Your GPC/SEC Toolbox

Have you got what you need for your polymer analysis?

Jean Lane
Applications Engineer
LC Columns and Consumables Technical Support
March 21, 2023

Why Determining MW and MWD is important?

The primary goal of GPC is to discover the MW distribution

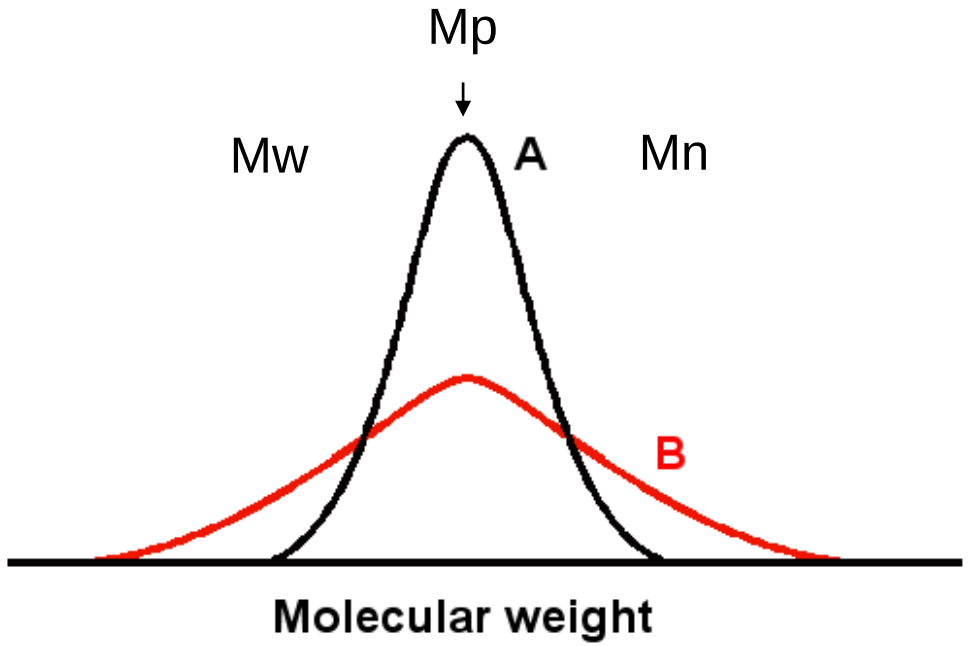
- Samples of synthetic polymers *always* contain polymer chains with a range of chain lengths
- One way to describe the length of the polymer chains is in terms of an average molecular weight – the average of all the chain lengths in the sample

However…

- Different samples of the same polymer can have the same average chain length, but very different distributions of chain lengths depending on the method of production
- In polymer science, it is the molecular weight *distribution* that is important

Effect of MW and Polydispersity on a Polymer

Sample having same molecular weight but different distributions



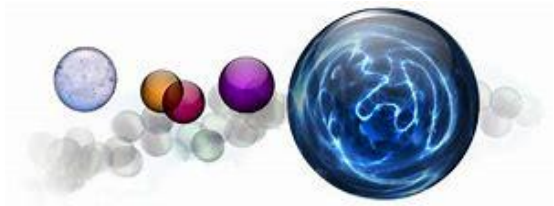
	Strength	Toughness	Brittleness	Melt Viscosity	Chemical Resistance	Solubility
Increasing Mw	+	+	+	+	+	-
Decreasing distribution	+	+	-	+	+	+

Sample Examples

Why GPC/SEC is done

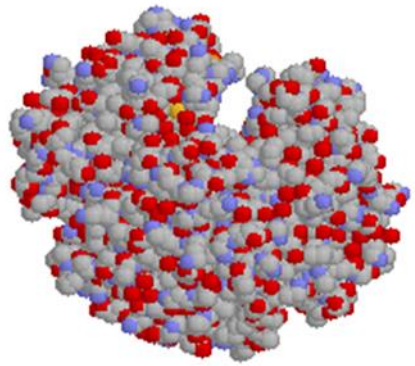
- **Plastics**
  - Mol wt dictates polymer strength, flexibility, and physical properties

- **Sample cleanup**
  - Separates target molecules from large molecules that fragment in MS and cause interference



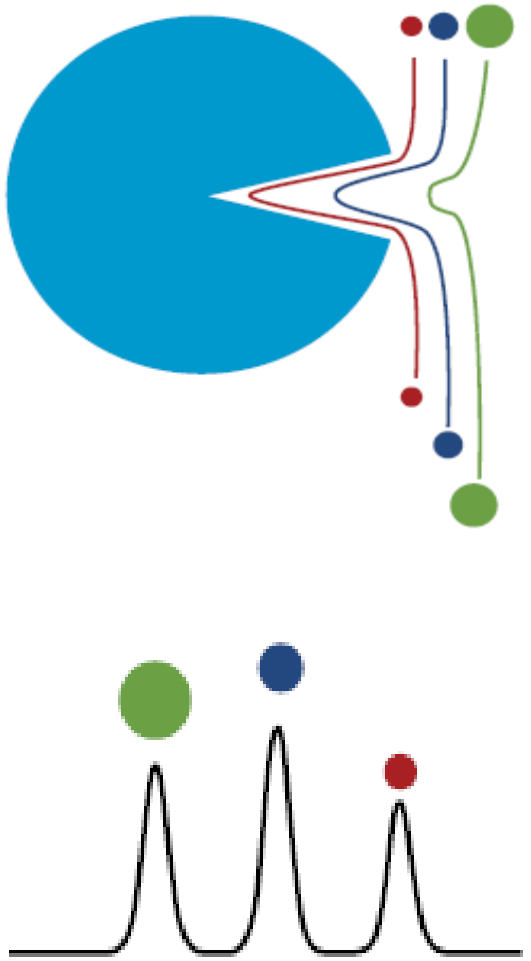
- **Water soluble polymers**
  - Mol wt impacts viscosity, surfactant effects, dissolution, and chemical characteristics

- **BioMolecules**
  - Mol wt is often known
  - Can be run on intact molecules
  - Aggregation can be dangerous



GPC/SEC Separation Mechanism

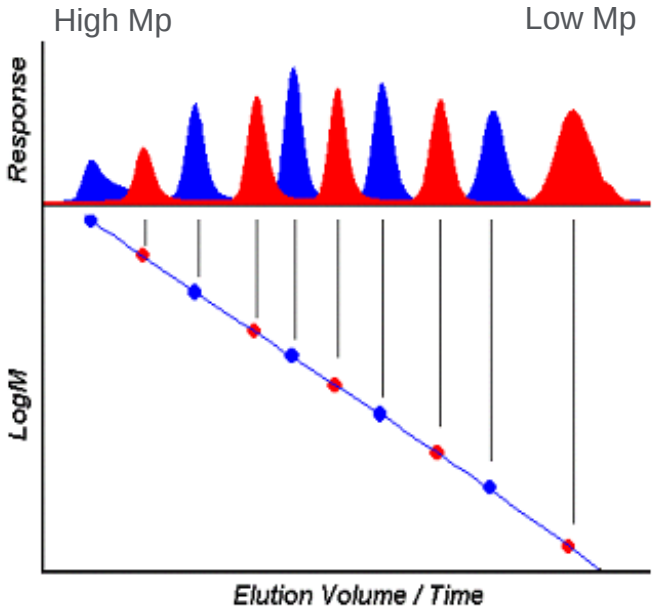
- A GPC/SEC column is packed with porous beads of controlled porosity and particle size
- Sample is prepared as a dilute solution in the eluent and injected into the system
- Large molecules are not able to permeate all pores and have a shorter residence time in the column
- Small molecules permeate deep into the porous matrix and have a long residence time in the column
- Sample molecules are separated according to molecular size, eluting largest first, smallest last



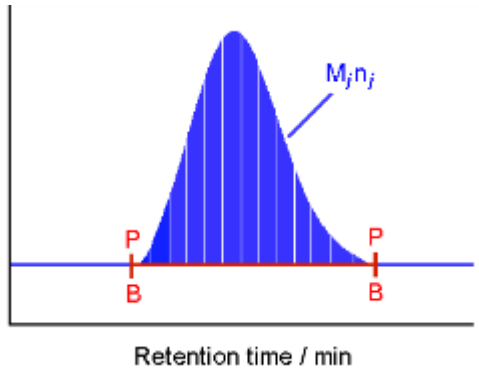
Conventional GPC/SEC Workflow

- Calibrate the GPC column with a set of narrow polymer standards
- Plot retention time (RT) versus peak log molecular weight (logM)
- Calibration is used to generate molecular weight (averages and distribution) of unknowns run on the same system/column set
- Molecular weights are relative to the standards used

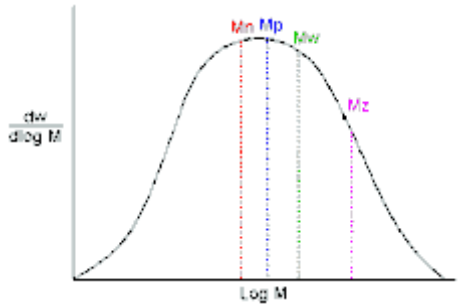
Chromatogram and plot of narrow standards



GPC sample chromatogram



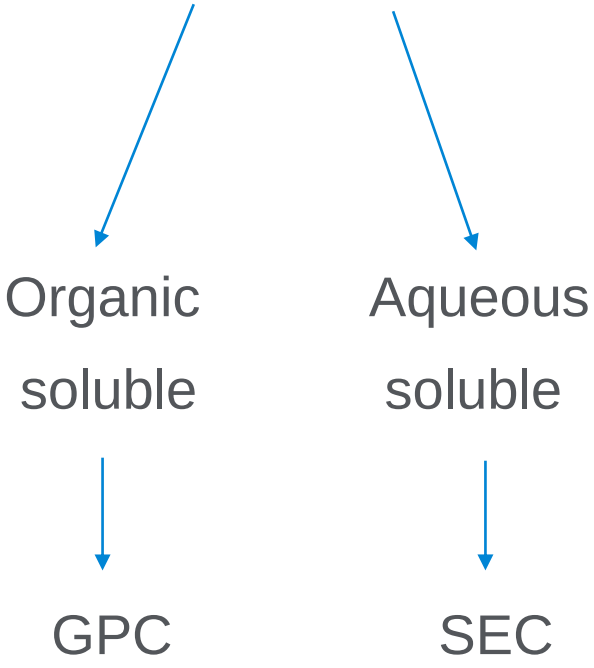
Molecular weight distribution



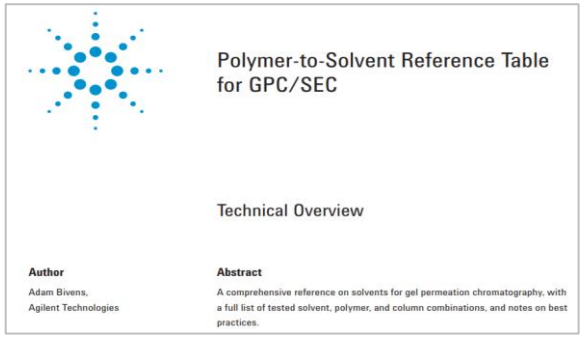
Polymer Sample Type
Solvent considerations

Questions that you need to ask

What type of polymer do I have?



An Agilent technical guide detailing most common solvent suggestions for polymer samples:


Polymer-to-Solvent Reference Table for GPC/SEC

Technical Overview

Author
Adam Bivens,
Agilent Technologies

Abstract
A comprehensive reference on solvents for gel permeation chromatography, with a full list of tested solvent, polymer, and column combinations, and notes on best practices.

Polymer-to-solvent Reference Table – publication number: 5991-6802EN

Solvents

- Selecting a solvent system is one of the first steps in developing a GPC method
- Some polymer samples are easy to dissolve, some are much harder
- Some polymers may require elevated temperature for dissolution
- The Agilent range of GPC/SEC columns are available with phase chemistries that are optimized for all types of solvents that may be required: aqueous and organic, polar and nonpolar solvents.

Criteria for Solvent Selection

Successful solvent choice

Polymers are often employed due to their strength and toughness. Aggressive solvents and long dissolution times often required while ensuring:

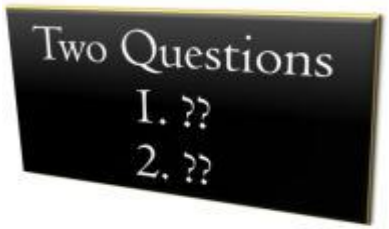
- The solvent must be able to fully solubilize the sample
- **Must have true sample solubility** to avoid non-size exclusion effects
- Compatibility with columns
- It must permit adequate detection (for example, refractive index, UV cut off)
- Safety (toxicity, elevated temperature)

	Solvent Polarity	Solvent
Low	6.0	Perfluoralkanes
↑	7.3	Hexane
	8.2	Cyclohexane
	8.9	Toluene
	9.1	Ethyl acetate
	9.1	Tetrahydrofuran (THF)
	9.3	Chloroform
	9.3	Methyl ethyl ketone (MEK)
	9.7	Dichloromethane
	9.8	Dichloroethane
	9.9	Acetone
	10.0	o-Dichlorobenzene (o-DCB)
	10.0	Trichlorobenzene (TCB)
	10.2	m-Cresol
	10.2	o-Chlorophenol (o-CP)
	10.7	Pyridine
	10.8	Dimethyl acetamide (DMAc)
	11.3	n-Methyl pyrolidone (NMP)
↓	12.0	Dimethyl sulphoxide (DMSO)
High	12.1	Dimethyl formamide (DMF))

Two Important Questions
Solvent considerations

Question 1: What solvent is your sample soluble in?

Type	Typical Solvents
Organic	• THF • Chloroform • Toluene • TCB/ODCB
Mixed or polar organic	• THF/water • DMF • NMP
Aqueous	• Water • Buffer in water • Water/methanol (up to 50%) • Water/other organic



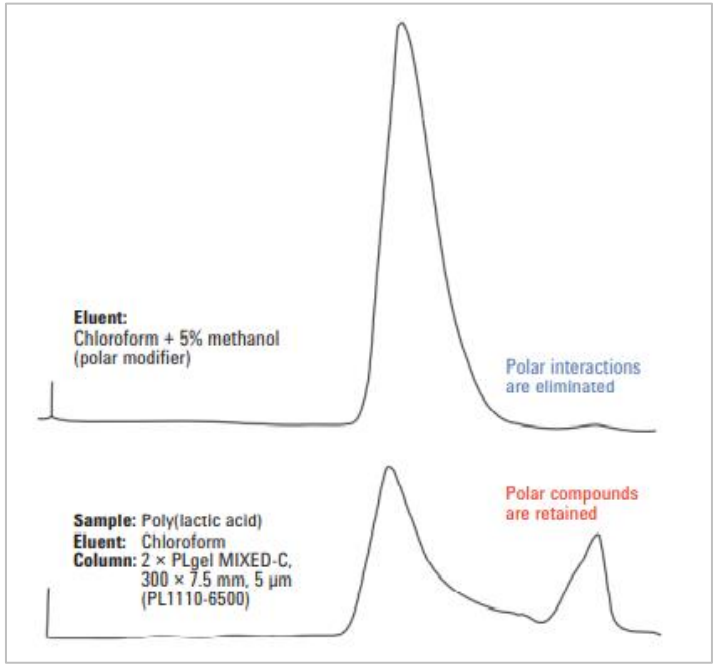
Additives can be employed to:

- Minimize nonsize exclusion interactions between the sample and the column
- Stabilize the solution of the polymer (ionic aggregation)

Successful Solvent choice

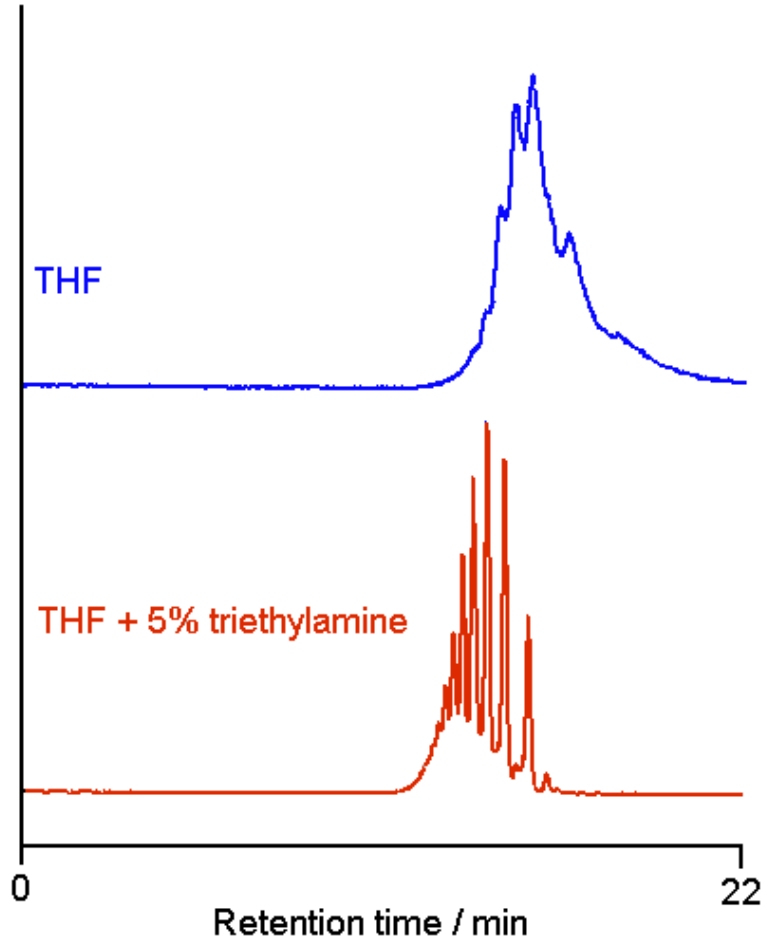
Tips for use of additives:

- Addition of salts to aqueous and polar organic solutions is the preferred method for eliminating polar interactions by electrostatic screening. **Salts should be flushed from the system after analysis.**
- For water-soluble polymers, interactions can also be minimized by addition of an organic solvent, such as methanol.
- Lewis bases, such as polyamines and polyamides, may interact with polymeric media, but this can be eliminated by the addition of an amine to the mobile phase, such as triethylamine (TEA).



Polar interactions in the lower chromatogram are eliminated with 5% methanol addition to the eluent

Eluent Modification in Organic GPC



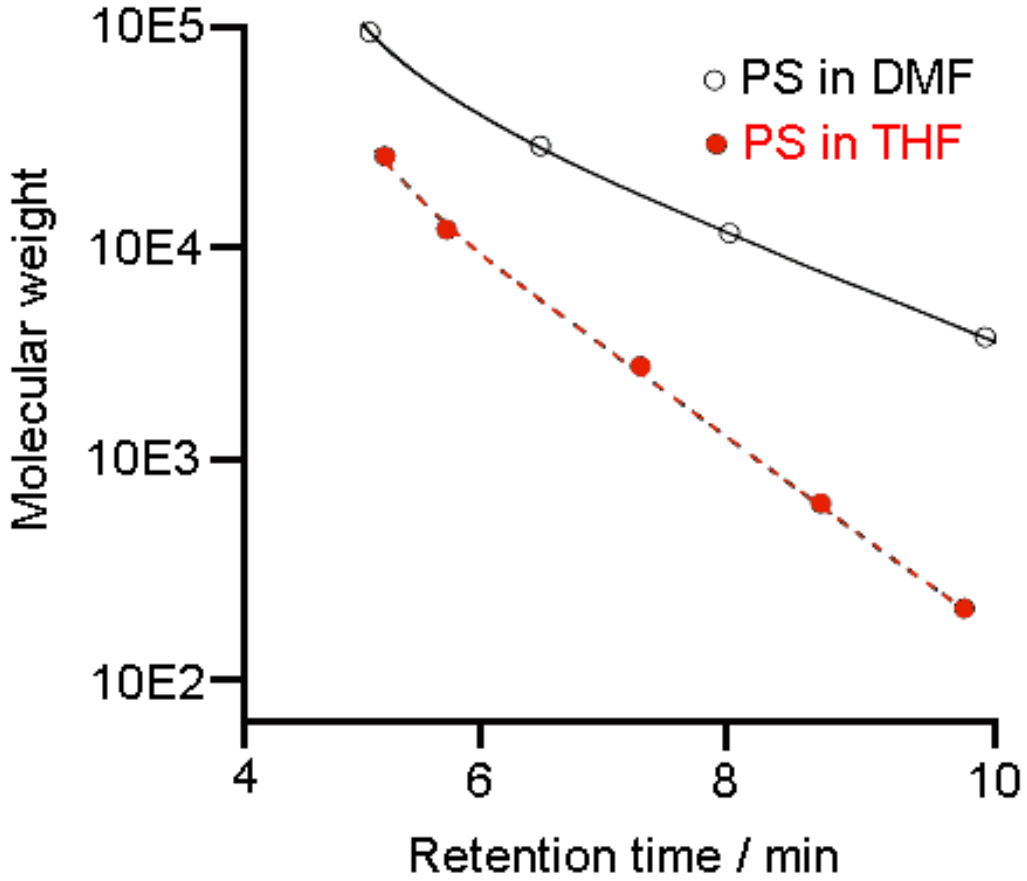
Hostavin N30

Polymeric UV stabilizer containing secondary amine groups

Column: 2 x Plgel, 3 µm, MIXED-E
Flow rate: 1.0 mL/min
Detector: PL-ELS 1000

Solvent Choice for Calibration Standards

Need to maintain GPC/SEC mechanism



PS/DVB columns are excellent in many solvents, but remember that although the column may be used in certain solvents this does not mean SEC will occur – the example here is polystyrene standards running in DMF.

Column: PL1110-6525 PLgel, 5 µm, 500 Å
300 x 7.5 mm

Selecting a GPC/SEC Column

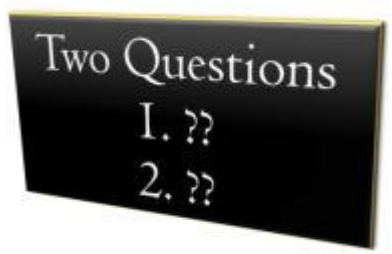
Points to consider when making a column choice:

- Is an organic or aqueous eluent being used?
- What is the expected molecular weight range for your sample?
- What type of column options are there?
- What are your **key** requirements for your GPC/SEC analysis?

Two Important Questions
Choosing a GPC/SEC column

Question 2: What is the expected molecular weight range of your polymer sample?

Mol Wt	Mol Wt Range (g/mol or Da)
High	Up to several millions
Intermediate	Up to hundreds of thousands
Low	Up to tens of thousands
Very low	A few thousand



Column Chemistries

Polymer chemistries

Common types:

Polymethacrylate packings

Polyester copolymers

DVB, divinylbenzene

PS-DVB, polystyrene divinylbenzene

Silica chemistries

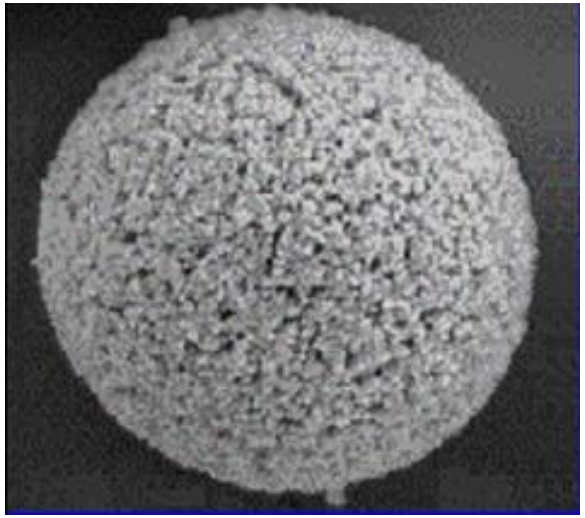
Common types:

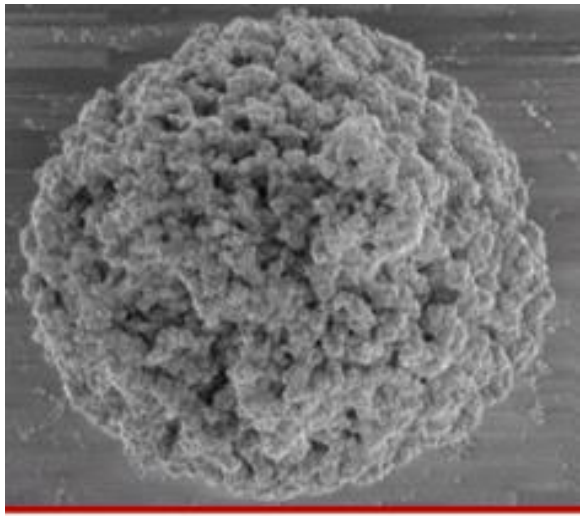
Diol

Surface-modified hydroxyl

Surface-modified polymeric

PLgel 10 µm 10E3 A and 10E6 A particles with their rigid pore structure

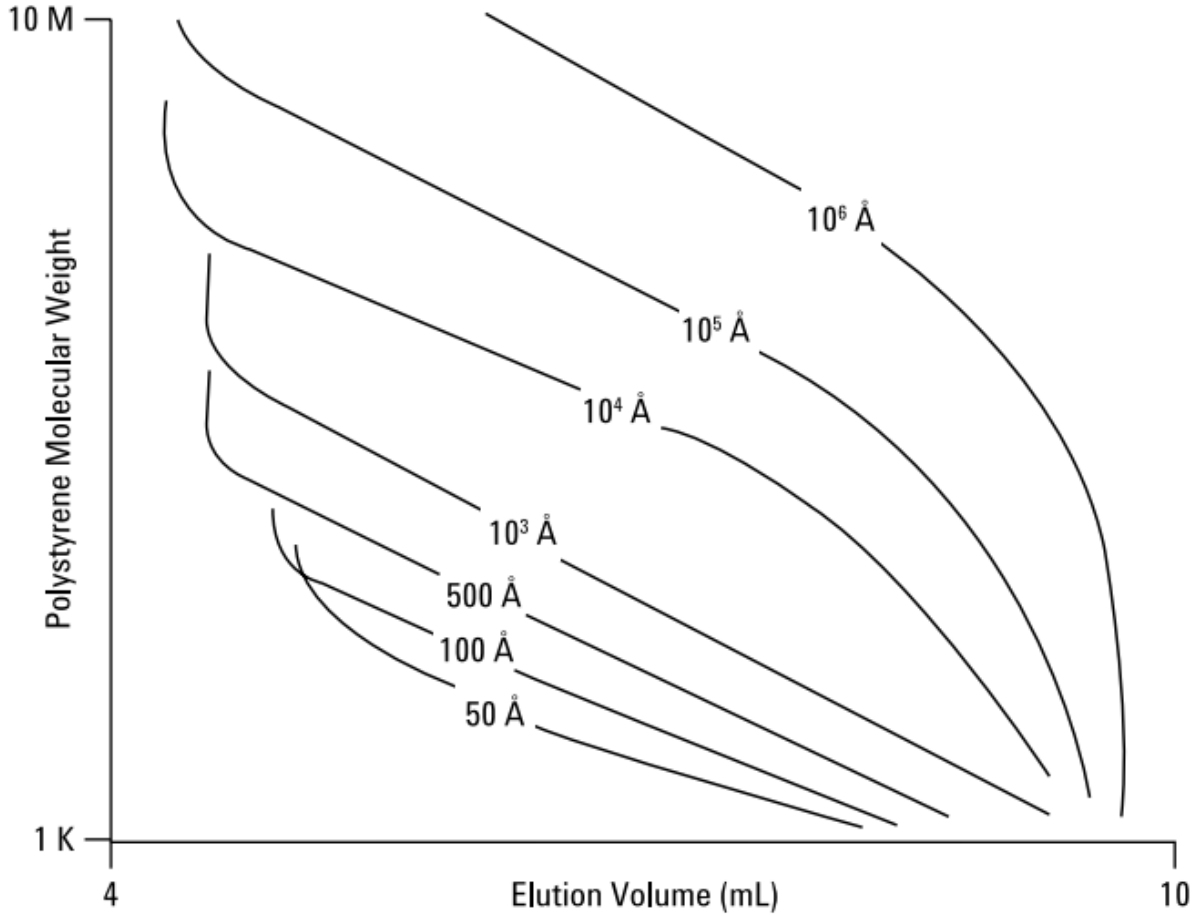




Column Types: Individual Pore Size

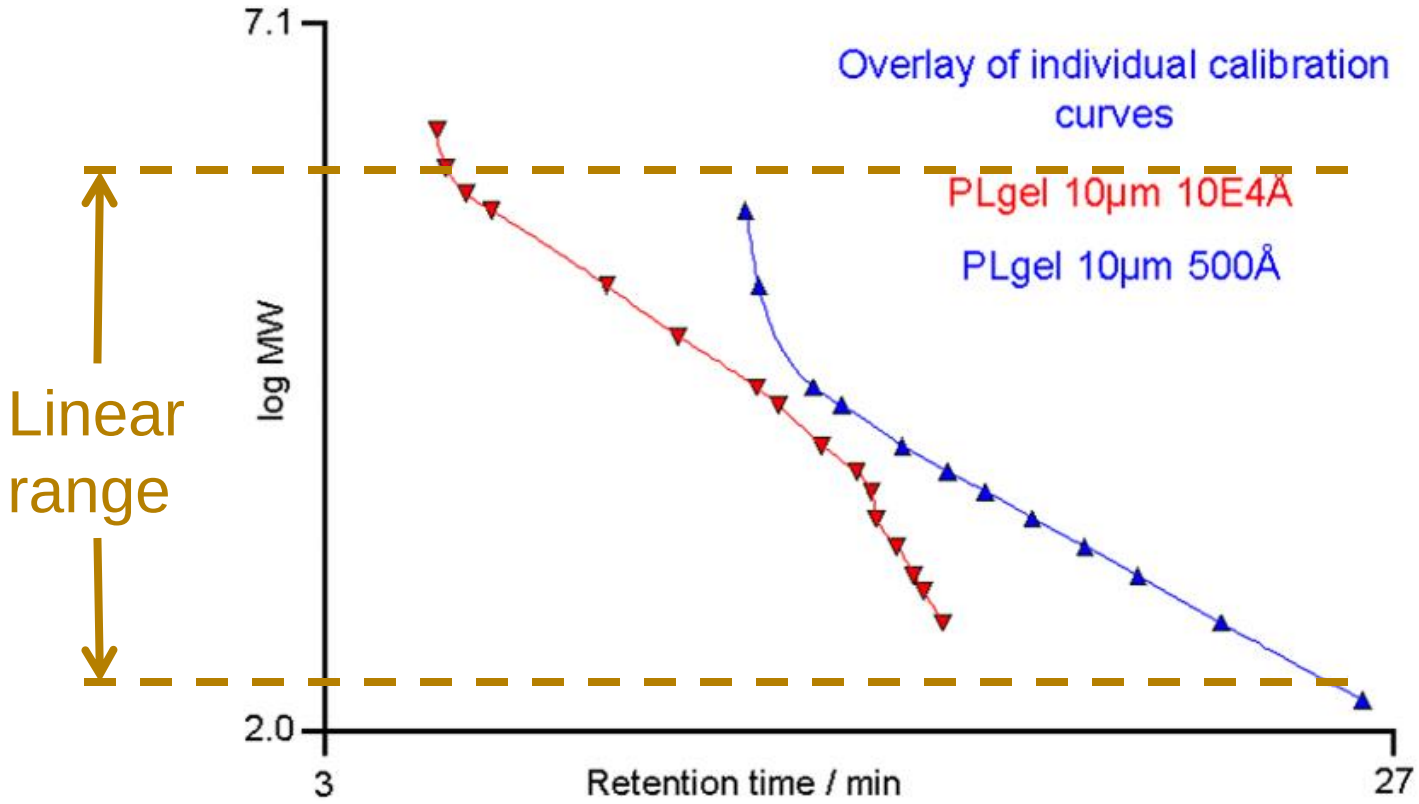
- All particles have the same pore size
- Good separation, but narrow range of mol wt
- Very nonlinear curve; linear only over a narrow mol wt range
- Oldest technology, but still popular, and useful for separating very small and very large compounds
- Wider mol wt range possible by combining different columns in a series, but you need to select carefully so you not to have a column ‘mismatch’

Calibration curve



PLgel individual pore size calibration plots

Increasing the Resolving Range

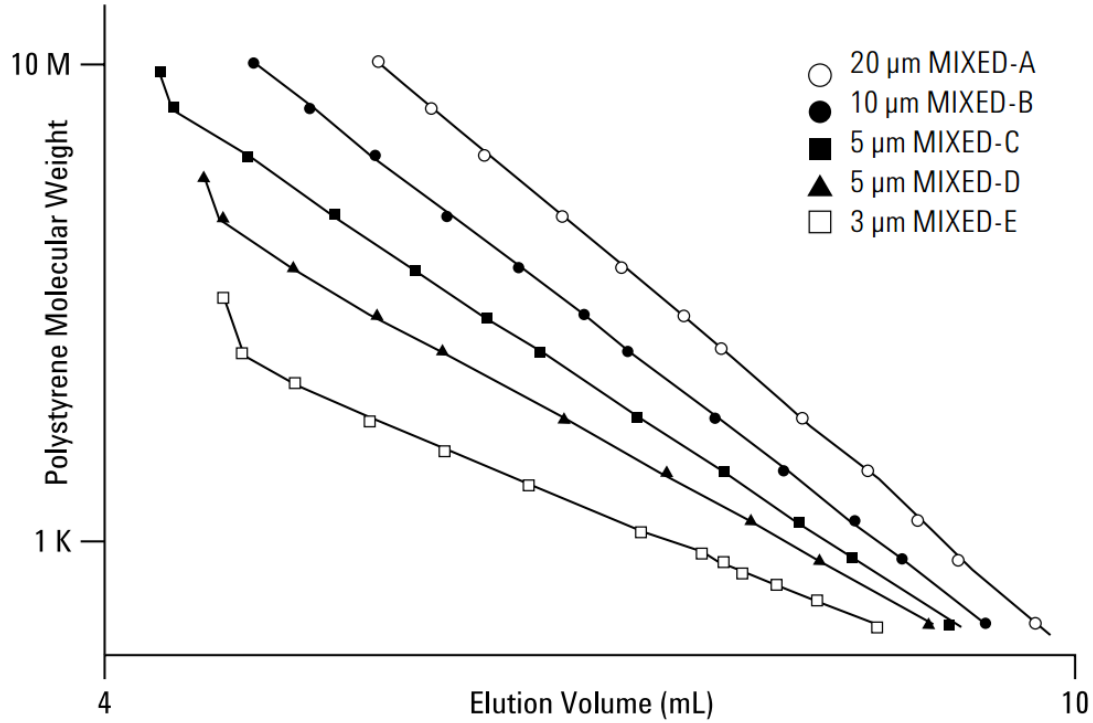


- Individual columns can be coupled in series
- Need linear calibration ranges to complement without overlap

Column Types: MIXED

- Individual pore size particles are mixed together/blended to make a linear curve
- Very wide ranges possible, but only a small amount of separation of each mol wt
- Linear curve makes chromatogram easy to read and analyze
- Most popular technology, well established and widely used
- Columns in series of same type are still linear

Column family: PLgel

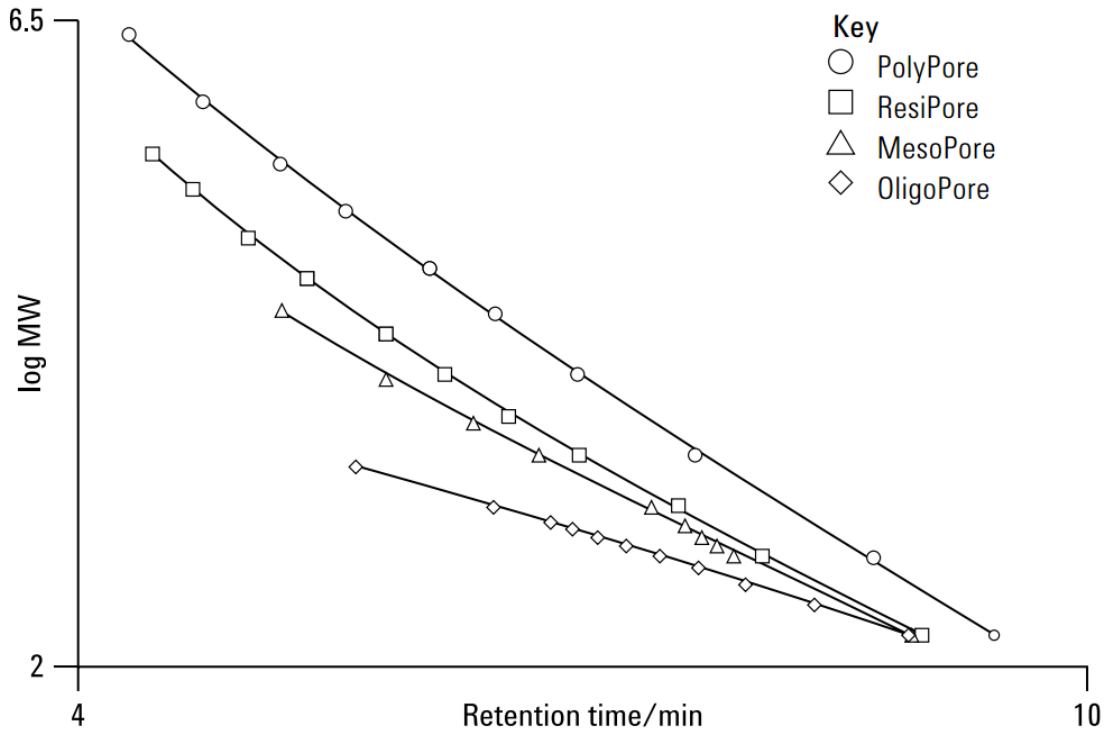


PLgel MIXED calibration plots

Column Types: Multipore Particle

- Newest, fastest growing technology
- Each particle has multiple pore sizes
- Increased pore volume
- Highest resolution and efficiency
- Best performance for most common mol wt ranges

Column family: PlusPore



PlusPore calibration plots

Agilent Columns for Polymer Applications Using Organic Solvents

PLgel and PlusPore series

- Cover all molecular weight ranges
- High pore volume
- High efficiency
- Maximize resolution

Unequalled solvent compatibility

- Easy transfer between polar and nonpolar eluents
- Outstanding physical rigidity
- Provides extended lifetimes that minimize downtime

Typical application areas include: polystyrenes, polyolefins, polycarbonates, polyurethanes, polysiloxanes, epoxy resins, polyester resins, silicone fluids, polyolefin waxes, prepolymers, resins, polyols

Available in multiple particle size options and column sizes ranging from narrow-bore to preparative

Agilent Columns for Polymer Applications Using Polar Organic or Aqueous Solvents

Polargel series

- Medium polarity surface
- High mechanical stability
- For use in intermediate and polar solvent combinations

Typical application areas include resins, starches, acrylics, biopolymers, polysaccharides, polyamides

PL aquagel-OH series

- Chemically and physically stable
- “Neutral” surface
- High performance analyses
- Neutral, ionic and hydrophobic moieties

Typical application areas include PEG, PEO, polysorbate, celluloses, dextran, and acrylamide

Available in multiple particle size options and columns sizes ranging from narrow-bore to preparative

Agilent Columns for Specialty Applications

PL HFIPgel

- Chemically and physically stable
- Multiporous packing, optimized separation range
- For use in hexafluoroisopropanol, HFIP, and related polar fluorinated solvents

Typical application areas include polyesters, polyamides (nylon), polyethylene terephthalate (PET), and poly(lactic-co-glycolic acid) (PLGA)

PLgel Olexis

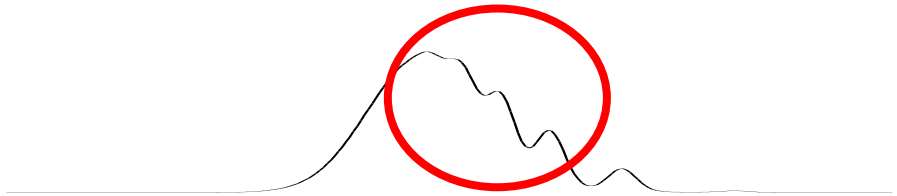
- 13 µm particles providing stability and resolution with no shear degradation
- Wide resolving range
- Excellent for use at very high temperatures
- Optimized for analysis of polyolefins and performance polymers

Column dimensions
HFIPgel: 4.6 x 250 mm and 7.5 x 300 mm
Olexis: 7.5 x 300mm

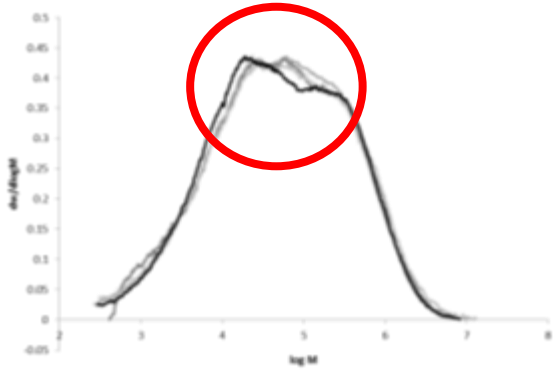
GPC Column Selection

Key Requirement

Resolution is too low

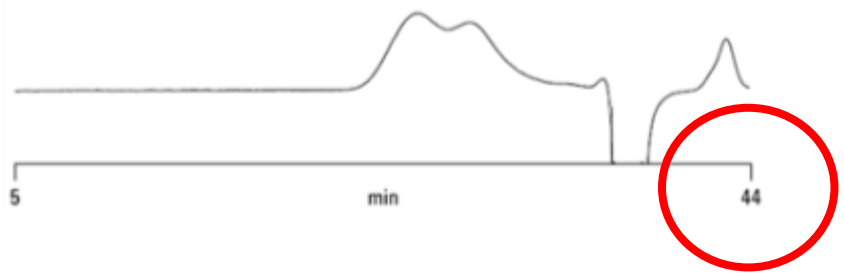


Results are not reproducible



Peak shapes are poor

Run times are too long



GPC Column Selection

Ways to improve resolution

Running two columns in a series using different pore sizes

- Extends the resolving range and enables analysis of multiple attributes in one run

Running two columns in a series using the same pore size/same type

- Increasing pore volume increases the resolution

Use a packing with a smaller particle size

- Decreasing the particle size increases column efficiency

GPC Column Selection

How many GPC/SEC columns to use

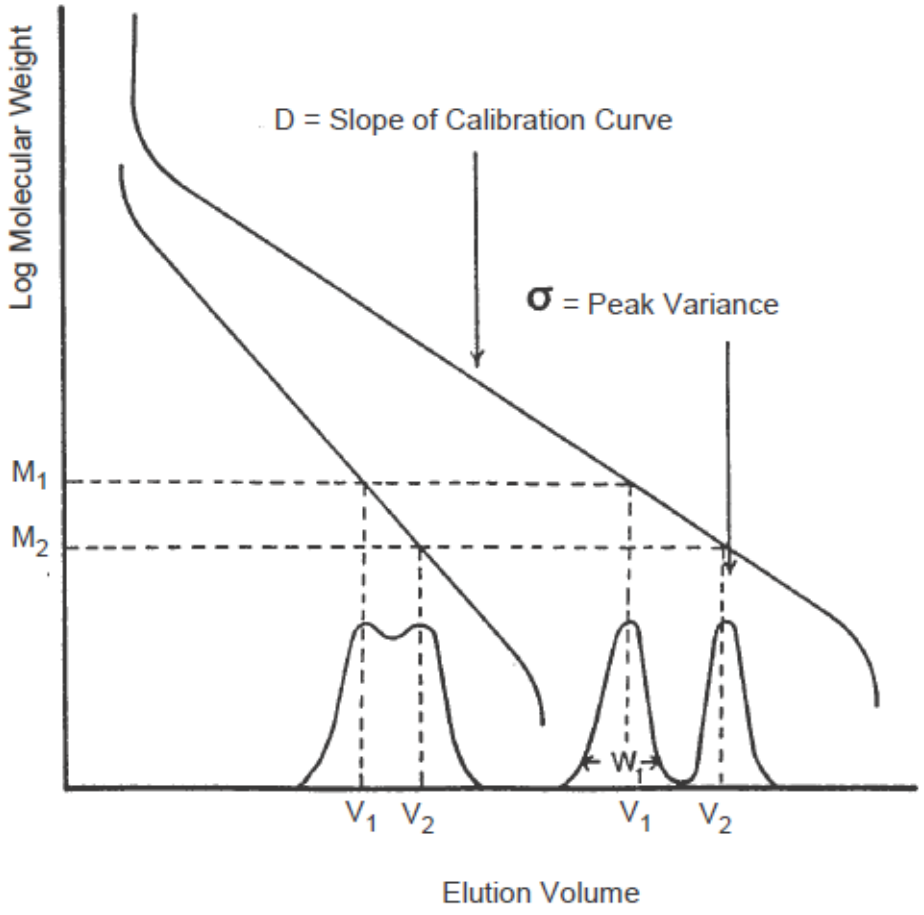
More than one column is typically used
More columns = improved resolution

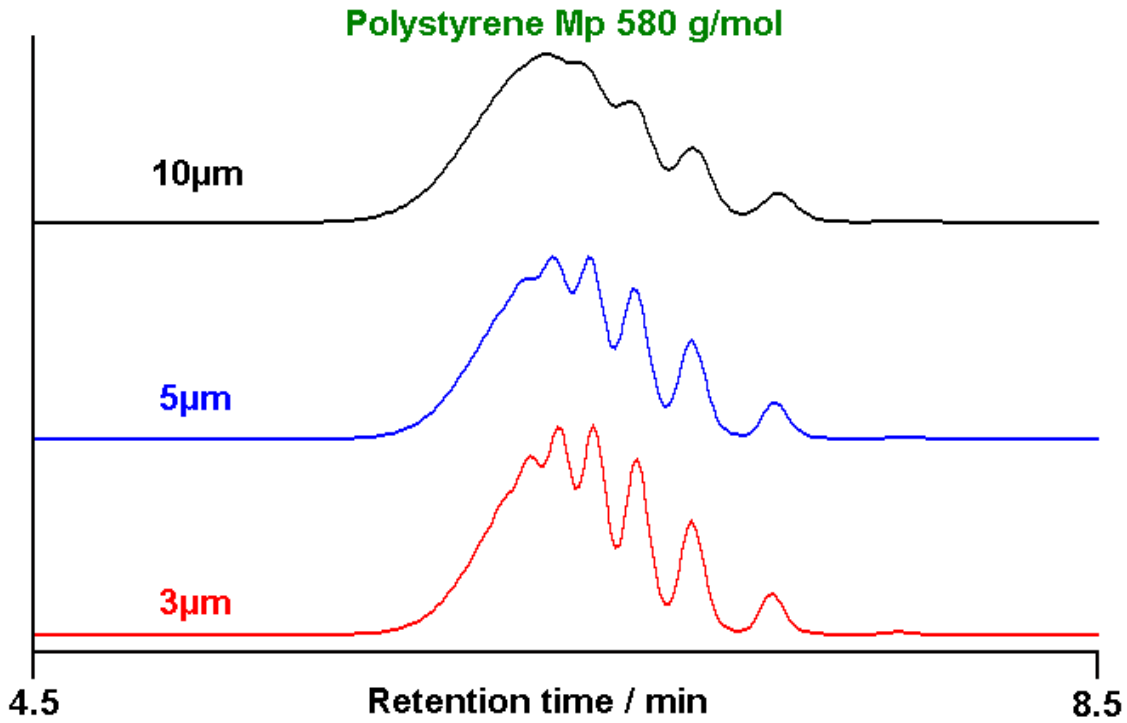
- The greater the particle size of the media in the column (which is dependent on the expected molecular weight of the samples), the lower the resolution. More columns will be required to maintain the quality of the results.
- For higher molecular weight samples, larger particles are necessary to reduce the danger of shear degradation of samples.

Particle Size	Number of Columns
20 µm	4
13 µm	3
10 µm	3
8 µm	3
5 µm	2
3 µm	2

Resolution Too Low

Column length and particle size





Eluent:	THF
Flow rate:	1.0 mL/min
Inj vol:	20 µL
Detector:	DRI

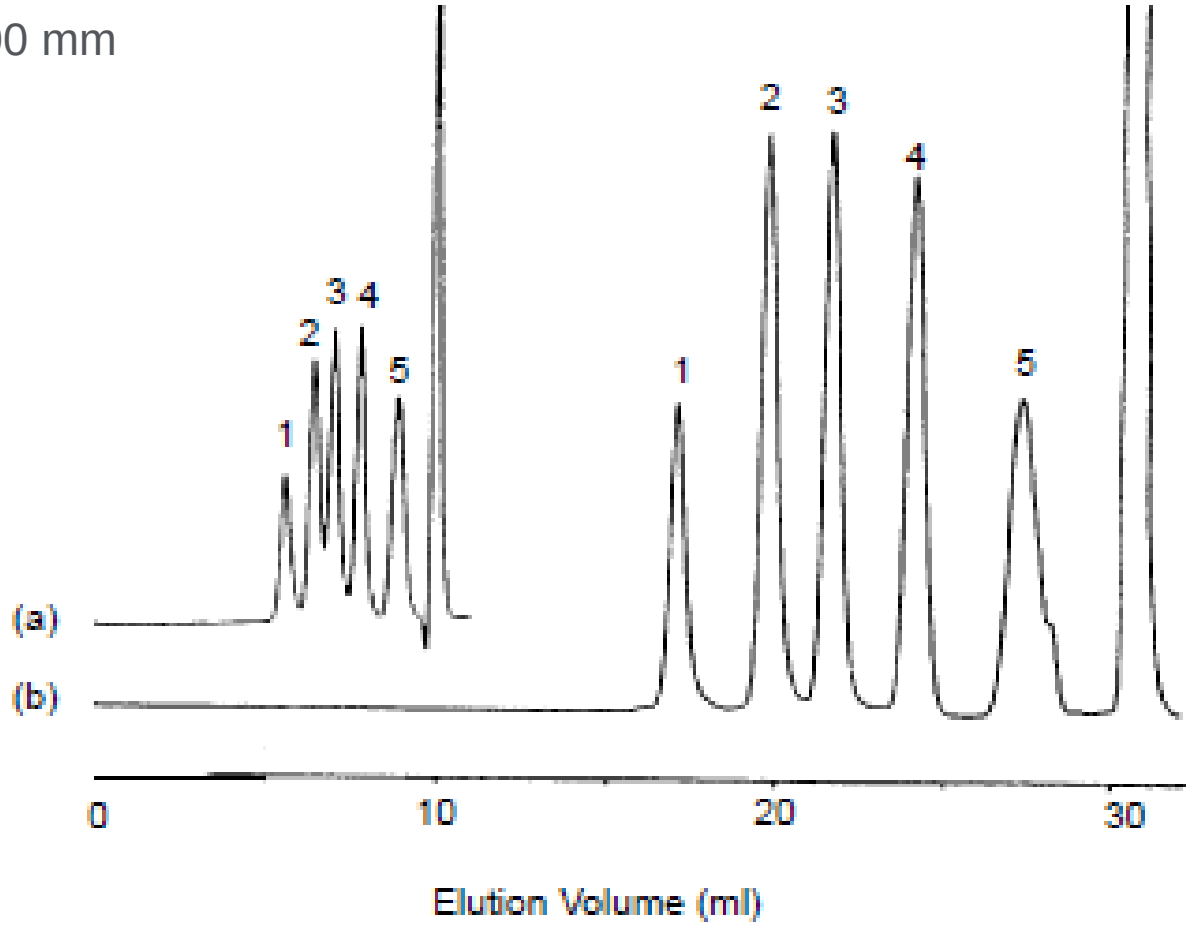
GPC Column Selection

Effect of column length on resolution

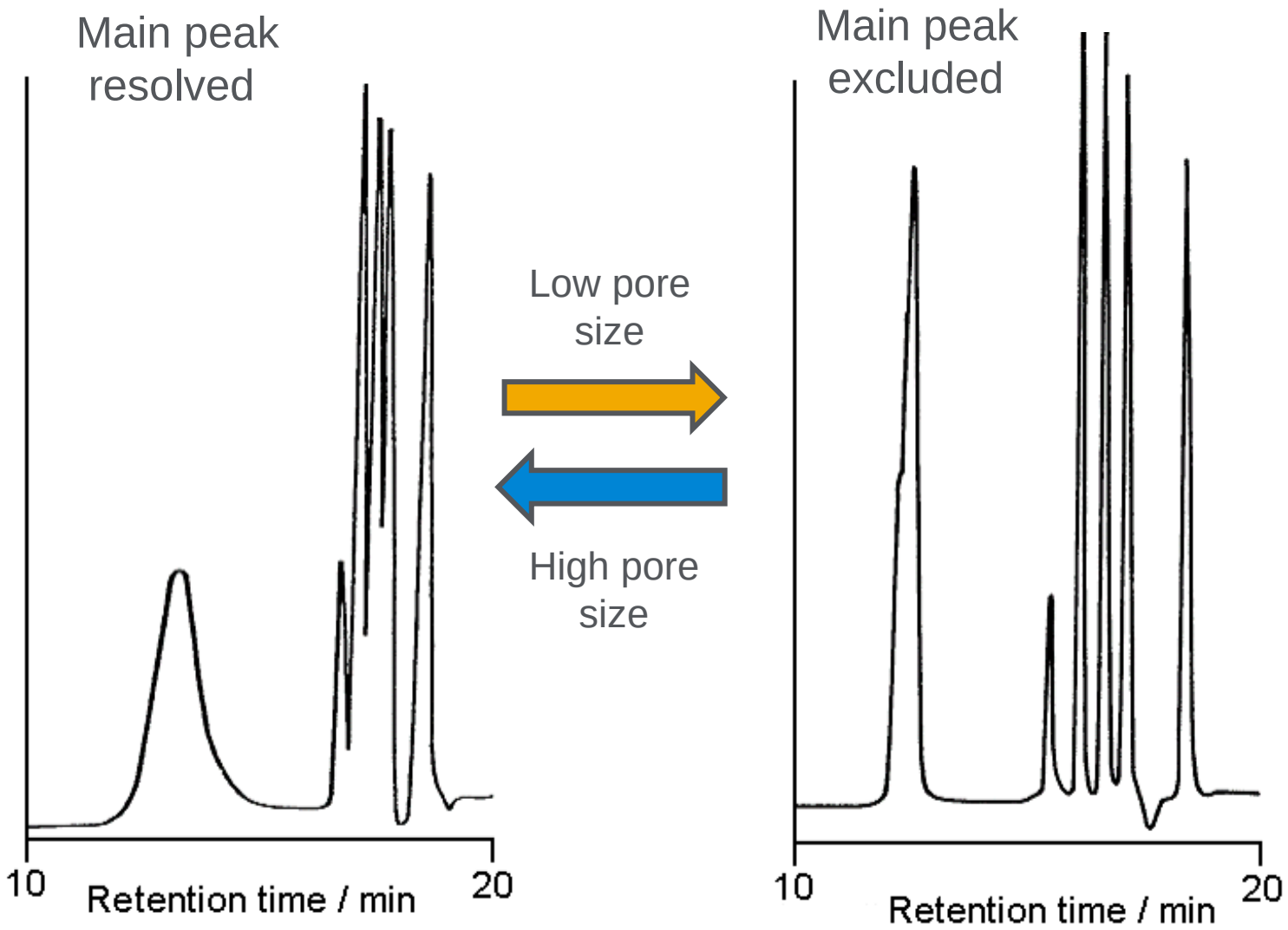
Columns: 1 x PLgel, 10 µm, MIXED-B, 7.5 x 300 mm
p/n PL1110-6100
3 x PLgel, 10 µm, MIXED-B, 7.5 x 300 mm
p/n PL1110-6100
Eluent: THF
Flow rate: 1 mL/min
Detector: RI

Polystyrene standards
Easical

1. 3,040,000
2. 330,000
3. 66,000
4. 9200
5. 580

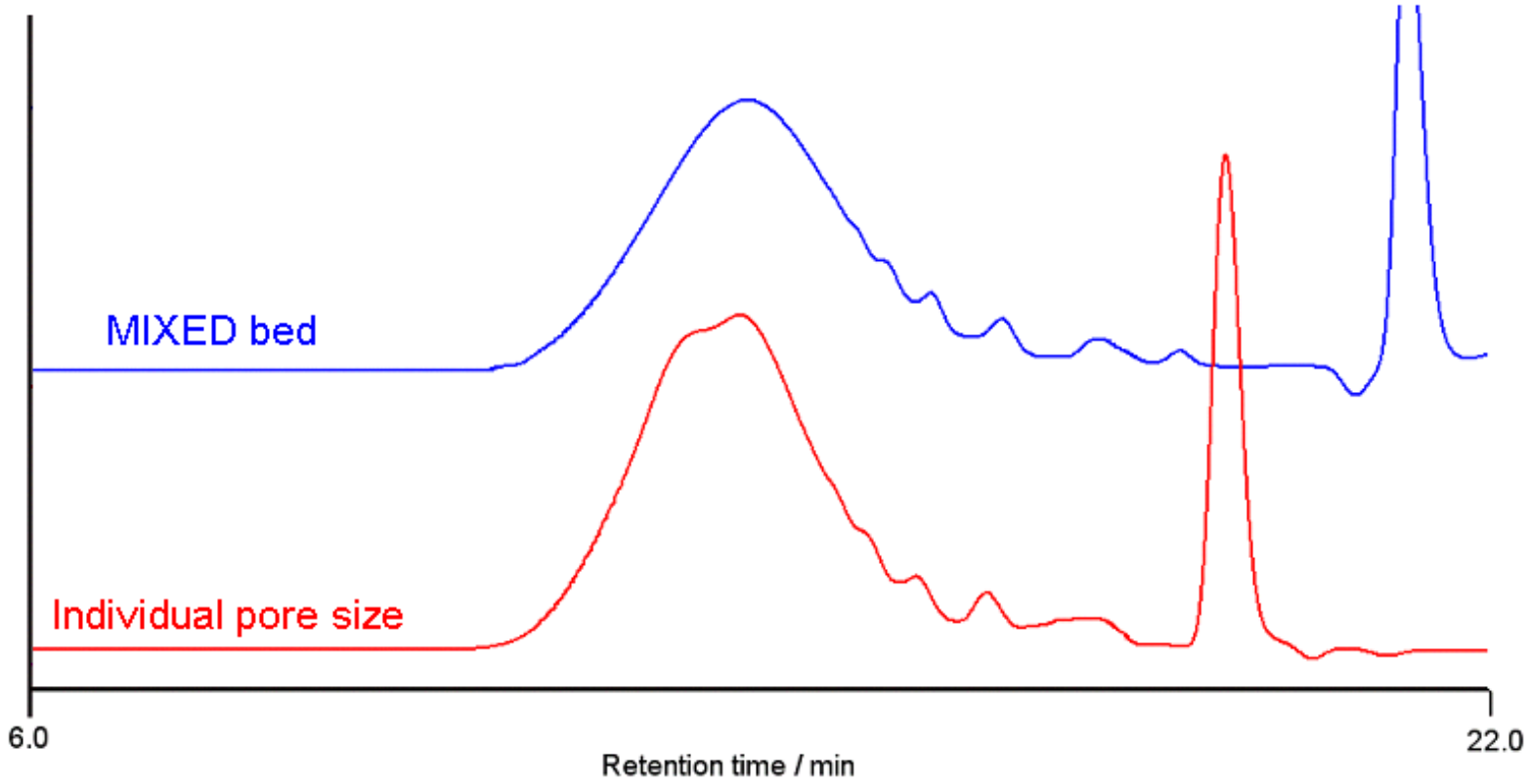


Resolution: Pore Size Selection

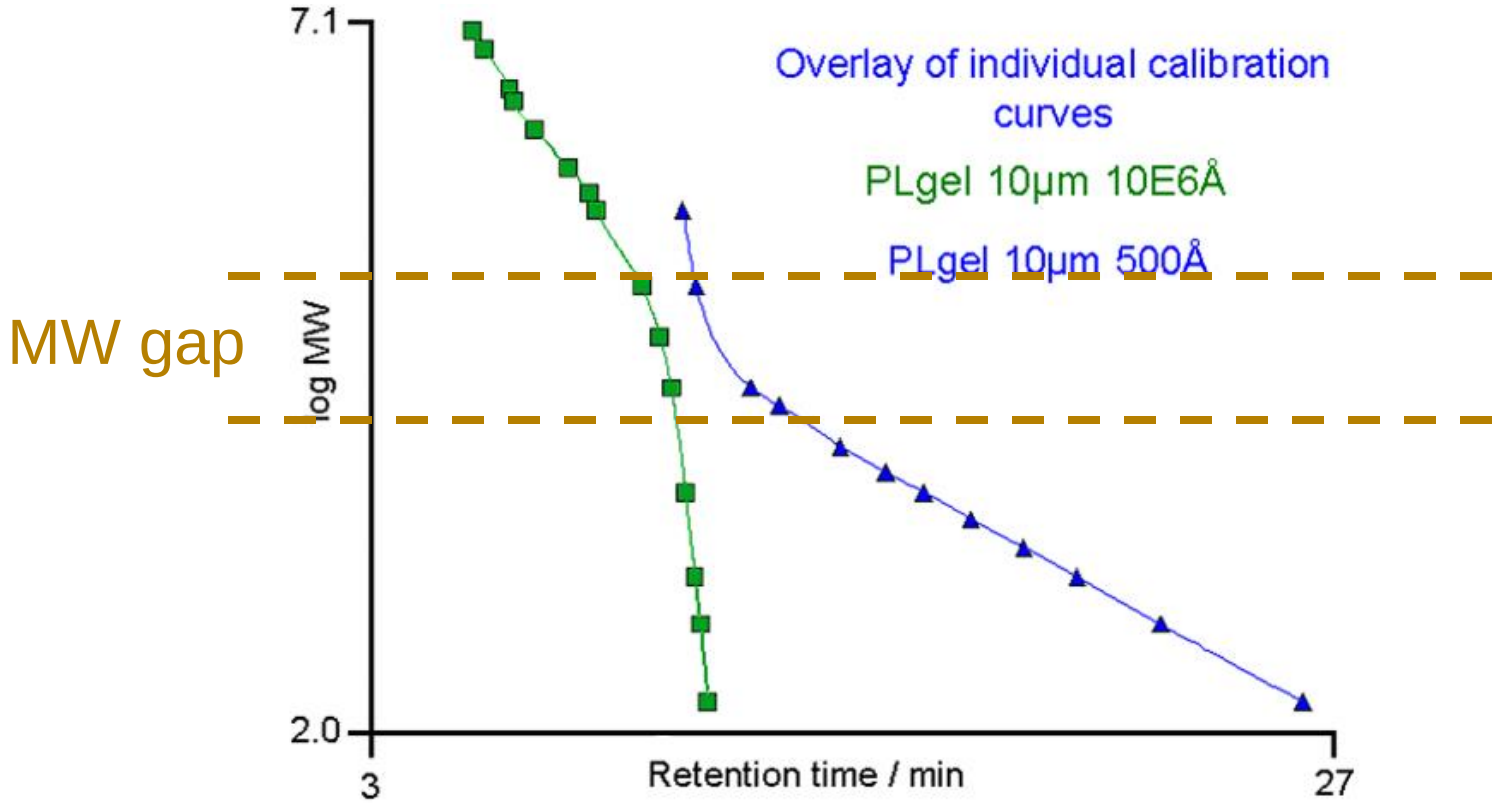


Results Not Reproducible

Individual pore versus MIXED for our sample



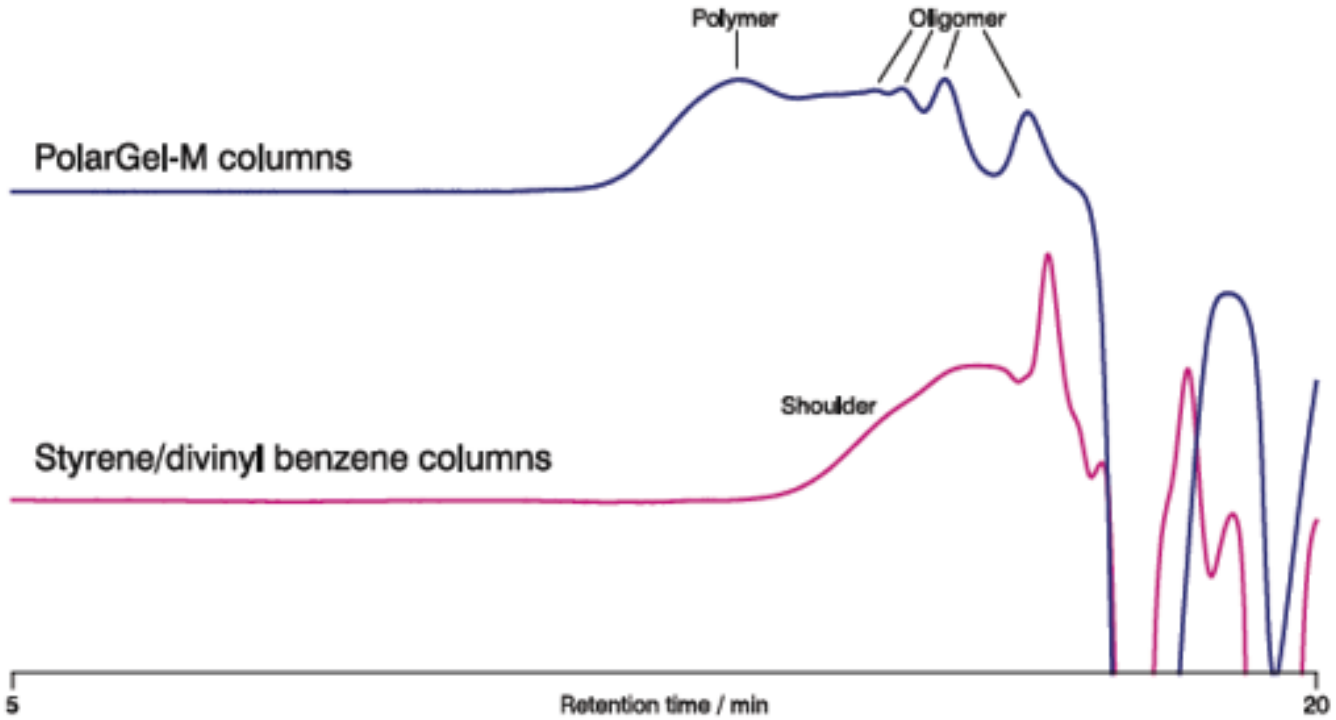
Wrongly Coupled Columns



- MW gap between linear ranges
- Changes retention and gives unusual peak shapes

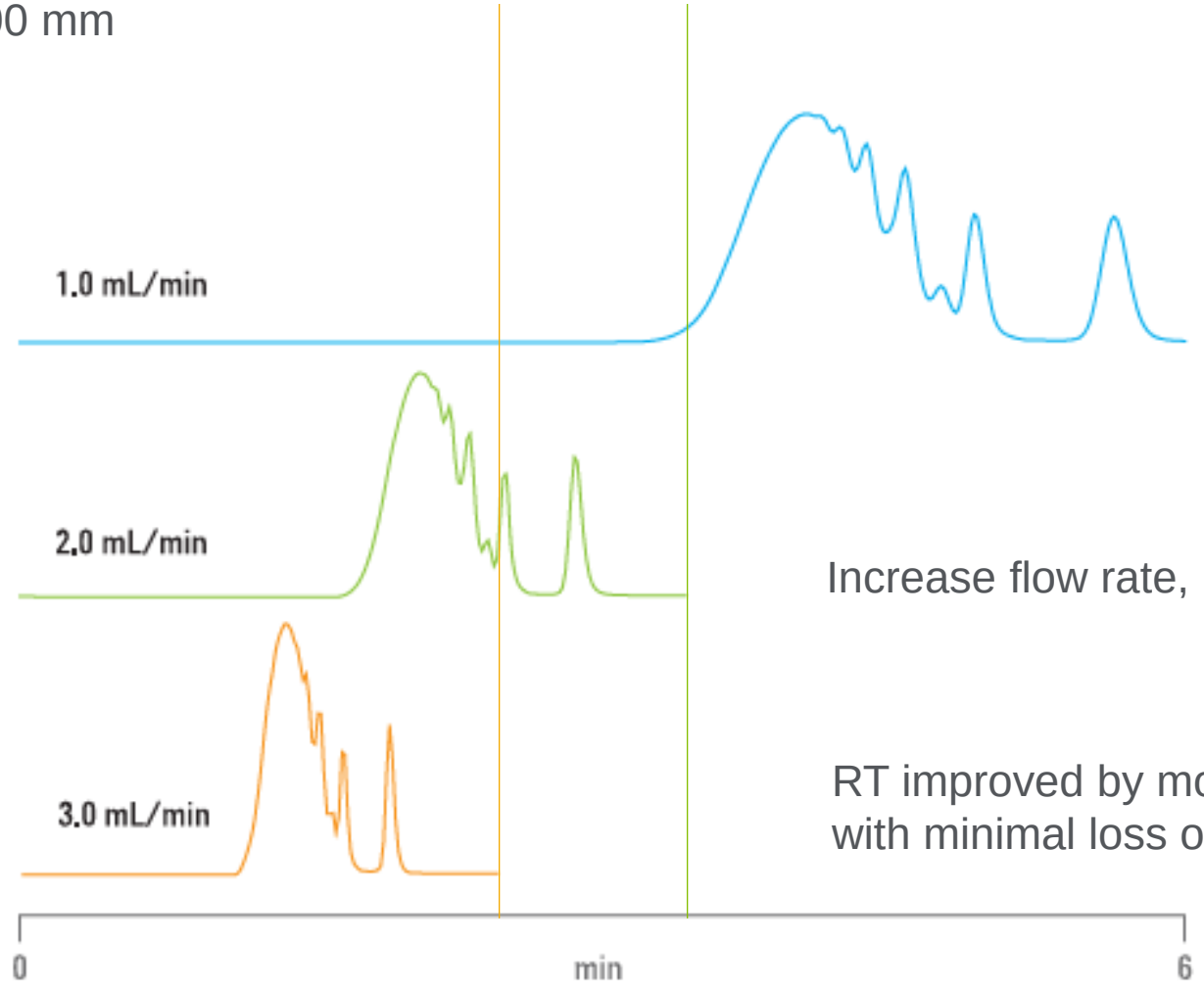
Correct Column Choice

Peak shapes of polar compounds improved using Polargel



Run Time Too Long
Rapide columns for fast trend analysis

Column: PL Rapide L, 10 x 100 mm
Sample: Epoxy resin
Eluent: THF
Flow rate: As noted
Detector: UV, 254 nm

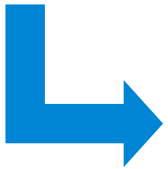


Increase flow rate, RT improved

RT improved by more than half
with minimal loss of sample resolution

Common Questions Around GPC/SEC Standards

What standards to use?



What is the eluent/mobile phase?

Solvent Type	GPC/SEC Standards Type
Organic	• Polystyrene (PS) • Polymethylmethacrylate (PM)
Mixed or Polar Organic	• Polymethylmethacrylate (PM) • Polyethylene glycol/oxide (PEG/PEO)
Aqueous	• Polyethylene glycol/oxide (PEG/PEO) • Polysaccharide (SAC) • Polyacrylic acid (PAA)

Agilent Polymer Calibration Standard Offerings

Which **type** of kits best suits my needs?

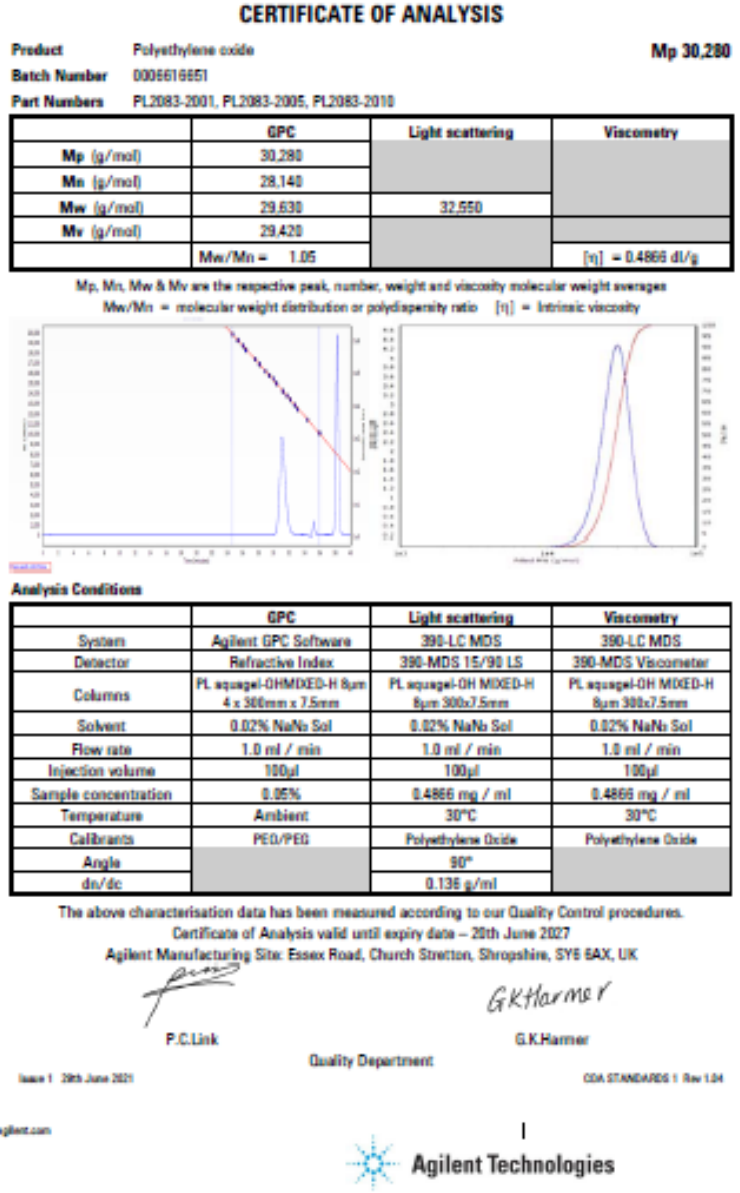
- EasiVial – pre-prepared for fast and easy, accurate concentration, 12-point column calibration for organic and aqueous solvents
- EasiCal – easy 3-step process for accurate 10-point calibration, for organic solvents
- Calibration kits and individual standards – Polystyrene, PMMA, PEG/PEO, Polysaccharide

Agilent GPC/SEC Polymer Standards, publication number: 5994-7996EN

Well Characterized Polymer Standards

Example Certificates of Analysis

- Agilent standards are manufactured under an ISO 9001:2008 approved quality system.
- Each standard is fully traceable with a unique batch number and provided with a complete certification of analysis (CoA).
- Finally, all CoAs include details of the exact method and characterization results for maximum transparency and reproducibility.



CERTIFICATE OF ANALYSIS

Product Polyethylene oxide — Mp 30,280

Batch Number 0006616651

Part Numbers PL2083-2001, PL2083-2005, PL2083-2010

	GPC	Light scattering	Viscometry
Mp (g/mol)	30,280		
Mn (g/mol)	28,140		
Mw (g/mol)	29,630	32,550	
Mv (g/mol)	29,420		
	Mw/Mn = 1.05		[η] = 0.4866 dl/g

Mp, Mn, Mw & Mv are the respective peak, number, weight and viscosity molecular weight averages
Mw/Mn = molecular weight distribution or polydispersity ratio [η] = Intrinsic viscosity

Analysis Conditions

	GPC	Light scattering	Viscometry
System	Agilent GPC Software	390-LC MDS	390-LC MDS
Detector	Refractive Index	390-MDS 15/90 LS	390-MDS Viscometer
Columns	PL aquagel-OH MIXED-H 8µm 4 x 300mm x 7.5mm	PL aquagel-OH MIXED-H 8µm 300x7.5mm	PL aquagel-OH MIXED-H 8µm 300x7.5mm
Solvent	0.02% NaN3 Sol	0.02% NaN3 Sol	0.02% NaN3 Sol
Flow rate	1.0 ml / min	1.0 ml / min	1.0 ml / min
Injection volume	100µl	100µl	100µl
Sample concentration	0.05%	0.4866 mg / ml	0.4866 mg / ml
Temperature	Ambient	30°C	30°C
Calibrants	PEO/PEG	Polyethylene Oxide	Polyethylene Oxide
Angle		90°	
dn/dc		0.135 g/ml	

The above characterisation data has been measured according to our Quality Control procedures.
Certificate of Analysis valid until expiry date – 20th June 2027
Agilent Manufacturing Site: Essex Road, Church Stretton, Shropshire, SY6 6AX, UK

P.C.Link — G.K.Harmer

Quality Department

Issue 1 20th June 2021 — CDA STANDARDS 1 Rev 1.04

www.agilent.com

Agilent Technologies

Example: Individual standard certificate

Easivial Certificate of Analysis

CERTIFICATE OF ANALYSIS

Product Polystyrene Medium EasiVials (2ml)

Part Numbers PL2010-0301, PL2010-0302, PL2010-0700

Batch Number 0006676796

Vial Code	IV (dL/g)	Mw (g/mol) (Light Scattering)	Mn (g/mol)	Mw (g/mol)	Mw/Mn	Mp (g/mol)	Mass/vial (mg)
RED	1.0263	319,200	348,500	364,700	1.05	**364,000**	0.4
	0.2543	50,800	46,950	48,900	1.04	**49,350**	0.8
	0.0691	7,090	6,090	6,260	1.03	**6,250**	1.2
	0.0264	1,100	890	950	1.07	**935**	1.6
YELLOW	0.6739	191,900	197,000	204,100	1.04	**200,500**	0.4
	0.1757	29,960	27,600	28,250	1.02	**28,440**	0.8
	0.0503	3,920	3,190	3,310	1.04	**3,320**	1.2
	0.0262	445	410	450	1.10	**370**	1.6
GREEN	0.3849	90,300	86,150	88,350	1.03	**89,050**	0.4
	0.1095	14,330	13,250	13,530	1.02	**13,440**	0.8
	0.0329	1,370	1,100	1,170	1.06	**1,180**	1.2
	-	-	-	-	1.00	**162**	1.6**

** Due to the volatile nature of this constituent weights may vary.

Mp, Mn & Mw are the respective peak, number and weight molecular weight averages.
Mw/Mn = molecular weight distribution or polydispersity ratio.
IV is the intrinsic viscosity value

The above characterisation data has been measured according to our Quality Control procedures.
Certificate of Analysis valid until expiry date: 28th April 2027
Agilent Manufacturing Site: Essex Road, Church Stretton, Shropshire, SY6 6AX, UK

Storage:
The polymers in each vial should be stored in a cool dark place when not in use. After preparation, the polymer solutions should be stored in a cool, dark place and used within 1 week.

P.C.Link M.Griffin

Q.C. Department

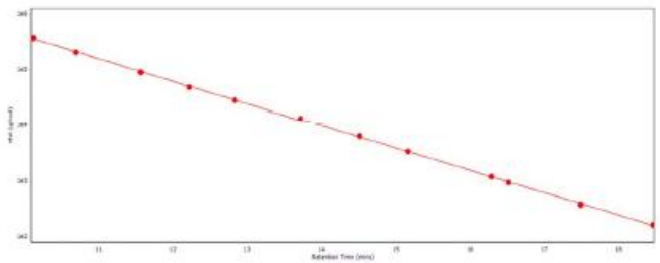
Issue 1 6th May 2022 COA STANDARDS5-3 Rev 2.21

Page 1 of 2

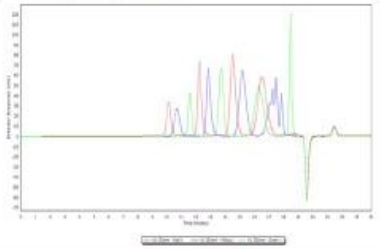
www.agilent.com

Agilent Technologies

GPC/SEC Calibration Curve



GPC/SEC EasiVials Overlay



Calibration Details

System	Agilent GPC software
Detector	Ultra Violet
Columns	2 x PLgel MIXED-D 5µm 300 x 7.5mm
Solvent	THF
Flow rate	1.0 ml / min
Injection volume	20µl
Sample concentration	1ml solvent / vial
Temperature	Ambient

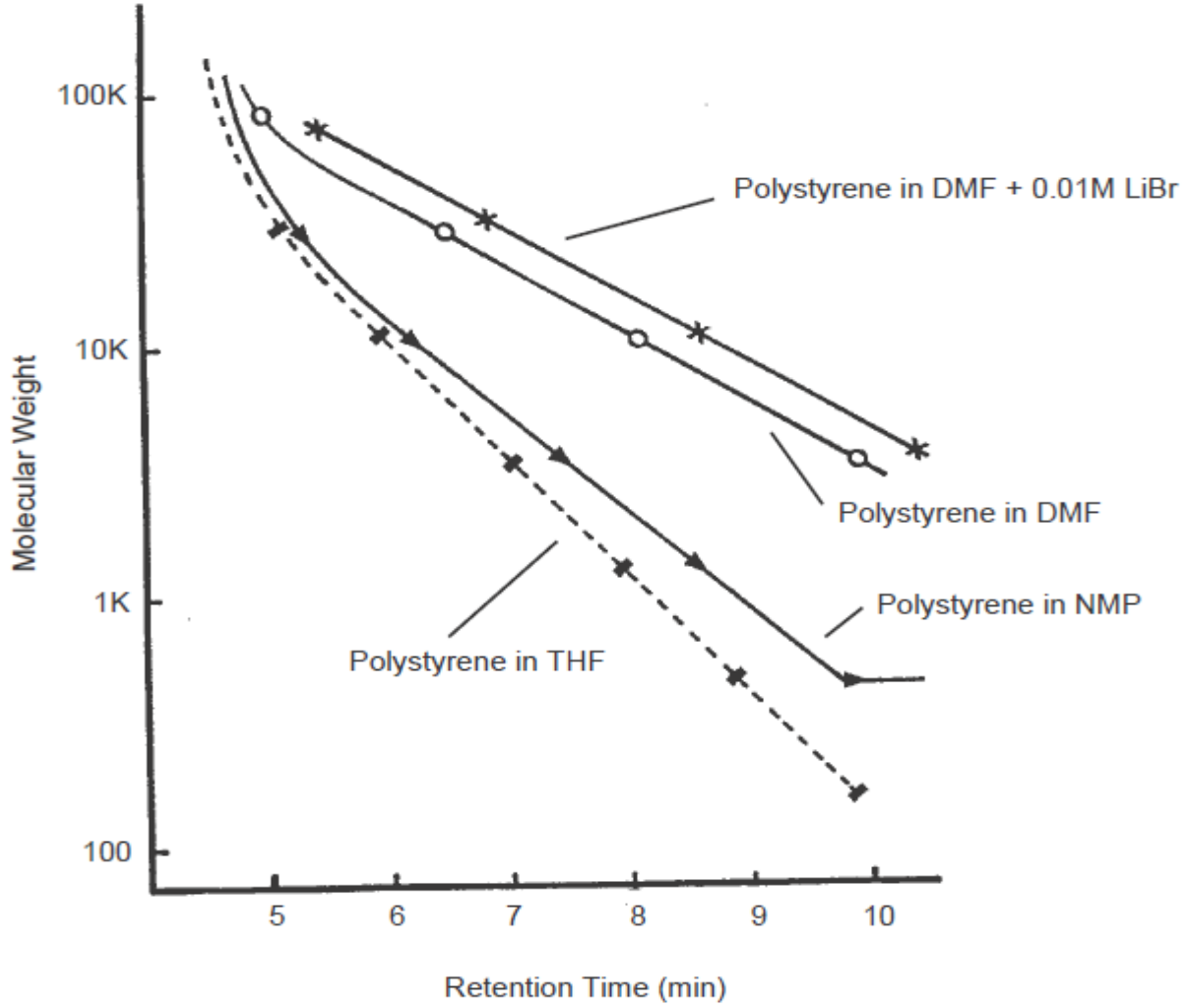
Page 2 of 2

www.agilent.com

Agilent Technologies

GPC/SEC Standards

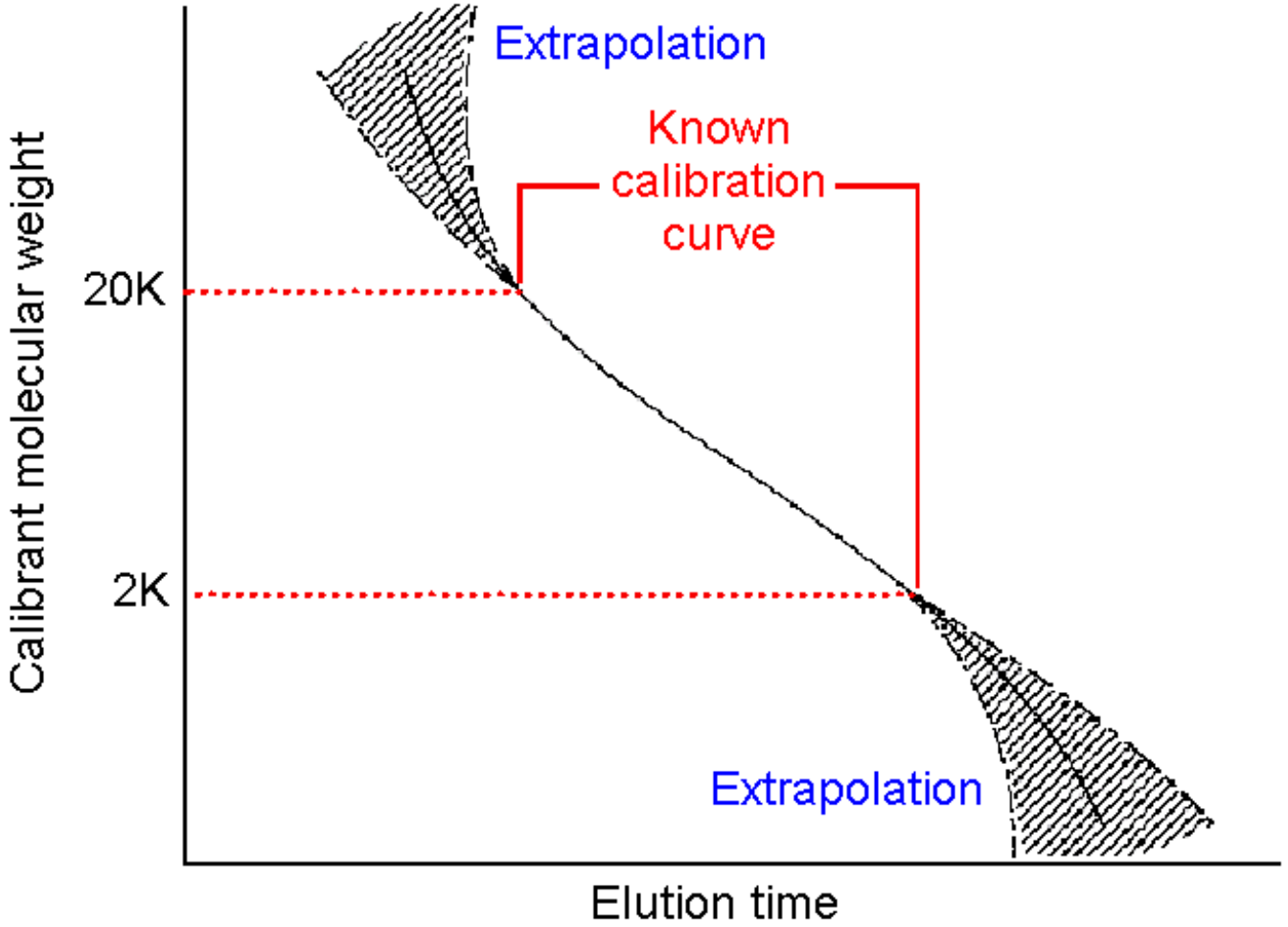
Importance of solvent selection



Example: PS/DVB columns are excellent in many solvents, but remember that, although the column may be used in certain solvents, this does not mean SEC will occur. The example here is polystyrene standards running in NMP, DMF.

Calibrate for the Column's MW Range

Importance for sample MW calculations

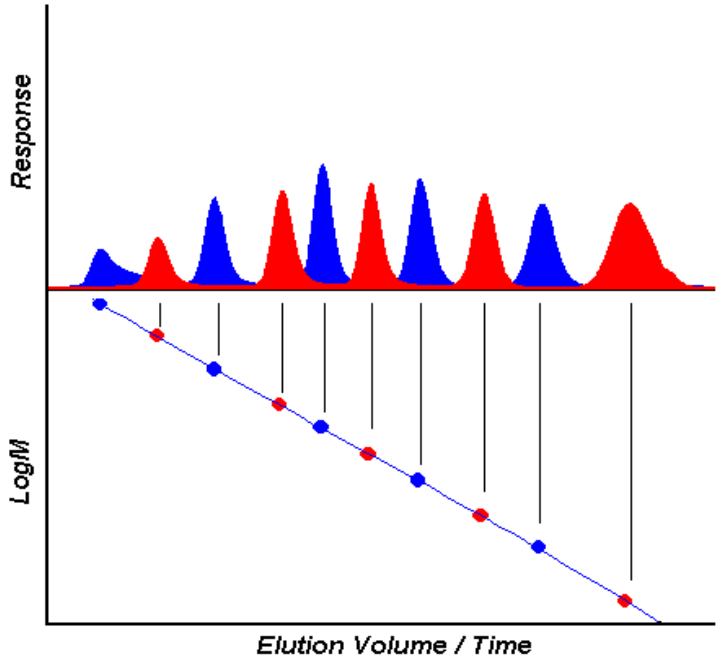


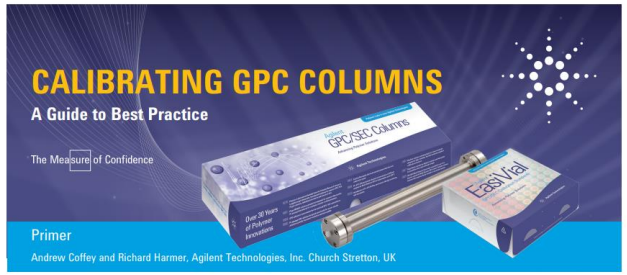
The choice of polymer standards for the column calibration should cover the full elution time region of the sample to avoid errors due to extrapolation.

Common Questions Around GPC/SEC Standards

How often should you calibrate?

- Calibration frequency is subjective. At minimum, once a week is suggested if no major changes occur with system/columns.
- Recalibration is essential whenever a component of the system is altered or there is an eluent or column change.
- Calibrating frequently can also help identify potential issues quickly and corrective/preventative steps can then be put into effect immediately.



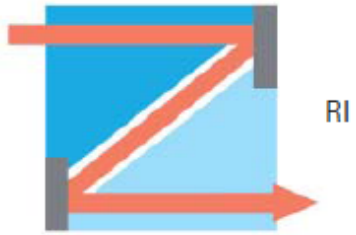


Publication number: 5991-2720EN

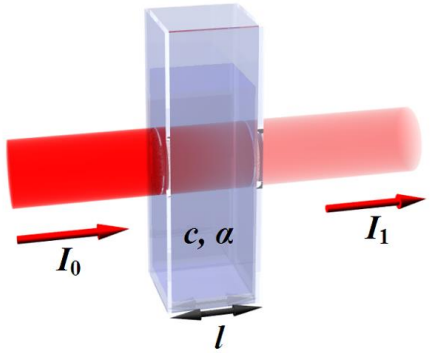
Detectors

Concentration detectors

Most common detectors for GPC/SEC are *concentration* detectors:



RID



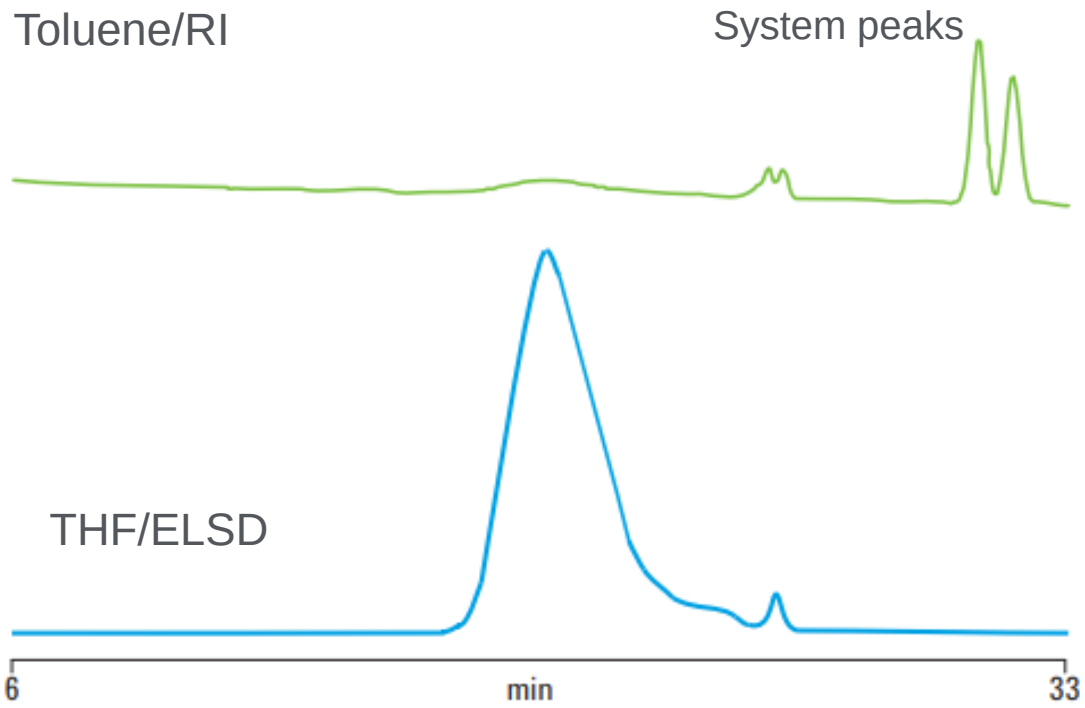
UV/DAD

ELSD

These provide information on the amount of polymer or sample eluting from the column at any given time.

System Detection

Choice of solvent and detection



Column:	3 x PLgel, 5 µm, MIXED-D
	7.5 x 300 mm, p/n PL1110-6504
Eluent:	Toluene or THF
Flow rate:	1.0 mL/min
Sample:	Polysiloxane, 0.2% w/v
Injection vol:	100 µL

Application note publication number: 5990-7897EN

Expanding Conventional GPC/SEC

Addition of viscometer and light scattering detectors

Advanced detectors give a greater understanding of the analyte as well as overcoming the limitations of conventional GPC.

GPC/SEC Technique	Molecular Weight	Molecular Size	Information
Conventional (RI or UV)	Relative to standards used for calibration	No	Molecular weight distribution, concentration
Viscometry	More accurate from universal calibration	Yes, hydrodynamic radius (Rh)	Conformation, branching. Works with copolymers
Light scattering	Absolute determination	Yes, radius of gyration (Rg) directly	Conformation, branching
Triple	Absolute determination	Yes, Rg and Rh, directly	The ultimate configuration for comprehensive polymer characterization

Agilent InfinityLab II 1260 with MDS

Your GPC/SEC Toolbox

Consumables to have on hand

Sample preparation

- Sample filters
- Syringes

Sample handling

- Vials and Caps

Mobile phase solvents

- Filtration
- Solvent containment and caps
- Inlet filters

System consumables

- Pump frits and piston seals
- Needle
- Needle seat
- Loop capillary
- Rotor seal
- Stainless steel capillary tubing
- Fittings/ferrules
- Waste tubing

[InfinityLab LC Supplies Guide (agilent.com)]

Agilent Acquires Polymer Standards Service GMbH – PSS

Broadening offerings for GPC/SEC polymer analysis – August 2, 2022

A Part of Agilent

Products from PSS to broaden and extend the Agilent portfolio

GPC/SEC/GFC chromatography columns

Polymer standards, reference materials, and kits

Chromatography systems and software

In the US and Canada, integration of the PSS GPC/SEC products is now complete, and columns and standards can be ordered through Agilent.

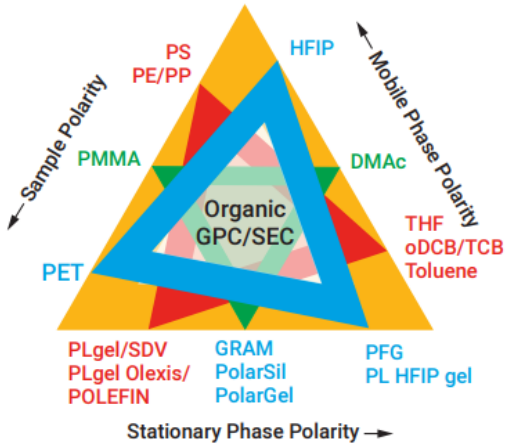
Visit Agilent website: [GPC/SEC Columns & Standards | Agilent]

Familiar PSS Products – Now a Part of Agilent

Column Product Name	Packing	Typical Solvents	Application Areas
SDV	Styrene divinylbenzene copolymer	THF, Toluene, TCM, DCM	Poly(styrene), poly(vinyl chloride), poly(carbonate), elastomers, resins and other
GRAM	Polyester copolymer	DMF, DMAc, NMP, DMSO	Polyurethane, polyimide, starches, cellulose, certain polyamide, other polar polymers
PolarSil	Polar modified silica	DMF, DMAc, NMP, DMSO	Low-to-medium molar mass resins and lignins
PFG	Polar modified silica	HFIP, TFE, other fluorinated solvents	Crystalline polymers, polyesters, polyamides, poly(lactides), POM
POLEFIN	Modified styrene-divinylbenzene copolymer	TCB, o-DCB, Decalin	Poly(ethylene), poly(propylene), other polyolefins

Organic GPC Columns

- Column particle sizes: 3 µm to 20 µm
- Column sizes: analytical to preparative sizes
- Column types: Individual pore and MIXED/linear type column packings



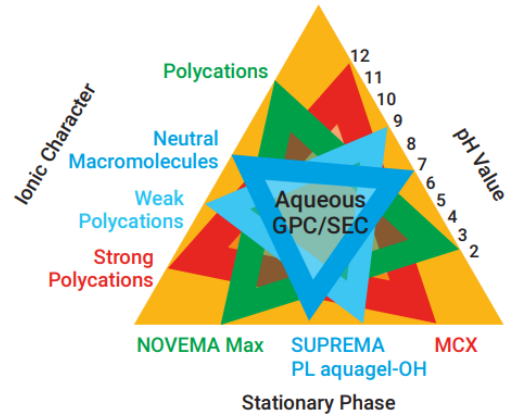
[Organic GPC Columns | Agilent]

Familiar PSS Products – Now a Part of Agilent

Column Product Name	Packing	Typical Solvents	Application Areas
SUPREMA	Modified acrylate copolymer	Water (with salts/buffers, MeOH, ACN) pH: 1.5 – 13	Neutral and anionic polymers (PEO, PEG, pullulan, dextran, poly(acrylamide), hyaluronic acid, poly(acrylic acid), carboxymethyl cellulose)
NOVEMA Max	NH-functionalized acrylate copolymer	Water, water with salt/buffer, MeOH, ACN, TFA; pH: 1.5 – 7.0	Cationic polymers, (polymeric quaternary ammonium Compounds, poly(DADMAC), poly(vinylpyridine),chitosan, poly(ethylene imine)
MCX	Sulfonated styrene-divinylbenzene copolymer	Water, water with salt/buffer, MeOH, ACN; pH: 7 – 13	Sulfonated polyanions, poly(styrene sulfonate), lignin sulfonate Modified starches, acids, alcohols, pectins
PROTEMA	Special modified silica	Water, water with salt/buffer, MeOH, ACN; pH: <7	Natural and synthetic proteins, peptides, enzymes, gelatins/collagens

Column particle sizes: 5 µm and 10 µm, 3 µm and 5 µm in PROTEMA
Column sizes: Analytical to preparative sizes

Column types: Individual pore and MIXED/linear type column packings



Other PSS Products – Now a Part of Agilent

A Part of Agilent

Polymer standards, reference materials, and kits – many polymer options

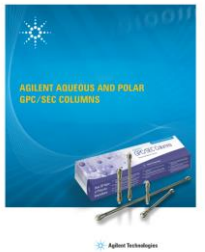
- Individual Standards
- GPC/SEC calibration kits – conventional kits, ReadyCal
- Validation kits – ReadyValid
- Specialty polymers and particle standards

Chromatography systems, detectors, and analysis software

Agilent weblink: [GPC/SEC Standards | Agilent]

GPC/SEC Columns and Supplies Resources

- Agilent webpage GPC/SEC: GPC/SEC Columns & Standards | Agilent
- **Expanded** Portfolio GPC/SEC Columns and Standards: Agilent GPC/SEC Columns and Standards Brochure
- Organic GPC Columns: Organic GPC Columns | Agilent
- Aqueous SEC Columns: Aqueous SEC Columns | Agilent
- GPC/SEC Polymer Standards: GPC/SEC Standards | Agilent
- GPC/SEC User Guide: GPC/SEC column user guide
- Polymer to Solvent Reference Table: Polymer to Solvent Reference Table
- GPC Troubleshooting poster: GPC Troubleshooting Guide
- InfinityLab Supplies catalog: InfinityLab LC Supplies (agilent.com)
- Consumables Community: Agilent Collection of Columns, Supplies, and Standards Resources - Consumables - Agilent Community
- App finder: Application Finder | Agilent
- Agilent University: Agilent University
- Your local product specialists
- Webinars, upcoming and recorded: LC and LC/MS Column Webinars | Agilent



Contact Agilent Chemistries and Supplies Technical Support

Available in the U.S. and Canada, 8-5 all time zones

1-800-227-9770 option 3, option 3:

Option 1 for GC and GC/MS columns and supplies

Option 2 for LC and LC/MS columns and supplies

Option 3 for sample preparation, filtration, and QuEChERS

Option 4 for spectroscopy supplies

Option 5 for chemical standards

Option 6 for Prozyme products

gc-column-support@agilent.com

lc-column-support@agilent.com

spp-support@agilent.com

spectro-supplies-support@agilent.com

chem-standards-support@agilent.com

pzi.info@agilent.com

Agilent

Trusted Answers