# Next Generation of Porous Layer Open Tubular (PLOT) Columns

- Stabilized particle layers improve robustness and reproducibility of retention and flow.
- Compatible with valve switching and Deans switching systems.
- Highly efficient, reproducible analyses; ideal for permanent gases, solvents, and hydrocarbons.
- Innovative manufacturing procedure reduces particle generation and improves performance of PLOT columns.
- Wound on a 7"-diameter, 11-pin cage unless otherwise noted.

## Model your PLOT column using our **Pro *EZ*GC Chromatogram Modeler**

Porous layer open tubular (PLOT) columns are very beneficial for solving application problems, especially for the analysis of volatile compounds. PLOT columns have a unique selectivity, allowing for the separation of volatile compounds at ambient temperature. Due to the adsorption mechanism of the stationary phases used in PLOT columns, permanent gases and light hydrocarbons can be resolved at ambient temperature; columns can then be programmed to higher temperatures to elute higher boiling compounds.

**Traditional PLOT Columns Offer Poor Stability**

The traditional PLOT column is built with a 5–50 µm layer of particles adhered to the tubing walls. Because this layer of particles generally lacks stability, PLOT columns must be used very carefully as particle release is common and can cause unpredictable changes in retention time and flow behavior. Traditional PLOT columns also must generally be used in conjunction with particle traps to prevent the contamination of valves, injectors, and GC detectors. Detectors contaminated with particles typically generate electronic noise, which shows up chromatographically as a spike in the baseline. In extreme cases, detector flow can be obstructed by particle buildup. Particles can also affect valves by becoming lodged in the valve and causing leaks or restricting flow. Figure 1 shows an example of blockage caused by particle accumulation inside a Press-Tight connector.

**Restek PLOT Columns Offer Improved Stability to Minimize Particle Release**

Restek has developed technology and procedures to manufacture PLOT columns with concentric stabilized adsorption layers. These next-generation PLOT columns show a constant flow behavior (permeability) and have significantly improved mechanical stability, resulting in easier operation, better chromatography, and reduced particle release. Greater particle stability means more reproducible retention times, virtually no spiking, and longer column lifetimes.* This innovative Restek stabilization chemistry is currently applied to all fused silica and metal PLOT columns featured here.

*A particle trap is still recommended to protect valves and detectors.

## PLOT Columns Available In:

Fused Silica

**Rt Column Phases:**

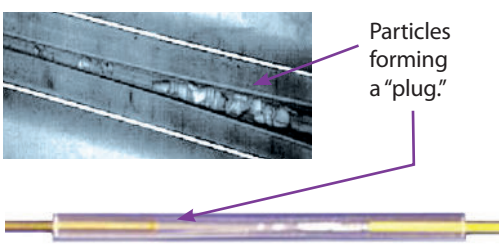
Rt-Alumina BOND/MAPD
Rt-Alumina BOND/$Na_2SO_4$
Rt-Alumina BOND/KCl
Rt-Alumina BOND/CFC
Rt-MSieve 5A
Rt-Q-BOND
Rt-QS-BOND
Rt-S-BOND
Rt-U-BOND

Metal

**MXT Column Phases:**

MXT-Alumina BOND/MAPD
MXT-Alumina BOND/$Na_2SO_4$
MXT-MSieve 5A
MXT-Q-BOND

**Figure 1:** Particles released from traditional PLOT columns can cause blockages.



**Consistent Flow Restriction Factor (F) Guarantees Reproducible Flow**

Thick layers of particles are difficult to deposit in a homogeneous layer, and in traditionally manufactured PLOT columns, this results in variable coating thicknesses. The positions where the layer is thicker act as restrictions and affect flow (Figure 2). Depending on the number and intensity of these restrictions, traditional PLOT columns often show greater variation in flow restriction than wall coated open tubular (WCOT) columns. In practice, conventional PLOT columns with the same dimensions can differ in flow by a factor of 4 to 6 when operated at the same nominal pressure. For applications where flow is important, such as with Deans switching, the nonreproducible flow behavior of most commercially available PLOT columns is a problem.

In order to measure flow restriction reproducibility, Restek introduced a new factor: the flow restriction factor (F). This factor is based on the retention time of an unretained marker compound as measured on both coated and uncoated tubing using the same back pressure setting (Equation 1). For quality control purposes, methane is used as the marker when evaluating porous polymer columns, and helium is used for testing molecular sieve 5A columns.

Flow restriction factor determination can be used to assess both the degree of column restriction and the reproducibility of the column coating process. Figure 3 shows typical results for PLOT columns manufactured using a conventional process. Because of the difference in flow restriction, individual columns have very different flow characteristics. In contrast, Figure 4 shows results for columns made using our Rt-QS-BOND (bonded porous polymer) PLOT column process. Clearly, our manufacturing process results in greater consistency in both column coating thickness and flow restriction, which results in more stable retention times and better performance in Deans and related flow switching techniques. Flow restriction factors are specified on the certificate of analysis (CofA) included with every Restek PLOT column, and the values are listed on the report.

**Figure 2:** Inconsistent coating thicknesses result in restrictions that cause significant variation in flow.

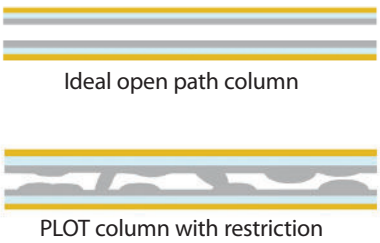
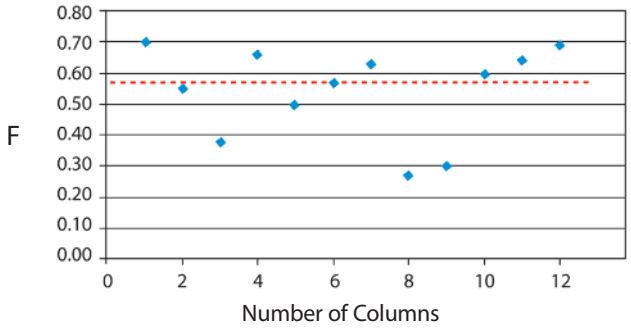



**Figure 3:** Traditional PLOT columns show significant flow variability, indicating inconsistent column coating thicknesses.



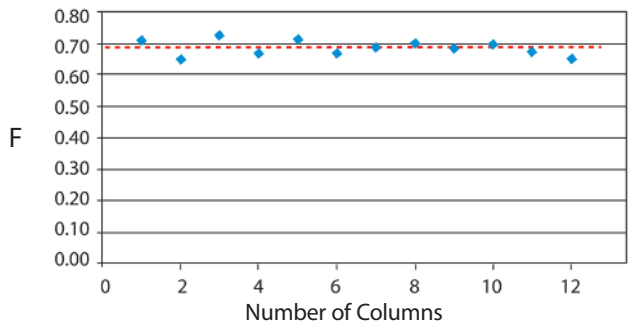

**Equation 1:** Flow restriction factor (F) is used to demonstrate coating consistency.

$$F = \frac{t_{R1} \text{ of unretained component (uncoated tubing)}}{t_{R2} \text{ of unretained component (coated column)}}$$

$t_R$ = retention time

Note: F values will always be <1 as the coated column always has more restriction than the uncoated column.

**Figure 4:** PLOT columns from Restek offer consistent flow restriction, giving more reproducible results column to column.



Restek's PLOT columns are exceptionally robust, featuring concentric stabilized coating layers. They allow for more consistent gas flows and are recommended for applications sensitive to variation in retention time or flow. These PLOT columns are a significant advance in technology and are ideal for efficient, reproducible analyses of permanent gases, solvents, and hydrocarbons.

## PLOT Column Phase Cross-Reference: Similar Selectivity

| Restek Rt and MXT Columns | Porous Layer | Supelco | Alltech | Agilent (J&W, Varian, Chrompack) | Quadrex |
|---|---|---|---|---|---|
| Alumina BOND/$Na_2SO_4$ | Aluminum oxide | Alumina-Sulfate | AT-Alumina | GS-Alumina, CP-$Al_2O_3$/$NA_2SO_4$ | ——— |
| Alumina BOND/KCl* | Aluminum oxide | Alumina-Chloride | ——— | GS-Alumina KCl, HP PLOT $Al_2O_3$, CP-$Al_2O_3$/KCl | _____ |
| Alumina BOND/CFC* | Aluminum oxide | | | **unique** product | |
| Alumina BOND/MAPD | Aluminum oxide | ——— | ——— | Select $Al_2O_3$ MAPD | ——— |
| Msieve 5A | Molecular sieve 5A | Molsieve 5A | AT-Molesieve | HP PLOT Molesieve, CP-Molesieve 5A | PLT-5A |
| Q-BOND | 100% Divinylbenzene | Supel-Q-PLOT | AT-Q | HP PLOT Q, CP-PoraPlot Q, PoraBond Q | ——— |
| QS-BOND* | Intermediate polarity porous polymer | ——— | ——— | GS-Q | _____ |
| S-BOND* | DVB vinylpyridine polymer | ——— | ——— | CP-PoraPlot S | _____ |
| U-BOND* | DVB ethylene glycol-dimethylacrylate polymer | _____ | _____ | HP PLOT U, CP-PoraPlot U, CP-PoraBond U | _____ |

*Available only with fused silica tubing.

### did you **know**?

Restek draws our own fused silica tubing and applies our own proprietary stationary phases. By fully managing our production streams, we are able to ensure unparalleled reliability and stability.

# Rt-Alumina BOND Columns

Restek Rt-Alumina BOND columns are highly selective for C1–C5 hydrocarbons and separate all saturated and unsaturated hydrocarbon isomers above ambient temperatures. The reactivity of the aluminum oxide stationary phase is minimized by deactivation with inorganic salts, such as KCl or $Na_2SO_4$, to improve column response for polar unsaturates, like dienes, and the column's sensitivity (or response) ensures linear and quantitative chromatographic analysis for these compounds. Strong bonding minimizes particle generation and release, which allows valve switching with minimal risk to the injection or detection systems. And because they are stable up to at least 200 °C, Rt-Alumina BOND columns can be regenerated to restore full efficiency and selectivity by conditioning at their maximum temperature if water is adsorbed. High capacity and loadability give you exceptionally symmetrical peaks, making these columns ideal for volatile hydrocarbon separations at percent levels, as well as impurity analyses at ppm concentrations. Restek Rt-Alumina BOND PLOT columns are manufactured on fused silica tubing; select phases are also available on metal MXT tubing.

To ensure reproducible retention times and predictable flow behavior column to column, each Rt-Alumina BOND column is extensively tested. A hydrocarbon test mix confirms proper phase retention and selectivity. To calculate k (retention or capacity factor), which is a measure of phase retention, 1,3-butadiene is used, while selectivity is measured using retention indices for propadiene and methyl acetylene. The resolution of *trans*-2-butene and 1-butene is also verified and, to measure efficiency, plates per meter are checked using 1,3-butadiene. We do not recommend recoiling PLOT columns as this may cause particles to dislodge from the side of the tubing.

**tech tip**

Traces of water in the carrier gas and samples will affect the retention and the selectivity of alumina. If exposed to water, the retention times will shorten. The column can be regenerated by conditioning for 15–30 minutes at 200 °C under normal carrier gas flow. Periodic conditioning ensures excellent run-to-run retention time reproducibility.

Unless noted, the maximum programmable temperature for an Rt-Alumina BOND column is 200 °C. Temperatures higher than the stated maximum temperature can cause irreversible changes to the porous layer adsorption properties.

## similar phases

Alumina-Sulfate; AT-Alumina; CP-$Al_2O_3$/$Na_2SO_4$, GS-Alumina

Rt-Alumina BOND columns show unique retention characteristics for hydrocarbons.

## also **available**!

**Metal MXT PLOT Columns**

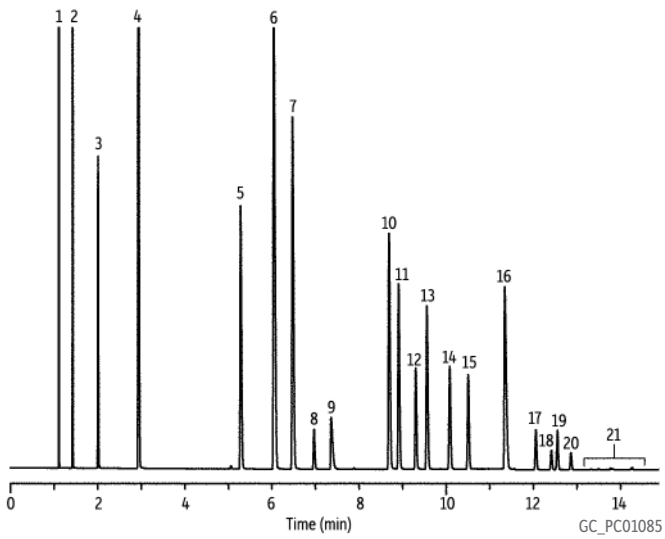
### **Rt-Alumina BOND/$Na_2SO_4$ Columns** (fused silica PLOT)

$Na_2SO_4$ deactivation

- Acetylene and propadiene elute after butanes.
- Best separation for butene isomers (impurities in butene streams).
- Methyl acetylene elutes after 1,3-butadiene.
- Cyclopropane (impurity in propylene) elutes well before propylene.
- Temperature range: -60 to 200 °C.

| ID | df | Length | Temp. Limits | qty. | cat.# |
|---|---|---|---|---|---|
| 0.25 mm | 4 µm | 30 m | -60 to 200 °C | ea. | 19775 |
| 0.32 mm | 5 µm | 30 m | -60 to 200 °C | ea. | 19757 |
| | 5 µm | 50 m | -60 to 200 °C | ea. | 19758 |
| 0.53 mm | 10 µm | 30 m | -60 to 200 °C | ea. | 19755 |
| | 10 µm | 50 m | -60 to 200 °C | ea. | 19756 |

### Refinery Gas on Rt-Alumina BOND ($Na_2SO_4$)




**Peaks**
1. Methane
2. Ethane
3. Ethylene
4. Propane
5. Propylene
6. Isobutane
7. *n*-Butane
8. Propadiene
9. Acetylene
10. *trans*-2-Butene
11. 1-Butene
12. Isobutylene
13. *cis*-2-Butene
14. iso-Pentane
15. *n*-Pentane
16. 1,3-Butadiene
17. *trans*-2-Pentene
18. 2-Methyl-2-butene
19. 1-Pentene
20. *cis*-2-Pentene
21. Hexanes

| | |
|---|---|
| **Column** | Rt-Alumina BOND/$Na_2SO_4$, 50 m, 0.53 mm ID, 10 µm (cat.# 19756) |
| **Sample** | Refinery gas |
| **Injection** | |
| Inj. Vol.: | 10 µL split |
| Liner: | Taper (2 mm) (cat.# 20795) |
| Inj. Temp.: | 200 °C |
| Split Vent Flow Rate: | 80 mL/min |
| **Oven** | |
| Oven Temp.: | 45 °C (hold 1 min) to 200 °C at 10 °C/min (hold 3.5 min) |
| **Carrier Gas** | $H_2$, constant pressure (8.0 psi, 55.2 kPa) |
| Linear Velocity: | 74 cm/sec @ 45 °C |
| **Detector** | FID @ 200 °C |

## similar phases

Alumina-Chloride; CP-$Al_2O_3$/KCl, GS-Alumina KCl, HP-PLOT $Al_2O_3$/KCl

Rt-Alumina BOND columns show unique retention characteristics for hydrocarbons.

## did you **know**?

All Restek PLOT columns come standard on a 7"-diameter, 11-pin cage. Metal MXT columns are also available coiled to 3.5" diameter for select phases by adding the suffix -273 to the part number. If you need more information, please call your local Restek representative.

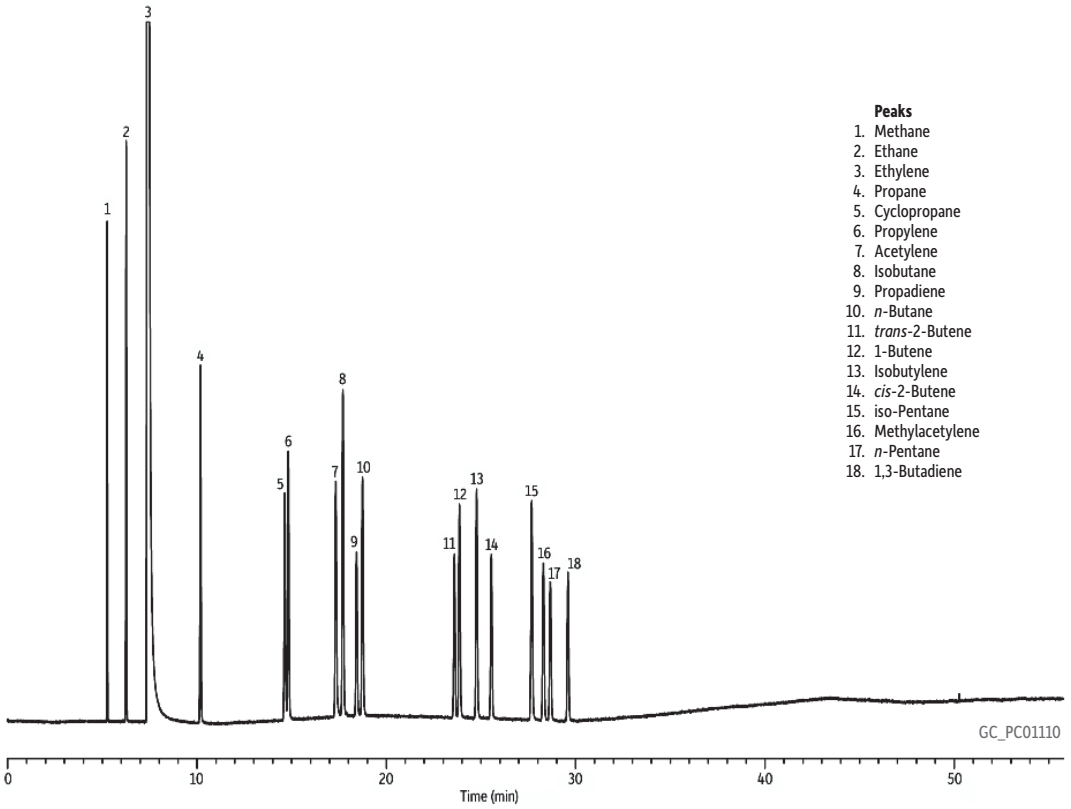
### **Rt-Alumina BOND/KCl Columns** (fused silica PLOT)

KCl deactivation

- Restek's lowest polarity alumina column.
- Low moisture sensitivity reduces the need for frequent regeneration.
- Acetylene elutes before *n*-butane.
- Methyl acetylene (impurity in 1,3-butadiene) elutes before 1,3-butadiene.
- Temperature range: -60 to 200 °C.

| ID | df | Length | Temp. Limits | qty. | cat.# |
|---|---|---|---|---|---|
| 0.25 mm | 4 µm | 30 m | -60 to 200 °C | ea. | 19776 |
| 0.32 mm | 5 µm | 30 m | -60 to 200 °C | ea. | 19761 |
| | 5 µm | 50 m | -60 to 200 °C | ea. | 19762 |
| 0.53 mm | 10 µm | 30 m | -60 to 200 °C | ea. | 19759 |
| | 10 µm | 50 m | -60 to 200 °C | ea. | 19760 |

### Ethylene and C1-C5 Hydrocarbons by ASTM D6159-97 on Rt-Alumina BOND/KCl, Rtx-1




**Peaks**
1. Methane
2. Ethane
3. Ethylene
4. Propane
5. Cyclopropane
6. Propylene
7. Acetylene
8. Isobutane
9. Propadiene
10. *n*-Butane
11. *trans*-2-Butene
12. 1-Butene
13. Isobutylene
14. *cis*-2-Butene
15. iso-Pentane
16. Methylacetylene
17. *n*-Pentane
18. 1,3-Butadiene

| | |
|---|---|
| **Column** | Rt-Alumina BOND/KCl *, 50 m, 0.53 mm ID, 10 µm (cat.# 19760) |
| **Sample** | Ethylene gas plus C1 through C5 hydrocarbons |
| **Injection** | |
| Inj. Vol.: | 1 µL split |
| Liner: | 2 mm splitless (cat.# 20712) |
| Inj. Temp.: | 200 °C |
| Split Vent Flow Rate: | 60 mL/min |
| **Oven** | |
| Oven Temp.: | 35 °C (hold 2 min) to 190 °C at 4 °C/min (hold 15 min) |
| **Carrier Gas** | He, constant pressure (8.0 psi, 55.2 kPa) |
| Linear Velocity: | 25.4 cm/sec @ 35 °C |
| **Detector** | FID @ 200 °C |
| Make-up Gas Type: | $N_2$ |
| Data Rate: | 20 Hz |
| **Instrument** | HP5890 GC |
| **Notes** | * Rt-Alumina BOND/KCl, 50 m, 0.53 mm ID, 10.0 µm (cat.# 19760) in series with an Rtx-1, 30 m, 0.53 mm ID, 5.0 µm (cat.# 10179) connected using a universal Press-Tight connector (cat.# 20401). |
| | (conditions as per ASTM D6159-97) |

## Rt-Alumina BOND/CFC Columns (fused silica PLOT)

- Improved inertness for chlorofluorocarbon (CFC) compounds.
- Highly selective alumina-based column, separates most CFCs.
- High retention and capacity for CFCs.
- Temperature range: -60 to 200 °C.

Restek **exclusive!**

The Alumina BOND/CFC adsorbent is ideal for retaining volatile halogenated compounds, especially CFCs (chlorinated fluorocarbons). It offers high selectivity, allowing a wide range of CFC isomers to be resolved at above ambient temperatures. The Rt-Alumina BOND/CFC column is thoroughly deactivated to reduce the reactivity of alumina. Even though there is still some residual reactivity for some mono- or di-substituted CFCs, the majority of these compounds can be accurately quantified from mainstream processes or in impurity analyses.

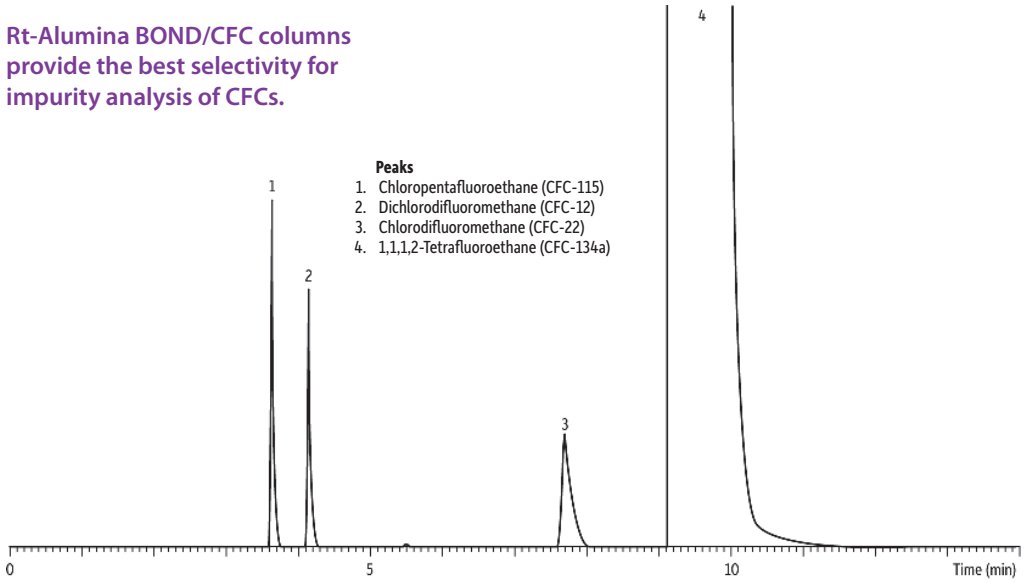
**tech tip**

Especially when valve switching or backflushing is used, Restek recommends using particle traps to help prevent detector spikes and valve rotor scratches.
Visit www.restek.com/plot for specialized PLOT column particle traps.

| ID | df | Length | Temp. Limits | qty. | cat.# |
|---|---|---|---|---|---|
| 0.53 mm | 10 µm | 30 m | -60 to 200 °C | ea. | 19763 |

### Impurity Analysis of 1,1,1,2-Tetrafluoroethane (CFC-134a) on Rt-Alumina BOND/CFC

**Rt-Alumina BOND/CFC columns provide the best selectivity for impurity analysis of CFCs.**




GC_GN1155

| | |
|---|---|
| **Column** | Rt-Alumina BOND/CFC, 30 m, 0.53 mm ID (cat.# 19763) |
| **Sample** | 1,1,1,2-Tetrafluoroethane |
| Conc.: | Neat |
| **Injection** | |
| Inj. Vol.: | 500 µL split |
| **Oven** | |
| Oven Temp.: | 80 °C (hold 6 min) to 140 °C at 10 °C/min (hold 2 min) |
| **Carrier Gas** | He |
| **Detector** | FID |
| **Notes** | Gas sampling, purity analysis |
| | Note that tailing peaks are common in CFC analyses due to overloading normally employed for this type of work. |

For more chromatograms, search our extensive library at
**www.restek.com/chromatograms**

**Rt-Alumina BOND/MAPD Columns** (fused silica PLOT)

- Optimized deactivation produces maximum response when analyzing trace levels of acetylene, methyl acetylene, and propadiene.
- Stable response factors make this column ideal for process-type applications where recalibration must be minimized.
- High loadability reduces peak tailing and improves separations.
- Extended temperature range up to 250 °C for fast elution of high molecular weight (HMW) hydrocarbons and accelerated column regeneration following exposure to water.
- Temperature range: -60 to 250 °C.

Rt-Alumina BOND/MAPD PLOT columns are made specifically for the analysis of petrochemicals and downstream products such as ethylene, propylene, butylenes, and butadiene.

Also available in metal MXT-Alumina columns!

Restek's R&D chemists have optimized the deactivation technology applied to our Rt-Alumina BOND/MAPD column for improved analysis of trace concentrations of polar hydrocarbons like acetylene, methyl acetylene, and propadiene in hydrocarbon streams containing higher levels of C1-C5 hydrocarbons. Our alumina PLOT deactivation produces an incredibly inert column that offers superior reproducibility and stable response factors to maximize the number of analyses before recalibration is required. Its high sample capacity reduces peak tailing, thereby improving the separation of target compounds. In addition, a 250 °C maximum operating temperature lets you more quickly elute hydrocarbons up to dodecane and reduces regeneration time when the column is exposed to water from samples or carrier gases.

also **available**!
**Metal MXT PLOT Columns**
See page 15 for more information.

## similar phases

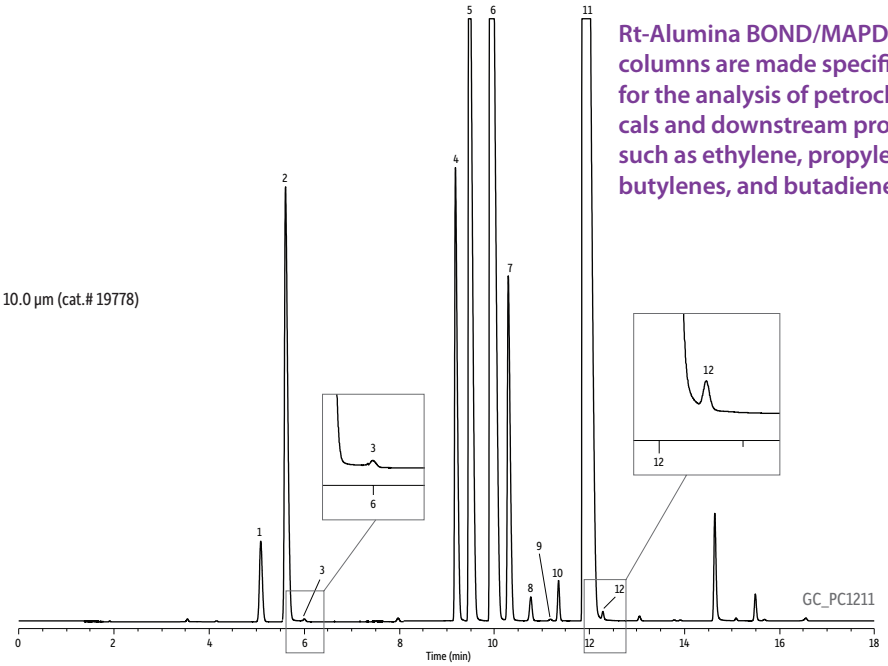
Select $Al_2O_3$ MAPD

| ID | df | Length | Temp. Limits | qty. | cat.# |
|---|---|---|---|---|---|
| 0.25 mm | 4 µm | 30 m | -60 to 250 °C | ea. | 19781 |
| 0.32 mm | 5 µm | 30 m | -60 to 250 °C | ea. | 19779 |
| | 5 µm | 50 m | -60 to 250 °C | ea. | 19780 |
| 0.53 mm | 10 µm | 50 m | -60 to 250 °C | ea. | 19778 |

### 1,3-Butadiene on Rt-Alumina BOND/MAPD (Purity Analysis)

**Peaks**
1. Isobutane
2. *n*-Butane
3. Propadiene
4. *trans*-2-Butene
5. 1-Butene
6. Isobutene
7. *cis*-2-Butene
8. Isopentane
9. *n*-Pentane
10. 1,2-Butadiene
11. 1,3-Butadiene
12. Methyl acetylene

| | |
|---|---|
| **Column** | Rt-Alumina BOND/MAPD, 50 m, 0.53 mm ID, 10.0 µm (cat.# 19778) |
| **Sample** | Crude 1,3-butadiene |
| **Injection** | |
| Inj. Vol.: | 10 µL split |
| Liner: | 2.0 mm ID straight inlet liner (cat.# 20712) |
| Inj. Temp.: | 200 °C |
| Split Vent Flow Rate: | 100 mL/min |
| **Oven** | |
| Oven Temp.: | 70 °C (hold 5 min) to 200 °C at 10 °C/min (hold 0 min) |
| **Carrier Gas** | He, constant pressure (20 psi, 137.9 kPa) |
| **Detector** | FID @ 250 °C |
| Make-up Gas Flow Rate: | 30 mL/min |
| Make-up Gas Type: | $N_2$ |
| Data Rate: | 20 Hz |
| **Instrument** | HP5890 GC |




**Rt-Alumina BOND/MAPD PLOT columns are made specifically for the analysis of petrochemicals and downstream products such as ethylene, propylene, butylenes, and butadiene.**

# Molecular Sieve 5A PLOT Columns

Restek's molecular sieve 5A PLOT columns are designed for efficient separation of argon/oxygen and other permanent gases, including carbon monoxide. Special coating and deactivation procedures ensure chromatographic efficiency and the integrity of the porous layer coating. Molecular sieves have very high retention, allowing separations of permanent gases at temperatures above ambient. Our deactivation technology also allows carbon monoxide to elute as a sharp peak. Additionally, our unique immobilization process guarantees that the uniform particles remain adhered to the tubing—even after continuous valve cycling.

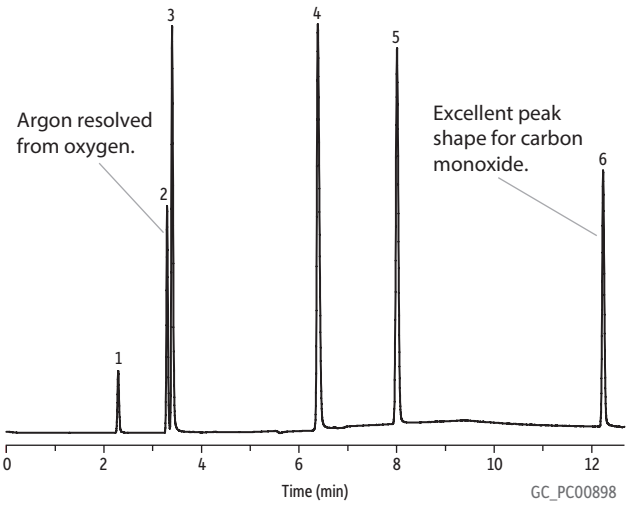
**Rt-Msieve 5A Columns** (fused silica PLOT)

- Improve accuracy with sharp, symmetrical peaks for argon, oxygen, and carbon monoxide.
- Easily separate permanent gases at temperatures above ambient.
- Restek PLOT technology reduces particle release, improving flow reproducibility and reducing downtime for maintenance.
- Temperature range: -100 to 300 °C.

We do not recommend recoiling PLOT columns as this may cause particles to dislodge from the side of the tubing.

| ID | df | Length | Temp. Limits | qty. | Similar to Part # | cat.# |
|---|---|---|---|---|---|---|
| 0.25 mm | 20 µm | 15 m | -100 to 300 °C | ea. | | 19773 |
| 0.32 mm | 30 µm | 15 m | -100 to 300 °C | ea. | Agilent 19091P-MS7; Scion/Bruker/Varian CP7535 | 19720 |
| | 30 µm | 30 m | -100 to 300 °C | ea. | Agilent 19091P-MS8; Scion/Bruker/Varian CP7536 | 19722 |
| 0.53 mm | 50 µm | 15 m | -100 to 300 °C | ea. | Agilent 19095P-MS9; Scion/Bruker/Varian CP7537 | 19721 |
| | 50 µm | 30 m | -100 to 300 °C | ea. | Agilent 19095P-MS0; Scion/Bruker/Varian CP7538 | 19723 |

**Separation of Argon/Oxygen and Other Permanent Gases on Rt-Msieve 5A**




| Peaks | Conc. (µg/mL) |
|---|---|
| 1. Hydrogen | 40 |
| 2. Argon | 30 |
| 3. Oxygen | 50 |
| 4. Nitrogen | 50 |
| 5. Methane | 40 |
| 6. Carbon monoxide | 50 |

| | |
|---|---|
| **Column** | Rt-Msieve 5A, 30 m, 0.53 mm ID, 50 µm (cat.# 19723) |
| **Sample** | Permanent gases |
| **Injection** | Sample valve |
| Sample Loop Vol.: | 5 µL |
| Valve Name: | 6-port Valco valve |
| Inj. Temp.: | 200 °C |
| Valve Temp.: | Ambient |
| **Oven** | |
| Oven Temp.: | 27 °C (hold 5 min) to 100 °C at 10 °C/min (hold 5 min) |
| **Carrier Gas** | He, constant flow |
| Flow Rate: | 5.0 mL/min |
| **Detector** | Valco helium ionization detector @ 150 °C |

**tech tip**

Because molecular sieve materials are very hydrophilic, they will adsorb water from the sample or carrier gas. Water contamination can have a detrimental effect on peak symmetry and can reduce the resolution of all compounds. If water contamination occurs, reactivate your Rt-Msieve 5A PLOT column by conditioning at 300 °C with dry carrier gas flow for 3 hours.

## similar phases

AT-Molsieve; CP-Molsieve 5A, HP PLOT Molesieve; Molsieve 5A; PLT-5A

Rt-Msieve 5A PLOT columns are designed for efficient separation of Ar/$O_2$ and other permanent gases, including $CH_4$, $C_2H_6$, and CO.

also **available**!

**Metal MXT PLOT Columns**

See page 14 for more information.

# Porous Polymer Columns

**Our porous polymer PLOT columns are not moisture sensitive, making them ideal for applications where moisture is of major concern.**

Porous polymers are unique, highly retentive stationary phases with a wide application range that are able to elute both polar and nonpolar compounds. They are very hydrophobic, so water has no impact on retention times and even elutes as a good chromatographic peak. The Q-BOND is our most nonpolar and widely used porous polymer column; functional groups can be added to increase polarity (i.e., QS-, S-, and U-BOND). The process used to manufacture porous polymer PLOT columns causes the particles to adhere strongly to the walls of the tubing, so there is virtually no particle generation. You get reproducible performance from column to column, including selectivity and flow.

## similar phases

AT-Q; CP-PoraBOND Q, CP-PoraPLOT Q, HP PLOT Q; Supel-Q-PLOT

Our porous polymer PLOT columns are not moisture sensitive, making them ideal for applications where moisture is of major concern.

## also available!

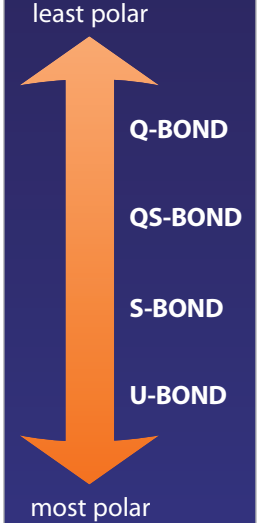
**Metal MXT PLOT Columns**

**Rt-Q-BOND Columns** (fused silica PLOT)
100% divinylbenzene

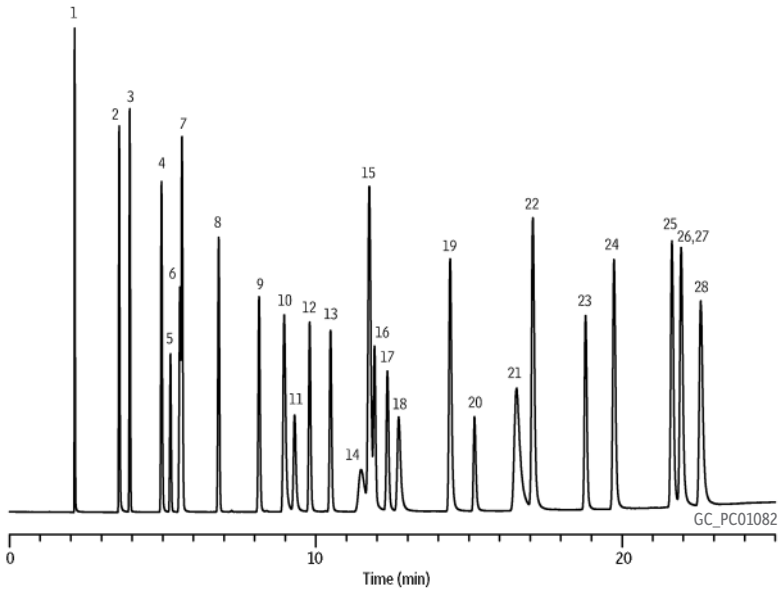
- Nonpolar PLOT column incorporating 100% divinylbenzene.
- Excellent for analysis of C1 to C3 hydrocarbons as well as isomers and alkanes up to C10.
- High retention for $CO_2$ simplifies gas analysis; $CO_2$ and methane separated from $O_2/N_2/CO$. (Note: $O_2/N_2/CO$ not separated at ambient temperature.)
- Use for analysis of oxygenated compounds and solvents.
- Maximum temperature of 300 °C.

| ID | df | Length | Temp. Limits | qty. | cat.# |
|---|---|---|---|---|---|
| 0.25 mm | 8 µm | 15 m | -60 to 280/300 °C | ea. | 19764 |
| | 8 µm | 30 m | -60 to 280/300 °C | ea. | 19765 |
| 0.32 mm | 10 µm | 15 m | -60 to 280/300 °C | ea. | 19743 |
| | 10 µm | 30 m | -60 to 280/300 °C | ea. | 19744 |
| 0.53 mm | 20 µm | 15 m | -60 to 280/300 °C | ea. | 19741 |
| | 20 µm | 30 m | -60 to 280/300 °C | ea. | 19742 |

**Restek porous polymer PLOT columns cover a wide range of polarities**




### Solvent Mixture on Rt-Q-BOND




**Peaks**
1. Methanol
2. Ethanol
3. Acetonitrile
4. Acetone
5. Dichloromethane
6. 1,1-Dichloroethene
7. Nitromethane
8. *trans*-1,2-Dichloroethylene
9. *cis*-1,2-Dichloroethylene
10. Tetrahydrofuran
11. Chloroform
12. Ethyl acetate
13. 1,2-Dichloroethane
14. 1,1,1-Trichloroethane
15. Benzene
16. 1,2-Dimethoxyethane
17. Trichloroethylene
18. 1,4-Dioxane
19. Pyridine
20. Dimethylformamide
21. Methylcyclohexane
22. Toluene
23. 2-Hexanone
24. Chlorobenzene
25. Ethylbenzene
26. *m*-Xylene
27. *p*-Xylene
28. *o*-Xylene

| | |
|---|---|
| **Column** | Rt-Q-BOND, 30 m, 0.53 mm ID, 20 µm (cat.# 19742) |
| **Sample** | Solvent mixture |
| **Injection** | |
| Inj. Vol.: | 1.0 µL split |
| Liner: | Splitless taper (4 mm) (cat.# 20798) |
| Inj. Temp.: | 200 °C |
| Split Vent Flow Rate: | 100 mL/min |
| **Oven** | |
| Oven Temp.: | 120 °C to 240 °C at 5 °C/min (hold 5.0 min) |
| **Carrier Gas** | $H_2$, constant pressure (4.2 psi, 29.0 kPa) |
| Linear Velocity: | 40 cm/sec @ 120 °C |
| **Detector** | FID @ 240 °C |

## **Rt-QS-BOND Columns** (fused silica PLOT)

porous divinylbenzene homopolymer

- Intermediate polarity porous polymer PLOT column incorporating low 4-vinylpyridine.
- Separates ethane, ethylene, and acetylene to baseline.
- Temperature range: -60 to 250 °C.

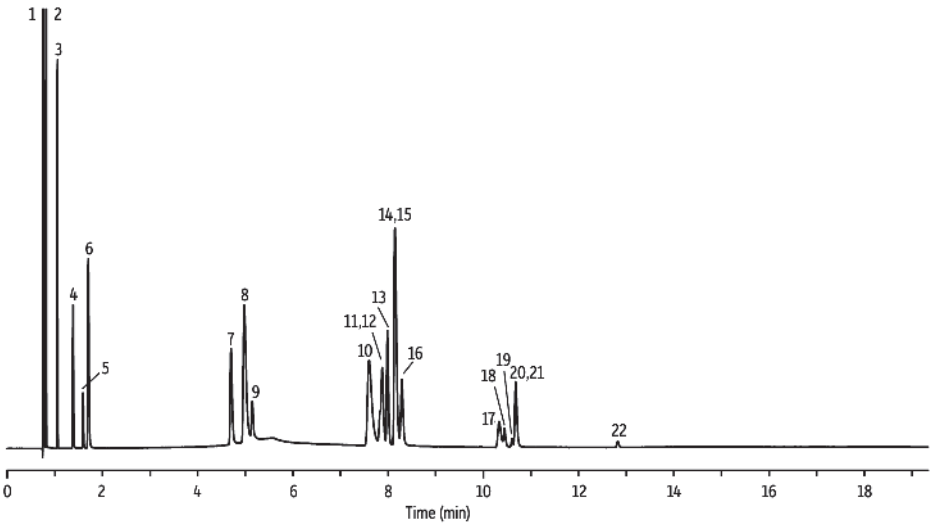
| ID | df | Length | Temp. Limits | qty. | cat.# |
|---|---|---|---|---|---|
| 0.25 mm | 8 µm | 15 m | -60 to 250 °C | ea. | 19767 |
| | 8 µm | 30 m | -60 to 250 °C | ea. | 19768 |
| 0.32 mm | 10 µm | 15 m | -60 to 250 °C | ea. | 19739 |
| | 10 µm | 30 m | -60 to 250 °C | ea. | 19740 |
| 0.53 mm | 20 µm | 15 m | -60 to 250 °C | ea. | 19737 |
| | 20 µm | 30 m | -60 to 250 °C | ea. | 19738 |

## similar phases

GS-Q

Our porous polymer PLOT columns are not moisture sensitive, making them ideal for applications in which moisture is of major concern.

### Refinery Gas Mixture on Rt-QS-BOND




GC_PC01143

**Peaks**
1. Air
2. Methane
3. Carbon dioxide
4. Ethylene
5. Acetylene
6. Ethane
7. Propylene
8. Propane
9. Propadiene
10. Isobutane
11. Isobutylene
12. 1-Butene
13. 1,3-Butadiene
14. *n*-Butane
15. *cis*-2-Butene
16. *trans*-2-Butene
17. Isopentane
18. 1-Pentene
19. 2-Methyl-2-butene
20. *n*-Pentane
21. *cis*-2-Pentene
22. *n*-Hexane

| | |
|---|---|
| **Column** | Rt-QS-BOND, 30 m, 0.53 mm ID, 20 µm (cat.# 19738) |
| **Sample** | Refinery gas standard |
| **Injection** | |
| Inj. Vol.: | 20 µL split |
| Liner: | 2 mm (cat.# 20712) |
| Inj. Temp.: | 200 °C |
| Split Vent Flow Rate: | 35 mL/min |
| **Oven** | |
| Oven Temp.: | 40 °C (hold 2 min) to 225 °C at 15 °C/min (hold 5 min) |
| **Carrier Gas** | He, constant pressure (11.5 psi, 79.3 kPa) |
| Linear Velocity: | 68 cm/sec @ 40 °C |
| **Detector** | TCD @ 225 °C |
| Make-up Gas Type: | He |
| Data Rate: | 20 Hz |
| Sensitivity Mode: | He/$H_2$ |
| **Instrument** | HP5890 GC |

## similar phases

CP-PoraPLOT S

Our porous polymer PLOT columns are not moisture sensitive, making them ideal for applications in which moisture is of major concern.

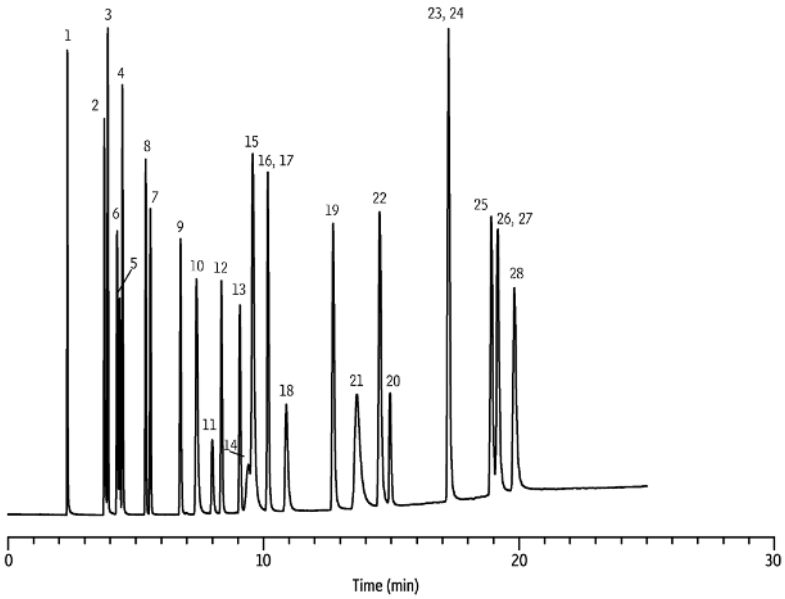
**Rt-S-BOND Columns** (fused silica PLOT)

porous divinylbenzene homopolymer

- Midpolarity porous polymer PLOT column, incorporating high 4-vinylpyridine.
- Use for the analysis of nonpolar and polar compounds.
- Temperature range: -60 to 250 °C.

| ID | df | Length | Temp. Limits | qty. | cat.# |
|---|---|---|---|---|---|
| 0.25 mm | 8 µm | 15 m | -60 to 250 °C | ea. | 19769 |
| | 8 µm | 30 m | -60 to 250 °C | ea. | 19770 |
| 0.32 mm | 10 µm | 30 m | -60 to 250 °C | ea. | 19748 |
| 0.53 mm | 20 µm | 15 m | -60 to 250 °C | ea. | 19745 |
| | 20 µm | 30 m | -60 to 250 °C | ea. | 19746 |

### Solvent Mixture on Rt-S-BOND




GC_PC01080

**Peaks**

1. Methanol
2. Ethanol
3. Acetonitrile
4. Acetone
5. Dichloromethane
6. 1,1-Dichloroethene
7. Nitromethane
8. *trans*-1,2-Dichloroethylene
9. *cis*-1,2-Dichloroethylene
10. Tetrahydrofuran
11. Chloroform
12. Ethyl acetate
13. 1,2-Dichloroethane
14. 1,1,1-Trichloroethane
15. Benzene
16. 1,2-Dimethoxyethane
17. Trichloroethylene
18. 1,4-Dioxane
19. Pyridine
20. Dimethylformamide
21. Methylcyclohexane
22. Toluene
23. 2-Hexanone
24. Chlorobenzene
25. Ethylbenzene
26. *m*-Xylene
27. *p*-Xylene
28. *o*-Xylene

| | |
|---|---|
| **Column** | Rt-S-BOND, 30 m, 0.53 mm ID, 20 µm (cat.# 19746) |
| **Sample** | Solvent mixture |
| **Injection** | |
| Inj. Vol.: | 1.0 µL split |
| Liner: | Taper (4 mm) (cat.# 20798) |
| Inj. Temp.: | 200 °C |
| Split Vent Flow Rate: | 100 mL/min |
| **Oven** | |
| Oven Temp.: | 120 °C to 220 °C at 5 °C/min (hold 5.0 min) |
| **Carrier Gas** | $H_2$, constant pressure (4.2 psi, 29.0 kPa) |
| Linear Velocity: | 40 cm/sec @ 120 °C |
| **Detector** | FID @ 220 °C |

**Rt-U-BOND Columns** (fused silica PLOT)
divinylbenzene ethylene glycol/dimethylacrylate

- Restek's highest polarity porous polymer column.
- Polar PLOT column, incorporating divinylbenzene ethylene glycol/dimethylacrylate.
- Highly inert for the analysis of polar and nonpolar compounds.
- Common applications include trace $H_2S$, COS, and mercaptans in hydrocarbon streams.
- Temperature range: -60 to 190 °C.

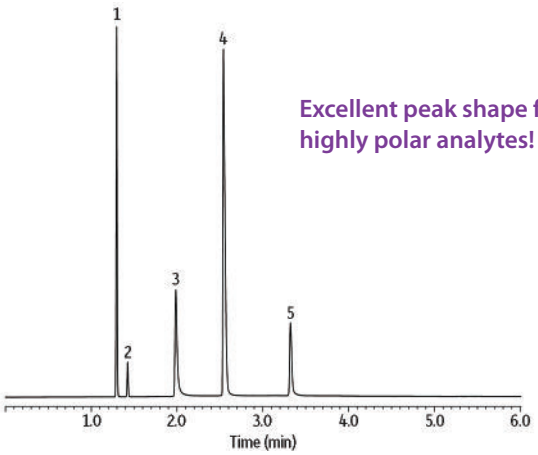
| ID | df | Length | Temp. Limits | qty. | cat.# |
|---|---|---|---|---|---|
| 0.25 mm | 8 µm | 15 m | -60 to 190 °C | ea. | 19771 |
| | 8 µm | 30 m | -60 to 190 °C | ea. | 19772 |
| 0.32 mm | 10 µm | 15 m | -60 to 190 °C | ea. | 19751 |
| | 10 µm | 30 m | -60 to 190 °C | ea. | 19752 |
| 0.53 mm | 20 µm | 15 m | -60 to 190 °C | ea. | 19749 |
| | 20 µm | 30 m | -60 to 190 °C | ea. | 19750 |

## similar phases

CP-PoraBOND U, CP-Pora-PLOT U, HP-PLOT U

Our porous polymer PLOT columns are not moisture sensitive, making them ideal for applications in which moisture is of major concern.

### Formaldehyde on Rt-U-BOND




GC_CH01137

Excellent peak shape for highly polar analytes!

**Peaks**
1. Air
2. Carbon dioxide
3. Formaldehyde
4. Water
5. Methanol

| | |
|---|---|
| **Column** | Rt-U-BOND, 30 m, 0.53 mm ID, 20 µm (cat.# 19750) |
| **Sample** | Formaldehyde (manual headspace) |
| **Injection** | |
| Inj. Vol.: | 10 µL split (split ratio 10:1) |
| Liner: | 2 mm split Precision liner w/wool (cat.# 20823) |
| Inj. Temp.: | 200 °C |
| Split Vent Flow Rate: | 40 mL/min |
| **Oven** | |
| Oven Temp.: | 100 °C (hold 1 min) to 150 °C at 25 °C/min (hold 3 min) |
| **Carrier Gas** | He, constant pressure (7.7 psi, 53.1 kPa) |
| Linear Velocity: | 39 cm/sec @ 100 °C |
| **Detector** | TCD @ 200 °C |
| Make-up Gas Type: | He |
| Data Rate: | 20 Hz |
| Sensitivity Mode: | He/$H_2$ |
| **Instrument** | HP5890 GC |

# MXT-Alumina Columns


7" diameter,
11-pin cage

## Molecular Sieve 5A PLOT Columns

Restek's molecular sieve 5A PLOT columns are designed for efficient separation of argon/oxygen and other permanent gases, including carbon monoxide. Special coating and deactivation procedures ensure chromatographic efficiency and the integrity of the porous layer coating. Molecular sieves have very high retention, allowing separations of permanent gases at temperatures above ambient. Our deactivation technology also allows carbon monoxide to elute as a sharp peak. Additionally, our unique immobilization process guarantees that the uniform particles remain adhered to the tubing—even after continuous valve cycling.

Because molecular sieve materials are very hydrophilic, they will adsorb water from the sample or carrier gas. Water contamination can have a detrimental effect on peak symmetry and can reduce the resolution of all compounds. If water contamination occurs, reactivate your Restek Msieve 5A PLOT column by conditioning at 300 °C with dry carrier gas flow for 3 hours.

### **MXT-Msieve 5A Columns** (Siltek-treated stainless-steel PLOT)

Advantages of metal MXT PLOT columns include:

- Can be made in small coil diameters—perfect for tight spaces.
- Rugged material withstands rough handling and shock.
- Designed for robust performance in process GCs and field instruments.
- Available in 3.5"-coil diameter or 7"-diameter, 11-pin cage.*

*We do not recommend recoiling PLOT columns as this may cause particles to dislodge from the side of the tubing.

| ID | df | Length | Temp. Limits | Column Config | qty. | cat.# |
|---|---|---|---|---|---|---|
| 0.53 mm | 50 µm | 30 m | -100 to 300 °C | 7" 11-pin cage | ea. | 79723 |
| | 50 µm | 30 m | -100 to 300 °C | 3.5" Coil | ea. | 79723-273 |

### **MXT-Alumina BOND/$Na_2SO_4$ Columns** (Siltek-treated stainless-steel PLOT)

Advantages of metal MXT PLOT columns include:

- Can be made in small coil diameters—perfect for tight spaces.
- Rugged material withstands rough handling and shock.
- Designed for robust performance in process GCs and field instruments.
- Available in 3.5"-coil diameter or 7"-diameter, 11-pin cage.*

*We do not recommend recoiling PLOT columns as this may cause particles to dislodge from the side of the tubing.

| ID | df | Length | Temp. Limits | Column Config | qty. | cat.# |
|---|---|---|---|---|---|---|
| 0.53 mm | 10 µm | 30 m | -60 to 200 °C | 7" 11-pin cage | ea. | 79714 |
| | 10 µm | 30 m | -60 to 200 °C | 3.5" Coil | ea. | 79714-273 |

## **MXT-Alumina BOND/MAPD Columns** (Siltek-treated stainless-steel PLOT)


- Optimized deactivation produces maximum response when analyzing trace levels of acetylene, methyl acetylene, and propadiene.
- Stable response factors make this column ideal for process-type applications where recalibration must be minimized.
- High loadability reduces peak tailing and improves separations.
- Extended temperature range up to 250 °C for fast elution of high molecular weight (HMW) hydrocarbons and accelerated column regeneration following exposure to water.
- Temperature range: -60 to 250 °C.

MXT-Alumina BOND/MAPD PLOT columns are made specifically for the analysis of petrochemicals and downstream products, such as ethylene, propylene, butylenes, and butadiene!

Also available in fused silica Rt-Alumina columns!

Restek's R&D chemists have optimized the deactivation technology applied to our MXT-Alumina BOND/MAPD column for improved analysis of trace concentrations of polar hydrocarbons like acetylene, methyl acetylene, and propadiene in hydrocarbon streams containing higher levels of C1-C5 hydrocarbons. Our new Alumina PLOT deactivation produces an incredibly inert column that offers superior reproducibility and stable response factors to maximize the number of analyses before recalibration is required. Its high sample capacity reduces peak tailing, thereby improving the separation of target compounds. In addition, a 250 °C maximum operating temperature lets you more quickly elute hydrocarbons up to dodecane and reduces regeneration time when the column is exposed to water from samples or carrier gases. We do not recommend recoiling PLOT columns as this may cause particles to dislodge from the side of the tubing.

| ID | df | Length | Temp. Limits | Column Config | qty. | cat.# |
|---|---|---|---|---|---|---|
| 0.53 mm | 10 µm | 30 m | -60 to 250 °C | 7" 11-pin cage | ea. | 79728 |
| | 10 µm | 30 m | -60 to 250 °C | 3.5" Coil | ea. | 79728-273 |

## **MXT-Q-BOND Columns** (Siltek-treated stainless-steel PLOT)

Advantages of metal MXT PLOT columns include:

- Can be made in small coil diameters—perfect for tight spaces.
- Rugged material withstands rough handling and shock.
- Designed for robust performance in process GCs and field instruments.
- Available in 3.5"-coil diameter or 7"-diameter, 11-pin cage.*

*We do not recommend recoiling PLOT columns as this may cause particles to dislodge from the side of the tubing.

| ID | df | Length | Temp. Limits | Column Config | qty. | cat.# |
|---|---|---|---|---|---|---|
| 0.25 mm | 8 µm | 15 m | -60 to 300 °C | 7" 11-pin cage | ea. | 79718 |
| | 8 µm | 15 m | -60 to 300 °C | 3.5" Coil | ea. | 79718-273 |
| 0.53 mm | 20 µm | 30 m | -60 to 280/300 °C | 7" 11-pin cage | ea. | 79716 |
| | 20 µm | 30 m | -60 to 280/300 °C | 3.5" Coil | ea. | 79716-273 |

20394

## MXT Low-Dead-Volume Connector Kits for Metal Columns

- Connect a guard column/transfer line to an MXT stainless-steel column.
- Low thermal mass tracks rapid oven temperature programming.
- Stainless-steel ferrules and nuts.
- Available in "Y" and union configurations.
- Siltek treatment ensures ultimate inertness.

Each kit contains the MXT union, two 1/32-inch ferrules and nuts.

| Description | Includes | Fits Column ID | Union Bore | qty. | cat.# |
|---|---|---|---|---|---|
| MXT Low-Dead-Volume Connector Kit | MXT union, 1/32-inch ferrules (2) and nuts (2) | For 0.28 mm ID MXT Columns | 0.25 mm | kit | 20397 |
| | MXT union, 1/32-inch ferrules (2) and nuts (2) | For 0.18/0.25/0.32 mm ID MXT Columns | 0.25 mm | kit | 20536 |
| | MXT union, 1/32-inch ferrules (2) and nuts (2) | For 0.53 mm ID MXT Columns | 0.25 mm | kit | 20394 |

19754

## PLOT Column Particle Trap

- Includes two Press-Tight connectors, a 2.5 m column, and high-temperature string.
- Protects detector and valves; connects between column and detector or valve.
- Eliminates detector spikes and scratches in valve rotors.

The technology used to adhere particles in PLOT columns is excellent; however, it is still possible for particles to dislodge when extreme pressure shocks and gas flow changes occur. This sometimes happens when valve switching or backflushing is used. In those cases, using particle traps is recommended.

| Description | Includes | Size | qty. | cat.# |
|---|---|---|---|---|
| PLOT Column Particle Trap | Press-Tight connectors (2); 2.5 m, 0.25 mm ID column; high-temperature string | 0.25 mm ID | ea. | 19774 |
| | Press-Tight connectors (2); 2.5 m, 0.32 mm ID column; high-temperature string | 0.32 mm ID | ea. | 19753 |
| | Press-Tight connectors (2); 2.5 m, 0.53 mm ID column; high-temperature string | 0.53 mm ID | ea. | 19754 |

Learn more at **www.restek.com/petro**

RESTEK
Pure Chromatography

**Questions? Contact us or your local Restek representative (www.restek.com/contact-us).**



**www.restek.com**

QUALITY ISO 9001 · 17025 · 17034

Lit. Cat.# PCSS1163K-UNV