



TOSOH

# TSKgel GPC columns



**TOSOH BIOSCIENCE**

# ABOUT US

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## **WITH A GLOBAL PERSPECTIVE.**

TOSOH BIOSCIENCE GmbH, Separations Business Unit, Griesheim, is an acknowledged global leader in the field of bioseparations. Established as TosoHaas in 1987, the original joint venture between Tosoh Corporation of Japan and the Rohm and Haas Company, USA, has become synonymous with advanced products and quality support. In the year 2000, Tosoh Corporation acquired a 100% controlling interest changing the name to TOSOH BIOSEP. In the course of unifying all Tosoh affiliates, the new Brand Name Tosoh Bioscience evolved. Today, the two branches, Bioseparations and Diagnostics operate with the same name Tosoh Bioscience - Separations Business Unit and accordingly Diagnostics Business Unit. Tosoh manufacturing sites in Japan provide products to the sales and support subsidiaries in the U.S. and Europe, ensuring full global coverage. Over the last 40 years, TSKgel SW columns have become the worldwide industry standard for size exclusion chromatography of biomolecules.



**1**  
**TOSOH BIOSCIENCE GMBH**  
IM LEUSCHNERPARK 4  
64347 GRIESHEIM  
GERMANY

T + 49 (0) 6155 70437 00  
F + 49 (0) 6155 83579 00  
INFO.TBG@TOSOH.COM  
WWW.TOSOHBIOSCIENCE.DE

**2**  
**TOSOH BIOSCIENCE LLC**  
3604 HORIZON DRIVE,  
SUITE 100  
KING OF PRUSSIA, PA 19406, USA

T +1 484 805 1219  
F +1 610 272 3028  
INFO.TBL@TOSOH.COM  
WWW.SEPARATIONS.US.TOSOHBIOSCIENCE.COM

**3**  
**TOSOH CORPORATION**  
3-8-2 SHIBA, MINATO-KU  
TOKYO 105-8623  
JAPAN

T +81 3 5427 5118  
F +81 3 5427 5198  
INFO@TOSOH.CO.JP  
WWW.TOSOHBIOSCIENCE.COM



**4**  
**TOSOH BIOSCIENCE SHANGHAI CO. LTD.**  
ROOM 301, PLAZA B,  
NO. 1289 YI SHAN ROAD  
XU HUI DISTRICT  
SHANGHAI, 200233, CHINA

T +86 21 3461 0856  
F +86 21 3461 0858  
INFO@TOSOH.COM.CN  
WWW.SEPARATIONS.ASIA.TOSOHBIOSCIENCE.COM

**5**  
**TOSOH ASIA PTE. LTD.**  
63 MARKET STREET #10-03  
BANK OF SINGAPORE CENTRE  
SINGAPORE 048942, SINGAPORE

T +65 6226 5106  
F +65 6226 5215  
INFO.TSAS@TOSOH.COM  
WWW.TOSOHASIA.COM

## TOSOH HISTORY

- 1935 TOYO SODA MANUFACTURING CO., LTD. IS FOUNDED
- 1936 OPERATION OF NANYO MANUFACTURING COMPLEX BEGINS
- 1971 SCIENTIFIC INSTRUMENTS DIVISION DEVELOPS FIRST GPC COLUMN USING TSKgel
- 1974 HPLC COLUMN PLANT IS COMPLETED
- 1979 TOSOH DEVELOPS TOYOPEARL MEDIA
- 1983 TOSOH DEVELOPS HYDROPHOBIC INTERACTION MEDIA
- 1987 TOSOHAS US STARTS OPERATING FROM MONTGOMERYVILLE
- 1989 TOSOHAS GmbH STARTS OPERATING FROM STUTTGART
- 1995 TOSOH NANYO GEL FACILITY RECEIVES ISO 9001
- 2000/2001 FORMER TOSOHAS US AND EUROPE OPERATIONS BECOME TOSOH BIOSEP, A 100% SUBSIDIARY OF TOSOH CORPORATION
- 2002/2003 ALL SCIENTIFIC AND DIAGNOSTIC SYSTEM RELATED COMPANIES IN EUROPE AND THE US ARE UNIFIED UNDER THE NEW NAME TOSOH BIOSCIENCE
- 2008 EcoSEC ,THE 7<sup>TH</sup> GENERATION GPC SYSTEM IS INTRODUCED
- 2009 TOSOH BIOSCIENCE GmbH CELEBRATES ITS 20<sup>TH</sup> ANNIVERSARY
- 2010 TOSOH CELEBRATES ITS 75<sup>TH</sup> YEAR IN BUSINESS AND CONTINUED RAPID EXPANSION IN CHINA
- 2011 TOSOH BIOSCIENCE CELEBRATES 40 YEARS OF OPERATION
- 2012 TOSOH RELEASES FIRST TOYOPEARL MIXED-MODE RESIN
- 2013 TOSOH RELEASES A HIGH CAPACITY PROTEIN A RESIN
- 2014 TOSOH BIOSCIENCE GmbH CELEBRATES ITS 25<sup>TH</sup> ANNIVERSARY
- 2015 TOSOH BIOSCIENCE GmbH MOVES TO GRIESHEIM, GERMANY

# TOSOH BIOSCIENCE

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# Introduction

## Size Exclusion Chromatography (SEC)

SEC separates molecules based on their size, or more precisely, their hydrodynamic volume. It is a well known technique for the separation of macromolecules like natural and synthetic polymers. When an aqueous eluent is used, SEC is also referred to as gel filtration chromatography (GFC). When an organic eluent is used, SEC is referred to as gel permeation chromatography (GPC). GPC is the method of choice for the characterization of polymer molecular weight and molecular weight distribution.

Tosoh Bioscience is a leading manufacturer of SEC/GPC columns and developed GPC instruments for the Asian market for more than 35 years. This brochure gives an overview over the Tosoh Bioscience GPC/SEC product portfolio for the separation of water and organic soluble polymers. The separation of proteins and biopolymers with silica based TSKgel SEC columns is not covered here.

## Gel Permeation Chromatography (GPC)

GPC plays an important role in the characterization of organic-soluble polymers in the chemical and petrochemical industries. TSKgel GPC columns contain particles prepared from polystyrene crosslinked with divinylbenzene. Available products are grouped according to their relative lack of adsorptive properties and the speed of analysis.

### Application Area: Organic-soluble polymers

Base material: polystyrene

Ultra-low adsorption columns with limited solvent range

- SuperHZ (high throughput)
- HXL (conventional)

Low adsorption columns with expanded solvent range

- SuperH (high throughput)
- HHR (conventional)

### Application Area: Water- and organic-soluble polymers

Base material: polyvinyl

- Alpha
- SuperAW

These columns are ideal for industrial polymers soluble in water, buffers and many organic solvents.

## Gel Filtration Chromatography (GFC)

GFC is popular among biochemists for the isolation of proteins, for the removal of aggregates, to desalt a protein sample, to separate nucleic acid fractions, or to characterize water-soluble polymers used in food products, paints, pharmaceutical preparations, etc. Available TSKgel products are classified by application area and particle composition.

These columns are ideal for industrial polymers, oligosaccharides, nucleic acids and small viruses using aqueous buffer or salt solutions as mobile phase. The PW<sub>XL</sub>-CP columns are developed to facilitate SEC separation of cationic polymers under low salt conditions.

### Application Area: Water-soluble polymers

Base material: polymethacrylate

- PW
- PW<sub>XL</sub>
- PW<sub>XL</sub>-CP

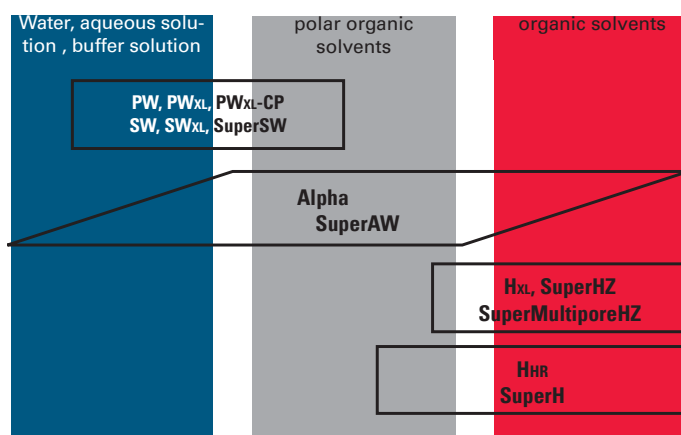
### Application Area: Proteins and other biopolymers

Base material: silica

- SW
- SW<sub>XL</sub>
- SuperSW

These columns are ideal for proteins and nucleic acids using an aqueous buffer as mobile phase.

### TSKgel SEC column: Solvents compatibility



# Introduction

## EcoSEC - THE WORLD'S FIRST SEMI-MICRO GPC/SEC SYSTEM FOR HIGH THROUGHPUT POLYMER ANALYSIS

### ECOSEC FEATURES & BENEFITS

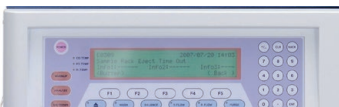
- ▶ Compact, low dead volume GPC/SEC system
- ▶ Outstanding performance at short analysis times
- ▶ Designed for semi-micro GPC, thereby saving solvent, waste disposal costs and analysis time
- ▶ Fully controlled by PSS WinGPC Unity software

detection for fast, high resolution, semi-micro GPC at temperatures below 60°C. It comprises a dual pump precision solvent delivery system, an automatic injector, a column oven and a high performance dual flow refractive index detector as standard (Figure 1). The EcoSEC can be equipped with additional detectors like UV, light scattering and viscosity detectors.


The EcoSEC GPC system is engineered to minimize extra column dead volume. This permits the use of smaller columns such as the TSKgel SuperMultiporeHZ semi-micro GPC columns. These columns are 4.6 mm ID x 15 cm L and consume about one sixth of the solvent compared to conventional systems and columns. In addition, run times are often half that of larger columns. At the same time semi-micro GPC often improves resolution and signal to noise levels.

EcoSEC is a compact, all-in-one system with refractive index

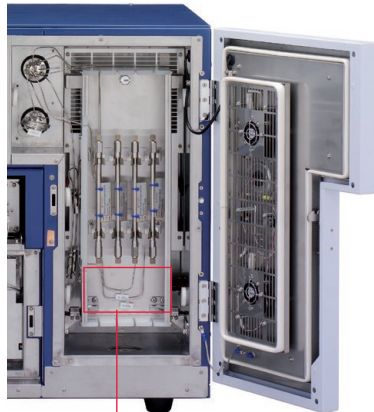
**System Controller**  
Controls each device including automatic warm-up/shut-down function.



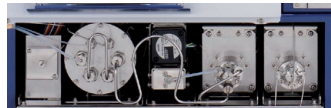
**Auto Injector**  
Loop injection for up to 100 samples with 1 - 1500 µl injection volume.



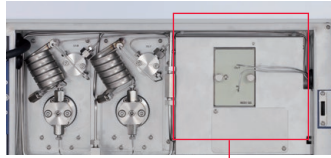
**Column Oven**  
Double layered, for up to 8 columns (7.8 mm ID x 30 cm L). Accommodates optional column switching valve. Temperature range from RT+10°C to 60°C.



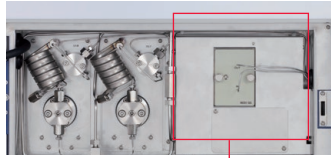
**Degasser/ Purge Unit**




**Solvent Delivery System**  
Thermostatted dual pump system. Flow rate 10 – 2000 µl/min.

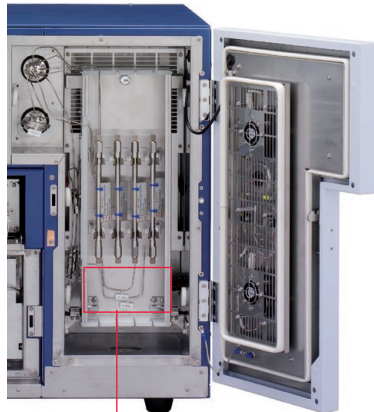


**Optional UV detector**

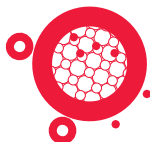




**Refractive Index Detector**  
Low volume, dual flow detector with excellent baseline stability, integrated in thermostatted column compartment.



▶ FIGURE 1



# Choosing the appropriate SEC column

## Choosing a TSKgel SEC column

Column type	Packing material	Sample type	Series	Features of series
H type	Styrene polymers	Synthetic polymers suitable for organic solvents	H <sub>XL</sub>	General analysis, low adsorption
			H <sub>HR</sub>	Analysis with various organic solvents
			SuperH	Quick and solvent-efficient analysis, high efficiency (semi-micro GPC column)
			SuperHZ	Quick, solvent-efficient analysis, high efficiency, low adsorption (semi-micro GPC column)
			Super MultiporeHZ	Calibration curve with high linearity
Alpha, SuperAW type	Hydrophilic polymers	Synthetic polymers suitable for organic solvents Water-soluble synthetic polymers Polysaccharides Biopolymers (protein, DNA)	Alpha	Adsorption mode applicable to various types of polymer from water-soluble to organic-soluble
			SuperAW	Quick, low-solvent, and efficient (semi-micro SEC column) adsorption mode applicable from water-soluble to organic-soluble polymers
PW type	Hydrophilic polymers	Water-soluble synthetic polymers Polysaccharides Biopolymers (protein, DNA)	PW	Suitable for hydrophilic synthetic polymers
			PW <sub>XL</sub>	High resolution
			PW <sub>XL</sub> -CP	Suitable for cationic polymers
SW type	Silica	Biopolymers (protein, peptide)	SW	Highly hydrophilic and suitable for separation of proteins
			SW <sub>XL</sub>	High resolution
			SuperSW	Efficient and solvent-saving (semi-micro SEC column)

## Solvents supported by H-type columns

Column	Standard solvent (shipped with column)	Custom-order solvent	User-exchangeable solvent	Remarks
SuperHZ	THF		Benzene, toluene, xylene, dichloromethane, dichloroethane	
		Chloroform, DMF, cyclohexane, AK-225		
SuperH, H <sub>HR</sub>	THF		Benzene, toluene, xylene, chloroform, dichloromethane, dichloroethane, DMF, DMSO, dioxane, n-hexane, cyclohexane, dodecane, NMP, quinoline, MEK, ODCB, trichlorobenzene, HFIP, HFIP/chloroform, pyridine, o-chlorophenol/chloroform, carbon tetrachloride, ethyl acetate, methanol/chloroform, acetone, ethanol, dimethylacetamide, 1-chloronaphthalene, FC-113, trichloroethane	<ul style="list-style-type: none"> <li>➤ All columns are shipped with THF as standard.</li> <li>➤ Please note that once the solvent has been changed to a polar solvent such as DMF, the absorption characteristic may change even if THF is again used as the solvent.</li> </ul>
H <sub>XL</sub>	THF		Benzene, toluene, xylene, chloroform, dichloromethane (excluding G1000H), dichloroethane (excluding G1000H)	
		Chloroform	m-Cresol/chloroform, HFIP/chloroform (< 10% HFIP)	
		DMF	THF, toluene, DMSO, dioxane	
		Acetone	DMF, DMSO, dioxane, n-hexane, cyclohexane, dodecane, NMP, quinoline, MEK, ODCB, HFIP/chloroform, pyridine, carbon tetrachloride, ethyl acetate, FC-113	
		ODCB	Trichlorobenzene, 1-chloronaphthalene	

# SuperH Series

Semi-micro GPC columns

This series comprises semi-micro GPC columns (6.0 mm ID × 15 cm L) packed with styrene-divinylbenzene-type particulate gel. Analysis can be conducted in half the time taken by a conventional column (7.8 mm ID × 30 cm L), with solvent consumption 1/3 that of a conventional column, while achieving equal separation.

Four types of mixed column are provided for efficient analysis. The solvent can be changed to various organic solvents.

## Analytical column

Description	Particle size µm	Exclusion limit (Polystyrene)	6.0 mm ID × 15 cm L	
			Part #	TP/15cm
TSKgel SuperH1000	3	1 × 10 <sup>3</sup>	0017990	16,000
TSKgel SuperH2000	3	1 × 10 <sup>4</sup>	0017991	16,000
TSKgel SuperH2500	3	2 × 10 <sup>4</sup>	0017992	16,000
TSKgel SuperH3000	3	6 × 10 <sup>4</sup>	0017993	16,000
TSKgel SuperH4000	3	4 × 10 <sup>5</sup>	0017994	16,000
TSKgel SuperH5000	3	4 × 10 <sup>6</sup>	0017995	16,000
TSKgel SuperH6000	5	4 × 10 <sup>7</sup> (Estimated)	0017996	10,000
TSKgel SuperH7000	5	4 × 10 <sup>8</sup> (Estimated)	0017997	10,000
TSKgel SuperHM-L (mixed-bed)	3	4 × 10 <sup>6</sup>	0017998	16,000
TSKgel SuperHM-N (mixed-bed)	3	4 × 10 <sup>5</sup>	0017999	16,000
TSKgel SuperHM-M (mixed-bed)	3	4 × 10 <sup>6</sup>	0018000	16,000
TSKgel SuperHM-H (mixed-bed)	3 & 5	4 × 10 <sup>8</sup> (Estimated)	0018001	16,000

## Guard column

Description	Part #	Column size	Remarks
TSKguardcolumn SuperH-L	0018002	4.6 mm ID × 3.5 cm L	For SuperH1000 – SuperH4000
TSKguardcolumn SuperH-H	0018003	4.6 mm ID × 3.5 cm L	For SuperH5000 – SuperH7000, SuperHM

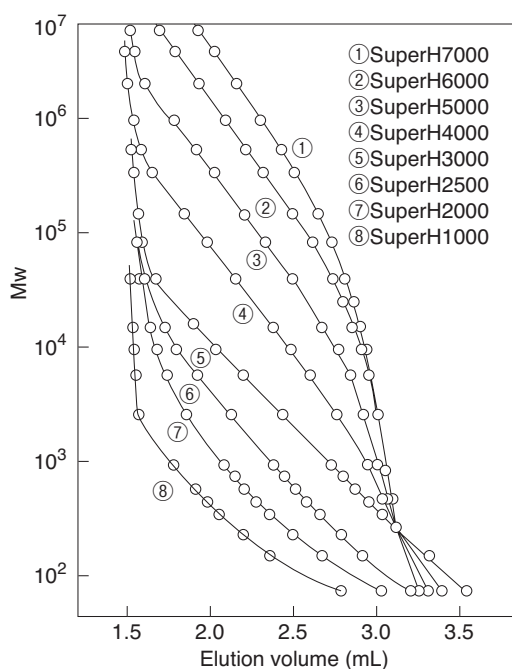
## Reference column\*

Description	Part #	Column size
TSKgel SuperH-RC	0018004	6.0 mm ID × 15 cm L

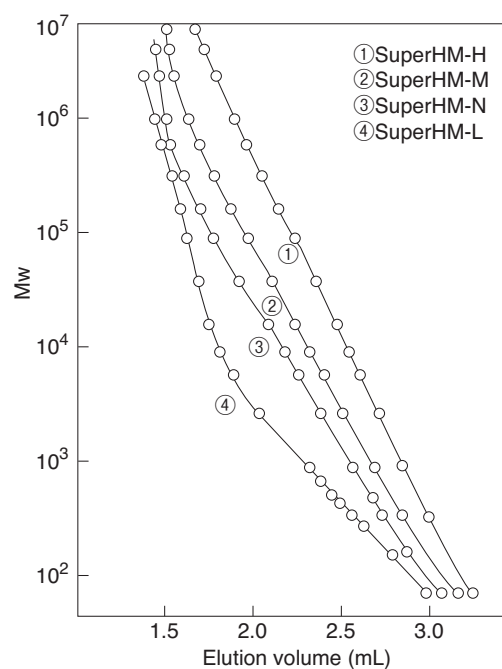
Standard solvent (shipped with the columns): THF

\* The reference column is used for the reference flow line of the refractive index detector of the EcoSEC GPC system, the column cannot be used for GPC separations.

## Calibration curves for TSKgel SuperH Series



Column: TSKgel SuperH Series  
(6.0 mm ID × 15 cm L)  
Eluent: THF  
Flow rate: 0.6 mL/min  
Temp.: 25 °C  
Detection: UV (254 nm)  
Sample: Standard polystyrene







# SuperHZ Series

Semi-micro GPC columns

This series comprises semi-micro SEC columns (4.6 mm ID × 15 cm L and 6.0 mm ID × 15 cm L) packed with a particulate gel based on styrene divinylbenzene. Analysis can be conducted in half the time taken by a conventional column (7.8 mm ID × 30 cm L), with solvent consumption 1/6 that of a conventional column (4.6 mm ID × 15 cm L), while achieving equal separation. All columns are shipped with THF as standard solvent.

## ≡ Analytical column (4.6 mm ID)

Description	Particle size µm	Exclusion limit (Polystyrene)	4.6 mm ID × 15 cm L	
			Part #	TP/15cm
TSKgel SuperHZ1000	3	1 × 10 <sup>3</sup>	0019309	16,000
TSKgel SuperHZ2000	3	1 × 10 <sup>4</sup>	0019310	16,000
TSKgel SuperHZ2500	3	2 × 10 <sup>4</sup>	0019311	16,000
TSKgel SuperHZ3000	3	6 × 10 <sup>4</sup>	0019312	16,000
TSKgel SuperHZ4000	3	4 × 10 <sup>5</sup>	0019313	16,000
TSKgel SuperHZN-N (mixed-bed)	3	7 × 10 <sup>5</sup>	0019660	16,000
TSKgel SuperHZN-M (mixed-bed)	3 & 5	4 × 10 <sup>6</sup>	0019662	16,000
TSKgel SuperHZN-H (mixed-bed)	10	4 × 10 <sup>8</sup> (Estimated)	0019664	19,000

With SuperHZ Series columns (4.6 mm ID), use Tosoh's GPC **only** system HLC-8320GPC. Note that these columns may not operate at maximum efficiency in conjunction with an ordinary HPLC system.

## ≡ Guard column

Description	Part #	Column size	Remarks
TSKguardcolumn SuperHZ-L	0019314	4.6 mm ID × 2.0 cm L	For SuperHZ1000 – 4000, M-N, -M
TSKguardcolumn SuperHZ-H	0019668	4.6 mm ID × 2.0 cm L	For SuperHZN-H

## ≡ Analytical column (6.0 mm ID)

Description	Particle size µm	Exclusion limit (polystyrene)	6.0 mm ID × 15 cm L	
			Part #	TP/15cm
TSKgel SuperHZ1000	3	1 × 10 <sup>3</sup>	0019302	16,000
TSKgel SuperHZ2000	3	1 × 10 <sup>4</sup>	0019303	16,000
TSKgel SuperHZ2500	3	2 × 10 <sup>4</sup>	0019304	16,000
TSKgel SuperHZ3000	3	6 × 10 <sup>4</sup>	0019305	16,000
TSKgel SuperHZ4000	3	4 × 10 <sup>5</sup>	0019306	16,000
TSKgel SuperHZN-N (mixed-bed)	3	7 × 10 <sup>5</sup>	0019661	16,000
TSKgel SuperHZN-M (mixed-bed)	3 & 5	4 × 10 <sup>6</sup>	0019663	16,000
TSKgel SuperHZN-H (mixed-bed)	10	4 × 10 <sup>8</sup> (Estimated)	0019665	19,000

With SuperHZ Series columns (6.0 mm ID), use Tosoh's GPC **only** system HLC-8320GPC or a HPLC system for semi-micro GPC columns. Note that these columns may not operate at maximum efficiency in conjunction with an ordinary HPLC system.

## ≡ Guard column

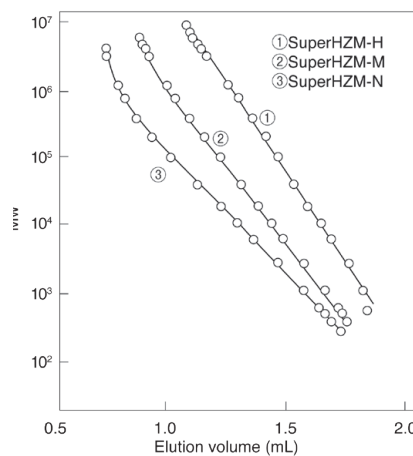
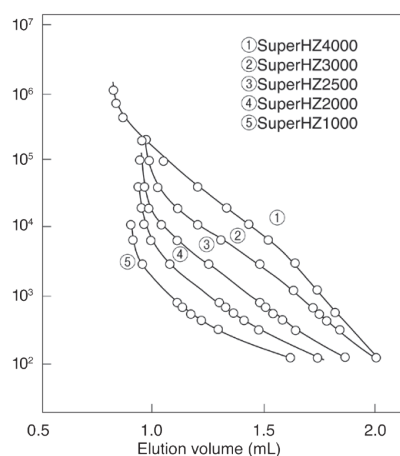
Description	Part #	Column size	Remarks
TSKguardcolumn SuperHZ-L	0019666	4.6 mm ID × 3.5 cm L	For SuperHZ1000 – 4000, M-N, -M
TSKguardcolumn SuperHZ-H	0019667	4.6 mm ID × 3.5 cm L	For SuperHZN-H

## ≡ Reference column\*

Description	Part #	Column size
TSKgel SuperH-RC	0018004	6.0 mm ID × 15 cm L

Standard solvent (shipped with the columns): THF

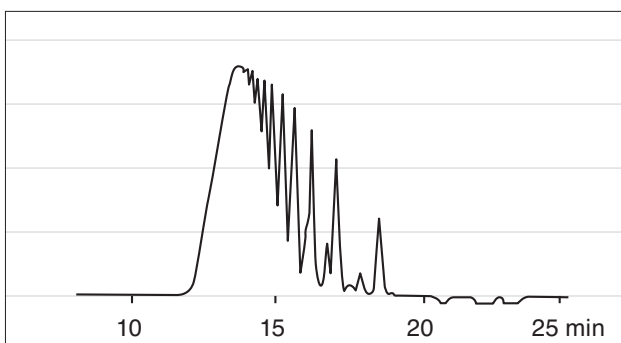
## Calibration curves for TSKgel SuperHZ Series



# SuperHZ Series

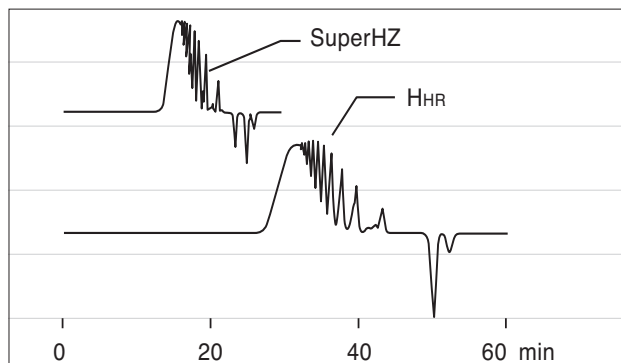
Semi-micro GPC columns

## Separation of epoxy resin



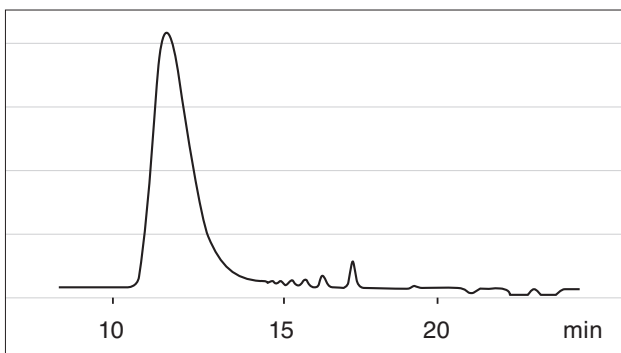
Column: TSKgel SuperHZ4000 + 3000 + 2000 + 2000  
(4.6 mm ID × 15 cm × 4 in series)  
Eluent: THF  
Flow rate: 0.35 mL/min  
Detection: RI  
Temperature: 40 °C  
Injection volume: 10 µL (1.0 g/L)

## Comparison of SuperHZ Series and HHR Series



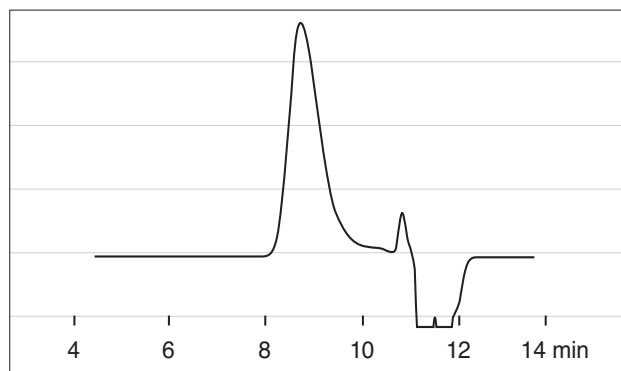
Column: TSKgel SuperHZ4000 + 3000 + 2500 + 2000  
(4.6 mm ID × 15 cm L × 4 in series)  
TSKgel G4000 + 3000 + 2500 + 2000HHR  
(7.8 mm ID × 30 cm L × 4 in series)  
Eluent: THF  
Flow rate: 0.35 mL/min (SuperHZ), 1.0 mL/min (HHR)  
Detection: RI  
Temperature: 40 °C  
Injection volume: 2 µL (SuperHZ), 20 µL (HHR), 0.5 g/L  
Sample: Epoxy resin

## Separation of polysulfone



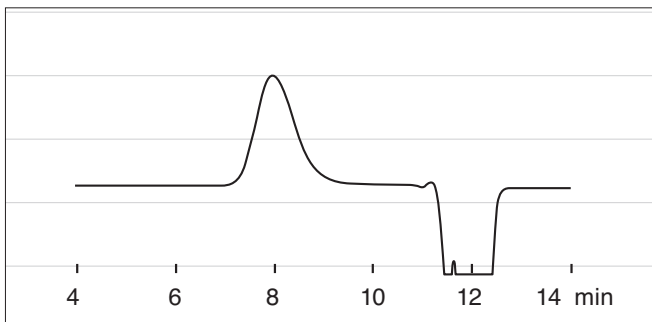
Column: TSKgel SuperHZ4000 + 3000 + 2000 + 2000  
(4.6 mm ID × 15 cm L × 4 in series)  
Eluent: THF  
Flow rate: 0.35 mL/min  
Detection: RI  
Temperature: 40 °C  
Injection volume: 10 µL (0.5 g/L)

## Separation of polycarbonate



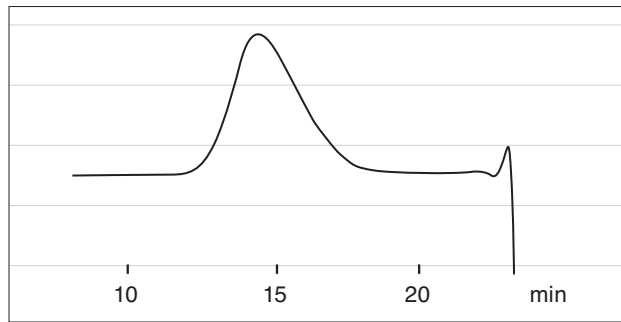
Column: TSKgel SuperHZM-H  
(4.6 mm ID × 15 cm L × 2 in series)  
Eluent: THF  
Flow rate: 0.35 mL/min  
Detection: RI  
Temperature: 40 °C  
Injection volume: 10 µL (0.5 g/L)

## Separation of polystyrene (SRM706)



Column: TSKgel SuperHZM-H  
(4.6 mm ID × 15 cm L × 2 in series)  
Eluent: THF  
Flow rate: 0.35 mL/min  
Detection: RI  
Temperature: 40 °C  
Injection volume: 10 µL (0.5 g/L)

## Separation of acrylic resin



Column: TSKgel SuperHZM-H  
(4.6 mm ID × 15 cm L × 4 in series)  
Eluent: THF  
Flow rate: 0.35 mL/min  
Detection: RI  
Temperature: 40 °C  
Injection volume: 10 µL (0.5 g/L)

# SuperMultiporeHZ Series

Multipore semi-micro GPC columns

This series comprises ultra-high-performance organic SEC columns with low dead volume (4.6 mm I.D. × 15 cm L) featuring a multipore with a wide pore distribution in each particle. The use of the multipore ensures that the calibration curves have excellent linearity. Chromatograms are free of irregularities because the calibration curves contain no inflection points. Three molecular weight ranges are available.

## Analytical column

Description	Particle size $\mu\text{m}$	Exclusion limit (Polystyrene)	4.6 mm ID × 15 cm L	
			Part #	TP/15cm
TSKgel SuperMultiporeHZ-H	6	$4.0 \times 10^7$ (Estimated)	0021885	11,000
TSKgel SuperMultiporeHZ-M	4	$2.0 \times 10^6$	0021488	16,000
TSKgel SuperMultiporeHZ-N	3	$1.2 \times 10^5$	0021815	20,000

## Guard column

Description	Part #	Column size	Remarks
TSKguardcolumn SuperMPHZ-H	0021886	4.6 mm ID × 2.0 cm L	For H grade
TSKguardcolumn SuperMPHZ-M	0021489	4.6 mm ID × 2.0 cm L	For M grade
TSKguardcolumn SuperMPHZ-N	0021816	4.6 mm ID × 2.0 cm L	For N grade

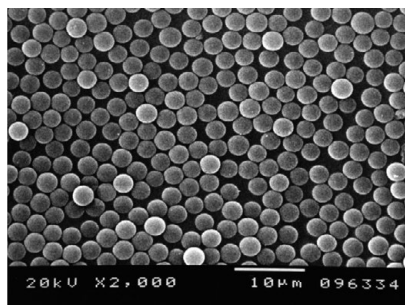
## Reference column\*

Description	Part #	Column size
TSKgel SuperH-RC	0018004	6.0 mm ID × 15 cm L

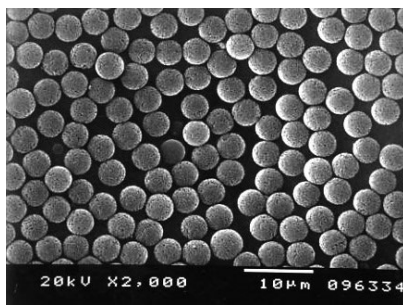
Standard solvent (shipped with the columns): THF

## SEM photographs of TSKgel SuperMultiporeHZ and Commercial mixed-bed column

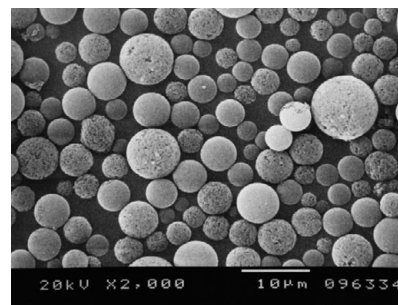
The SuperMultiporeHZ Series is packed with monodispersed particles of uniform diameter, which results in a high theoretical plate number.



TSKgel SuperMultiporeHZ-N



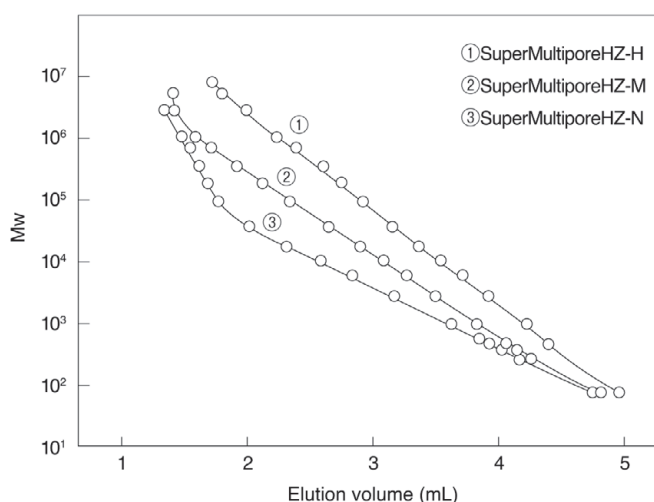
TSKgel SuperMultiporeHZ-M



Commercial product (mixed-bed)

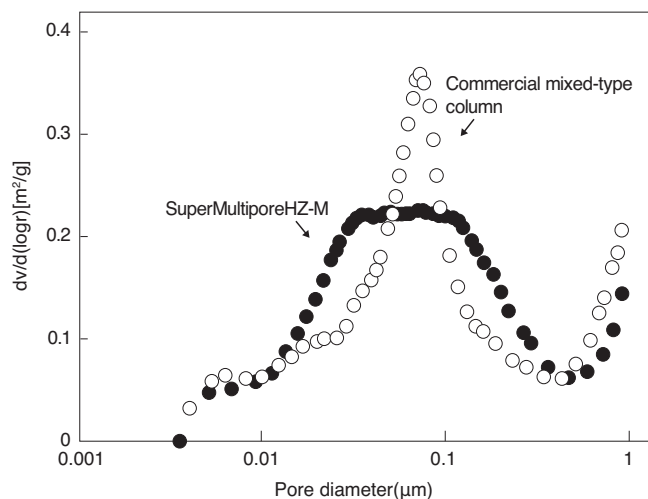
## TSKgel SuperMultiporeHZ Series: Calibration curves

The calibration curves of the SuperMultiporeHZ Series show excellent linearity.



Column: 4.6 mm I.D. × 15 cm L      Detection: UV(254 nm)  
 Eluent: THF      Temp.: 25 °C  
 Flow rate: 0.35 mL/min      Sample: Standard polystyrene

## Comparison of pore size distribution

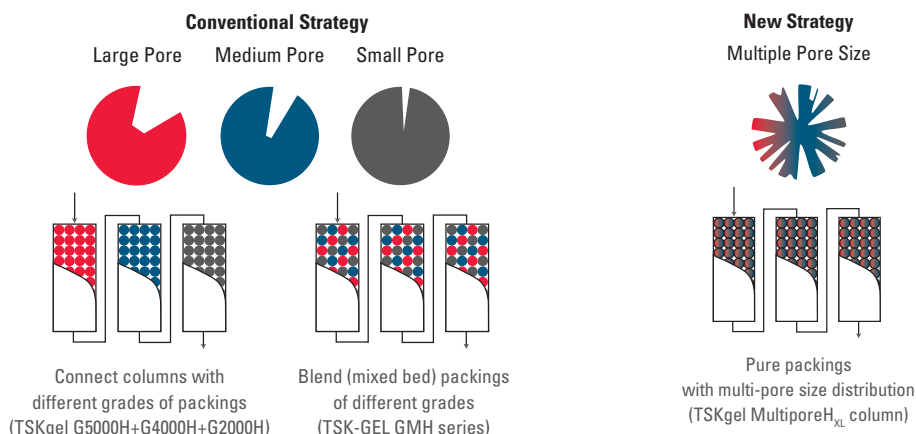


# SuperMultiporeHZ Series

Multipore semi-micro GPC columns

Generally, SEC packing materials have a comparatively narrow pore distribution. When conducting analysis of synthetic polymers with relatively wide molecular weight distribution, it is necessary to use several connected columns containing packing materials with different pore diameters, or a single column containing several packing materials of different pore diameters (mixed bed column). The calibration curves of these columns show deviations or level differences (inflection points) where the calibration curves of packing materials with different pore diameters meet. This causes irregularities in the resulting chromatograms. In contrast, multipore-type packing materials have a very wide range of molecular weight fractions because each particle has pores of various diameters. The calibration curves show excellent linearity and no inflection points, and accurate analysis of molecular weight may be achieved.

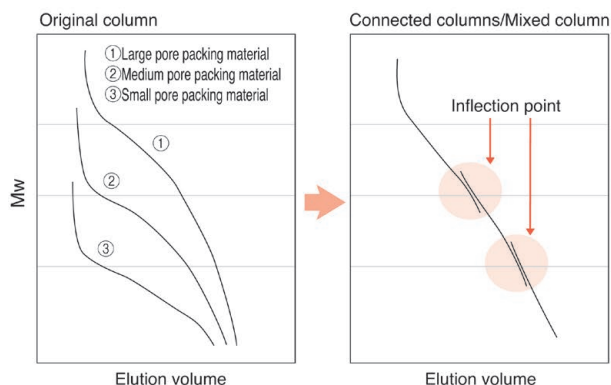
## Schematics of SEC packing materials



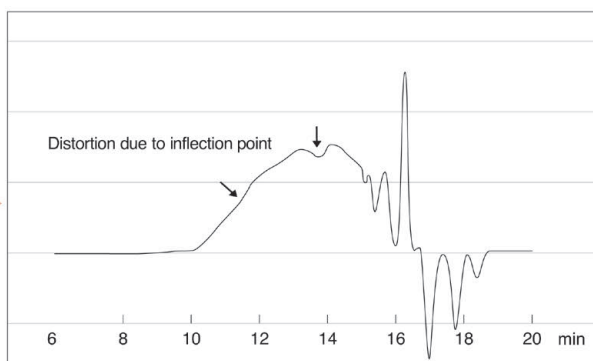
## Calibration curve and chromatogram irregularities

If columns containing packing materials with different pore diameters are connected, or a mixed-type column is used, inflection points appear on the calibration curve. This may cause irregularities in the chromatogram.

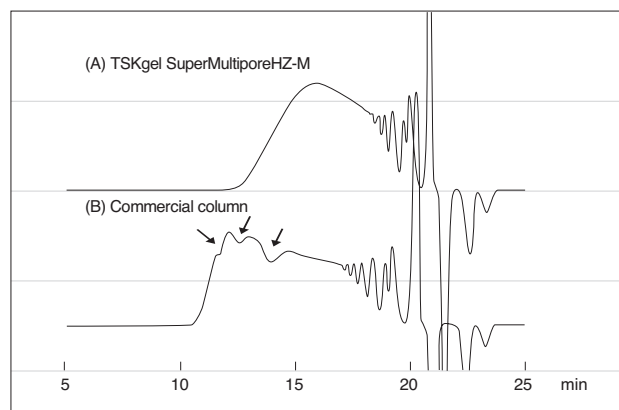
### Calibration curve of conventional SEC column



### Chromatogram from mixed-type column

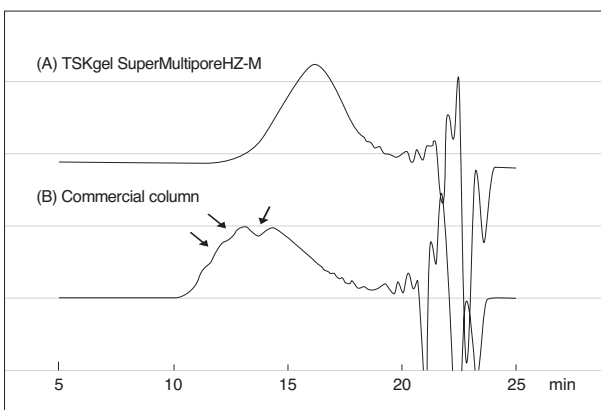


### Separation of phenol resin



Column: (A) SuperMultiporeHZ-M (4.6 mm ID × 15 cm L × 4 in series)  
 (B) Commercial column (4.6 mm ID × 15 cm L × 4 in series)  
 Eluent: THF Temperature: 40 °C  
 Flow rate: 0.35 mL/min Detection: RI  
 Sample: Phenolic resin 0.3%, 10 μL

### Separation of acryl polymer



Column: (A) SuperMultiporeHZ-M (4.6 mm ID × 15 cm L × 4 in series)  
 (B) Commercial column (4.6 mm ID × 15 cm L × 4 in series)  
 Eluent: THF Temperature: 40 °C  
 Flow rate: 0.35 mL/min Detection: RI  
 Sample: Acrylic resin 0.3% 10 μL



# MultiporeHXL-M

Multipore linear GPC columns

Columns of the MultiporeHXL-M Series contain packing material (multipore gel) which features a wide distribution of pore diameters in each particle, unlike conventional SEC packing materials. The calibration curves of these columns show improved linearity (compared with those of conventional columns) and no inflection points. These characteristics ensure a more accurate analysis of molecular weight distribution.

## Analytical column

Description	Particle size μm	Exclusion limit (Polystyrene)	7.8 mm ID × 30 cm	
			Part #	TP/30cm
TSKgel MultiporeHXL-M	5	2 × 10 <sup>6</sup>	0018403	16,000

## Guard column

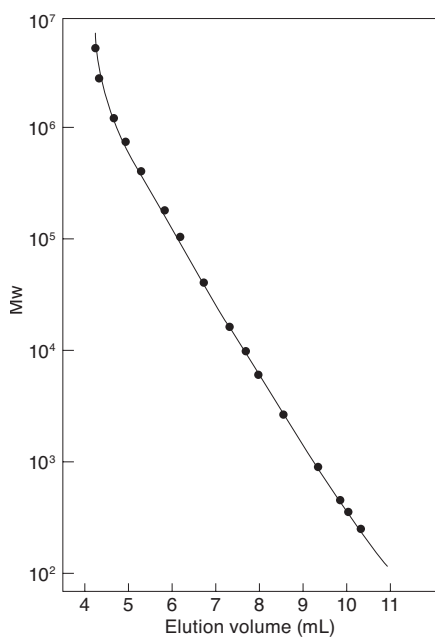
Description	Part #	Column size	Remarks
TSKguardcolumn MP <sub>(XL)</sub>	0018404	6.0 mm ID × 4 cm	For MultiporeHXL-M

## Reference column\*

Description	Part #	Column size
TSKgel SuperH-RC	0018004	6.0 mm ID × 15 cm

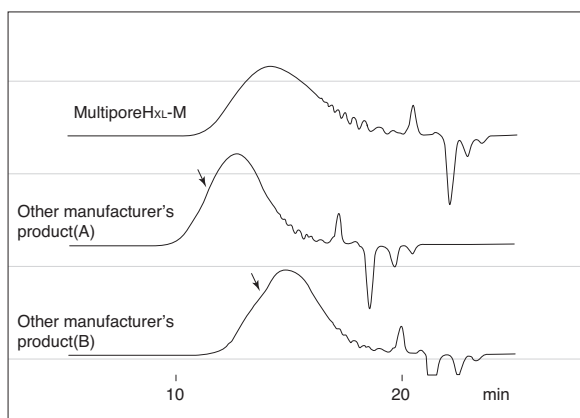
Standard solvent (shipped with the columns): THF

## TSKgel MultiporeHXL-M



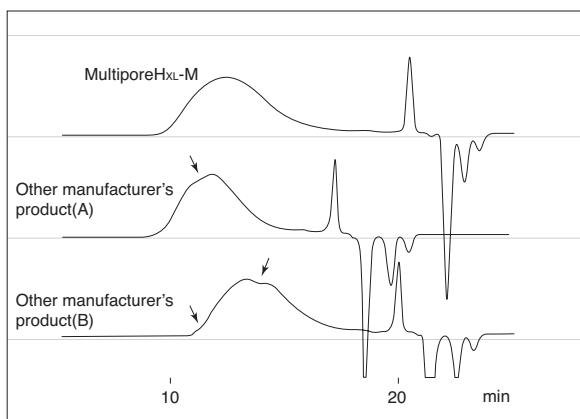
Column: TSKgel MultiporeHXL-M  
(7.8 mm ID × 30 cm)  
Solvent: THF  
Flow rate: 1.0 mL/min  
Temp.: 25 °C  
Detection: UV (254 nm)  
Sample: Standard polystyrene

## Separation of epoxy resin by TSKgel MultiporeHXL-M: Comparison with linear columns from other manufacturers



Column: TSKgel MultiporeHXL-M, (7.8 mm ID × 30 cm × 2 in series)  
Eluent: THF  
Flow rate: 1.0 mL/min  
Temperature: 40 °C  
Detection: RI

## Separation of acrylic resin by TSKgel MultiporeHXL-M, compared with linear columns from other manufacturers



Column: TSKgel MultiporeHXL-M, (7.8 mm ID × 30 cm × 2 in series)  
Eluent: THF  
Flow rate: 1.0 mL/min  
Temperature: 40 °C  
Detection: RI

# HXL-Series

High performance GPC columns

This series comprises high-speed SEC columns (7.8 mm ID × 30 cm) packed with 5 μm and 9 μm styrene divinylbenzene gels.

## Analytical column

Description	Particle size μm	Exclusion limit (Polystyrene)	7.8 mm ID × 30 cm L	
			Part #	TP/30cm
TSKgel G1000H <sub>XL</sub>	5	1 × 10 <sup>3</sup>	0016131	16,000
TSKgel G2000H <sub>XL</sub>	5	1 × 10 <sup>4</sup>	0016134	16,000
TSKgel G2500H <sub>XL</sub>	5	2 × 10 <sup>4</sup>	0016135	16,000
TSKgel G3000H <sub>XL</sub>	5	6 × 10 <sup>4</sup>	0016136	16,000
TSKgel G4000H <sub>XL</sub>	5	4 × 10 <sup>5</sup>	0016137	16,000
TSKgel G5000H <sub>XL</sub>	9	4 × 10 <sup>6</sup>	0016138	14,000
TSKgel G6000H <sub>XL</sub>	9	4 × 10 <sup>7</sup> (Estimated)	0016139	14,000
TSKgel G7000H <sub>XL</sub>	9	4 × 10 <sup>8</sup> (Estimated)	0016140	14,000
TSKgel GMH <sub>XL</sub> -L (mixed-bed)	5	4 × 10 <sup>6</sup>	0016652	16,000
TSKgel GMH <sub>XL</sub> (mixed-bed)	9	4 × 10 <sup>8</sup> (Estimated)	0016141	14,000

## Guard column

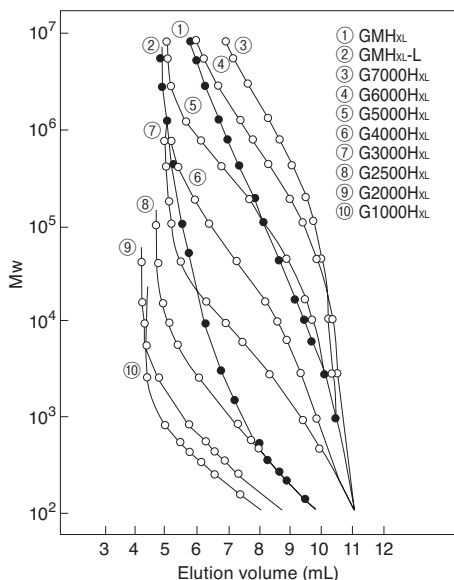
Description	Part #	Column size	Remarks
TSKguardcolumn H <sub>XL</sub> -L	0007113	6.0 mm ID × 4 cm L	For G1000H <sub>XL</sub> – G4000H <sub>XL</sub>
TSKguardcolumn H <sub>XL</sub> -H	0013727	6.0 mm ID × 4 cm L	For G5000H <sub>XL</sub> – GMH <sub>XL</sub> , GMH <sub>XL</sub> -L

## Reference column\*

Description	Part #	Column size
TSKgel SuperH-RC	0018004	6.0 mm ID × 15 cm L

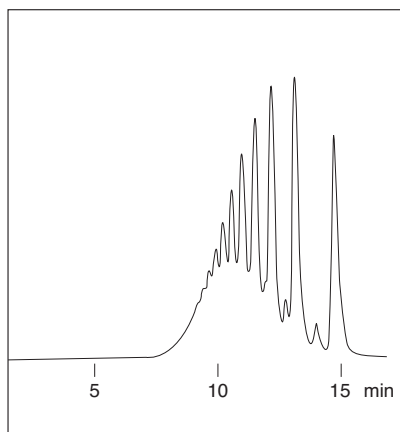
Standard solvent (shipped with the columns): THF

## Calibration curves for H<sub>XL</sub> Series



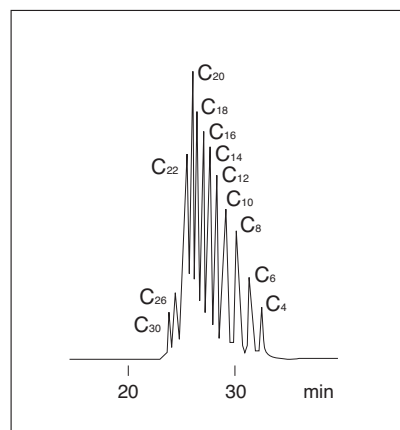
Column: TSKgel H<sub>XL</sub> Series  
(7.8 mm I.D. × 30 cm L)  
Eluent: THF  
Flow rate: 1.0 mL/min  
Detection: UV (254 nm)  
Temp.: 25 °C  
Sample: Standard polystyrene

## Separation of epoxy resin

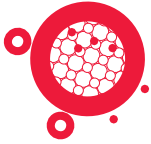


Column: TSKgel G2500H<sub>XL</sub>  
(7.8 mm ID × 30 cm L × 2 in series)  
Eluent: THF  
Flow rate: 1.0 mL/min  
Detection: RI

## Separation of fatty acids



Column: TSKgel G2500H<sub>XL</sub>  
(7.8 mm ID × 30 cm L × 2 in series)  
Eluent: THF  
Flow rate: 1.0 mL/min  
Detection: RI



# HHR-Series

Solvent compatible GPC columns

This series comprises high-speed SEC columns (7.8 mm ID × 30 cm L) packed with 5 μm styrene divinylbenzene-type gel. The columns feature excellent solvent compatibility and durability. The solvent can be changed to various organic solvents.

## ≡ Analytical column

Description	Particle size μm	Exclusion limit (Polystyrene)	7.8 mm ID × 30 cm L	
			Part #	TP/30cm
TSKgel G1000H <sub>HR</sub>	5	1 × 10 <sup>3</sup>	0017352	16,000
TSKgel G2000H <sub>HR</sub>	5	1 × 10 <sup>4</sup>	0017353	16,000
TSKgel G2500H <sub>HR</sub>	5	2 × 10 <sup>4</sup>	0017354	16,000
TSKgel G3000H <sub>HR</sub>	5	6 × 10 <sup>4</sup>	0017355	16,000
TSKgel G4000H <sub>HR</sub>	5	4 × 10 <sup>5</sup>	0017356	16,000
TSKgel G5000H <sub>HR</sub>	5	4 × 10 <sup>6</sup>	0017357	16,000
TSKgel G6000H <sub>HR</sub>	5	4 × 10 <sup>7</sup> (Estimated)	0017358	16,000
TSKgel G7000H <sub>HR</sub>	5	4 × 10 <sup>8</sup> (Estimated)	0017359	16,000
TSKgel GMH <sub>HR</sub> -L (mixed-bed)	5	4 × 10 <sup>6</sup>	0017362	16,000
TSKgel GMH <sub>HR</sub> -N (mixed-bed)	5	4 × 10 <sup>5</sup>	0018055	16,000
TSKgel GMH <sub>HR</sub> -M (mixed-bed)	5	4 × 10 <sup>6</sup>	0017392	16,000
TSKgel GMH <sub>HR</sub> -H (mixed-bed)	5	4 × 10 <sup>8</sup> (Estimated)	0017360	16,000

## ≡ Guard column

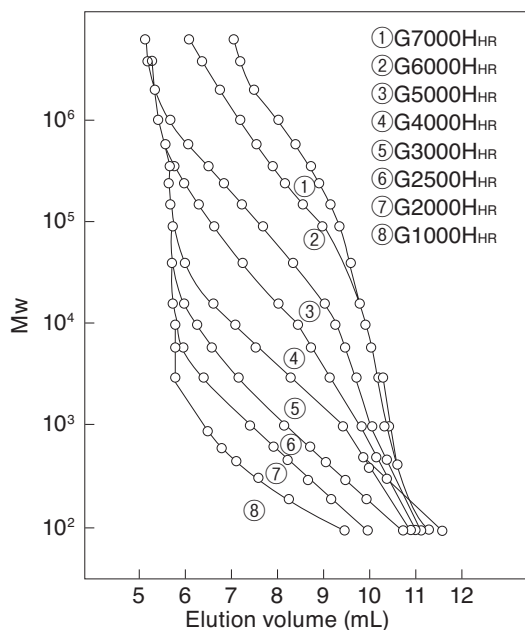
Description	Part #	Column size	Remarks
TSKguardcolumn H <sub>HR</sub> -L	0017368	6.0 mm ID × 4 cm L	For G1000H <sub>HR</sub> – G4000H <sub>HR</sub>
TSKguardcolumn H <sub>HR</sub> -H	0017369	6.0 mm ID × 4 cm L	For G5000H <sub>HR</sub> – GMH <sub>HR</sub> -L, -N, -M, -H

## ≡ Reference column\*

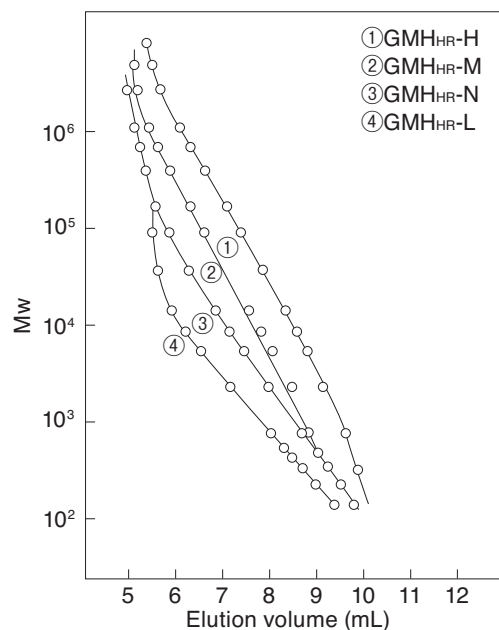
Description	Part #	Column size
TSKgel SuperH-RC	0018004	6.0 mm ID × 15 cm L

Standard solvent (shipped with all analytical columns): THF

## Calibration curves for H<sub>HR</sub> Series



Column: TSKgel H<sub>HR</sub> Series (7.8 mm ID × 30 cm L)  
 Flow rate: 1.0 mL/min  
 Detection: UV (254 nm)



Eluent: THF  
 Temp.: 25 °C  
 Sample: Standard polystyrene

# H-HT Series

High temperature GPC columns

For use in high temperature SEC applications, these columns (7.8 mm ID × 30 cm L), packed with styrene divinylbenzene-type gel, feature excellent solvent exchangeability and durability with temperature variation.

## Analytical column

Description	Particle size μm	Exclusion limit (Polystyrene)	7.8 mm ID × 30 cm L	
			Part #	TP/30cm
TSKgel GMH <sub>HR</sub> -H(30)HT (mixed-bed)	30	4 × 10 <sup>8</sup> (Estimated)	0018391	≥ 4,000
TSKgel GMH <sub>HR</sub> -H(20)HT (mixed-bed)	20	4 × 10 <sup>8</sup> (Estimated)	0018392	≥ 6,000
TSKgel GMH <sub>HR</sub> -H(S)HT (mixed-bed)	13	4 × 10 <sup>8</sup> (Estimated)	0018393	≥ 8,000

Standard solvent (shipped with all analytical columns): ODCB

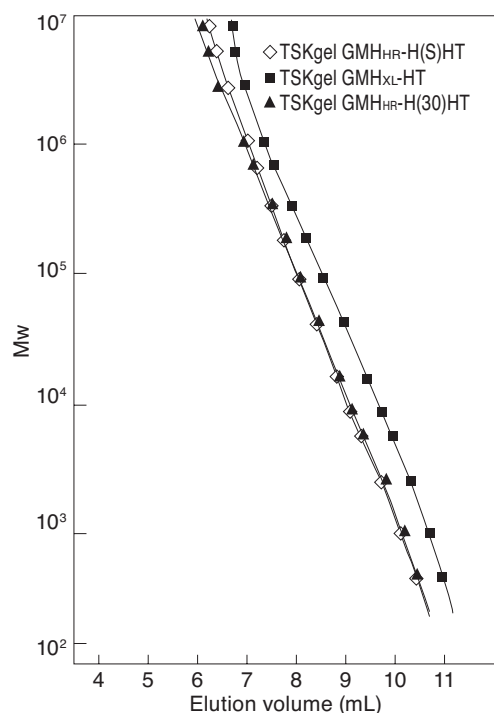
## Guard column

Description	Particle size μm	Part #	Column size
TSKgel Guard Column for TSKgel GMH <sub>HR</sub> -H(S)HT & GMH <sub>XL</sub> -HT	30	0018397	7.5 mm ID × 7.5 cm L

## Accessories

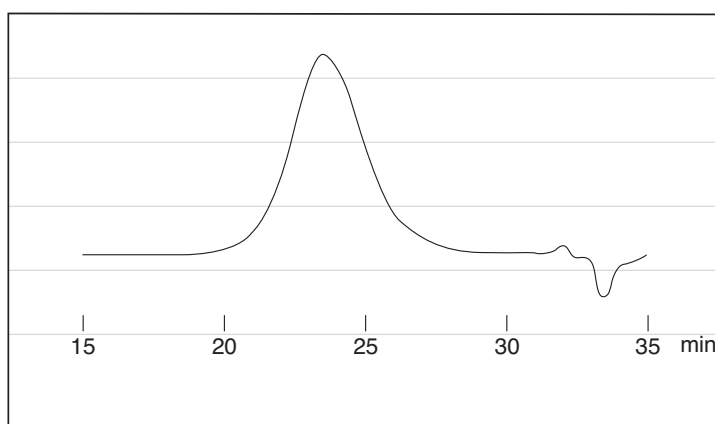
Description	Part #
Sample vial, transparent, 10 mL, 30/pk (PTFE cover)	0023809
Aluminum sheets, 30 mm, square, 100/pk	0023810
Stainless steel mesh, 26 μm, 50 mm, square, 100/pk	0023811
Stainless steel mesh, 96 μm, 50 mm, square, 100/pk	0023812

## Calibration curves for high temperature GPC mixed column series



Column: TSKgel GMH<sub>HR</sub>-H (S) HT  
 TSKgel GMH<sub>XL</sub>-HT  
 TSKgel GMH<sub>HR</sub>-H (30) HT  
 Eluent: ODCB (o-dichlorobenzene)  
 Flow rate: 1.0 mL/min  
 Temperature: 135 °C  
 Detection: RI  
 Sample: Standard polystyrene

## Separation of polyethylene



Column: TSKgel GMH<sub>HR</sub>-H (20) HT (7.8 mm ID × 30 cm L × 3 in series)  
 Eluent: ODCB  
 Flow rate: 1.0 mL/min  
 Temperature: 145 °C  
 Detection: RI  
 Sample: SRM1475





## H-HT-Series

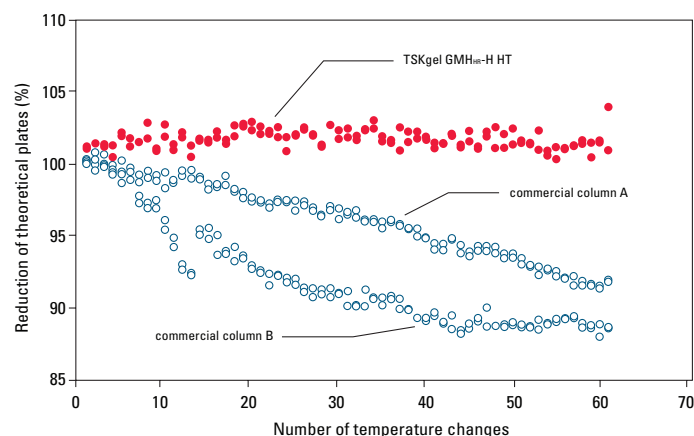
High temperature GPC columns

TSKgel H series columns are recommended for the analysis of organic-soluble polymers and are packed with spherical particles composed of polystyrene cross-linked with divinylbenzene (PS-DVB). The "GM" prefix denotes a column packed with particles of different pore sizes blended to provide an extended linear calibration curve. The TSKgel HT series are for high temperature applications ( $\leq 140$  °C) while the TSKgel HT2 columns are used in ultra-high temperature (up to 220 °C) applications.

The figure below demonstrates the performance stability of the TSKgel GMH<sub>HR</sub>-H HT columns compared to other commercially available high temperature GPC columns during repetitive temperature changes.

The TSKgel H<sub>HR</sub> HT columns and two commercially available high temperature GPC columns were subjected to drastic changes in temperature by raising the temperature for 2 hours followed by lowering the temperature for two hours for a total of 60 cycles. The number of theoretical plates was shown to remain constant for the TSKgel H<sub>HR</sub> HT columns and to decrease by 15% for the two commercially available high temperature GPC columns; thus revealing the superior performance stability of the TSKgel H<sub>HR</sub> HT columns.

Table 2 lists the attributes of the TSKgel HT columns which are for high temperature applications up to 140 °C.



### Durability of TSKgel H<sub>HR</sub> HT columns compared to two commercially available high temperature GPC columns

Column: TSKgel GMH<sub>HR</sub>-H HT, 5  $\mu$ m, 7.8 mm ID  $\times$  30 cm L  $\times$  2  
 Mobile phase: ODCB with 0.05% BHT  
 Flow rate: 1 mL/min  
 Detector: RI (EcoSEC High Temperature GPC System);  
 Temperature: 40 to 145 °C

# H-HT2-Series

Ultra-high temperature GPC columns

The TSKgel column series also includes four columns for the analysis of polymers at ultra-high temperatures (up to 220 °C). The TSKgel HT2 columns are specifically designed for the analysis of organic-soluble polymers at extremely elevated temperatures. The attributes of the TSKgel HT2 column series are listed below.

## Analytical column

Description	Particle size $\mu\text{m}$	Exclusion limit (Polystyrene)	7.8 mm ID $\times$ 30 cm L	
			Part #	TP/30 cm
TSKgel GMH <sub>HR</sub> -H(20) HT2	20	$4.0 \times 10^8$	0022888	$\geq 6,000$
TSKgel GMH <sub>HR</sub> -H(30) HT2	30	$4.0 \times 10^8$	0022887	$\geq 4,000$
TSKgel GMH <sub>HR</sub> -H(S) HT2	20	$4.0 \times 10^8$	0022889	$\geq 8,000$
TSKgel G2000H <sub>HR</sub> -H HT2	20	$1.0 \times 10^4$	0022890	$\geq 6,000$

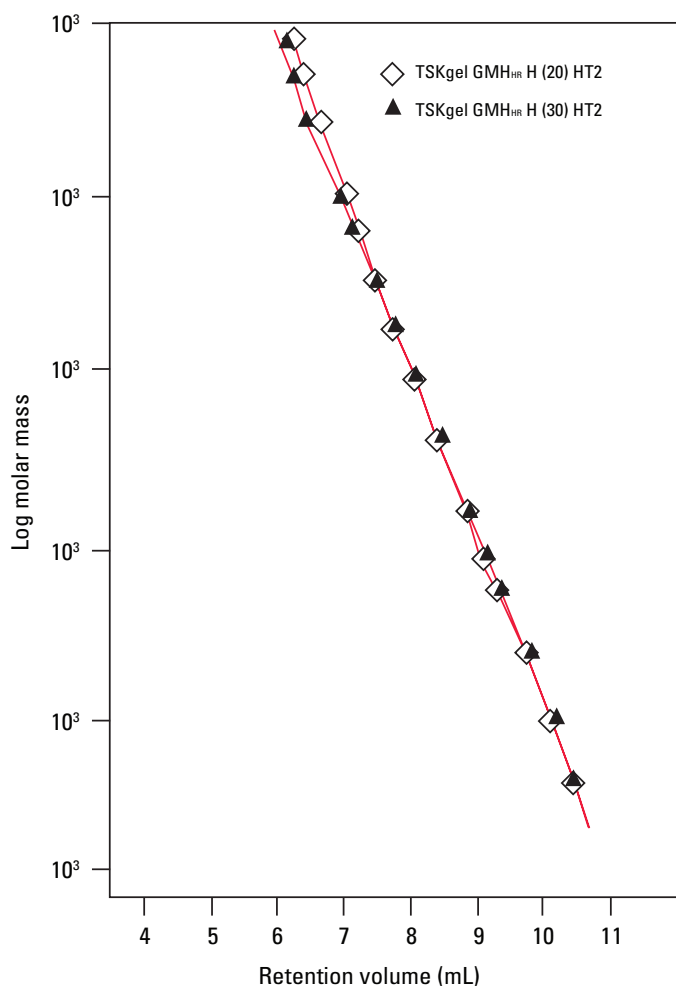
## Guard column

Description	Particle size $\mu\text{m}$	Part #	Column size
TSKgel Guard Column for TSKgel GMH <sub>HR</sub> -H (20) HT2 & GMH <sub>HR</sub> -H(30) HT2	30	0022891	7.5 mm ID $\times$ 7.5 cm L
TSKgel Guard Column for TSKgel GMH <sub>HR</sub> -H(S) HT2	13	0022892	7.5 mm ID $\times$ 7.5 cm L

## Accessories

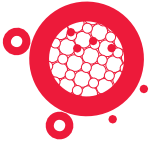
Description	Part #
Sample vial, transparent, 10 mL, 30/pk (PTFE cover)	0023809
Aluminum sheets, 30 mm, square, 100/pk	0023810
Stainless steel mesh, 26 $\mu\text{m}$ , 50 mm, square, 100/pk	0023811
Stainless steel mesh, 96 $\mu\text{m}$ , 50 mm, square, 100/pk	0023812

Standard solvent (shipped with all analytical columns): THF



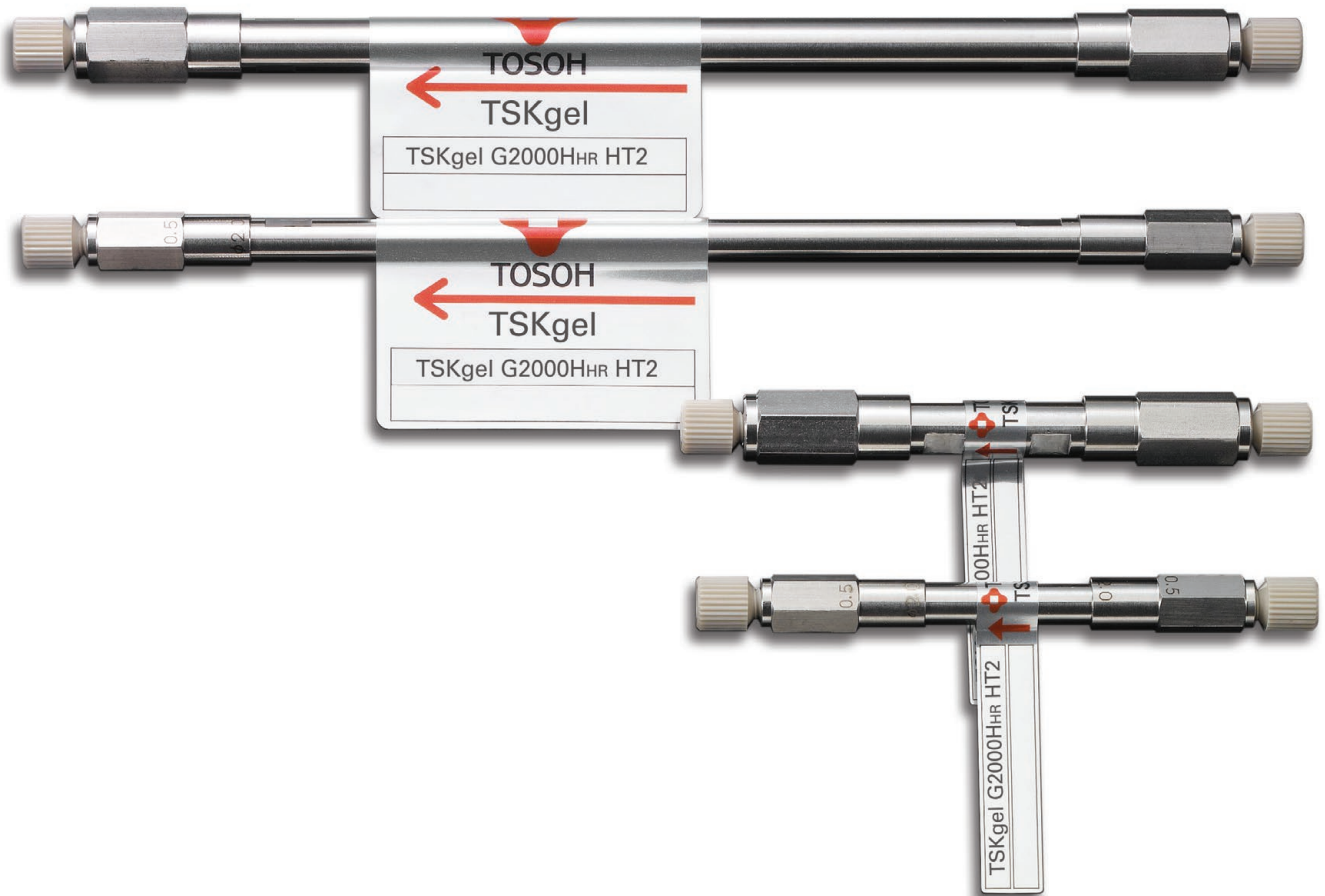
## Polystyrene calibration curves for TSKgel HT2 columns

Columns: TSKgel GMH<sub>HR</sub>-H(20) HT2, 20  $\mu\text{m}$ , 7.8 mm ID  $\times$  30 cm L  
 TSKgel GMH<sub>HR</sub>-H(30) HT2, 30  $\mu\text{m}$ , 7.8 mm ID  $\times$  30 cm L  
 Mobile phase: ODCB  
 Flow rate: 1.0 mL/min  
 Detection: RI  
 Temp.: 135 °C  
 Sample: polystyrene standards



# H-HT2-Series

Ultra-high temperature GPC columns



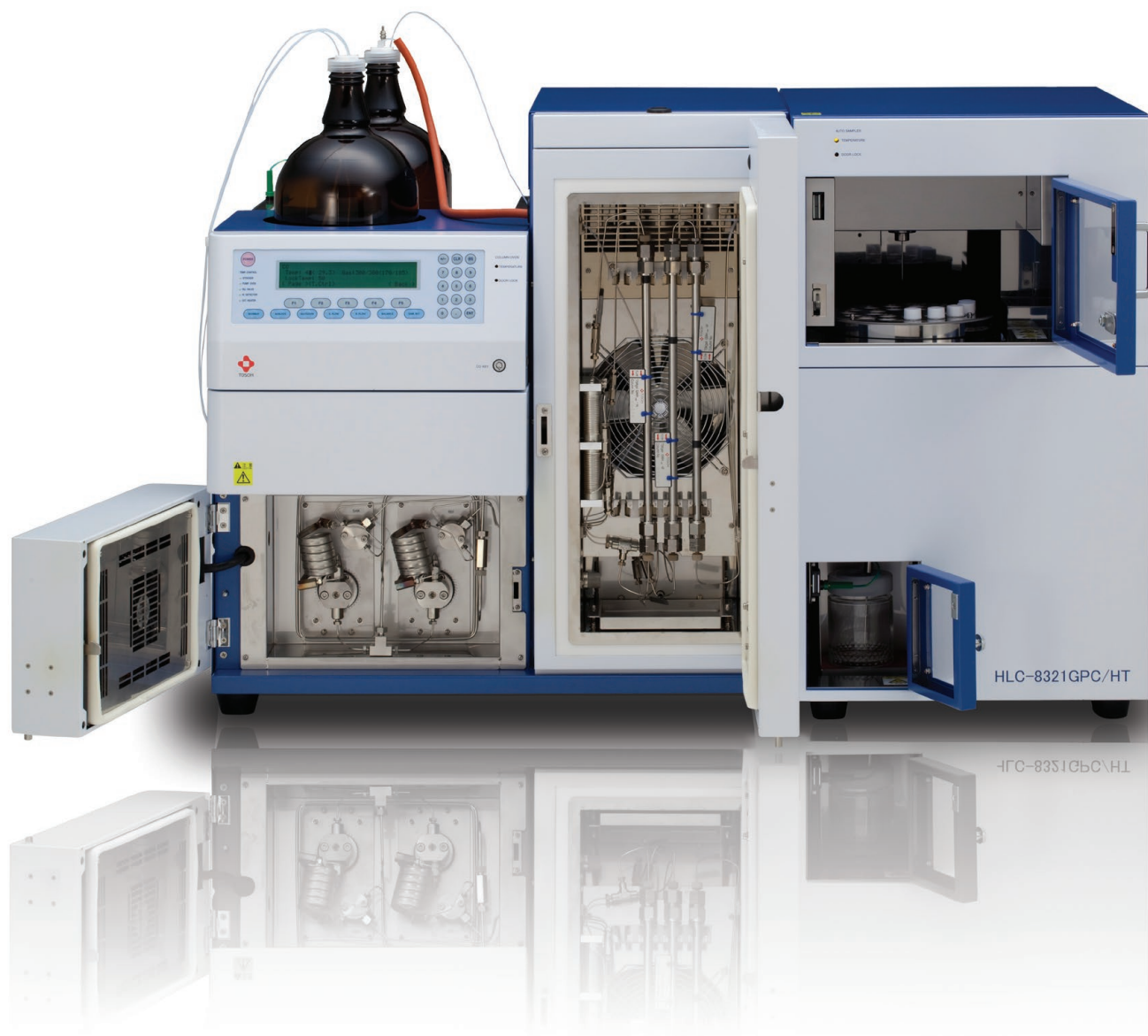
# H-HT2 Series

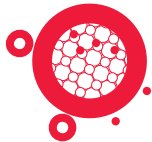
High temperature GPC instrument

With over 40 years in the GPC market Tosoh Bioscience is proud of our latest EcoSEC High Temperature GPC System. Designed by engineers, built by dedicated employees, tested by experienced polymer scientists, and supported by an entire organization, you can trust your analyses to the EcoSEC High Temperature GPC System. Demanding high temperature analyses require a system that delivers results reliably, reproducibly, and produces these results in an easy to use, safe instrument.

OUT OF THE BOX, THE NEW EcoSEC HIGH TEMPERATURE GPC SYSTEM FEATURES THE FOLLOWING:

- Reliability
- Safety
- Reproducibility
- All-in-One Design
- Stability
- Ease of Use





# SuperAW Series

Polar organic SEC semi-micro columns

Designed for ultra-high-speed SEC, this series comprises semi-micro columns (6.0 mm ID × 15 cm L) packed with a micro-particulate gel based on a hydrophilic vinyl polymer. As the high-strength gel does not show significant expansion or contraction in the presence of different types of solvent, the columns can be used with a wide range of solvents, from aqueous solution to organic solvents.

The analysis time is half that of a conventional column (7.8 mm ID × 30 cm), with solvent consumption 1/3 that of a conventional column, while achieving equal separation.

## ≡ Analytical column

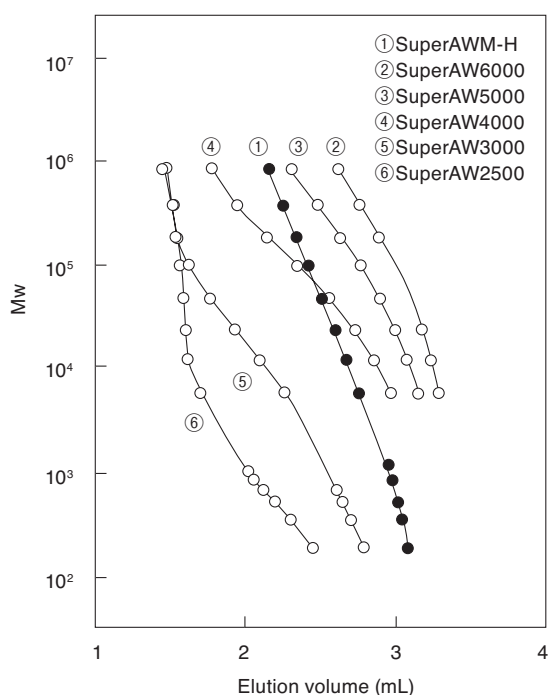
Description	Particle size μm	Exclusion limit (Polystyrene)	6.0 mm ID × 15 cm L	
			Part #	TP/15cm
TSKgel SuperAW2500	4	$2 \times 10^3$	0019315	16,000
TSKgel SuperAW3000	4	$6 \times 10^4$	0019316	16,000
TSKgel SuperAW4000	6	$4 \times 10^5$	0019317	10,000
TSKgel SuperAW5000	7	$4 \times 10^6$	0019318	10,000
TSKgel SuperAW6000	9	$>4 \times 10^7$ (Estimated)	0019319	17,000
TSKgel SuperAWM-H (mixed-bed)	9	$>4 \times 10^7$ (Estimated)	0019320	07,000

## ≡ Guard column

Description	Part #	Column size	Remarks
TSKguardcolumn SuperAW-L	0019321	4.6 mm ID × 3.5 cm L	For SuperAW2500 – 4000
TSKguardcolumn SuperAW-H	0019322	4.6 mm ID × 3.5 cm L	For SuperAW5000, 6000, and SuperAWM-H

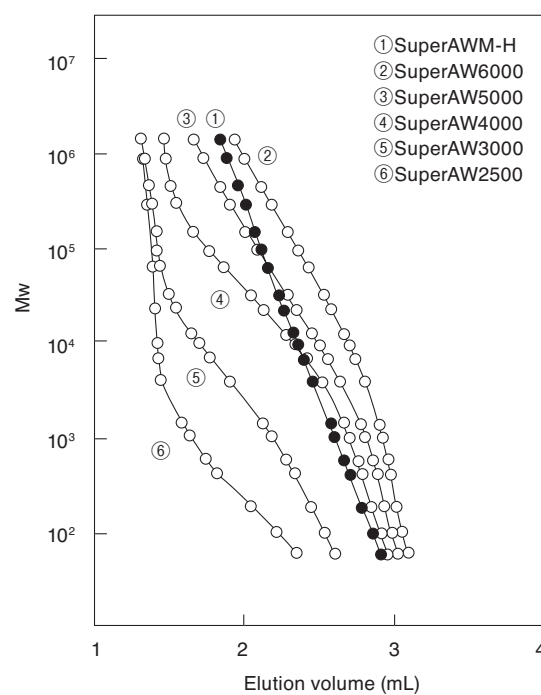
Standard solvent (shipped with column): H<sub>2</sub>O

## Calibration curves using PEG and PEO



Column: TSKgel SuperAW Series  
(6.0 mm ID × 15 cm L)  
Eluent: H<sub>2</sub>O  
Flow rate: 0.6 mL/min  
Temperature: 25 °C  
Detection: RI

## Calibration curve obtained using polystyrene



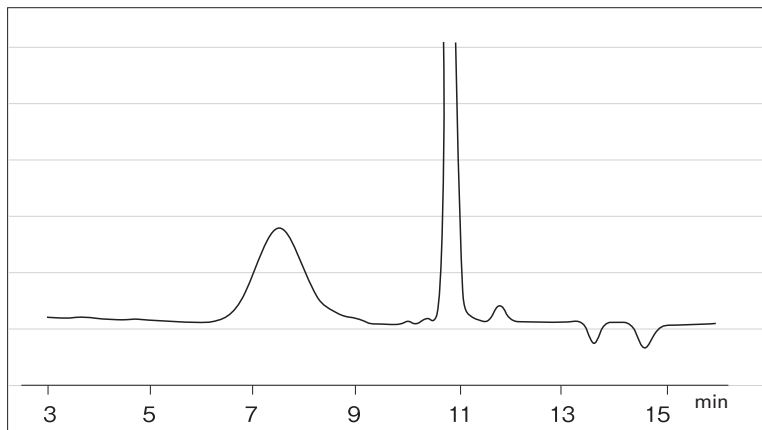
Column: TSKgel SuperAW Series  
(6.0 mm ID × 15 cm L)  
Eluent: DMF containing 10 mmol/L LiBr  
Flow rate: 0.6 mL/min  
Temperature: 25 °C  
Detection: RI

# SuperAW Series

Polar organic SEC semi-micro columns

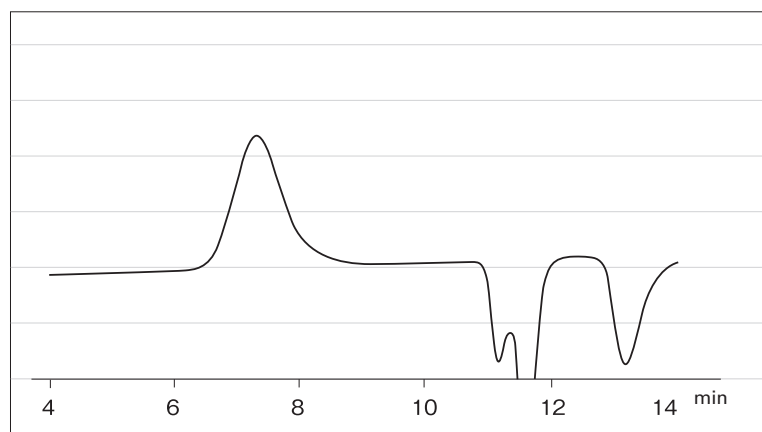
GPC

## Separation of sodium alginate



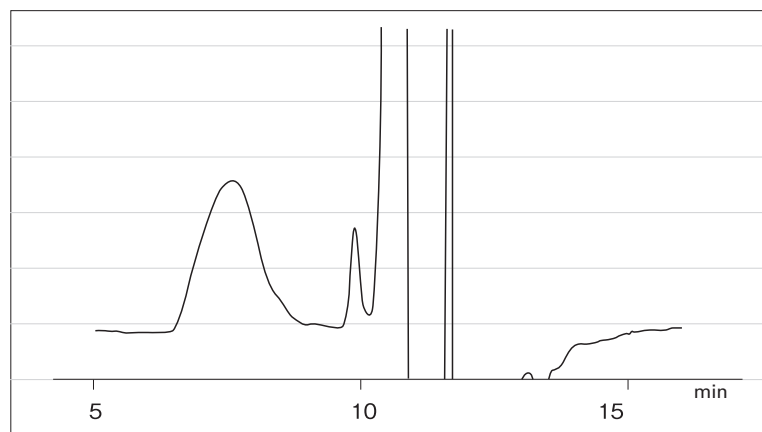
Column: TSKgel SuperAWM-H  
(6.0 mm ID × 15 cm L × 2 in series)  
Eluent: 0.2 mol/L sodium sulfate  
Flow rate: 0.6 mL/min  
Temperature: 40 °C  
Detection: RI  
Sample: Sodium alginate (0.2 g/L)  
Injection volume: 20 µL

## Separation of polyacrylonitrile



Column: TSKgel SuperAWM-H  
(6.0 mm ID × 15 cm L × 2 in series)  
Eluent: DMF containing 10 mmol/L LiBr  
Flow rate: 0.6 mL/min  
Temperature: 40 °C  
Detection: RI  
Sample: Polyacrylonitrile (0.2 g/L)  
Injection volume: 20 µL

## Separation of sodium sulfonate

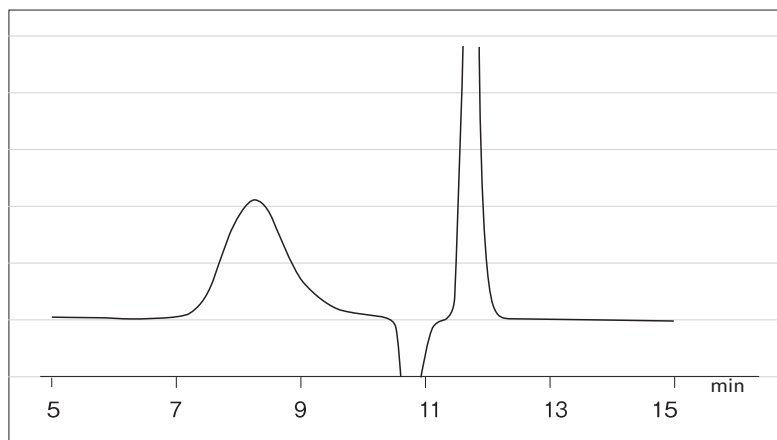


Column: TSKgel SuperAWM-H  
(6.0 mm ID × 15 cm L × 2 in series)  
Eluent: 0.2 mol/L sodium sulfate / acetonitrile = 8 / 2  
Flow rate: 0.6 mL/min  
Detection: RI  
Temperature: 40 °C  
Sample: Polystyrene sulfonate sodium (0.2 g/L)  
Injection volume: 20 µL

# SuperAW Series

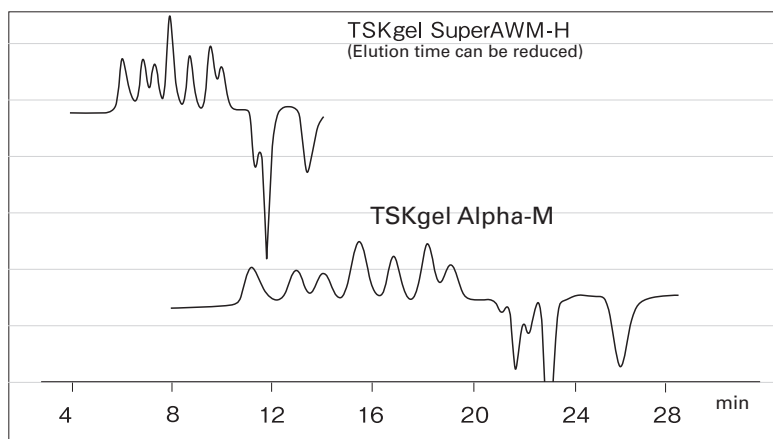
Polar organic SEC semi-micro columns

## Separation of ethyl hydroxyethyl cellulose



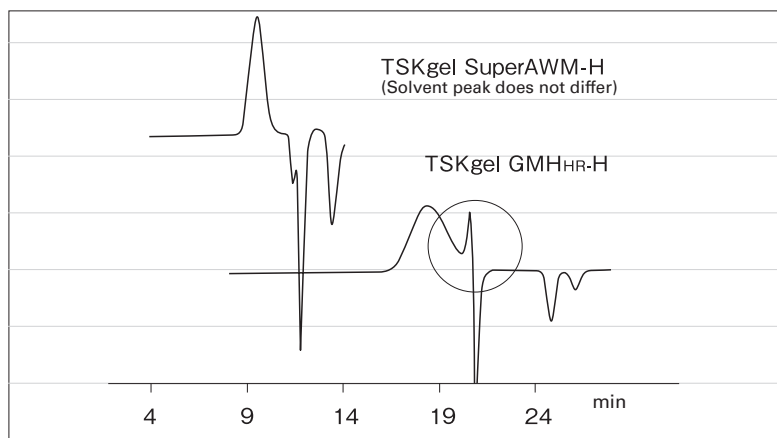
Column: TSKgel SuperAWM-H  
(6.0 mm ID × 15 cm L × 2 in series)  
Eluent: Methanol containing 10 mmol/L LiBr  
Flow rate: 0.6 mL/min  
Detection: RI  
Temperature: 40 °C  
Sample: Ethyl hydroxyethyl cellulose (0.1 g/L)  
Injection volume: 20 µL

## Comparison of elution times for chromatograms obtained using DMF



Column: TSKgel SuperAWM-H  
(6.0 mm ID × 15 cm L × 2 in series)  
TSKgel Alpha-M  
(7.8 mm ID × 30 cm L × 2 in series)  
Eluent: DMF containing 10 mmol/L LiBr  
Flow rate: 0.6 mL/min (SuperAW), 1.0 mL/min (Alpha-M)  
Temp.: 40 °C  
Detection: RI  
Sample: Standard polystyrene (0.01 to 0.02 g/L)  
Injection vol.: 20 µL (SuperAW), 50 µL (Alpha-M)

## Comparison of chromatograms obtained using DMF (effect of solvent peak)



Column: TSKgel SuperAWM-H  
(6.0 mm ID × 15 cm L × 2 in series)  
TSKgel GMH<sub>HR</sub>-H  
(7.8 mm ID × 30 cm L × 2 in series)  
Eluent: DMF containing 10 mmol/L LiBr  
Flow rate: 0.6 mL/min (SuperAW), 1.0 mL/min (H<sub>HR</sub>)  
Temp.: 40 °C  
Detection: RI  
Sample: Styrene-allyl alcohol copolymer  
Injection vol.: 20 µL (SuperAW), 50 µL (H<sub>HR</sub>), 1.0 g/L each

# Alpha Series

Polar organic SEC columns

This series comprises SEC columns for use with polar organic solvents, containing hydrophilic vinyl polymer-based particles. The columns, which feature excellent solvent tolerance and durability, can be used for a wide range of solvents, from aqueous solution to organic solvents. They can be used for samples of many types, ranging from water-soluble polymers and saccharides to general synthetic polymers.

## ➤ Analytical column

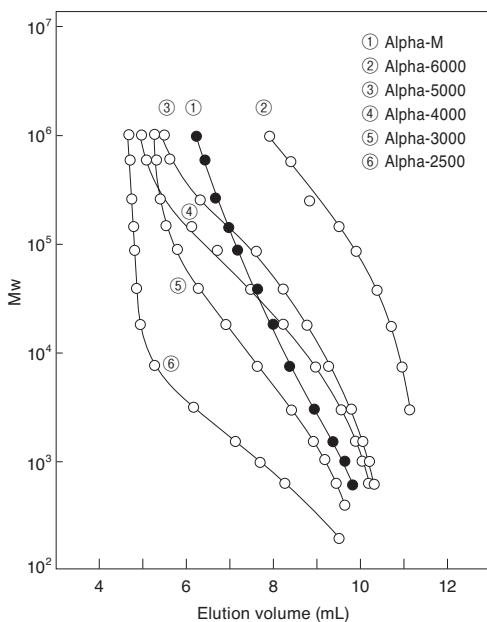
Description	Particle size µm	Exclusion limit		7.8 mm ID x 30 cm L	
		(PEO and PEG/Water)	(Polystyrene/THF)	Part #	TP/30cm
TSKgel Alpha-2500	7	$5 \times 10^3$	$1 \times 10^4$	0018339	16,000
TSKgel Alpha-3000	7	$9 \times 10^4$	$1 \times 10^5$	0018340	16,000
TSKgel Alpha-4000	10	$4 \times 10^5$	$1 \times 10^6$	0018341	10,000
TSKgel Alpha-5000	10	$1 \times 10^6$	$7 \times 10^6$	0018342	10,000
TSKgel Alpha-6000	13	$>1 \times 10^7$ (Estimated)	$>1 \times 10^7$ (Estimated)	0018343	7,000
TSKgel Alpha-M (mixed-bed)	13	$>1 \times 10^7$ (Estimated)	$>1 \times 10^7$ (Estimated)	0018344	7,000

## ➤ Guard column

Description	Part #	Column size	Remarks
TSKguardcolumn Alpha	0018345	6.0 mm ID x 4.0 cm L	For all Alpha Series

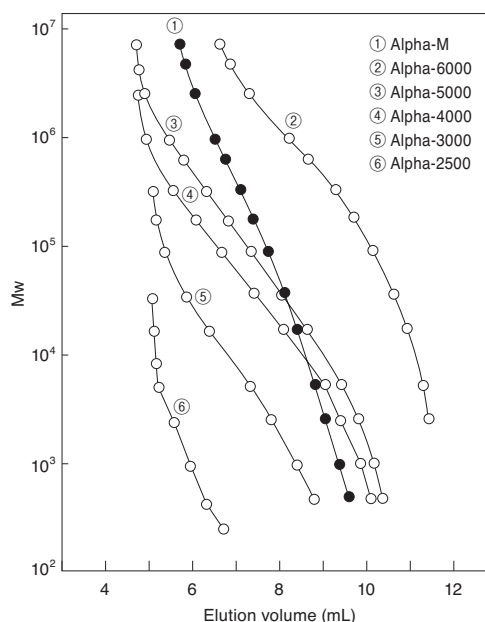
Standard solvent (shipped with columns): H<sub>2</sub>O

### Calibration curves using PEG and PEO



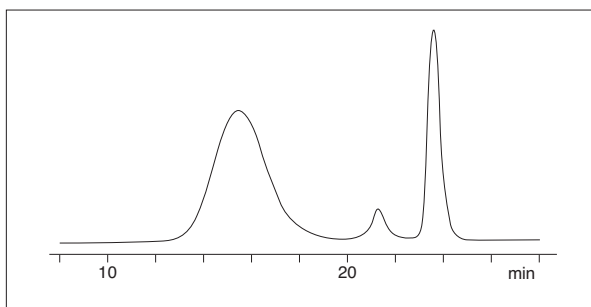
Column: TSKgel Alpha Series (7.8 mm ID x 30 cm L)  
 Eluent: Methanol containing 10 mmol/L LiBr  
 Flow rate: 1.0 mL/min  
 Temperature: 40 °C  
 Detection: RI

### Calibration curves obtained using polystyrene



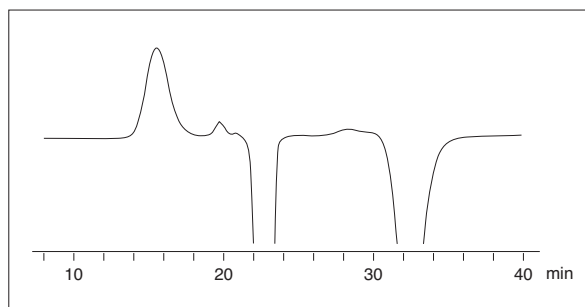
Column: TSKgel Alpha Series (7.8 mm ID x 30 cm L)  
 Eluent: DMF containing 10 mmol/L LiBr  
 Flow rate: 1.0 mL/min  
 Temperature: 40 °C  
 Detection: 0.1%, 50 µL

### Separation of ethyl hydroxyethyl cellulose



Column: TSKgel Alpha-M (7.8 mm ID x 30 cm L)  
 Eluent: DMF containing 10 mmol/L LiBr  
 Flow rate: 0.5 mL/min  
 Temperature: 40 °C  
 Detection: RI  
 Injection volume: 0.1%, 50 µL

### Separation of polyimide



Column: TSKgel Alpha-M (7.8 mm ID x 30 cm L)  
 Eluent: NMP containing 10 mmol/L LiBr  
 Flow rate: 0.5 mL/min  
 Temperature: 40 °C  
 Detection: RI  
 Injection volume: 0.1%, 50 µL





## PW Series

General-purpose aqueous SEC columns

This series comprises aqueous SEC columns containing a hydrophilic vinyl polymer-based packing material. The columns, which feature excellent solvent tolerance and durability, are suitable for separation and molecular weight analysis of water-soluble polymers and saccharides.

### ≡ Analytical column

Description	Particle size μm	Exclusion limit (Dextran)	7.5 mm ID × 30 cm L		7.5 mm ID × 60 cm L	
			Part #	TP/30cm	Part #	TP/30cm
TSKgel G2000PW	12	$5 \times 10^3$ *	0005761	5,000	0005105	5,000
TSKgel G2500PW	12	$5 \times 10^3$ *	0008028	5,000	0008029	5,000
TSKgel G3000PW	12	$2 \times 10^5$	0005762	5,000	0005106	5,000
TSKgel G4000PW	17	$1 \times 10^6$	0005763	3,000	0005107	3,000
TSKgel G5000PW	17	$2.5 \times 10^6$	0005764	3,000	0005108	3,000
TSKgel G6000PW	17	$5 \times 10^7$ (Estimated)	0005765	3,000	0005109	3,000
TSKgel GMPW (mixed-bed)	17	$5 \times 10^7$ (Estimated)	0008026	3,000	0008027	3,000

 Standard solvent (shipped with column): H<sub>2</sub>O

\*By polyethylene glycol

Description	Particle size μm	Exclusion limit (PEG/PEO)	6.0 mm ID × 15 cm L	
			Part #	TP/30cm
TSKgel SuperMultiporePW-N	4	$3 \times 10^2 - 3 \times 10^4$	0022789	> 16,000
TSKgel SuperMultiporePW-M	5	$5 \times 10^2 - 1 \times 10^6$	0022790	> 12,000
TSKgel SuperMultiporePW-H	8	$1 \times 10^3 - 3 \times 10^3$	0022791	> 7,000

### ≡ Guard column

Description	Part #	Column size	Packed solvent	Remarks
TSKguardcolumn PWL	0006763	7.5 mm ID × 7.5 cm L	H <sub>2</sub> O	For G2000PW analytical columns
TSKguardcolumn PWH	0006762	7.5 mm ID × 7.5 cm L	H <sub>2</sub> O	For G2500PW – GMPW analytical columns



# PWXL Series

High-performance aqueous SEC columns

This series comprises high-performance aqueous SEC columns with a hydrophilic vinyl polymer-based packing material. The particle size of PW<sub>XL</sub> series columns is smaller than the particle size of PW series. The columns, which feature excellent solvent tolerance and durability, are suitable for separation and molecular weight analysis of water-soluble polymers and saccharides.

## Analytical column

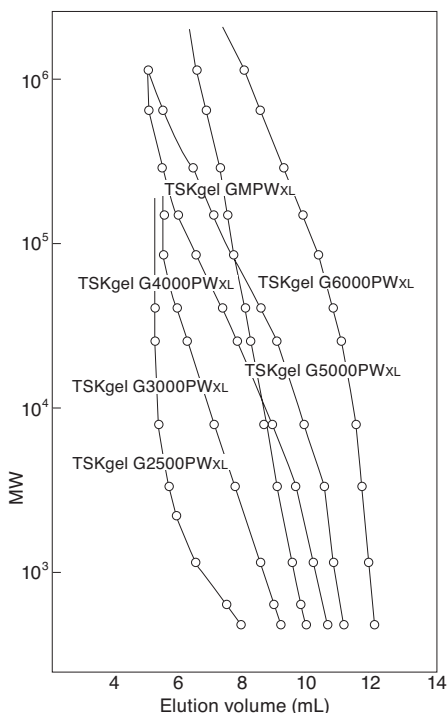
Description	Particle size $\mu\text{m}$	Exclusion limit (Dextran)	7.8 mm ID $\times$ 30 cm L	
			Part #	TP/30cm
TSKgel G2500PW <sub>XL</sub>	7	$5 \times 10^3^*$	0008020	16,000
TSKgel G3000PW <sub>XL</sub>	7	$2 \times 10^5$	0008021	16,000
TSKgel G4000PW <sub>XL</sub>	10	$1 \times 10^6$	0008022	10,000
TSKgel G5000PW <sub>XL</sub>	10	$2.5 \times 10^6$	0008023	10,000
TSKgel G6000PW <sub>XL</sub>	13	$5 \times 10^7$ (Estimated)	0008024	7,000
TSKgel GMPW <sub>XL</sub> (mixed-bed)	13	$5 \times 10^7$ (Estimated)	0008025	7,000
TSKgel G-Oligo-PW	07	$5 \times 10^3^*$	0008031	16,000
TSKgel G-DNA-PW	10	Approximately 7,000 base pairs or less	0008032	10,000

## Guard column and bulk packing

Description	Part #	Column size	Packed solvent	Remarks
TSKguardcolumn PW <sub>XL</sub>	0008033	6.0 mm ID $\times$ 4.0 cm L	H <sub>2</sub> O	For PW <sub>XL</sub> Series
TSKguardcolumn Oligo	0008034	6.0 mm ID $\times$ 4.0 cm L	H <sub>2</sub> O	For G-Oligo-PW
TSKtopoffgel PW <sub>XL</sub>	0008035	--	H <sub>2</sub> O	PW <sub>XL</sub> bulk packing 1 mL

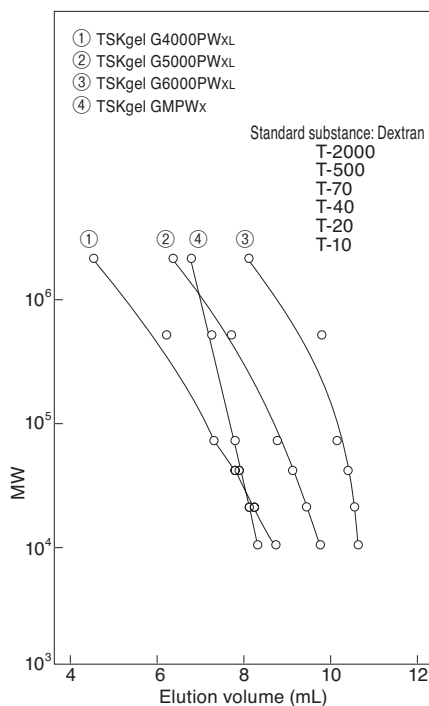
Standard solvent (shipped with column): H<sub>2</sub>O

## Calibration curves obtained using PEG and PEO



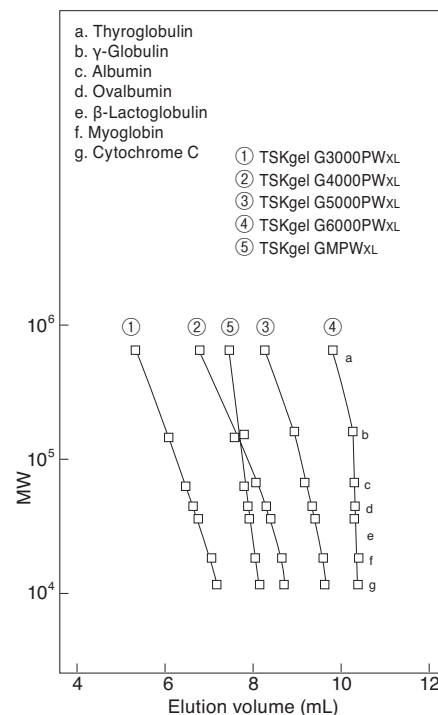
Column: TSKgel PW<sub>XL</sub> Series (7.8 mm ID  $\times$  30 cm L)  
 Eluent: H<sub>2</sub>O  
 Flow rate: 1.0 mL/min  
 Detection: RI

## Calibration curves obtained using dextran

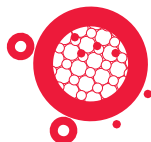


Column: TSKgel PW<sub>XL</sub> Series (7.8 mm ID  $\times$  30 cm L)  
 Eluent: 0.2 mol/L phosphate buffer  
 Flow rate: 1.0 mL/min  
 Detection: RI

## Calibration curves obtained using proteins



Column: TSKgel PW<sub>XL</sub> Series (7.8 mm ID  $\times$  30 cm L)  
 Eluent: 0.2 mol/L phosphate buffer  
 Flow rate: 1.0 mL/min  
 Detection: UV (280 nm)



## PWXL-CP Series

Aqueous SEC columns for cationic polymer analysis

This series comprises aqueous SEC columns for analysis of cationic polymers. The stationary phase of the PWXL Series has been modified to minimize ionic interactions between cationic polymers and the packing material, which is a common problem in aqueous SEC. This enables molecular weight analysis of cationic polymers under mild conditions.

### Analytical column

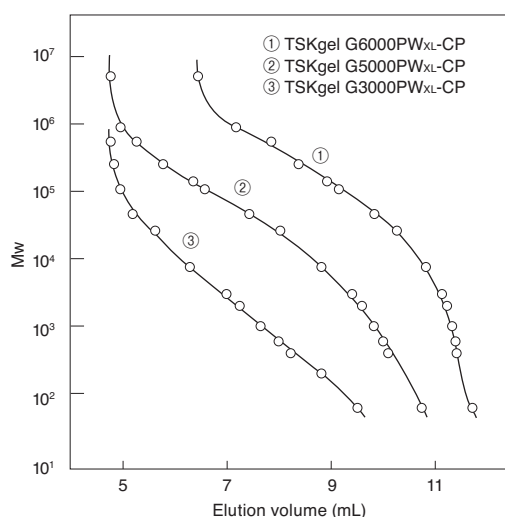
Description	Particle size $\mu\text{m}$	Exclusion limit (PEO conversion)	7.8 mm ID $\times$ 30cm L	
			Part #	TP/30cm
TSKgel G3000PW <sub>XL</sub> -CP	7	$9 \times 10^4$	0021873	16,000
TSKgel G5000PW <sub>XL</sub> -CP	10	$1 \times 10^6$	0021874	10,000
TSKgel G6000PW <sub>XL</sub> -CP	13	$2 \times 10^7$ (Estimated)	0021875	7,000

### Guard column

Description	Part #	Column size	Packed solvent	Remarks
TSKguardcolumn PW <sub>XL</sub> -CP	0021876	6.0 mm ID $\times$ 4 cm L	H <sub>2</sub> O	For PW <sub>XL</sub> -CP Series

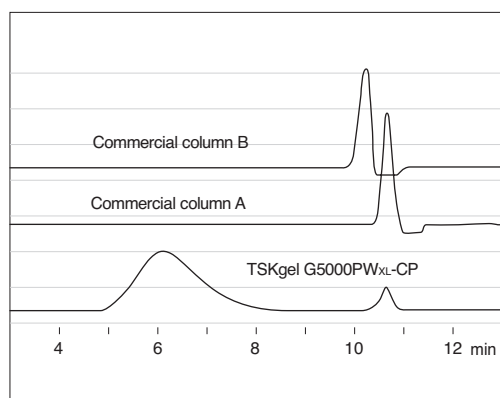
Standard solvent (shipped with column): H<sub>2</sub>O

### Calibration curves obtained using PEG and PEO



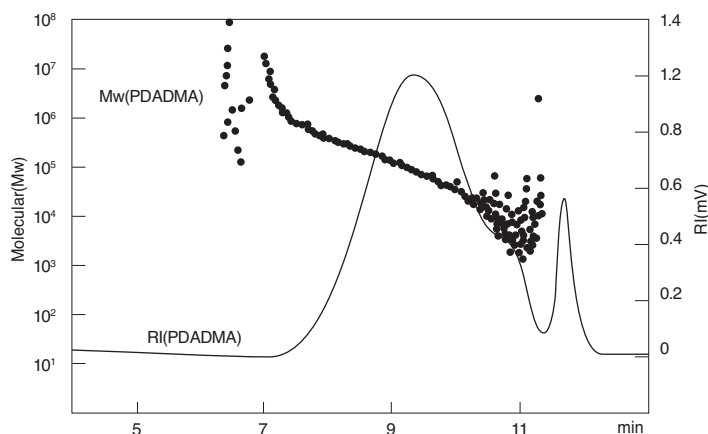
Column: TSKgel PW<sub>XL</sub>-CP Series  
 Eluent: 0.1 mol/L sodium sulfate aqueous solution  
 Flow rate: 1.0 mL/min  
 Temperature: 25 °C  
 Detection: RI

### Separation of cationic polymer



Column: TSKgel G5000PW<sub>XL</sub>-CP (7.8 mm ID  $\times$  30 cm L)  
 Commercial column A (7.8 mm ID  $\times$  30 cm L)  
 Commercial column B (7.5 mm ID  $\times$  30 cm L)  
 Eluent: 0.1 mol/L sodium sulfate aqueous solution  
 Flow rate: 1.0 mL/min  
 Temperature: 25 °C  
 Detection: RI  
 Sample: Polyallylamine

### Molecular weight analysis of cationic polymer using SEC-MALS



Column: TSKgel G6000PW<sub>XL</sub>-CP (7.8 mm ID  $\times$  30 cm L)  
 Eluent: 0.1 mol/L sodium sulfate aqueous solution  
 Flow rate: 1.0 mL/min  
 Temperature: 25 °C  
 Detection: RI, MALS  
 Sample: Polydiiallyl dimethyl ammonium chloride (PDADMA)



## **TOSOH BIOSCIENCE**

Im Leuschnerpark 4, 64347 Griesheim, Germany  
Tel: +49 (0)6155 70437 00 Fax: +49 (0)6155 83579 - 00  
info.tbg@tosoh.com [www.tosohbioscience.de](http://www.tosohbioscience.de)