the RESTEK Advantage

Innovators of High Resolution Chromatography Products

Rtx®-VGC Column

Improved GC separation of MTBE

by Christopher English, Applications Chemist

The US Clean Air Act of 1990 mandated the addition of oxygenates in 30% of America's gasoline supply to improve combustion of gasoline and decrease polluting emissions. Oxygen-containing compounds most commonly added to gasoline are methanol, ethanol, *tert*-butanol, methyl-*tert*-butylether (MTBE), diisopropylether (DIPE), ethyl-*tert*-butylether (ETBE), and *tert*-amyl-methylether (TAME). Of these compounds, MTBE is the primary additive. The combination of its relatively low manufacturing cost and non-corrosive nature made it a clear choice for the petroleum industry. Other oxygenates are added at much lower concentrations.

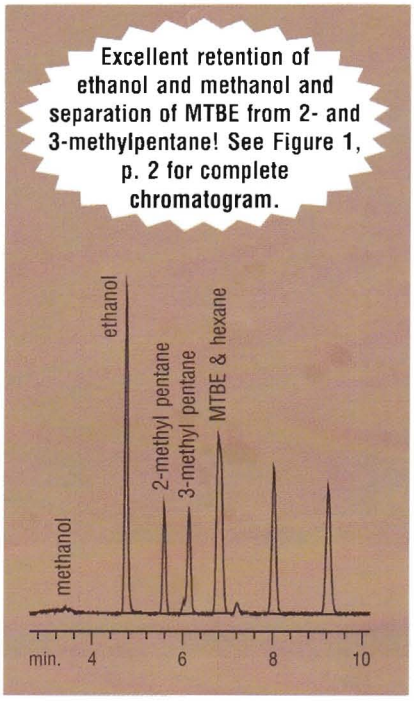
- ✔ *Oxygenates, including alcohols, resolved on one column*
- ✔ *Fewer coelutions than other columns, to prevent misidentifications*
- ✔ *Excellent capacity for ethanol and other polar compounds*

Now, however, we know that the ethers pose a threat to human health. These compounds have vapor pressures that range from 68mm Hg for TAME to 250mm Hg for the most volatile, MTBE. The high vapor pressure of MTBE threatens air quality at gasoline pumps. The oxygenates also are soluble in water, which contaminates ground water. In fact, an estimated 9,000 community drinking water wells now have detectable levels of MTBE contamination. Therefore, the US Environmental Protection Agency (EPA) has moved to ban MTBE use in gasoline. Other ethers can be used as additives, but they are more expensive and pose similar health risks.

Corn-based ethanol is the proposed gasoline additive. Ethanol has a lower toxicity, lower volatility, and is not environmentally persistent. A variety of methods has been used for the capillary gas chromatographic (GC) analysis of oxygenates in gasoline.* Success of these methods is based on the established ability of the GC capillary columns to resolve oxygenates from early-eluting alkanes such as 2-methylpentane and 3-methylpentane. Because of the possibility of widespread corn-based ethanol use, the environmental chemist now must find a GC column appropriate for the analysis of oxygenates including the alcohols.

The new Rtx®-VGC column retains the alcohols to allow quantitation of ethanol without interference from methanol. Methanol is commonly used in preparing VOA standards and may be added to gasoline as well. The Rtx®-VGC column is more polar than other capillary columns commonly used for gasoline range organic (GRO) analysis. This column is designed to exhibit greater retention and

Excellent retention of ethanol and methanol and separation of MTBE from 2- and 3-methylpentane! See Figure 1, p. 2 for complete chromatogram.



elution order is different compared to other more non-polar stationary phases. MTBE elutes after 2- and 3-methylpentane. These are the most commonly misidentified compounds when using PID/FID for GRO analysis.

Mass spectrometry (MS) can be used to increase the level of confidence in your analysis. Column selection for MS must ensure that compounds sharing ions will not coelute. Gasoline samples may

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Fall 2000 INTERNATIONAL

Rtx®-VGC Column, cont.

selectivity and fewer coelutions provided by the Rtx®-VGC column decreases high bias.

Ethanol analysis using purge-and-trap concentration and MS detection has proved successful with Rtx®-VGC columns (Figure 1). Benzene, toluene, ethylbenzene, xylene (BTEX); surrogates; retention time markers; and other branched aromatics were added, along with the oxygenates. Because ethanol does not purge well, the concentration of ethanol in the calibration mix was added at 100 times that of the ethers. The sample was analyzed using the Rtx®-VGC column and was detected using an MS system. Environmental laboratories have reported linear calibrations of ethanol and detection limits of 2.5ppm in 5mL of water using this method.

Whether using PID, FID or MS, the Rtx®-VGC column will ensure excellent selectivity and improve your laboratory's data quality for MTBE, ethanol, and other oxygenate analytes.

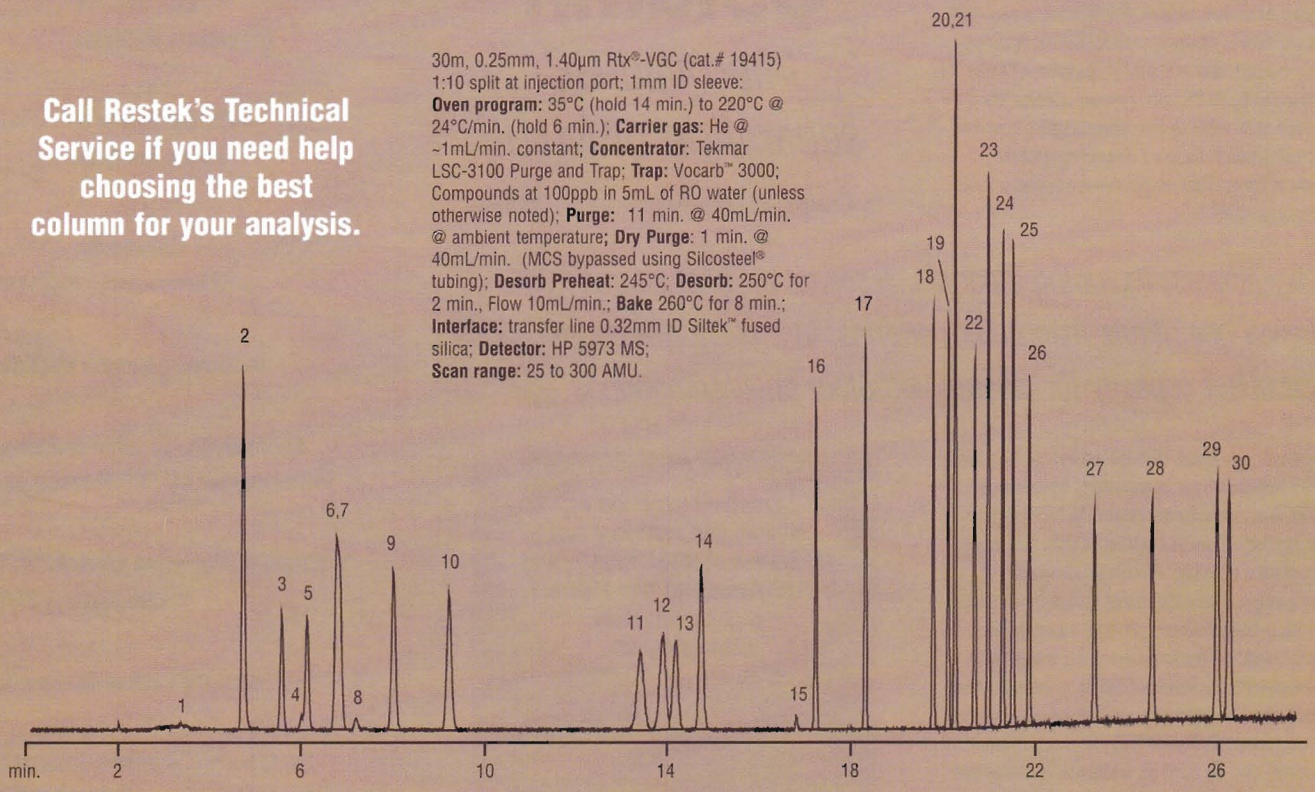
The Rtx®-VGC column has a programmable temperature limit of 260°C and exhibits exceptionally low bleed at common operating temperatures of 220°C.

Figure 1

The Rtx®-VGC column resolves gasoline components and commonly used oxygenate additives.

Call Restek's Technical Service if you need help choosing the best column for your analysis.

30m, 0.25mm, 1.40µm Rtx®-VGC (cat.# 19415) 1:10 split at injection port; 1mm ID sleeve: **Oven program:** 35°C (hold 14 min.) to 220°C @ 24°C/min. (hold 6 min.); **Carrier gas:** He @ ~1mL/min. constant; **Concentrator:** Tekmar LSC-3100 Purge and Trap; **Trap:** Vocarb™ 3000; Compounds at 100ppb in 5mL of RO water (unless otherwise noted); **Purge:** 11 min. @ 40mL/min. @ ambient temperature; **Dry Purge:** 1 min. @ 40mL/min. (MCS bypassed using Silcosteel® tubing); **Desorb Preheat:** 245°C; **Desorb:** 250°C for 2 min., Flow 10mL/min.; **Bake** 260°C for 8 min.; **Interface:** transfer line 0.32mm ID Siltek™ fused silica; **Detector:** HP 5973 MS; **Scan range:** 25 to 300 AMU.



1. methanol 100,000ppb
2. ethanol 10,000ppb
3. 2-methylpentane
4. 2-propanol 500ppb
5. 3-methylpentane
6. hexane
7. methyl-*tert*-buyl ether
8. *tert*-butanol 500ppb
9. diisopropyl ether
10. ethyl-*tert*-butyl ether
11. isooctane
12. benzene
13. *n*-heptane
14. *tert*-amyl-methyl ether
15. 1-butanol 500ppb
16. α,α,α-trifluorotoluene
17. toluene
18. 1-chloro-3-fluorobenzene
19. ethylbenzene
20. *m*-xylene
21. *p*-xylene
22. *o*-xylene
23. isopropylbenzene
24. decane
25. 1,3,5-trimethylbenzene
26. 1,2,4-trimethylbenzene
27. 4-bromochlorobenzene
28. naphthalene
29. 2-methylnaphthalene 150ppb
30. 1-methylnaphthalene 150ppb

Rtx®-VGC (Fused Silica)

ID	df (µm)	Temp. Limits	30-Meter	60-Meter	75-Meter	105-Meter
0.25mm	1.40	-40 to 240/260°C	19415	19416	—	—
0.32mm	1.80	-40 to 240/260°C	19419	19420	—	—
0.45mm	2.55	-40 to 240/260°C	19408	—	19409	—
0.53mm	3.00	-40 to 240/260°C	19485	19488	19474	19489
ID	**df (µm)**	**Temp. Limits**	**20-Meter**	**40-Meter**		
0.18mm	1.00	-40 to 240/260°C	49414	49415	—	—

*American Society for Testing and Materials (ASTM) Method D2887/D4814, and EPA Methods 8015, 8260, and 8020.

Rtx®-5MS

Choosing the right GC column for dioxin and furan analysis

by Frank Dorman, Ph.D., R&D Chemist

- ✔ *Best 2,3,7,8-TCDD separation*
- ✔ *Columns individually tested to guarantee low GC/MS bleed*

Byproducts from incomplete incineration and from impurities in some reaction mixtures—polychlorinated dibenzo dioxins (PCDDs) and polychlorinated dibenzo furans (PCDFs)—are among the most toxic compounds commonly analyzed in the environmental testing field. Exposure to these compounds is connected to an array of health effects.

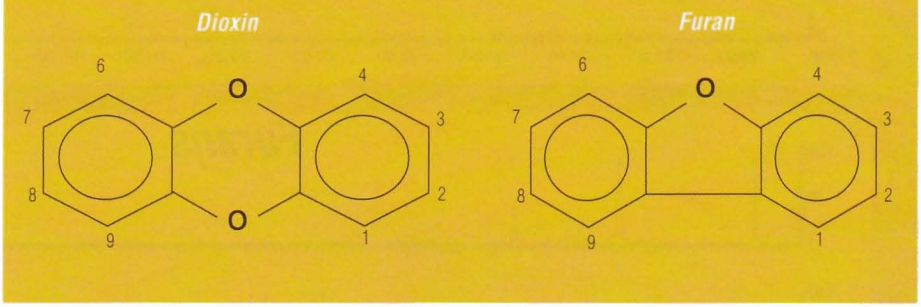
The dioxin molecule is comprised of two benzene rings connected by two oxygen links; the furans have similar toxicity and structure but only one oxygen link (Figure 1). Depending on the extent and position of chlorine substitution, the congeners have very different toxicity. Substitution at the outermost positions (2, 3, 7, and 8) lead to the most toxic congeners, which are the most important to resolve. US Environmental Protection Agency (EPA) Methods 8290 and 1613 require analysis of all dioxin and furan congeners that have chlorine substitution at the 2, 3, 7 or 8 positions. This requirement, coupled with the similar boiling points of these compounds and the desired low limits of detection, make these separations challenging.

Chemists performing the analysis of dioxins and furans by gas chromatography (GC) with high-resolution mass spectrometry (GC/HRMS) have a difficult time determining the best column for the separation of these target compounds. Many columns are on the market for this analysis, but choosing the right one is critical.

Because a mass spectrometer (MS) is used for detection, many analysts want the lowest bleed columns possible. Some laboratories have begun performing this analysis on silarylene columns (i.e., Rtx®-5Sil MS, DB-5MS®) due to their low GC/MS bleed. It is important to note that these columns do not typically perform the separation required by the analytical methods. For example, silarylene columns can yield a coelution between 2,3,7,8-TCDD and 1,2,3,9-TCDD. Also, silarylene columns are not equivalent to standard phenyl/methyl columns—elution orders and retention times will be different. This is especially important because the window performance mixtures were designed for use with a 5% diphenyl/95% dimethyl polysiloxane stationary phase.

Restek's 5% diphenyl/95% dimethyl polysiloxane (Rtx®-5MS) columns are better suited to meet the performance standards of this analysis. Notice how the Rtx®-5MS column separates all of the important dioxin and furan congeners (Figure 2, page 4). The key column performance parameter is the separation of 2,3,7,8-TCDD. It must be separated from its nearest eluting neighbor—1,2,3,7-TCDD/1,2,3,8-TCDD—by a 25% valley or better. These columns are individually tested to provide low bleed levels for MS detection. If you would like more information on this application, or choices of confirmation columns, please contact Restek's technical service at 800-356-1688 or 814-353-1300, ext. 4.

Figure 1
The amount and position of chlorine substitution determines the toxicity of the congeners.



Rtx®-5MS (Fused Silica)

Crossbond® 5% diphenyl/95% dimethyl polysiloxane

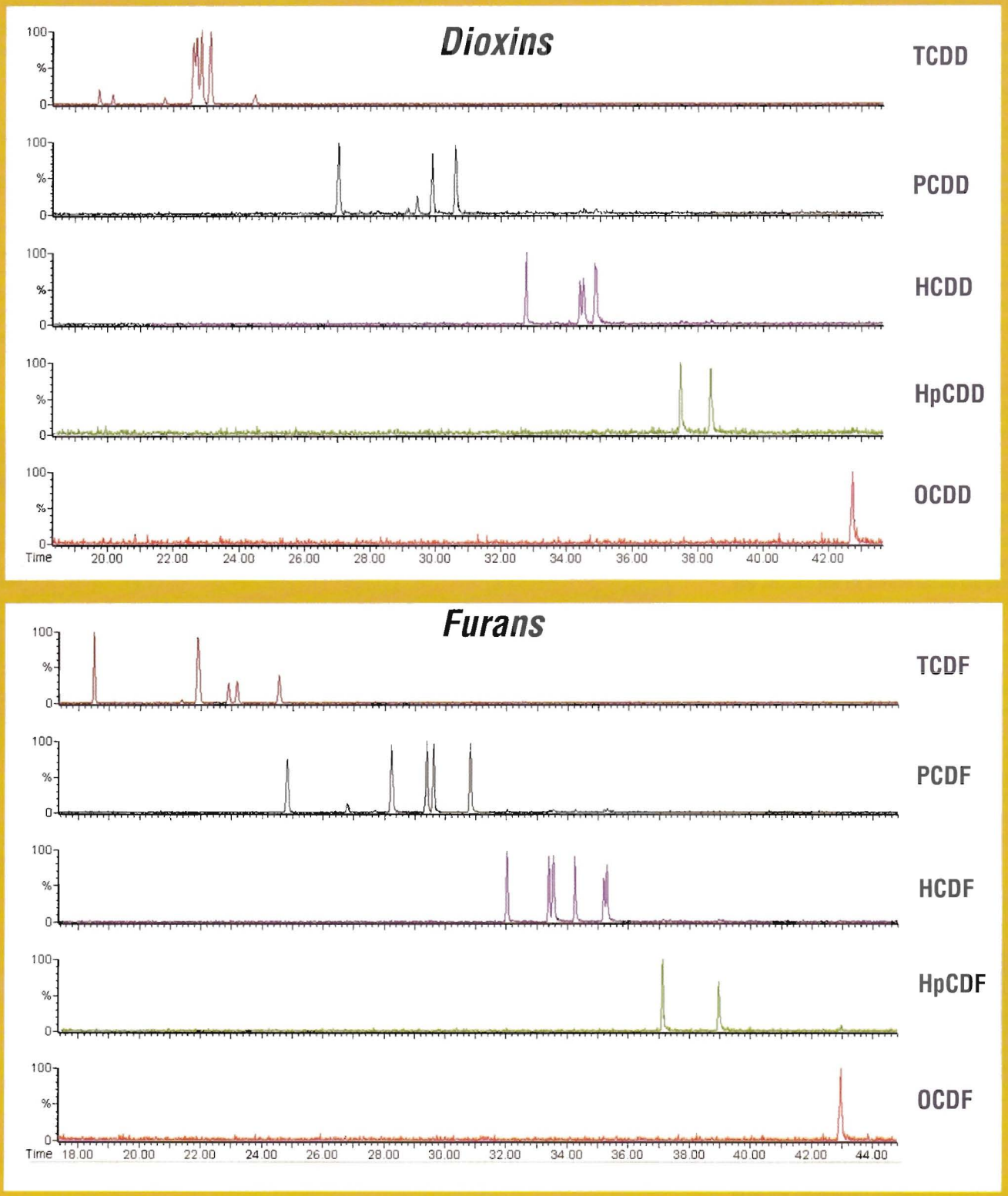
ID	df (µm)	Temp. Limits	15-Meter	30-Meter	60-Meter
0.25mm	0.10	-60 to 330/350°C	12605	12608	12611
	0.25	-60 to 330/350°C	12620	12623	12626
	0.50	-60 to 330/350°C	12635	12638	12641
	1.00	-60 to 325/350°C	12650	12653	—
0.32mm	0.10	-60 to 330/350°C	12606	12609	12612
	0.25	-60 to 330/350°C	12621	12624	12627
	0.50	-60 to 330/350°C	12636	12639	12642
	1.00	-60 to 325/350°C	12651	12654	—
0.53mm	0.50	-60 to 320/340°C	12637	12640	—
	1.00	-60 to 320/340°C	12652	12655	—
	1.50	-60 to 310/330°C	12667	12670	—

Questions?

Restek's Technical Service Department will go to great lengths to find the answers to your toughest analytical problems. Call us at 800-356-1688 or 814-353-1300, ext. 4. Our regular technical service hours are 8AM to 7PM EST, Monday through Thursday, and 8AM to 5PM EST on Fridays. You also can fax us at 814-353-1309 or email us at support@restekcorp.com.

Figure 2

Rtx®-5MS phenyl/methyl column provides the best separation of dioxin and furan congeners.



60m, 0.25mm ID, 0.25µm Rtx®-5MS (cat.# 12626)
43psi head pressure/constant pressure. **Temp.:** 100°C (hold 1 min.) to 200°C @ 40°C/min. to 235°C @ 3°C/min. (hold 10 min.) to 300°C @ 6°C/min. (hold 5-10 min.).

Chromatograms courtesy of Karen McPherson, Ontario Ministry of the Environment

Rt-CW20M™ F&F GC Column

20M selectivity with improved inertness for flavor and fragrance analysis

by Sherry Sponsler-Navaroli,
FFF Applications Manager

For years, a nonbonded Carbowax® phase of nominal 20,000 molecular weight (mean actual molecular weight is 17,000) has been the standard stationary phase for capillary gas chromatography (GC) columns used in the flavor and fragrance industry. Because retention indices of thousands of compounds have been recorded on the Carbowax® phase, analysts are reluctant to use other polyethylene glycol (PEG) columns, which show marked differences in selectivity and compound retention indices. Restek has designed the new Rt-CW20M™ F&F nonbonded column and tests it with a special mix to ensure similar selectivity corresponding to the nonbonded Carbowax® phase for many flavor and fragrance applications.

To ensure that the selectivity of the Rt-CW20M™ F&F polymer matches that of other nonbonded Carbowax® 20M capillary columns, Restek designed a new polar test mix that contains compounds commonly analyzed in flavor or fragrance samples. This new test mix verifies the performance of each Rt-CW20M™ F&F polymer batch, to ensure consistent performance. The selectivity of the Restek phase is evaluated from the retention indices of selected alcohols, aldehydes, ketones, and esters, using methyl esters as marker compounds.

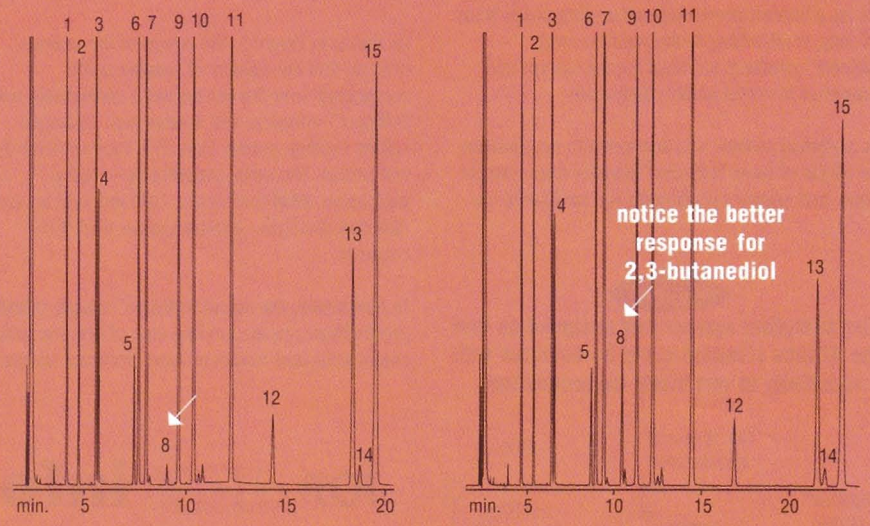
Calculations of Kováts indices for two bonded phase and two nonbonded phase PEG columns reveal similarities and differences in selectivity (Table I). Comparison of the indices confirms the excellent match in selectivity (no difference exceeded 0.02 units) between the two nonbonded phases—the Rt-CW20M™ F&F column and the traditional 20M columns. The two bonded phases—the Rtx®-Wax and Stabilwax® columns—differ by as much as 0.08 units between each other and by as much as 0.13 units from the nonbonded columns.

A comparison of an Rt-CW20M™ F&F column and a traditional Carbowax® 20M column, using the new test mix, demonstrates an excellent match in selectivity between the two columns (Figure 1). However, notice the poor response for 2,3-butanediol on the traditional column, suggesting the Rt-CW20M™ F&F column may be more inert.*

For many flavor and fragrance analyses, the new Rt-CW20M™ F&F column features selectivity equivalent to the traditional nonbonded Carbowax® 20M column. Our new test mixture ensures proper selectivity and product consistency.

Figure 1

The Rt-CW20M™ F&F column has equivalent selectivity but better inertness, compared to a traditional nonbonded Carbowax® column.



1. methyl heptanoate
2. hexanol
3. methyl octanoate
4. nonanal
5. menthone
6. citronellal
7. methyl nonanoate
8. 2,3-butanediol
9. linalool
10. linalyl acetate
11. methyl decanoate
12. menthol
13. α-terpineol
14. γ-terpineol
15. methyl undecanoate

50m, 0.32mm ID, 0.33µm, Rt-CW20M™ and traditional 20M. On-column injection of 5ng to 150ng each compound in methylene chloride, split 10:1. **Carrier gas:** hydrogen, 40cm/sec.; **Inj./det. temperatures:** 220°C; **Oven temp.:** 110°C.

Table I

Kováts indices for PEG columns show equivalent selectivity for the nonbonded Rt-CW20M™ F&F and HP-20M columns.

	Rt-CW20M™	HP-20M	Rtx®-Wax	Stabilwax®
methyl heptanoate (ME7)	7.00	7.00	7.00	7.00
hexanol	7.46	7.49	7.50	7.54
methyl octanoate (ME8)	8.00	8.00	8.00	8.00
nonanal	8.06	8.06	8.07	8.09
menthone	8.81	8.80	8.82	8.86
citronellal	8.88	8.88	8.90	8.92
methyl nonanoate (ME9)	9.00	9.00	9.00	9.00
2,3-butanediol	9.26	9.30	9.37	9.45
linalool	9.44	9.44	9.47	9.50
linalyl acetate	9.62	9.62	9.63	9.63
methyl decanoate (ME10)	10.00	10.00	10.00	10.00
menthol	10.34	10.34	10.37	10.42
α-terpineol	10.87	10.87	10.91	10.98
γ-terpineol	10.91	10.91	10.95	10.98
methyl undecanoate (ME11)	11.00	11.00	11.00	11.00

Rt-CW20M™ F&F

(nonbonded fused Silica) Stable to 220°C

dimensions	cat.#
30m, 0.25mm ID, 0.25µm	12523
50m, 0.32mm ID, 0.33µm	12539

* Both columns were connected to one inlet using a short piece (<0.25m) of 0.53mm ID Siltek™ guard column (cat.# 10028) and a Y connector (Siltek™ 'Y' Press-Tight® connector cat.# 20469). On-column concentration of 2,3-butanediol is 37.5ng for each column.

Sulfinert™ Sample Cylinders

Sampling of sulfur compounds at low ppb levels

by Dave Shelow, Environmental Innovations Chemist

- ✔ Inert, for less than 1ppm concentration*
- ✔ Stability proven for 54 hours of storage

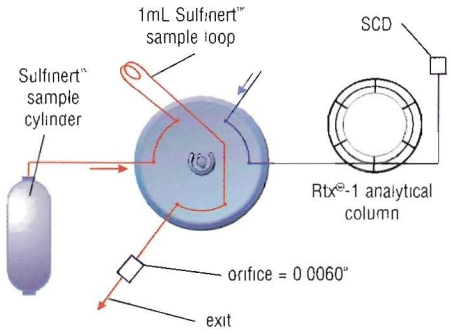
Stainless steel sample cylinders commonly are used in the collection and analysis of refinery and natural gas samples. These samples often contain trace amounts of sulfur-containing compounds (e.g., hydrogen sulfide, mercaptans, and sulfides), which may interfere with reactions or damage catalysts in many petrochemical processes. Because sulfur compounds are quickly adsorbed by the stainless steel surfaces, accurate determination is impossible when using untreated sample cylinders.

Restek's Sulfinert™ passivation technique bonds an inert layer to the surface of stainless steel. This layer acts as a barrier, preventing active compounds from reacting or adsorbing to the stainless steel. Sulfinert™ products are ideal for the storage and transfer of low-level sulfur compounds.

An analytical method was developed to demonstrate the effects of using Sulfinert™ transfer lines, sample loops, and sample cylinders for the analysis of low-level reactive sulfur compounds (Figure 1). To characterize the Sulfinert™ surface, the stability of sulfur compounds in three Sulfinert™-treated cylinders was tested over a 54-hour period.

Figure 1

The analytical system was designed so that the 17ppbv standard could be detected with sensitivity to quantitate compound loss.



Sulfinert™ Sample Cylinders	
Size	**cat.#**
75cc	24130
150cc	24131
300cc	24132
500cc	24133
1000cc	24134

*Silcosteel® products can be used for concentrations >1ppm

The standards were made by adding 1mL of 100ppm standard into a 500cc sample cylinder and pressurizing to 160psig. No water was added to the standards in order to simulate the petrochemical process. Dimethyl sulfide, which has been shown to be non-reactive in the standard and is not adsorbed by stainless steel, was used as an internal standard for the study.

As shown in Figure 2, the results of the analysis indicate that the stability of reactive sulfur compounds over the test period is remarkable using Sulfinert™ cylinders and accessories. Hydrogen sulfide exhibits greater than 85% recovery over the test period. The other compounds—methyl mercaptan, ethyl mercaptan, carbonyl sulfide, and dimethyl disulfide—exhibit greater than 90% recovery.

In conclusion, the use of Sulfinert™ sample cylinders greatly increases the holding time of reactive sulfur compounds and results in more accurate analyses.

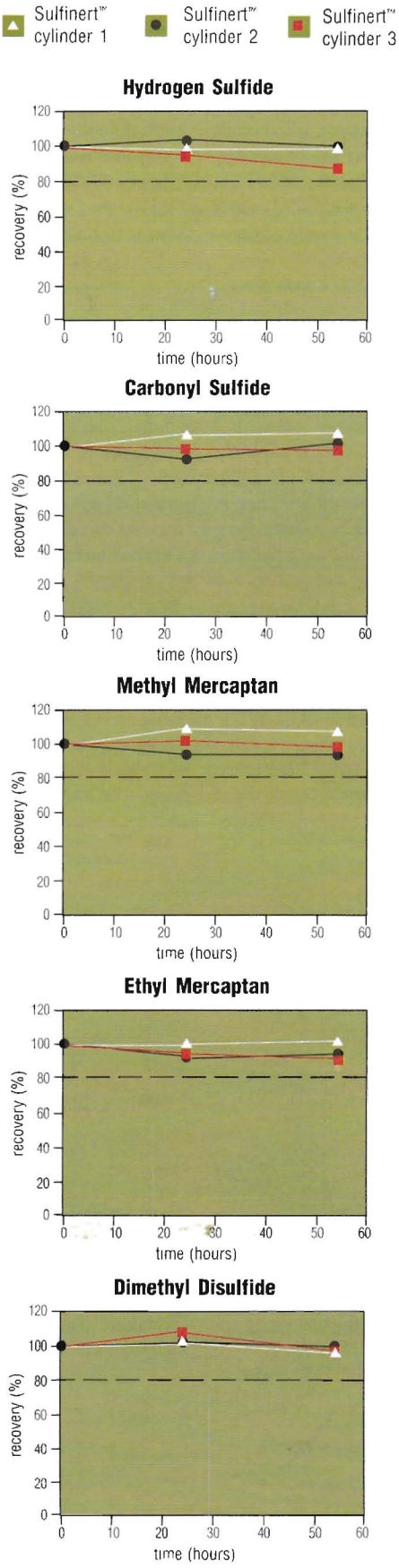
for more info

For more information on Sulfinert™, request the flyer lit. cat.# 59203 or visit www.restekcorp.com/sulfinrt.htm.

Sulfinert™ Sample Loops	
Size	**cat.#**
5µL	22840
10µL	22841
20µL	22842
25µL	22843
50µL	22844
100µL	22845
250µL	22846
500µL	22847
1cc	22848
2cc	22849
5cc	22850

Figure 2

Stability of sulfur compounds is remarkable in Sulfinert™ cylinders.



Semivolatile Organic Reference Materials

For US EPA Methods 8270C & 8270D

by Christopher Cox, Senior R&D Chemist

✔ Flexibility in calibration

✔ Convenience and maximum stability

Update IVA of the third edition of SW-846—Test Methods for Evaluating Solid Waste, Physical/Chemical Methods—includes US Environmental Protection Agency (EPA) Method 8270D, the analysis of semivolatile organic pollutants in solid waste, soil, water, and air matrices, using gas chromatography/mass spectrometry (GC/MS). There are no major revisions from EPA Method 8270C.

Restek carefully reviewed EPA Methods 8270C and 8270D and prepared analytical reference materials to include all of the most commonly calibrated compounds. The compounds have been divided to provide flexibility, convenience, and maximum stability. Restek also offers all the required surrogate, internal standard, calibration check, matrix spike, and tuning mixtures currently required for this method. We also can make custom mixtures to meet client-specific compound lists!

8270 Calibration Mix #1

benzoic acid
4-chloro-3-methylphenol
2-chlorophenol
2,4-dichlorophenol
2,6-dichlorophenol
2,4-dimethylphenol
4,6-dinitro-2-methylphenol
2,4-dinitrophenol
dinoseb
2-methylphenol (*o*-cresol)
3-methylphenol (*m*-cresol)
4-methylphenol (*p*-cresol)
2-nitrophenol
4-nitrophenol
pentachlorophenol
phenol
2,3,4,6-tetrachlorophenol
2,4,5-trichlorophenol
2,4,6-trichlorophenol

2,000µg/mL ea. in methylene chloride. 1mL/ampul

Each	5-pk.	10-pk.
31618	31618-510	
with data pack		
31618-500	31618-520	31718

8270 Calibration Mix #2

aniline
benzidine
4-chloroaniline
3,3'-dichlorobenzidine
diphenylamine
2-nitroaniline
3-nitroaniline
4-nitroaniline
N-nitrosodimethylamine
N-nitrosodi-*n*-propylamine
pyridine

2,000µg/mL ea. in methylene chloride. 1mL/ampul

Each	5-pk.	10-pk.
31619	31619-510	
with data pack		
31619-500	31619-520	31719

8270 Calibration Mix #3

aramite
bis (2-chloroethyl) ether
bis (2-chloroethoxy) methane
bis (2-chloroisopropyl) ether
4-bromophenyl phenyl ether
chlorobenzilate
2-chloronaphthalene
4-chlorophenyl phenyl ether
1,2-dichlorobenzene
1,3-dichlorobenzene
1,4-dichlorobenzene
1,3-dinitrobenzene
hexachlorobenzene
hexachlorobutadiene
hexachlorocyclopentadiene
hexachloroethane
hexachloropropene
isodrin
kepone
pentachlorobenzene
pentachloronitrobenzene
1,2,4,5-tetrachlorobenzene
1,2,4-trichlorobenzene

2,000µg/mL ea. in methylene chloride. 1mL/ampul

Each	5-pk.	10-pk.
31620	31620-510	
with data pack		
31620-500	31620-520	31720

8270 Calibration Mix #4

acetophenone
azobenzene
benzyl alcohol
bis (2-ethylhexyl) phthalate
butyl benzyl phthalate
dibenzofuran
diethyl phthalate
dimethyl phthalate
di-*n*-butyl phthalate
di-*n*-octyl phthalate
2,4-dinitrotoluene
2,6-dinitrotoluene
ethyl methanesulfonate
isophorone
isosafrole (*cis* & *trans*)
methyl methanesulfonate
1,4-naphthoquinone
nitrobenzene
4-nitroquinoline-1-oxide
phenacetin
safrole

2,000µg/mL ea. in methylene chloride. 1mL/ampul

Each	5-pk.	10-pk.
31621	31621-510	
with data pack		
31621-500	31621-520	31721

8270 Calibration Mix #5

acenaphthene
acenaphthylene
anthracene
benzo(a)anthracene
benzo(a)pyrene
benzo(b)fluoranthene
benzo(g,h,i)perylene
benzo(k)fluoranthene
chrysene
dibenz(a,h)anthracene
fluoranthene
fluorene
ideno(1,2,3-cd)pyrene
3-methylcholanthrene
1-methylnaphthalene
2-methylnaphthalene
naphthalene
phenanthrene
pyrene

2,000µg/mL ea. in methylene chloride. 1mL/ampul

Each	5-pk.	10-pk.
31622	31622-510	
with data pack		
31622-500	31622-520	31722

8270 Calibration Mix #6

diallate (*cis* or *trans*)
dimethoate
disulfoton
famphur
methyl parathion
parathion
phorate
pronamide
thionazine
O,O,O-triethyl phosphorothioate

2,000µg/mL ea. in methylene chloride. 1mL/ampul

Each	5-pk.	10-pk.
31623	31623-510	
with data pack		
31623-500	31623-520	31723

Organochlorine Pesticide Mix AB #1

aldrin
α-BHC
α-chlordane
β-BHC
4,4'-DDD
4,4'-DDE
4,4'-DDT
δ-BHC
dieldrin
endosulfan I
endosulfan II
endosulfan sulfate
endrin
endrin aldehyde
endrin ketone
γ-BHC (lindane)
γ-chlordane
heptachlor
heptachlor epoxide
methoxychlor

200µg/mL ea in hexane/toluene (1:1). 1mL/ampul

Each	5-pk.	10-pk.
32291	32291-510	
with data pack		
32291-500	32291-520	32391

Appendix IX Mix #1

2-acetylaminofluorene
4-aminobiphenyl
p-dimethylaminoazobenzene
3,3'-dimethylbenzidine
α,α,-dimethylphenethylamine (free base)
methapyrilene (free base)
1-naphthylamine
2-naphthylamine
5-nitro-*o*-toluidine
N-nitrosodibutylamine
N-nitrosodiethylamine
N-nitrosomethylethylamine
N-nitrosomorpholine
N-nitrosopiperidine
N-nitrosopyrrolidine
1,4-phenylenediamine
2-picoline
o-toluidine

2,000µg/mL ea. in methylene chloride. 1mL/ampul

Each	5-pk.	10-pk.
31625	31625-510	
with data pack		
31625-500	31625-520	31725

for more info

Request the Fast Facts lit. cat.# 59326 for a complete product listing including more calibration mixtures; calibration check compound, internal standards, surrogate and matrix spiking mixes; and calibration kits.

Rtx®-VMS 0.25mm ID Column

Analyzes 84 volatile organic compounds in 11 minutes

By Christopher English, Applications Chemist

- ✔ *Excellent resolution of difficult components*
- ✔ *Tuned selectivity for VOCs in drinking water*

Volatile organic compounds (VOCs) are some of the most prevalent contaminants found in water supplies. In fact, they are present in one-fifth of the US water supplies. VOCs enter ground water from a variety of sources—from leaking underground fuel tanks to industrial solvent used in septic system cleaners. They may have a variety of harmful health effects including central nervous system depression.

US Environmental Protection Agency (EPA) Method 524.2 was created to monitor the most common contaminants found in the drinking water supply, using gas chromatography/mass spectrometry (GC/MS). The latest revision to this method has introduced 24 additional compounds to the existing list of 60 analytes. Further updates allow alternate sorbents to trap VOCs, provided all quality assurance criteria are met. However, purge time and purge gas flow rates have remained the same as in previous revisions, and cannot be changed.

Restek has introduced the Rtx®-VMS column for the analysis of these contaminants. This column features fast analyses and excellent resolution (Figure 1). The 84 compounds are analyzed on a 0.25mm ID column in eleven minutes. The starting temperature is set to 45°C, which is high enough to allow a quick overall oven cycle time without sacrificing gas compound resolution. The total cycle time depends on several factors: the type of GC, the oven start temperature, the final oven temperature, and the temperature of the room in which the analysis occurs. The limiting factor becomes the purge and trap cycle time, which can vary greatly depending on the dry purge time, bake time, and trap cool-down temperature. The total oven cycle time for this analysis was less than 17 minutes. We used a Vocarb™ 3000 trap with a 1 minute dry purge. Changes in dry purge time using this trap did not

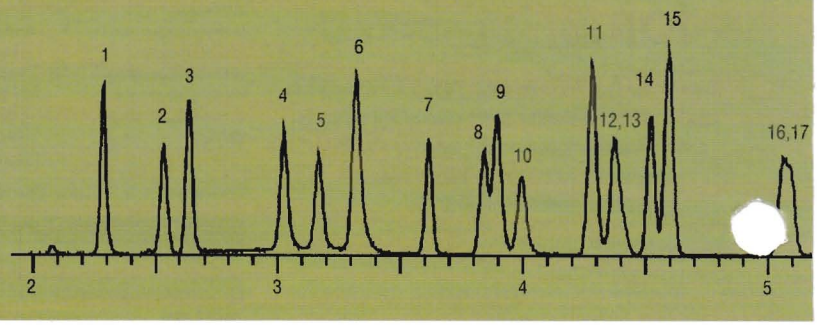
Figure 1

Rtx®-VMS column provides fast and excellent resolution of VOCs in drinking water.

1. dichlorofluoromethane
2. chloromethane
3. vinyl chloride
4. bromomethane
5. chloroethane
6. trichlorofluoromethane
7. diethyl ether
8. 1,1-dichloroethene
9. carbon disulfide
10. iodomethane
11. allyl chloride
12. methylene chloride
13. acetone
14. *trans*-1,2-dichloroethene
15. methyl-*tert*-butyl-ether
16. 1,1-dichloroethane
17. acrylonitrile
18. *cis*-1,2-dichloroethene
19. 2,2-dichloropropane
20. bromochloromethane
21. chloroform
22. methyl acrylate
23. carbon tetrachloride
24. tetrahydrofuran
25. 1,1,1-trichloroethane
26. 2-butanone
27. 1,1-dichloropropene
28. 1-chlorobutane
29. benzene
30. propionitrile
31. 1,2-dichloroethane
32. fluorobenzene
33. trichloroethene
34. dibromomethane
35. 1,2-dichloropropane
36. bromodichloromethane
37. methyl methacrylate
38. *cis*-1,3-dichloropropene
39. toluene
40. chloroacetonitrile
41. 2-nitropropane
42. 1,1-dichloropropanone
43. 4-methyl-2-penanone
44. tetrachloroethene
45. *trans*-1,3-dichloropropene
46. ethyl methacrylate
47. 1,1,2-trichloroethane
48. dibromochloromethane
49. 1,3-dichloropropane
50. 1,2-dibromoethane
51. 2-hexanone
52. ethylbenzene
53. chlorobenzene
54. 1,1,1,2-tetrachloroethane
55. *m*-xylene
56. *p*-xylene
57. *o*-xylene
58. stryrene
59. bromoform
60. isopropylbenzene
61. 4-bromofluorobenzene
62. *n*-propylbenzene
63. bromobenzene
64. 1,1,2,2-tetrachloroethane
65. 1,3,5-trimethylbenzene
66. 2-chlorotoluene
67. 1,2,3-trichloropropane
68. *trans*-1,4-dichloro-2-butene
69. 4-chlorotoluene
70. *tert*-butylbenzene
71. 1,2,4-trimethylbenzene
72. pentachloroethane
73. *sec*-butylbenzene
74. *p*-isopropyltoluene
75. 1,3-dichlorobenzene
76. 1,4-dichlorobenzene
77. *n*-butylbenzene
78. hexachloroethane
79. 1,2-dichlorobenzene-d4
80. 1,2-dichlorobenzene
81. 1,2-dibromo-3-chloropropane
82. nitrobenzene
83. hexachlorobutadiene
84. 1,2,4-trichlorobenzene
85. naphthalene
86. 1,2,3-trichlorobenzene

30m, 0.25mm ID, 1.4µm Rtx®-VMS (cat.# 19915)
Linear velocity: Helium @ ~1.3mL/min. constant pressure; **Dead time:** 2.1 min.; **Concentrator:** Tekmar LSC-3000 Purge and Trap; **Oven program:** 45°C (hold 2 min.) to 85°C @ 14°C/min. to 210°C @ 40°C/min. (hold 4 min.); **Trap:** Vocarb 3000; **GC:** HP6890 Series II Hewlett-Packard 5973 Mass Selective Detetector scan range 35 to 300 AMU; **Purge:** 11 min. @ 40mL/min.; **Dry purge:** 1 min. @ 40mL/min. (MCS bypassed); **Desorb preheat:** 245°C; **Desorb:** 250°C for 2 min.; **Bake:** 260°C for 8 min.; **Interface:** 1:10 split in port; **Transfer line:** 0.32mm ID Siltek™ tubing (cat.# 10027)

Standards:
20ppb in 5mL of RO water (unless otherwise noted); ketones, alcohols in 40ppb.
502.2 Cal Mix #1 (cat.# 30042)
502.2 Cal2000 MegaMix™ (cat.# 30431)
524 Cal Mix A&B (cat.# 30202)
524 Cal Mix #8 (cat.# 30203)
524 IS/SS Mix (cat.# 30201)



significantly affect the amount of methanol and water on the column. The "purge ready" temperature was set to 35°C, which increased the concentrator cycle time, but prevented breakthrough of the gases.

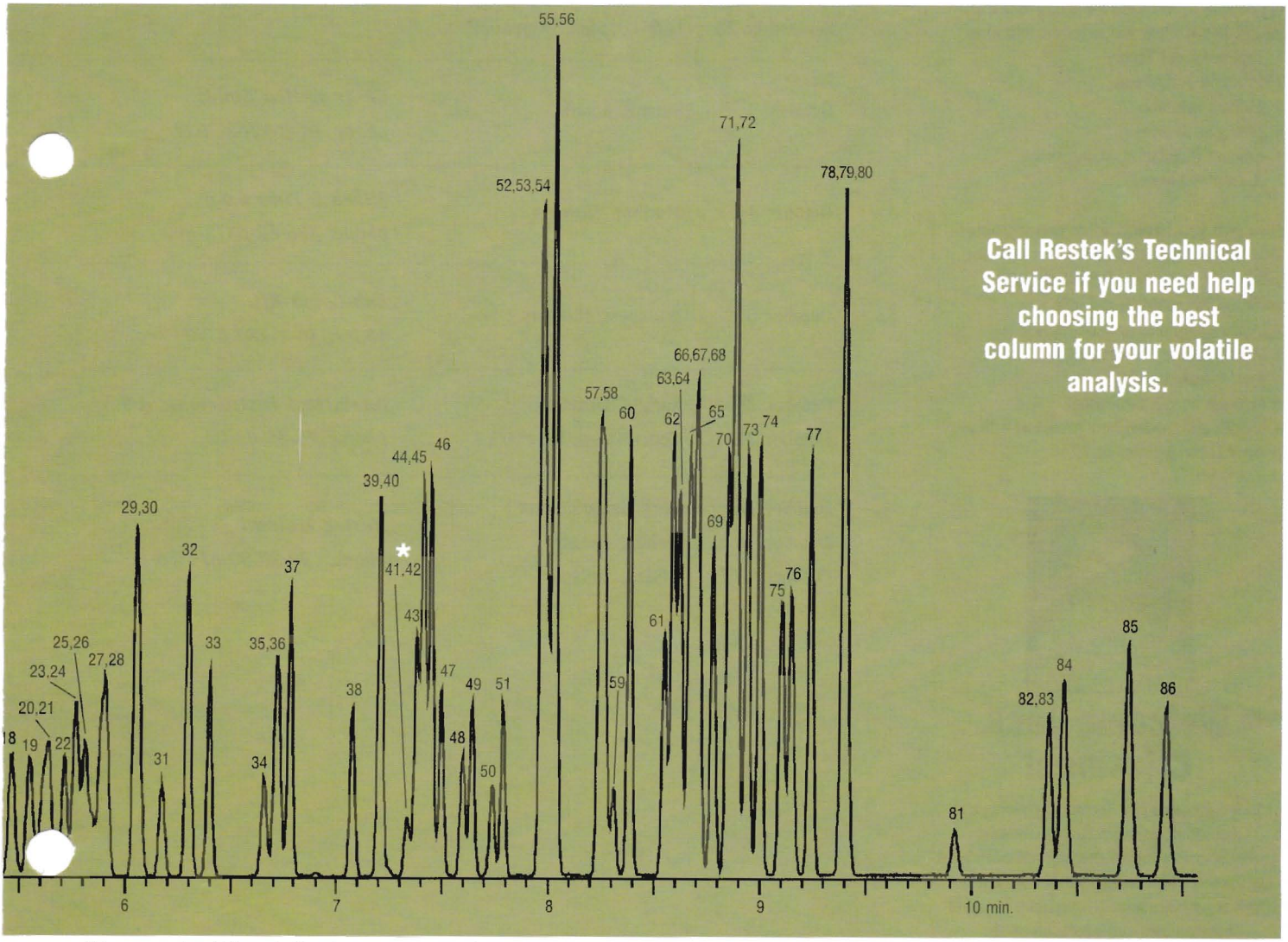
The narrow-bore (0.25mm ID) Rtx®-VMS column provides excellent sensitivity and optimized selectivity for a broad range of halogenated compounds and aromatics. Sensitivity can be increased by using a larger purge volume or a more sensitive MS. The small column ID improves sensitivity though narrower bandwidths. For Figure 1, a 10:1 split injection provided optimum flow to the MS (~1mL/min.) and helped achieve method detection limits (MDLs). The tuned selectivity of the phase prevents problems with closely-eluting compounds that share ions, such as carbon tetrachloride/1,1,1-trichloroethane and tetrahydrofuran/2-butanone. These compounds have similar spectra but are resolved by retention time. Maximum separation of substituted aromatic isomers allows a fast final oven ramp rate, preventing late-eluting compounds from coeluting and affecting quantification over a varied concentration range.

Rtx®-VMS (Fused Silica)

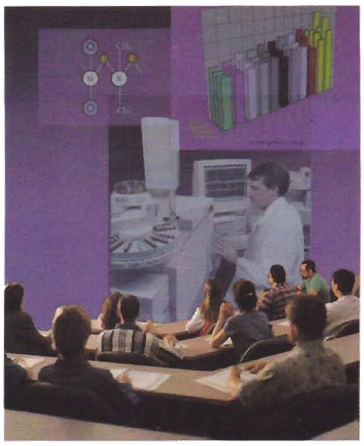
ID	df (µm)	Temp. Limits	30-Meter	60-Meter
0.25mm	1.40	-40 to 240/260°C	19915	19916
0.32mm	1.80	-40 to 240/260°C	19919	19920
0.45mm	2.55	-40 to 240/260°C	19908	19909
ID	**df (µm)**	**Temp. Limits**	**20-Meter**	**40-Meter**
0.18mm	1.00	-40 to 240/260°C	49914	49915

Siltek™ Transfer Lines/Guard Columns

Nominal ID	Nominal OD	5-Meter	10-Meter
0.25mm	0.37 ± 0.04mm	10026	10036
0.32mm	0.45 ± 0.04mm	10027	10037
0.53mm	0.69 ± 0.04mm	10028	10038



*These peaks (41 and 42) share a quantitation ion (43)



Comprehensive GC Seminar

Coming to a location near you

by Jack Crissman, Technical Training and Education Manager

Restek "On-the-Road" presents its Comprehensive GC Seminar series. This full-day course is presented in an engaging multimedia format. We teach key chromatographic concepts, tricks of the trade, and little known secrets that are of benefit to the novice and the seasoned veteran. We are chromatographers talking about chromatography, presenting the facts on how to help improve your chromatography analyses. This is a great opportunity to learn tips for saving time and money. The seminar will cover the following:

- Principles and Theory
- Injection Techniques
- Column Selection
- Detection Systems
- Column Installation, Maintenance & Troubleshooting

How will you benefit from this training?
This informative, technical seminar provides solutions to a number of challenges in the analytical laboratory. It will help you:

- Improve chromatographic efficiencies.
- Identify and adjust variables to optimize your system.
- Increase sample throughput.
- Identify and troubleshoot problems with your analysis and instrument.

Welcome Jack Crissman!

Jack is Restek's new Technical Training and Education Manager. He has extensive chromatography knowledge and will work hard to share it with chemists worldwide. Contact Jack at jcrissman@restekcorp.com for all of your training and education needs.

International Seminars

Restek's Comprehensive Capillary Chromatography Seminars will be presented in the following cities. Please contact these Restek offices for details.

Date	Location	Contact
September 25 September 26 September 27 September 28	Ulm, Germany Berlin, Germany Dusseldorf, Germany Ludwigshafen, Germany	***Restek GmbH*** *phone: 06172-2797-0*
October 2	Vienna, Austria	***CP-Analytica GmbH*** *phone: 61-3-9762-2034*
October 4	Maribor, Slovenia	***Mikro & Polo d.o.o.*** *phone: 386-62-6373-300*
October 6	Budapest, Hungary	***Lab-Comp Kft.*** *phone: 36-1-280-6770*
October 23 October 24	Aarhus, Denmark Copenhagan, Denmark	***Analytical Instruments A/S*** *phone: 44-35-02-02*
October 26 October 30 October 31	Cork, Ireland Dublin, Ireland Belfast, Ireland	***Restek Ireland*** *phone: 44-28-90-814576*

Rt-XLSulfur™ GC Columns

Analyze low-level sulfur compounds in C1-C6 hydrocarbon mixes

by Barry Burger, Petrochemical Industrial Innovations Chemist

This is the second generation of packing material for the analysis of sulfur compounds. The first packing material, in the Rt-Sulfur™ column, ensured inertness for low ppmv levels of sulfur compounds. Now, with the Rt-XLSulfur™ column, it is possible to achieve low ppbv detection of sulfur compounds.

The analysis of sulfur compounds in C1-C6 hydrocarbon streams by gas chromatography (GC) is an important application in the petrochemical field. The presence of sulfur compounds in petroleum products can affect the longevity and performance of catalysts used in hydrocarbon processing. As requirements for sulfur detection become more stringent, the importance of good chromatographic separation of hydrocarbons from sulfur compounds and the inertness of the analytical columns increases.

Detectors used for sulfur determination generally are specific (e.g., sulfur chemiluminescence detection) and help eliminate positive response from chromatographic interferences. Unfortunately, when high levels of hydrocarbons elute through the detector simultaneously with sulfur compounds, the signal for sulfur is quenched and area counts are low. For a successful analysis, the analytical column must resolve the hydrocarbons listed in Figure 1 from hydrogen sulfide, carbonyl sulfide, methyl mercaptan, ethyl mercaptan and dimethylsulfide. A packed, micropacked, or PLOT column can be used to achieve this requirement.

Hydrocarbons are non-reactive but sulfur compounds, especially hydrogen sulfide and methyl mercaptan, are easily adsorbed by undeactivated surfaces. Therefore, there are two areas of concern when performing this analysis with a packed or micropacked column: one is the inertness and selectivity of the solid support, the other is the inertness of the tubing wall. Metal tubing commonly is used to construct packed and micropacked columns. Metal tubing provides ruggedness, but the surface is very adsorptive for sulfur compounds. Teflon® tubing provides excellent inertness for sulfur analysis but is permeable to contaminants in the surrounding air. Also, Teflon® tubing will expand and contract during temperature changes.

Restek designed the Rt-XLSulfur™ column to address these concerns. The packing material for Rt-XLSulfur™ columns is extensively deactivated for the analysis of low ppbv levels of hydrogen sulfide and methyl mercaptan. It is then treated to achieve the proper sensitive separation of the hydrocarbons from sulfur compounds (Figure 1).

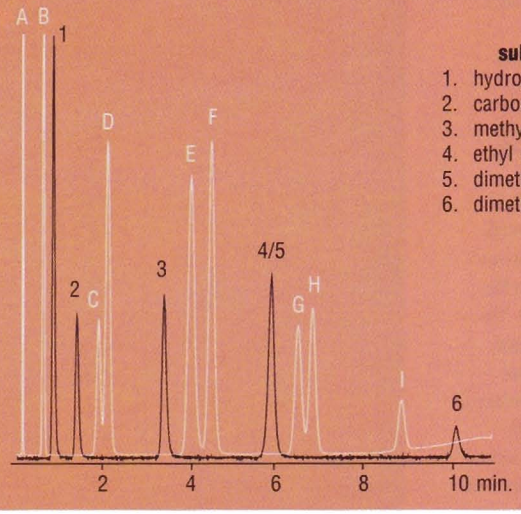
The interior wall and the end-plugs of the Rt-XLSulfur™ column are treated with Sulfinert™ coating, a passivation technique designed to deactivate metal surfaces. The Sulfinert™ coating is very inert to hydrogen sulfide and methyl mercaptan. (For more information on Sulfinert™ coating, request lit. cat.# 59203 or visit www.restekcorp.com/sulfinrt.htm.)

The extra care taken with the surfaces in this column result in a more accurate analysis of sulfur compounds in hydrocarbon processing. If you perform this type of analysis, try the Rt-XLSulfur™ column.

for more info

For detailed information including a chromatogram illustrating a **50ppbv sulfur analysis**, request the Applications Note lit. cat.# 59165.

Figure 1
The Rt-XLSulfur™ micropacked column separates hydrocarbons from sulfur compounds.



sulfurs
1. hydrogen sulfide
2. carbonyl sulfide
3. methyl mercaptan
4. ethyl mercaptan
5. dimethyl sulfide
6. dimethyl disulfide

hydrocarbons
A. methane
B. ethane
C. propylene
D. propane
E. isobutane
F. butane
G. isopentane
H. pentane
I. hexane

1m x 0.75mm ID Rt-XLSulfur™ micropacked column (cat.# 19806) **Oven temp.:** 60°C to 230°C at 15°C/min. **Carrier gas:** Helium; **Flow rate:** 9mL/min.; **Detection:** SCD/FID

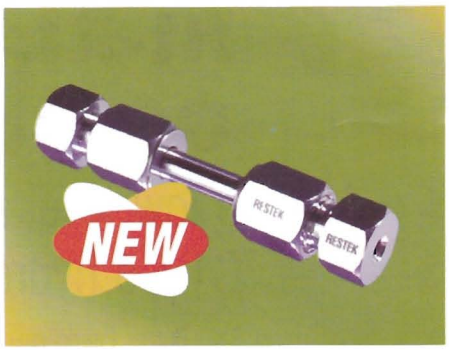
Rt-XLSulfur™ Packed & Micropacked Columns*

OD (in.)	ID (mm)	1-Meter	2-Meter
0.95mm	0.75	19806	19807
3/16	3.2	80482	80483
1/8	2.0	80484	80485
1/16	1.0	19804	19805

***Installation kit must be purchased with column** (no kit needed for 3/16" columns)

Kits for 0.95mm OD, 0.75mm ID columns	
For valve applications	cat.# 21062
For split applications	cat.# 21063
For all HP GCs	cat.# 21064
Kits for 1/16" OD, 1mm ID columns	
For valve applications	cat.# 21065
For direct injections	cat.# 21066
Kits for 1/8" OD, 2mm ID columns	
For valve applications	cat.# 21067

Ultra Aqueous C18 HPLC Column



Reversed-phase analysis of polar compounds

by Terry Reid, HPLC R&D Chemist

- ✔ Permits use of highly aqueous mobile phases
- ✔ Enhanced retention and selectivity for polar analytes
- ✔ Excellent base deactivation

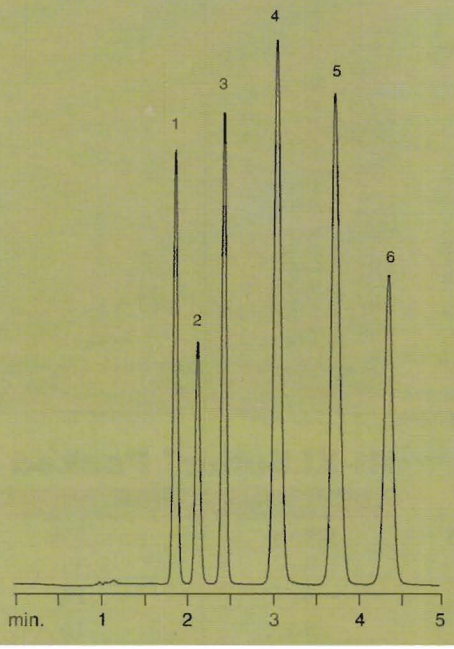
Highly polar compounds such as short-chain organic acids, nucleotides, catecholamines, and water-soluble vitamins are difficult to retain using conventional reversed phase columns, even with little or no organic solvent in the mobile phase. The Ultra Aqueous C18 column enhances the retention of polar analytes, while maintaining a high level of base deactivation and a selectivity that is similar to a conventional C18 column. Six organic acids that are difficult to retain using many conventional C18 columns can be well retained on the Ultra Aqueous C18 column (Figure 1)

The unique qualities of the Ultra Aqueous C18 column are apparent when comparing this column to the Ultra C18 column—a highly retentive, well-deactivated, general-purpose C18 column—in a separation of polar compounds The Ultra Aqueous C18 column has very similar retention and selectivity to the Ultra C18 column when analyzing neutral, hydrophobic compounds While phenol, a neutral polar compound, is retained similarly by both columns (Figure 2), the basic compound pyridine is retained approximately 2.5 times longer on the Ultra Aqueous C18 column Also note that, in spite of its greater retention, pyridine elutes from the Ultra Aqueous C18 column as a relatively symmetrical peak (pyridine is commonly used as a test probe for column base deactivation) This proves that enhanced retention for polar compounds is achieved on the Ultra Aqueous C18 column without sacrificing base deactivation.

The Ultra Aqueous C18 column is designed using Type B, high-purity silica, and a novel bonding chemistry that produces a true C18 phase (USP L1) with alkyl chains that remain completely extended, even when continually exposed to a highly aqueous mobile phase. This is because polar groups on the silica surface keep the stationary phase wetted. The unique secondary polar character prevents chain folding (i.e., the hydrophobic C18 chains do not self-associate or "fold down" onto the silica surface to avoid associating with a very hydrophilic mobile phase), and enhances the retention and selectivity of polar compounds without compromising the level of base deactivation. Ultimately, this means that the Ultra Aqueous C18 column offers stable and reproducible retention, even with 100% aqueous mobile phases.

Figure 1

Small, highly polar, carboxylic acids are retained well on the Ultra Aqueous C18 column.



Peak List:	Sample Conc.: (µg/mL)
1. malonic acid	500
2. lactic acid	500
3. acetic acid	1000
4. citric acid	1000
5. succinic acid	2000
6. fumaric acid	10

Sample:	All analytes dissolved in HPLC grade water.
Inj.:	10µL
Column:	**Ultra Aqueous C18**
Catalog #:	9178565
Dimensions:	150 x 4.6mm
Particle Size:	5µm
Pore Size:	100Å
Conditions:	
Mobile Phase:	pH2.5 50mM Potassium Phosphate:Acetonitrile 99:1
Flow:	1.5mL/min.
Temp.:	25°C
Det.:	UV @ 210nm

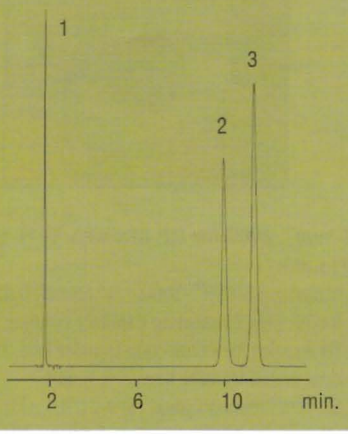
Ultra Aqueous C18 HPLC Columns, 5µm

Particle Size: 5µm length	1.0mm ID cat.#	2.1mm ID cat.#	3.2mm ID cat.#	4.6mm ID cat.#
30mm	9178531	9178532	9178533	9178535
50mm	9178551	9178552	9178553	9178555
100mm	9178511	9178512	9178513	9178515
150mm	9178561	9178562	9178563	9178565
200mm	9178521	9178522	9178523	9178525
250mm	9178571	9178572	9178573	9178575

Figure 2

The Ultra Aqueous C18 column provides enhanced retention of pyridine while maintaining a high level of base deactivation.

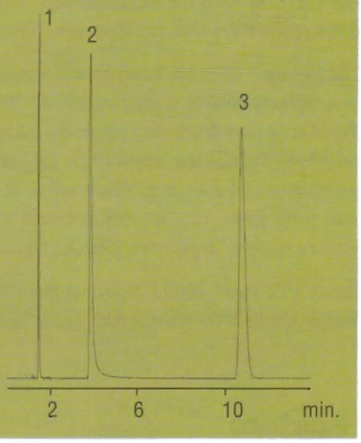
Ultra Aqueous C18 (cat.# 9178565)
Dimensions: 150x4.6mm; **Particle Size:** 5µm;
Pore Size: 100Å



Peak List:
1. uracil
2. pyridine
3. phenol

Conditions:
Mobile Phase: 80:20 pH 7.0, 20mM potassium phosphate acetonitrile
Flow: 1.0mL/min.
Temp: 25°C
Det.: UV@254nm

Base-deactivated C18
Dimensions: 150x4.6mm; **Particle Size:** 5µm;
Pore Size: 100Å



Restek is your free technical literature source!

Call 814-353-1300 or 800-356-1688, ext. 5, or contact your local Restek representative.

Restek's new, 68-page **HPLC Columns and Accessories Catalog** features Restek's complete line of HPLC columns and accessories, along with helpful tech tips and over 75 application chromatograms. Chemists will find the column selection and US Pharmacopoeia sections useful. Request yours today! (lit. cat# 59241)

To access HPLC literature and applications **on-line**, go to www.restekcorp.com/library.htm.

HPLC Application Notes

Improved HPLC Analysis of Analgesics (#59511)
The Ultra IBD Column Allows HPLC Separation of Polar and Non-Polar Analytes from the Same Sample (#59512)
HPLC Stationary Phase Selection for the Analysis of Steroids (#59510)
Allure™ PFP Propyl HPLC Column Provides Improved LC/MS Analyses of Basic Compounds (#59118A)

HPLC Fast Facts

HPLC Mobile Phase Accessories (#59728)
Trident™ Integral HPLC Guard Column System (#59896)
HPLC and LC/MS Column Kits (#59302)
Allure™ Acidix HPLC Columns (#59303)
Trident™ Direct Guard Column System (#59314)
Ultra IBD HPLC Columns (#59614A)

Restek's **HPLC Tech Tips Wall Chart** (lit. cat.# 59894) features step-by-step instructions on HPLC setup and storage. The chart also includes quick reference tables on miscibility and solubility, pressure conversion factors, buffers and other valuable tips to enhance your chromatography.

EZ-Vent™ 2000

Saving you time and money when you switch columns in your MS*

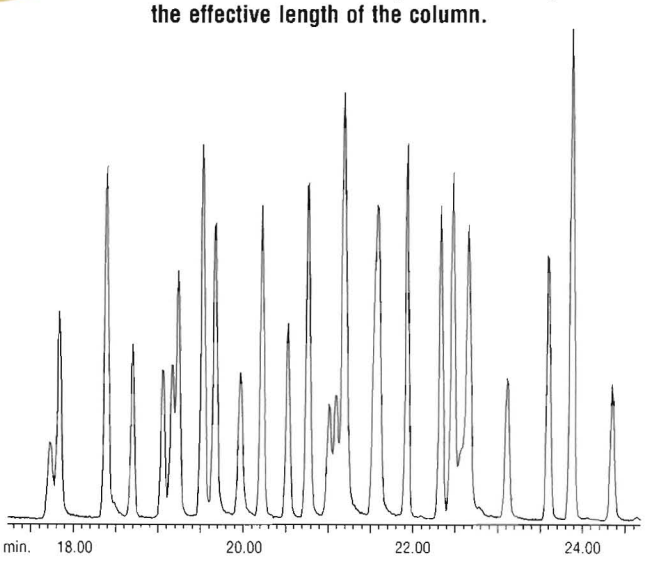
We designed a common sense, affordable solution to the hassle of changing columns in your mass spectrometer (MS). By using the Restek EZ-Vent™ 2000 interface, you can avoid the typical, lengthy vent and pump-down cycles every time you change a column.

The EZ-Vent™ 2000 MS interface will revolutionize the way you connect columns to your MS. When the outlet of a capillary column is inserted into an MS vacuum, the negative pressure propagates several meters inside the column thus decreasing efficiency. Using the EZ-Vent™ 2000 interface minimizes this effect, thereby increasing the effective length of the column. The EZ-Vent™ 2000 interface does not require any additional plumbing and works on a critical orifice principle, thereby eliminating the need to plumb your MS interfaces with purge gases. Plus, it's easy to install! Just connect the EZ-Vent™ 2000 transfer line and connectors and you are ready to begin using your MS without worry of pumping it down during the next column change.

Restek's EZ-Vent™ 2000 interface is available for Hewlett-Packard GCs with a 5971/5972 or 5973 MS and Varian Saturn 2000 systems with 3400, 3600, or 3800 GCs.

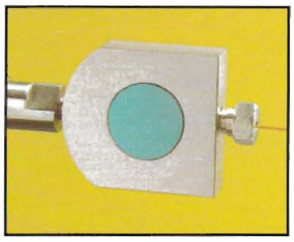
Feature	Benefit
Decreased column changing time.	Saves time.
Cost effective.	Costs associated with cool-downs and venting are now investments in analytical runs.
Less Expensive.	Save money compared to other models with equal performance.
Very low dead volume fittings and small ID tubing.	Ensure no band broadening or change in analytical performance.
All metal components are Silcosteel®-coated and transfer lines are deactivated for maximum inertness.	Less adsorption or loss of reactive compounds = more accurate analyses.

Figure 1 **The EZ-Vent™ interface causes no peak broadening and increases the effective length of the column.**



30m, 0.25mm ID, 0.5µm Rtx®-5MS (cat.# 12638)
4mm single gooseneck liner with fused silica wool (cat.# 22405)
Inj.: 50ng/µL semivolatile standard; **Oven temp.:** 35°C (hold 1 min.) to 300°C @ 10°C/min. (hold 20 min.); **Splitless hold time:** 1 min.; **Inj. temp.:** 300°C; **Det. temp.:** 310°C; **Det.:** HP 5971A MS, full scan; **Carrier gas:** helium @ 15psi

* Available for HP GCs with a 5971/5972 or 5973 MS and Varian Saturn 2000 systems with 3400, 3600, or 3800 GCs.



EZ-Vent™ 2000 for HP GCs with 5971/5972 or 5973 MS:
Includes EZ-Vent™ 2000, 1/16" SS nut, 0.4mm ID ferrules for connecting capillary column, 0.4mm ID ferrules for connecting transfer line, 100µm deactivated transfer line (3 ft.), and EZ-Vent™ column plug; cat.# 21013, (kit)

EZ-Vent™ 2000 for Varian Saturn 2000 systems with 3400, 3600, or 3800 GCs:
Includes EZ-Vent™ 2000, 1/16" SS nut, 0.4mm ferrules for connecting capillary column, 0.4mm ID ferrules for connecting transfer line, 100µm deactivated transfer line (3 ft.), and EZ-Vent™ column plug; cat.# 21014, (kit)

Replacement EZ-Vent™ 2000 ferrules for connecting capillary column to EZ-Vent™:
0.4mm ID: cat.# 21015, (2-pk.)
0.5mm ID: cat.# 21016, (2-pk.)

Replacement EZ-Vent™ 2000 ferrules for connecting transfer line to EZ-Vent™:
0.4mm ID: cat.# 21043, (2-pk.)

Replacement EZ-Vent™ 2000 union:
cat# 21017, (ea.)

Replacement EZ-Vent™ 2000 deactivated transfer line :
100µm: cat.# 21018, (3 ft.)

Open-end wrench tool (1/4"- & 5/16"-inch):
cat.# 20110, (2-pk.)

Replacement EZ-Vent™ column nut:
cat.# 21072, (2-pk.)

for more info

Request the *EZ-Vent™ 2000 Fast Facts* (lit. cat.# 59307).

Recently, your feedback on the EZ-Vent™ 2000 has been invaluable in solving column switching problems in MS instruments. Restek is committed to being the source of solutions for your analytical problems. This philosophy is at the core of all services and products that Restek offers. During the development cycle of a product, our Innovation Teams focus on addressing customer needs and making the product easy to use. We solicit input from analysts and use extensive beta testing to prove product design and technology.

Peak Performers

Precision™ Inlet Liners (Formerly called Focal liners)

- ✔ Wool is placed at the injection point to maximize vaporization and help wipe the needle during injection.
- ✔ Designed for easy changing of the wool—no more guessing where the wool should be placed.
- ✔ Wool stays in position during pressure pulses in the inlet and during injection.
- ✔ Available with all Restek deactivations and packing materials.
- ✔ Direct replacement for SGE's Focus™ liners.

Instrument	each	5-pk.
HP 5890/6890 4mm Split Precision™ Liner	21022	21023
Varian 1078/1079 Split Precision™ Liner	21024	21025
Shimadzu 17A Split Precision™ Liner	21020	21021
Varian 1075/1077 Split Precision™ Liner	21030	21031
Fisons, Trace, 8000 Series 5mm Split Precision™ Liner	21028	21029
PE Auto SYS Split Precision™ Liner	21026	21027

Encapsulated Ferrules

- ✔ Aluminum encapsulated.
- ✔ Will not deform and stick in fittings.
- ✔ Allows ferrule to be reused.
- ✔ Less torque needed to seal ferrule.
- ✔ Unique blend of graphite minimizes fragmentation and outgassing.
- ✔ For 1/16" compression fittings.

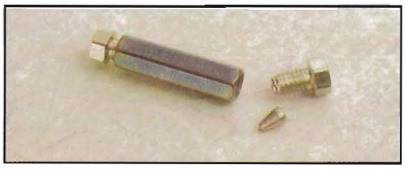
Ferrule ID	Fits column ID	cat.#	10-pk.
0.4mm	0.25mm	21036	
0.5mm	0.32mm	21037	
0.8mm	0.53mm	21038	

MXT® Connectors

- Stainless steel construction means no more breakage.
- Silcosteel®-treated for inertness, causes no peak tailing.
- Low dead volume minimizes peak tailing.
- Connects metal capillary tubing to fused silica capillary tubing.
- 1/32" union uses metal ferrules with metal tubing, Valcon polyimide ferrules for connecting fused silica tubing.

MXT® Connector: **for 0.28mm ID columns:** cat.# 20397 (ea.)
for 0.53mm ID columns: cat.# 20394 (ea.)

MXT® "Y" Connector: **for 0.28mm ID columns:** cat.# 20396 (ea.)
for 0.53mm ID columns: cat.# 20395 (ea.)



Connector Replacement Nut and Ferrules

1/32" Replacement Nut: cat.# 20389 (5-pk.)
1/32", 0.4mm Vespel®/graphite ferrule, for use with fused silica tubing in an MXT® connector: cat.# 21039 (5-pk.)
1/32", 0.5mm Vespel®/graphite ferrule, for use with fused silica tubing in an MXT® connector: cat.# 20259 (5-pk.)

1/32" Stainless Steel Replacement Ferrules for MXT® Connectors

Ferrule ID	Fits Column	cat.#	10-pk.
0.59mm	0.28mm ID	20398	
0.79mm	0.53mm ID	20399	

Valco® One-Piece Fused Silica Adaptors

- For use in fittings where the ferrule will not be removed.
- Valcon polyimide for use up to 350°C.
- Compatible with fused silica capillary columns in MXT® connectors.

1/32" Adaptor, 5-pk.

Tubing OD (mm)	Tubing ID (mm)	Valco® #	Valcon Polyimide
0.25–0.4	0.25	FS.4-5	20137, (5-pk.)
0.4–0.5	0.32	FS.5-5	20140, (5-pk.)
0.5–0.8	0.53	FS.5V-5	20141, (5-pk.)

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