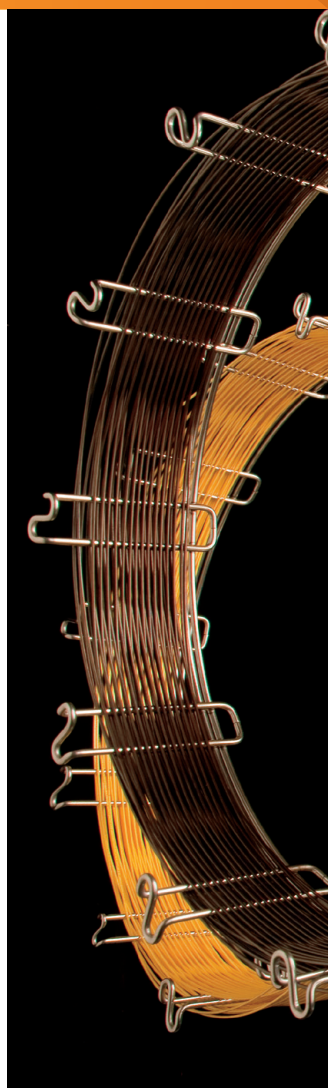
GC Columns

PLOT Columns

Stable Bonded GC PLOT Columns



- Innovative bonding process minimizes particle release, reducing column blockage and protecting instrument parts.
- More consistent flow means stable retention times in Deans and related flow switching techniques.
- Outstanding peak symmetry improves impurity analysis for gases, solvents, and hydrocarbons.

Quick Reference Chart

PLOT Column	Description/Application
Rt-Silica BOND (p. 120)	Bonded silica Light hydrocarbons, sulfur gases, carbon dioxide, and halocarbons
Rt-Alumina BOND/Na_2SO_4 (p. 121) MXT-Alumina BOND/Na_2SO_4 (p. 129)	C1–C5 hydrocarbons Purity analysis of ethylene, propylene, butenes, butadiene
Rt-Alumina BOND/KCl (p. 122)	C1-C10 hydrocarbons, C1-C5 isomers Purity analysis of ethylene, propylene, butene, butadiene.
Rt-Alumina BOND/CFC (p. 123)	Multi-halogenated alkanes, C1-C-5 range Chlorofluorocarbons (CFCs)
Rt-Alumina BOND/MAPD (p. 124) MXT-Alumina BOND MAPD (p. 129)	Trace analysis of methylacetylene, propadiene, acetylene
Rt-Msieve 5A (p. 125) MXT-Msieve 5A (p. 129)	Permanent gas analysis He, Ne, Ar, O_2, N_2, Xe, Rn, CH_4, and CO
Rt-Q-BOND (p. 126) MXT-Q-BOND (p. 129)	Nonpolar porous polymer High retention for solvents, alcohols, polar volatiles, CO_2, sulfur, and ppm water in solvents
Rt-QS-BOND (p. 127)	Intermediate polarity porous polymer (polarity between Q-BOND and S-BOND) Neutral solvents, ketones, esters, hydrocarbons, and baseline separation of ethane, ethene, acetylene
Rt-S-BOND (p. 127) MXT-S-BOND (p. 129)	Intermediate polarity porous polymer Light gases in ethylene and propylene, ketones, esters, hydrocarbons
Rt-U-BOND (p. 128)	Polar porous polymer More retention for polar compounds

PLOT Column Phase Cross-Reference: Similar Selectivity

Restek® Rt® and MXT® Columns	Porous Layer	Supelco	Alltech	Agilent (J&W, Varian, Chrompack)	Quadrex
Silica BOND	Bonded silica	———	———	CP Silica PLOT, GS-GasPro	———
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-Molsieve 5A	PLT-5A
Q-BOND	100% Divinylbenzene	Supel-Q-PLOT	AT-Q	HP PLOT Q ,CP-PoraPLOT Q, CP-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	———

Stable Bonded Porous Layer Open Tubular (PLOT) Columns

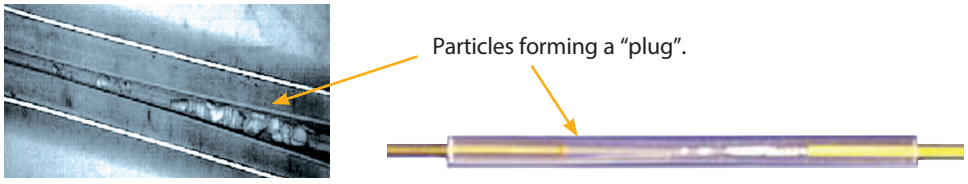
- Stabilized particle layers improve robustness and reproducibility of retention and flow.
- Fully compatible with valve switching and Deans switching systems.
- Highly efficient, reproducible analyses; ideal for permanent gases, solvents, and hydrocarbons.
- Innovative manufacturing procedure reduces particle generation and improves performance of porous polymer and molecular sieve PLOT columns.

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 gaseous compounds at room temperature. Due to the adsorption mechanism of the supports used in PLOT columns, permanent gases and light hydrocarbons can be resolved at room 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-fit connector.

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



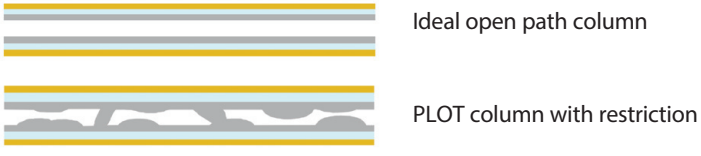
Restek® PLOT Columns Offer Improved Stability to Minimize Particle Release

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.

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.

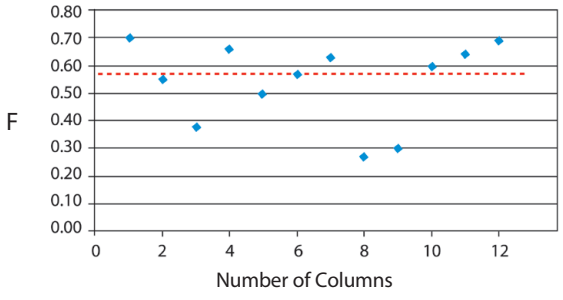
Figure 2: Inconsistent coating thicknesses result in restrictions that cause significant variation in flow.



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 backpressure 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. Flow restriction can also be calculated (Equation 2). 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, Restek's 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 3: Traditional PLOT columns show significant flow variability, indicating inconsistent column coating thicknesses.



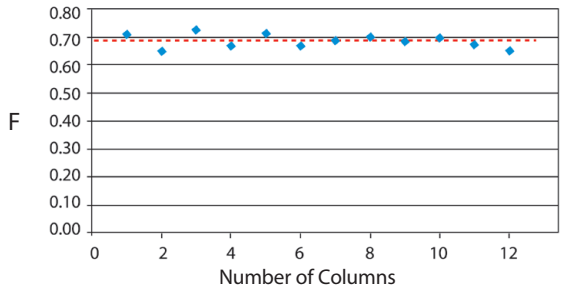
Equation 1: Flow restriction factor (F) is used to demonstrate coating consistency.

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

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.



Equation 2: Percent flow restriction of coated column.

$$\% \text{ restriction} = (1-F) \times 100$$

See what makes Restek's new **Rt®-Silica BOND** column the best on the market! .....**page 120**

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.

Fused Silica Capillary & PLOT Column Ferrule Guide

GC Column ID	Ferrule ID
0.15 mm	0.4
0.18 mm	0.4
0.25 mm	0.4
0.32 mm	0.5
0.53 mm	0.8

similar phases

GS-GasPro, CP-SilicaPLOT

NEW!

Rt®-Silica BOND Columns (fused silica PLOT)

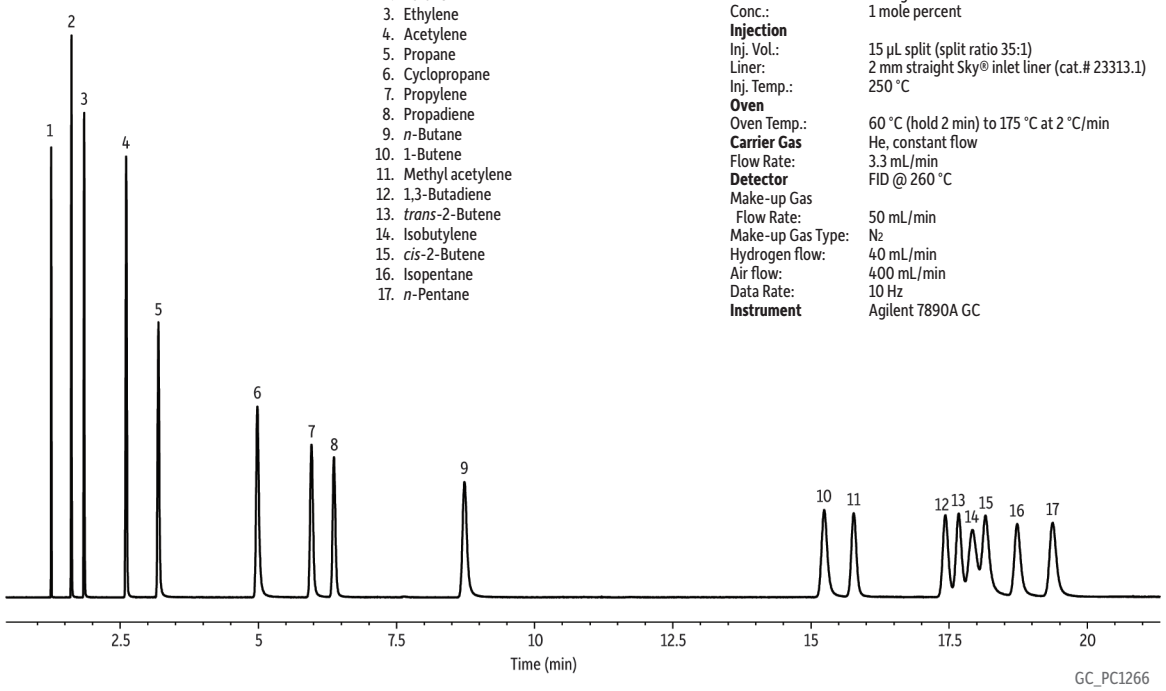
- Versatile column ideal for analysis of light hydrocarbons, sulfur gases, halocarbons, and carbon dioxide.
- Individually QC tested with sensitive C4 probes to ensure consistent selectivity.
- Proprietary manufacturing process practically eliminates particle release, reducing downtime due to obstructed FID jets.
- Bonded silica stationary phase minimizes impact of water, resulting in reproducible retention times for water-containing samples.
- Stable to 260 °C.

Restek's Rt®-Silica BOND columns are robust, versatile, selective PLOT columns that offer excellent performance for the analysis of light hydrocarbons, sulfur gases, and halocarbons above ambient temperature. In addition, carbon dioxide and other gases can be retained at ambient temperature on this silica-based column. High loadability, inertness, and consistent selectivity, as well as unmatched robustness at a maximum temperature of 260 °C, make the Rt®-Silica BOND column ideal for the analysis of active unsaturated hydrocarbons.

Rigorous C4 selectivity testing and additional testing to confirm efficiency and inertness ensure good separations are achieved with optimal peak shape and response for active analytes. As with all Restek® PLOT columns, our proprietary manufacturing process minimizes particle generation, which reduces the problems commonly associated with released particles (signal spikes, valve damage, and obstructed FID jets).

ID	temp. limits	15-Meter cat.#	30-Meter cat.#	60-Meter cat.#
0.32 mm	-80 to 260 °C	19784	19785	19786

Saturated and Unsaturated Hydrocarbons on Rt®-Silica BOND PLOT Column



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

Column	Rt®-Silica BOND, 30 m, 0.32 mm ID (cat.# 19785)
Sample	Custom DCG gas standard
Diluent:	Nitrogen
Conc.:	1 mole percent
Injection	
Inj. Vol.:	15 µL split (split ratio 35:1)
Liner:	2 mm straight Sky® inlet liner (cat.# 23313.1)
Inj. Temp.:	250 °C
Oven	
Oven Temp.:	60 °C (hold 2 min) to 175 °C at 2 °C/min
Carrier Gas	He, constant flow
Flow Rate:	3.3 mL/min
Detector	FID @ 260 °C
Make-up Gas Flow Rate:	50 mL/min
Make-up Gas Type:	N_2
Hydrogen flow:	40 mL/min
Air flow:	400 mL/min
Data Rate:	10 Hz
Instrument	Agilent 7890A GC

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 to improve column response for polar unsaturates, such as dienes, and the column's sensitivity (or response) ensures linear and quantitative chromatographic analysis for these compounds. Strong bonding prevents particle generation and release, which allows valve switching without harming 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.

similar phases

GS-Alumina, CP-Al_2O_3/Na_2SO_4, Alumina-Sulfate

tech tip

Trace Water in the Carrier Gas

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.

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.
- Stable to 200 °C.

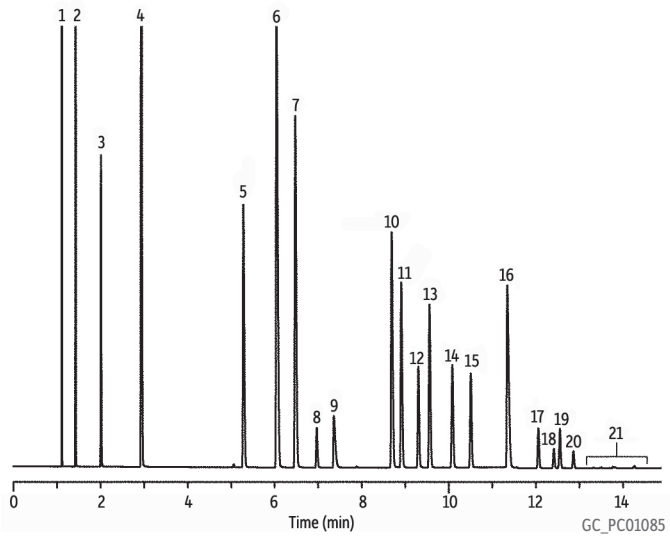
ID	df	temp. limits	30-Meter cat.#	50-Meter cat.#
0.25 mm	4 µm	to 200 °C	19775	—
0.32 mm	5 µm	to 200 °C	19757	19758
0.53 mm	10 µm	to 200 °C	19755	19756

also available

Metal MXT® PLOT Columns

See **page 129.**

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

Fused Silica Alumina BOND Columns

similar phases

GC-Alumina KCl, HP-PLOT Al_2O_3/KCl, CP-Al_2O_3/KCl, Alumina-Chloride

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.
- Stable to 200 °C.

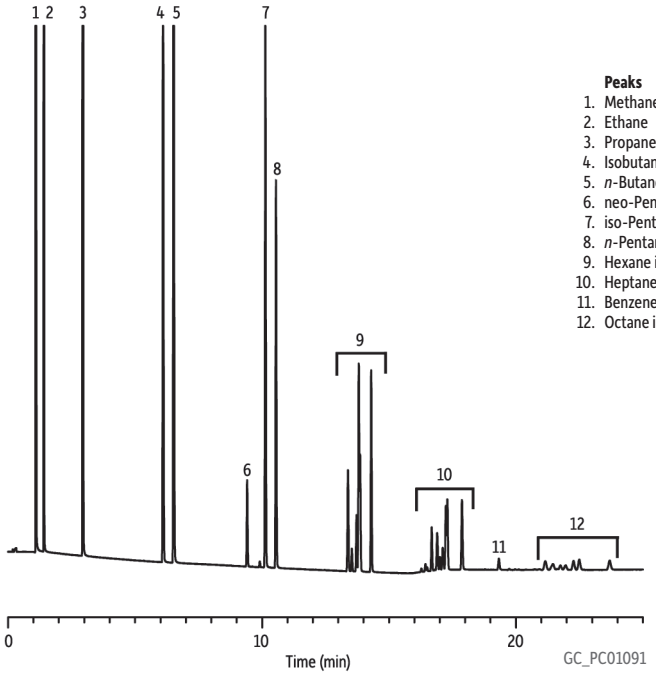
ID	df	temp. limits	30-Meter cat.#	50-Meter cat.#
0.25 mm	4 µm	to 200 °C	19776	—
0.32 mm	5 µm	to 200 °C	19761	19762
0.53 mm	10 µm	to 200 °C	19759	19760

Fused Silica Capillary & PLOT Column Ferrule Guide

GC Column ID	Ferrule ID
0.15 mm	0.4
0.18 mm	0.4
0.25 mm	0.4
0.32 mm	0.5
0.53 mm	0.8

We pack Restek quality into each and every column we ship.

Natural Gas on Rt®-Alumina BOND/KCl



Column	Rt®-Alumina BOND/KCl, 50 m, 0.53 mm ID, 10 µm (cat.# 19760)
Sample	Natural gas
Injection	
Inj. Vol.:	500 µL split
Liner:	2.0 mm ID single taper (cat.# 20795)
Inj. Temp.:	200 °C
Split Vent Flow Rate:	50 mL/min
Oven	
Oven Temp.:	45 °C (hold 1 min) to 200 °C at 10 °C/min (hold 8.5 min)
Carrier Gas	H_2, constant pressure (8.0 psi, 55.2 kPa)
Linear Velocity:	45 cm/sec @ 45 °C
Detector	FID @ 200 °C
Make-up Gas Type:	N_2
Data Rate:	20 Hz
Instrument	HP5890 GC

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.
- Stable to 200 °C.

The Alumina BOND/CFC adsorbent is ideal for retaining halogenated compounds, especially CFCs (chlorinated fluorocarbons) like Freon® products. 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 main stream processes or in impurity analyses.

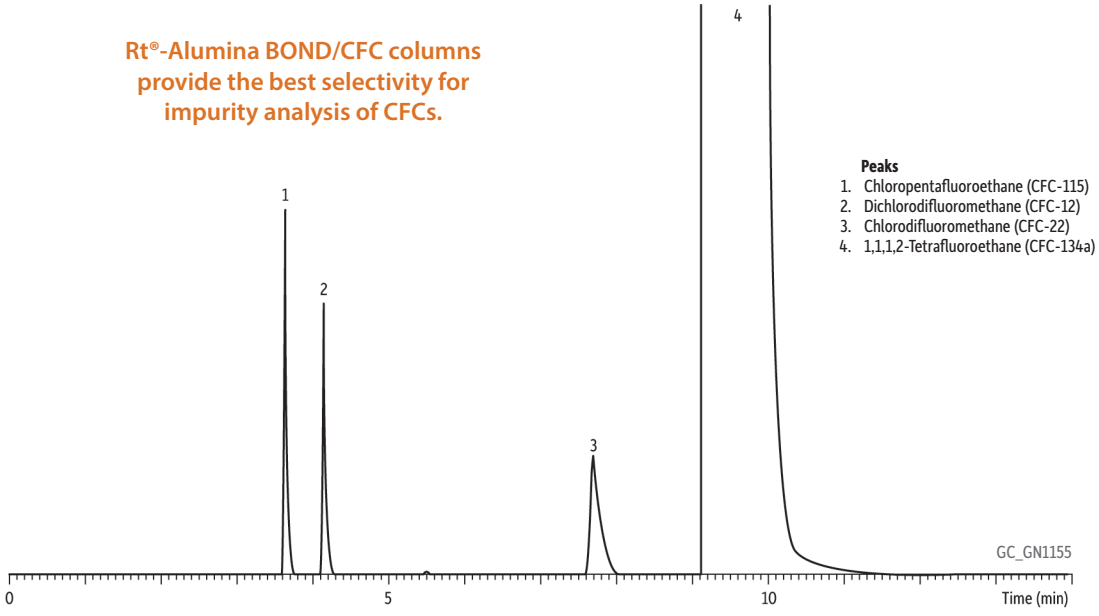
ID	df	temp. limits	30-Meter cat.#
0.53 mm	10 µm	to 200 °C	19763

did you know?

All Restek PLOT columns come standard on a 7"-diameter, 11-pin cage.

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.



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.

Fused Silica Alumina BOND Columns

similar phases

Select Al_2O_3 MAPD

free literature

Analyze Trace Polar Hydrocarbons More Accurately and Reliably With New Alumina BOND/MAPD PLOT Columns

Download your free copy from

www.restek.com

lit. cat.# PCBR1412A-UNV

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.
- Stable to 250 °C.

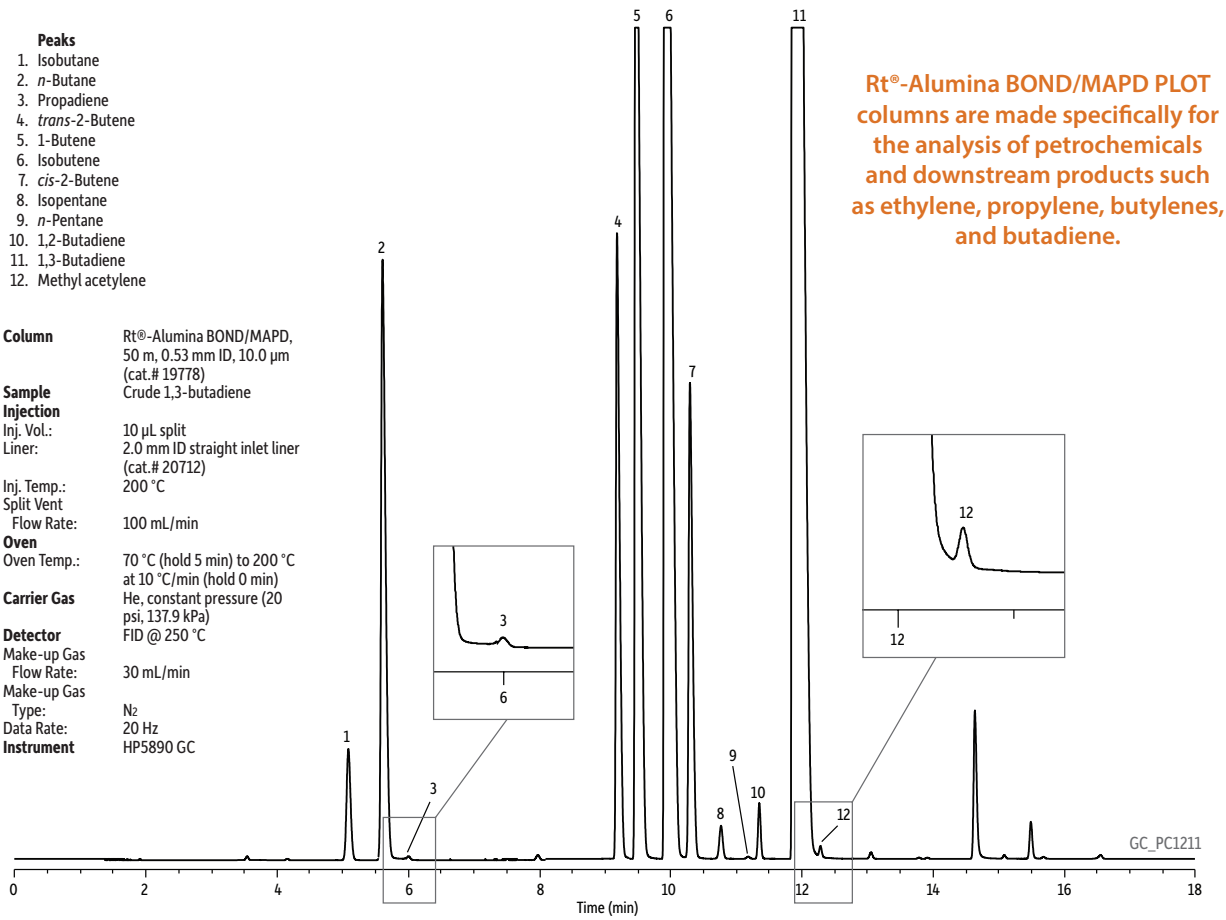
Restek's R&D chemists have optimized the deactivation technology applied to our Rt®-Alumina BOND/MAPD column for improved analysis of trace concentrations of polar hydrocarbons like acetylene, methyl acetylene, and propadiene in hydrocarbon streams containing higher levels of C1-C5 hydrocarbons. Our 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.

ID	df	temp. limits	30-Meter cat.#	50-Meter cat.#
0.25 mm	4 µm	to 250 °C	19781	—
0.32 mm	5 µm	to 250 °C	19779	19780
0.53 mm	10 µm	to 250 °C	19777	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

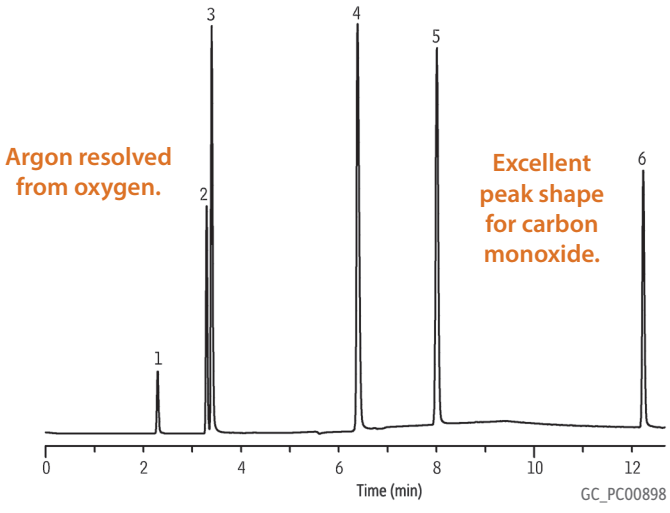
Restek's molecular sieve 5A PLOT columns are designed for efficient separation of argon/oxygen and other permanent gases, including carbon monoxide. Special coating and deactivation procedures ensure chromatographic efficiency and the integrity of the porous layer coating. Molecular sieves have very 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.
- Stable to 300 °C.

ID	df	temp. limits	15-Meter cat.#	30-Meter cat.#
0.25 mm	20 µm	to 300 °C	19773	—
0.32 mm	30 µm	to 300 °C	19720	19722
0.53 mm	50 µm	to 300 °C	19721	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

did you know?

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

similar phases

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

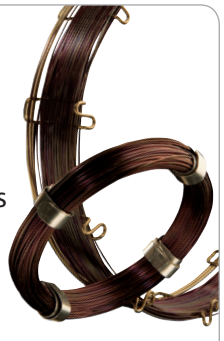
tech tip

Molecular sieve materials are very hydrophilic

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.

also available

Metal MXT® PLOT Columns



See **page 129.**

Fused Silica Porous Polymer Columns

Porous Polymer Columns

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

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

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

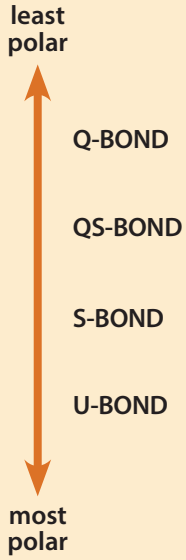
Rt®-Q-BOND Columns (fused silica PLOT)

100% divinylbenzene

- Nonpolar PLOT column incorporating 100% divinylbenzene.
- Excellent for analysis of C1 to C3 isomers and alkanes up to C12.
- 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 room temperature.)
- Use for analysis of oxygenated compounds and solvents.
- Maximum temperature of 300 °C.

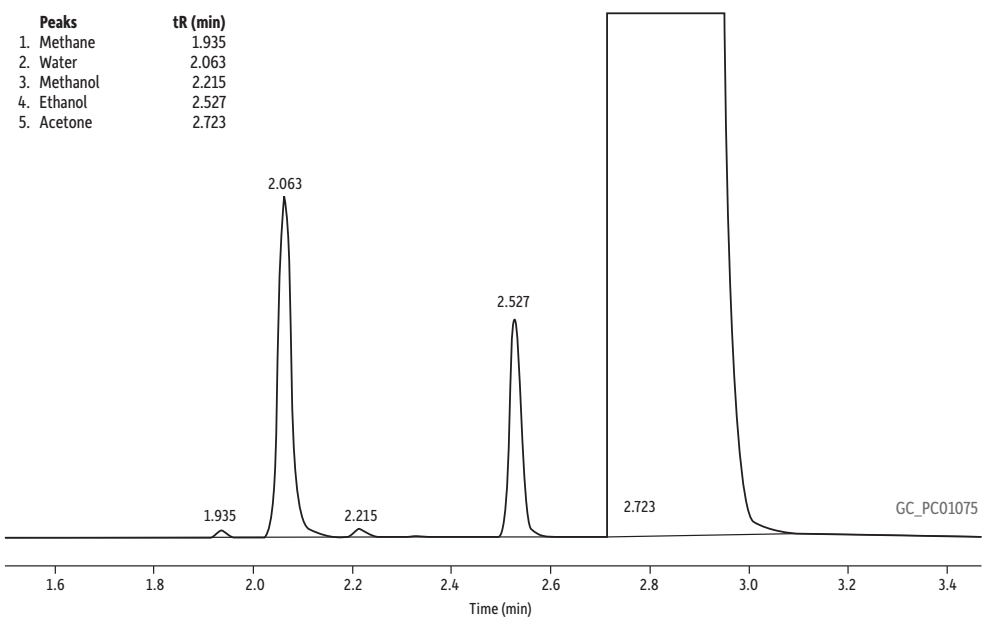
ID	df	temp. limits	15-Meter cat.#	30-Meter cat.#
0.25 mm	8 µm	to 280/300 °C	19764	19765
0.32 mm	10 µm	to 280/300 °C	19743	19744
0.53 mm	20 µm	to 280/300 °C	19741	19742

Restek porous polymer PLOT columns cover a wide range of polarities



Water and Ethanol in Acetone on Rt®-Q-BOND

Peaks	tR (min)
1. Methane	1.935
2. Water	2.063
3. Methanol	2.215
4. Ethanol	2.527
5. Acetone	2.723



Column	Rt®-Q-BOND, 30 m, 0.53 mm ID, 20 µm (cat.# 19742)
Sample	
Diluent:	Acetone
Conc.:	0.5% Water and ethanol
Injection	
Inj. Vol.:	3 µL split (split ratio 11:1)
Liner:	Splitless taper (4 mm) w/wool (cat.# 22405)
Inj. Temp.:	250 °C
Oven	
Oven Temp.:	200 °C (hold 4 min)
Carrier Gas	He, constant linear velocity
Linear Velocity:	28.7 cm/sec @ 200 °C
Detector	TCD @ 260 °C

Rt®-QS-BOND Columns (fused silica PLOT)

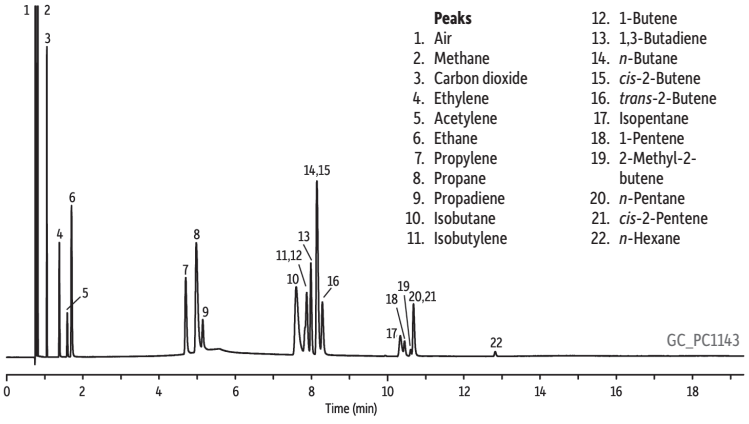
porous divinylbenzene homopolymer

- Intermediate polarity PLOT column incorporating low 4-vinylpyridine.
- Separates ethane, ethylene, and acetylene to baseline.
- Designed for the best possible separation between all C2 isomers.
- Stable to 250 °C.

similar phases
GS-Q

ID	df	temp. limits	15-Meter cat.#	30-Meter cat.#
0.25 mm	8 µm	to 250 °C	19767	19768
0.32 mm	10 µm	to 250 °C	19739	19740
0.53 mm	20 µm	to 250 °C	19737	19738

Refinery Gas Mixture on Rt®-QS-BOND



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

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

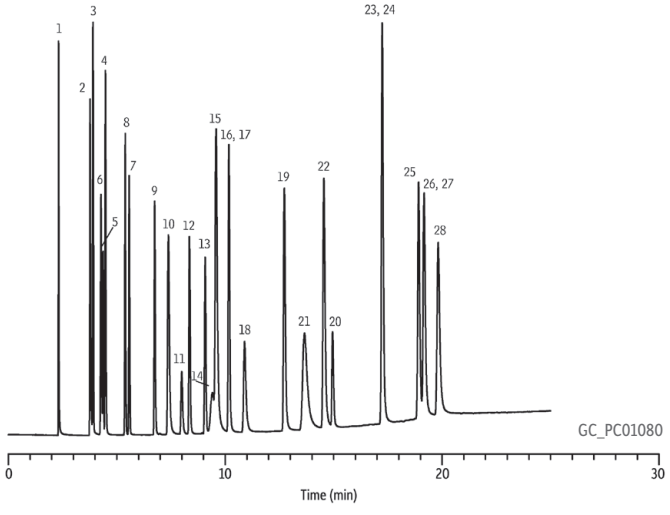
porous divinylbenzene homopolymer

- Midpolarity PLOT column, incorporating high 4-vinylpyridine.
- Use for the analysis of nonpolar and polar compounds.
- Stable to 250 °C.

similar phases
CP-PoraPLOT S

ID	df	temp. limits	15-Meter cat.#	30-Meter cat.#
0.25 mm	8 µm	to 250 °C	19769	19770
0.32 mm	10 µm	to 250 °C	19747	19748
0.53 mm	20 µm	to 250 °C	19745	19746

Solvent Mixture on Rt®-S-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®-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

Fused Silica Porous Polymer Columns, Particle Trap

similar phases

HP-PLOT U, CP-PoraPLOT U, CP-PoraBOND U

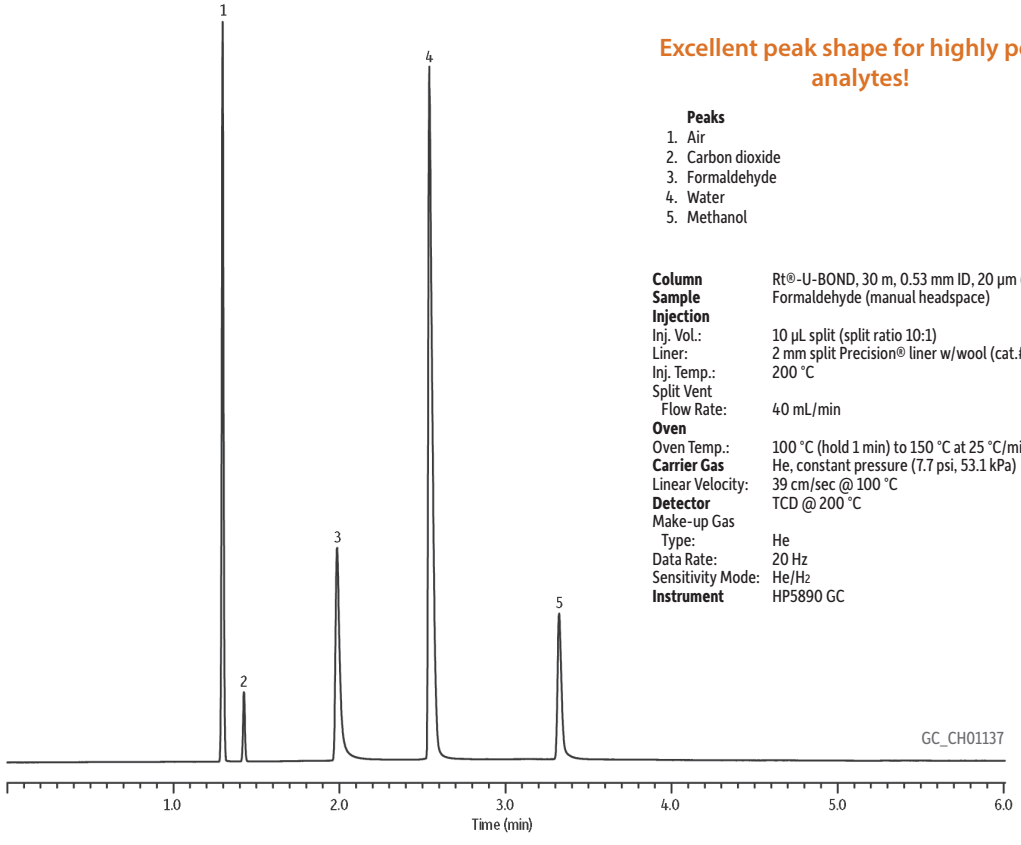
Rt®-U-BOND Columns (fused silica PLOT)

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.
- Stable to 190 °C.

ID	df	temp. limits	15-Meter cat.#	30-Meter cat.#
0.25 mm	8 µm	to 190 °C	19771	19772
0.25 mm	12 µm	to 190 °C	19782	—
0.32 mm	10 µm	to 190 °C	19751	19752
0.53 mm	20 µm	to 190 °C	19749	19750

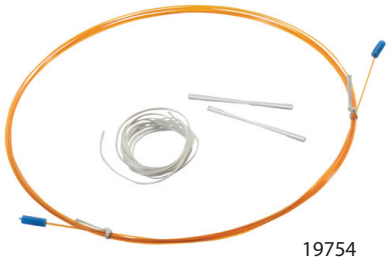
Formaldehyde on Rt®-U-BOND



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



19754

PLOT Column Particle Trap

- Includes two Press-Tight® connectors and a 2.5 m column.
- 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 possibile 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	qty.	cat.#
PLOT Column Particle Trap, 2.5 m, 0.32 mm ID with 2 Press-Tight Connectors	ea.	19753
PLOT Column Particle Trap, 2.5 m, 0.53 mm ID with 2 Press-Tight Connectors	ea.	19754

Metal MXT® PLOT Columns

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.

Restek® chemists have developed technology that allows many of our popular PLOT columns to be made on Siltek®-treated stainless steel. These columns have the same characteristics and performance as fused silica PLOT columns, but offer additional benefits for process GCs and field applications as they are virtually unbreakable and can be coiled into very small diameters.

ID	df	temp. limits	3.5" coil 15-Meter cat.#	7" diameter 11-pin cage 15-Meter cat.#	3.5" coil 30-Meter cat.#	7" diameter 11-pin cage 30-Meter cat.#
MXT-Msieve 5A						
0.25 mm	20 µm	to 300 °C	79717-273	79717	—	—
0.53 mm	50 µm	to 300 °C	—	—	79723-273	79723
MXT-Alumina BOND/Na_2SO_4						
0.53 mm	10 µm	to 200 °C	—	—	79714-273	79714
MXT-Alumina BOND/MAPD						
0.53 mm	10 µm	to 250 °C	—	—	79728-273	79728
MXT-Q-BOND						
0.25 mm	8 µm	to 300 °C	79718-273	79718	—	—
0.53 mm	20 µm	to 280/300 °C	—	—	79716-273	79716
MXT-S-BOND						
0.53 mm	20 µm	to 250 °C	—	—	79712-273	79712

MXT® GC Column Ferrule Guide

GC Column ID	GC Column OD	Ferrule ID
0.18 mm	0.36 ± 0.001	0.4
0.25 mm	0.41 ± 0.001	0.5
0.28 mm	0.56 ± 0.001	0.6
0.32 mm	0.44 ± 0.0015	0.5
0.53 mm	0.74 ± 0.001	0.8