

PHENOGETM GPC/SEC COLUMNS

- 5, 10, and 20 μm particle sizes
- **Narrow bore (4.6 mm ID) solvent-saver to preparative columns available**
- **Very good alternative to Polymer Labs PLgel and Waters Styragel, Ultrastyrigel, Styragel HT, and Styragel HR columns**
- **Highly cross-linked for mechanical and chemical stability**
- **Temperature stable to 140 °C**

Phenogel is available in seven different pore sizes ranging from 50 Å to 10⁶ Å†, and a linear bed configuration. Pore size distribution and pore volume are closely controlled parameters in the manufacturing process; accounting for the high resolution, tight linear calibration curves and excellent column-to-column reproducibility.

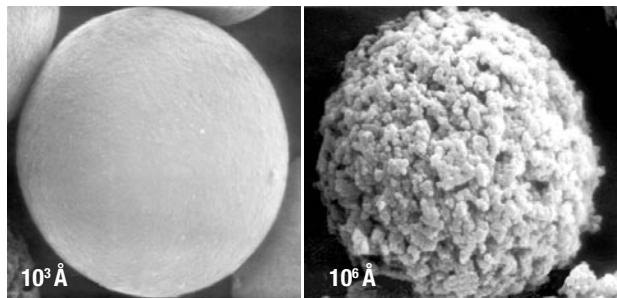
Sample Elution

Each standard dimension Phenogel column (300 x 7.8 mm) has an internal volume of 15 mL that is distributed as follows:

- 3 mL is occupied by the solid portions of the gel particles (20 % of total column volume)
- 6 mL is the pore volume of the packing material (40 % of total column volume)
- 6 mL is the interstitial volume or volume between the gel particles (40 % of total column volume)

Thus, about 6 mL of solvent must elute through each column before even the largest molecules can emerge, while the smallest molecules emerge with the total column volume of 12 mL. This constant distribution of volume makes it possible to predict the amount of solvent and time necessary to complete any analysis.

SEM Photos of Phenogel Polymer Beads



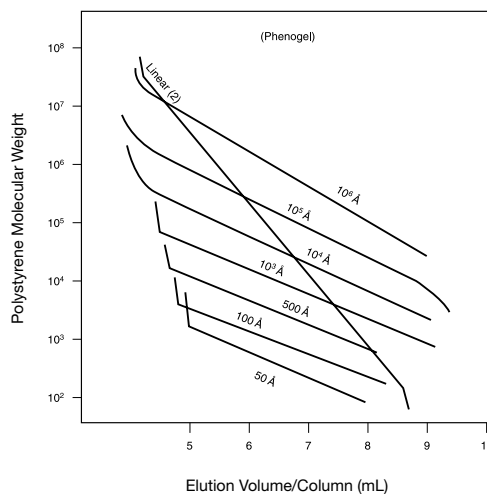
Technical Specifications

Material:	SDVB
Particle Size:	5, 10, 20 μm
Porosities:	50 Å to 10 ⁶ Å†, and mixed beds
Typical Pressure:	5 μm : 350 psi 10 μm : 200 psi
Maximum Pressure:	1000 psi
Maximum Temperature:	140 °C
Minimum Efficiency*:	5 μm : 45,000 p/m** 10 μm : 35,000 p/m**
Typical Flow Rates:	4.6 mm ID: 0.35 mL/min 7.8 mm ID: 1.0 mL/min 21.2 mm ID: 8.0 mL/min
End Fittings:	Valco Compatible

* Tested in THF ** For 300 x 7.8 mm ID columns

† See note on p. 397 regarding pore sizes and exclusion limits

Column Molecular Weight Calibration Curves



Column Selection by Molecular Weight

Sample Type	Molecular Weight	Phenogel Column
Small Organics	100 - 3 K	50 Å
	500 - 6 K	100 Å
	1 K - 15 K	500 Å
Resins	1 K - 75 K	10 ³ Å
	5 K - 500 K	10 ⁴ Å
	10 K - 1,000 K	10 ⁵ Å
High MW Polymers	60 K - 10,000 K	10 ⁶ Å
	100 - 10,000 K	Linear(2)

PHENOGEL™ GPC/SEC COLUMNS

Solvent and Temperature Compatibility

- Phenogel columns are packed in tetrahydrofuran (THF)
- Columns can also be shipped in solvents such as DMF, Methylene Chloride, NMP, and *o*-CP, to help minimize equilibration time

Solvent Compatibility Table

Mobile Phase Solvent	Phenogel Pore Size: (Å)							Linear & Mixed	Suggested Operating Temp.
	50	100	500	10 ³	10 ⁴	10 ⁵	10 ⁶		
Acetone	Y	Y	Y	Y	Y	Y	Y	Y	
Benzene	Y	Y	Y	Y	Y	Y	Y	Y	
Carbon Tetrachloride	Y	Y	Y	Y	Y	Y	Y	Y	
Chloroform	Y	Y	Y	Y	Y	Y	Y	Y	
30 % HFIP/Chloroform	Y	Y	Y	Y	Y	Y	Y	Y	
Diethyl Ether	Y	Y	Y	Y	Y	Y	Y	Y	
Dimethylacetamide (DMAC)	Y*	Y	Y	Y	Y	Y	Y	Y	60 °C
Dimethylformamide (DMF)	Y*	Y	Y	Y	Y	Y	Y	Y	60 °C
Dioxane	Y	Y	Y	Y	Y	Y	Y	Y	
DMSO	Y*	Y	Y	Y	Y	Y	Y	Y	60 °C
Ethyl Acetate	Y	Y	Y	Y	Y	Y	Y	Y	
Hexafluoroisopropanol (HFIP)	Y	Y	Y	Y	Y	Y	Y	Y	
Hexane	Y	Y	Y	Y	Y	Y	Y	Y	
<i>m</i> -Cresol	Y*	Y	Y	Y	Y	Y	Y	Y	100 °C
Methyl Ethyl Ketone	Y	Y	Y	Y	Y	Y	Y	Y	
Methylene Chloride	Y	Y	Y	Y	Y	Y	Y	Y	
<i>o</i> -Chlorophenol	Y*	Y	Y	Y	Y	Y	Y	Y	100 °C
<i>o</i> -Dichlorobenzene	Y*	Y	Y	Y	Y	Y	Y	Y	135 °C
Quinolin	Y*	Y	Y	Y	Y	Y	Y	Y	60 °C
Tetrahydrofuran	Y	Y	Y	Y	Y	Y	Y	Y	
Toluene	Y	Y	Y	Y	Y	Y	Y	Y	
Trichlorobenzene	Y*	Y	Y	Y	Y	Y	Y	Y	135 °C
Water	N	N	N	N	N	N	N	N	
Xylene	Y	Y	Y	Y	Y	Y	Y	Y	

*Not recommended on 5 µm 50 Å columns.

N = Not Compatible
Y = Compatible

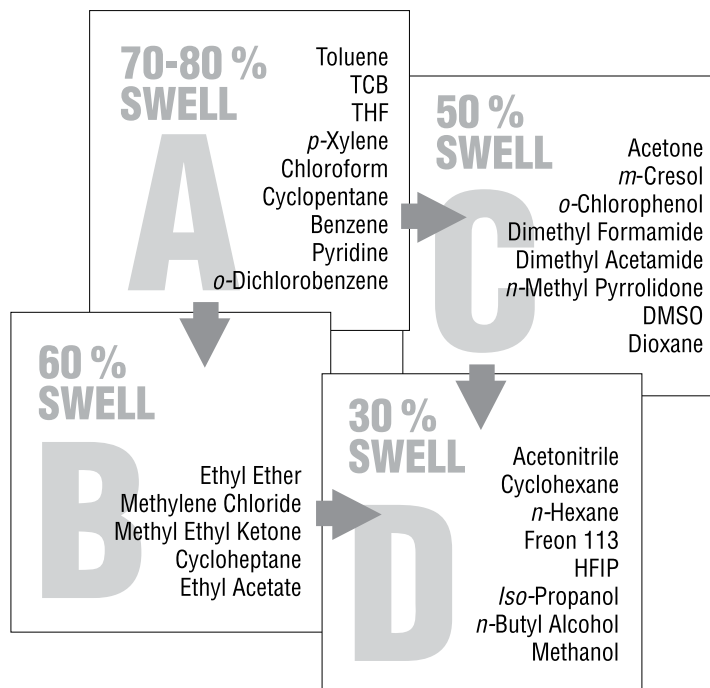


Solvent Switching Considerations

Although Phenogel columns are rugged and can withstand strong solvent changes, care should be exercised when switching from high-swell solvents (A) to low-swell solvents (B, C, and D). Improper solvent switches can result in a void. Best results are attained when an intermediate-swell solvent is used, and column lifetime is improved. Contact Phenomenex regarding solvents not listed below.

Column life can be maximized by dedicating certain columns to certain solvents. This will also minimize solvent switches. If care is not taken, a void may occur.

- Reduce flow rate to 0.2 mL/min
- Backpressure must NEVER exceed 1000 psi
- Always check solvent miscibility in a beaker or follow the solvent miscibility table on page 380 before proceeding with ANY solvent switch.
- Compare the swell characteristics of solvent 1 (old solvent) to solvent 2 (new solvent) and use the following guidelines:
 - If solvent 1 and solvent 2 belong to the same swell category (see table below), check the solvent miscibility and proceed with the switch.
 - If solvent 1 and solvent 2 belong to successive swell categories as indicated by the arrows in the table below, check the miscibility and proceed with the switch.
 - If solvent 1 and solvent 2 DO NOT belong to the same OR successive swell categories, switch to an intermediate solvent FIRST, as indicated by the arrows in the table.



PHENOGEL™ GPC/SEC COLUMNS

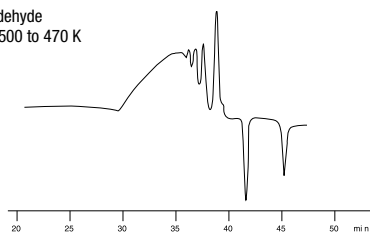
50 Å - 10⁶ Å COLUMNS

- High resolution at low cost
- Customize your analysis by coupling different pore-size columns
- Wide range of solvent compatibility

Phenolic Resins

App ID 5429

Column: Phenogel 5 µm 500 Å x 2, 10³ Å, 10⁴ Å
Dimensions: 300 x 7.8 mm
Solvent: THF
Flow Rate: 1.0 mL/min
Detection: RI
Injection Volume: 5 µL
Temperature: 25 °C
Sample: Phenolic Aldehyde Resin, MW 500 to 470 K

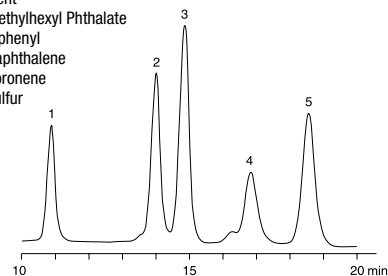


Organic Compounds

App ID 5430

Column: Phenogel 10 µm 100 Å
Dimensions: 250 x 21.2 mm
Part No: 00G-0642-P0
Mobile Phase: Dichloromethane
Flow Rate: 4.0 mL/min
Detection: UV @ 254 nm
Temperature: Ambient
Sample:

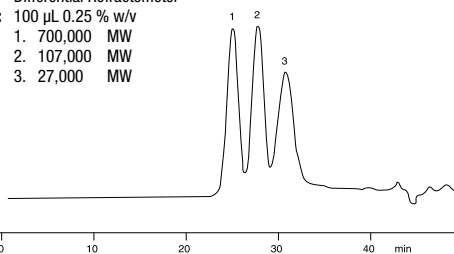
1. Diethylhexyl Phthalate
2. Biphenyl
3. Naphthalene
4. Coronene
5. Sulfur



Polymethyl Methacrylates (Wide MW Range)

App ID 5431

Column: Phenogel 5 µm 10² Å, 10³ Å, 10⁴ Å, 500 Å
Dimensions: 300 x 7.8 mm
Solvent: THF
Flow Rate: 1.0 mL/min
Detection: Differential Refractometer
Injection Volume: 100 µL 0.25 % w/v
Sample:

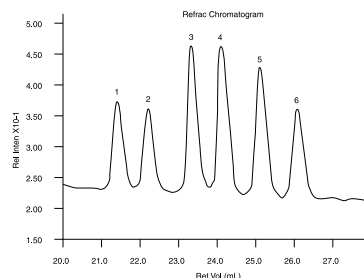


Closely Related Hydrocarbons

App ID 5432

Column: Phenogel 5 µm 50 Å, 100 Å, 500 Å
Dimensions: 300 x 7.8 mm
Solvent: THF
Flow Rate: 1.0 mL/min
Detection: Differential Refractometer
Injection Volume: 100 µL 0.25 % w/v
Temperature: Ambient
Sample:

- | | | | |
|--------|--------|--------|--------|
| 1. C40 | 562 MW | 4. C20 | 282 MW |
| 2. C32 | 450 MW | 5. C16 | 226 MW |
| 3. C24 | 338 MW | 6. C13 | 184 MW |

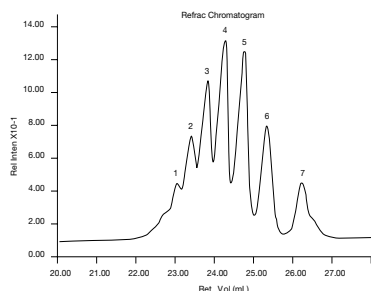


Polyethylene Glycol 330

App ID 5433

Column: Phenogel 5 µm 50 Å, 100 Å, 500 Å
Dimensions: 300 x 7.8 mm
Solvent: THF
Flow Rate: 1.0 mL/min
Detection: Differential Refractometer
Injection Volume: 100 µL 0.25 % w/v
Temperature: Ambient
Sample:

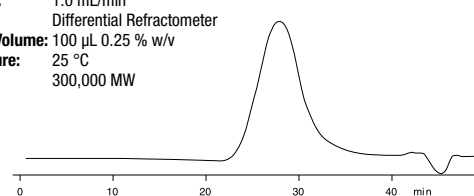
- | | | | |
|--------|--------|--------|--------|
| 1. dp7 | 546 MW | 5. dp3 | 194 MW |
| 2. dp6 | 458 MW | 6. dp2 | 106 MW |
| 3. dp5 | 370 MW | 7. dp1 | 62 MW |
| 4. dp4 | 282 MW | | |



Polyvinyl Butyral

App ID 5438

Column: Phenogel 5 µm 500, 10³, 10⁴, 10⁵ Å
Dimensions: 300 x 7.8 mm
Solvent: THF
Flow Rate: 1.0 mL/min
Detection: Differential Refractometer
Injection Volume: 100 µL 0.25 % w/v
Temperature: 25 °C
Sample: 300,000 MW

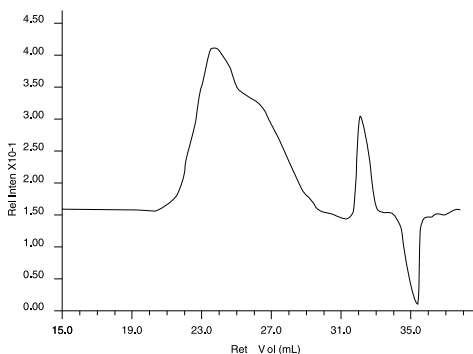


PHENOGEL™ GPC/SEC COLUMNS

50 Å - 10⁶ Å Columns (continued)

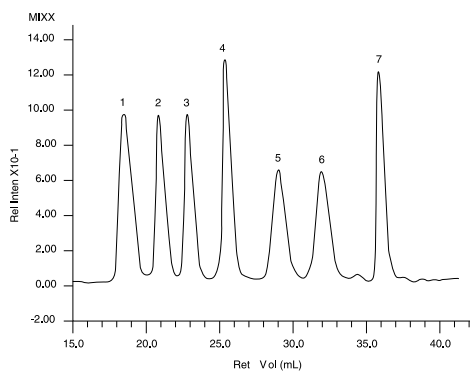
App ID 5434 Polyethylene Oxide (PEO)

Column: Phenogel 10 μm 10⁵, 10⁴, 10³ Å
Dimensions: 300 x 7.8 mm
Mobile Phase: DMF (0.1 M LiBr)
Flow Rate: 1.0 mL/min
Detection: Differential Refractometer
Injection Volume: 100 μL 0.125 % w/v
Temperature: 50 °C
Sample: 1,400,000 MW



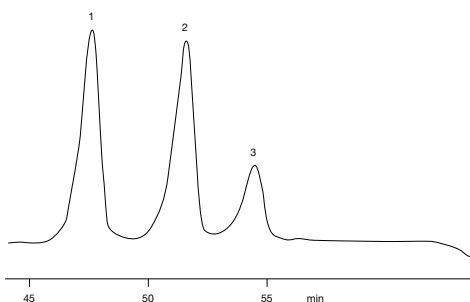
App ID 5435 Polystyrenes (Wide MW Range)

Column: Phenogel 10 μm 10⁵, 10⁴, 10³ Å **Sample:** 1. 1,560,000 MW
Dimensions: 300 x 7.8 mm 2. 260,000 MW
Mobile Phase: THF 3. 94,000 MW
Flow Rate: 1.0 mL/min 4. 30,000 MW
Detection: Differential Refractometer 5. 6,100 MW
Injection Volume: 100 μL 0.25 % w/v 6. 845 MW
Temperature: Ambient 7. 146 MW



App ID 5436 Isoprenes from In Vitro Translation on Products

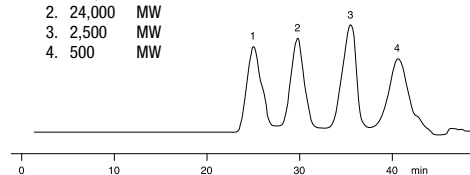
Column: Phenogel 5 μm 50 Å, 100 Å in series
Dimensions: 300 x 7.8 mm
Mobile Phase: THF
Flow Rate: 0.25 mL/min
Detection: Differential Refractometer
Sample: 1. Squalene C30 (2, 6, 10, 15, 19, 23-Hexamethyltetracosane)
 2. Phytane C20 (2, 6, 10, 14-Tetramethylhexadane)
 3. Farnesene C15 (2, 6, 10-Trimethyltridecane)



The columns were used in tandem to characterize isoprene chain lengths removed from labeled in vitro translation products or cell proteins. The isoprenoids were removed by treatment with Raney nickel and extracted into pentane. The pentane extractable material was hydrogenated over platinum catalyst and injected onto the column. Fractions were collected at 0.5 minute intervals and radioactivity was monitored by liquid scintillation. These saturated hydrocarbon chains were characterized by comparing radioactive peaks to standard retention times. Chromatogram courtesy of W. Maltese and R. Erdman, Weis Center for Research, Geisinger Clinic.

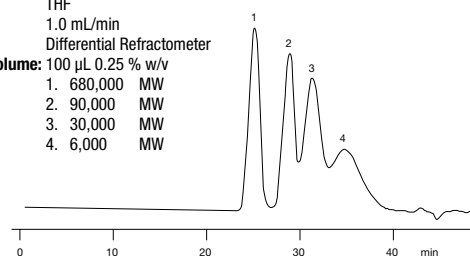
App ID 5437 Polybutadienes (Wide MW Range)

Column: Phenogel 5 μm 10⁵, 10⁴, 10³, 500 Å
Dimensions: 300 x 7.8 mm
Solvent: THF
Flow Rate: 1.0 mL/min
Detection: Differential Refractometer
Injection Volume: 100 μL 0.25 % w/v
Sample: 1. 420,000 MW
 2. 24,000 MW
 3. 2,500 MW
 4. 500 MW



App ID 5439 Poly-(α-Methyl Styrene) (Wide MW Range)

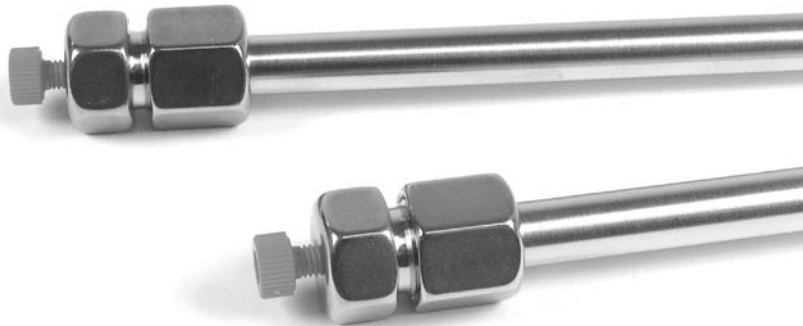
Column: Phenogel 5 μm 10⁵, 10⁴, 10³, 500 Å
Dimensions: 300 x 7.8 mm
Solvent: THF
Flow Rate: 1.0 mL/min
Detection: Differential Refractometer
Injection Volume: 100 μL 0.25 % w/v
Sample: 1. 680,000 MW
 2. 90,000 MW
 3. 30,000 MW
 4. 6,000 MW



PHENOGETM GPC/SEC COLUMNS

LINEAR COLUMNS

- Linear calibration to 10 million daltons
- Long column life
- Excellent mechanical stability
- Excellent for analyzing a wide range of molecular weights

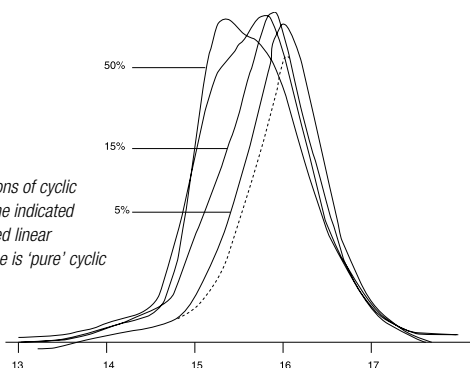


App ID 5440

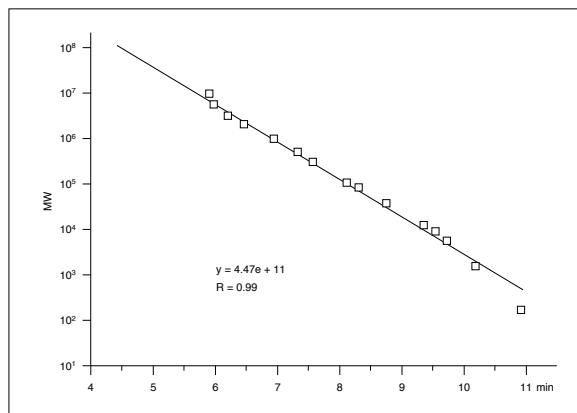
Cyclic Polymer Characterization

Column: Phenogel 10 μm Linear(2)
Dimensions: 600 x 7.8 mm
Part No: 00K-3260-KO
Mobile Phase: THF with 1 % TEA
Flow Rate: 1.3 mL/min
Detection: UV @ 268 nm
Injection Volume: 7 μL 1.25 % w/v
Temperature: Ambient
Sample: Poly-(2-Vinylpyridine) [0.05 % - 0.25 % (w/v)]

SEC traces of solutions of cyclic P2VP that contain the indicated percentages of added linear precursor (dotted line is 'pure' cyclic P2VP)



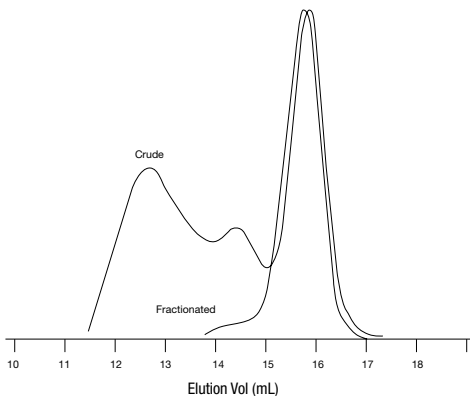
Calibration Curve: Linear (2) - Phenogel 5 μm 300 x 7.8 mm



App ID 5441

Cyclic Polymer Characterization

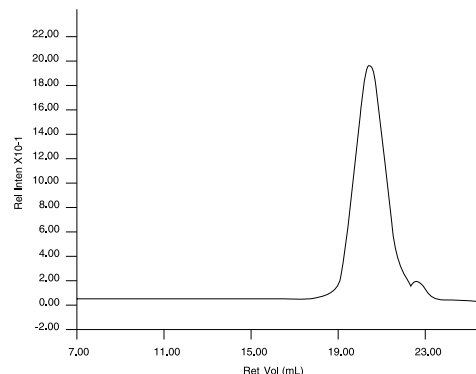
Column: Phenogel 10 μm Linear(2)
Dimensions: 600 x 7.8 mm
Part No: 00K-3260-KO
Mobile Phase: THF with 1 % TEA
Flow Rate: 1.3 mL/min
Detection: UV @ 268 nm
Injection Volume: 40 μL 0.2 % w/v
Temperature: Ambient
Sample: Poly-(2-Vinylpyridine) [0.05 % - 0.25 % (w/v)]



App ID 5445

Nylon 6 in HFIP

Column: Phenogel 10 μm Linear(2) x 2
Dimensions: 300 x 7.8 mm
Part No: 00H-3260-KO
Mobile Phase: HFIP (0.01 M NATFAT)
Flow Rate: 1.0 mL/min
Detection: Differential Refractometer
Injection Volume: 100 μL 0.025 % w/v
Temperature: 30 °C
Sample: 14,500 MW



PHENOGEL™ GPC/SEC COLUMNS

NARROW BORE COLUMNS

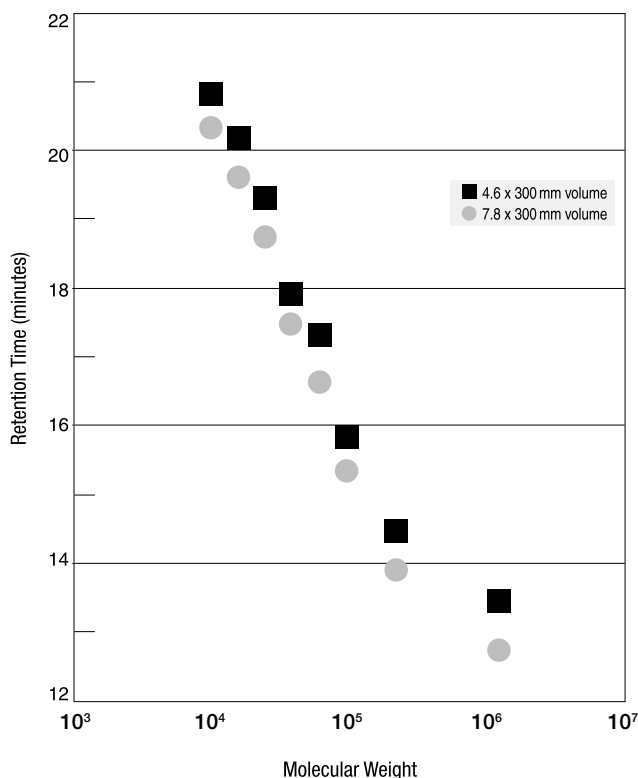
An Improved Dimension in GPC Analysis

- Decrease solvent consumption
- Retain same elution profile
- Reduce solvent disposal costs

Phenogel-NB (NarrowBore) columns are optimized to reduce solvent consumption. The Phenogel-NB columns have a 4.6 mm column ID and run at 0.35 mL/min, reducing solvent consumption and disposal costs up to 65 %!

Loading

With narrow bore GPC/SEC columns, the volume in which the sample elutes is significantly decreased, thus increasing the effective concentration of the sample. This increase in sensitivity is exploited in HPLC, but in GPC it leads to overloading effects and proportionally lower sample loadings must be used.



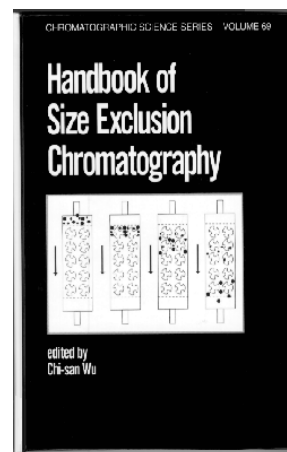
Handbook of Size Exclusion Chromatography

Chromatographic Science Series Vol. 69
Chi-San Wu. 1995. 453 pp.

This single-source reference details the practical use of size exclusion chromatography (SEC) in characterizing the molecular weight distribution of important polymeric materials — addressing problems encountered in SEC of specific substances, including copolymers, polyamides, polyvinyl alcohol and acetate, lignin derivative, proteins and starch. SEC column technology is thoroughly reviewed, and the use of semirigid polymer gels and modified silica-based packing materials is clearly delineated. Written by more than 25 internationally renowned authorities in their respective fields, the *Handbook of Size Exclusion Chromatography* is an invaluable resource for polymer chromatographers.

Part No.: AA0-3346

Price:



For high-temperature GPC columns see p. 223.

PHENOGEL™ GPC/SEC COLUMNS



If Phenogel does not provide at least equivalent separation as compared to a competing column of the similar particle size, phase, and dimensions, send in your comparative data within 45 days and keep the column for FREE.

ORDERING INFORMATION

5 µm Columns (mm)		300 x 7.8	600 x 7.8	300 x 21.2	Guards 50 x 7.8
Pore Size	MW Range				
50 Å	100-3 K	00H-0441-K0	—	—	03B-2088-K0
100 Å	500-6 K	00H-0442-K0	00K-0442-K0	—	03B-2088-K0
500 Å	1K-15 K	00H-0443-K0	00K-0443-K0	—	03B-2088-K0
10-3 Å	1K-75 K	00H-0444-K0	—	—	03B-2088-K0
10-4 Å	5K-500 K	00H-0445-K0	00K-0445-K0	00H-0445-P0	03B-2088-K0
10-5 Å	10K-1,000 K	00H-0446-K0	00K-0446-K0	00H-0446-P0	03B-2088-K0
10-6 Å	60K-10,000 K	00H-0447-K0	00K-0447-K0	00H-0447-P0	03B-2088-K0
Mixed Beds		300 x 7.8	600 x 7.8	—	50 x 7.8
Linear(2)	100-10,000 K	00H-3259-K0	00K-3259-K0	—	03B-2088-K0

5 µm Narrow Bore (NB) Columns (mm)		300 x 4.6	Guards 30 x 4.6
Pore Size	MW Range		
50 Å	100-3 K	00H-0441-E0	03A-2088-E0
100 Å	500-6 K	00H-0442-E0	03A-2088-E0
500 Å	1K-15 K	00H-0443-E0	03A-2088-E0
10-3 Å	1K-75 K	00H-0444-E0	03A-2088-E0
10-4 Å	5K-500 K	00H-0445-E0	03A-2088-E0

10 µm Columns (mm)		300 x 7.8	600 x 7.8	300 x 21.2	600 x 21.2	Guards 50 x 7.8
Pore Size	MW Range					
50 Å	100-3 K	00H-0641-K0	00K-0641-K0	00H-0641-P0	00K-0641-P0	03B-2090-K0
100 Å	500-6 K	00H-0642-K0	00K-0642-K0	00H-0642-P0	00K-0642-P0	03B-2090-K0
500 Å	1K-15 K	00H-0643-K0	00K-0643-K0	—	00K-0643-P0	03B-2090-K0
10-3 Å	1K-75 K	00H-0644-K0	00K-0644-K0	00H-0644-P0	00K-0644-P0	03B-2090-K0
10-4 Å	5K-500 K	00H-0645-K0	00K-0645-K0	00H-0645-P0	00K-0645-P0	03B-2090-K0
10-5 Å	10K-1,000 K	00H-0646-K0	00K-0646-K0	00H-0646-P0	00K-0646-P0	03B-2090-K0
10-6 Å	60K-10,000 K	00H-0647-K0	00K-0647-K0	00H-0647-P0	00K-0647-P0	03B-2090-K0
Mixed Beds		300 x 7.8	600 x 7.8	300 x 21.2	—	50 x 7.8
Linear(2)	100-10,000K	00H-3260-K0	00K-3260-K0	00H-3260-P0	—	03B-2090-K0

Other Shipping Solvents:

Methanol, Methylene Chloride, Cyclohexane, Ethyl Acetate, NMP, DMAC, DMF

Size (mm)	Price
30 x 4.6	
50 x 4.6	
300 x 4.6	
300 x 7.8	
600 x 7.8	
300 x 21.2	
600 x 21.2	

NOTE: Phenogel columns are routinely shipped in THF. Columns can be shipped in Toluene and Chloroform upon request at no additional charge.

Phenogel Columns are a Recommended Alternative to:

Manufacturer	Columns
Jordi Associates	Jordi GPC-DVB
Polymer Labs	PLgel™
Waters	Styragel® µStyragel® UltraStyragel® Styragel® HT Styragel® HR



All other column dimensions available. Phenogel columns are routinely shipped in THF. However, columns are also available in commonly used solvents such as Toluene and Chloroform as well as DMF, NMP, and other solvents. Refer to the chart above for the additional charge for these shipping solvents. Please specify shipping solvent when ordering.



See p. 199 for full line of Polymer Calibration Standards.



See pp. 344-345 for Column Heaters.