



# EcoSEC HIGH TEMPERATURE GPC SYSTEM



**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. Tosoh has a long and successful history in manufacturing instruments for gel permeation chromatography (GPC) for the Asian market. Based on the wide experience in GPC instrument design and GPC column technology, Tosoh has developed the new EcoSEC and EcoSEC HT systems to meet the market demands for high throughput, semi micro GPC.



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**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 TOSOH US STARTS OPERATING FROM MONTGOMERYVILLE
- 1989 TOSOH GmbH STARTS OPERATING FROM STUTTGART
- 1995 TOSOH NANYO GEL FACILITY RECEIVES ISO 9001
- 2000/2001 FORMER TOSOH 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

# TOSOH BIOSCIENCE

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# EcoSEC HIGH TEMPERATURE GPC SYSTEM A TRADITION OF GPC EXCELLENCE



Tosoh Bioscience established itself as a world leader in the field of polymer analysis in 1971 with the introduction of TSKgel GPC columns. The following year, Tosoh launched a dedicated instrument for GPC analysis. Since that first instrument there have been 7 generations

of ambient GPC systems as well as 2 generations of high temperature GPC systems. Today Tosoh Bioscience continues a tradition of GPC excellence with a 3<sup>rd</sup> generation high temperature GPC system: the EcoSEC High Temperature GPC System.

## 1972: HLC-801 GPC SYSTEM

- First GPC instrument from Tosoh
- "All-in-one" concept incorporated



## 1977: HLC-811 HT GPC SYSTEM

- First high temperature GPC system

## 1982: HLC-801A GPC SYSTEM

- Dual Flow refractive index (RI) detector
- "Stable RI Baseline" implemented



## 1986: HLC-8020 GPC SYSTEM

- Temperature controlled pump system
- "High Reproducibility" obtained



## 1993: HLC-8121 GPC SYSTEM

- First semi-micro GPC columns from Tosoh
- "Semi-micro" concept incorporated



## 1998: HLC-8121 HT GPC SYSTEM

- 2<sup>nd</sup> generation high temperature system

## 2008: EcoSEC GPC SYSTEM

- 7<sup>th</sup> generation Tosoh GPC System
- Released in overseas market

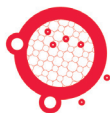


## 2013: EcoSEC HIGH TEMPERATURE GPC SYSTEM

- 3<sup>rd</sup> generation Tosoh high temperature GPC System
- Released in overseas market







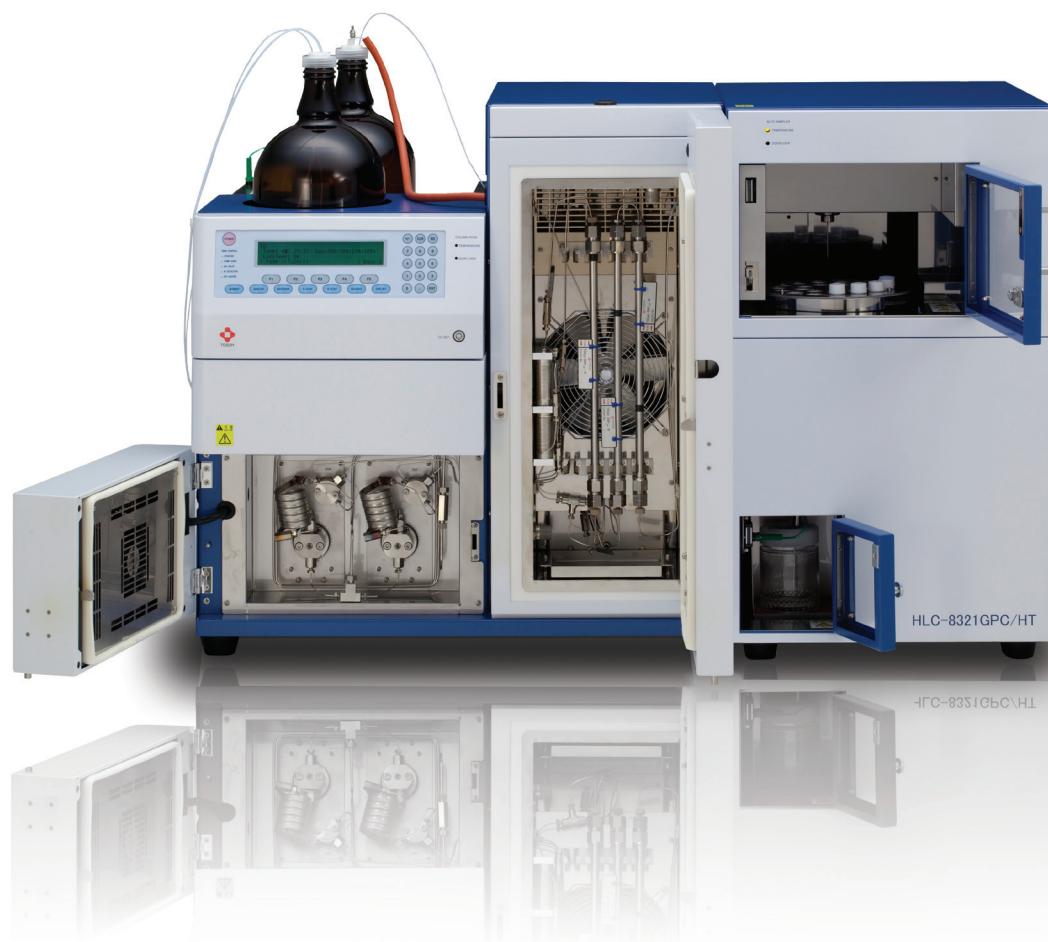
# EcoSEC HIGH TEMPERATURE GPC SYSTEM A HISTORY OF PERFORMANCE

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.

The EcoSEC High Temperature GPC System incorporates the proven design and technology used in our ambient EcoSEC GPC System. The dual pump system, dual flow RI detector, spacious column oven, total system temperature control, autosampler, sample prep station, safety features, and all-in-one design controlled by intuitive software combine to deliver Performance.

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

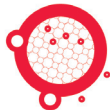
- |                   |                     |
|-------------------|---------------------|
| ➤ Reliability     | ➤ Safety            |
| ➤ Reproducibility | ➤ All-in-One Design |
| ➤ Stability       | ➤ Ease of Use       |





# EcoSEC HIGH TEMPERATURE GPC SYSTEM ENGINEERED FOR PERFORMANCE

COMPONENT	DESCRIPTION	BENEFIT
SOLVENT HOLDER	Maintains a constant temperature of 40 °C.	Prevent possible solvent freezing.
CONTROL PANEL	Allows the system to be controlled manually and at the discretion of the operator.	Saves time by controlling a series of operations without the use of the computer or software.
TEMPERATURE CONTROLLED PUMPS	Pump heads and solvent lines are maintained at a constant temperature.	Improves baseline stability by removing the effect of temperature fluctuations. This results in consistent and accurate flow rates and reproducible molar mass determinations.
COLUMN OVEN	Maintains 40 - 220 °C. Can accommodate up to 8, 30 cm length columns.	Constant column temperature ensures precise and reproducible molar mass determinations.
AUTOSAMPLER	24 sample capacity. Equipped with temperature controlled system by aluminum block and controllable from 40 - 220 °C.	Precise injection volume. Variety of loop sizes. Door is locked under sampling operation for safety.
RI DETECTOR	Solvent flows through a separate reference cell. 10 µL volume flow cell.	Temperature controlled, stable baseline, quick response, low noise. Enhanced baseline stability from dual flow cell RI detector.
PURGE UNIT AND DEGASSER	Variable degassing capacity. Temperature controlled degassing unit and auto purge function.	Saves time with rapid solvent changes via purge valve eliminating solvent replacement and other time-consuming manual operations.

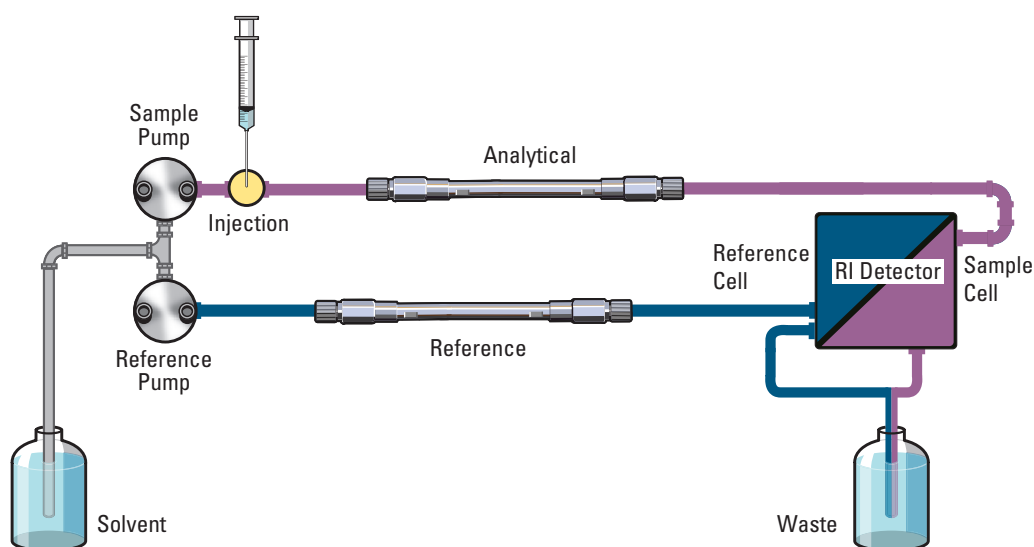


# EcoSEC HIGH TEMPERATURE GPC SYSTEM PERFORMANCE MEANS BASELINE STABILITY

Incorporated into the design of our two pump delivery system is 40+ years experience in engineering. The EcoSEC High Temperature GPC System has a unique dual flow design which includes the use of two pumps. Figure 1 demonstrates the flow paths of the sample and reference pumps. The sample pump flows solvent from the solvent reservoir through the following system components in sequence: autosampler, analytical column, sample side of RI detector cell, and waste container. The solvent flows via the reference pump from the solvent reservoir through a reference column, the reference side of the RI detector cell, and then the waste container. The entire flow system is temperature controlled to eliminate the effects of fluctuations in ambient temperature.

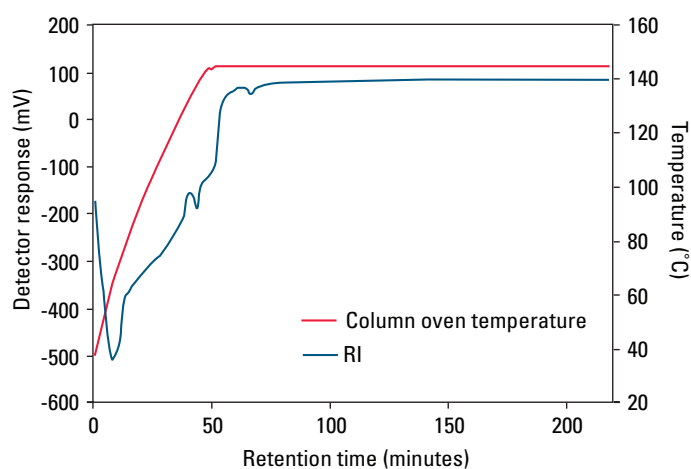
On the EcoSEC High Temperature GPC System the RI baseline is considered stabilized when the drift in the signal is  $3.0 \times 10^{-7}$  RIU/h or less. When a new set of columns is manually placed on the EcoSEC High Temperature GPC System and the flow rate and temperature controls are started, the RI baseline stabilizes after 3 hours. Figure 2 demonstrates the equilibration time from start-up of the EcoSEC High Temperature GPC System in orthodichlorobenzene (ODCB).

➤ **FIGURE 1**



FLOW PATHS OF SAMPLE AND REFERENCE PUMPS IN THE EcoSEC HIGH TEMPERATURE GPC SYSTEM

➤ **FIGURE 2**



REFRACTIVE INDEX DETECTOR SIGNAL DURING EQUILIBRATION OF THE EcoSEC HIGH TEMPERATURE GPC SYSTEM

Column: TSKgel GMH<sub>HR</sub>-H(S) HT2, 13  $\mu$ m, 7.8 mm ID  $\times$  30 cm L  $\times$  2  
 Mobile phase: ODCB with 0.05% BHT; Flow rate: 1.0 mL/min;  
 Detection: RI (EcoSEC High Temperature GPC System); Temp.: 145 °C



# EcoSEC HIGH TEMPERATURE GPC SYSTEM PERFORMANCE MEANS BASELINE STABILITY



Advanced engineering, along with complete temperature control and a dual flow RI detector, means rock steady baselines in even the most challenging solvents and temperatures. The RI baselines as obtained for three commonly used high temperature GPC solvents: Trichlorobenzene (TCB) at 145 °C, orthodichlorobenzene (ODCB) at 145 °C and 1-chloronaphthalene (1-CN) at 210 °C are shown in Figure 3. The RI baseline drift for all three solvents is less than 1 mV/h.

The unmatched baseline stability of the dual flow RI detector in the EcoSEC High Temperature GPC System is also shown in Table 1 through the drift, fluctuation, and noise obtained when ODCB at 145 °C, TCB at 145 °C, 1-CN at 210 °C, and THF at 40 °C are used as the mobile phase.

FIGURE 3

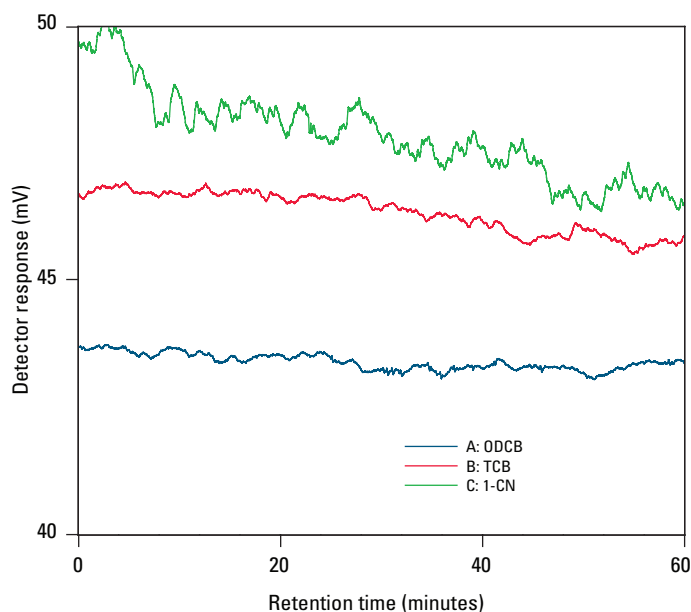


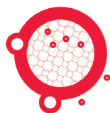
TABLE 1

BASELINE DRIFT, FLUCTUATION AND NOISE OF THE EcoSEC HIGH TEMPERATURE GPC SYSTEM IN ODCB, TCB, 1-CN, AND THF

Solvent (temperature)	Drift (mV/h)	Flucuation (mV)	Noise (mV)
ODCB (145 °C)	-0.41	0.54	0.044
TCB (145 °C)	-1.30	0.69	0.046
1-CN (210 °C)	-0.91	1.61	0.098
THF (40 °C)	-0.35	0.23	0.022

BASELINE DRIFT OF THE DUAL FLOW REFRACTIVE INDEX DETECTOR OF THE EcoSEC HIGH TEMPERATURE GPC SYSTEM FOR TCB, ODCB, AND 1-CN

Column: TSKgel GMH<sub>HR</sub>-H(S) HT2, 13 μm, 7.8 mm ID × 30 cm L × 2;  
Mobile phase: A: ODBC; B: TCB; C: 1-CN; Flow rate: 1.0 mL/min;  
Detection: RI (EcoSEC High Temperature GPC System); Temperature: A and B: 145 °C; C: 210 °C

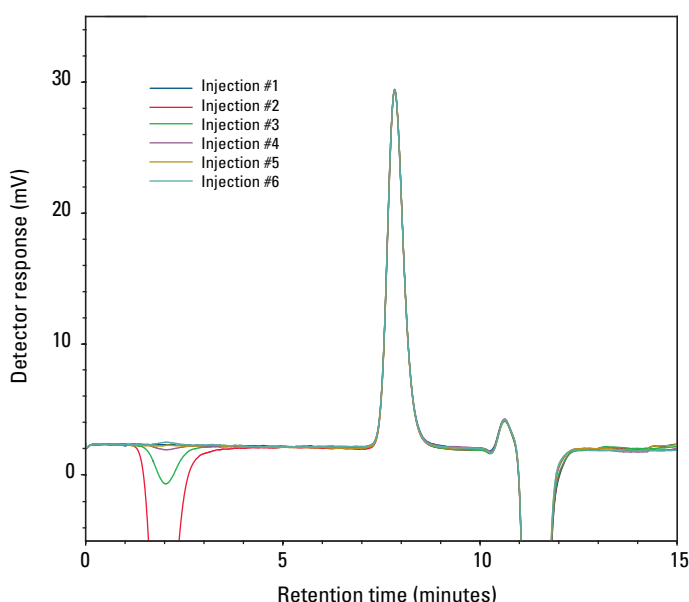


# EcoSEC HIGH TEMPERATURE GPC SYSTEM PERFORMANCE MEANS REPRODUCIBILITY

The dual flow design of the RI detector and the temperature controlled pumps of the EcoSEC High Temperature GPC System deliver precise flow rates at all temperatures, even when changes in environmental conditions occur, thus producing reproducible results sample after sample, day after day. The intraday and day-to-day reproducibility of the EcoSEC High Temperature GPC System are shown in Figure 4.

The engineering design concepts of the EcoSEC High Temperature GPC System result in a high degree of reproducibility of retention times (Figure 5A) and molar mass determinations (Figure 5B). The coefficients of variation for retention time and weight-average molar mass,  $M_w$ , are well below 1% for successive injections.

FIGURE 4



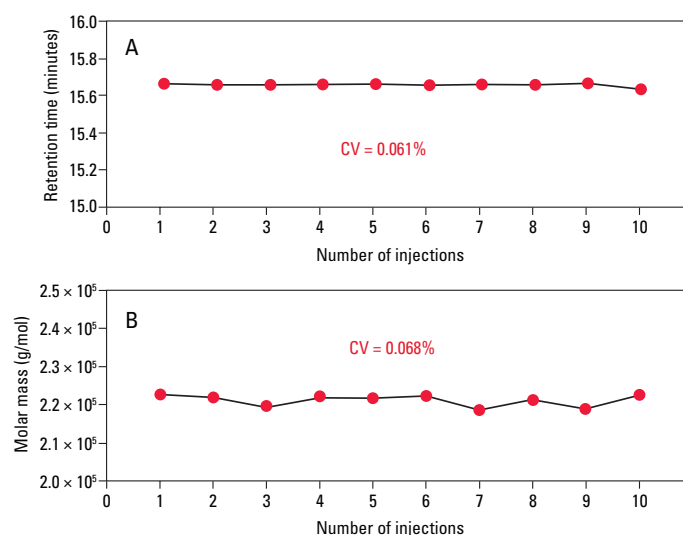
GPC ELUTION PROFILE OF INTRADAY REPRODUCIBILITY OF THE EcoSEC HIGH TEMPERATURE GPC SYSTEM

Reproducibility (intraday, n=6)  
R.T.: CV 0.017%; Area: CV 0.42%

Reproducibility (day to day, n=5)  
R.T.: CV 0.047%; Area: CV 0.71%

Column: TSKgel GMH<sub>HR</sub>-H(S) HT2, 13  $\mu$ m, 7.8 mm ID  $\times$  30 cm L  $\times$  2;  
Mobile phase: ODCB with 0.05% BHT; Flow rate: 1.0 mL/min;  
Detection: RI (EcoSEC High Temperature GPC System); Temp: 145  $^{\circ}$ C  
Injection vol.: 300  $\mu$ L; Sample: polystyrene (F-20), 0.02%

FIGURE 5



A: INTRADAY RETENTION TIME REPRODUCIBILITY, B: INTRADAY WEIGHT-AVERAGE MOLAR MASS REPRODUCIBILITY

Column: TSKgel GMH<sub>HR</sub>-H(S) HT2, 13  $\mu$ m, 7.8 mm ID  $\times$  30 cm L  $\times$  2;  
Mobile phase: ODCB with 0.05% BHT; Flow rate: 1.0 mL/min;  
Detection: RI (EcoSEC High Temperature GPC System);  
Temperature: 145  $^{\circ}$ C; Injection vol.: 300  $\mu$ L; Sample: polypropylene

# EcoSEC HIGH TEMPERATURE GPC SYSTEM

## PERFORMANCE PROOF - APPLICATIONS



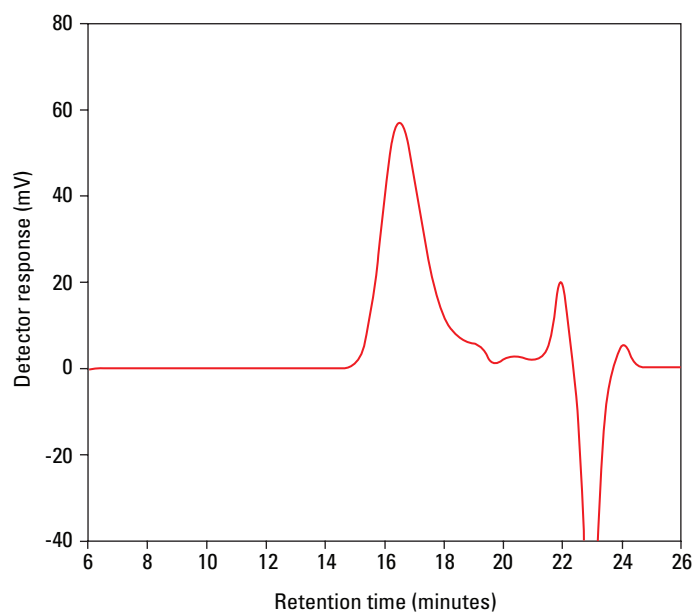
### POLYPHENYLENESULFIDE (PPS)

Polyphenylene sulfide (PPS), an organic polymer consisting of aromatic rings linked with sulfides, is effectively separated by ultra-high temperature GPC (Figure 6). Synthetic fiber and textiles derived from this polymer are known to resist chemical and thermal attack. PPS is used to make filter fabric for coal boilers, papermaking felts, electrical insulation, specialty membranes, gaskets, and packings. PPS has not been found to dissolve in any solvent at temperatures below about 200 °C (392 °F).

### POLYMETHYLPENTENE (PMP)

The separation of polymethylpentene (PMP), a high performance, heat resistant (mp > 200 C) polymer with characteristics similar to polyolefins, is shown in Figure 7. PMP's exhibit excellent electrical insulating properties and strong hydrolysis resistance. One of the principle applications is for a release film used in the electronics industry.

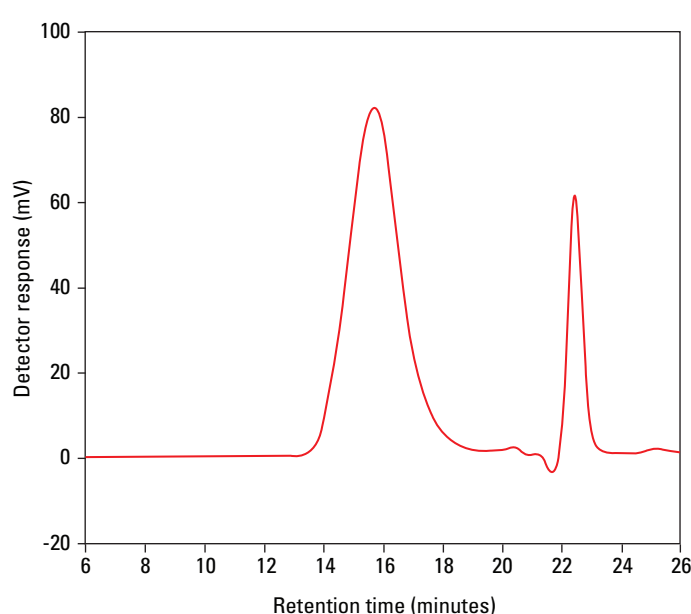
➤ FIGURE 6



#### ANALYSIS OF POLYPHENYLENE SULFIDE BY ULTRA-HIGH TEMPERATURE GPC

Column: TSKgel GMH<sub>HR</sub>-H(S) HT2, 13 μm, 7.8 mm ID × 30 cm L × 2  
 Mobile phase: 1-CN; Flow rate: 1.0 mL/min;  
 Detector: RI (EcoSEC High Temperature GPC System);  
 Temp.: 220 °C; Concentration: 1.0 g/L; Injection vol.: 300 μL

➤ FIGURE 7



#### ANALYSIS OF POLYMETHYLPENTENE BY HIGH TEMPERATURE GPC

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

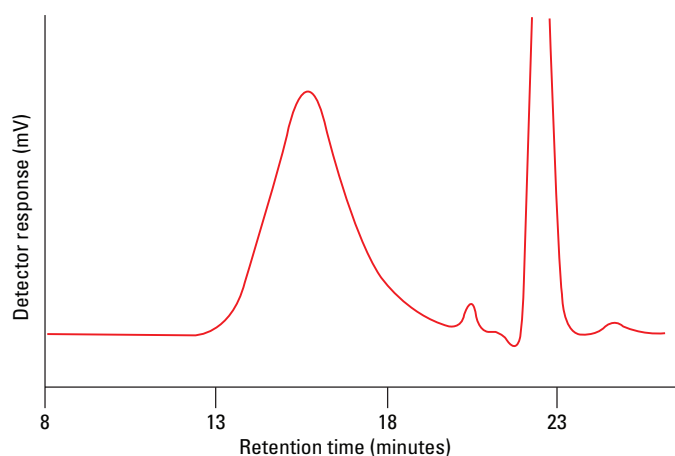


# EcoSEC HIGH TEMPERATURE GPC SYSTEM PERFORMANCE PROOF - APPLICATIONS

## POLYPROPYLENE

Polypropylene (PP), also known as polypropene, is a thermoplastic plastic polyolefin polymer used in a wide variety of applications including packaging and labeling, textiles (e.g., ropes, thermal underwear and carpets), stationery, plastic parts and reusable containers of various types, laboratory equipment, loudspeakers, automotive components, and polymer banknotes. Polymers made from the monomer propylene, are rugged and unusually resistant to many chemical solvents, bases and acids. Analysis of polypropylene using two TSKgel GMHHR-H HT columns and the EcoSEC High Temperature GPC System is shown in Figure 8.

▶ **FIGURE 8**



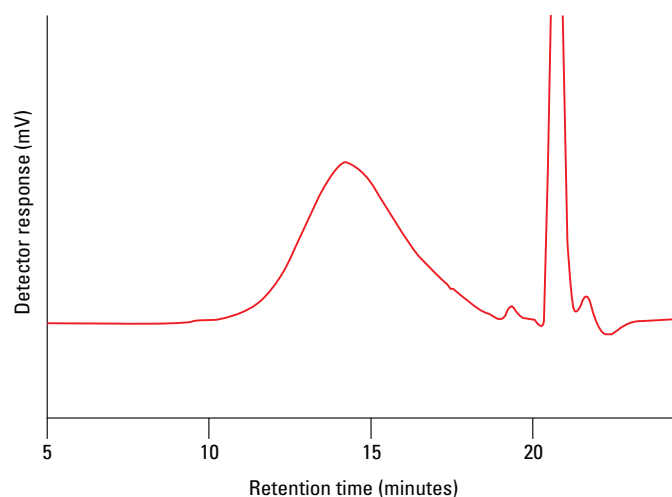
### ANALYSIS OF POLYPROPYLENE BY HIGH TEMPERATURE GPC

Column: TSKgel GMH<sub>HR</sub>-H(S)HT, 13  $\mu$ m, 7.8 mm ID  $\times$  30 cm L  $\times$  2  
 Mobile phase: ODCB with 0.05% BHT; Flow rate: 1.0 mL/min  
 Detector: RI (EcoSEC High Temperature GPC System); Temp.: 145  $^{\circ}$ C;  
 Injection vol.: 300  $\mu$ L; Sample: polypropylene; Sample load: 1.0 g/L

## HIGH-DENSITY POLYETHYLENE

Analysis of high-density polyethylene (HDPE) or polyethylene high-density (PEHD), a polyethylene thermoplastic made from petroleum, by high temperature GPC is shown in Figure 9. HDPE's are known for their high strength to density ratio and are commonly used in the production of plastic bottles, corrosion-resistant piping, geomembranes, and plastic lumber.

▶ **FIGURE 9**



### ANALYSIS OF HIGH-DENSITY POLYETHYLENE BY HIGH TEMPERATURE GPC

Column: TSKgel GMH<sub>HR</sub>-H HT, 5  $\mu$ m, 7.8 mm ID  $\times$  30 cm L  $\times$  2  
 Mobile phase: ODCB; Flow rate: 1 mL/min;  
 Detector: RI (EcoSEC High Temperature GPC System); Temp.: 140  $^{\circ}$ C;

# EcoSEC HIGH TEMPERATURE GPC SYSTEM PERFORMANCE SOFTWARE



## EcoSEC HIGH TEMPERATURE GPC SYSTEM WORKSTATION SOFTWARE

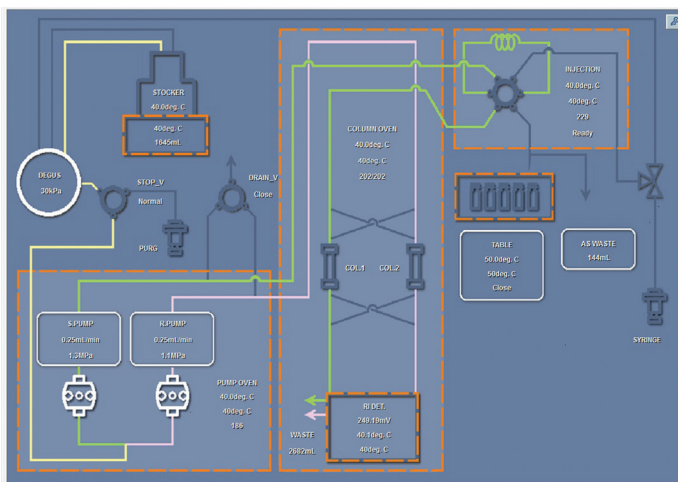
- GPC-specific EcoSEC High Temperature GPC system software to simplify system control and data handling
- Controls up to 2 EcoSEC High Temperature GPC Systems
- Excellent data handling and report generation
- Fully featured data handling system; analyze data from two detectors
- Start and stop system automatically
- One license for multiple locations

### FEATURES INCLUDE:

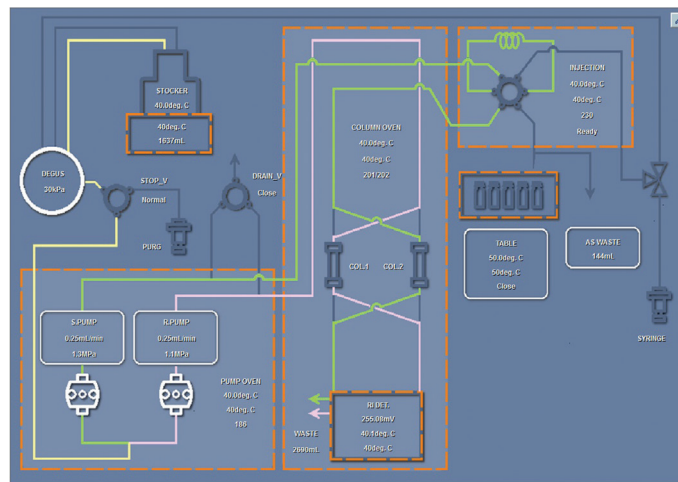
#### FLOW DIAGRAM

- Unique screen allows you to easily modify running conditions of an individual component

#### Typical flow

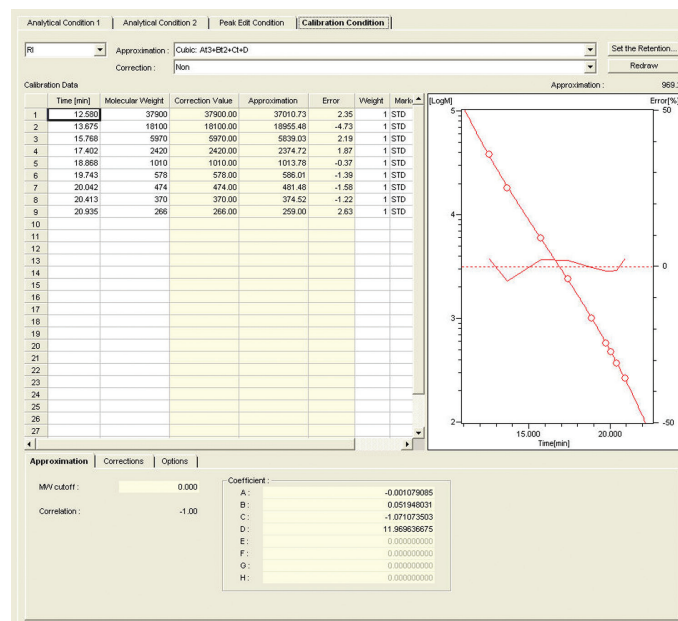


#### With use of column switching valve



### METHOD

- All parameters for data acquisition and peak integration, including baseline operations, are saved in the template method
- One click switching between calibration curves

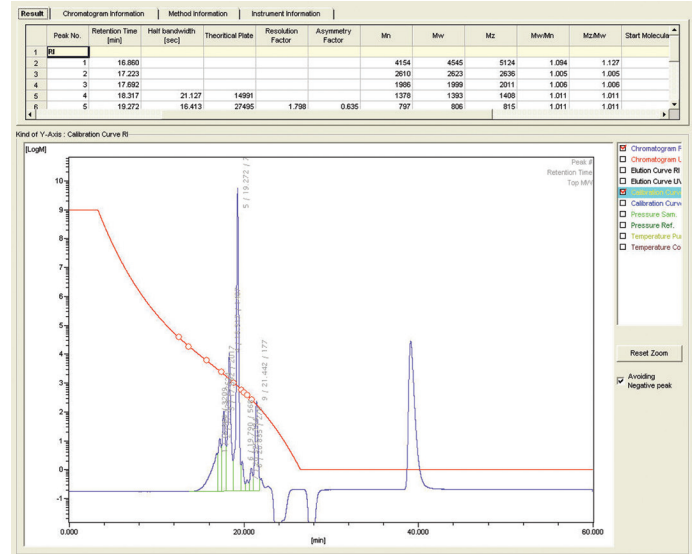




# EcoSEC HIGH TEMPERATURE GPC SYSTEM PERFORMANCE SOFTWARE

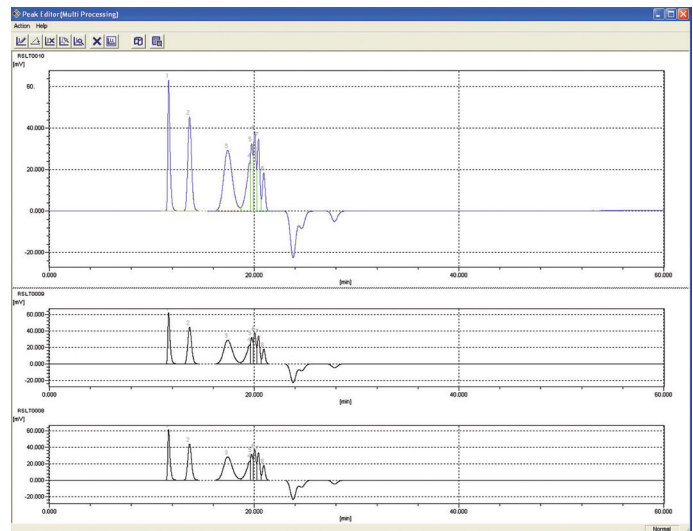
## GPC SPECIFIC QUANTITATIVE CALCULATIONS

- $M_n$ ,  $M_w$ , and  $M_z$  molar mass averages
- Cumulative and differential molar mass plotting
- Polydispersity index (PDI) values



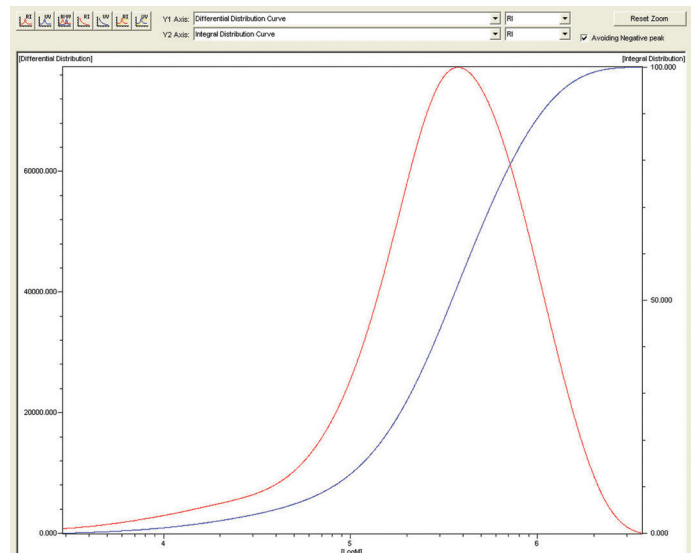
## DATA MANAGEMENT AND REPORT GENERATION

- Allows viewing of chromatograms, elution, curve, flow rate, pressure, and temperature.
- Large number of built in reports
- Fully customizable reports
- Easily export data into text or pdf files



## PEAK EDITING AND MULTIPROCESSING FUNCTION

- Full editing functionality including baseline setting and peak splitting using the mouse
- Automatic peak editing
- Automatic application of peak detection and integration parameters to multiple chromatograms of the same sample using the multiprocessing function; resulting in identical processing for similar chromatograms for enhanced reproducibility.





# EcoSEC HIGH TEMPERATURE GPC SYSTEM ACCESSORIES TO MAXIMIZE PERFORMANCE



## SAMPLE PREP SYSTEM

- Sample shaker 10 - 100 RPM
- 24 vial capacity
- Aluminum heated block
- 40 - 220 °C



## COLUMN SWITCHING VALVE

- Easily change between 2 column sets
- Equipped above column oven
- Manual switching
- Position is recognized by software



TOSOH BIOSCIENCE CAN TAILOR A SYSTEM TO MEET YOUR APPLICATION NEEDS.

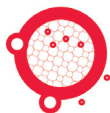
Does your analysis require additional detectors beyond RI?

The EcoSEC High Temperature GPC System provides easy, effortless and temperature controlled connectivity when using multi-detector configurations. We offer external light scattering and viscometry detectors, as well as coupling options for FT-IR analysis.

CONTACT US FOR A QUOTE!

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# EcoSEC HIGH TEMPERATURE GPC SYSTEM

## THE HEART OF PERFORMANCE - COLUMNS

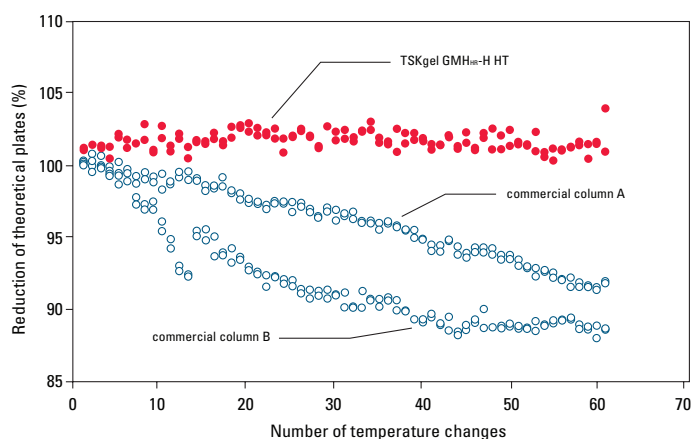
TSKgel H series columns are recommended for the analysis of organic-soluble polymers and are packed with spherical particles composed of polystyrene cross-linked with divinylbenzene (PS-DVB). The "GM" prefix denotes a column packed with particles of different pore sizes blended to provide an extended 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.

Figure 10 demonstrates the performance stability of the TSKgel GMHHR-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.

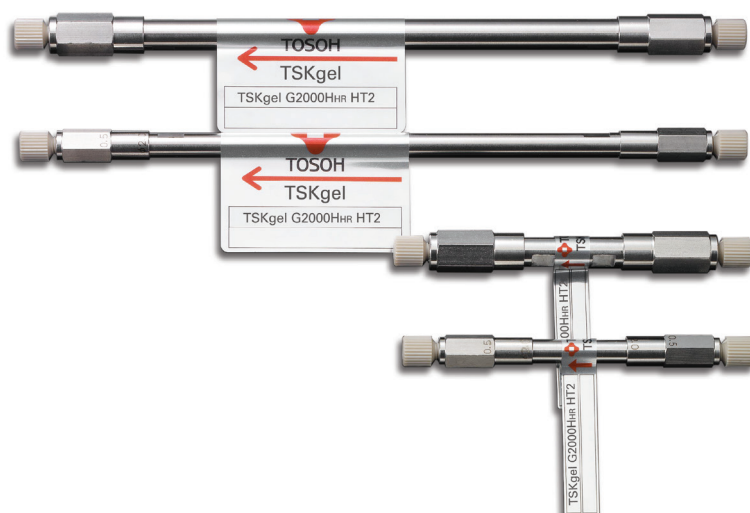
Table 2 lists the attributes of the TSKgel HT columns which are for high temperature applications up to 140 °C.

**FIGURE 10**



### DURABILITY OF TSKgel H<sub>HR</sub> HT COLUMNS COMPARED TO TWO COMMERCIALY 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



# EcoSEC HIGH TEMPERATURE GPC SYSTEM THE HEART OF PERFORMANCE - COLUMNS

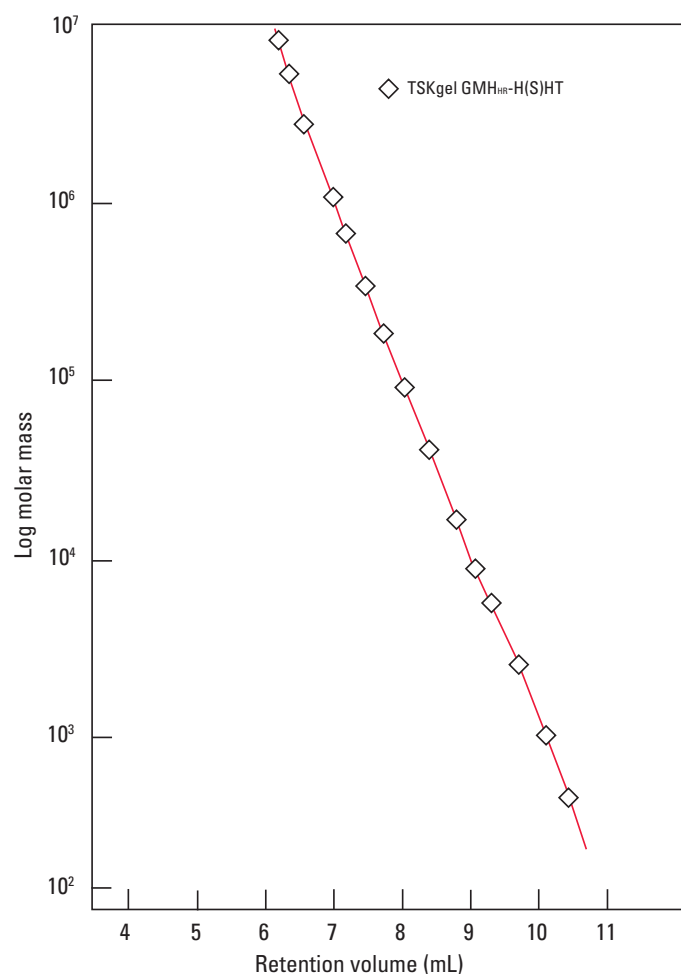


**TABLE 2**

PROPERTIES AND SEPARATION RANGES FOR TSKgel HT COLUMNS

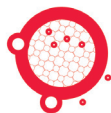
TSKgel COLUMN	PARTICLE SIZE	PORE SIZE	EXCLUSION LIMIT	MAX. TEMP.
GMH <sub>HR</sub> -H(S) HT	13 μm	mixed pore sizes	4.0 x 10 <sup>8</sup> Da	140 °C
G2000H <sub>HR</sub> -HT	20 μm	2 nm	1.0 x 10 <sup>4</sup> Da	140 °C
GMH <sub>HR</sub> -H(20) HT	20 μm	mixed pore sizes	4.0 x 10 <sup>8</sup> Da	140 °C
GMH <sub>HR</sub> -H(30) HT	30 μm	mixed pore sizes	4.0 x 10 <sup>8</sup> Da	140 °C
GMH <sub>HR</sub> -H HT	5 μm	2 nm	4.0 x 10 <sup>8</sup> Da	140 °C
GMH <sub>XL</sub> -HT	13 μm	mixed pore sizes	4.0 x 10 <sup>8</sup> Da	140 °C

**FIGURE 11**



POLYSTYRENE CALIBRATION CURVES FOR TSKgel GMH<sub>HR</sub>-H(S) HT COLUMN

Column: TSKgel GMH<sub>HR</sub>-H(S) HT, 13 μm, 7.8 mm ID × 30 cm L;  
 Mobile phase: ODCB; Flow rate: 1.0 mL/min; Detection: RI;  
 Temperature: 135 °C; Sample: polystyrene



# EcoSEC HIGH TEMPERATURE GPC SYSTEM

## THE HEART OF PERFORMANCE - 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

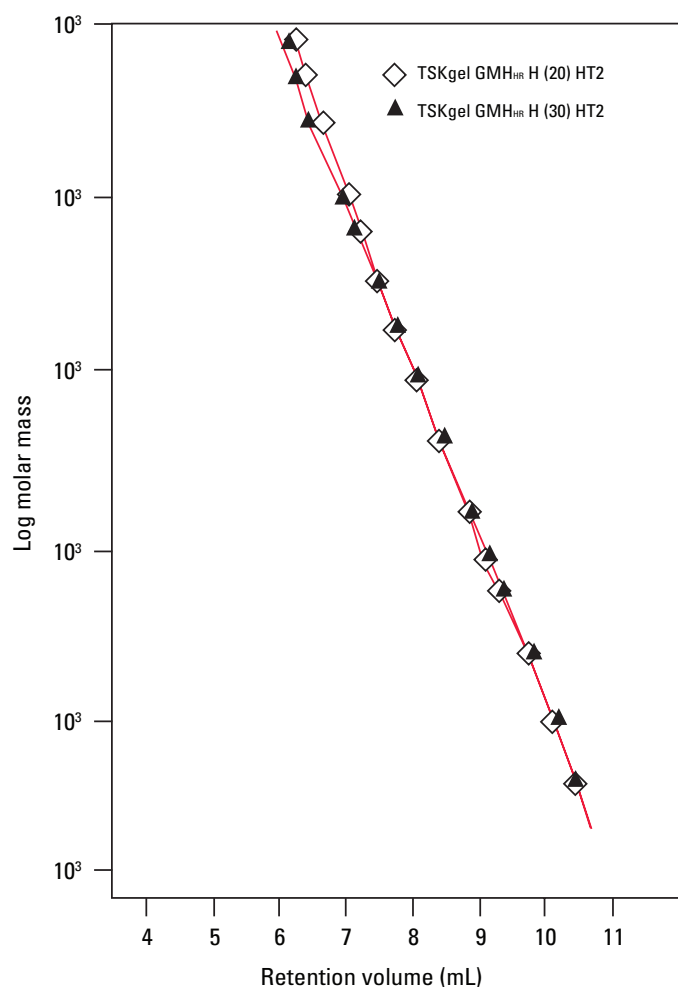
for the analysis of organic-soluble polymers at extremely elevated temperatures. The attributes of the TSKgel HT2 column series are listed in Table 3.

➤ **TABLE 2**

PROPERTIES AND SEPARATION RANGES FOR TSKgel HT2 COLUMNS

TSKgel COLUMN	PARTICLE SIZE	PORE SIZE	EXCLUSION LIMIT	MAX. TEMP.
GMH <sub>HR</sub> -H(20) HT2	20 μm	mixed pore sizes	4.0 x 10 <sup>8</sup> Da	220 °C
GMH <sub>HR</sub> -H(30) HT2	30 μm	mixed pore sizes	4.0 x 10 <sup>8</sup> Da	220 °C
GMH <sub>HR</sub> -H(S) HT2	13 μm	mixed pore sizes	4.0 x 10 <sup>8</sup> Da	220 °C
G2000H <sub>HR</sub> -HT2	20 μm	2 nm	1.0 x 10 <sup>4</sup> Da	220 °C

➤ **FIGURE 12**



POLYSTYRENE CALIBRATION CURVES FOR TSKgel HT2 COLUMNS

Columns: TSKgel GMH<sub>HR</sub>-H(20) HT2, 20 μm, 7.8 mm ID × 30 cm L; TSKgel GMH<sub>HR</sub>-H(30) HT2, 30 μm, 7.8 mm ID × 30 cm L; Mobile phase: ODCB; Flow rate: 1.0 mL/min; Detection: RI; Temp.: 135 °C; Sample: polystyrene standards



# ORDERING INFORMATION

## ORDERING INFORMATION

### TSKgel HIGH TEMPERATURE COLUMNS

Part #	Description	Matrix	Housing	ID (mm)	Length (cm)
18420	TSKgel GMH <sub>HR</sub> -H HT, 13 µm, mixed bed	polymer	Stainless Steel	7.8	30
18393	TSKgel GMH <sub>HR</sub> -H(S) HT, 13 µm, mixed bed	polymer	Stainless Steel	7.8	30
18392	TSKgel GMH <sub>HR</sub> -H(20) HT, 20 µm, mixed bed	polymer	Stainless Steel	7.8	30
18391	TSKgel GMH <sub>HR</sub> -H(30) HT, 30 µm, mixed bed	polymer	Stainless Steel	7.8	30
18395	TSKgel G2000H <sub>HR</sub> -H HT, 20 µm, 2 nm	polymer	Stainless Steel	7.8	30
07112	TSKgel GMH <sub>XL</sub> -HT, 13 µm, mixed bed	polymer	Stainless Steel	7.8	30
18397	TSKgel Guard Column for TSKgel GMH <sub>HR</sub> -H(S) HT & GMH <sub>XL</sub> -HT column, 30 µm	polymer	Stainless Steel	7.5	7.5
18396	TSKgel Guard Column for TSKgel GMH <sub>HR</sub> -H(20) HT & GMH <sub>HR</sub> -H(30) HT columns, 30 µm	polymer	Stainless Steel	7.5	7.5
22888	TSKgel GMH <sub>HR</sub> -H(20) HT2, 20 µm, mixed bed	polymer	Stainless Steel	7.8	30
22887	TSKgel GMH <sub>HR</sub> -H(30) HT2, 30 µm, mixed bed	polymer	Stainless Steel	7.8	30
22889	TSKgel GMH <sub>HR</sub> -H(S) HT2, 13 µm, mixed bed	polymer	Stainless Steel	7.8	30
22890	TSKgel G2000H <sub>HR</sub> -H HT2, 20 µm, 2 nm	polymer	Stainless Steel	7.8	30
22891	TSKgel Guard Column for TSKgel GMH <sub>HR</sub> -H (20) HT2 & GMH <sub>HR</sub> -H(30) HT2 columns, 30 µm	polymer	Stainless Steel	7.5	7.5
22892	TSKgel Guard Column for TSKgel GMH <sub>HR</sub> -H(S) HT2 column, 13 µm	polymer	Stainless Steel	7.5	7.5

### ACCESSORIES

Part #	Description
23809	Sample vial, transparent, 10 mL, 30/pk (PTFE cover)
23810	Aluminum sheets, 30 mm, square, 100/pk
23811	Stainless steel mesh, 26 µm, 50 mm, square, 100/pk
23812	Stainless steel mesh, 96 µm, 50 mm, square, 100/pk



# ORDERING INFORMATION

## ORDERING INFORMATION

### TSKgel POLYSTYRENE CALIBRATION STANDARDS

TSKgel polystyrene bulk calibration standards are used to calibrate GPC columns for subsequent analysis of unknown samples. The standards range from 400 to  $2.1 \times 10^7$  Da.

### TSKgel POLYSTYRENE CALIBRATION STANDARDS

Part #	Description	Weight
05202	A-300, 400 Da	10 g
05203	A-500, 530 Da	10 g
05204	A-1000, 950 Da	10 g
05205	A-2500, 2,800 Da	5 g
05206	A-5000, 6,200 Da	5 g
05207	F-1, $1.0 \times 10^4$ Da	5 g
05208	F-2, $1.7 \times 10^4$ Da	5 g
05209	F-4, $4.4 \times 10^4$ Da	5 g
05210	F-10, $1.0 \times 10^5$ Da	5 g
05211	F-20, $1.9 \times 10^5$ Da	5 g
05212	F-40, $4.2 \times 10^5$ Da	5 g
05213	F-80, $7.8 \times 10^5$ Da	5 g
05214	F-128, $1.3 \times 10^6$ Da	1 g
05215	F-288, $2.9 \times 10^6$ Da	1 g
05216	F-380, $3.8 \times 10^6$ Da	1 g
05217	F-450, $4.5 \times 10^6$ Da	1 g
05218	F-550, $5.5 \times 10^6$ Da	1 g
05219	F-700, $6.8 \times 10^6$ Da	1 g
05220	F-850, $8.4 \times 10^6$ Da	1 g
05221	F-2000, $2.1 \times 10^7$ Da	1 g
06476	Oligomer Kit, A-500 thru F-128	12 x 1 g
06477	High MW Kit, F-10 thru F-2000	12 x 1 g



# YOWA SPECIALIST IN SEPARA RATION





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