AGILENT AQUEOUS AND POLAR GPC/SEC COLUMNS

Agilent Technologies
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1976
PLgel columns, individual standards, and standard kits
Polymer Laboratories founded to develop market-leading products for organic GPC/SEC

1981
PLgel MIXED columns, PL aquagel columns
MIXED columns improve data quality, and novel chemistries for analysis of water-soluble polymers

1984
GPC software
Dedicated software streamlines GPC/SEC calculations

1993
EasiCal standards
New format shortens sample preparation time and the speed of calibration

1999
PL-GPC 220 instrument
Market-leading high temperature GPC system for even the most difficult samples at temperatures up to 220 °C
AGILENT GPC/SEC COLUMNS

For molecular weight separation in aqueous and polar solvents

Tough
Agilent GPC/SEC columns set the standard for robustness and lifetime across a wide range of solvents and conditions. This uncompromising quality has made it the workhorse of the analytical industry for over 35 years.

Inert
The neutral surface and the ability to operate across a wide range of eluent conditions allows for high performance analyses of compounds with neutral, ionic and hydrophobic moieties.

Fast
The unmatched chemical and physical stability of Agilent’s GPC/SEC media allows for wider pores and larger volumes, which translates to faster separations, higher resolution, and reduced cost-of-analysis.

2004
PlusPore columns and EasiVial standards
New chemistries deliver high-pore-volume materials for increased resolution, and EasiVial standards simplify calibration procedures even further

2007
PLgel Olexis columns
Optimized for polyolefin analysis with highest resolution and data quality for even ultrahigh molecular weight samples

2009
1260 Infinity Multi Detector Suite and PolarGel columns
The 1260 Infinity MDS turns any LC into a powerful multi-detector GPC system, and PolarGel columns analyze polar samples in any solvent system

2015
The 1260 Infinity II Multi-Detector GPC/SEC System
The first choice for accurate, reproducible polymer analysis. Select any combination of light scattering, viscometry and refractive index detection for absolute molecular weights and sizes.

2017
PL MultiSolvent GPC columns
The newest addition to the InfinityLab GPC family, offering solvent flexibility for a variety of GPC analyses all on one column.
High performance size exclusion chromatography across solvents

- Polymer-coated silica offers excellent resolution without sticking
- Special amphoteric surface chemistry is compatible with aqueous, polar organic, and nonpolar solvents and samples
- Short, efficient, and fast, these columns maximize instrument throughput and minimize labor costs

Characteristics:
- pH range: 2 to 8.5
- Solvent compatibility: Water, Buffer, Chloroform, Dichloromethane, THF
- Typical pressure: < 200 bar (2900 psi) (aqueous buffer)
- Maximum pressure: 400 bar (5800 psi)
- Maximum temperature: 80 °C

Recommended calibrants:
- For aqueous solvents:
  - EasiVial PEG/PEO for convenient 12 point calibration in three preweighed vials (2 mL vials: PL2080-0201 4 mL vials: PL2080-0200)
- For polar solvents:
  - EasiVial PMMA for convenient 12 point calibration in three preweighed vials (2 mL vials: PL2020-0201 4 mL vials: PL2020-0200)

Polystyrene calibration curves in various solvents

Polymethylmethacrylate calibration curves in various solvents
Fast separation of an epoxy sample in dichloromethane

MW distribution of epoxy sample

A switch to aqueous buffer and rapid analysis of dextrin

MW distribution of dextrin sample
### Ordering information

**InfinityLab PL Multisolvent**

<table>
<thead>
<tr>
<th>Description</th>
<th>MW range (g/mol) (PEG/PEO)</th>
<th>Guaranteed efficiency (p/m)</th>
<th>Part No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>InfinityLab PL Multisolvent 20, 4.6 x 150 mm</td>
<td>up to 30,000</td>
<td>&gt; 90,000 (50 mm)</td>
<td>PL1515-3321</td>
</tr>
<tr>
<td>InfinityLab PL Multisolvent 20, 4.6 x 50 mm</td>
<td></td>
<td>&gt; 100,000 (150 mm)</td>
<td>PL1515-1321</td>
</tr>
<tr>
<td>InfinityLab PL Multisolvent 20, 7.8 x 150 mm</td>
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<td></td>
<td>PL1015-3321</td>
</tr>
<tr>
<td>InfinityLab PL Multisolvent 20, 7.8 x 50 mm</td>
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<td></td>
<td>PL1015-1321</td>
</tr>
<tr>
<td>InfinityLab PL Multisolvent 30, 4.6 x 150 mm</td>
<td>2,000 to 100,000</td>
<td>&gt; 90,000 (50 mm)</td>
<td>PL1515-3323</td>
</tr>
<tr>
<td>InfinityLab PL Multisolvent 30, 4.6 x 50 mm</td>
<td></td>
<td>&gt; 100,000 (150 mm)</td>
<td>PL1515-1323</td>
</tr>
<tr>
<td>InfinityLab PL Multisolvent 30, 7.8 x 150 mm</td>
<td></td>
<td></td>
<td>PL1015-3323</td>
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<td>InfinityLab PL Multisolvent 30, 7.8 x 50 mm</td>
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<td>PL1015-1323</td>
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</tbody>
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**Agilent InfinityLab**

**Maximize Your LC Workflow Efficiency**

How can you make your LC workflow more efficient, so you can spend more time on your analytical priorities?

Find out—with Agilent InfinityLab—an optimized portfolio of LC instruments, columns, and supplies designed to work together in perfect harmony.

Learn more at:

[www.agilent.com/chem/infinitylab](http://www.agilent.com/chem/infinitylab)
PL AQUAGEL-OH SEC COLUMNS

High performance aqueous size exclusion chromatography

- Highly stable matrix ensures reliable separations, even with modified eluents
- MIXED columns cover a wide spread of molecular weights, eliminating dislocations and inaccurate measurements
- Highly inert towards neutral, polar, anionic, and cationic samples

Characteristics:

- pH range: 2-10
- Solvent compatibility: Water and buffers containing up to 50% methanol
- Typical pressure: <30 bar (435 psi)
- Maximum pressure: 140 bar (2030 psi)
- Maximum temperature: 90 ºC

Recommended calibrants:

For PL aquagel-OH 5 µm columns:
- EasiVial PEG for convenient 12 point calibration in three preweighed vials
  (2 mL vials: PL2070-0201 4 mL vials: PL2070-0200)

For PL aquagel-OH 8 µm columns:
- EasiVial PEG/PEO for convenient 12 point calibration in three preweighed vials
  (2 mL vials: PL2080-0201 4 mL vials: PL2080-0200)

For PL aquagel-OH 15 µm columns:
- EasiVial PEG/PEO for convenient 12 point calibration in three preweighed vials
  (2 mL vials: PL2080-0201 4 mL vials: PL2080-0200)

Tip: Polymers with MW over 2,000,000 are much more likely to suffer from shear degradation. This is largely eliminated by switching from 8 µm to 15 µm particles.
**Typical applications**

Heparin, gum, polyacrylic acid, polyacrylamide, pectin, dextran

**Conditions**

- **Columns**: 3 x PL aquagel-OH MIXED 8 μm, 7.5 x 300 mm
- **Eluent**: 0.2 M NaNO₃, 0.01 M NaH₂PO₄, pH 7
- **Flow rate**: 1.0 mL/min
- **Detector**: PL-GPC 50 (RI)

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**Chromatogram**

Retention time/min

Mw 1,800,00 g/mol

LogM

---

Polyvinyl alcohol

**Conditions**

- **Columns**: 2 x PL aquagel-OH 30 8 μm, 7.5 x 300 mm
- **Eluent**: 0.2 M NaNO₃, 0.01M NaH₂PO₄, pH 7
- **Flow rate**: 1.0 mL/min
- **Detector**: PL-GPC 50 (RI)

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Hyaluronic acid

**Conditions**

- **Columns**: 2 x PL aquagel-OH 20 5 μm, 7.5 x 300 mm
- **Eluent**: 0.25 M ammonium formate in water
- **Flow rate**: 1.0 mL/min
- **Injection volume**: 20 μL
- **Software**: Agilent GPC/SEC software
- **Detector**: Agilent ELS (neb = 30 °C, evap = 30 °C, gas = 1.4 SLM)

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Heparin

**Conditions**

- **Columns**: PL aquagel-OH 60 15 μm, 7.5 x 300 mm
- **Eluent**: 0.2 M NaNO₃, 0.01 M NaH₂PO₄, pH 7
- **Flow rate**: 1.0 mL/min
- **Detector**: PL-GPC 50 (RI)

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**Differences in composition of two alkyl naphthalene sulfonates**
## PL AQUAGEL-OH SEC COLUMNS

### Ordering information

**PL aquagel-OH columns, 7.5 x 300 mm**

<table>
<thead>
<tr>
<th>Description</th>
<th>Particle size (µm)</th>
<th>MW range (g/mol) (PEG/PEO)</th>
<th>Guaranteed Efficiency (p/m)</th>
<th>Part No.</th>
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</thead>
<tbody>
<tr>
<td>PL aquagel-OH 20</td>
<td>5</td>
<td>100 to 20,000</td>
<td>&gt; 55,000</td>
<td>PL1120-6520</td>
</tr>
<tr>
<td>PL aquagel-OH 30</td>
<td>8</td>
<td>100 to 60,000</td>
<td>&gt; 35,000</td>
<td>PL1120-6830</td>
</tr>
<tr>
<td>PL aquagel-OH 40</td>
<td>8</td>
<td>10,000 to 200,000</td>
<td>&gt; 35,000</td>
<td>PL1149-6840</td>
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<tr>
<td>PL aquagel-OH 40</td>
<td>15</td>
<td>10,000 to 200,000</td>
<td>&gt; 15,000</td>
<td>PL1149-6240</td>
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<tr>
<td>PL aquagel-OH 50</td>
<td>8</td>
<td>50,000 to 600,000</td>
<td>&gt; 35,000</td>
<td>PL1149-6850</td>
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<tr>
<td>PL aquagel-OH 50</td>
<td>15</td>
<td>50,000 to 600,000</td>
<td>&gt; 15,000</td>
<td>PL1149-6250</td>
</tr>
<tr>
<td>PL aquagel-OH 60</td>
<td>8</td>
<td>200,000 to 1,000,000</td>
<td>&gt; 35,000</td>
<td>PL1149-6860</td>
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<tr>
<td>PL aquagel-OH 60</td>
<td>15</td>
<td>200,000 to 1,000,000</td>
<td>&gt; 15,000</td>
<td>PL1149-6260</td>
</tr>
<tr>
<td>PL aquagel-OH MIXED-H</td>
<td>8</td>
<td>6,000 to 10,000,000</td>
<td>&gt; 35,000</td>
<td>PL1149-6880</td>
</tr>
<tr>
<td>PL aquagel-OH MIXED-M</td>
<td>8</td>
<td>1,000 to 500,000</td>
<td>&gt; 35,000</td>
<td>PL1149-6881</td>
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</tbody>
</table>

### Ordering information

**PL aquagel-OH analytical column accessories**

<table>
<thead>
<tr>
<th>Description</th>
<th>Quantity (pk)</th>
<th>Part No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frit removal tool for threaded columns only</td>
<td>1</td>
<td>PL1310-0001</td>
</tr>
<tr>
<td>Frit (2 µm) kit for threaded columns, 7.5 mm id</td>
<td>5</td>
<td>PL1310-0002</td>
</tr>
<tr>
<td>Frit (5 µm) kit for threaded columns, 7.5 mm id</td>
<td>5</td>
<td>PL1310-0012</td>
</tr>
<tr>
<td>Column connecting nuts, 1/16 in. tube</td>
<td>5</td>
<td>PL1310-0007</td>
</tr>
<tr>
<td>Tubing ferrules, 1/16 in. tube</td>
<td>5</td>
<td>PL1310-0008</td>
</tr>
<tr>
<td>LDV intercolumn SS connector</td>
<td>1</td>
<td>PL1310-0005</td>
</tr>
<tr>
<td>Connecting tubing, 10 cm length, 0.01 in. id</td>
<td>10</td>
<td>PL1310-0048</td>
</tr>
</tbody>
</table>

### Ordering information

**PL aquagel-OH Guard columns**

<table>
<thead>
<tr>
<th>Description</th>
<th>Particle size (µm)</th>
<th>id (mm)</th>
<th>Length (mm)</th>
<th>Part No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>PL aquagel-OH Guard</td>
<td>10</td>
<td>25.0</td>
<td>25</td>
<td>PL1249-1120</td>
</tr>
<tr>
<td>PL aquagel-OH Guard</td>
<td>5</td>
<td>7.5</td>
<td>50</td>
<td>PL1149-1530</td>
</tr>
<tr>
<td>PL aquagel-OH Guard</td>
<td>8</td>
<td>7.5</td>
<td>50</td>
<td>PL1149-1840</td>
</tr>
</tbody>
</table>

See also: Polymer Calibration Standards, with highly characterized molecular weights, publication 5990-7996EN
Fast separations on high dispersion systems

- Maximize throughput when using older systems or multiple detectors
- High sample throughput reduces labor costs per sample
- Net savings of solvents due to reduced analysis time

Characteristics:
- pH range: 2-10
- Solvent compatibility: Water and buffers containing up to 50% methanol
- Typical pressure: <30 bar (435 psi)
- Maximum pressure: 140 bar (2030 psi)
- Maximum temperature: 90 ºC

Recommended calibrants:

For PL Rapide L columns:
- EasiVial PEG for convenient 12 point calibration in three preweighed vials (2 mL vials: PL2070-0201 4mL vials: PL2070-0200)

For PL Rapide H columns:
- EasiVial PEG/PEO for convenient 12 point calibration in three preweighed vials (2 mL vials: PL2080-0201 4mL vials: PL2080-0200)

Typical applications

Sodium acrylate

Conditions
- Column: PL Rapide Aqua H, 7.5 x 150 mm
- Eluent: Water + 0.2 M NaNO₃, 0.01 M NaH₂PO₄, pH 7
- Flow rate: 1.0 mL/min
- Detector: RI

Ordering information

PL Rapide Aqua columns

<table>
<thead>
<tr>
<th>Description</th>
<th>MW range (g/mol)</th>
<th>Guaranteed efficiency (p/m)</th>
<th>Part No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>PL Rapide Aqua H, 7.5 x 150 mm</td>
<td>6,000 to 10,000,000</td>
<td>&gt; 35,000</td>
<td>PL1149-3800</td>
</tr>
<tr>
<td>PL Rapide Aqua H, 10 x 100 mm</td>
<td>6,000 to 10,000,000</td>
<td>&gt; 35,000</td>
<td>PL1049-2800</td>
</tr>
<tr>
<td>PL Rapide Aqua L, 7.5 x 150 mm</td>
<td>100 to 60,000</td>
<td>&gt; 35,000</td>
<td>PL1120-3830</td>
</tr>
<tr>
<td>PL Rapide Aqua L, 10 x 100 mm</td>
<td>100 to 60,000</td>
<td>&gt; 35,000</td>
<td>PL1020-2830</td>
</tr>
</tbody>
</table>
Rapid and convenient scale-up

- Up to 10 x scale-up for milligram to gram quantities
- Efficient 8 µm particles offer greater speed, purity, and recovery
- High pore volume maximizes loadability

Preparative PL aquagel-OH columns use the same 8 µm particles as standard columns. This enables rapid and reliable scale-up from analytical to preparative separations.

The analytical grade 8 µm media offer much higher efficiency than conventional large particle SEC and GFC columns. This efficiency results in fast separations to maximize throughput, and sharp peak shape to maximize purity and yield from each cut.

Typical applications

Fractionation of disperse polymers, component isolation

| Conditions | Column: PL aquagel-OH 40 8 µm, 25 x 300 mm | Eluent: 0.2M NaNO₃, 0.01M NaH₂PO₄, pH 7 | Flow rate: 10.0 mL/min | Loading: 10 mg/mL, 2 mL | Detector: RI |

Ordering information

**PL aquagel-OH preparative columns 8 µm, 25 x 300 mm**

<table>
<thead>
<tr>
<th>Description</th>
<th>MW range (g/mol) (PEG/PEO)</th>
<th>Part No.</th>
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</thead>
<tbody>
<tr>
<td>PL aquagel-OH 30</td>
<td>100 to 60,000</td>
<td>PL1220-6130</td>
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<tr>
<td>PL aquagel-OH 40</td>
<td>10,000 to 200,000</td>
<td>PL1249-6140</td>
</tr>
<tr>
<td>PL aquagel-OH 50</td>
<td>50,000 to 600,000</td>
<td>PL1249-6150</td>
</tr>
<tr>
<td>PL aquagel-OH MIXED</td>
<td>6,000 to 10,000,000</td>
<td>PL1249-6100</td>
</tr>
<tr>
<td>PL aquagel-OH Guard, 25 x 25 mm</td>
<td></td>
<td>PL1249-1120</td>
</tr>
</tbody>
</table>

Polyvinyl alcohol
AGILENT POLARGEL GPC COLUMNS

For intermediate polarity solvents and polar solvent combinations

- Eliminates the risk of interactions and bad data when using in high polarity solvents such as DMSO, NMP, DMAc, and DMF
- High efficiency and resolution maximizes sample throughput
- Excellent stability and lifetime in challenging polar solvents and at elevated temperatures

Highly polar groups present on some polymers can lead to non-specific interactions and secondary separation mechanisms when using polar solvents. These secondary effects result in distorted chromatograms and inaccurate MW data.

PolarGel “mixed bed” columns have a medium polarity surface and high mechanical stability. They are capable of operating in a wide range of solvents and solvent combinations, greatly enhancing their ability to analyze polar polymers that are not soluble in traditional aqueous or organic solvents.

Characteristics:
- pH range: 2-10
- Solvent range: THF to Water
- Particle size: 8 μm
- Efficiency: > 35,000 p/m
- Typical pressure: < 30 bar (435 psi)
- Maximum pressure: 140 bar (2030 psi)
- Maximum temperature: 80 °C

Recommended calibrants:
- For polar solvents:
  - EasiVial PMMA for convenient 12 point calibration in three preweighed vials
    (2 mL vials: PL2070-0202 4 mL vials: PL2070-0203)
- For Ppolar/aqueous solvents:
  - EasiVial PEG/PEO for convenient 12 point calibration in three preweighed vials
    (2 mL vials: PL2080-0201 4 mL vials: PL2080-0200)

Tip: Buffers in a stored column may crystallize out and cause damage, so flush out the column with water containing a small amount of sodium azide, to prevent biological growth.
**AGILENT POLARGEL GPC COLUMNS**

**Ordering information**

**PolarGel columns**

<table>
<thead>
<tr>
<th>Description</th>
<th>MW range (g/mol)</th>
<th>Guaranteed efficiency (p/m)</th>
<th>Part No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>PolarGel-L, 7.5 x 300 mm</td>
<td>100 to 60,000</td>
<td>&gt; 35,000</td>
<td>PL1117-6830</td>
</tr>
<tr>
<td>PolarGel-M, 7.5 x 300 mm</td>
<td>1,000 to 500,000</td>
<td>&gt; 35,000</td>
<td>PL1117-6800</td>
</tr>
</tbody>
</table>

**Ordering information**

**PolarGel Guards 7.5 x 50 mm**

<table>
<thead>
<tr>
<th>Description</th>
<th>Part No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>PolarGel-L Guard column, 7.5 x 50 mm</td>
<td>PL1117-1830</td>
</tr>
<tr>
<td>PolarGel-M Guard column, 7.5 x 50 mm</td>
<td>PL1117-1800</td>
</tr>
</tbody>
</table>

**Conditions**

- **Columns:** 2 x PolarGel-L, 7.5 x 300 mm
- **Eluent:** Dimethylformamide + 0.1% LiBr
- **Flow rate:** 1.0 mL/min
- **Injection volume:** 100 μL
- **Temperature:** 50 °C
- **Detector:** RI

Two samples of melamine resin analyzed by PolarGel-L.

**Tip:** Filter samples through a 0.45 μm filter prior to injection to extend column lifetime.
Further reading

<table>
<thead>
<tr>
<th>GPC/SEC publication</th>
<th>Publication number</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Primer</strong></td>
<td></td>
</tr>
<tr>
<td>An introduction to gel permeation chromatography and size exclusion chromatography</td>
<td>5990-6969EN</td>
</tr>
<tr>
<td>Calibrating GPC/SEC columns - a guide to best practice</td>
<td>5991-2720EN</td>
</tr>
<tr>
<td>Step-by-step method development in GPC</td>
<td>5991-7272EN</td>
</tr>
<tr>
<td>Polymer-to-solvent reference table for GPC/SEC</td>
<td>5991-6802EN</td>
</tr>
<tr>
<td>Instrument setup for Fast GPC</td>
<td>5991-7191EN</td>
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<tr>
<td><strong>Application compendia</strong></td>
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<tr>
<td>Analysis of polymers by GPC/SEC - energy &amp; chemicals applications</td>
<td>5991-2517EN</td>
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<tr>
<td>Analysis of polymers by GPC/SEC - food applications</td>
<td>5991-2029EN</td>
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<td>Analysis of polymers by GPC/SEC - pharmaceutical applications</td>
<td>5991-2519EN</td>
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<tr>
<td>Excipient analysis by GPC/SEC and other LC techniques</td>
<td>5990-7771EN</td>
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<tr>
<td>Biodegradable polymers - analysis of biodegradable polymers by GPC/SEC</td>
<td>5990-6920EN</td>
</tr>
<tr>
<td>Analysis of engineering polymers by GPC/SEC</td>
<td>5990-6970EN</td>
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<tr>
<td>Analysis of elastomers by GPC/SEC</td>
<td>5990-6868EN</td>
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<tr>
<td>Analysis of polyolefins by GPC/SEC</td>
<td>5990-6971EN</td>
</tr>
<tr>
<td>Low molecular weight resins - Analysis of low molecular weight resins and prepolymer by GPC/SEC</td>
<td>5990-6945EN</td>
</tr>
<tr>
<td><strong>Product guides</strong></td>
<td></td>
</tr>
<tr>
<td>Aqueous and polar GPC/SEC columns</td>
<td>5990-7995EN</td>
</tr>
<tr>
<td>GPC/SEC standards</td>
<td>5990-7996EN</td>
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</tbody>
</table>

**Agilent GPC/SEC calibration standards**

Calibrating your GPC/SEC columns with the highest quality polymer standards, Agilent EasiVial and Agilent EasiCal, ensures superior results and boosts productivity through:

- Improved reproducibility
- Improved resolution, leading to better accuracy
- Earlier detection of problems
- Reduced trouble-shooting and system downtime
- Statistically significant analysis of the system

To learn more about calibrating your GPC columns, refer to the primer **Calibrating GPC Columns - A Guide to Best Practice** (5991-2720EN).

Get your copy, and find other useful documents at [www.agilent.com/chem/gpcresources](http://www.agilent.com/chem/gpcresources)
The Agilent 1260 Infinity II GPC/SEC system and 1260 Infinity II Multi-Detector GPC/SEC system are part of Agilent InfinityLab, an optimized portfolio of LC instruments, columns and supplies that work together seamlessly for maximum efficiency and performance.

The Agilent 1260 Infinity II GPC/SEC system has been designed to meet the challenges of today’s polymer analyst.

The system features the new Infinity II refractive index detector for exceptional improvements in resolution and speed. The newly developed vialsampler offers higher unattended sample throughput, while the multicolumn thermostat provides accurate temperature control to minimize detector noise and baseline drift. The updated isocratic pump allows for extra flow precision to maximize reproducibility and accuracy in MW measurements.

The Agilent 1260 Infinity II Multi-Detector GPC/SEC system is the first choice for accurate, reproducible polymer analysis. Select any combination of light scattering, viscometry and refractive index detection for absolute molecular weights and sizes.

The system provides a wealth of information regarding polymer structure and it is also possible to identify and quantify properties such as branching which can influence processing and physical properties. Precise temperature control minimizes equilibration time and maximizes sample throughput.

Innovative InfinityLab supplies that simplify your work

• Handle mobile phases with ease using ergonomic, easy-grip solvent bottles
• Prevent harmful solvents from leaching into the air with InfinityLab Stay Safe caps
• Safely control solvent drainage with InfinityLab Anti-Drain Fitting
• Ensure leak-free column connections with InfinityLab Quick Connect Fittings
Calibration is key to generating reliable and accurate GPC data. To learn more, refer to the primer:

**Calibrating GPC Columns—A Guide to Best Practice**
*Publication 5991-2720EN*

Learn more
www.agilent.com/chem/gpcresources

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