



Linearity Improvements From Parallel Multiple Pore Size GPC Column Technology

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Outline

Basics of GPC Calibration

Wide Molecular Weight Range Separation

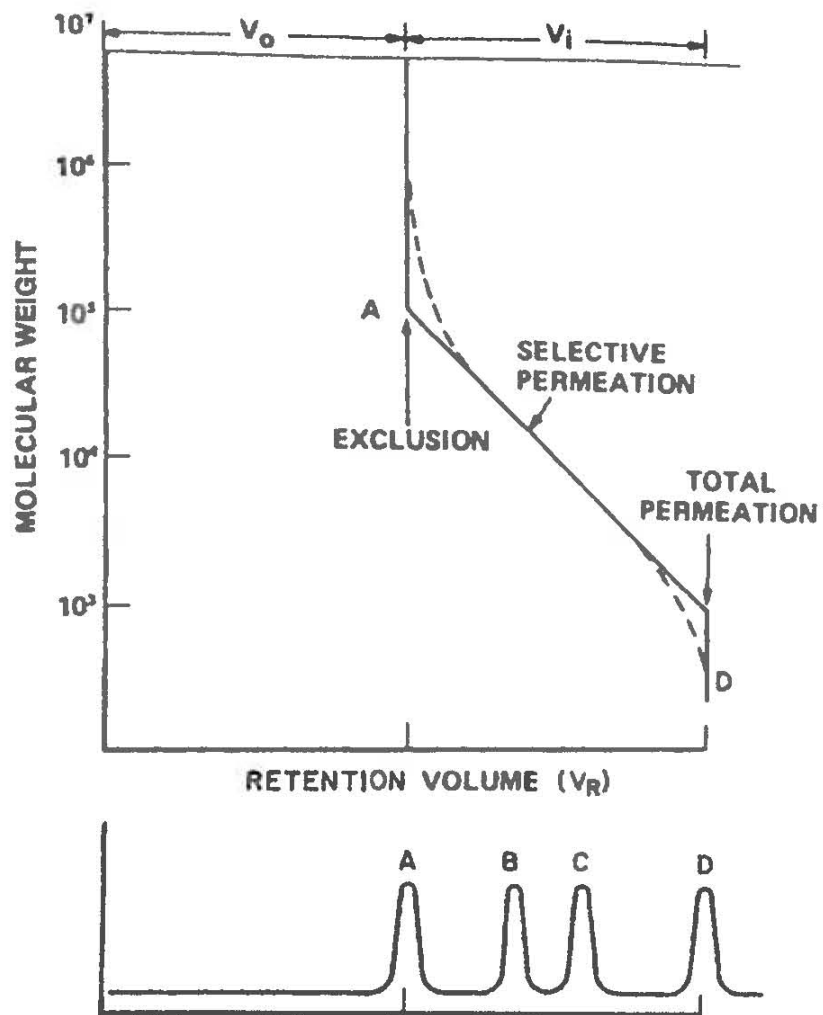
- Serial Approach
- Parallel Approach

Characteristics of TSK-GEL SupermultiporeHZ Columns

The Tosoh EcoSEC[®] GPC System

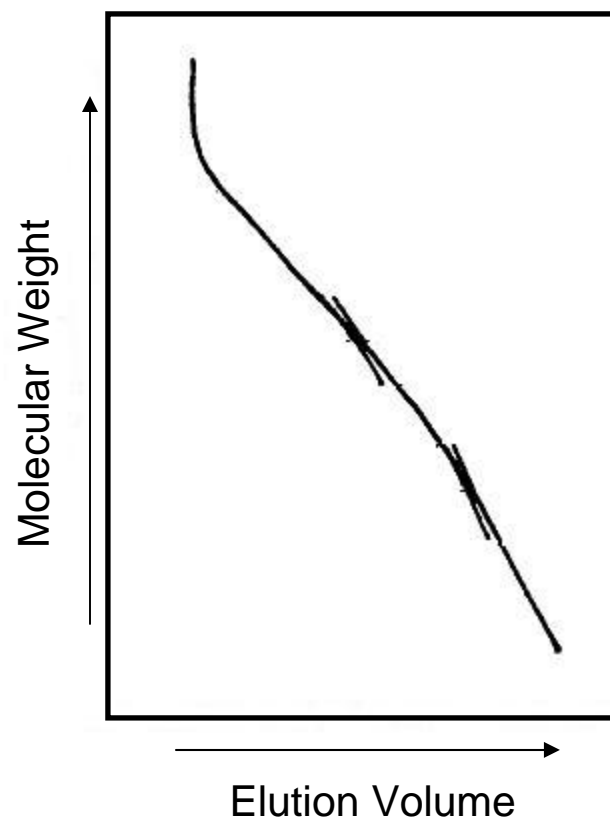
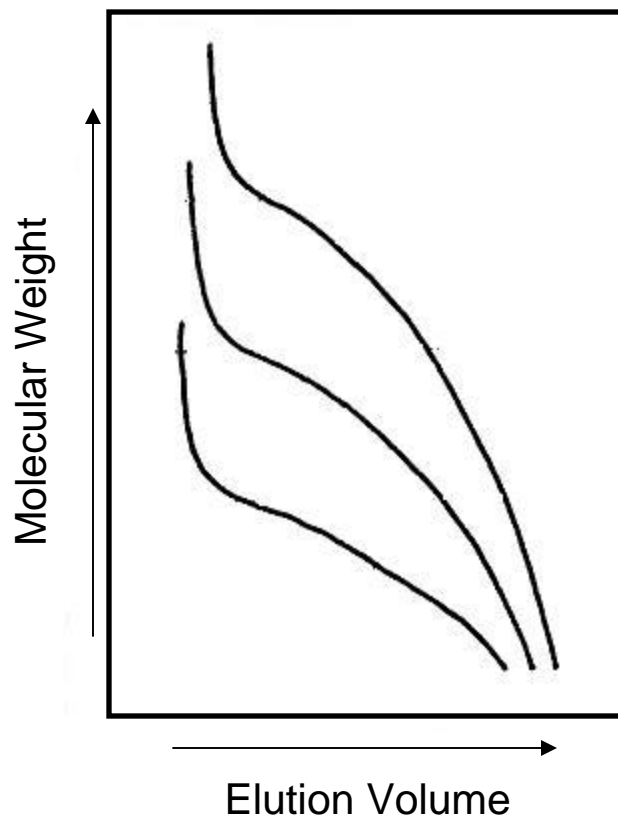


GPC Calibration



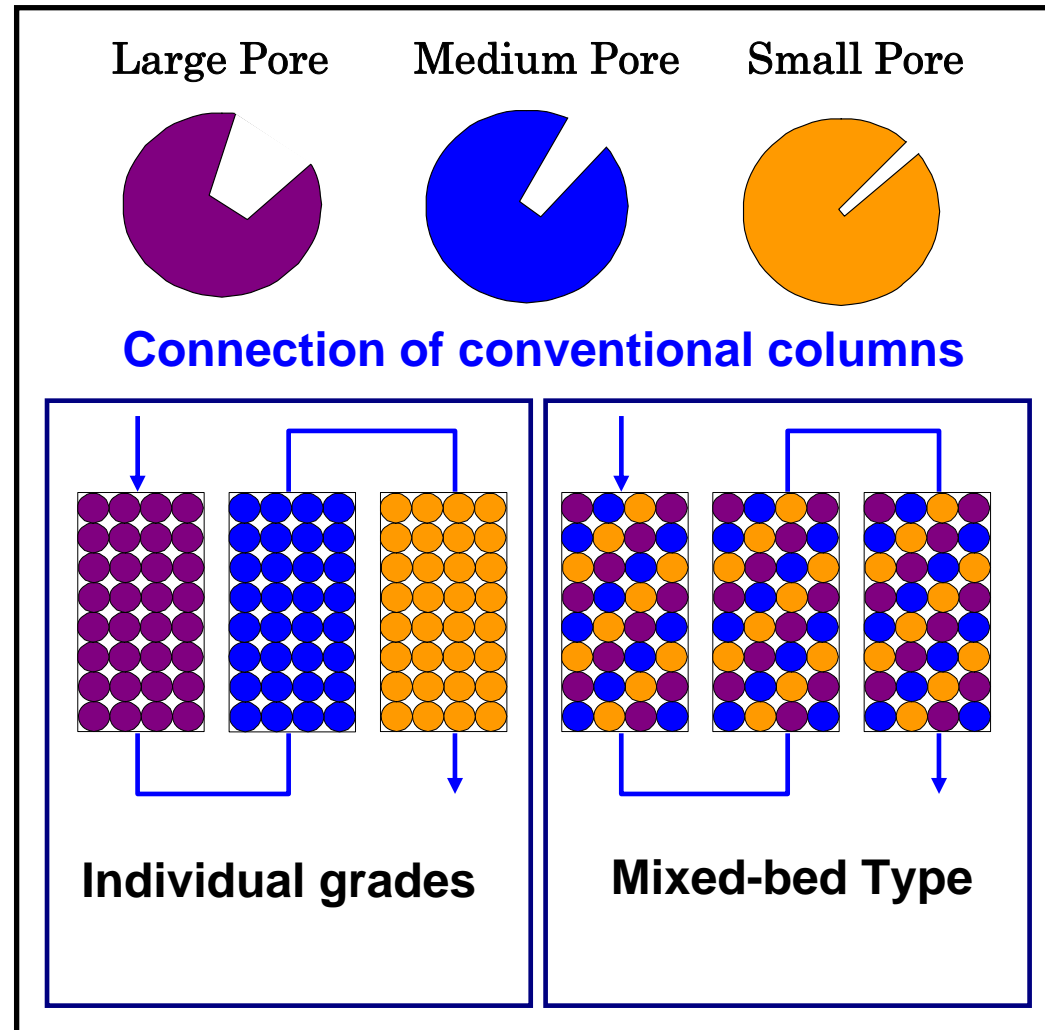


GPC Calibration Curves



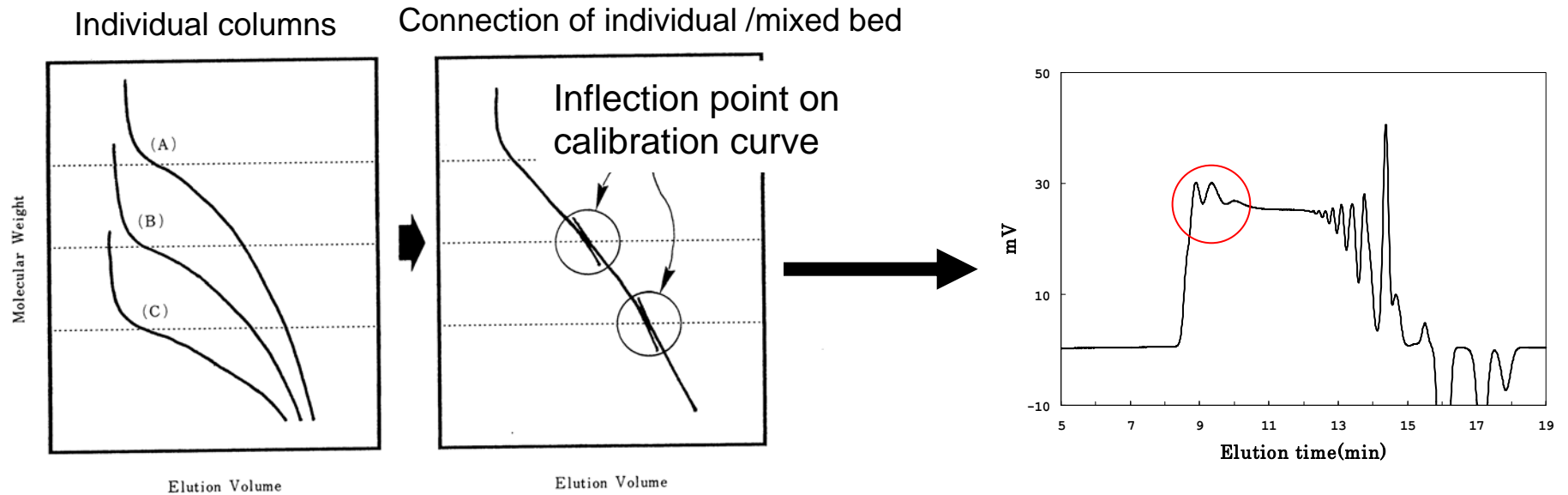


Schematic diagrams of SEC packings





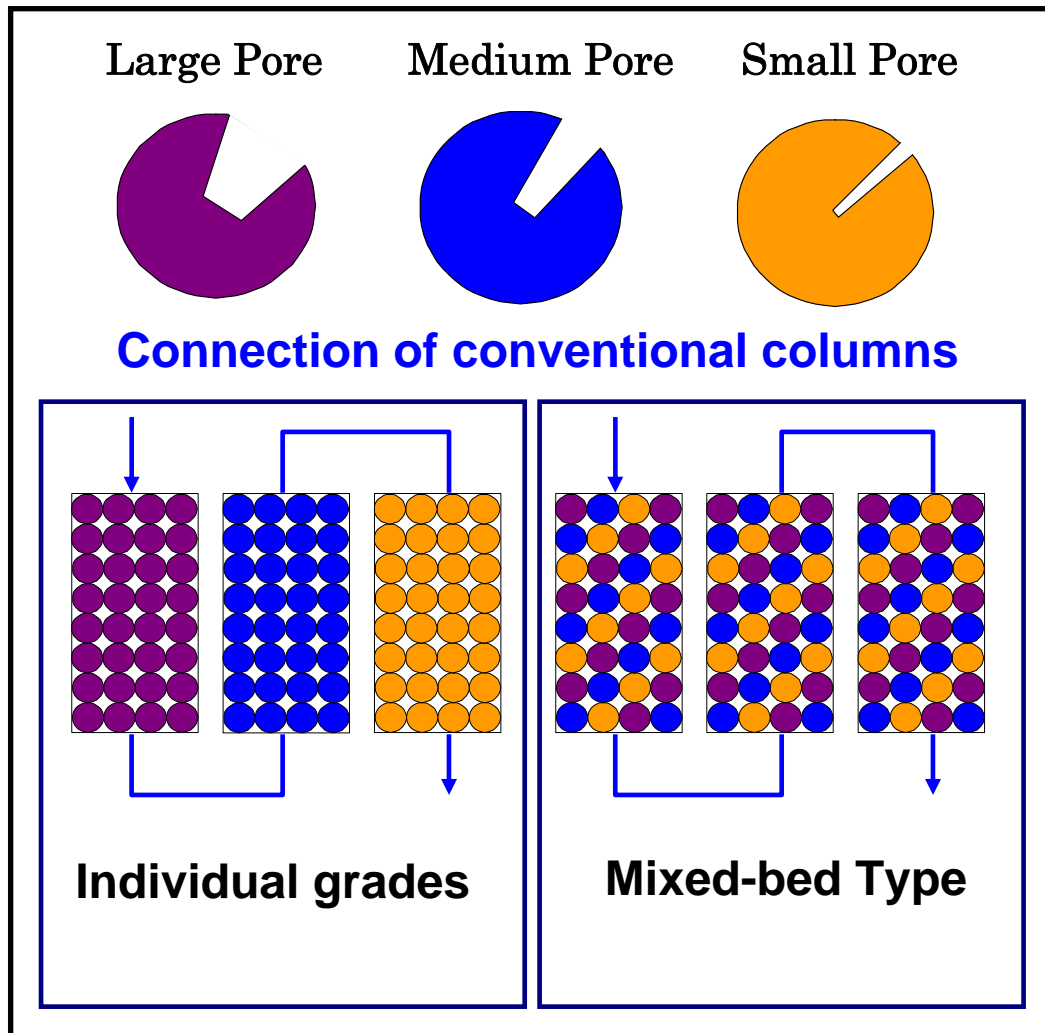
Distortion in chromatogram on conventional columns



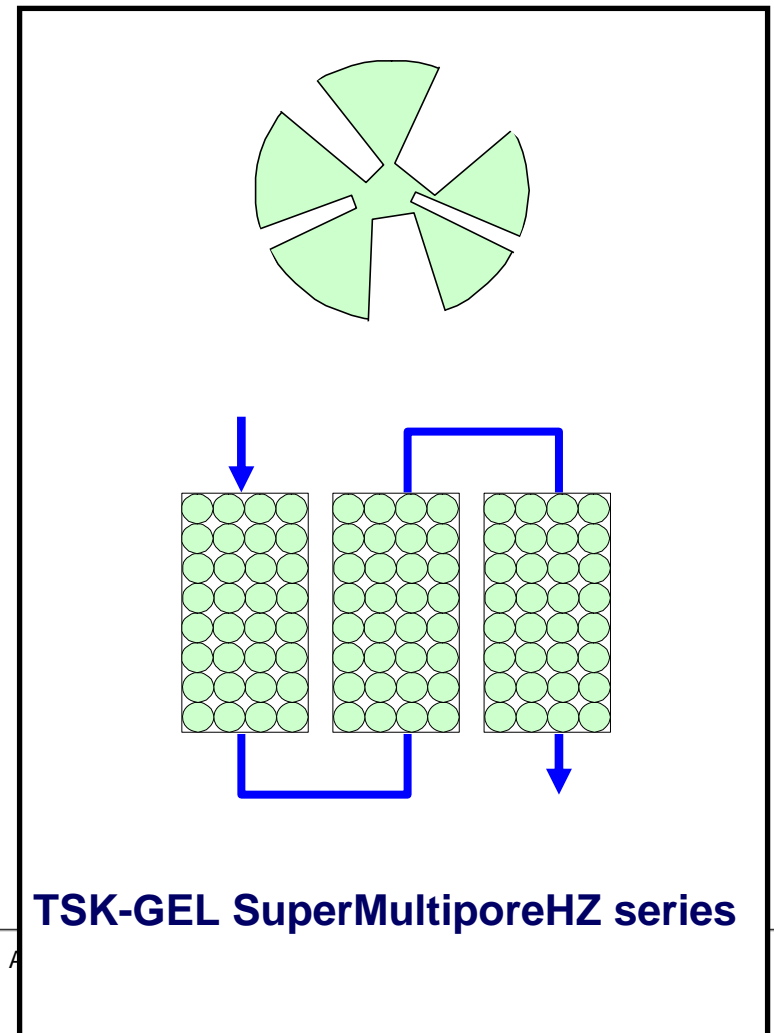


Schematic diagrams of SEC packings

Conventional packings/columns



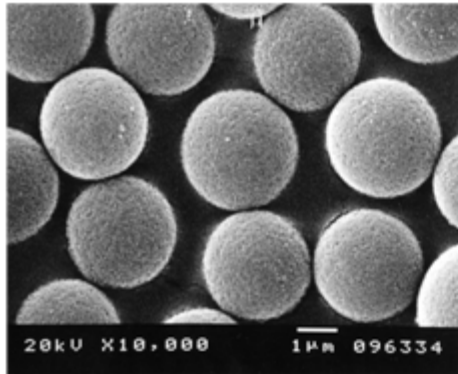
Multipore type packings



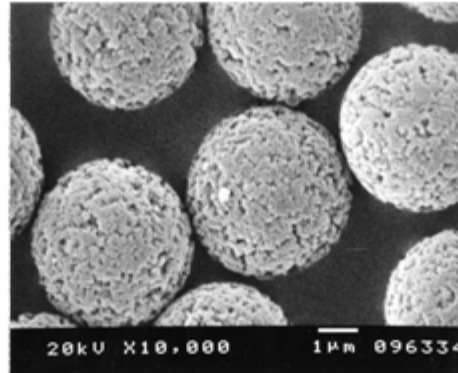


TSK-GEL SuperMultiporeHZ Packing via SEM

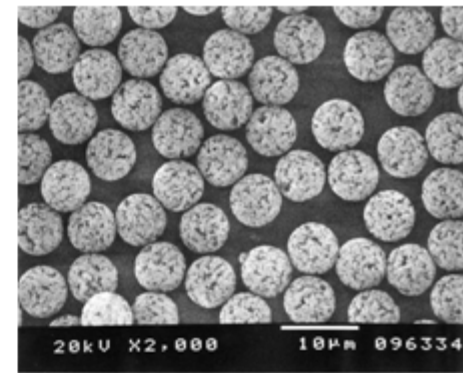
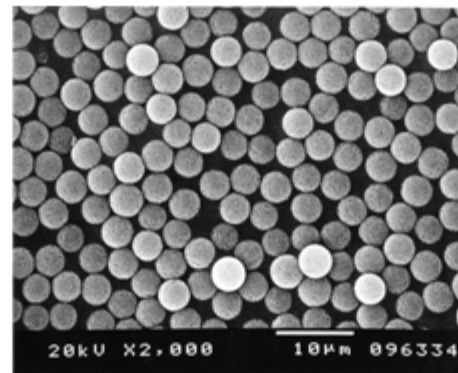
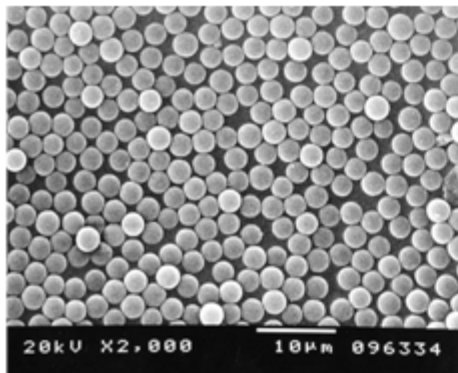
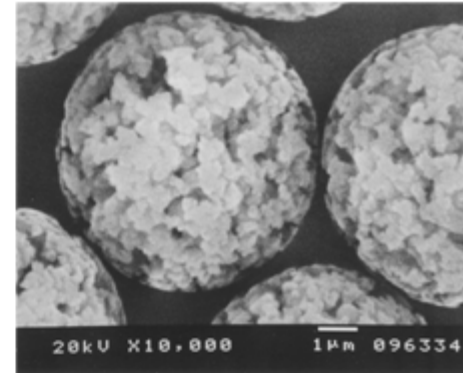
TSKgel SuperMultiporeHZ-N
3 μ m



TSKgel SuperMultiporeHZ-M
4 μ m

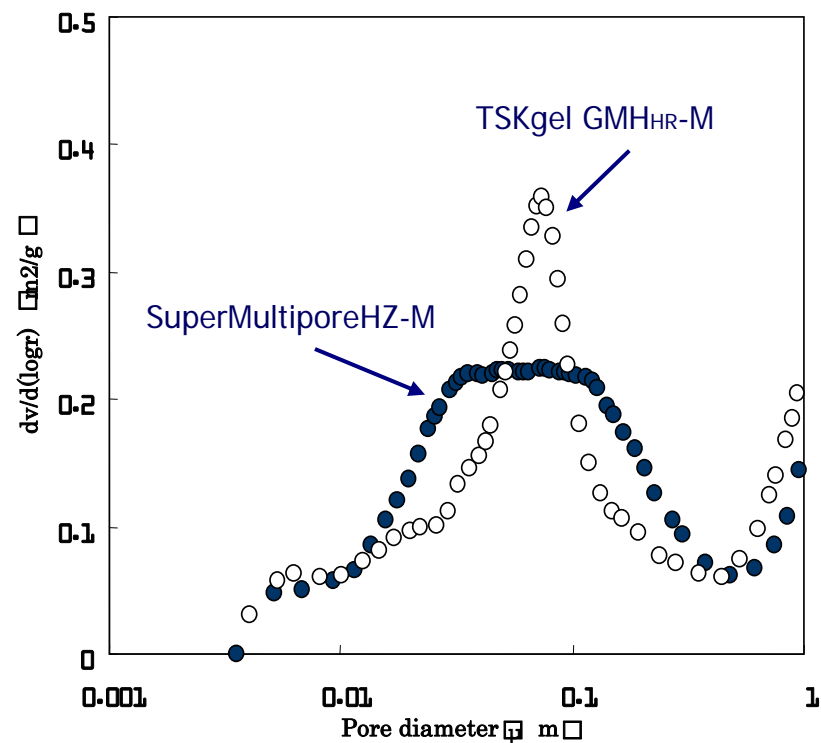
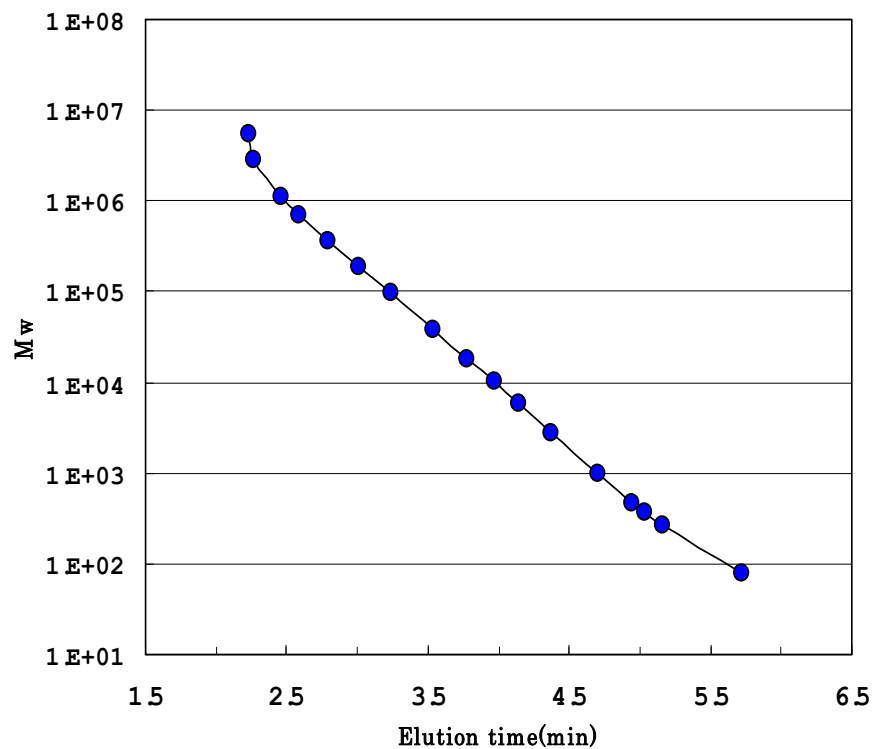


TSKgel SuperMultiporeHZ-H
6 μ m



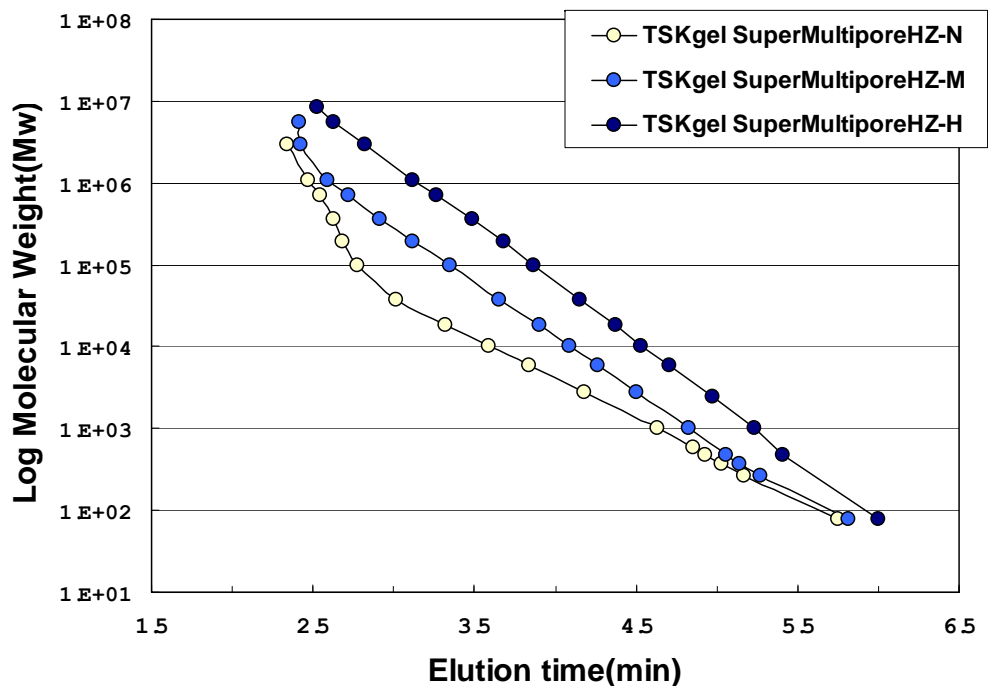


Pore characterization of TSKgel SuperMultiporeHZ-M





Calibration curves of TSK-GEL SuperMultiporeHZ columns



Column: TSK-GEL SuperMultiporeHZ
(4.6mmID x 15cm)
Eluent: THF
Flow rate: 0.35 mL/min
Detector: UV254nm
Temp. : 25°C
Inj. Volume: 5µL
Samples: Std. Polystyrene



Features of TSK-GEL[®] SuperMultiporeHZ

Packing materials with broad pore size distribution

- No inflection point in calibration curve
- No distortion in chromatogram

Real linear calibration curve

- Lower error between actual MW and calibration curve
- More accurate MW measurement

Large porosity

- High resolution especially in oligomeric region

Lower lot-to-lot variation

- Better reproducibility of MW measurement

3 types of columns with different separation ranges

- Applicable to wide MW range

Small particle size packed in **semi-micro columns**

- High-speed, high-resolution, low solvent consumption



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Semi-micro vs. Conventional Columns

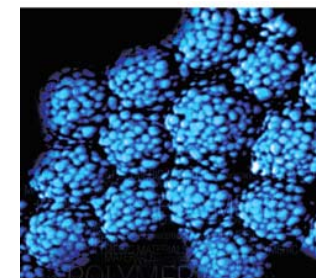
	Conventional	Semi-micro
Diameter (mm)	7.8	4.6-6.0
Length (cm)	30	15
Flow Rate (mL/min.)	1.0	0.35
Run Time (Arbitrary)	100	50

Semi-micro columns reduce run times by 50% and flow rate by 2/3. Throughput is doubled and solvent costs drop by 1/6.



Properties of TSK-GEL SuperMultiporeHZ columns

	SuperMultiporeHZ-N	SuperMultiporeHZ-M	SuperMultiporeHZ-H
Base	PS/DVB	PS/DVB	PS/DVB
Particle Size (μM)	3	4	6
Exclusion Limit (MW)	120,000	2,000,000	40,000,000
Mean Pore Dia. (nm)	8	14	
Separation Range (MW)	300-50,000	500-1,000,000	1,000-10,000,000
Theoretical Plates	20,000TP/15cm	16,000TP/15cm	11,000TP/15cm
Column Size	4.6mm I.D. x 15 cm	4.6mm I.D. x 15 cm	4.6mm I.D. x 15 cm

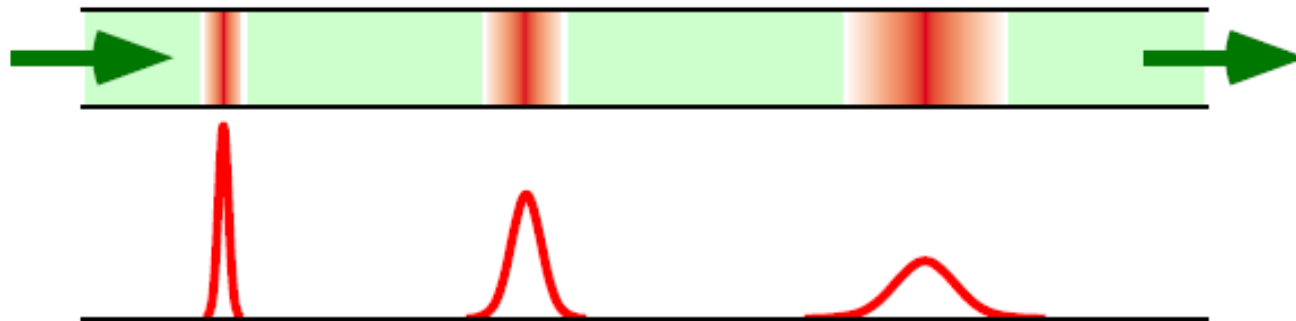




Effect Of System Volume On Resolution

Why Do Bands Spread?

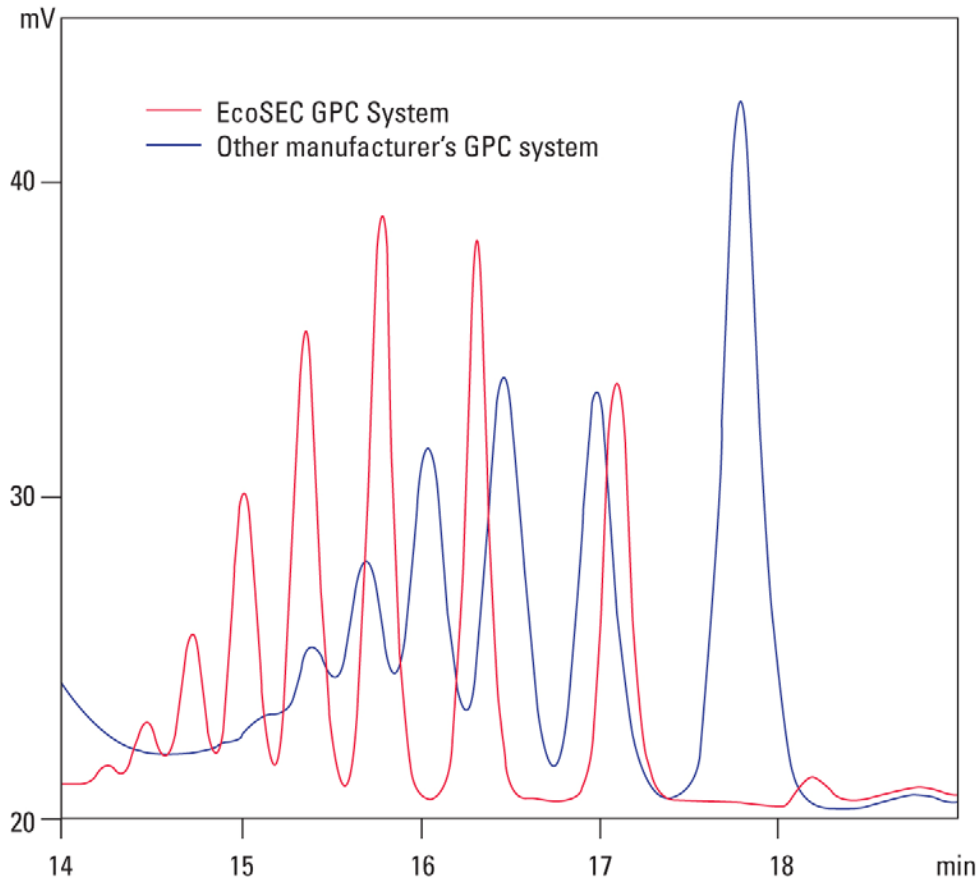
- a. Eddy diffusion
- b. Mobile phase mass transfer
- c. Stagnant mobile phase mass transfer
- d. Stationary phase mass transfer
- e. Longitudinal diffusion





Resolution: Semi-micro vs. Conventional System

- Semi-micro system offers better resolution for semi-micro columns



TSKgel SuperHZ2000, 4.6mm ID x 15cm, x 4

Mobile phase: THF
Flow rate: 0.35mL/min
Detection: RI
Temperature: 40°C
Injection vol.: 10 μ L (0.2mg/mL)



EcoSEC GPC System





Save Time and Money

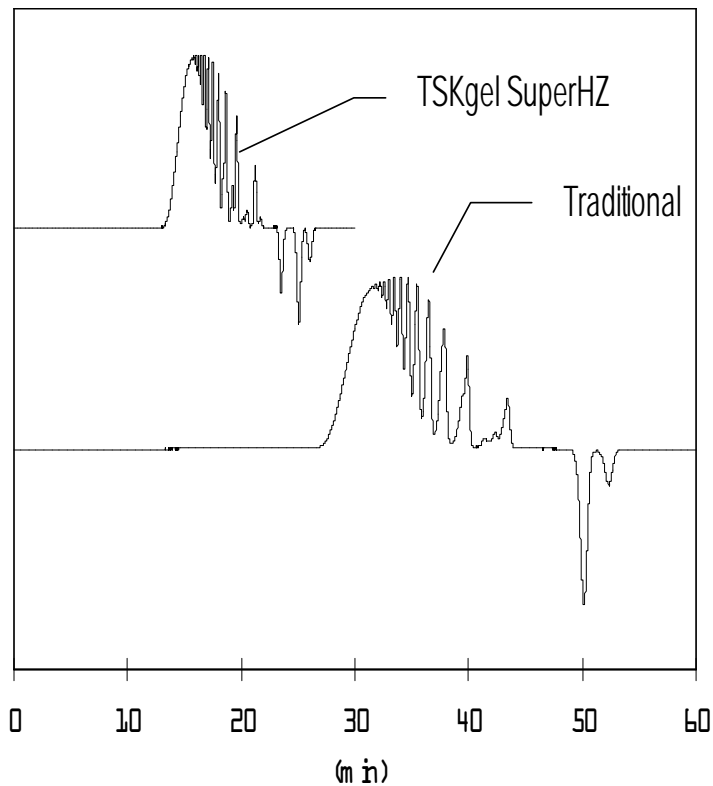
- Low dead volume design and system layout
 - 7.5 μ L Stroke Volume
 - 2.5 μ L RI Cell Volume
 - Use of 0.2mm and 0.4mm tubing





Save Time and Money

- Reduce run times by 50%



Flow rate: TSKgel SuperHZ(0.35mL/min)
TSKgel H_{HR}(1.0mL/min)

Dimensions: 4.6mm ID x 15cm*4 (TSKgel SuperHZ)
7.8mm ID x 30cm*4 (TSKgel H_{HR})



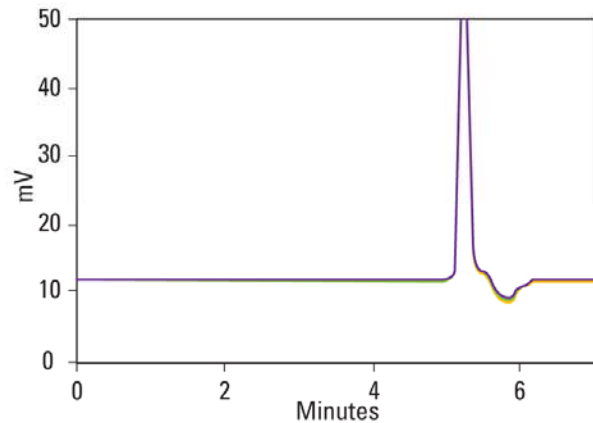
Save Time and Money

- Reduce solvent usage by 85%

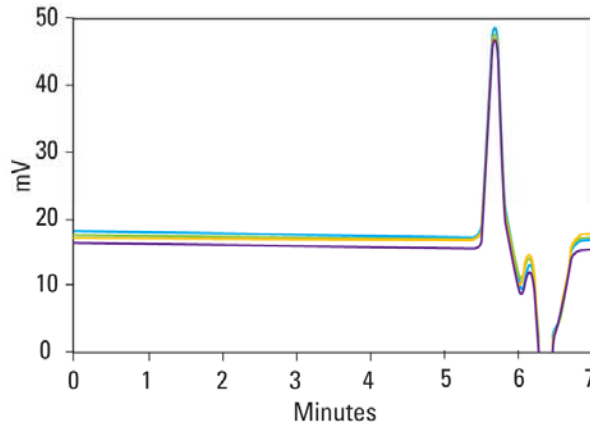
Solvent	Competitor GPC (solvent + disposal)	EcoSEC GPC System (solvent + disposal)	<u>Savings</u>
NMP (\$30/L)	\$3082	\$1312	\$1,770.00
Chloroform (\$17/L)	\$1830	\$779	\$1,051.00
DMF (\$25/L)	\$2600.50	\$1117	\$1,463.50
HFIP (\$1000/L)	\$96,493	\$41,193	\$55,300.00



Superior Performance



EcoSEC GPC System



Other GPC manufacturer

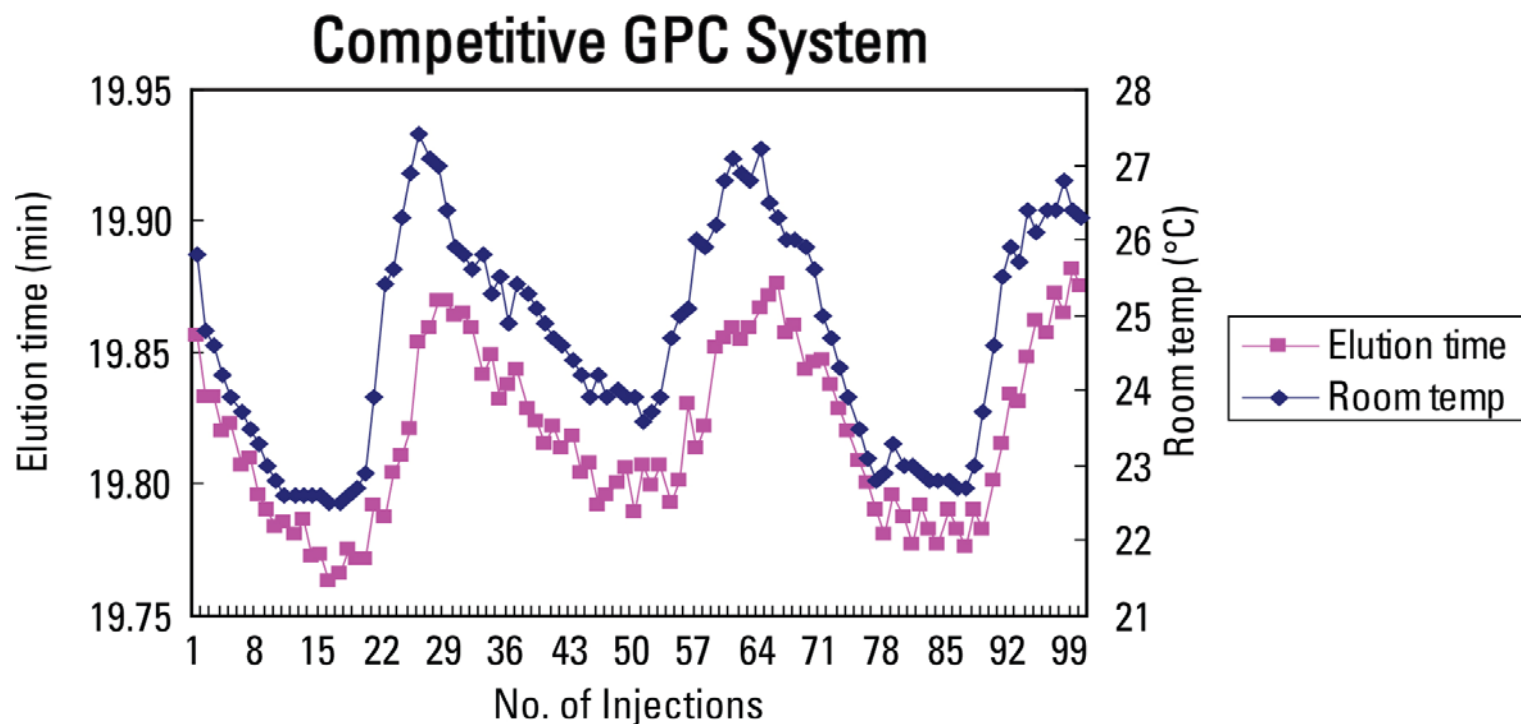
**TSKgel SuperMultiporeHZ-M,
4.6mm ID x 15cm**

Mobile Phase: THF
Flow rate: 0.35mL/min
Detection: RI
Temperature: 40°C
Injection vol.: 10µL
Sample: dicyclohexyl phthalate



Superior Performance

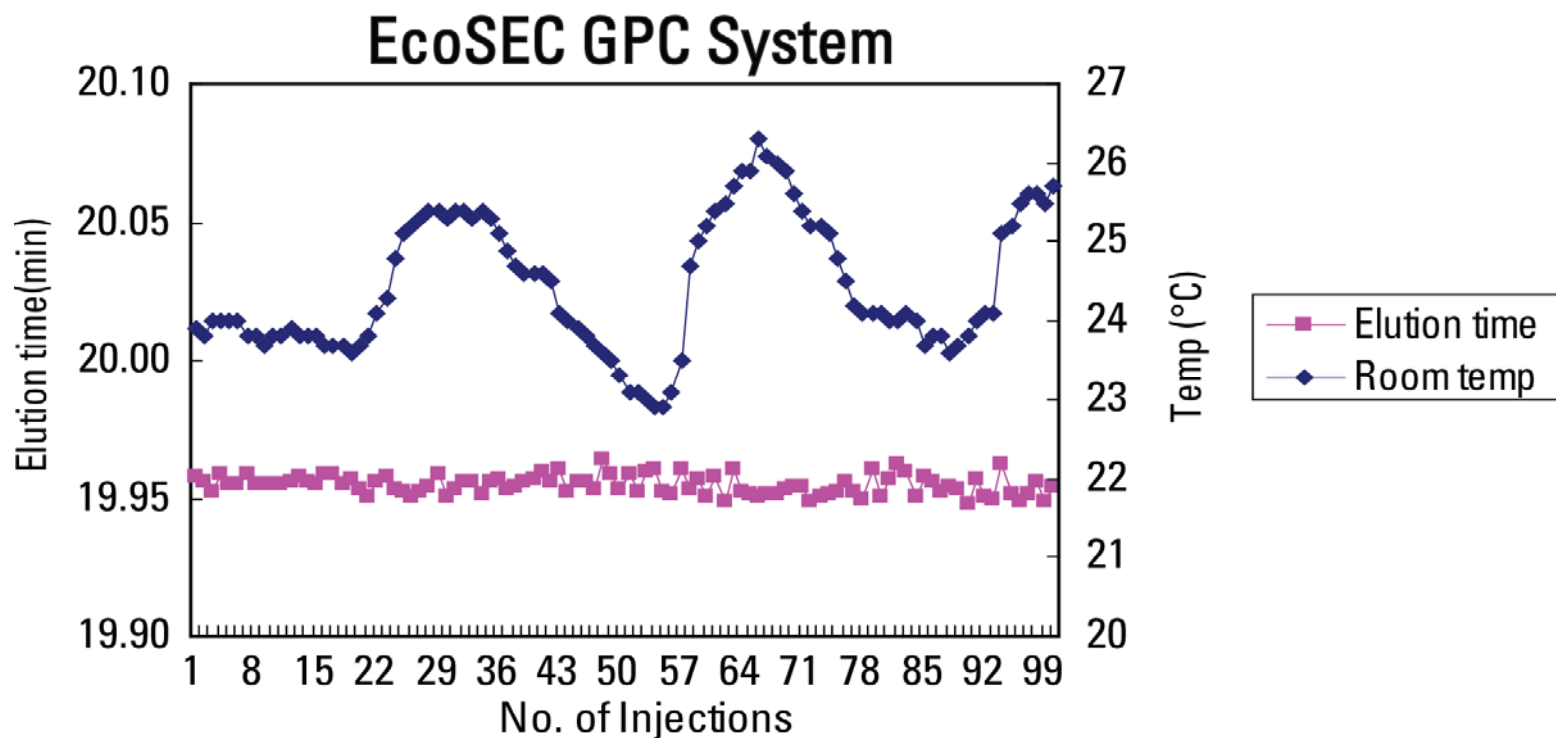
- Room Temperature Affect On Retention Time
 - Conventional Instrument-No Pump Temperature Control





Superior Performance

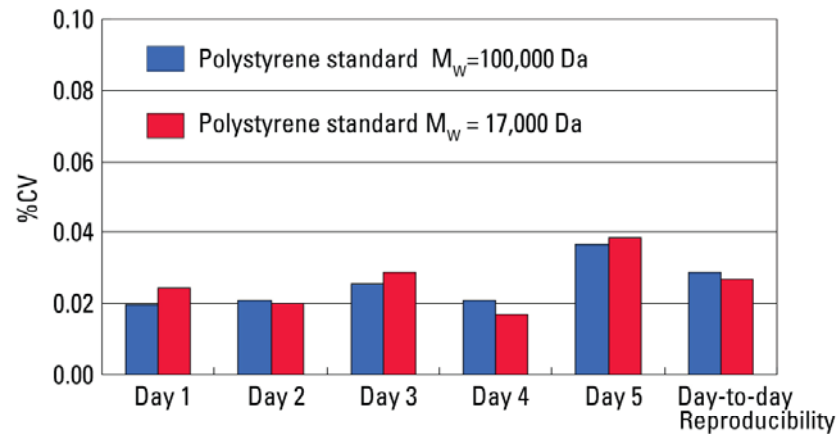
- Room Temperature Affect On Retention Time
 - EcoSEC GPC System-With Temperature Controlled Pumps





Superior Performance

- Temperature Controlled Pumps
- Excellent Retention Time Precision



CV value less than 0.04% a day.

CV value less than 0.03% on different days.

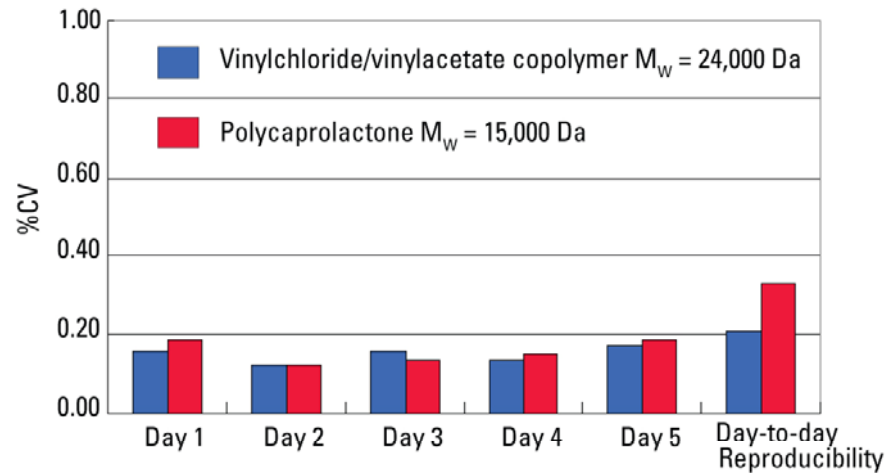
TSKgel SuperMultiporeHZ-M, 4.6mm ID x 15cm, x 2

Mobile phase: THF
Flow rate: 0.35mL/min
Temperature: 40°C
Injection vol.: 10 μ L
Samples: polystyrene standards
of injections: **10/day**



Superior Performance

- Temperature Controlled Pumps
- Excellent Molecular Weight Precision



CV value less than 0.2% or less a day.

CV value less than 0.4% on different days.

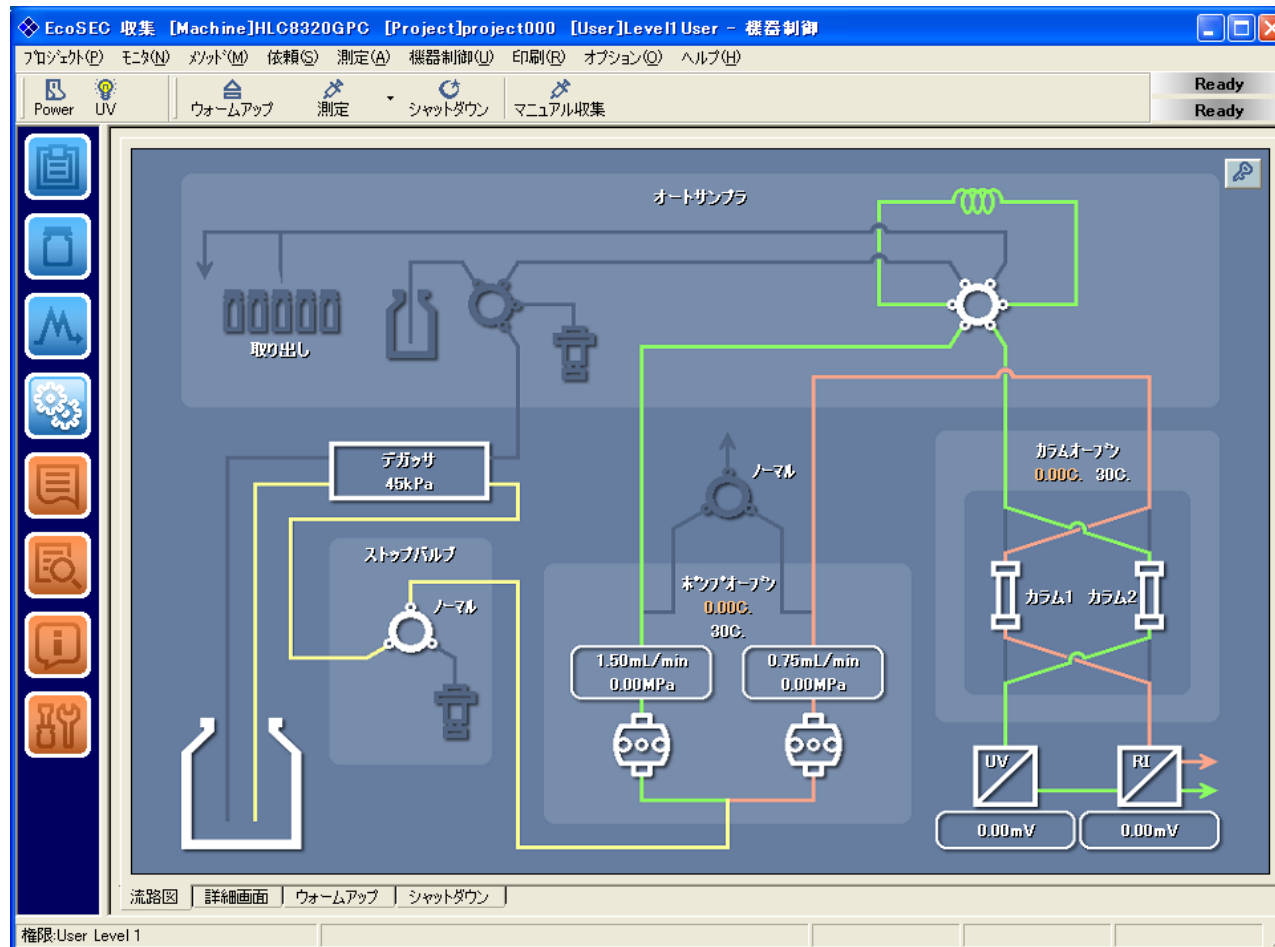
TSKgel SuperMultiporeHZ-M, 4.6mm ID x 15cm, x 2

Mobile phase: THF
Flow rate: 0.35mL/min
Temperature: 40°C
Injection vol.: 10 μ L
Samples: copolymer and polyester standards
of injections: 10/day



Versatility

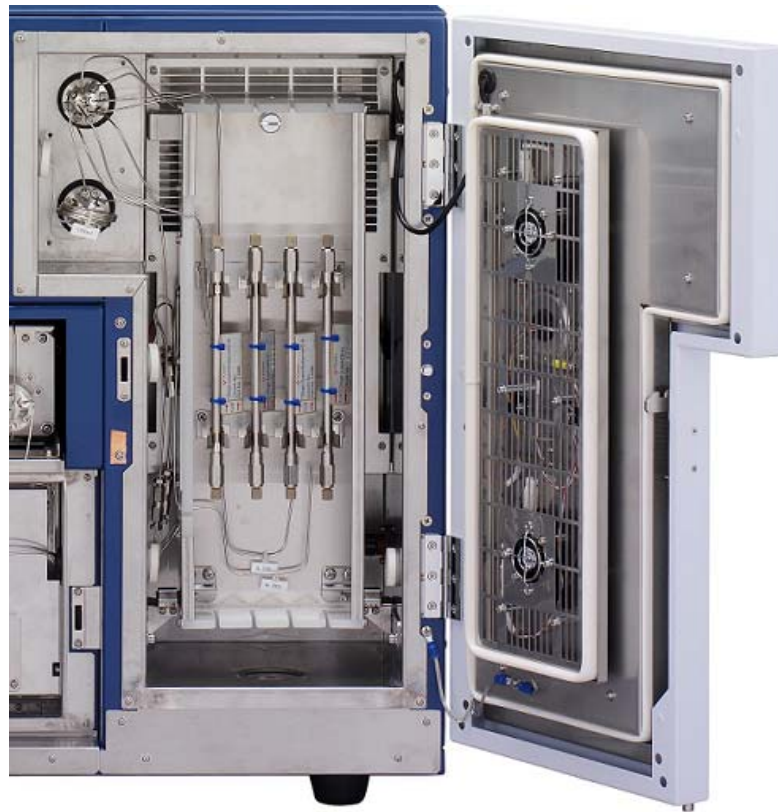
- Easy to use software





Versatility

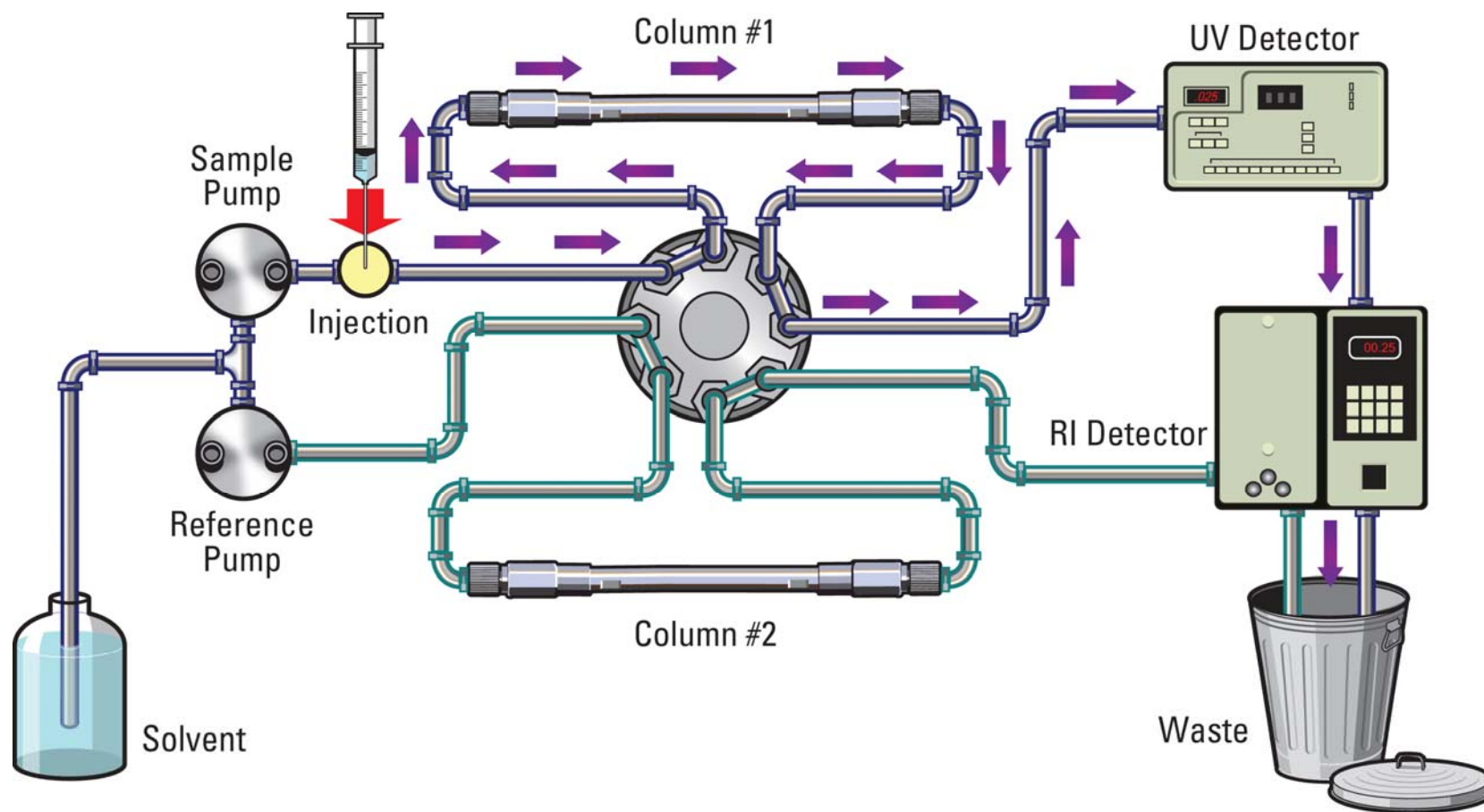
- Column oven holds up to 8, 30cm columns





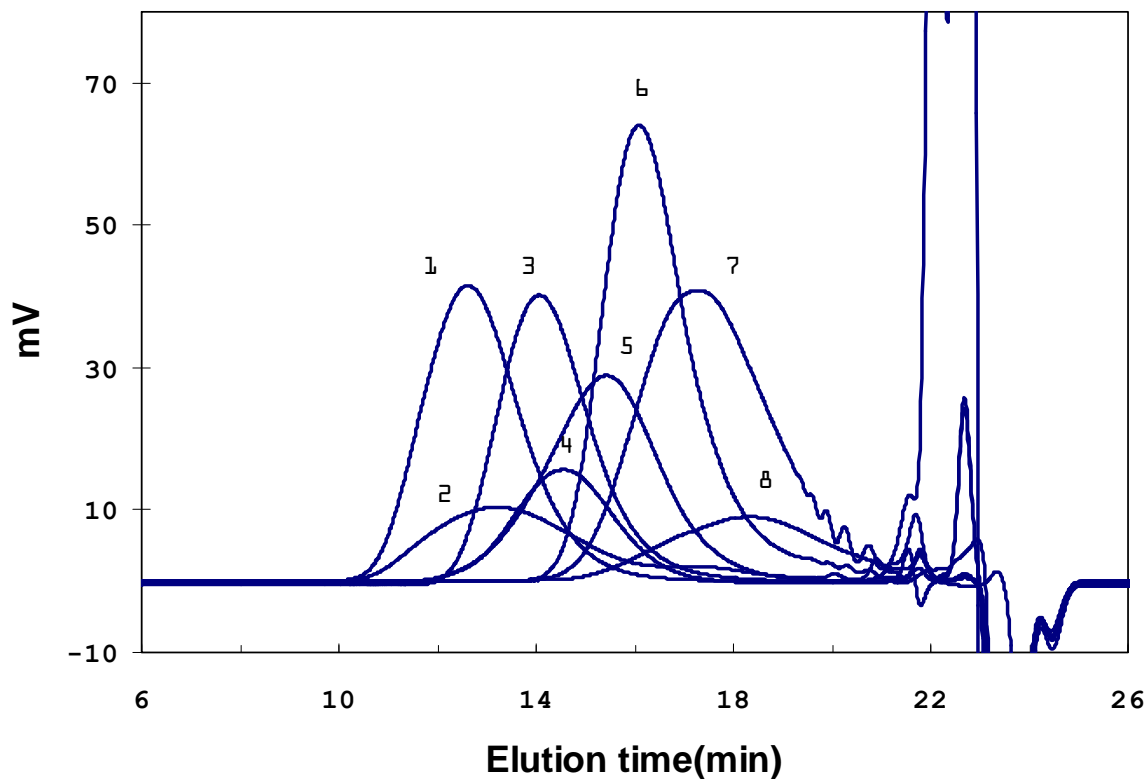
Versatility

- Optional Column Switching Valve





Chromatograms of various polymers on SuperMultiporeHZ column



Column: TSK-GEL
SuperMultiporeHZ-H
(4.6mmID x 15cm) x 4
Eluent: THF
Flow rate: 0.35 mL/min
Detection: RI
Temp.: 40°C
Load: 10 μ L, 3g/L each
Sample: 1. Poly isobutylene
2. Acrylic resin #1
3. Polystyrene
(SRM706)
4. Polyvinylchloride
5. Polyvinylbutylral
6. Polycarbonate
7. Epoxy resin
8. Acrylic resin #2



Conclusion

- TSK-GEL SupermultiporeHZ columns provide accurate wide linear range separations
- Semi-micro columns
 - Save Time and Money
- Eco-SEC GPC System combined with TSK-GEL SupermultiporeHZ columns
 - Superior Performance
 - Versatility