is made to order]

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 a mixed-gel column capable of analyzing samples over a wide range of molecular weight distribution. See page 60 for solvent replacement applicability of Organic SEC (GPC) columns.

Base Material: Styrene divinylbenzene copolymer
Shipping Solvent: N,N-Dimethylformamide (DMF)

Target molecular weight range and exclusion limit

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

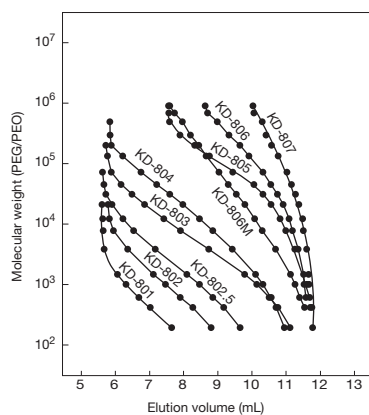
Product Name	Target Molecular Weight Range	Exclusion Limit	Product Name	Target Molecular Weight Range	Exclusion Limit
KD-801	100 - 1,500	2,500	KD-805	30,000 - ** (4,000,000)	** (4,000,000)
KD-802	200 - 4,000	7,000	KD-806	30,000 - ** (40,000,000)	** (40,000,000)
KD-802.5	400 - 10,000	20,000	KD-806M	1,000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

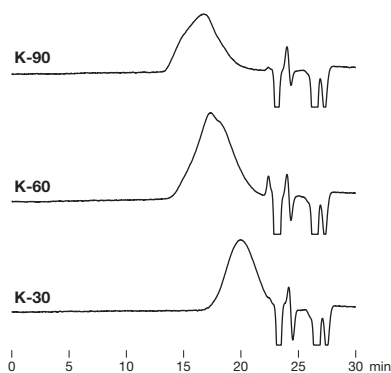
Calibration curves for KD-800 series using PEG/PEO



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

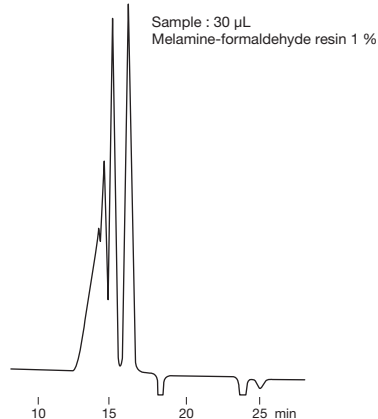
Polyvinylpyrrolidones

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

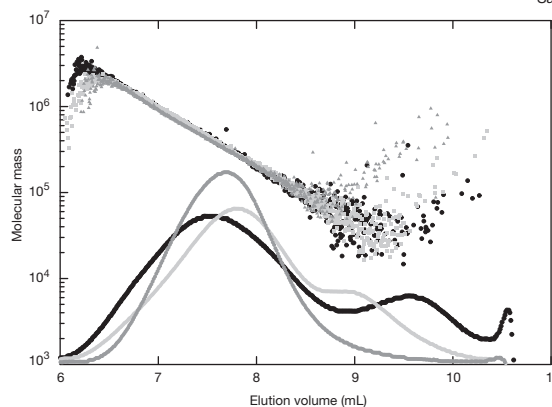
Melamine formaldehyde resin



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



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.

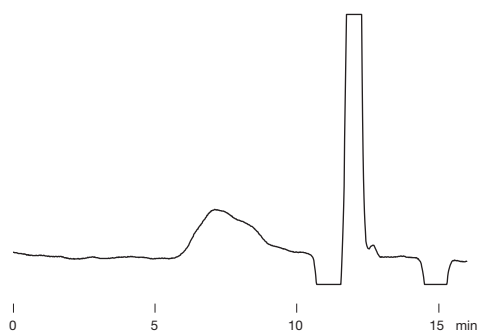
Column : Shodex GPC KD-806M
Eluent : 1 % LiCl in *DMI
Flow rate : 0.5 mL/min
Detector : RI, MALS (Multi angle light scattering)
Column temp. : 60 °C

*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

Potato starch

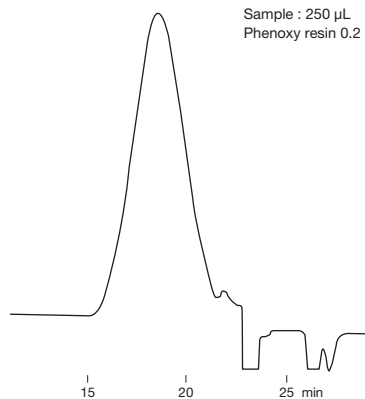
Sample : 100 μ L
 Potato starch in DMSO 0.1 %
 (dissolved at 80 °C)



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

Phenoxy resin

Sample : 250 μ L
 Phenoxy resin 0.2 %



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

Organic SEC (GPC) Columns: High Performance Analysis

Features

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-NF L21 requirements

• High performance semi-micro columns

* 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
F6700300	GPC KF-G 4A	(guard column)	8	—	4.6 x 10

See page 60 for solvent replacement applicability of Organic SEC (GPC) columns.

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

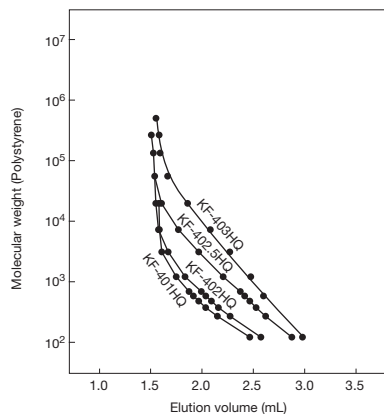
Target molecular weight range and exclusion limit

• Measured with polystyrene (eluent: THF)

Product Name	Target Molecular Weight Range	Exclusion Limit
KF-401HQ	100 - 700	1,500
KF-402HQ	200 - 1,500	4,000
KF-402.5HQ	300 - 10,000	20,000
KF-403HQ	600 - 50,000	70,000

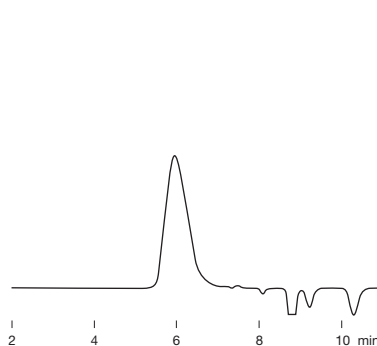
Please use the above tables for reference purposes only when selecting columns.

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

Liquid paraffin

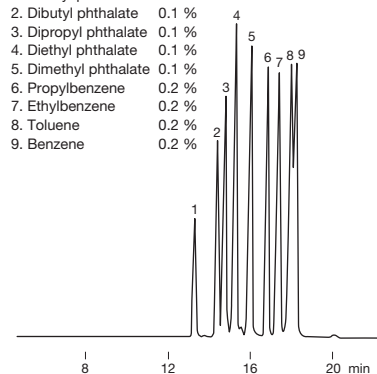
Sample : Liquid paraffin 1 %, 5 μ L

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 % |

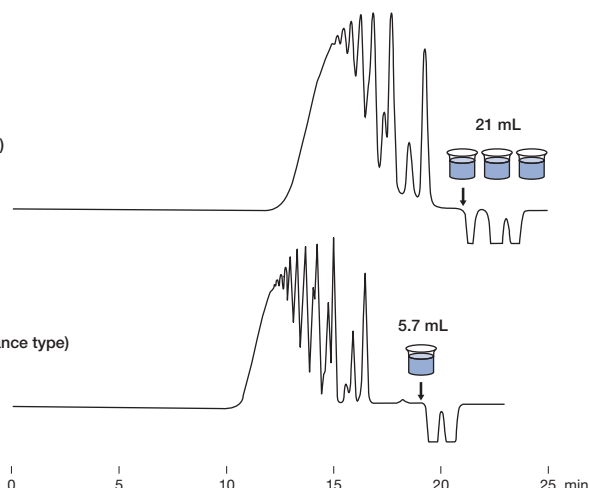


Column : Shodex GPC KF-401HQ x 2
Eluent : THF
Flow rate : 0.3 mL/min
Detector : UV (254 nm) (small cell volume)
Column temp. : 40 °C

Comparison of standard 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



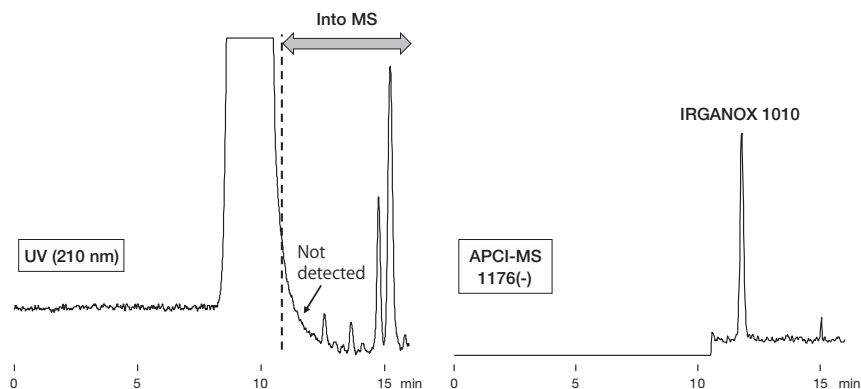
Sample : EPON1001 0.2 %

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

LC/MS analysis of antioxidant (IRGANOX 1010) in a cup of instant noodles (styrene foam)

Generally, pretreatment is required for additives analysis in polymers. By using a size exclusion chromatography column, it separates the additives from polymers, and only the low molecular weight region containing the additive is introduced into a mass spectrometer (MS). Therefore, sample pretreatment is not required, and thus a simple and rapid detection can be expected.



Sample : 5 μ L
 Cup of instant noodles (styrene foam) 1000 mg/L

Column : Shodex GPC KF-402HQ x 2
Eluent : THF
Flow rate : 0.3 mL/min
Detector : UV (210 nm), APCI-MS (SIM)
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
- Fulfills USP-NF L21 requirements

• Ultra-Rapid analysis semi-micro columns

* 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
F6025020	GPC HK-402	≥ 12,000	3	300	4.6 x 150
F6025030	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
F6025060	GPC HK-406	≥ 5,000	6.5	10,000	4.6 x 150

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

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

• 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 sample-origin insoluble components.



Attach directly to the analytical column.

Usable solvents

Solvent	Product Name	
	HK-401 HK-403 HK-404L HK-405 HK-406	HK-402
Chloroform	✓	✓
N,N-Dimethylformamide (DMF)	✓	✓
Toluene	✓	✓
Hexafluoroisopropanol (HFIP)	✓	×
30 % HFIP/Chloroform	✓	✓

✓ : Solvent replacement possible × : Solvent replacement not possible

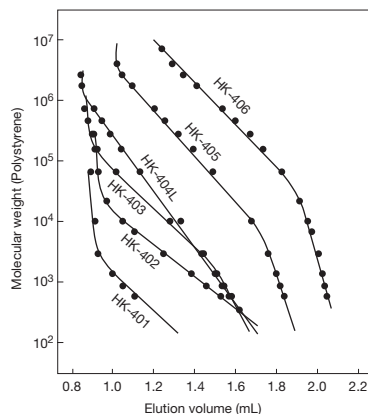
Target molecular weight range and exclusion limit

• Measured with polystyrene (eluent: THF)

Product Name	Target Molecular Weight Range	Exclusion Limit
HK-401	100 - 1,500	2,000
HK-402	200 - 10,000	20,000
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
HK-406	30,000 - 8,000,000	10,000,000

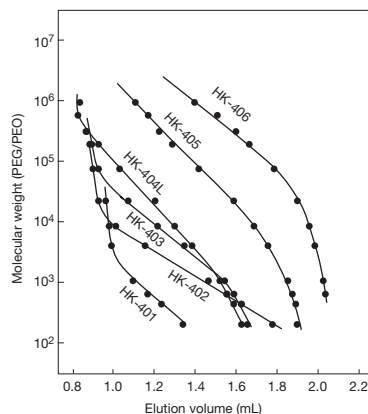
Please use the above table for reference purposes only when selecting columns.

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



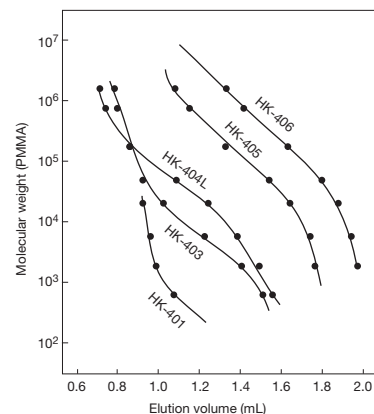
Column : Shodex GPC HK-400 series
 Eluent : THF
 Flow rate : 1.0 mL/min
 Detector : RI (small cell volume)
 Column temp. : 40 °C

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



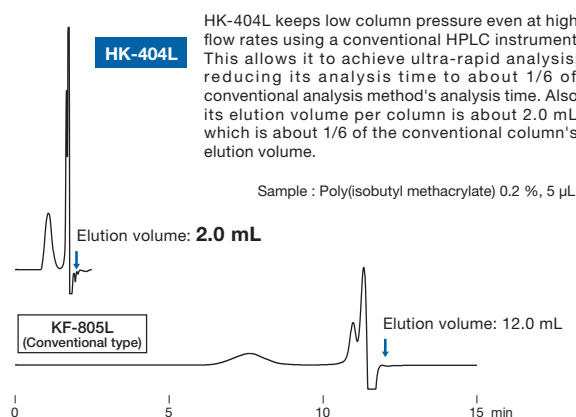
Column : Shodex GPC HK-400 series
 Eluent : DMF
 Flow rate : 1.0 mL/min (HK-402: 0.8 mL/min)
 Detector : RI (small cell volume)
 Column temp. : 40 °C

Calibration curve for HK-400 series using PMMA (eluent : HFIP)



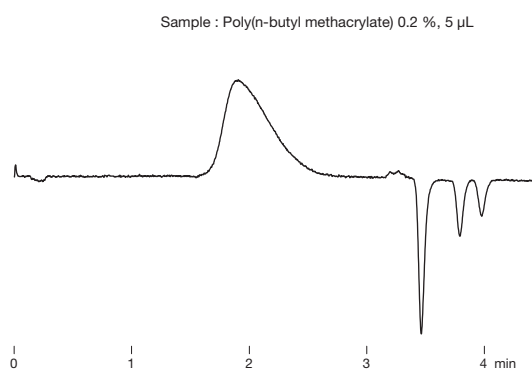
Column : Shodex GPC HK-400 series
 Eluent : 5 mM CF₃COONa in HFIP
 Flow rate : 0.3 mL/min
 Detector : RI (small cell volume)
 Column temp. : 40 °C

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



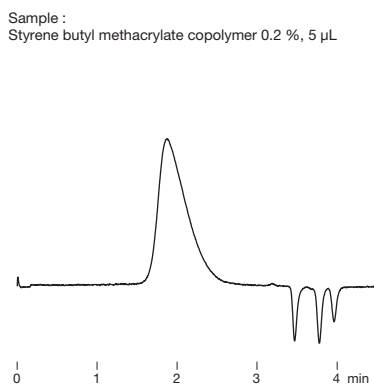
Column : Shodex GPC HK-404L, KF-805L
 Eluent : THF
 Flow rate : 1.0 mL/min
 Detector : RI (small cell volume)
 Column temp. : 40 °C

Poly (butyl methacrylate)



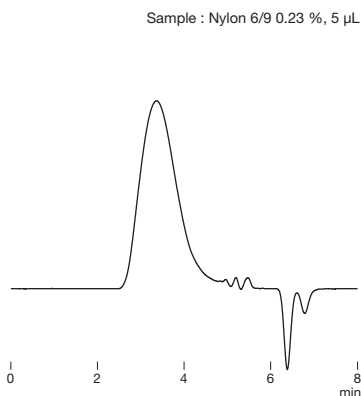
Column : Shodex GPC HK-404L x 2
 Eluent : THF
 Flow rate : 1.0 mL/min
 Detector : RI (small cell volume)
 Column temp. : 40 °C

Styrene butyl methacrylate copolymer



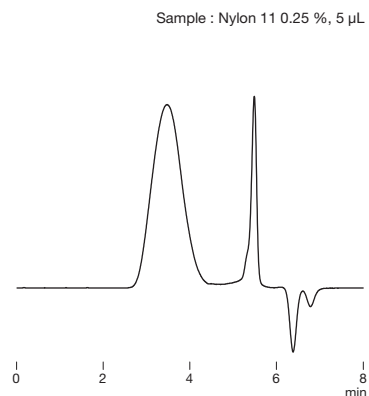
Column : Shodex GPC HK-404L x 2
 Eluent : THF
 Flow rate : 1.0 mL/min
 Detector : RI (small cell volume)
 Column temp. : 40 °C

Polyamide (Nylon 6/9)



Column : Shodex GPC HK-404L
 Eluent : 5 mM CF₃COONa in HFIP
 Flow rate : 0.3 mL/min
 Detector : RI (small cell volume)
 Column temp. : 40 °C

Polyamide (Nylon 11)



Column : Shodex GPC HK-404L
 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 wide molecular weight range
- Rapid analysis column (LF-604) and high performance analysis column (LF-404) are also available
- LF-604 and LF-404 reduce solvent use
- Fulfills USP-NF L21 requirements

• Standard columns

Product Code	Product Name	Plate Number (TP/column)	Particle Size (μm)	Pore Size (Å)	Column Size (mm) I.D. x Length
F6021041	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 60 for solvent replacement applicability of Organic SEC (GPC) columns.

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

• Rapid analysis downsized columns

* 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 60 for solvent replacement applicability of Organic SEC (GPC) columns.

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

• High performance semi-micro columns

* 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 60 for solvent replacement applicability of Organic SEC (GPC) columns.

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

Target molecular weight range and exclusion limit

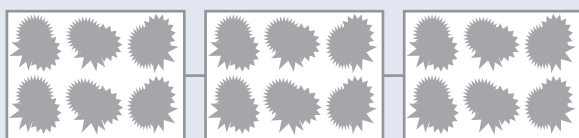
• Measured with polystyrene (eluent: THF)

Product Name	Target Molecular Weight Range	Exclusion Limit
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.

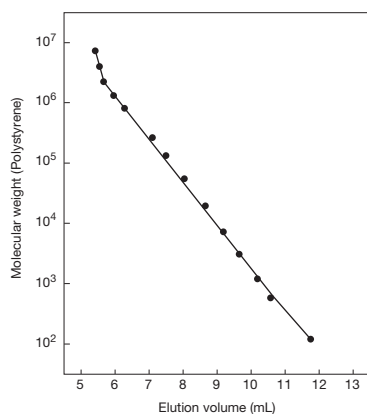
Connecting mixed-gel columns (KF-804L, etc.)



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

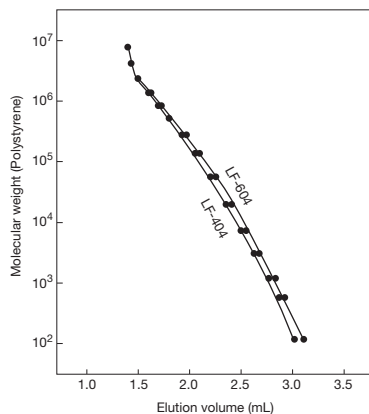


Calibration curve for LF-804 using polystyrene



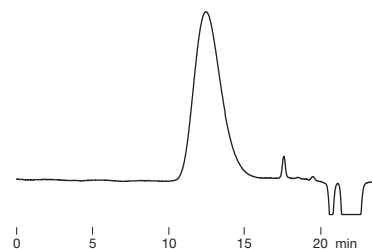
Column : Shodex GPC LF-804
Eluent : THF
Flow rate : 1.0 mL/min
Detector : RI
Column temp. : 40 °C

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



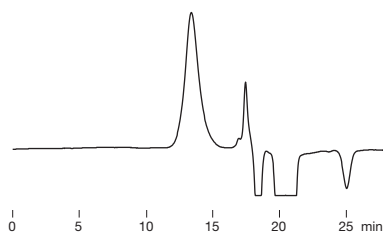
Column : Shodex GPC LF-604, LF-404
Eluent : THF
Flow rate : 0.5 mL/min (LF-604)
 0.3 mL/min (LF-404)
Detector : RI (small cell volume)
Column temp. : 40 °C

Polyurethane

Sample : Polyurethane 0.1 %, 20 μ L

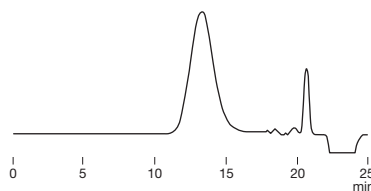
Column : Shodex GPC LF-404 x 2
Eluent : THF
Flow rate : 0.3 mL/min
Detector : RI (small cell volume)
Column temp. : 40 °C

Xylan

Sample : Xylan 0.1 %, 100 μ L

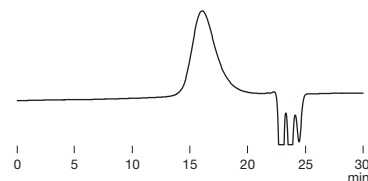
Column : Shodex GPC LF-804
Eluent : 20 mM H_3PO_4 + 20 mM LiBr
 in DMSO/DMF = 80/20
Flow rate : 0.6 mL/min
Detector : RI
Column temp. : 50 °C

Polyamide (Nylon 6/6)

Sample : Nylon 6/6 0.1 %, 20 μ L

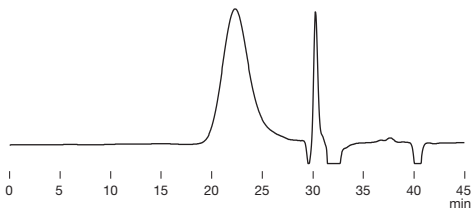
Column : Shodex GPC LF-404
Eluent : 5 mM CF_3COONa in HFIP
Flow rate : 0.15 mL/min
Detector : RI (small cell volume)
Column temp. : 40 °C

Polymethyl methacrylate

Sample : Polymethyl methacrylate, 100 μ L

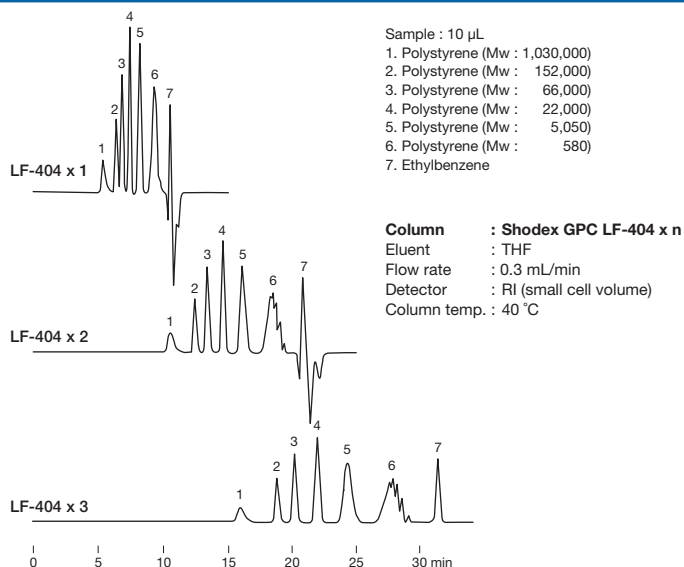
Column : Shodex GPC LF-804 x 2
Eluent : Methyl ethyl ketone
Flow rate : 1.0 mL/min
Detector : RI
Column temp. : 40 °C

Polyamic acid

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

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

Effects of using multiple LF-404 columns on polystyrene separation



Organic SEC (GPC) Column: Rapid Preparation

Features

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 such as THF, toluene, dichloroethane, ethyl acetate, DMF, and acetone used in GPC analysis in addition to chloroform

• 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
F6102520	GPC FP-2002	≥ 30,000	8	20.0 x 600
F6700340	GPC FP-G 8B	(guard column)	8	8.0 x 50

Base Material: Styrene divinylbenzene copolymer
Shipping Solvent: Chloroform

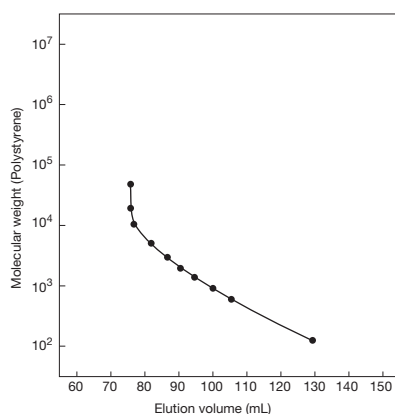
Target molecular weight range and exclusion limit

• Measured with polystyrene (eluent: chloroform)

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

Please use the above for reference purpose only.

Calibration curve for FP-2002 using polystyrene

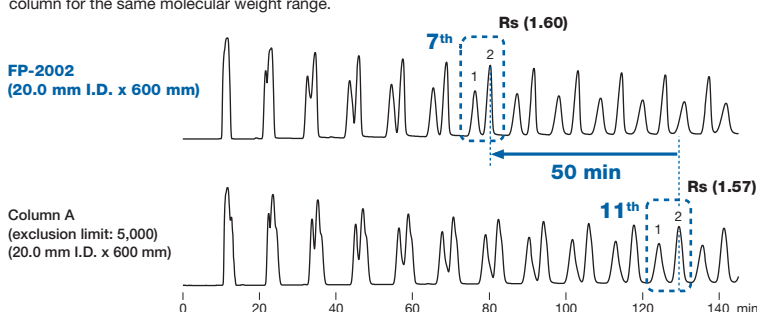


Column : Shodex GPC FP-2002
Eluent : Chloroform
Flow rate : 10 mL/min
Detector : UV (254 nm)
(preparative type)
Column temp. : 30 °C

Comparison of recycling separation

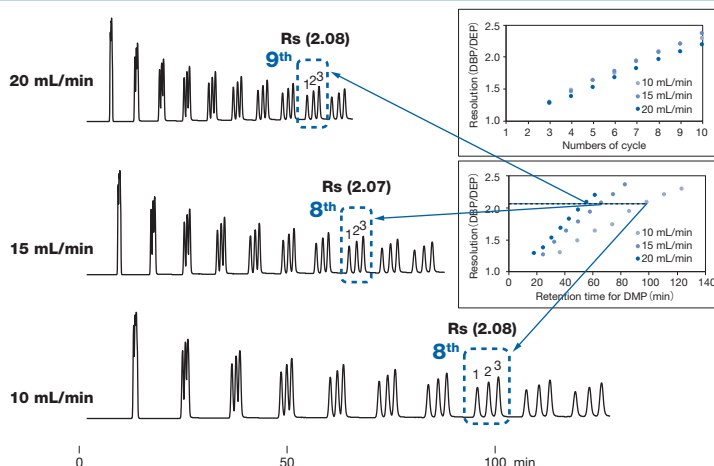
GPC FP-2002 is a column suitable for rapid organic solvent SEC(GPC) separation. Phthalate esters were used to compare recycled separations with other manufacturer's rapid preparative column (exclusion limit: 5,000). The recycling separation using FP-2002 can be made faster than other column for the same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

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

GPC KF-2000 series

Shipping Solvent: Tetrahydrofuran (THF)

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

KF-2006M is a mixed-gel column capable of analyzing samples over a wide range of molecular weight distribution.

Base Material: Styrene divinylbenzene copolymer

GPC K-2000 series

Shipping Solvent: Chloroform

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

K-2006M is a mixed-gel column capable of analyzing samples over a wide range of molecular weight distribution.

Base Material: Styrene divinylbenzene copolymer

[Customized columns]

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

H-2006M is a mixed-gel column capable of analyzing samples over a wide range of molecular weight distribution.

Base Material: Styrene divinylbenzene copolymer

GPC 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)

Base Material: Styrene divinylbenzene copolymer

GPC 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	KF-801
F6109020	GPC K-5002	15	50.0 x 300	KF-802
F6109025	GPC K-5002.5	15	50.0 x 300	KF-802.5
F6109030	GPC K-5003	15	50.0 x 300	KF-803
F6109040	GPC K-5004	15	50.0 x 300	KF-804
F6700409	GPC K-G 20C	15	20.0 x 100	(guard column)

Base Material: Styrene divinylbenzene copolymer

Solvent Replacement Applicability of Organic 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-805L KF-806M KF-806L KF-807L	KF-401HQ KF-402HQ KF-402.5HQ	KF-403HQ	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
Tetrahydrofuran (THF)	✓	✓	✓	✓	✓	✓	✓	×	×	✓
Chloroform	✓	✓	✓	✓	✓	✓	✓	×	×	✓
Carbon tetrachloride	×	✓	✓	✓			✓	×	×	✓
Benzene	✓	✓	✓	✓	✓	✓		×	✓	✓
Toluene	✓	✓	✓	✓	✓	✓	✓	×	✓	✓
p-Xylene	×	✓	✓	✓	✓	✓		×	✓	✓
o-Dichlorobenzene (ODCB)	×	×	✓	✓	✓	✓		×	✓	✓
1,2,4-Trichlorobenzene (TCB)	×	×	✓	✓	✓	✓		×	✓	✓
Dioxane	×	✓	✓	✓				×	✓	✓
Diethyl ether	×	×	✓	✓				×	✓	✓
Ethyl acetate	×	×	✓	✓				×	×	✓
Acetone	×	×	✓	✓	✓	✓	✓	×	✓	✓
Methyl ethyl ketone	×	×	✓	✓	✓	✓	✓	×	✓	✓
N,N-Dimethylformamide (DMF)	×	×	✓	✓	✓*	✓*	✓*	✓	✓	✓
N,N-Dimethylacetamide (DMAc)	×	×	✓	✓	✓*	✓*	✓*	×	✓	✓
Hexafluoroisopropanol (HFIP)	×	×	×	✓	×	△*	✓*	×	✓	✓
m-Cresol	×	×	✓	✓				×	✓	✓
o-Chlorophenol	×	×	✓	✓				×	✓	✓
Quinoline	×	×	✓	✓				×	✓	✓
N-Methyl-2-pyrrolidone (NMP)	×	×	✓	✓	✓*	✓*	✓*	×	✓	✓
Dimethyl sulfoxide (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

See page 66 for solvent replacement method for Organic SEC (GPC) columns.

Calibration Standards for SEC

When measuring molecular weight distribution of polymers using size exclusion chromatography (SEC), it is necessary to obtain a calibration curve using standard samples with known molecular weights.

Shodex STANDARDS are stable polymer standard samples with little branching and an extremely narrow molecular weight distribution. Shodex STANDARDS are proudly recommended for the preparation of calibration curves.

Polystyrene (PS)

Features

SL-105

- For organic solvent SEC (GPC)

SM-105

- Less branched polystyrene with anionic polymerization

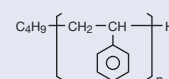
SH-75

- Easily soluble in tetrahydrofuran (THF), chloroform, toluene, and o-dichlorobenzene (ODCB)

Standard kit

Product Code	Product Name	Contents	Molecular Weight (Mp) Range
F8601105	STANDARD SL-105	0.5 g x 10 kinds	580 - 18,000
F8602105	STANDARD SM-105	0.5 g x 10 kinds	1,180 - 3,210,000
F8603075	STANDARD SH-75	0.5 g x 7 kinds	662,000 - 6,550,000

Structural formula of S series



◆ SL-105

Std.No.	Mp	Mw/Mn
S-18	18,000	1.02
S-13	13,400	1.02
S-9.8	9,320	1.02
S-6.7	6,660	1.03
S-4.9	4,910	1.03
S-3.3	3,320	1.04
S-2.0	1,990	1.05
S-1.2	1,180	1.07
S-0.9	940	1.07
S-0.6	580	1.13

◆ SM-105

Std.No.	Mp	Mw/Mn
S-3210	3,210,000	1.06
S-1570	1,570,000	1.04
S-607	607,000	1.03
S-298	298,000	1.04
S-129	129,000	1.03
S-49	49,400	1.04
S-17	17,100	1.03
S-6.3	6,250	1.03
S-3.3	3,320	1.04
S-1.2	1,180	1.06

◆ SH-75

Std.No.	Mp	Mw/Mn
S-6550	6,550,000	1.07
S-3550	3,550,000	1.05
S-3020	3,020,000	1.03
S-2330	2,330,000	1.03
S-1860	1,860,000	1.04
S-885	885,000	1.05
S-662	662,000	1.04

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

Polymethylmethacrylate (PMMA)

Features

M-75

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

Standard kit

Product Code	Product Name	Contents	Molecular Weight (Mp) Range
F8604075	STANDARD M-75	0.5 g x 7 kinds	3,310 - 1,230,000

(Note)

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

◆ M-75

Std.No.	Mp	Mw/Mn
M-1230	1,230,000	1.09
M-539	539,000	1.02
M-210	210,000	1.02
M-60	60,300	1.02
M-18	17,900	1.03
M-6.9	6,940	1.10
M-3.3	3,310	1.09

Pullulan

Features

P-82

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

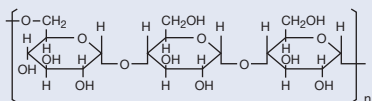
Standard kit

Product Code	Product Name	Contents	Molecular Weight (Mp) Range
F8400000	STANDARD P-82	0.2 g x 8 kinds	6,400 - 692,000

(Note)

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

Structural formula of P series



◆ P-82

Std.No.	Mp	Mw/Mn
P-800	692,000	1.30
P-400	354,000	1.22
P-200	218,000	1.16
P-100	110,000	1.12
P-50	49,400	1.08
P-20	21,900	1.10
P-10	9,800	1.07
P-5	6,400	1.08