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Advantage

High Resolution GC/MS Separations of Dioxin and Furan Congeners

Using Restek's New Rtx®-Dioxin2 Capillary GC Column

By Frank Dorman, Ph.D., Director of Technical Development

- ✓ Resolves 2,3,7,8-substituted congeners from each other and from non-toxic congeners.
- ✓ Resolves furan congeners from chlorodiphenyl ethers.
- ✓ Stable to 320°C, for longer column life

An accurate GC analysis of dioxin and furan congeners is a challenge. Separation of the toxic congeners (configurations with substitutions at the 2, 3, 7, and 8 positions) from the non-toxic congeners is

difficult on almost any stationary phase. Most laboratories perform an initial analysis using a 5% diphenyl / 95% dimethyl polysiloxane column (e.g., Rtx®-5) to

obtain reasonable estimates of concentrations for the 2,3,7,8-substituted congeners. For some of the target congeners, this quantitation is biased toward high values, due to coelution with non-toxic congeners. As many as five non-toxic TCDFs can coelute with 2,3,7,8-tetrachlorodibenzofuran, for example, in an analysis on a 5% diphenyl / 95% dimethyl polysiloxane (5-type) column.

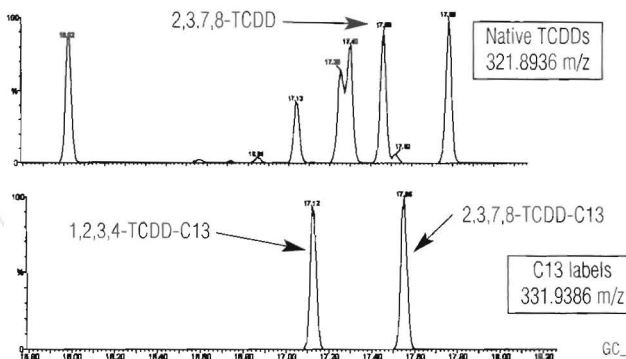
Because of this coelution issue, many laboratories use confirmation columns, most commonly high

cyanopropyl (225-type) stationary phases (e.g., Rtx®-225, Rtx®-2330), in order to more accurately quantify the toxic congeners. Unfortunately, cyanopropyl columns exhibit poor thermal stability, and therefore column lifetimes are short

Since most methods for analysis of dioxins and furans include extensive sample extract cleanup, and high-resolution mass spectrometry, a primary requirement of the ideal analytical column is complete separation of the toxic dioxin and furan congeners from each other. Additionally, it is desirable for the column to have high thermal stability and long lifetime.

With these characteristics in mind, Restek chemists developed Rtx®-Dioxin2 capillary GC columns. These new columns completely resolve the 2,3,7,8-substituted congeners from each other, and from the non-toxic congeners as well. Figure 1 shows the separation of the tetrachlorodibenzodioxins on a 60m x 0.25mm ID x 0.25µm Rtx®-Dioxin2 column. 2,3,7,8-TCDD is well resolved from the other congeners in this group and can be quantified accurately. The column also is available in an alternative format commonly used for this analysis: 40m x 0.18mm ID x 0.18µm. Either column is stable to 320°C.

Figure 1—2,3,7,8-Tetrachlorodibenzodioxin can be resolved from other TCDD congeners by using an Rtx®-Dioxin2 column.



60m, 0.25mm ID, 0.25µm Rtx®-Dioxin2
(cat.# 10758)

Oven temp.: 130°C (hold 1 min.) to
205°C @ 45°C/min. to 305°C @
6°C/min. (hold 30 min.); Dead time:
2.89 min.; Carrier gas: helium at
1.5mL/min., constant flow

GC_EV00702

Chromatogram courtesy of Karen MacPherson and Eric Rainer, Ontario Ministry of the Environment, Etobicoke, Ontario, Canada

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Quantitation of the hexachlorodibenzofurans on Rtx®-5 or equivalent columns, like quantitation of the dioxins, can be made difficult by coelutions of toxic and non-toxic congeners. The new column resolves furan congeners as effectively as dioxins. Figure 2 is a chromatogram for the HCDF congener group in reference material WMS-01; the congeners are very well resolved (reference material courtesy of Wellington Laboratories, Guelph, Ontario, Canada).

Table 1 lists values for 1,2,3,4,7,8-hexachlorodibenzofuran in several reference materials. In analyses on 5-type stationary phases, a number of non-toxic hexafuran congeners can coelute with the toxic 1,2,3,4,7,8-HCDF congener, producing inflated values for 1,2,3,4,7,8-HCDF. In fact, it is generally assumed that in fly ash the actual value for 1,2,3,4,7,8-HCDF is approximately 3-fold less than the value obtained when using a 5-type column. This

is one of the reasons confirmation on a high-cyano phase is necessary. As shown in Table 1, the value for 1,2,3,4,7,8-HCDF on an Rtx®-Dioxin2 column is approximately 3-fold less than what was quantified using a 5-type column. The difference is explained by the excellent separation in Figure 2: the lower, more accurate value is due to elimination of coelutions with non-toxic congeners. Values for other congeners compare equally well.

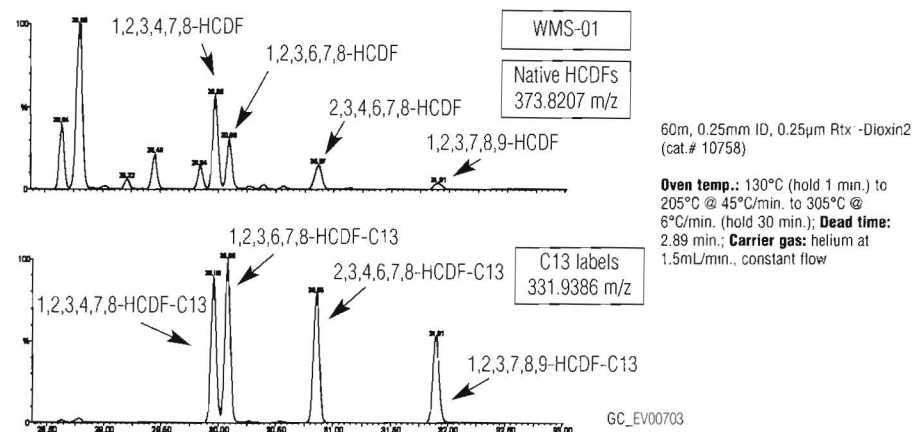
Table 1—An Rtx®-Dioxin2 column gives more accurate quantitation than 5-type columns for 1,2,3,4,7,8-hexachlorodibenzofuran in common matrices (all values pg/g).

	5-type column	Rtx®-Dioxin2 column	Certified Value
Biota-1	nd	nd	
Biota-2	nd	nd	
Sediment	290	210	
Fly ash	570	200	
EC-2 (DX-1)	780	630	714 ±276
NST 1974	nd	nd	

Table 2—Values for 2,3,7,8-tetrachlorodibenzofuran in biota reflect the Rtx®-Dioxin2 column's ability to resolve target compounds from potentially interfering chlorodiphenylethers (all values pg/g; provisional (non-2,3,7,8-TCDF confirmed)).

	5-type	Column 225-type	Rtx®-Dioxin2	Certified Value
Biota-1	1	1.3	0.8	
Biota-2	4.3	4.3	2.2	
Sediment	37	19	19	
Fly ash	240	38	32	
EC-2 (DX-1)	88	n/a	37	89 ±44
NST 1974	4.7	n/a	3.3	

Figure 2—Hexachlorodibenzofuran congeners resolved by an Rtx®-Dioxin2 column.



Chromatogram courtesy of Karen MacPherson and Eric Reiner, Ontario Ministry of the Environment, Etobicoke, Ontario, Canada.

Rtx®-Dioxin2 Columns (fused silica)

ID	df (μm)	temp. limits	40-Meter	60-Meter
0.18mm	0.18	20°C to 320°C	10759	\$650
0.25mm	0.25	20°C to 320°C	—	10758 \$750

Additional columns for dioxins analysis

Rtx®-Dioxin, 60m, 0.25mm ID, 0.15μm, cat.# 10755, \$715

Rtx®-Dioxin, 40m, 0.18mm ID, 0.11μm, cat.# 10756, \$655

Rtx®-5, 60m, 0.25mm ID, 0.25μm, cat.# 10226, \$705

Rtx®-5MS, 60m, 0.25mm ID, 0.25μm, cat.# 12626, \$710

An additional advantage of the Rtx®-Dioxin2 column is its ability to separate the chlorodiphenylethers, commonly found in biota extracts, from the furans. Coelution of these materials is a common problem on both 5% diphenyl / 95% dimethyl stationary phases and cyanopropyl stationary phases, but chromatographic separation is necessary for accurate quantification of the chlorofurans: the chlorodiphenylethers form chlorofurans in the ion source of the mass spectrometer, and therefore cannot be separated spectrally from the target compounds. Table 2 summarizes results from analyzing several matrices for 2,3,7,8-tetrachlorodibenzofuran (2,3,7,8-TCDF). The values for the biota extracts demonstrate the importance of the furan/chlorodiphenylether separation. Because neither the 5% diphenyl / 95% dimethyl-type column nor the cyanopropyl-type column solves the coelution problem, quantified values for 2,3,7,8-TCDF in biota are high for both columns. The Rtx®-Dioxin2 column separates these compounds, and the quantified values for 2,3,7,8-TCDF, approximately one-half of the values obtained on the other stationary phases for these particular samples, are more accurate values.

If you are involved in analyzing dioxins and furans, and would like detailed information about Rtx®-Dioxin2 columns, we can provide elution orders for all of the commonly analyzed congeners, and chromatograms for each congener group in the WMS-01 reference material. Please contact our Technical Service chemists at 800-356-1688 or 814-353-1300, ext. 4, or contact your Restek representative.



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Restek chromatography supplies and accessories—designed by

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This 50-page reference manual lists the consumer-replaceable items, supplies, and accessories you need to keep your Agilent GC running at top performance: injector and inlet supplies, detector parts and supplies, gas system components, tools, vials, syringes, and much more. Many items have been designed to save you time or improve your results, and are exclusive to Restek. Many other items are manufactured specifically to duplicate or exceed the performance of the instrument manufacturer's parts.

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Analyze Underivatized Chlorophenoxyacid Herbicides by HPLC

Using an Ultra Aqueous C18 Column and New Reference Mixtures

By Rebecca Wittrig, Ph.D., Senior Innovations Chemist, and Katia May, Ph.D., Senior R&D Chemist

- ✓ HPLC eliminates time-consuming derivatizations (required for GC).
- ✓ Ultra Aqueous C18 column has excellent selectivity for chlorophenoxyacid herbicides.
- ✓ New reference mixes for the most widely performed analyses.

Chlorophenoxyacid herbicides - 2,4-D, dicamba, picloram, Silvex (2,4,5-TP), and others - are used to control agricultural and aquatic weeds. While not considered highly toxic, chlorophenoxyacid herbicides are monitored in agricultural monitoring wells and drinking water sources. They are encountered in the acid form, or as the salts or esters.

Traditionally, these compounds have been analyzed by gas chromatography, according to US EPA Method 8151 or other methods. To make them amenable to GC, the acids must be converted to methyl esters, using a derivatizing agent such as diazomethane. High performance liquid chromatography is an

attractive option to this lengthy, hazardous procedure. Unlike in the GC procedures, derivatization is not necessary; the analytes can be separated and detected in the free acid form. Comparatively large injection volumes, relative to GC, also make HPLC attractive.

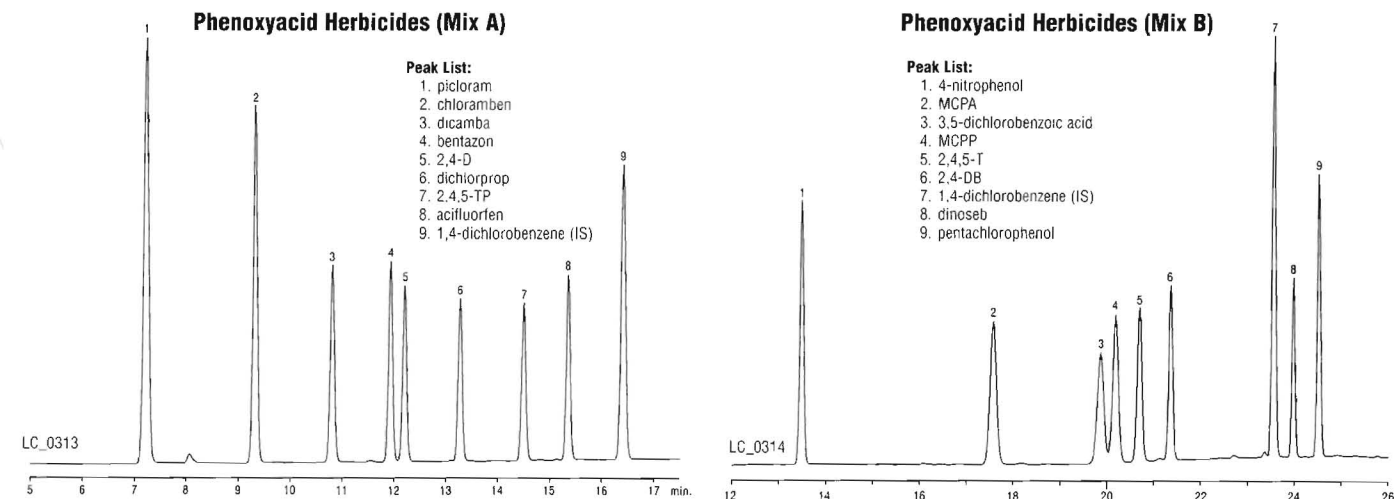
US EPA Method 555 was developed for analysis of chlorophenoxyacid herbicides, in the acid form, in drinking water. To minimize coelutions, the herbicides are divided into two sets. Figure 1 includes a chromatogram for each set, analyzed on an Ultra Aqueous C18 column, using gradient conditions optimized for each analysis. Note that this column

has excellent selectivity for resolving these structurally similar compounds. The gradient procedure is useful when analyzing a range of these herbicides; an isocratic mobile phase saves analysis and reequilibration time if samples contain only 2,4-D and Silvex.¹ EPA Method 8321, a general LC/MS or LC/UV method for semivolatile compounds, also includes a discussion of these herbicides.

Restek chemists have formulated a full complement of reference materials for Method 555. New chlorinated acids mixes A and B include all target compounds except 5-hydroxydicamba, a product of dicamba oxidation. Dicamba is stable under normal chromatographic conditions, but strong oxidizers in a sample could convert it to 5-hydroxydicamba and make identification difficult. To avoid this problem, we offer 5-hydroxydicamba in a single, separate solution. We designed these mixes with special consideration for stability, which is a concern because these herbicides, especially in the acid form, are light sensitive and readily degrade in the presence of alkaline substances.

(continued on pg. 5)

Figure 1—Chlorophenoxyacid herbicides are resolved well by an Ultra Aqueous C18 column. HPLC eliminates time-consuming, hazardous derivatizations.



Conditions for Mix A:

Mobile Phase A: 0.05% H₃PO₄
Mobile Phase B: acetonitrile

Time	%B
0	20
15	80
20	80
21	20

Flow: 1.0mL/min
Temp.: ambient
Det.: UV @ 225nm

Conditions for Mix B:

Mobile Phase A: 0.05% H₃PO₄
Mobile Phase B: acetonitrile

Time	%B
0	10
10	45
16	45
22	90
24	90
25	10

Flow: 1.0mL/min
Temp.: ambient
Det.: UV @ 225nm

Column and Sample for both chromatograms:

Column: Ultra Aqueous C18
Cat. #: 9178565
Dimensions: 150 x 4.6mm
Particle Size: 5µm
Pore Size: 100Å
Sample: 10µL
Inj.: 10 ppm each herbicide
Conc.:
Sample Diluent: acetonitrile

HPLC columns and additional reference materials listed on pg. 5.

¹Isocratic mobile phase: 0.05% phosphoric acid:acetonitrile, 60:40. For an example chromatogram of the isocratic analysis, request *Environmental HPLC: Applications-Columns-Reference Materials* (lit. cat.# 59741).

A Good Word

"After the disaster of 9-11, Diazald, a highly explosive compound used in Herbicide analysis, was immediately controlled by the U.S. government which made shipment impossible. Restek was instrumental in helping me to develop an isocratic HPLC method that did not require the use of Diazald. This method is not only safer, but it saves us time and money. Thanks, Restek!"

Chris Domaradzki, Organics manager,
Environmental Testing Laboratories

Chlorinated Acids by HPLC, Mix A

acifluorfen (Blazer®)
bentazon
chloramben
2,4-D
dicamba
dichlorprop
picloram
2,4,5-TP (Silvex)

1,000µg/mL each in acetonitrile, 1mL/ampul

Each	5-pk.	10-pk.
32431 \$57	32431-510 \$256.50	—
w/data pack		
32431-500 \$67	32431-520 \$285	32531 \$513

Chlorinated Acids by HPLC, Mix B

2,4-DB
3,5-dichlorobenzoic acid
dinoseb
MCPA
MCPP (mecoprop)
4-nitrophenol
pentachlorophenol
2,4,5-T

1,000µg/mL each in acetonitrile, 1mL/ampul

Each	5-pk.	10-pk.
32430 \$57	32430-510 \$256.50	—
w/data pack		
32430-500 \$67	32430-520 \$285	32530 \$513

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Extracolumn Volume and its Effects in Gradient HPLC

To Maintain Efficiency and Resolution, Use Short Lengths of Narrow-Bore Tubing

By Randy Romesberg, HPLC Applications Chemist

- ✓ Amount and location of extracolumn volume affect efficiency and resolution.
- ✓ Extracolumn volume *after* the column has greater effect than extracolumn volume *before* the column.
- ✓ 150µL of extra volume can cut efficiency by almost 50%.

Effects of extracolumn volume on band broadening, and the resulting chromatography, have been well studied and documented. These investigations, however, have primarily explored effects in isocratic separations. In this investigation, we have taken a practical look at extracolumn volume in gradient analyses, and studied the effects on actual separations. The data we have obtained show that the location of extracolumn volume in the sample flow path, as well as the amount of extracolumn volume, has a negative effect on theoretical plates (efficiency) and resolution. These extracolumn effects, in combination with the variables of column dimension and analyte retention, play important roles in the resulting chromatography.

To establish baseline chromatographic performance, we analyzed a homologous series of compounds consisting of toluene, ethylbenzene, propylbenzene, butylbenzene, and pentylbenzene on an optimized Agilent series 1100 chromatograph, using a 150 x 4.6mm Pinnacle II™ C18 column (5µm packing) and a methanol gradient (80-100% in 10 min.) or a 50 x 4.6mm

Pinnacle II™ C18 column and methanol gradient (80-100% in 3.3 min.). After establishing performance baselines, we added PEEK® tubing of a known internal volume to the sample flow path, ahead of the column or after the column, and repeated the analysis.

Effect of Extracolumn Volume and Location: 15cm Column

Figures 1a and 1b show the effect on efficiency (plates/meter, N/m) and resolution caused by increased extracolumn volume when using a 150 x 4.6mm C18 column under gradient conditions. Chromatographic performance deteriorates, as expected. Unlike observations from isocratic separations, however, extracolumn volume in the portion of the sample path between the column and the detector has a more significant effect than extracolumn volume in the tubing, connections, guard column, etc. located before the column inlet. In fact, for the later-eluting compounds in the test mix, 150µL of extra volume after the column had the same effect as 500µL of extra volume before the column.

Effect of Extracolumn Volume and Location: 5cm Column

Figures 1c and 1d show the effect on efficiency and resolution caused by adding extracolumn volume when using a 50 x 4.6mm C18 column. The effects are, overall, equivalent to those observed with the 150 x 4.6mm column. Since the peak volume is much smaller for this shorter column, however, equal amounts of extracolumn volume have greater effect than on a 150mm column. In this system, 150µL of extra volume before the column reduced efficiency by 46%, whereas with the 150mm column the loss in efficiency was only 20%.

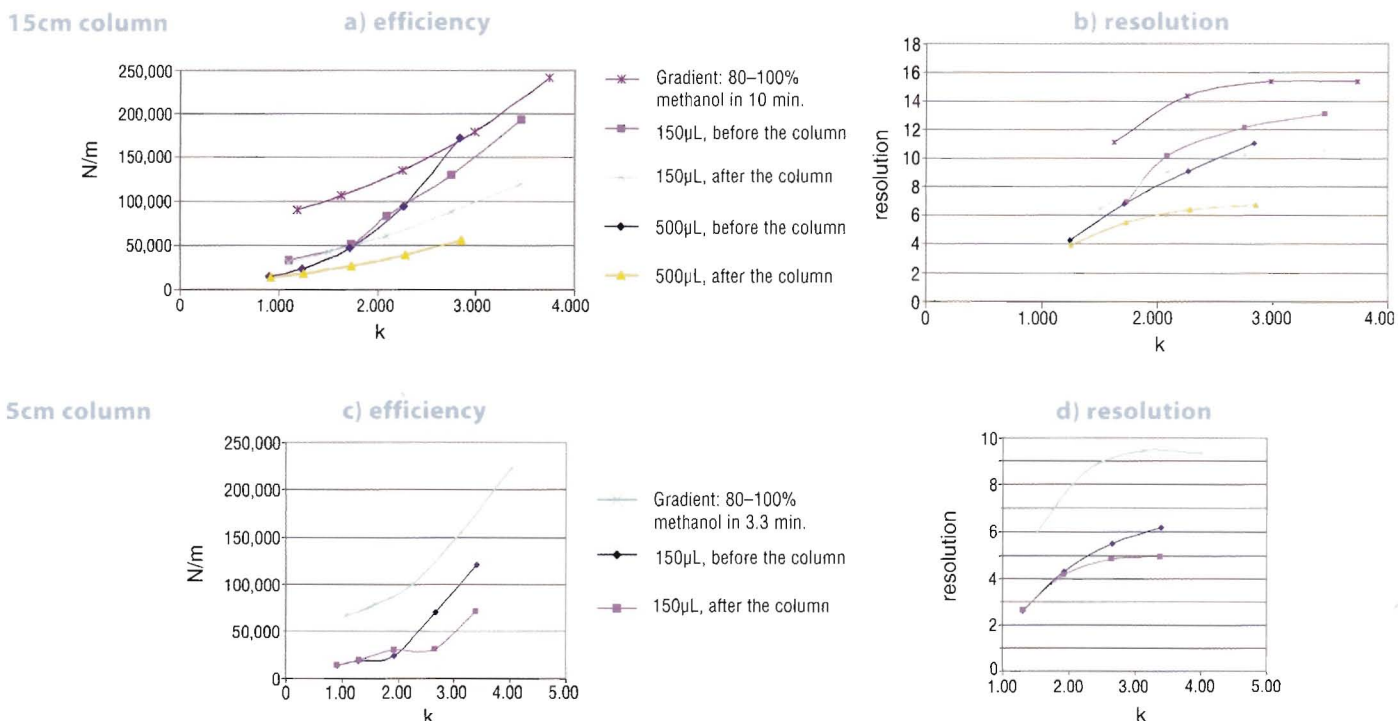
Conclusions

In a gradient analysis, the location of extracolumn volume in the sample flow path can be equally important to the amount of extracolumn volume in its effects on chromatographic performance. In particular, extra volume after the column should be reduced. This is especially important for fast analyses on short columns.

For any HPLC separation, it is best to keep tubing as short and the ID as narrow as practical. Additionally it is wise to use precut stainless steel tubing, or PEEK® tubing cut with a guillotine-style cutter, to ensure square, burr-free ends for minimal dead volume at connections.

For an extensive selection of tubing, low-volume fittings, and related tools, request our HPLC catalog (lit. cat.# 59241A).

Figure 1— Extracolumn volume after the column has greatest negative impact on efficiency and resolution in gradient analysis, as shown by consistently lowest values for plates/meter and resolution versus k.



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PEEK® Tubing, 1/16" OD x 0.005" ID x 3m	red stripe	ea.	25065	\$30
PEEK® Tubing, 1/16" OD x 0.007" ID x 3m	yellow stripe	ea.	25066	\$31
PEEK® Tubing, 1/16" OD x 0.010" ID x 3m	blue stripe	ea.	25067	\$31
PEEK® Tubing, 1/16" OD x 0.020" ID x 3m	orange stripe	ea.	25068	\$31

HPLC Stainless Steel Capillary Tubing

- 316 grade stainless steel.
- Precise pre-cut lengths.



Length	ID	OD	qty.	cat.#	price
5cm	0.005"	1/16"	3-pk.	25240	\$11
10cm	0.005"	1/16"	3-pk.	25241	\$13
20cm	0.005"	1/16"	3-pk.	25242	\$15
30cm	0.005"	1/16"	3-pk.	25243	\$17
5cm	0.007"	1/16"	3-pk.	25244	\$11
10cm	0.007"	1/16"	3-pk.	25245	\$13
20cm	0.007"	1/16"	3-pk.	25246	\$15
30cm	0.007"	1/16"	3-pk.	25247	\$17
5cm	0.010"	1/16"	3-pk.	25248	\$11
10cm	0.010"	1/16"	3-pk.	25249	\$13
20cm	0.010"	1/16"	3-pk.	25250	\$15
30cm	0.010"	1/16"	3-pk.	25251	\$17
5cm	0.020"	1/16"	3-pk.	25252	\$11
10cm	0.020"	1/16"	3-pk.	25253	\$13
20cm	0.020"	1/16"	3-pk.	25254	\$15
30cm	0.020"	1/16"	3-pk.	25255	\$17

Clean-Cut® Tubing Cutter

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Clean-Cut® Tubing Cutter	ea.	25069	\$38
Replacement Blade for Clean-Cut® Cutter	ea.	25070	\$6



Environmental HPLC: Applications, Columns, Reference Materials

(lit. cat.# 59741)
Restek HPLC columns support environmental HPLC applications with rapid analysis times and effective resolution of target analytes.

Sample turn-around can be 50% faster, or more, than with alternative columns. Applications in this 8-page publication include polycyclic aromatic hydrocarbons, carbamates, phenoxyacid herbicides, explosives, and carbonyls. Analytical reference materials and solid phase extraction sample clean-up products also are listed.

Analyze Underivitized Chlorophenoxyacid Herbicides by HPLC (cont. from pg. 3)

Historically, 2,4-D and Silvex mixtures have comprised many herbicide formulations, and we developed a reference mix for laboratories that analyze only these two compounds. Similarly, we offer an individual solution of dalapon, a herbicide not listed in Method 555, but included in more general Method 8321A. We offer 1,4-dichlorobenzene as an internal standard for this assay. All of our new herbicides

mixes are prepared in acetonitrile, as appropriate for HPLC applications, at a convenient concentration of 1000µg/mL.

If your analyses include monitoring chlorophenoxyacid herbicides, an Ultra Aqueous C18 column and our new reference mixes will help you obtain the most accurate data.

Ultra Aqueous C18 HPLC Columns (USP L1)

particle size: 3 or 5µm, spherical; not end-capped; pore size: 100Å; pH range: 2.5 to 7.5; temperature limit: 80°C

Length	1.0mm ID		2.1mm ID		3.2mm ID		4.6mm ID	
	cat.#	price	cat.#	price	cat.#	price	cat.#	price
3µm Columns								
30mm	9178331	\$360	9178332	\$340	9178333	\$340	9178335	\$340
50mm	9178351	\$360	9178352	\$340	9178353	\$340	9178355	\$340
100mm	9178311	\$386	9178312	\$366	9178313	\$366	9178315	\$366
5µm Columns								
30mm	9178531	\$335	9178532	\$315	9178533	\$315	9178535	\$315
50mm	9178551	\$335	9178552	\$315	9178553	\$315	9178555	\$315
100mm	9178511	\$360	9178512	\$340	9178513	\$340	9178515	\$340
150mm	9178561	\$386	9178562	\$366	9178563	\$366	9178565	\$366
200mm	9178521	\$412	9178522	\$392	9178523	\$392	9178525	\$392
250mm	9178571	\$438	9178572	\$418	9178573	\$418	9178575	\$418

Chlorinated Acid Herbicide Mix

2,4-dichlorophenoxyacetic acid
2,4,5-TP (Silvex)
1,000µg/mL each in acetonitrile, 1mL/ampul

Each	5-pk.	10-pk.
32429 \$25.80	32429-510 \$116.10	—
w/data pack		
32429-500 \$35.80	32429-520 \$129	32529 \$232.20

Dalapon

dalapon
1,000µg/mL in acetonitrile, 1mL/ampul

Each	5-pk.	10-pk.
32432 \$21.70	32432-510 \$97.65	—
w/data pack		
32432-500 \$31.70	32432-520 \$108.50	32532 \$195.30

1,4-Dichlorobenzene

1,4-dichlorobenzene
1,000µg/mL in acetonitrile, 1mL/ampul

Each	5-pk.	10-pk.
30498 \$43.40	30498-510 \$195.30	—
w/data pack		
30498-500 \$53.40	30498-520 \$217	30598 \$390.60

5-Hydroxydicamba

5-hydroxydicamba
100µg/mL in acetone:water (90:10), 5mL/ampul

Each
MET-346A \$130.30

Restek Replacement Parts for HPLC Systems

By Greg France, HPLC Products Marketing Manager

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The column may be the heart of an HPLC system but, just like the human body, the system can only perform as well as the weakest part. Detector lamps, check valves,* pump piston seals, and other components wear out or become contaminated over time. Working with defective parts means poor chromatography and, possibly, shortened column lifetimes.

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Replacement Parts for Agilent HPLC Systems

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	Autosampler Preventive Maintenance Kit	1100	G1313-68709	kit	25271	\$215
	Pump Maintenance Kit	1050 & 1100	G1311-68710	kit	25270	\$360
	Outlet Ball Valve, Binary Pump	1100	G1312-60012	ea.	25267	\$225
	Outlet Ball Valve	1050 & 1100	G1311-60012	ea.	25276	\$200
	Sieves for Outlet Valve	1050 & 1100	5063-6505	10-pk.	25266	\$10
	Piston Seals	1050 & 1100	5063-6589	2-pk.	25274	\$60
	Seal Wash Kit, Binary Pump (4 seals, 4 gaskets)	1100	—	kit	25268	\$130
	Seal Wash Kit (2 seals, 2 gaskets)	1100	—	kit	25269	\$80
	Wash Seal	1050 & 1100	0905-1175	ea.	25277	\$34
AUTOSAMPLER	Piston (Sapphire)	1050 & 1100	5063-6586	ea.	25273	\$79
	Pump Piston Rod (Sapphire)	1050, 1100	—	ea.	25197	\$90
	Pump Piston Rod (Sapphire)	1090	—	ea.	25198	\$90
	Needle Seat	1050	79846-67101	ea.	25258	\$30
	Needle Seat Assembly	1100	G1313-87101	ea.	25265	\$75
	Needle Assembly	1100	G1313-87201	ea.	25278	\$46
	Rotor Seal (not for use with 7125)	1050	0101-0626	ea.	25272	\$60
	Rotor Seal	1100	0100-1853	ea.	25275	\$44
	Detector Lamp, 1090 DA, 1050 VW/DA/MWD	1090, 1050	79883-60002	ea.	25260	\$440
	Lamp, DAD G1315A, G1365A	1100	2140-0590	ea.	25261	\$490
DETECTOR	Lamp, VWD G1314A	1100	G1314-60100	ea.	25262	\$445
	8453 Deuterium Lamp	—	2140-0605	ea.	25263	\$490
	G1321 Fluorescence Detector Flash Lamp	—	2140-0600	ea.	25264	\$640

Restek also offers replacement parts for PerkinElmer HPLC systems. Please contact us for more information.



Pump piston rods for Waters™ HPLC systems

Replacement Parts for Shimadzu HPLC Systems

	Description	Model #	Similar to Shimadzu part #	qty.	cat.#	price
PUMP	Inlet Check Valve	LC-6A, LC-10AS	228-12353-91	ea.	25287	\$98
	Inlet Check Valve	LC-600, LC-9A, LC-10AD	228-18522-91	ea.	25295	\$120
	Outlet Check Valve	LC-6A, LC-10AS	228-09054-93	ea.	25288	\$98
	Check Valve Rebuild Kit	LC-6A, LC-10AS	228-11200-91	2-pk.	25289	\$67
	Outlet Check Valve	LC-600, LC-9A, LC-10AD	228-18522-92	ea.	25282	\$120
	Plunger Seal	LC-6A	228-11999-00	ea.	25285	\$26
	Plunger Seal	LC-10AS	228-21975-00	ea.	25290	\$40
	Plunger Seal	LC-600, LC-9A, LC-10AD	228-18745-00	ea.	25293	\$35
	Plunger Rinse Seal	LC-10AS	228-28499-00	ea.	25292	\$52
	Plunger	LC-6A	228-12904-93	ea.	25286	\$95
AUTOSAMPLER	Plunger (Sapphire)	LC-10AS	228-17019-93	ea.	25291	\$115
	Plunger (Sapphire)	LC-600, LC-9A, LC-10AD	228-18523-91	ea.	25294	\$85
	Deuterium Lamp	SPD-6A	062-65056-02	ea.	25283	\$250
	Deuterium Lamp	SPD-10A, 10AV	228-34016-02	ea.	25284	\$420

Rheodyne® Style Replacement Parts for Waters™ HPLC Systems

Description	Similar to Rheodyne® part #	qty.	cat.#	price
7010 VespeI® Rotor Seal	7010-039	ea.	25279	\$55
7125 VespeI® Rotor Seal	7125-047	ea.	25280	\$55
Isolation Seal, 7010	7010-015	ea.	25281	\$12



Replacement parts for Agilent HPLC systems



Replacement parts for Waters™ HPLC systems

*Check valves listed separately - please request our HPLC catalog (lit. cat.# 59241A).

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Replacement Parts for Waters™ HPLC Systems

Description	Model #	Similar to Waters™ part #	qty.	cat.#	price
Inlet Check Valve Assembly	M6KA, 501, 510, 515, 590, 600E	33679, 25214	ea.	25360	\$125
Inlet Check Valve Housing	M6KA, 501, 510, 515, 590, 600E	25203	ea.	25361	\$30
Inlet Check Valve Rebuild Kit	M6KA, 501, 510, 515, 590, 600E	60495	2-pk.	25362	\$100
Outlet Check Valve Assembly (Actuator Style)	M6KA, 501, 510, 515, 590, 600E	25030	ea.	25363	\$100
Outlet Check Valve Housing (Actuator Style)	M6KA, 501, 510, 515, 590, 600E	25212	ea.	25364	\$38
Outlet Check Valve Rebuild Kit (Actuator Style)	M6KA, 501, 510, 515, 590, 600E	26016	2-pk.	25365	\$42
Outlet Check Valve Assembly (Ball & Seat Style)	M6KA, 501, 510, 515, 590, 600E	25216	ea.	25366	\$125
Outlet Check Valve Housing (Ball & Seat Style)	M6KA, 501, 510, 515, 590, 600E	25207	ea.	25367	\$35
Outlet Check Valve Rebuild Kit (Ball & Seat Style)	M6KA, 501, 510, 515, 590, 600E	26014	2-pk.	25368	\$100
Inlet Check Valve Assembly, 225µL (Extended Flow)	M6KA, 501, 510, 515, 590, 600E	60307	ea.	25369	\$130
PerformancePLUS™ Check Valve Cartridge	M6KA, 501, 510, 515, 590, 600E	700000254	2-pk.	25370	\$130
Check Valve Rebuild Kit (Extended Flow)	M6KA, 501, 510, 515, 590, 600E	88223	2-pk.	25371	\$120
PerformancePLUS™ Check Valve Housing	M6KA, 501, 510, 515, 590, 600E	—	ea.	25372	\$40
Round Pump Head w/ Actuator Outlets	M6KA, 510, 590, 600	60058	ea.	25413	\$365
Round Pump Head, Ball & Seat Check Valves	M6KA, M45, 501	—	ea.	25414	\$360
Round Pump Head w/o Check Valves (Actuator Style)	M6KA	—	ea.	25415	\$190
Round Pump Head w/o Check Valves (Ball & Seat Style)	M45, 501	—	ea.	25416	\$190
Check Valve Cartridges	Alliance™	WAT270941	2-pk.	25373	\$140
Super Seal™ for Analytical Heads	M6KA, 501, 510, 515, 590, 600E	22946, 22934	ea.	25374	\$26
Plunger Seal, Gold (Analytical Heads)	M6KA, 501, 510, 515, 590, 600E	22934	ea.	25375	\$26
Plunger Seal, Tan	M6KA, 501, 510, 515, 590, 600E	25384	ea.	25376	\$25
Plunger Seal, Red	M6KA, 501, 510, 515, 590, 600E	25638	ea.	25377	\$25
Plunger Seal, Black	M6KA, 501, 510, 515, 590, 600E	26613	ea.	25378	\$24
Plunger Seal, Black (EF Heads)	510, 590, 600E	26644	ea.	25379	\$25
Plunger Seal, Gold (EF Heads)	510, 590, 600E	26644	ea.	25380	\$25
Seal Wash Plunger Seal	Alliance™	WAT271018	2-pk.	25386	\$45
Head Plunger Seal Kit	Alliance™	WAT270938	2-pk.	25387	\$48
Head Plunger Seal Kit (Black)	Alliance™	WAT271066	2-pk.	25388	\$48
Insert Seal Parts Kit	M6KA, 501, 510, 515, 590, 600E	60012	kit	25389	\$18
Plunger (Sapphire)	M6KA, 510, 590, 600	25656	ea.	25381	\$105
Plunger (Sapphire Extended Flow)	510, 590, 600E	60304	ea.	25382	\$98
Plunger (Sapphire)	M45, M501	26524	ea.	25383	\$98
Plunger (Sapphire)	M515	WAT207069	ea.	25384	\$125
Plunger (Sapphire)	616, 625, 626	31788	ea.	25420	\$133
Plunger (Sapphire)	Alliance™	WAT270959	ea.	25385	\$125
Pump Piston Rod (Sapphire)	616, 625, 626	—	ea.	25195	\$145
Pump Piston Rod (Sapphire)	Alliance™ 2690	—	ea.	25196	\$135
Single Solvent Inlet Manifold	600E	60034, 60042	ea.	25390	\$385
Pressure Transducer	M6KA, 501, 510, 515, 590, 600E	60328	ea.	25391	\$425
Draw-Off Tube Assembly	M6KA, 501, 510, 515, 590, 600E	25470	ea.	25392	\$40
1/16" Stainless Steel TEE	M6KA, 501, 510, 515, 590, 600E	75215	ea.	25411	\$49
Inlet Manifold Kit	M45, 501, 510, 590, 600E	60448	kit	25412	\$28
Ferrule, Stainless Steel	515	22330	ea.	25417	\$2.80
Gradient Proportioning Valve, 9 Volt	600E	34423	ea.	25418	\$630
Gradient Proportioning Valve, 12 Volt	600E	62037	ea.	25419	\$630
Wash Face Seal	Alliance™ 2690	WAT271017	ea.	25428	\$29
Wash Tube Seal Kit	Alliance™ 2690	WAT270940	4-pk.	25429	\$89
Proportioning Valve	Alliance™ 2690	WAT270927	ea.	25430	\$885

Replacement Parts for Waters™ Detectors

Description	Model #	Similar to Waters™ part #	qty.	cat.#	price
LED	410 Refractometer	70162	ea.	25402	\$355
Solenoid Valve	410 Refractometer	70376	ea.	25421	\$289
Quartz Flow Cell	410, 401	48414, 70239	ea.	25422	\$680
Window Gasket	484, 486, 490	80335	ea.	25423	\$19
Lamp Side Gasket	484, 486, 490	80336	ea.	25424	\$20
Quartz Cell Window	484, 486, 490	97091	ea.	25425	\$40
Quartz Lens	486	80687	ea.	25427	\$135
Xenon Lamp (w/o holder or mirror)	470	—	ea.	25404	\$370
Xenon Lamp	474	—	ea.	25405	\$385
Deuterium Lamp (UV/Vis)	480, 481	99499	ea.	25403	\$385
Deuterium Lamp (UV/Vis)	484	80357	ea.	25406	\$385
Deuterium Lamp (UV/Vis)	486	80678	ea.	25407	\$385
Deuterium Lamp	996, 2996	WAT052586	ea.	25408	\$498
Deuterium Lamp	2487	WAS081142	ea.	25409	\$400
Deuterium Lamp, long life (2000 hours)	—	—	ea.	25410	\$485

Restek is your technical literature source!

Visit our website to request free application notes, technical guides, product catalogs, and more!



HPLC Mobile Phase Accessories

(lit. cat.# 59728A)

Items in this 2-page note include: Trident™ guard system components; in-line and reservoir filters and spargers; PEEK® tubing and connectors, Teflon® tubing; PEEK®/Teflon® tubing cutter; tubing clips and elbows; ValveTool wrench; our HPLC Survival Kit of tubing, connectors, filters, and tools. To see our latest HPLC columns and accessories innovations, visit our website.



HPLC Tech Tips Wall Chart

(lit. cat.# 59894A)

Almost everything you need to remember about HPLC, condensed into 3 feet by 2 feet: mobile phase basics, buffers (types, pKas, pH ranges, formula masses, more), miscibility and solubility chart (invaluable!), system setup and optimization, detector tips, pressure conversion factors, most-used chromatographic equations, column storage essentials. Post near your instrument to save time; perhaps save a column.

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Faster GC Analysis of Volatile Organics

Using an Rtx®-624 Capillary GC Column and a New MegaMix™ Reference Mix

By Christopher English, Environmental Innovations Chemist, and Katia May, Ph.D., Senior R&D Chemist

- ✓ New MegaMix™ completes a line of reference materials for volatile organics in wastewater.
- ✓ High concentration mixes—more analyses per ampul.
- ✓ Rtx®-624 column: fast analysis, excellent resolution of early-eluting gases.

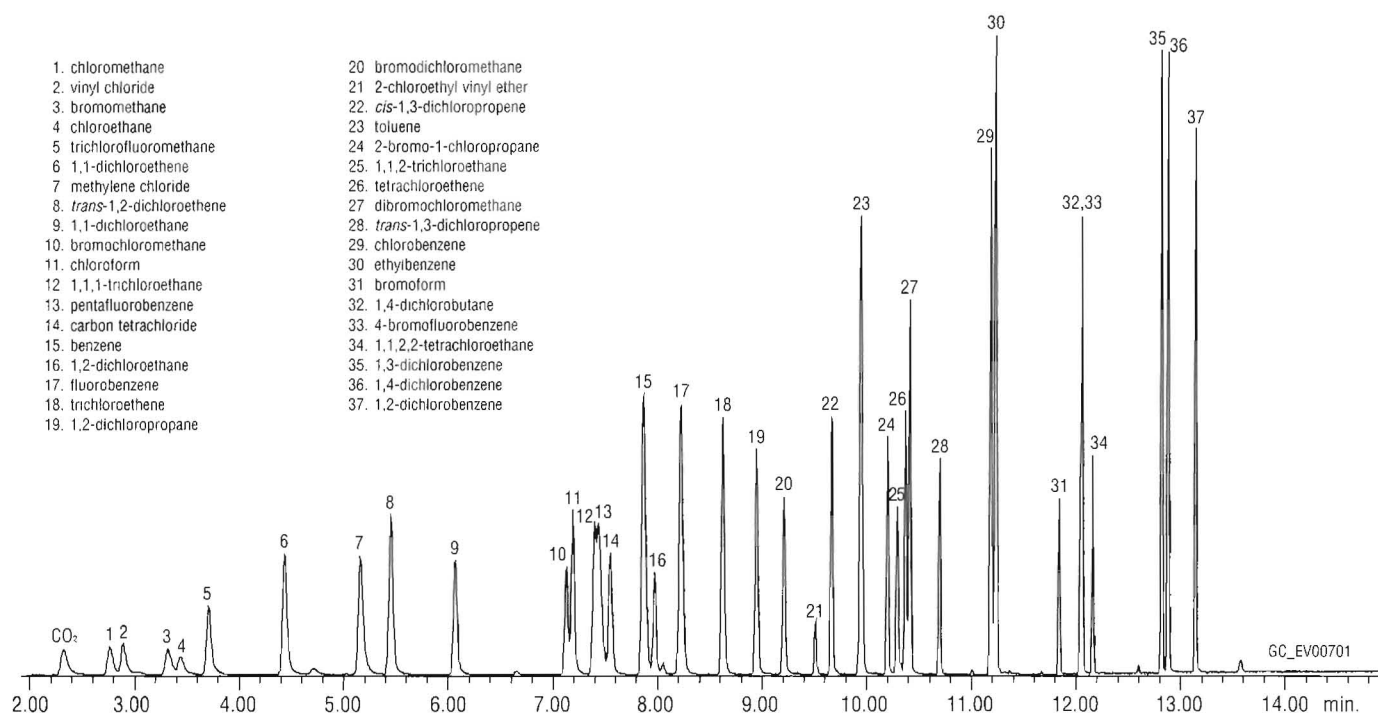
In the US Environmental Protection Agency method for determining 31 volatile organic pollutants in wastewater, EPA Method 624, the target volatile organics are analyzed using purge and trap gas chromatography/mass spectrometry. The purge and trap system efficiently transfers the volatile analytes from the aqueous phase to the vapor phase, from which they are adsorbed to the packing material in a sorbent trap. The concentrated sample is transferred to the chromatographic column by heating the trap under carrier gas flow.

Our new *Volatiles MegaMix™ EPA Method 624* includes the 26 target compounds in Method 624 that are not gases at ambient temperature and pressure. The 5 target gases in Method 624—bromomethane, chloromethane, chloroethane, trichlorofluoromethane, and vinyl chloride—are components in our 624 Calibration Mix #1 (cat.# 30020). We prepare the new MegaMix™, and the gas mix, at a high concentration of 2000µg/mL each component, to enable you to conduct several analyses from each ampul of material.

One of the target compounds in Method 624, 2-chloroethyl vinyl ether, is stable in solution by itself, but hydrolyzes to the enol form in weakly acidic media, then converts to the aldehyde and ketone forms. Because the halocarbon target analytes in Method 624 are slightly acidic compounds, 2-chloroethyl vinyl ether usually is offered separately from the other analytes. We studied the stability of 2-chloroethyl vinyl ether and decided we could include it in our MegaMix™ solution of Method 624 volatiles if we also included a small amount of preservation agent. 2-Chloroethyl vinyl ether is stable in the MegaMix™ mix, but analysts should monitor the stability of this compound in working solutions, regardless of what reference material is the source of the compound. To meet user preference, we also offer 2-chloroethyl vinyl ether in individual solution (cat.# 30265).

Method 624 calls for spiking all samples with surrogate standards, to monitor laboratory performance.

Figure 1—Rapid analysis of Method 624 analytes, with excellent chromatography for early-eluting gases, using a short, narrow bore Rtx®-624 column.



Rtx®-624, 40m, 0.18mm ID, 1.0µm (cat.# 40925)
Sample: 624 Internal Standard Mix (cat.# 30023)
624 Surrogate Standard Mix (cat.# 30243)
Volatiles MegaMix™ EPA Method 624 (cat.# 30497)

Purge and trap conditions:

Concentrator: Tekmar LSC-3100 Purge and Trap
Trap: Vocarb 3000 (type K)
compounds at 50 ppb (IS @ 40ppb) in 5mL of RO water
Purge: 11 min. @ 40 mL/min. @ ambient temperature
Dry purge: 1 min. @ 40mL/min. (MCS byoassed using Silcosteel® tubing)
Desorb preheat: 245°C
Desorb: 250°C for 2 min., flow 10mL/min.
Bake: 260°C for 8 min.
Interface: Silcosteel® transfer line, 1: 40 split at injection port.
1mm ID liner

Chromatography:

Inj. temp.: 250°C
Carrier gas: helium, constant flow
Flow rate: 1.1 mL/min.
Dead time: 2.06 minutes @ 50°C
Oven temp.: 50°C (hold 4 min.) to 100°C @ 12°C/min. (no hold)
to 330°C @ 27°C/min. (hold 2 min.).
Det.: Agilent 5971A GC/MS
Transfer line temp.: 280°C
Scan range: 35-260 amu
Tune: PFTBA/BFB
Ionization: EI

Our reference materials for the method include the recommended surrogates (cat.# 30243). The method also requires 3 or more internal standards that are similar in analytical behavior to the target compounds. Our internal standard mix (cat.# 30023) includes recommended compounds and satisfies this requirement.

Based on a cyanopropylphenyl/dimethyl polysiloxane phase, our Rtx®-624 column has unique polarity, and provides excellent separation of the target compounds. By using a short, narrow bore column (40m x 0.18mm ID, 1.0µm phase) we reduced analyses time and improved resolution. This particular column configuration also eliminates non-target interference with target compounds. Figure 1 shows an analyses of all Method 624 target compounds on a 40m x 0.18mm ID Rtx®-624 column. Total cycle time is 17 minutes, which matches the cycle time for the purge and trap concentrator.

By using a 40m x 0.18mm ID, 1.0µm Rtx®-624 column and Restek's convenient, carefully formulated reference materials, you can obtain rapid analyses and accurate data. These practical advantages make Restek the best source for materials for EPA Method 624, and for wastewater volatiles analyses in general.

Rtx®-624 Columns (fused silica)

(Crossbond® 6% cyanopropylphenyl/94% dimethyl polysiloxane)

ID	df (µm)	temp. limits	20-Meter		40-Meter	
0.18mm	1.00	-20 to 240°C	40924	\$360	40925	\$635
ID	df (µm)	temp. limits	30-Meter	60-Meter	75-Meter	105-Meter
0.25mm	1.40	-20 to 240°C	10968	\$425	10969	\$705
0.32mm	1.80	-20 to 240°C	10970	\$455	10972	\$765
0.45mm	2.55	-20 to 240°C			10982	\$920
0.53mm	3.00	-20 to 240°C	10971	\$485	10973	\$805
					10974	\$940
					10975	\$1020

624 Calibration Mix #1

bromomethane trichlorofluoromethane
chloroethane vinyl chloride
chloromethane

2,000µg/mL each in P&T methanol, 1mL/ampul

Each	5-pk.	10-pk.
30020 \$26.80	30020-510 \$117.80	—
w/data pack		
30020-500 \$37.10	30020-520 \$131	30120 \$228.40

624 Surrogate Standard Mix

4-bromofluorobenzene pentafluorobenzene
fluorobenzene

2,000µg/mL each in P&T methanol, 1mL/ampul

Each	5-pk.	10-pk.
30243 \$23.70	30243-510 \$103.60	—
w/data pack		
30243-500 \$34	30243-520 \$114.70	30343 \$201

Volatiles MegaMix™, EPA Method 624 (26 components)

benzene *trans*-1,2-dichloroethylene
bromodichloromethane 1,2-dichloropropane
bromoform *cis*-1,3-dichloropropylene
carbon tetrachloride *trans*-1,3-dichloropropylene
chlorobenzene ethylbenzene
2-chloroethyl vinyl ether methylene chloride
chloroform (dichloromethane)
dibromochloromethane 1,1,2,2-tetrachloroethane
1,2-dichlorobenzene tetrachloroethylene
1,3-dichlorobenzene toluene
1,4-dichlorobenzene 1,1,1-trichloroethane
1,1-dichloroethane 1,1,2-trichloroethane
1,2-dichloroethane trichloroethylene
1,1-dichloroethylene

2,000µg/mL each in P&T methanol, 1mL/ampul

Each	5-pk.	10-pk.
30497 \$46	30497-510 \$207	—
w/data pack		
30497-500 \$56	30497-520 \$230	30597 \$414

624 Internal Standard Mix

bromochloromethane 1,4-dichlorobutane
2-bromo-1-chloropropane

1,500µg/mL each in P&T methanol, 1mL/ampul

Each	5-pk.	10-pk.
30023 \$23.70	30023-510 \$103.60	—
w/data pack		
30023-500 \$34	30023-520 \$114.70	30123 \$201

HOT Tech Tip!

Stability of 2-Chloroethyl vinyl ether

2-Chloroethyl vinyl ether is stable in neutral pH and in slightly basic solutions. If the solution is slightly acidic, the analyte will rapidly decompose. Restek specially prepares stable individual solutions of 2-chloroethyl vinyl ether in neutral purge and trap methanol. These solutions are very stable and can be diluted without problems, using pure, neutral, P&T grade methanol. Be careful when combining these solutions with other calibration materials - some solutions can contain trace acidic impurities that will cause rapid decomposition of 2-chloroethyl vinyl ether. Be especially cautious of calibration mixtures that contain high concentrations or a large number of chlorinated target compounds; these often will contain sufficient trace HCl to cause stability problems with 2-chloroethyl vinyl ether.

Restek's
MegaMix™
Standards



MegaMix™ Reference Mixes

For US EPA Methods

Volatiles: 524.2, 624, 8260,
OLC 03.2, OLM 04.2, 502.2

Semivolatiles: 525.2, 625, 8270,
OLC 03.2, OLM 04.2

- ✓ Fewest mixes needed for calibration or matrix spike
- ✓ Maximum stability
- ✓ Most commonly analyzed compounds:
 - 8260—76 volatile compounds in 1 mix
 - gases and ketones in separate mixes, for maximum stability
 - 8270—76 semivolatile compounds in 1 mix
 - Appendix IX—59 semivolatile compounds in 3 mixes
 - 524—73 volatile compounds in 1 mix
 - 525—90 semivolatile compounds in 5 mixes
 - 625—54 semivolatile compounds in 1 mix
 - CLP 03.2 (volatiles and semivolatiles)
 - CLP 04.2 (volatiles and semivolatiles)

For details, visit our website at www.restekcorp.com

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New Analytical Reference Materials

For Forensic and Environmental Analyses

By Katia May, Ph.D., Senior R&D Chemist



Forensic Ethanol Standards

- ✓ 0.08g/dL standard supports new federal blood alcohol limit.
- ✓ 0.4g/dL standard supports autopsy of alcohol-related deaths.
- ✓ 0.05g/dL standard supports limits for long-haul truck drivers.
- ✓ Many other concentrations available.

The United States' blood alcohol limit has been reduced to 0.08g/dL. Consistent with our commitment to support police and crime laboratories, we are introducing three new reference mixes to meet current needs. Restek Forensic Ethanol Standards are NIST traceable. Data packs included.

Blood Alcohol Mix Resolution Control Standard

acetaldehyde ethyl acetate
acetone isopropanol
acetonitrile methanol
ethanol (NIST certified value) methyl ethyl ketone

0.100g/dL each in water, 1mL/ampul

Each w/data pack	
36256	\$30

Forensic ethanol solutions w/data pack	5-pk. 1mL/ampul	10-pk. 1mL/ampul	ea. 5mL/ampul	ea. 20mL/ampul
0.05g/dL forensic ethanol solution	36257 \$25	36259 \$40	36258 \$25	36260 \$45
0.08g/dL forensic ethanol solution	36262 \$25	36264 \$40	36263 \$25	36265 \$45
0.4g/dL forensic ethanol solution	36266 \$25	36268 \$40	36267 \$25	36269 \$45

Carbazole

- ✓ No interference with OLC 03.2 target compounds.

Many laboratories following US EPA Contract Laboratory Program OLC 03.2 Statement of Work also analyze for carbazole. Most carbazole reference solutions are in methanol, but certain target compounds in OLC 03.2 SOW react with methanol (e.g., benzaldehyde, atrazine). We prepare our new reference standard in methanol-free methylene chloride, to prevent reactions when it is added to OLC 03.2 Semivolatile MegaMix™ (cat.# 31812).

Carbazole

carbazole

1,000µg/mL in methylene chloride (methanol free), 1mL/ampul

Each	5-pk.	10-pk.
31836 \$21.70	31836-510 \$97.65	—
w/data pack		
31836-500 \$31.70	31836-520 \$108.50	31936 \$195.30

ε-Caprolactam

A precursor in the synthesis of nylon-6, ε-caprolactam is one of the most heavily and widely used chemical intermediates—more than 9.5 billion pounds each year, worldwide. Environmental contamination should be anticipated, and caprolactam has toxic effects. This solution is suitable for monitoring ε-caprolactam.

ε-Caprolactam

ε-caprolactam

2,000µg/mL in methylene chloride (methanol free), 1mL/ampul

Each	5-pk.	10-pk.
31833 \$21.70	31833-510 \$97.65	—
w/data pack		
31833-500 \$31.70	31833-520 \$108.50	31933 \$195.30

Glyphosate and AMPA (glyphosate metabolite)

- ✓ Glyphosate packaged in two volumes, to meet varied requirements.
- ✓ Glyphosate at 1000µg/mL concentration, for more analyses per ampul.

Glyphosate (N-phosphonomethyl glycine) is a broad-spectrum post-emergence herbicide used in agriculture and forestry and for aquatic weed control. A weak organic acid, glyphosate usually is formulated as the isopropylamine salt to increase solubility. Our new mix is suitable for EPA Method 547, for identifying and measuring glyphosate in drinking water (HPLC with fluorescence detection and post-column derivatization).

Aminomethylphosphonic acid—AMPA—is the primary degradation product of glyphosate in plants, soil, and water. The chemical structures of the two compounds are very similar, and they have similar toxicological profiles. The health base value for glyphosate also applies to AMPA, and to glyphosate and AMPA in combination.

Glyphosate

glyphosate

Each	5-pk.	10-pk.
1,000µg/mL in DI water, 1mL/ampul		
32426 \$21.70	32426-510 \$97.65	—
w/ data pack		
32426-500 \$31.70	32426-520 \$108.50	32526 \$195.30
1,000µg/mL in DI water, 5mL/ampul		
32427 \$65.10	32427-510 \$292.95	—
w/ data pack		
32427-500 \$75.10	32427-520 \$325.50	32527 \$585.90

AMPA (glyphosate metabolite)

aminomethyl phosphonic acid (AMPA)

100µg/mL in DI water, 1mL/ampul

Each	5-pk.	10-pk.
32428 \$21.70	32428-510 \$97.65	—
w/data pack		
32428-500 \$31.70	32428-520 \$108.50	32528 \$195.30

PCB-Free Transformer Oil

- ✓ Convenient 5mL and 50mL packaging.

Use and disposal of all mineral oil-filled transformers have been subject to federal regulation since 1978. Traditionally, transformer oil is tested for polychlorinated biphenyls (PCBs) contamination by GC.

PCB-Free Transformer Oil

PCB-Free transformer oil

Neat

5mL	50mL
32424 \$18	32425 \$55

Acrolein & Acrylonitrile

- ✓ High concentrations:
acrolein: 10,000µg/mL
acrylonitrile: 2,000µg/mL
acrolein/acrylonitrile: 2,000µg/mL.

Acrolein and acrylonitrile are monomers used in manufacturing polyacrylamide and other acrylic polymers. These new mixes are suitable for use with US EPA Method 603, or other methods for testing water samples for acrylonitrile and acrolein by purge & trap GC. They have a shelf life of 2-3 months.

Acrolein

acrolein

10,000µg/mL in P&T methanol, 1mL/ampul

Each	5-pk.	10-pk.
30499 \$21.70	30499-510 \$97.65	—
w/data pack		
30499-500 \$31.70	30499-520 \$108.50	30599 \$195.30

Acrylonitrile

acrylonitrile

2,000µg/mL in P&T methanol, 1mL/ampul

Each	5-pk.	10-pk.
30246 \$21.70	30246-510 \$96	—
w/data pack		
30246-500 \$32	30246-520 \$106.60	30346 \$191.90

Acrolein/Acrylonitrile

acrolein

acrylonitrile

2,000µg/mL in P&T methanol, 1mL/ampul

Each	5-pk.	10-pk.
30600 \$23.70	30600-510 \$106.65	—
w/data pack		
30600-500 \$33.70	30600-520 \$118.50	30700 \$213.30

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Bulk HPLC Silica and Bonded Phase Packings

For Scale-Up or Other Applications

By Greg France, HPLC Product Marketing Manager

- ✓ Consistent, high-quality porous spherical silicas for
 - neutral to slightly acidic compounds
 - basic compounds.
- ✓ Silica and bonded materials rigorously tested; ISO 9001:2000 registered facility.

Restek is one of the few HPLC column suppliers manufacturing chromatography grade silica. We now offer our high-quality silicas and bonded phase materials in bulk, for packing analytical-scale columns, for preparative and process purification, or as raw materials for other LC analytical platforms.

Pinnacle II™ is a Type A spherical silica with a mean pore size of 110Å and a surface area of 180m²/g. It matches Hypersil® silica in many respects, but the metals content in Pinnacle II™ is almost an order of magnitude less than that in Hypersil® silica.¹ Practically, this is expressed as a less active surface and a more durable particle. Packings based on

Pinnacle II™ silica are excellent for analyzing or purifying neutral to slightly acidic compounds (Figure 1). Standard particle sizes for Pinnacle II™ materials are 3µm and 5µm; 10µm and 15µm particles are available on request.

Highly base-deactivated Pinnacle™ DB silica has mechanical strength and durability similar to Pinnacle II™ silica, but Pinnacle™ DB silica has larger pores (140 Å). The total metals content is less than 250ppm, and no single metal exceeds 100ppm.² Packings based on Pinnacle™ DB silica are suitable for a wide range of analytes; basic analytes often can be analyzed with little or no mobile phase

modifier (Figure 2). Performance is very similar to Hypersil® BDS material.

Our extensive QC program ensures the quality and reproducibility of Pinnacle II™ and Pinnacle™ DB silicas: each lot of material must meet specifications for mean particle size, particle size distribution, pore diameter, surface area, and total metals content. You can use these materials with confidence.

Figure 2—Sharp, near-symmetric peak for a basic analyte (pyridine) without a mobile phase modifier, using a Pinnacle™ DB column.

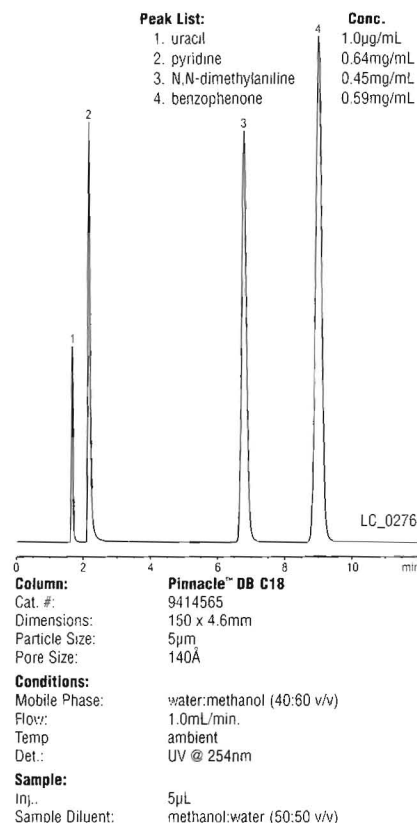
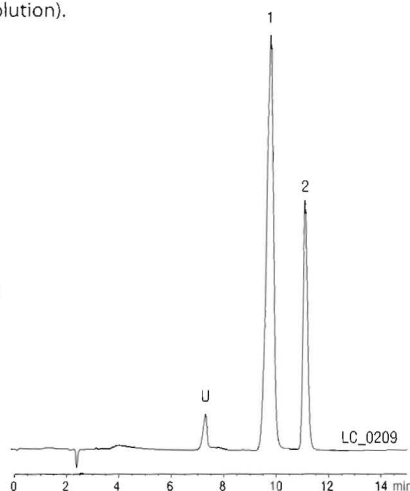
Figure 1—Morphine sulfate resolved from manufacturing solvent, using a Pinnacle II™ C18 column (USP 25 Resolution Solution).

Peak List:	Conc. (µg/mL)
U. unknown	unknown
1. phenol	0.15
2. morphine sulfate	0.24

Column:	Pinnacle II™ C18
Cat.#:	9214575-700
Dimensions:	250 x 4.6mm
Particle Size:	5µm
Pore Size:	110Å

Conditions:	
Mobile Phase:	A: 0.73g 1-heptane sulfonic acid and 10mL glacial acetic acid diluted to 720mL with water, pH=2.33
	B: methanol 72A:28B, v/v
Flow:	1.00mL/min
Temp.:	26.5°C
Det.:	UV @ 284nm

Sample:	
Inj.:	20.0µL
Solvent:	mobile phase



3µm Pinnacle II™ Bulk Packing Materials

Description	min. qty.	cat.#	price per gram
Pinnacle II™ C8 Bulk Packing	5g	92133	\$31
Pinnacle II™ C18 Bulk Packing	5g	92143	\$31
Pinnacle II™ Cyano Bulk Packing	5g	92163	\$31
Pinnacle II™ Phenyl Bulk Packing	5g	92153	\$31
Pinnacle II™ Silica Bulk Packing	5g	92103	\$16

5µm Pinnacle II™ Bulk Packing Materials

Description	min. qty.	cat.#	price per gram
Pinnacle II™ C8 Bulk Packing	5g	92135	\$26
Pinnacle II™ C18 Bulk Packing	5g	92145	\$26
Pinnacle II™ Cyano Bulk Packing	5g	92165	\$26
Pinnacle II™ Phenyl Bulk Packing	5g	92155	\$26
Pinnacle II™ Silica Bulk Packing	5g	92105	\$13

5µm Pinnacle™ DB Bulk Packing Materials

Description	min. qty.	cat.#	price per gram
Pinnacle™ DB C18 Bulk Packing	5g	94145	\$50
Pinnacle™ DB C8 Bulk Packing	5g	94135	\$50
Pinnacle™ DB Cyano Bulk Packing	5g	94165	\$50
Pinnacle™ DB Silica Bulk Packing	5g	94105	\$38

HOT Tech!

How important is metals content?

Metal ions on a silica particle weaken the particle and negatively affect chromatography, particularly for basic analytes. These problems can be overcome—temporarily—by annealing the metals into the framework of the particles. As the particles age, the metals are re-exposed. Base deactivation is lost and the particles' stability in highly aqueous mobile phases is further eroded.

Pinnacle II™ and Pinnacle™ DB silicas do not require annealing; they provide more consistent peak shapes for bases as the column ages, and a potentially longer column lifetime.

¹Request publication 59517.

²Request Applications Note 59742.

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Peak Performers

Avoid Septum Problems

By Donna Lidgett, GC Accessories Marketing Manager

- ✓ Handle septa carefully, to prevent contamination.
- ✓ Minimize bleed—use preconditioned, low-bleed septa.

Septum Handling

All septa, regardless of their composition, puncturability, or resistance to thermal degradation, will be a source of problems if they are mishandled. Always use clean forceps or wear clean cotton gloves when handling septa; do not handle them with bare fingers, nor with powdered latex gloves—contaminants such as finger oils, perfumes, make-up, fingernail polish, skin creams, hand soaps, and talcum can be absorbed into the septum and will bleed from the septum during your analyses.

Also, follow septum and instrument manufacturers' recommendations when installing a septum. Overtightening a septum nut invariably will reduce septum lifetime by increasing septum coring and splitting problems.

Septum Bleed

All septa contain various amounts of volatile materials (e.g., silicone oils, phthalates) that can be released when the septum is heated to analysis temperatures. Septum bleed occurs when these volatiles from the septum collect on the column, then elute from the column and create baseline disturbances or extraneous (ghost) peaks in the chromatogram. This problem is prevalent in temperature-programmed analyses, because the septum volatiles collect on the column during the oven cool-down and initial hold periods. Capillary columns require much lower gas flow rates than packed columns, therefore septum volatiles are more concentrated, and bleed problems are more pronounced in capillary GC systems.

Because most GCs are equipped with a septum purge, septum bleed generally will disappear within 30 minutes after installing a new septum and exposing it to normal injector temperatures. All Restek septa eliminate this conditioning period because they are preconditioned and can be used without delay.

Why are Low-Bleed Septa Important?

Either baseline rise or extraneous peaks caused by septum bleed can interfere with identification and quantification of target analytes. And, because septum bleed is inconsistent, method reproducibility can be a problem. Using low-bleed septa can minimize these effects and help produce more reliable results.

Why Does Septum Puncturability Matter?

A septum that can be penetrated cleanly and easily by a syringe needle has a longer life, and consistent injections made through such a septum help ensure accurate results. The soft silicone rubber from which all Restek septa are manufactured is specially

formulated for chromatographic performance, which ensures our septa are easy to puncture.

What Septum Configurations are Available, and for Which GCs?

Restek has fashioned septa for all major brands of gas chromatographs and injectors. Use the septum size chart to determine the septum diameter for your instrument, or measure an old septum against the template if your model is not listed.

Which Septa Should I Use?

Thermolite® septa are a proven low-bleed champion. With a maximum temperature of 340°C, there are very few applications for which Thermolite® septa are not suitable.

Thermolite® Septa

- Usable to 340°C inlet temperature.
- Each batch tested with FIDs, ECDs, and MSDs to ensure lowest bleed.
- Excellent puncturability.
- Preconditioned and ready to use.
- Do not adhere to hot metal surfaces.
- Packaged in non-contaminating glass jars.



Septum Diameter	25-pk./price		50-pk./price		100-pk./price	
5mm (3/16")	20351	\$40	20352	\$60	20353	\$100
6mm (1/4")	20355	\$40	20356	\$60	20357	\$100
7mm	20381	\$40	20382	\$60	20383	\$100
8mm	20370	\$40	20371	\$60	—	—
9mm	20354	\$40	20358	\$60	20362	\$100
9.5mm (7/16")	20359	\$40	20360	\$60	20361	\$100
10mm	20378	\$40	20379	\$60	20380	\$100
11mm (7/16")	20363	\$40	20364	\$60	20365	\$100
11.5mm	22385	\$40	22386	\$60	22387	\$100
12.5mm (1/2")	20367	\$40	20368	\$60	20369	\$100
17mm	20384	\$43	20385	\$80	20386	\$155
Shimadzu Plug	20372	\$40	20373	\$60	20374	\$100

InfraRed™ Septa

- Usable to 325°C inlet temperature.
- Preconditioned and ready to use.
- Excellent puncturability.
- Do not adhere to hot metal surfaces.
- Low bleed.
- Packaged in non-contaminating glass jars.



Septum Diameter	25-pk./price		50-pk./price		100-pk./price	
9mm	21417	\$40	21418	\$60	21419	\$100
9.5mm (7/16")	21421	\$40	21422	\$60	21423	\$100
10mm	21424	\$40	21425	\$60	21426	\$100
11mm (7/16")	21427	\$40	21428	\$60	21429	\$100
11.5mm	21430	\$40	21431	\$60	21432	\$100
12.5mm (1/2")	21433	\$40	21434	\$60	21435	\$100
17mm	21436	\$43	21437	\$80	21438	\$155
Shimadzu Plug	21439	\$40	21440	\$60	21441	\$100

We've
expanded
our web site!

- New Features.
- Fast searches.
- Easy navigation.

We welcome
your visit.



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InfraRed™ septa are low bleed septa with a 325°C maximum temperature. Even at maximum temperature, InfraRed™ septa provide long lifetime with little coring.

IceBlue™ septa are ideal for analysts using inlet temperatures 250°C or below, or using solid phase microextraction (SPME) sampling techniques. IceBlue™ septa will accommodate puncturing from the large needles used in SPME, and still assure consistent injections and long lifetime.

IceBlue™ Septa

- Usable to 250°C inlet temperature.
- General-purpose septa.
- Excellent puncturability.
- Preconditioned and ready to use.
- Do not adhere to hot metal surfaces.
- Packaged in non-contaminating glass jars.
- Ideal for SPME.



Septum Diameter	50-pk./price		100-pk./price	
9mm	22381	\$35	22382	\$65
9.5mm (3/8")	22388	\$35	22389	\$65
10mm	22390	\$35	22391	\$65
11mm (7/16")	22392	\$35	22393	\$65
11.5mm	22383	\$35	22384	\$65
12.5mm (1/2")	22394	\$35	22395	\$65
17mm	22396	\$35	22397	\$65
Shimadzu Plug	22398	\$35	22399	\$65



Leak Detective™ II Leak Detector

Compact, sensitive, affordable.

- Affordable thermal conductivity leak detector—every analyst should have one.
- Compact, ergonomic design is easy to hold and operate.
- Sensitive—detects helium, hydrogen, or nitrogen at 1x10⁻⁶cc/sec. (absolute concentration as low as 100ppm.)*
- Fast results—responds in less than 2 seconds to trace leaks of gases with thermal conductivities different from air.
- Auto zeroing with the touch of a button.
- Battery-operated for increased portability (requires one 9-volt battery; two Ni-MH rechargeable batteries and charger included for your convenience).



Description	qty.	cat.#	price
Leak Detective™ II Leak Detector with 110Volt Battery Charger	ea.	20413	\$675
Leak Detective™ II Leak Detector with 220Volt European Battery Charger	ea.	20413-EUR	\$675
Leak Detective™ II Leak Detector with 220Volt UK Battery Charger	ea.	20413-UK	\$675

*Never use liquid leak detectors on a capillary system because liquids can be drawn into the column.

Caution: NOT designed for determining leaks of combustible gases. A combustible gas detector should be used for determining combustible gas leaks in possible hazardous conditions.

Merlin Microseal™ Septa for Agilent GCs

- High-pressure capability allows operation from 2 to 100psi.
- Top wiper rib improves resistance to particulate contamination and can be taken apart for cleaning.
- High resistance to wear greatly reduces shedding of septum particles into the injection port liner, eliminating a major source of septum bleed and ghost peaks.
- Longer life reduces the risk of septum leaks during extended automated runs.



Microseal™ High-Pressure Septa, 400 Series (100psi)	Merlin#	Similar to Agilent#	cat.#	price
Standard kit (nut, 2 septa)	404	Not offered	22810	\$340
Starter kit (nut, 1 septum)	405	5182-3442	22811	\$240
Nut kit (1 nut, fits 300 & 400 series septa)	403	5182-3445	22809	\$100
High-pressure replacement septum (1 septum)	410	5182-3444	22812	\$140
Microseal™ Septa, 300 Series (30psi)	Merlin#	Similar to Agilent#	cat.#	price
Standard kit (nut, 2 septa)	304	5181-8833	22813	\$250
Starter kit (nut, 1 septum)	305	5181-8816	22814	\$190
Microseal replacement septum (1 septum)	310	5181-8815	22815	\$90
Replacement PTFE washers (2-pk.)	311	5181-0853	22808	\$5

Septum Puller



- Keep several on hand in your laboratory—can be used in many different ways.
- Hooked end can remove septa and O-rings; pointed end works well for removing stuck ferrule fragments.



Remove septa, o-rings, and ferrules without damaging fittings.



Description	qty.	cat.#	price
Septum Puller	ea.	20117	\$13

handy septum size chart

Instrument	Septum Size (mm)
Agilent (HP)	
5880A, 5890, 6890, 6850, PTV	11
5700, 5880	9.5/10
On-Column Injection	5
CE Instruments (TMQ)	
TRACE™ GC	17
Finnigan (TMQ)	
GC 9001	9.5
GCQ	9.5
GCQ w/TRACE™, PTV	17
QCQ™	9.5
TRACE™ 2000	9.5
Fisons/Carlo Erba (TMQ)	
8000 series	17
Gow-Mac	
6890 series	11
All other models	9.5
PerkinElmer	
Sigma series	11
900,990	11
8000 series	11
Auto SYS	11
Auto SYS XL	11
Pye/Unicam	
All models	7
Shimadzu	
All models	Plug
SRI	
All models	Plug
Tracor	
540	11.5
550,560	9.5
220,222	12.5
Varian	
<i>Injector type:</i>	
Packed column	9.5/10
Split/splitless 1078/1079	10/11
1177	9
1075/1077	11

tools

Super-Clean™ Gas Filters

By Donna Lidgett, GC Accessories Marketing Manager

- ✓ MS-quality output: 99.9999% pure gas.
- ✓ "Quick connect" fittings for fast, easy, leak-free cartridge changes.
- ✓ Glass inside prevents diffusion, plastic outside for safety.

Super-Clean™ system: fast, simple cartridge changes

Cartridge-style gas purification systems make changing gas filters quick and easy, and the Super-Clean™ gas filter system is the latest improvement to cartridge-style technology. A baseplate in the Super-Clean™ system allows cartridges to be exchanged without introducing atmospheric oxygen and water vapor: spring-loaded check valves seal when a cartridge is removed and open only when a new cartridge

has been locked in place. You no longer need to loosen and tighten fittings every time you change a cartridge, and your system cannot become contaminated during the changing process.

Use a 2- or 3-position baseplate to purify multiple GC gas streams at one location—Figure 1 shows some possible filter cartridge combinations. Many combinations are possible because any Super-Clean™ filter cartridge can be used with any baseplate.

Figure 1—Filter cartridges can be configured for different applications.

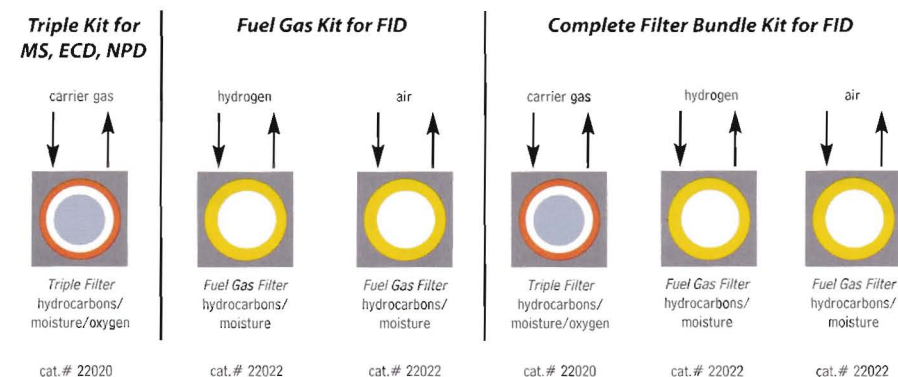


Table I—Each Super-Clean™ filter provides high-purity outlet gas.

Type of Filter	Outlet Gas Quality (%)	Max. Pressure	Use for:	Indicator Color Change	H ₂ O (g)	Capacity O ₂ (mL)	Hydrocarb.	Estimated Lifetime (years)
Moisture cat. # 22028	>99.9999	11 bar 159psi	Inert carrier gas Air Hydrogen	Yellow to Clear	7.2	—	—	>2
Oxygen cat. # 22029	>99.9999	11 bar 159psi	Inert carrier gas	Green to Grey	NA	1000	—	>2
Hydrocarbons cat. # 22030	>99.9999	11 bar 159psi	Inert carrier gas Air Hydrogen	No Indicator	NA	—	—	>2
Fuel Gas Filter cat. # 22022	>99.9999	11 bar 159psi	Inert carrier gas Air Hydrogen	Yellow to Clear	3.6	—	—	>1.5
Triple (Moist., O ₂ , Hydroc.) cat. # 22020	>99.9999	11 bar 159psi	Inert carrier gas	Yellow to Clear Green to Grey	1.8	500	—	>1
Helium cat. # 21982	>99.9999	11 bar 159psi	Helium	Yellow to Clear Green to Grey	1.8	500	—	>1

High-purity output improves sensitivity

The Triple Filter cartridge (cat. # 22020) is ideal for purifying carrier gas (Figure 1). It combines oxygen, moisture, and hydrocarbon removers in one cartridge. Purity of carrier gas leaving a Triple Filter is better than "six nines" (99.9999%), which is ideal for noise-free baselines from sensitive mass spectrometry or electron capture detection equipment, and for protecting your analytical columns against damage from contaminants.

The Fuel Gas Filter cartridge (cat. # 22022) is perfect for purifying flame ionization detector fuel gases, removing both moisture and hydrocarbons. Use Fuel Gas Filters in a 2-position baseplate for FID hydrogen and air (Figure 1), to produce a stable baseline and improve overall sensitivity and reproducibility. The new Helium Specific Carrier Gas Cleaning Kit (cat. # 21983) is designed specifically for purifying helium used in GC/MS systems. The cartridge is prepared and conditioned using high-purity helium, to minimize conditioning time in your system.

All Super-Clean™ filter cartridges except the hydrocarbon cartridge feature **easy-to-read indicators.**

The indicator code is shown on every trap so there is no confusion about when to replace it.



Refer to the **Purus™ Gas Systems** section of the Restek catalog for all your gas system needs:

- Many additional gas purifiers.
- Gas generators: convenient, safe, economical alternatives to gas cylinders.
- Pressure regulators.
- Tubing, tubing tools, fittings and valves.
- Leak detectors.
- Much more.

Super-Clean™ Filter and Baseplate Kits

- High-purity output ensures 99.9999% pure gas.
- "Quick connect" fittings for easy, leak-free cartridge changes.
- Glass inside to prevent diffusion; plastic outside for safety.

Description	qty.	cat. #	price
Carrier Gas Cleaning Kit (includes mounting baseplate, 1/8" inlet/outlet fittings, and oxygen/moisture/hydrocarbon Triple Filter)	kit	22019	\$333
Fuel Gas Purification Kit (includes mounting baseplate, 1/8" inlet/outlet fittings, and hydrocarbon/moisture filter)	kit	22021	\$323

Replacement Filters

Description	qty.	cat. #	price
Replacement Triple Filter (removes oxygen, moisture and hydrocarbons)	ea.	22020	\$136
Replacement Fuel Gas Filter (removes moisture and hydrocarbons)	ea.	22022	\$125

Filter Bundle Kit

Kit includes two Fuel Gas Filters for FID fuel gases and one Triple Filter for carrier gas. Ideal for use in combination with 3-position baseplate—purchase separately.

Description	qty.	cat. #	price
Filter Bundle Kit	kit	22031	\$350

Helium-Specific Super-Clean™ Filter and Kit

- Specifically designed for purification of helium in GC/MS Systems.
- Traps are packed and conditioned using helium.
- Uses standard single-position baseplate.

new

Description	qty.	cat. #	price
Helium-Specific Carrier Gas Cleaning Kit (includes mounting baseplate, 1/8" inlet/outlet fittings, and helium-conditioned oxygen/moisture/hydrocarbon filter)	kit	21983	\$345
Helium-Specific Replacement Filter (removes oxygen, moisture and hydrocarbons)	ea.	21982	\$155

Super-Clean™ Ultra-High Capacity Filters

Description	qty.	cat. #	price
Ultra-High Capacity Hydrocarbon Filter	ea.	22030	\$120
Ultra-High Capacity Moisture Filter	ea.	22028	\$120
Ultra-High Capacity Oxygen Filter	ea.	22029	\$120

Baseplates

All baseplate fittings are 1/8". To adapt to 1/4", order 1/8" to 1/4" tube-end union listed below.

Description	qty.	cat. #	price
Single-Position Baseplate	ea.	22025	\$198
2-Position Baseplate	ea.	22026	\$364
3-Position Baseplate	ea.	22027	\$520

Replacement O-Rings

Pack includes 10 large O-rings and 10 small O-rings.

Description	qty.	cat. #	price
Replacement O-Rings for Cartridge Baseplates	20-pk.	22023	\$12.50

1/8-Inch to 1/4-Inch Tube-End Unions

All Super-Clean™ baseplate fittings are 1/8". To adapt to 1/4", use a 1/8" to 1/4" tube-end union.

Description	qty.	cat. #	price
1/8" to 1/4" Tube-End Unions	5-pk.	21833	\$23

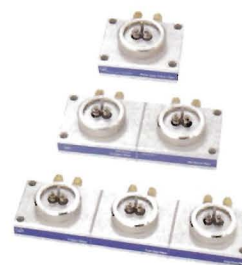
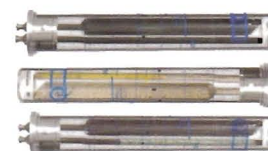
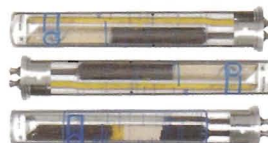
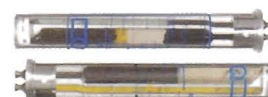
Wall Mounting Bracket

Baseplates may be mounted by using screws and the mounting holes on the baseplate or by using this optional wall mounting bracket.

Description	qty.	cat. #	price
Wall Mounting Bracket for Super-Clean™ Baseplates	ea.	21984	\$40



All traps measure: 10 5/8" x 1 3/4"
Each baseplate unit measures:
4" x 4" x 1 7/8"



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Service Rewards Program Distributes More Than 50,000 STAR™ Points

Labs Already Cutting Service Costs

By Doug Elliott, STAR Service Rewards Coordinator

- ✓ Order high quality products, obtain credits toward instrument service and repair.



The STAR™ Service Reward Program was initiated in April 2002 in a test-market mode on the US west coast. The program was launched nationally in May of 2003. Since its inception the program has dis-

tributed more than 50,000 STAR™ Points to chromatography laboratories who are, in turn, using the points to lower their service and repair parts costs. One west coast lab already has redeemed 600 STAR™ Points with their preferred service provider, another lowered their service costs by redeeming over 500 STAR™ Points.

If you're not participating in this program, it's not too late! Register your lab by calling the Restek Customer Service Team at 1-800-356-1688, ext. 3. Just provide your company account number and your ship-to address—that's it! After your lab is registered, you will begin to receive STAR™ Points in your product packages, just like Wizard Dollars—

1 STAR™ Point for every \$50 increment of Restek products you purchase.

Maximize your STAR™ Points by choosing Restek supplies for all your chromatography needs. Take a minute to review the Vials and Syringes, Instrument Supplies, Purus™ Gas Systems, Column Installation, and HPLC Products sections in the Restek catalog. You will see the wide variety of quality, economical supplies you can get from Restek, while increasing your lab's STAR™ Points and Wizard Dollars at the same time. Innovative and proven Restek chromatography supplies include:

- autosampler vials
- ferrules
- FID jets
- filters for GC & HPLC
- gas generators
- gas leak detectors
- gas purifiers
- Hamilton & SGE syringes
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- septa
- fittings and tubing, GC & HPLC
- tools

Register your lab with the STAR™ Service Reward Program today, then let us know how much you save on instrument service costs in 2004!

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2004

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- Many Application Chromatograms
- Helpful Technical Information
- New GC and HPLC Columns
- New Chromatography Accessories
- New Analytical Reference Materials
- New Books, Gas Delivery Products, Vials and Syringes, Air Monitoring Apparatus

Look for your copy
in January!



New!

Keep your Agilent Instrument
Running with Replacement Parts
from Restek!

If you're having difficulty locating parts for your Agilent 5890, 6890, or 7673A/B, call Restek. We now offer vial turrets, motors, belts, and more. Performance will equal or exceed that of OEM parts. For descriptions of current parts, see the revolving Feature Product box on the home page of our web site: www.restekcorp.com



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