

# PLOT Columns

Top: Pete Rose, Fused Silica Operations Group  
Leader

Bottom: Brian Salisbury, Applied Sciences Group  
Engineer



## Features & Benefits of Restek PLOT Columns

Feature	Benefit
Highest quality porous materials.	The most consistent and efficient analyses obtainable.
Consistency in porosity and uniformity in particle and pore size are major concerns in designing the solid stationary phase. We developed a unique synthesis and selection technology to yield uniform, small diameter particles that are ideal for a specific separation.	
Particles are 100% bonded to the tubing.	No need for particle traps because particle generation is eliminated.
Restek coating and bonding techniques produce strong, uniform particle adherence to the inside of the capillary tubing. Customers have described Restek's Rt-Msieve™ 5A PLOT column as "bulletproof," meaning that the stationary phase is bonded so strongly that particle generation is completely eliminated.	
Reproducible quality.	Reproducible performance.
Because we use advanced technology to make these columns, the entire manufacturing process is simple and stable. Each step of the column-making process is meticulously quality-checked, allowing Restek to offer the best quality PLOT columns.	

## Quick Reference Chart

PLOT Column	Application	Page
Rt-Alumina™	C1–C5 hydrocarbons. Example: purity analysis of ethylene, propylene, butenes	92–93
Rt-Msieve™ 5A	Argon/oxygen separation; gas purity analysis. Example: gas purity in the semiconductor industry	94
Rt-Msieve™ 13X	Hydrogen, oxygen, nitrogen, methane, and carbon monoxide. Examples: natural gas and refinery gas purity analysis	94
Rt-QPLOT™	Gases and volatile organic compounds. Examples: polar solvents, alcohols, nonpolar hydrocarbons.	95
Rt-SPLOT™	Light gases in ethylene and propylene, ketones, esters. Example: intermediate polarity hydrocarbons.	95
Rt-UPLOT™	Polar volatiles, nitriles, nitro compounds, alcohols, aldehydes, ethane/ethylene. Example: polar hydrocarbons	95

## PLOT Column Phase Cross-Reference: Similar Performance

Restek	Porous Layer	Agilent/J&W	Supelco	Alltech	Varian/Chrompack	Quadrex
Rt-Alumina™	Aluminum oxide	GS-Alumina HP PLOT S, HP PLOT M	Alumina-PLOT	AT-Alumina	CP-Al <sub>2</sub> O <sub>3</sub> /NA <sub>2</sub> SO <sub>4</sub>	—
Rt-Msieve™ 5A	Molecular sieve 5A	GS-Molsieve HP PLOT/Molesieve	Molsieve 5A PLOT	AT-Molesieve	CP-Molesieve 5A	PLT-5A
Rt-Msieve™ 13X	Molecular sieve	Restek Exclusive				
Rt-QPLOT™	DVB porous polymer	GS-Q	Supel-Q-PLOT	AT-Q	CP-PoraPlot Q	—
Rt-SPLOT™	DVB vinylpyridine polymer	—	—	—	CP-PoraPlot S	—
Rt-UPLOT™	DVB ethyleneglycoldimethylacrylate polymer	HP-UPLOT	—	—	CP-PoraPlot U	—

## Rt-Alumina™ PLOT Columns

### Rt-Alumina™ PLOT Columns

1. Selectivity is measured by the retention indices of unsaturates such as alkenes, alkynes, and dienes. Unsaturates have much higher retention index values than the saturates (paraffins and isoparaffins) in the same carbon number group.
2. Reactivity of aluminum oxide stationary phase is minimized so that column response for polar unsaturates, such as dienes, is optimized. Column sensitivity or response ensures a linear and quantitative chromatographic analysis for these compounds.
3. Strong bonding prevents particle generation. The column is unaffected during valve-switching.
4. The thermally stable column can be regenerated easily after contamination by water, ensuring reproducible analytical data.

### did you know?

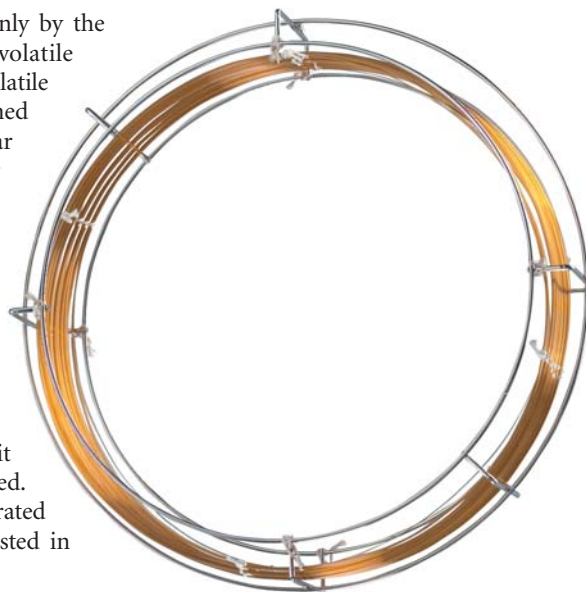
Rt-Alumina™ PLOT columns show unique retention characteristics for hydrocarbons.

### Selectivity

The selectivity of the Rt-Alumina™ PLOT column is measured by the retention indices for acetylene and propadiene. Retention increases as the degree of unsaturation increases; retention also increases with decreasing volatility.

For saturates, retention is determined mainly by the volatility of the compound, with less volatile compounds retained longer than more volatile compounds. E.g., isoparaffins are less retained than less volatile normal paraffins of similar carbon number, and saturates of higher carbon number are more strongly retained than those of lower carbon number.

For unsaturates, retention is strongly influenced by polarity or degree of unsaturation. In general, hydrocarbons having a higher degree of unsaturation are more polar. This polarity comes from the presence of  $\pi$  electrons; the more  $\pi$  electrons present in a compound, the more polar it behaves and the more strongly it is retained. Retention indices for some unsaturates separated on the Rt-Alumina™ PLOT column are listed in Table I.



### Sensitivity

Proper deactivation is critical to minimize reactivity of the aluminum oxide stationary phase and maximize column sensitivity. Quantitation can be done only if the column exhibits linear response, which results from good stationary phase inertness. Rt-Alumina™ PLOT columns are specially deactivated and provide high inertness for unsaturates and saturates. In fact, Rt-Alumina™ PLOT columns are almost four times more sensitive for unsaturates than other brands on the market. Column sensitivities for various unsaturated hydrocarbons, measured by the peak height ratio based on *n*-butane, are shown in Table I.

**Table I:** Retention indices and column response for unsaturates on an Rt-Alumina™ PLOT column at 80°C.

	Ethylene	Acetylene	Propylene	Propadiene
Retention Index	255	421	372	407
Peak Ratio (vs. <i>n</i> -butane)	0.65	0.72	0.84	0.54

**Guaranteed Reproducibility**

Each Rt-Alumina™ PLOT column is tested with a hydrocarbon test mix to ensure proper phase thickness and deactivation (see figure). Pentane is used to calculate *k* (capacity factor), which is a measure of phase thickness. The ratio of isobutane to acetylene retention is measured to ensure proper deactivation of the alumina oxide layer. The plates per meter value is calculated to evaluate column efficiency.

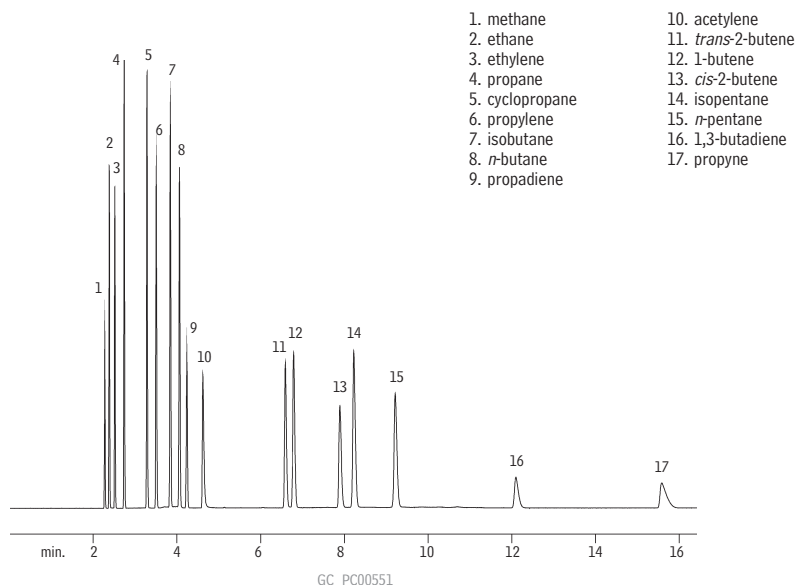
Restek's Rt-Alumina™ PLOT columns offer fast and reproducible hydrocarbon stream and purity analyses. The 0.32mm ID Rt-Alumina™ PLOT column provides fast and efficient analysis of C1 to C5 hydrocarbons. The higher capacity of the 0.53mm ID Rt-Alumina™ PLOT column makes it ideal for purity analysis of many common petrochemicals, such as 1,3-butadiene, ethylene, and propylene.

**Rt-Alumina™ Columns (fused silica PLOT)**(NaSO<sub>4</sub> Deactivation)

ID	df (μm)	temp. limits	30-Meter	50-Meter	60-Meter
0.32mm	3	to 200°C	19702	—	19703
0.53mm	6	to 200°C	19700	19701	—



**Neil Mosesman**  
Marketing Manager  
19+ years of service!

**Each Rt-Alumina™ PLOT column is tested to ensure proper phase thickness and deactivation.**

50m, 0.53mm ID, 6μm Rt-Alumina™ PLOT (cat. # 19701)  
50μL gas-tight syringe injection, 1000ppm each analyte

Oven temp.: 80°C  
Inj. & det. temp.: 200°C  
Carrier gas: helium  
Linear velocity: 42cm/sec. set @ 80°C (5.6mL/min.)  
Split flow: 40mL/min.  
FID sensitivity: 1.28 x 10<sup>-10</sup> AFS

**tech tip**

Trace water in the carrier gas can affect the selectivity of an alumina PLOT column by decreasing retention of unsaturated compounds. The column can be regenerated by baking out the water (50°C to 190°C @ 8°C/min., 50cm/sec. flow rate). Periodic conditioning ensures excellent run-to-run retention time reproducibility.

The maximum programmable temperature for an Rt-Alumina™ PLOT column is 200°C. Higher temperatures cause irreversible changes to the porous layer adsorption properties.

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**Applications**

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Searching for a chromatogram?

[www.restek.com](http://www.restek.com)

## Molecular Sieve 5A PLOT Columns

### please note

Rt-Msieve™ 5A PLOT columns are designed for efficient separation of Ar/O<sub>2</sub> and other permanent gases.

### tech tip

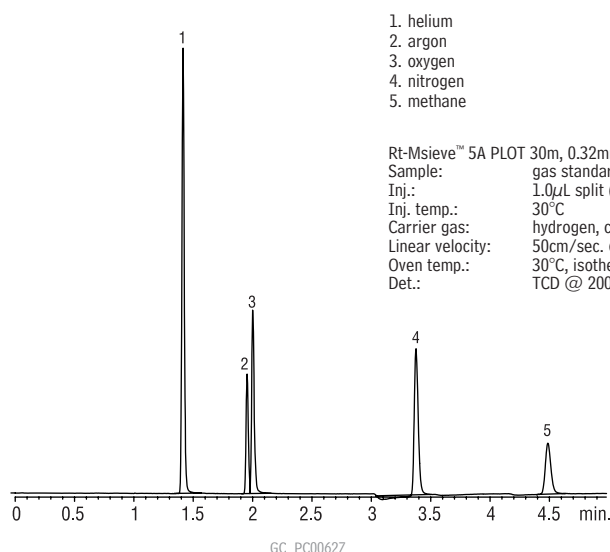
Because molecular sieve materials are very hydrophilic, they will adsorb water from the sample or carrier gas. Water contamination can have a detrimental effect on peak symmetry and can reduce the resolution of all compounds. If water contamination occurs, reactivate your Rt-Msieve™ 5A PLOT column by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

### Rt-Msieve™ 5A PLOT Columns

Rt-Msieve™ 5A PLOT columns are designed for efficient separation of Ar/O<sub>2</sub> and other permanent gases. Special coating and deactivation procedures ensure chromatographic efficiency and the integrity of the porous layer bonding. The pore size of this uniform material is finely controlled to allow selective adsorption of certain compounds, and to achieve separations that a capillary column has difficulty performing without subambient temperatures. Additionally, Restek's unique immobilization process guarantees that the uniform particles remain adhered to the tubing—even after continuous valve-cycling.

Our revolutionary molecular sieve 5A PLOT columns separate Ar/O<sub>2</sub> and H<sub>2</sub>/He at ambient temperature or above (see figure below). These columns also are an excellent choice for rapid separation of permanent gases in refinery or natural gas.

#### Permanent gases on an Rt-Msieve™ 5A PLOT column.



### Rt-Msieve™ 5A Columns (fused silica PLOT)

ID	df (µm)	temp. limits	15-Meter	30-Meter
0.32mm	30	to 300°C	19720	19722
0.53mm	50	to 300°C	19721	19723

### did you know?

ShinCarbon ST micropacked columns are another alternative for analyzing permanent gases.

See page 102 for information.

### Rt-Msieve™ 13X Columns (fused silica PLOT)

ID	df (µm)	temp. limits	15-Meter	30-Meter
0.53mm	20	up to 300°C	19708	19706



### dependable execution

David "Junior" has a reputation for making outstanding PLOT columns, as a result of his attention to details. He also has provided excellent suggestions for improving consistency of these columns, through his observations and notes on variables that improve success rates in manufacturing.

David W. Rhodes Jr., GC Column Manufacturing Technician

## Porous Polymers: Rt-QPLOT™, Rt-SPLOT™, and Rt-UPLOT™ Columns

Restek has developed unique polymer technology and coating processes, to make excellent porous polymer PLOT columns. Selectivity is similar to that of Porapak® and HayeSep® packings.

Unlike molecular sieve and alumina columns, porous polymer PLOT columns are not moisture sensitive, making them particularly useful for applications in which moisture is of major concern.

Chromatographic selectivity, in terms of polarity or chemical functionality, can be modified by incorporating polar functional groups in the styrene/divinylbenzene matrix. The least polar, or nonpolar, Rt-QPLOT™ columns are made with divinylbenzene. Rt-SPLOT™ columns incorporate 4-vinylpyridine, providing intermediate polarity. Highly-polar Rt-UPLOT™ columns are modified with an ethyleneglycol/dimethylacrylate functional group to provide excellent selectivity for unsaturated compounds.

Use these porous PLOT columns for a wide variety of separations. Permanent gases can be separated at subambient temperatures. Inorganic gases such as CO<sub>2</sub> easily can be analyzed on porous polymer columns. For hydrocarbon analysis, tremendous versatility based on a choice of selectivity is advantageous. These columns also are designed for analysis of various polar and nonpolar solvents.

### Rt-QPLOT™ Columns (fused silica PLOT)

divinylbenzene

ID	df (μm)	temp. limits	15-Meter	30-Meter
0.32mm	10	to 310°C	19717	19718
0.53mm	20	to 310°C	19715	19716

### Rt-SPLOT™ Columns (fused silica PLOT)

4-vinylpyridine

ID	df (μm)	temp. limits	15-Meter	30-Meter
0.32mm	10	to 250°C	19711	19710
0.53mm	20	to 250°C	19713	19712

### Rt-UPLOT™ Columns (fused silica PLOT)

ethylene glycol/dimethylacrylate

ID	df (μm)	temp. limits	15-Meter	30-Meter
0.32mm	10	to 190°C	19725	19724
0.53mm	20	to 190°C	19727	19726

## did you know?

New purification techniques have improved the peak shapes for polar compounds on our Rt-QPLOT™ columns.

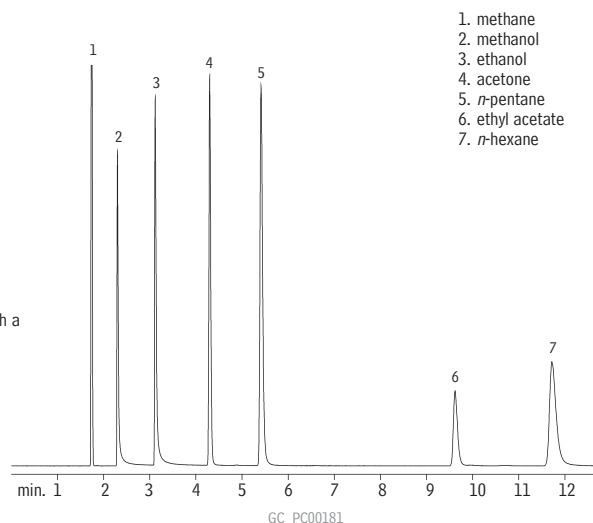
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### Solvents on a polar Rt-QPLOT™ column.

30m, 0.32mm ID Rt-QPLOT™ PLOT (cat.# 19718)  
20μL split injection. 50ppm (w/v) each in helium with a Cyclosplitter® inlet liner (cat.# 20755)

Oven temp.: 150°C  
Inj./det. temp.: 200°C  
Carrier gas: hydrogen  
Det.: FID  
Split ratio: 20/1



## please note

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