

### Versatile GC Columns for Forensics

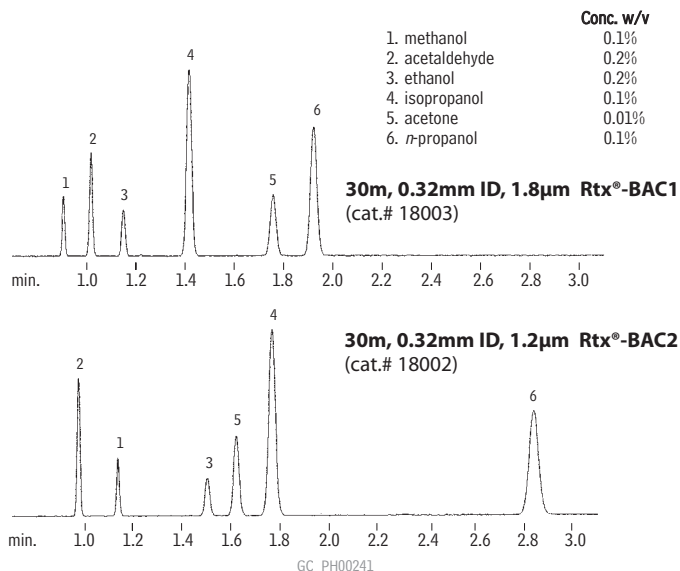
Use an Rtx®-BAC1 / Rtx®-BAC2 Column Set To Evaluate Blood Alcohol, Abused Substances, and Other Materials

By Kristi Sellers, Clinical/Forensic Innovations Chemist

- Unique column set for resolving/ confirming abused substances.
- 3-minute analysis for blood alcohols.
- Reliable data for ethylene glycol or GHB.

Analytical toxicology laboratories assist in criminal investigations by performing analyses for abused substances or poisons. Additional responsibilities include testing for accelerants or explosive materials in investigations of fires or explosions and assessing occupational/environmental exposure. Volatile and non-volatile compounds commonly tested for include blood alcohols, alkyl nitrites, anesthetics, inhalants, glycols, gamma-hydroxybutyrate (GHB), industrial solvents, petroleum hydrocarbons, and nitrogen-containing explosives.

**Figure 1** Baseline resolution of all blood alcohol components in less than 3 minutes, using Rtx®-BAC1 and Rtx®-BAC2 columns.



Dual-column analysis using a two-hole ferrule.

1.0mL headspace sample of a blood alcohol mix on a PerkinElmer HS 40 headspace autosampler

Oven temp.:	40°C	Vial sampling time:	0.01 min.
Inj. temp.:	200°C	Transfer line:	0.32mm ID Hydroguard™ fused silica tubing
Carrier gas:	helium	Transfer line temp.:	200°C
Sample equilibration:	70°C, 15 min.	Injection port sleeve:	2mm ID
Vial pressure:	30psi	Split flow:	20mL/min.
Vial pressurization time:	0.15 min.		

### in this issue

Versatile GC Columns for Forensics .....	1
Optimized, 17-Minute GC Analysis of Semivolatiles .....	5
High-Speed Detailed Hydrocarbon Analysis .....	8
Rapidly Determine Benzene and Toluene in Gasolines .....	10
Rapid, Dual Column Analysis for Organochlorine Pesticides .....	11
New Analytical Reference Materials for Fuels, Accelerants .....	12
Superior Moisture Dry-Down and Corrosion Resistance .....	14
Simple HPLC Analysis for Sudan Dyes .....	16
Enhanced Electronic Leak Detector .....	17
Genuine Restek HPLC Parts and Accessories .....	18
Genuine Restek Supplies & Accessories for ASE® Systems .....	20
Syringe Filters .....	21
Bulk Adsorbents .....	21
Instrument Innovations .....	22
Cool Tools .....	23
www.restek.com/expert .....	24

#### Where We'll Be in October

##### October 17-21, 2005

Society of Forensic Toxicologists (SOFT), Renaissance Nashville Hotel, Nashville, TN, booth #19

##### October 18-20, 2005

Gulf Coast Conference, Moody Gardens Convention Center, Galveston Island, TX

Help Us Celebrate Our 20th Birthday! Visit us at Booth 707, and receive a FREE Restek 20th Anniversary Travel Mug and Tote Bag!

##### October 25-27, 2005

ISA Expo 2005, McCormick Place Lakeside Center, Chicago, IL, booth #1322

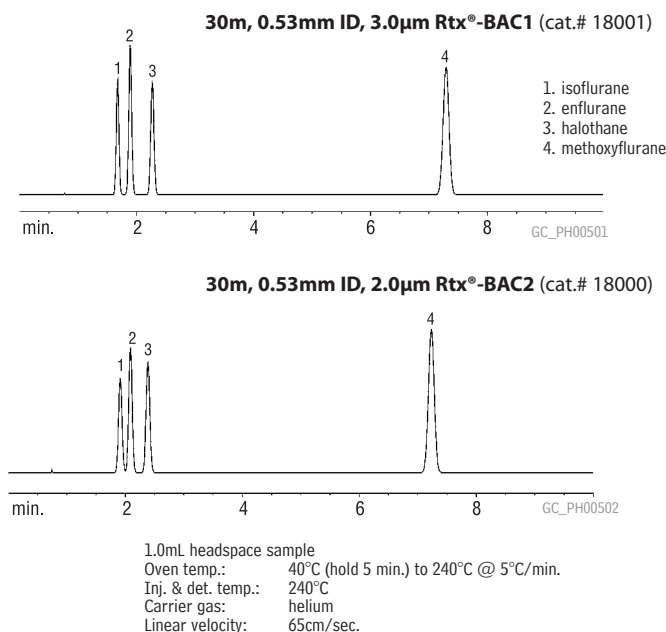
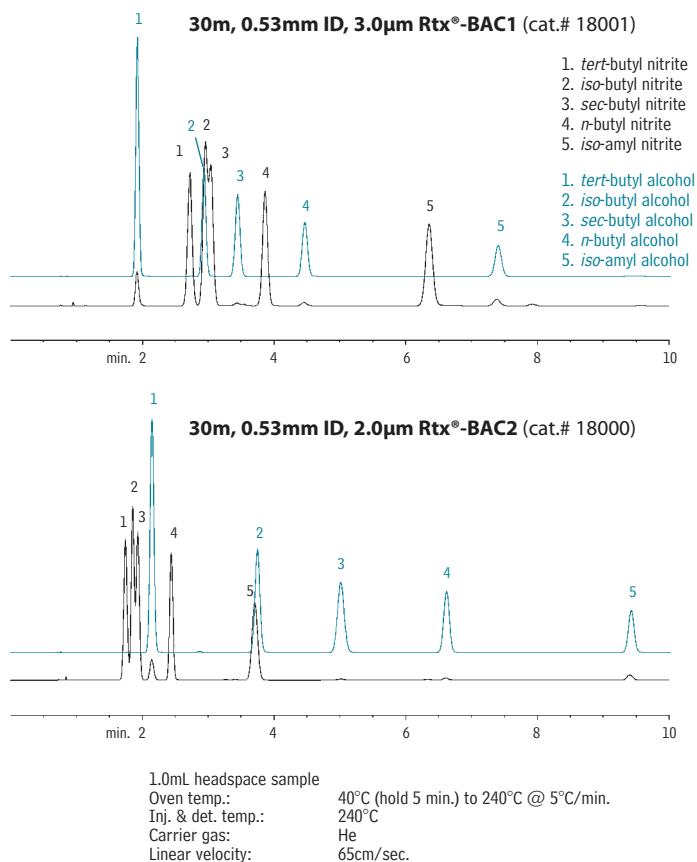
#### Correction

In *Advantage 2005v2*, page 11: Analysis of Nitrofurans in Honey. Mobile phase components A and B contain acetic acid, not formic acid. Honey samples containing nitrofurans metabolites were dissolved in 125mM HCl, derivatized with 2-nitrobenzaldehyde, extracted, evaporated, and reconstituted with mobile phase.

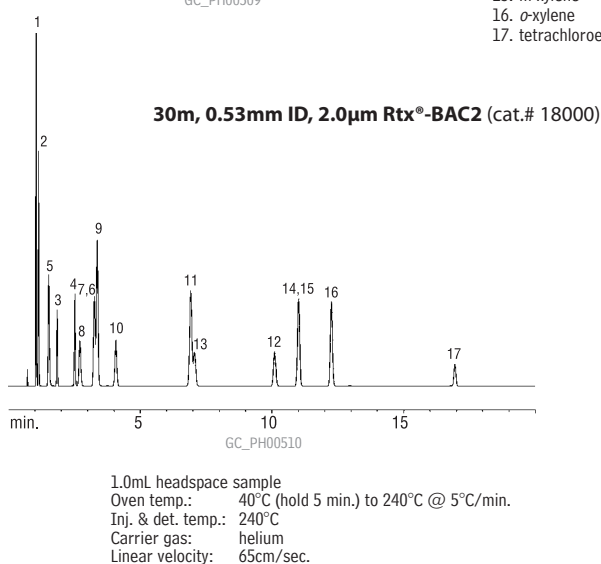
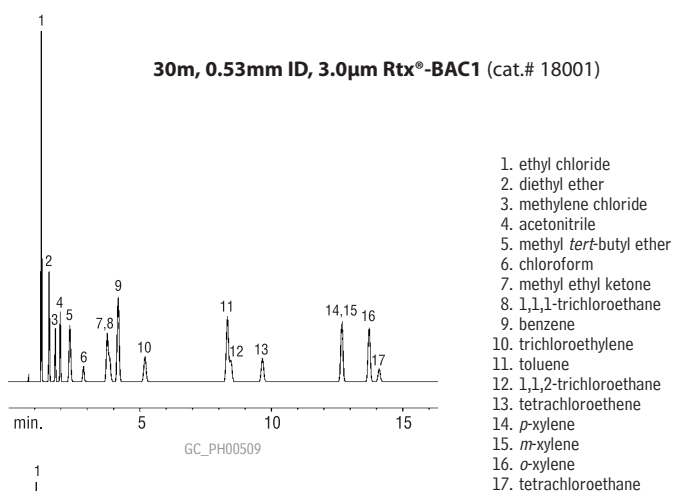
**Table I** Retention Times for Abused Substances

Compound	Rtx®-BAC1		Rtx®-BAC2	
	Elution Order	Ret. Time (min.)	Elution Order	Ret. Time (min.)
methanol	1	1.017	5	1.237
acetaldehyde	2	1.146	1	1.063
ethyl chloride	3	1.275	2	1.071
ethanol	4	1.299	8	1.648
diethyl ether	5	1.574	4	1.167
isopropanol	6	1.607	15	1.945
isoflurane	7	1.661	13	1.922
methylene chloride	8	1.805	11	1.849
Freon® 113	9	1.864	3	1.145
enflurane	10	1.891	16	2.081
<i>tert</i> -butyl alcohol	11	1.926	17	2.154
acetone	12	1.992	10	1.787
acetonitrile	13	1.997	20	2.553
<i>n</i> -propanol	14	2.191	25	3.130
halothane	15	2.267	18	2.383
methyl <i>tert</i> -butyl ether	16	2.366	7	1.554
hexane	17	2.495	6	1.386
<i>tert</i> -butyl nitrite	18	2.736	9	1.750
chloroform	19	2.870	27	3.290
<i>sec</i> -butyl alcohol	20	2.962	30	3.793
isobutyl nitrite	21	2.973	12	1.853
<i>sec</i> -butyl nitrite	22	3.059	14	1.939
isobutyl alcohol	23	3.460	32	5.100
tetrahydrofuran	24	3.736	24	2.845
methyl ethyl ketone	25	3.768	26	3.271
ethyl acetate	26	3.800	23	2.785
carbon tetrachloride	27	3.842	21	2.565
1,1,1-trichloroethane	28	3.869	22	2.729
<i>n</i> -butyl nitrite	29	3.879	19	2.469
benzene	30	4.186	28	3.392
<i>n</i> -butyl alcohol	31	4.565	33	6.747
trichloroethylene	32	5.205	31	4.084
isoamyl nitrite	33	6.377	29	3.728
methoxyflurane	34	7.279	36	7.219
isoamyl alcohol	35	7.428	38	9.447
toluene	36	8.358	34	6.944
1,1,2-trichloroethane	37	8.498	39	10.138
methyl isobutyl ketone	38	9.510	37	7.964
tetrachloroethylene	39	9.681	35	7.081
chlorobenzene	40	11.810	41	11.012
ethylbenzene	41	12.279	40	10.704
<i>p</i> -xylene	42	12.726	42	11.038
<i>m</i> -xylene	43	12.727	43	11.046
<i>o</i> -xylene	44	13.733	44	12.280
tetrachloroethane	45	14.106	50	16.968
isopropylbenzene	46	14.845	46	12.962
<i>n</i> -propylbenzene	47	15.966	47	14.124
1,3,5-trimethylbenzene	48	16.565	48	14.711
decane	49	17.166	45	12.369
1,2,4-trimethylbenzene	50	17.586	49	15.904
butylbenzene	51	19.739	51	17.732
tetradecane	52	29.806	52	24.950

30m, 0.53mm ID, 3.0µm Rtx®-BAC1 (cat.# 18001) and  
 30m, 0.53mm ID, 2.0µm Rtx®-BAC2 (cat.# 18000).  
 1.0mL headspace sample  
 Oven temp.: 40°C (hold 5 min.) to 240°C @ 5°C/min.  
 Inj. & det. temp.: 240°C  
 Carrier gas: He  
 Linear velocity: 65cm/sec.

**Figure 2** Rapid analysis for volatile anesthetics using Rtx®-BAC1 and Rtx®-BAC2 columns.**Figure 3** Screen for and confirm alkyl nitrites and metabolites on Rtx®-BAC1 and Rtx®-BAC2 columns.

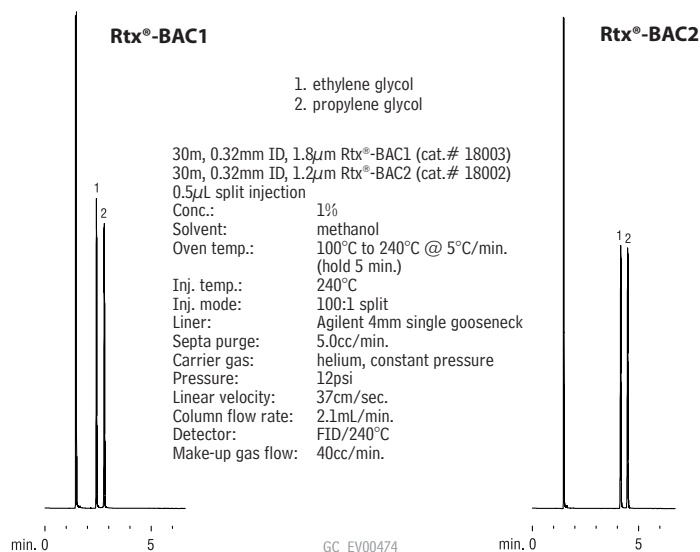
**Figure 4** Elution order changes for common industrial solvents on Rtx®-BAC1 and Rtx®-BAC2 columns.



### Blood Alcohol Standards

Compound	qty.	cat.#
<b>0.015g/dL forensic ethanol solution</b>		
1mL/ampul	5-pk.	36232
1mL/ampul	10-pk.	36332
5mL/ampul	ea.	36240
20mL/ampul	ea.	36248
<b>0.02g/dL forensic ethanol solution</b>		
1mL/ampul	5-pk.	36233
1mL/ampul	10-pk.	36333
5mL/ampul	ea.	36241
20mL/ampul	ea.	36249
<b>0.025g/dL forensic ethanol solution</b>		
1mL/ampul	5-pk.	36234
1mL/ampul	10-pk.	36334
5mL/ampul	ea.	36242
20mL/ampul	ea.	36250
<b>0.04g/dL forensic ethanol solution</b>		
1mL/ampul	5-pk.	36235
1mL/ampul	10-pk.	36335
5mL/ampul	ea.	36243
20mL/ampul	ea.	36251
<b>0.05g/dL forensic ethanol solution</b>		
1mL/ampul	5-pk.	36257
1mL/ampul	10-pk.	36259
5mL/ampul	ea.	36258
20mL/ampul	ea.	36260
<b>0.08g/dL forensic ethanol solution</b>		
1mL/ampul	5-pk.	36262
1mL/ampul	10-pk.	36264
5mL/ampul	ea.	36263
20mL/ampul	ea.	36265
<b>0.1g/dL forensic ethanol solution</b>		
1mL/ampul	5-pk.	36236
1mL/ampul	10-pk.	36336
5mL/ampul	ea.	36244
20mL/ampul	ea.	36252
<b>0.15g/dL forensic ethanol solution</b>		
1mL/ampul	5-pk.	36237
1mL/ampul	10-pk.	36337
5mL/ampul	ea.	36245
20mL/ampul	ea.	36253
<b>0.2g/dL forensic ethanol solution</b>		
1mL/ampul	5-pk.	36238
1mL/ampul	10-pk.	36338
5mL/ampul	ea.	36246
20mL/ampul	ea.	36254
<b>0.3g/dL forensic ethanol solution</b>		
1mL/ampul	5-pk.	36239
1mL/ampul	10-pk.	36339
5mL/ampul	ea.	36247
20mL/ampul	ea.	36255
<b>0.4g/dL forensic ethanol solution</b>		
1mL/ampul	5-pk.	36266
1mL/ampul	10-pk.	36268
5mL/ampul	ea.	36267
20mL/ampul	ea.	36269

**Figure 5** Glycols of forensic interest on Rtx®-BAC1 and Rtx®-BAC2 Columns.



### Blood Alcohol Mix Resolution

#### Control Standard (8 components)

acetaldehyde	ethyl acetate
acetone	isopropanol
acetonitrile	methanol
ethanol (NIST certified value)	methyl ethyl ketone
0.100g/dL each in water, 1mL/ampul	
cat. # 36256 (ea.)	

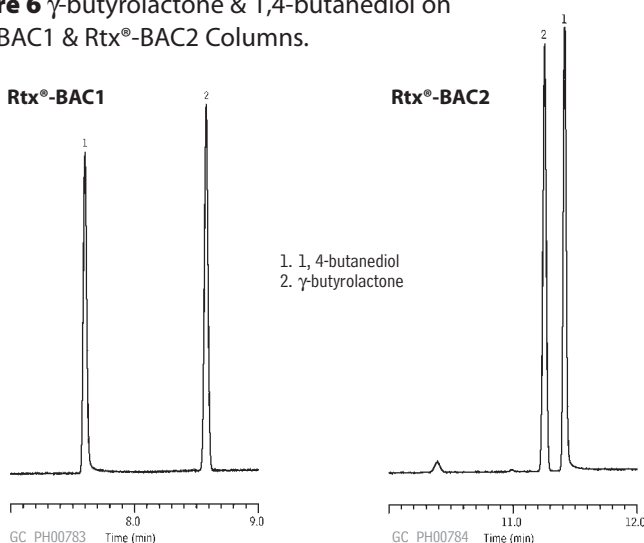
We designed Rtx®-BAC1 and Rtx®-BAC2 columns for blood alcohol analysis by headspace GC/FID (Figure 1), but many other materials of forensic interest also can be analyzed and confirmed using this column pair in a headspace GC/FID system, including inhalant anesthetics, alkyl nitrites, glycols, industrial solvents, and petroleum hydrocarbons. The substances in these target groups are resolved to baseline on one column or the other. Inhalants (Figure 2) or alkyl nitrites and their alcohol metabolites (Figure 3), for example, show excellent resolution and responses, and symmetrical peak shapes, in short analysis times. Similarly, performance is excellent for common industrial solvents (Figure 4). Retention times for many compounds of interest are presented in Table 1.1

For the analysis and confirmation of blood alcohols or other materials on Rtx®-BAC1 and Rtx®-BAC2 columns, we use a GC/FID equipped with a headspace autosampler that simultaneously introduces sample onto the two analytical columns. This dual column technique increases throughput by providing screening and confirmation data from a single injection. By using 0.32mm ID columns and a high carrier gas flow rate, we achieve baseline resolution of blood alcohol compounds in less than 3 minutes (Figure 1).

Other abused substances of interest, such as gamma-hydroxybutyrate (GHB, the "date rape drug"), and poisons, such as ethylene glycol, typically are analyzed from liquid injections. The Rtx®-BAC1 / Rtx®-BAC2 dual column system coupled with FID assures excellent responses and peak shapes for ethylene glycol and propylene glycol (Figure 5) or for GHB (Figure 6), which usually is converted to gamma-butyrolactone (GBL) for the analysis.

By analyzing these abused substances and poisons simultaneously on Rtx®-BAC1 and Rtx®-BAC2 columns, compounds coeluting on one stationary phase are resolved on the complementary stationary phase, and analytical and confirmation data are obtained in half the time required with sequential injections. Analytes characteristically are eluted with excellent responses and peak shapes. These example applications establish dual column analysis and confirmation on Rtx®-BAC1 and Rtx®-BAC2 columns as a very useful and highly adaptable forensics technique.

**Figure 6**  $\gamma$ -butyrolactone & 1,4-butanediol on Rtx®-BAC1 & Rtx®-BAC2 Columns.



Column: Rtx®-BAC1 30m, 0.32 mm ID, 1.8 $\mu$ m (cat.# 18003) and Rtx®-BAC2 30m, 0.32 mmID, 1.2 $\mu$ m (cat.# 18002)  
 Sample: 100 $\mu$ g/mL each  $\gamma$ -butyrolactone (GBL) and 1, 4-butanediol in methanol  
 Inj.: 1.0 $\mu$ L split (split ratio 1:10), 4mm single gooseneck inlet liner with wool (cat. # 22405)  
 Inj. Temp.: 240°C  
 Carrier Gas: helium, constant flow  
 Flow Rate: 3.0mL/min.  
 Oven Temp.: 50°C to 240°C @ 10°C/min. (hold 2 min.)  
 Det.: FID @ 240°C



#### Rtx®-BAC1 Columns (fused silica)

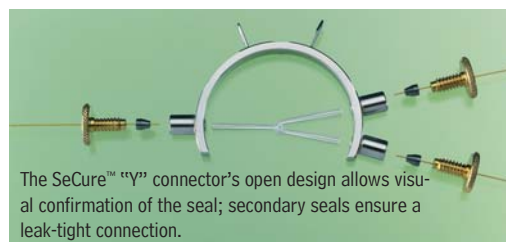
ID	df ( $\mu$ m)	temp. limits	length	cat. #
0.32mm	1.80	-20 to 240/260°C	30-Meter	18003
0.53mm	3.00	-20 to 240/260°C	30-Meter	18001

#### Rtx®-BAC2 Columns (fused silica)

ID	df ( $\mu$ m)	temp. limits	length	cat. #
0.32mm	1.20	-20 to 240/260°C	30-Meter	18002
0.53mm	2.00	-20 to 240/260°C	30-Meter	18000

#### SeCure™ "Y" Connector Kit

SeCure™ "Y" connector body, 3 knurled nuts, "Y" Universal Press-Tight® union, 3 ferrules.



The SeCure™ "Y" connector's open design allows visual confirmation of the seal; secondary seals ensure a leak-tight connection.

Description	Ferrules Fit Column ID	qty.	cat.#
Connector Kit	0.28/0.32mm	kit	20277

#### Intermediate-Polarity Deactivated Guard Columns/Transfer Lines

Nominal ID	Nominal OD	5-Meter
0.32mm	0.45 $\pm$ 0.04mm	10044
0.53mm	0.69 $\pm$ 0.05mm	10045

<sup>1</sup>For more information about analyses of anesthetics, or for analyses of petroleum hydrocarbons, please request Application Note 59548 or 59574, respectively.

#### additional reading

*Clarke's Analysis of Drugs and Poisons*, Third Edition, A.C. Moffat, M.D. Osselton and B. Widdop (editors), Pharmaceutical Press, 2004.

*Drug-Facilitated Sexual Assault: A Forensic Handbook*, Marc A. LeBeau and Ashraf Mozayani, Academic Press, 2001

*Handbook of Forensic Drug Analysis*, Frederick P. Smith and Jay A. Siegel (editors), Academic Press, 2004



# Optimized, 17-Minute GC Analysis of Semivolatiles

Using a 0.25mm ID Rtx®-5Sil MS Column

By Christopher English, Innovations Group Leader

- Excellent column for many methods, including US EPA methods 8270, 625, and 525.
- Greater on-column sample capacity, longer lifetimes than columns with thinner phase films.
- Analysis optimized for scanning mass spectrometers (ion trap or quadrupole).

Restek Innovations chemists have evaluated many combinations of stationary phase, column dimensions, and analytical conditions for analyzing environmental semivolatile compounds such as those listed in US Environmental Protection Agency Method 8270. Using a typical benchtop quadrupole mass spectrometer, we have achieved a 15-minute analysis, while maintaining a scan rate of at least 5 scans per target analyte.<sup>1</sup> Time-of-flight mass spectrometers (TOFMS) make analysis times under 9 minutes achievable,<sup>2</sup> because they can scan more than 100 times faster than quadrupole instruments.

After developing this analysis on a 0.18mm ID, 0.36µm column,<sup>3</sup> our chemists decided to experiment with a column of standard ID and phase film dimensions (0.25mm ID / 0.50µm film), in an attempt to establish a similarly rapid analysis on a larger bore column. The column they chose was a 30m x 0.25mm ID x 0.5µm Rtx®-5Sil MS column. The target compound list included our 8270 MegaMix™ and Appendix IX Mix #2 mixes, plus internal standards and surrogates—a total of 117 compounds. Advantages of using a 0.25mm ID column with a 0.5µm phase film include increased sample capacity and longer column lifetime, combined with rapid analyses.

## Injection Port Optimization

The first step in the experiment was to optimize conditions in the injection port. We found that the inlet liner and seal remain inert longer when we inject only 0.5µL of sample into the injection port. This increases the number of passing calibration checks per liner and seal, and so reduces instrument downtime. The key to maintaining sensitivity when injecting smaller amounts of sample is to attain the most efficient sample transfer possible: we determined a 2mm ID inlet liner most efficiently transfers 0.5µL samples.

Splitless hold time also is important; a change of only several seconds can significantly affect the amount of sample ultimately delivered onto the column. We discovered that a pulsed splitless time, using a 0.4-minute pulse at 30psi (normal column backpressure is 8.8psi at 50°C), dramatically improves sample transfer onto the column. Making the pulse longer than the splitless hold time allows excess solvent to be swept away quickly and dramatically sharpens resolution of the early eluting Method 8270 Appendix IX compounds, such as 1,4-dioxane.

## Other Conditions

After optimizing conditions in the injection port, we adjusted other analytical conditions to deliver a fast, rugged analysis on a 0.25mm ID column. In combination, a constant flow of 1.1mL/min., a short initial hold time (0.5 min.) and a fast initial temperature ramp rate (25°C/min.) elute benzo(ghi)perylene in 16.5 minutes. The final temperature ramp rate is a relatively slow 4°C/min., to better resolve benzo(b)fluoranthene and benzo(k)fluoranthene.

With all conditions optimized, the 117 target compounds in our sample are well resolved by quantification ion in one analysis (Figure 1, page 6).

## 8270 MegaMix™ (76 components)

acenaphthene	2,4-dinitrophenol
acenaphthylene	2,4-dinitrotoluene
aniline	2,6-dinitrotoluene
anthracene	di- <i>n</i> -butyl phthalate
azobenzene**	di- <i>n</i> -octyl phthalate
benzo(a)anthracene	diphenylamine***
benzo(a)pyrene	fluorene
benzo(b)fluoranthene	fluoranthene
benzo(ghi)perylene	hexachlorobenzene
benzo(k)fluoranthene	hexachlorobutadiene
benzyl alcohol	hexachlorocyclopentadiene
benzyl butyl phthalate	hexachloroethane
bis 2-ethylhexyl adipate	indeno(1,2,3- <i>cd</i> )pyrene
bis(2-chloroethoxy)methane	isophorone
bis(2-chloroethyl)ether	1-methylnaphthalene
bis(2-chloroisopropyl)ether	2-methylnaphthalene
bis(2-ethylhexyl)phthalate	2-methylphenol
4-bromophenyl phenyl ether	3-methylphenol
carbazole	4-methylphenol
4-chloroaniline	naphthalene
4-chloro-3-methylphenol	2-nitroaniline
2-chloronaphthalene	3-nitroaniline
2-chlorophenol	4-nitroaniline
4-chlorophenyl phenyl ether	nitrobenzene
chrysene	2-nitrophenol
dibenzo(a,h)anthracene	4-nitrophenol
dibenzofuran	N-nitrosodimethylamine
1,2-dichlorobenzene	N-nitroso-di- <i>n</i> -propylamine
1,3-dichlorobenzene	pentachlorophenol
1,4-dichlorobenzene	phenanthrene
2,4-dichlorophenol	phenol
diethyl phthalate	pyrene
dimethyl phthalate	pyridine
2,4-dimethylphenol	2,3,4,6-tetrachlorophenol
1,2-dinitrobenzene	2,3,5,6-tetrachlorophenol
1,3-dinitrobenzene	1,2,4-trichlorobenzene
1,4-dinitrobenzene	2,4,5-trichlorophenol
4,6-dinitro-2-methylphenol	2,4,6-trichlorophenol

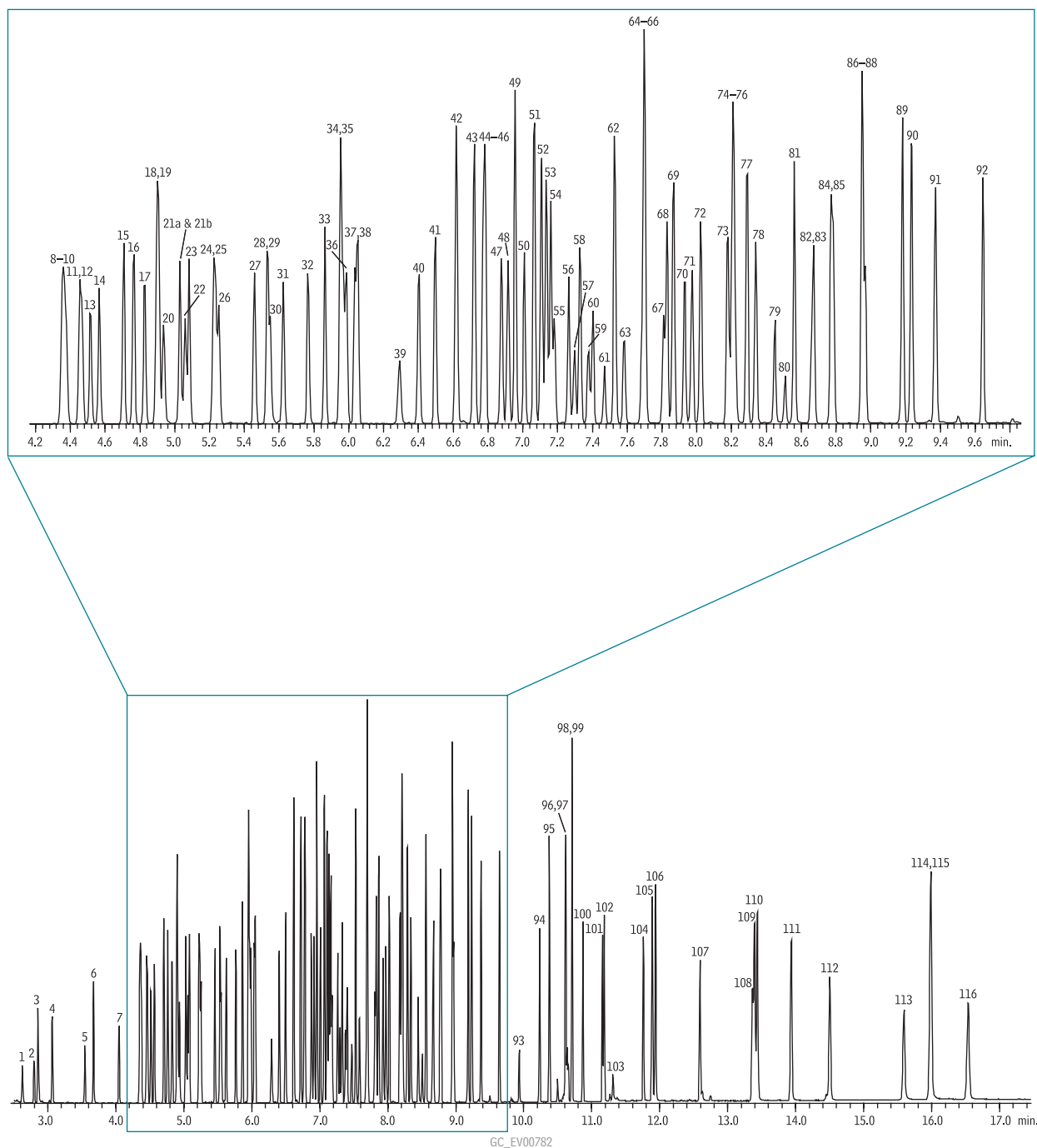
1,000µg/mL each in methylene chloride, 1mL/ampul\*  
cat. # 31850

\*3-methylphenol and 4-methylphenol concentration is 500µg/mL.

\*\*1,2-diphenylhydrazine (8270-listed analyte) decomposes to azobenzene (mix component).

\*\*\*N-nitrosodiphenylamine (8270-listed analyte) decomposes to diphenylamine (mix component).

**Figure 1** 117 semivolatile compounds rapidly eluted and well resolved using a 0.25mm ID x 0.50µm Rtx®-5Sil MS column.



1. 1,4-dioxane	39. ε-caprolactam	78. azobenzene
2. N-nitrosodimethylamine	40. 4-chloro-3-methylphenol	79. 2,4,6-tribromophenol
3. pyridine	41. isosafrole ( <i>cis</i> )	80. 1,3,5-trinitrobenzene
4. ethyl methacrylate	42. 2-methylnaphthalene	81. phenacetin
5. methyl methanesulfonate	43. 1-methylnaphthalene	82. diallate
6. 2-fluorophenol	44. hexachlorocyclopentadiene	83. 4-bromophenyl phenyl ether
7. ethyl methanesulfonate	45. isosafrole ( <i>trans</i> )	84. hexachlorobenzene
8. phenol-d6	46. 1,2,4,5-tetrachlorobenzene	85. atrazine
9. phenol	47. 2,4,6-trichlorophenol	86. pronamide
10. benzaldehyde	48. 2,4,5-trichlorophenol	87. pentachlorophenol
11. aniline	49. 2-fluorobiphenyl	88. pentachloronitrobenzene
12. bis(2-chloroethyl)ether	50. 2-chloronaphthalene	89. phenanthrene
13. pentachloroethane	51. biphenyl	90. anthracene
14. 2-chlorophenol	52. safrole	91. carbazole
15. 1,3-dichlorobenzene	53. 1-chloronaphthalene	92. di- <i>n</i> -butylphthalate
16. 1,4-dichlorobenzene	54. diphenyl ether	93. 4-nitroquinoline-N-oxide
17. benzyl alcohol	55. 2-nitroaniline	94. isodrin
18. 2-methylphenol	56. 1,4-naphthoquinone	95. fluoranthene
19. 1,2-dichlorobenzene	57. 1,4-dinitrobenzene	96. pyrene
20. bis(2-chloroisopropyl)ether	58. dimethylphthalate	97. benzidine
21a. 4-methylphenol	59. 1,3-dinitrobenzene	98. <i>p</i> -terphenyl-d14
21b. 3-methylphenol	60. 2,6-dinitrotoluene	99. Aramite
22. N-nitroso-di- <i>n</i> -propylamine	61. 1,2-dinitrobenzene	100. chlorobenzilate
23. acetophenone	62. acenaphthylene	101. benzyl butyl phthalate
24. hexachloroethane	63. 3-nitroaniline	102. bis(2-ethylhexyl)adipate
25. nitrobenzene-d5	64. 2,4-dinitrophenol	103. Kepone
26. nitrobenzene	65. acenaphthene	104. bis(2-ethylhexyl)phthalate
27. isophorone	66. 4-nitrophenol	105. benzo(a)anthracene
28. 2,4-dimethylphenol	67. 2,4-dinitrotoluene	106. chrysene
29. 2-nitrophenol	68. pentachlorobenzene	107. di- <i>n</i> -octyl phthalate
30. diallate (isomer)	69. dibenzofuran	108. 7,12-dimethylbenzo(a)anthracene
31. bis(2-chloroethoxy)methane	70. 2,3,5,6-tetrachlorophenol	109. benzo(b)fluoranthene
32. 2,4-dichlorophenol	71. 2,3,4,6-tetrachlorophenol	110. benzo(k)fluoranthene
33. 1,2,4-trichlorobenzene	72. diethyl phthalate	111. benzo(a)pyrene
34. naphthalene	73. 4-chlorophenyl phenyl ether	112. 3-methylcholanthrene
35. 4-chloroaniline	74. 4-nitroaniline	113. dibenzo(a,j)acridine
36. 2,6-dichlorophenol	75. fluorene	114. indeno(1,2,3- <i>cd</i> )pyrene
37. hexachloropropene	76. 4,6-dinitro-2-methylphenol	115. dibenzo(a,h)anthracene
38. hexachlorobutadiene	77. diphenylamine	116. benzo(ghi)perylene

Column: Rtx®-5Sil MS 30m, 0.25mm ID, 0.50µm (cat.# 12738)  
Sample: US EPA Method 8270D Appendix IX mix  
8270 MegaMix™ (cat.# 31850)  
Appendix IX Mix #2 (cat.#31806)  
Acid Surrogate Mix (4/89 SOW) (cat.# 31063)  
B/N Surrogate Mix (4/89 SOW) (cat.# 31062)  
Inj.: 0.5µL, splitless, 100ppm each compound (50ng on column)  
2mm Cyclo double gooseneck splitless inlet liner  
(cat.# 20907), 0.3 min. splitless hold time, 0.4 min.  
pressure pulse @ 30psi  
Inj. temp.: 250°C  
Carrier gas: helium, constant flow  
Flow rate: 1.1mL/min.  
Oven temp.: 50°C (hold 0.5 min.) to 310°C @ 25°C/min. (hold 0 min.)  
to 330°C @ 4°C/min. (hold 4 min.)  
Det.: MS  
Det. temp.: 280°C  
Transfer line  
temp.: 280°C  
Scan range: 35-550 amu  
Solvent Delay: 1 min.  
Tune: DFTPP  
Ionization: EI  
Instrument: Agilent 6890 / 5973

## Conclusions

Complex mixtures of semivolatiles can be resolved on an Rtx®-5Sil MS column in a conventional 30m x 0.25mm ID x 0.50µm configuration, without sacrificing the speed associated with shorter, thin phase film columns, and with greater sample capacity. Restek can provide the columns, reference mixes, inlet and other accessories, and technical help you need for reliable, problem-free analyses of semivolatiles by US EPA or other methodology.

## References

1. *Fast Analysis of Semivolatile Organic Analytes*, Restek Advantage, 2004, Vol.2 p.2.
  2. *Nine-Minute Analysis of Semivolatile Organic Compounds*, Restek Advantage, 2005, Vol.1 p. 8.
  3. *Fast GC/MS Analysis of Semivolatile Organic Compounds*, Restek Advantage, 2005, Vol 1 p. 14.
- References available on request.

## Appendix IX Mix #2 (32 components)

acetophenone	hexachloropropene
Aramite	isodrin
atrazine	isosafrole ( <i>cis</i> & <i>trans</i> )
benzaldehyde	kepone
biphenyl	3-methylcholanthrene
ε-caprolactam	methyl methanesulfonate
chlorobenzilate	1,4-naphthoquinone
1-chloronaphthalene	4-nitroquinoline-N-oxide
diallate	pentachlorobenzene
dibenzo(a,i)acridine	pentachloroethane
2,6-dichlorophenol	pentachloronitrobenzene
7,12-dimethylbenz(a)anthracene	phenacetin
1,4-dioxane	pronamide
diphenyl ether	safrole
ethyl methacrylate	1,2,4,5-tetrachlorobenzene
ethyl methanesulfonate	1,3,5-trinitrobenzene

1,000µg/mL each in methylene chloride, 1mL/ampul  
cat. # 31806

## Acid Surrogate Mix (4/89 SOW)

2-fluorophenol	2,4,6-tribromophenol
phenol-d6	

2,000µg/mL each in methanol, 1mL/ampul  
cat. # 31025

10,000µg/mL each in methanol, 1mL/ampul  
cat. # 31063

10,000µg/mL each in methanol, 5mL/ampul  
cat. # 31087

## B/N Surrogate Mix (4/89 SOW)

2-fluorobiphenyl	<i>p</i> -terphenyl-d14
nitrobenzene-d5	

1,000µg/mL each in methylene chloride, 1mL/ampul  
cat. # 31024

5,000µg/mL each in methylene chloride, 1mL/ampul\*  
cat. # 31062

5,000µg/mL each in methylene chloride, 5mL/ampul\*  
cat. # 31086

\*Requires warming and sonication before use.

## Rtx®-5Sil MS Columns (fused silica)

(Selectivity equivalent to Crossbond® 5% diphenyl / 95% dimethyl polysiloxane)

ID	df (µm)	temp. limits	length	cat. #
0.18mm	0.18	-60 to 325°C	20-Meter	42702
0.18mm	0.36	-60 to 330/350°C	20-Meter	42704
0.25mm	0.25	-60 to 330/350°C	30-Meter	12723
0.25mm	0.50	-60 to 330/350°C	30-Meter	12738

# High-Speed Detailed Hydrocarbon Analysis

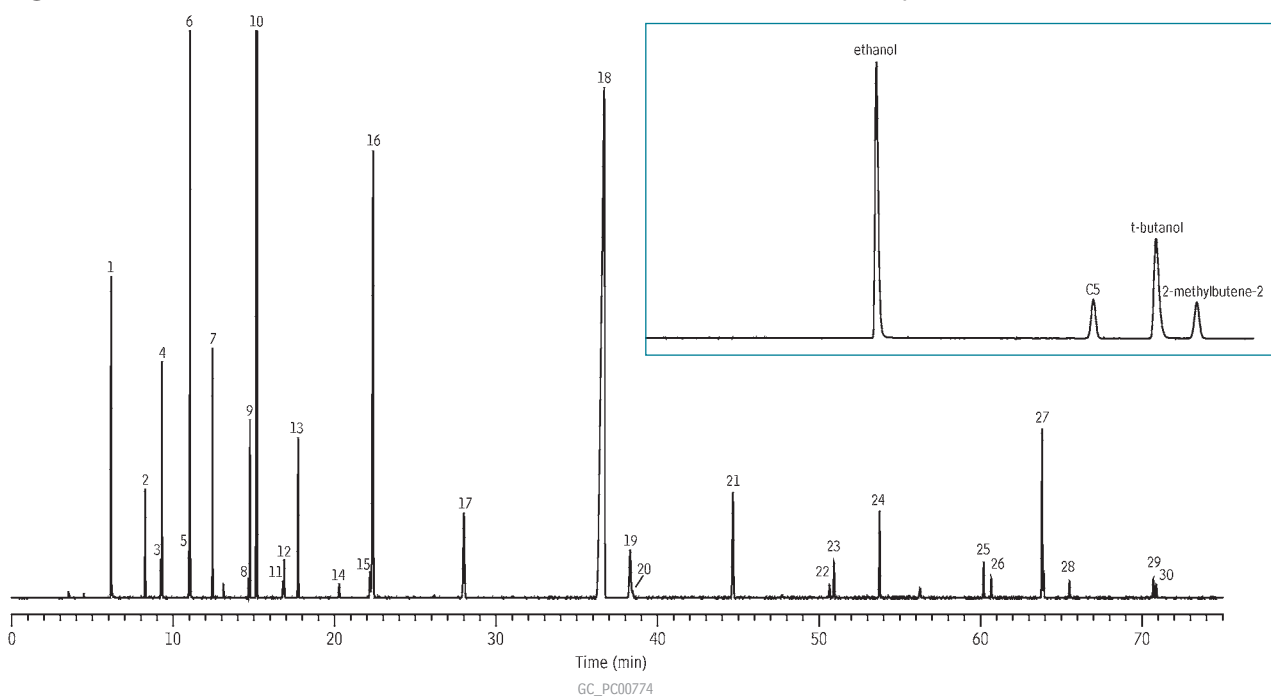
53% Faster Analysis, Using an Rtx®-1 PONA Column and Hydrogen Carrier Gas

By Barry Burger, Petroleum Applications Chemist

- C13 eluted within 70 minutes.
- Excellent response and peak symmetry for polar oxygenates.
- Column meets or exceeds all ASTM D-6730-01 and Canadian General Standards Board method requirements.
- Guaranteed column-to-column reproducibility.

American Society for Testing and Materials method D-6730-01 was designed specifically for determining the individual hydrocarbons in spark ignition fuels and fuel blends containing oxygenates such as methyl *tert*-butyl ether (MTBE), ethyl *tert*-butyl ether (ETBE), *tert*-butanol, and ethanol. To maximize the resolution of these complex mixtures, ASTM recommends a 100 meter x 0.25mm ID capillary column with a 0.5µm film of 100% dimethyl polysiloxane stationary phase as the primary analytical column. To control selectivity for the aromatic compounds, a short tuning column, typically 2-3 meters, containing a 5% diphenyl / 95% dimethyl polysiloxane stationary phase, is connected to the inlet of the primary column. To meet the demanding resolution and retention criteria in ASTM method D-6730-01, and in Canadian General Standards Board (CGSB) methodology for detailed hydrocarbon analysis (DHA), Restek Innovations chemists have reformulated our Rtx®-1PONA column.

**Figure 1** Rtx®-1PONA column meets ASTM D-6731-01 resolution and retention specifications.



Column: Rtx®-1PONA 100m, 0.25mm, 0.5µm (cat.# 10195) plus Rtx®-5PONA tuning column (cat.# 10196), connected via angled Press-Tight® connector (cat.# 20446)

Sample: DHA/oxygenates setup blend

Inj.: 0.01µL, split (split ratio 150:1), 4mm ID cup inlet liner (cat.# 20709)

A: front slice of DHA/oxygenates setup blend

B: DHA/oxygenates setup blend

Carrier gas: hydrogen, constant flow (3.62cc/min.)

Linear velocity: 55cm/sec.

Inj. temp.: 250°C

Oven temp.: A: 35°C  
B: 5°C (hold 8.32 min.) (elute C5) to 48°C @ 22°C/min. (hold 26.32 min.) (elute ethylbenzene) to 141°C @ 3.20°C/min. (no hold) (elute C12) to 300°C @ 1°C/min.

Det.: FID @ 300°C

**A: Front end of DHA/oxygenates setup blend**

C5 efficiency: 586,825 plates  
C5 k': 0.476  
*tert*-butanol skew: 2.10  
Resolution *tert*-butanol/  
2-methylbutene-2: 5.39

**B: DHA/oxygenates setup blend**

1. ethanol
2. C5
3. *tert*-butanol
4. 2-methylbutene-2
5. 2,3-dimethylbutane
6. methyl *tert*-butyl ether (MTBE)

7. C6
8. 1-methylcyclopentene
9. benzene
10. cyclohexane
11. 3-ethylpentane
12. 1,2-dimethylcyclopentane
13. C7
14. 2,2,3-trimethylpentane
15. 2,3,3-trimethylpentane
16. toluene
17. C8
18. ethylbenzene
19. *p*-xylene
20. 2,3-dimethylheptane
21. C9

22. 5-methylnonane
23. 1,2-methylethylbenzene
24. C10
25. C11
26. 1,2,3,5-tetramethylbenzene
27. naphthalene
28. C12
29. 1-methylnaphthalene
30. C13

Chromatogram courtesy of Neil Johansen, Inc., Aztec, New Mexico, in association with Envantage Analytical Software, Inc., Cleveland, Ohio.



Method D-6730-01 suggests using helium as the carrier gas, at a linear velocity of 24cm/sec. (approximately 2.3mL/min.). The tridecane (C13) retention time this combination yields, approximately 146 minutes, greatly limits sample throughput per day. Our enhanced Rtx®-1PONA column meets or exceeds all criteria in the method, but does so in 30% less time: retention time for C13 is 97 minutes, using helium as the carrier gas.<sup>1</sup> In most applications hydrogen is a better alternative to helium as the carrier gas, because it can be used at much higher linear velocities without compromising critical resolutions.

A revision to ASTM D 6730-01 proposed by Neil Johansen Inc. (Aztec, New Mexico), in association with Envantage Analytical Software Inc. (Cleveland, Ohio), has established optimal DHAX (detailed hydrocarbon analysis—extended) parameters, including specifying hydrogen as the carrier gas. Using these conditions, analysis time is reduced to within 71 minutes (C13)—a 53% reduction versus using helium as the carrier gas. The method also is extended to include middle distillates having final boiling points up to 509°C/948°F (*n*-C38).

Restek provided Neil Johansen Inc. with an enhanced Rtx®-1PONA column (100m x 0.25mm ID x 0.5µm df) and an Rtx® 5PONA tuning column for DHAX method development. The Rtx®-1PONA column was connected to 3 meters of the tuning column through a Universal Angled Press-Tight® Connector (cat.# 20446) and was installed in a PerkinElmer AutoSystem XL GC equipped with a flame ionization detector and programmable pneumatic control. The data system used was ChromPerfect Spirit (Justice Laboratory Software, Denville, NJ). Individual compounds were identified by using Dragon- DHA software, developed by Envantage Analytical Software Inc. in association with Neil Johansen Inc., which uses algorithms to process high-resolution chromatographic data. Processed data for the PONA VI reference standard, containing more than 400 individual components of finished gasoline, can be reviewed on the Restek website: [www.restek.com/PONA](http://www.restek.com/PONA)

The proposed DHAX method was optimized with hydrogen carrier gas at a rate of 3.62mL/min, constant flow, producing a linear velocity of 55cm/sec. The new Rtx®-1PONA column was conditioned in less than two hours, as follows: 35°C for 15 min., to 300°C at 10°C/min., hold 30 min., cool to 35°C. Dead time was adjusted to elute methane at 3.50 ±0.05 min., then a DHA/oxygenates setup blend was introduced into the column to determine the column's suitability for the method.

Figure 1A lists the measured critical criteria. Once established that the column met the method criteria, GC oven program parameters were entered and trial injections of the DHA/oxygenates setup blend were begun. The analysis was permitted to run until *n*-C13 was eluted. Based on the resolutions achieved, the length of the tuning column was reduced incrementally until all critical pairs met D-6730-01 specifications. In this example application, the appropriate tuning column length was 2.36 meters. Figure 1B indicates the critical pairs. The full analysis of the 400-plus component PONA VI reference standard, listing retention indices (RIs) calculated using Dragon-DHA software, is posted on the Restek website.

The benefits of using hydrogen carrier gas for the PONA analysis are obvious: all critical components are resolved, per method D-6703-01, in the greatly reduced time of 70.5 minutes (C13), versus 146 minutes or 97 minutes using helium. Relative to the results anticipated in the method, we virtually doubled sample throughput.

We evaluate each column for film thickness, column efficiency, peak skewness, selectivity, resolution, and bleed to guarantee performance and reproducibility from column to column. The redesigned Rtx®-1PONA column earned Restek chemists the Concluded Research Award at the 2004 Gulf Coast Conference. When you use an Rtx®-1PONA column, we think you'll agree the award was well justified.

### Rtx®-1PONA Column (fused silica)

(Crossbond® 100% dimethyl polysiloxane)\*

ID	df (µm)	temp. limits	length	cat. #
0.25mm	0.50	-60 to 300/340°C	100-Meter	10195

\*Optimized phase for hydrocarbon analysis

### Rtx®-5PONA Tuning Column (fused silica)

(Crossbond® 5% diphenyl/95% dimethyl polysiloxane)

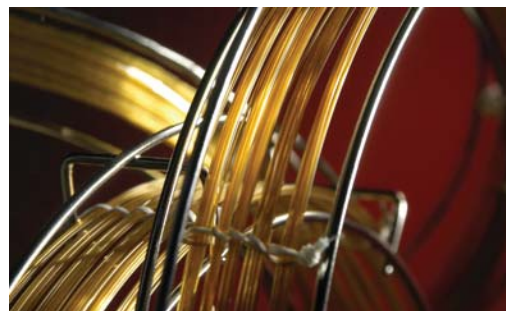
ID	df (µm)	temp. limits	length	cat. #
0.25mm	1.0	-60 to 325°C	5-Meter	10196



### Universal Angled Press-Tight® Connectors

- Ideal for connecting a tuning column to an analytical column.
- Inert fused silica.
- Angle reduces strain on the connection.
- Fit all column ODs from 0.33–0.74mm (Restek 0.1mm–0.53mm ID).

5-pk./price	25-pk./price	100-pk./price
<b>Universal Angled Press-Tight® Connectors</b>		
20446	20447	20448
<b>Siltek®-treated Universal Angled Press-Tight® Connectors</b>		
20482	20483	20484



### Reference

1. Stidsen, G. and B. Burger, *Enhanced Rtx®-1PONA Column Improves Detailed Hydrocarbon Analysis*, Restek Advantage 2005v1: 12 (2005).

### for more info!

Processed data for the PONA VI reference standard, containing more than 400 individual components of finished gasoline, can be reviewed on the Restek website: [www.restek.com/PONA](http://www.restek.com/PONA)

### please note

To achieve critical resolutions in detailed hydrocarbon analysis, a 5-meter 5% diphenyl/ 95% dimethyl polysiloxane tuning column (Rtx®-5PONA) is connected to the analytical column and adjusted to the needed length through a series of trial analyses.

# Rapidly Determine Benzene and Toluene in Gasolines

## Micropacked GC Columns Reduce Analysis Time by 63%

By Barry Burger, Petroleum Applications Chemist

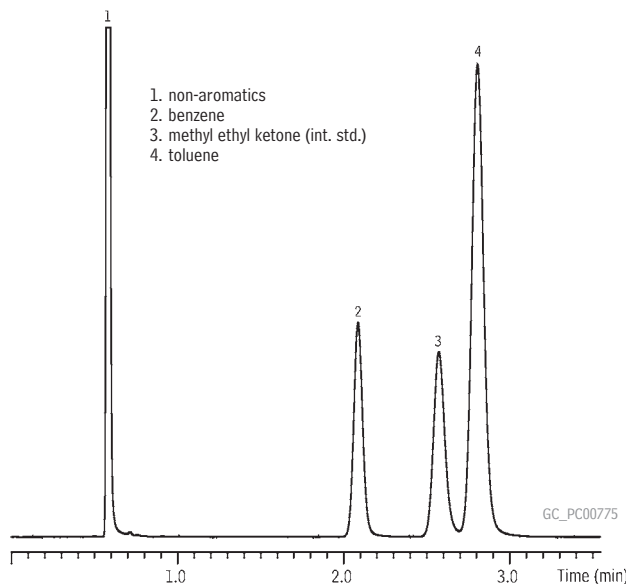
- 3-Minute Cycles for ASTM Method D-3606-99.
- Nearly triple sample throughput.
- Easy set-up, using Restek adaptor kit.

American Society for Testing and Materials test method D-3606-99 is focused on measuring benzene and toluene in finished motor and aviation gasolines: benzene can be determined from 0.1% to 5% by volume and toluene from 2.0% to 20% by volume. The method requires two columns connected in series. Typically, column A is a 0.8 meter x 1/8 inch stainless steel packed column containing a 10% loading of a nonpolar stationary phase, such as Rtx®-1 or OV®-101. This column separates sample components by boiling point. After n-octane (C8) elutes, the column is back-flushed to prevent heavier compounds from entering column B, the main analytical column. The light compounds, C8 and below, pass into column B, a 4.0 meter x 1/8 inch stainless steel packed column containing highly polar 1,2,3 tris(2-cyanoethoxy) propane (TCEP). Here, the aromatic compounds are separated from the non-aromatics, and quantitative information is obtained.

For method D-3606-99, micropacked column technology is an efficient, practical, time-saving alternative to 1/8 inch packed columns. Micropacked column A is a 0.8 meter x 1/16 inch x 1mm ID Silcosteel® column packed with 10% Rtx®-1 crosslinked on 60/80 Chromosorb® WAW. Micropacked column B is a 4.0 meter x 1/16 inch x 1mm ID Silcosteel® column packed with 20% TCEP on 80/100 Chromosorb® PAW. We installed the columns in an Agilent 6890 GC capillary inlet, configured in the on-column injection mode using our Micropacked Column Adaptor Kit for On-Column Injection (cat.# 22425). We used hydrogen as the carrier gas and, to attain the 9mL/min. flow rate, we adjusted the column head pressure to 44psig at 145°C.

Figure 1 illustrates the analysis of a sample containing 1% benzene, 2% toluene, and internal standard methyl ethyl ketone (MEK), in *n*-pentane (C5). The cycle time, just under 3 minutes, is greatly reduced, relative to the 8 minute cycle imposed by 1/8 inch packed columns and helium carrier gas. The micropacked column / hydrogen carrier gas combination reduces analysis time by 63%, nearly tripling sample throughput. If you are performing method D-3606-99 analyses, and time is important to you, we highly recommend this micropacked column approach.

**Figure 1** Benzene, toluene, and internal standard resolved in 3 minutes, using a micropacked column.



Column: A: 10% Rtx® 1 on 60/80 Chromosorb® WAW, 0.8m x 1/16 inch x 1mm ID Silcosteel® tubing  
B: 20% TCEP on 80/100 Chromosorb® PAW, 4.0m x 1/16 inch x 1mm ID Silcosteel® tubing  
connected in series and using Micropacked Column On-Column Injection Kit (cat.# 22425)  
Sample: benzene, toluene, methyl ethyl ketone in pentane  
Inj.: 1.0µL, on-column, 4mm ID splitless inlet liner (cat.# 20772)  
Carrier gas: hydrogen, constant flow  
Flow rate: 9.0mL/min.  
Inj. temp.: 200°C  
Oven temp.: 145°C  
Det.: FID @ 200°C

### Micropacked Columns

1/16 inch micropacked columns containing 10% Rtx®-1 on 60/80 Chromosorb® W or 20% TCEP on 80/100 Chromosorb® PAW are prepared on request. For details, please contact your Restek representative.

### Micropacked Inlet Conversion Kits

Convert a capillary GC split/splitless inlet for use with 1/16" OD micropacked columns.

- For use with Agilent 5890 and 6890 GCs.
- Sample pathways deactivated for ultimate inertness.

Description	qty.	cat.#
Micropacked Column Adaptor Kit for On-Column Injection*		
Complete kit with FID and injection port adaptors		
Kit includes: Dual Vespel® Ring Inlet Seal, large bore; reducing nut, large bore; FID adaptor, large bore; 1/4" ferrule, Vespel®/graphite; 1/4" nut, stainless steel; 1/16" ferrules, Vespel®/graphite (2); Siltek®-treated metal liner installation guide; 1/16" nuts, stainless steel (2)	kit	22425

\*For use with packed column FIDs only.

# Rapid, Dual Column Analysis for Organochlorine Pesticides

## 12-Minute Analysis Using Rtx®-CLPesticides2 / Rtx®-440 Capillary GC Columns

By Jason Thomas, Environmental Innovations Chemist

- Analysis and confirmation with a single injection.
- Rapid analysis increases throughput.
- New, thicker Rtx®-CLPesticides2 phase increases column lifetime.

Capillary GC stationary phases for organochlorine pesticides (e.g. US EPA Method 8081) must possess the selectivity needed to resolve target pesticides, yet withstand the rigors of repeated injections of extracts containing harsh residuals from the sample matrix. The US EPA method also requires a suitable counterpart column for confirmation, to quantify potential pesticide "hits." An efficient way to meet these requirements is through dual column analysis, which eliminates the need for a separate confirmation run, or GC/MS analysis. A newly enhanced version of our Rtx®-CLPesticides2 column, with dimensions of 30m x 0.32mm ID x 0.50µm (cat.# 11325) is now available for this application. The Rtx®-CLPesticides2 column, coupled with an Rtx®-440 column of the same dimensions (cat.# 12939), can provide a complete separation of the 20 most commonly analyzed organochlorine pesticides, listed in Method 8081, in less than 12 minutes (Figure 1).

The unique selectivities of the Rtx®-CLPesticides2 column and the Rtx®-440 column enable the analysis to be run quickly, with good resolution and peak shapes, as shown in Figure 1. Both columns produce similar run times, with a set of elution order inversions and, because they share a common stationary phase thickness, they should exhibit similar life expectancies. For accurate, time-saving analyses of organochlorine pesticides, we highly recommend the Rtx®-CLPesticides2 / Rtx®-440 column combination.

### Rtx®-CLPesticides2 Column (fused silica)

ID	df (µm)	temp. limits	length	cat. #
0.32mm	0.50	-60 to 320/340°C	30-Meter	11325

### Rtx®-440 Column (fused silica)

ID	df (µm)	temp. limits	length	cat. #
0.25mm	0.25	20°C to 320/340°C	30-Meter	12923

### SeCure™ "Y" Connector Kit

SeCure™ "Y" connector body, 3 knurled nuts, "Y" Universal Press-Tight® union, 3 ferrules.

Ferrules Fit Column ID	qty.	cat. #
0.28/0.32mm	kit	20277

### Organochlorine Pesticide Mix AB #2

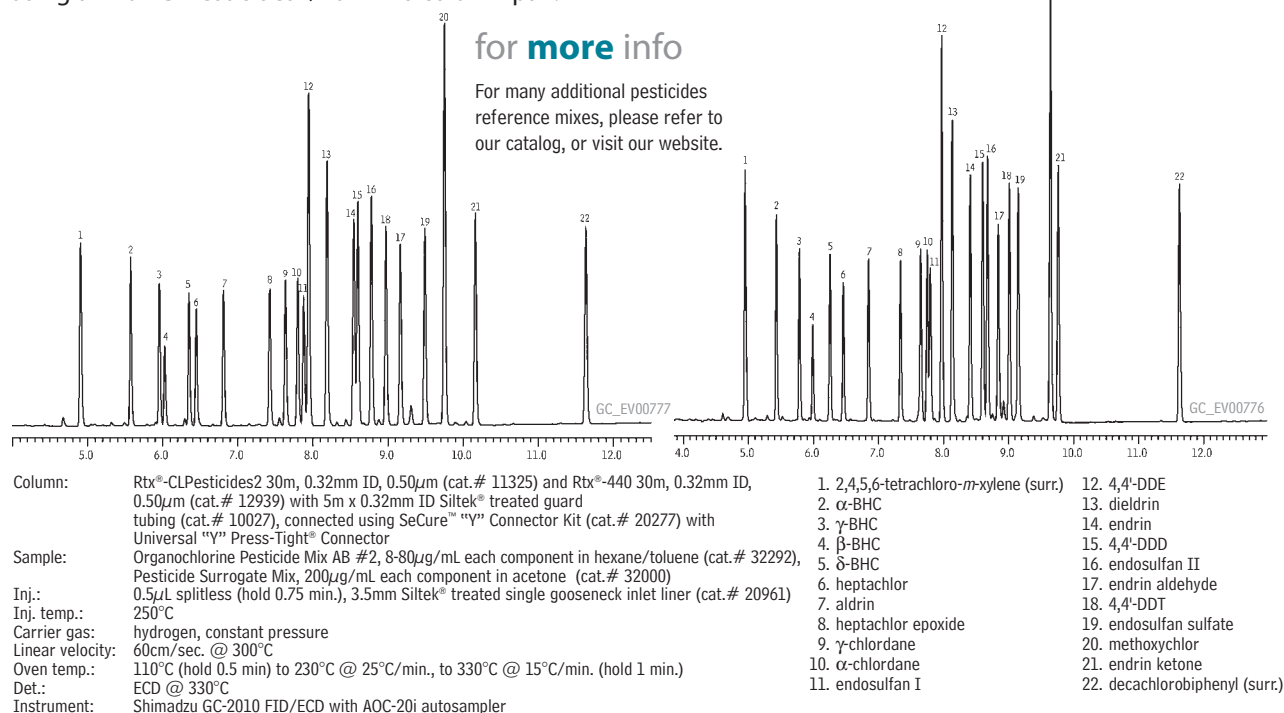
20 components, listed in Figure 1, 8-80µg/mL in hexane:toluene (1:1), 1mL/ampul

cat. # 32292

### Pesticide Surrogate Mix

decachlorobiphenyl 2,4,5,6-tetrachloro-*m*-xylene  
200µg/mL each in acetone, 1mL/ampul  
cat. # 32000

**Figure 1** Sub-12-minute dual column analysis of organochlorine pesticides, using an Rtx®CLPesticides2/Rtx®-440 column pair.





# New Analytical Reference Materials for Fuels, Accelerants

By Ken Herwehe, Analytical Reference Materials Product Marketing Manager, Mark Badger, Senior Organic Chemist



**did you know?**

We have over 2,000 pure, characterized, neat compounds in our inventory! If you do not see the EXACT mixture you need listed on any of these pages, call us.

For our on-line Custom Reference Materials Request Form visit us on the web at [www.restek.com/solutions](http://www.restek.com/solutions).

## **tert-Amyl ethyl ether Standard**

Oxygenate additive in (US) gasolines.

A US EPA target analyte that is not commercially available, this reference material is prepared from a laboratory-synthesized sample.

2,000µg/mL in P&T methanol, 1mL/ampul  
cat. # 30617

## **Oxygenates Standard**

diisopropyl ether (DIPE)	2,000µg/mL
ethyl-tert-butyl ether (ETBE)	2,000
tert-amyl ethyl ether (TAEE)	2,000
tert-amyl methyl ether (TAME)	2,000
tert-butyl alcohol (TBA)	10,000

In P&T methanol, 1mL/ampul  
cat. # 30619

## **tert-Butanol-d<sup>9</sup> Standard**

An internal standard for oxygenates.

20,000µg/mL in P&T methanol, 1mL/ampul  
cat. # 30618

## **Diesel/Biodiesel 80:20 Blend Standard**

The biodiesel component is methyl soyate.

5,000µg/mL in methylene chloride, 1mL/ampul  
cat. # 31880

## **Florida TRPH Standard** (17 components)

<i>n</i> -octane (C8)	<i>n</i> -hexacosane (C26)
<i>n</i> -decane (C10)	<i>n</i> -octacosane (C28)
<i>n</i> -dodecane (C12)	<i>n</i> -triacontane (C30)
<i>n</i> -tetradecane (C14)	<i>n</i> -dotriacontane (C32)
<i>n</i> -hexadecane (C16)	<i>n</i> -tetratriacontane (C34)
<i>n</i> -octadecane (C18)	<i>n</i> -hexatriacontane (C36)
<i>n</i> -eicosane (C20)	<i>n</i> -octatriacontane (C38)
<i>n</i> -docosane (C22)	<i>n</i> -tetracontane (C40)
<i>n</i> -tetracosane (C24)	

500µg/mL each in hexane, 1mL/ampul  
cat. # 31266

2,000µg/mL each in carbon disulfide, 1mL/ampul\*

**NEW Higher concentration**

cat. # 31878

## **Florida TRPH Surrogate Mix**

*n*-nonatriacontane (C39)  
3,000µg/mL in carbon disulfide, 1mL/ampul\*  
cat. # 31456

3,000µg/mL in carbon disulfide, 10mL/ampul\*  
**NEW Larger volume**

cat. # 31877

\*Ground transportation shipments only.



## **About Biodiesel Fuel**

In the US, soybean oil is the predominant feedstock for biodiesel fuel. Through transesterification, the oil is converted to methyl soyate, which has the characteristics and physical properties appropriate for a diesel-type fuel. Although biodiesel fuel can be used alone in diesel engines, many fleet operators blend it with petroleum-based diesel fuels to stretch the supply and lessen the cost of using what is still an expensive commodity, as biodiesel fuel still is not produced on a large scale.

Biodiesel fuel in an 80:20 blend (B20) has huge benefits for the consumer, including reduced emissions. The relatively high oxygen content of biodiesel fuel can reduce particulates, and has been shown to reduce NOx emissions and engine wear. New low-sulfur diesel fuels, mandated by the US EPA to reduce SOx emissions, lose some of the inherent lubrication that the sulfur species impart. However, biodiesel fuel has adequate inherent lubrication to offset the effects of the low-sulfur petroleum-based fuels.

Other biodiesel standards, at different blend ratios (e.g., B80 or B100), are available as custom products. In addition, we can custom prepare materials that comply with ASTM D6584, the method used to determine glycerin and free glycols in biodiesel fuel.

### Single Source Unleaded Gasoline (ASTM Class 2 Accelerant)

These solutions are prepared from a single source (one refinery) product. Samples of regular and premium grade unleaded gasoline were collected, then blended in equal volumes. The weathered materials indicate the percent weight loss from the original material.

Compound	cat.# (ea.)
5,000µg/mL in P&T methanol, 1mL/ampul	
unleaded gasoline: unweathered	30096
unleaded gasoline: 25% weathered	30097
unleaded gasoline: 50% weathered	30098
unleaded gasoline: 75% weathered	30099
unleaded gasoline: 99% weathered	30436

### Kerosene (ASTM Class 4 Accelerant)

These solutions are prepared from a single source (one refinery) product. The weathered materials indicate the percent weight loss from the original material.

Compound	cat.# (ea.)
5,000µg/mL in methylene chloride, 1mL/ampul	
kerosene: unweathered	31229
kerosene: 25% weathered	31230
kerosene: 50% weathered	31231
kerosene: 75% weathered	31232

### Diesel Fuel #2 (ASTM Class 5 Accelerant)

These solutions are prepared from a single source (one refinery) product. The weathered materials indicate the percent weight loss from the original material.

Compound	cat.# (ea.)
5,000µg/mL in methylene chloride, 1mL/ampul	
diesel fuel #2: unweathered	31233
diesel fuel #2: 25% weathered	31234
diesel fuel #2: 50% weathered	31235
diesel fuel #2: 75% weathered	31236

### Mineral Spirits

The mineral spirit solutions listed below were prepared from an equal volume blend of Type I, II, and III mineral spirits.

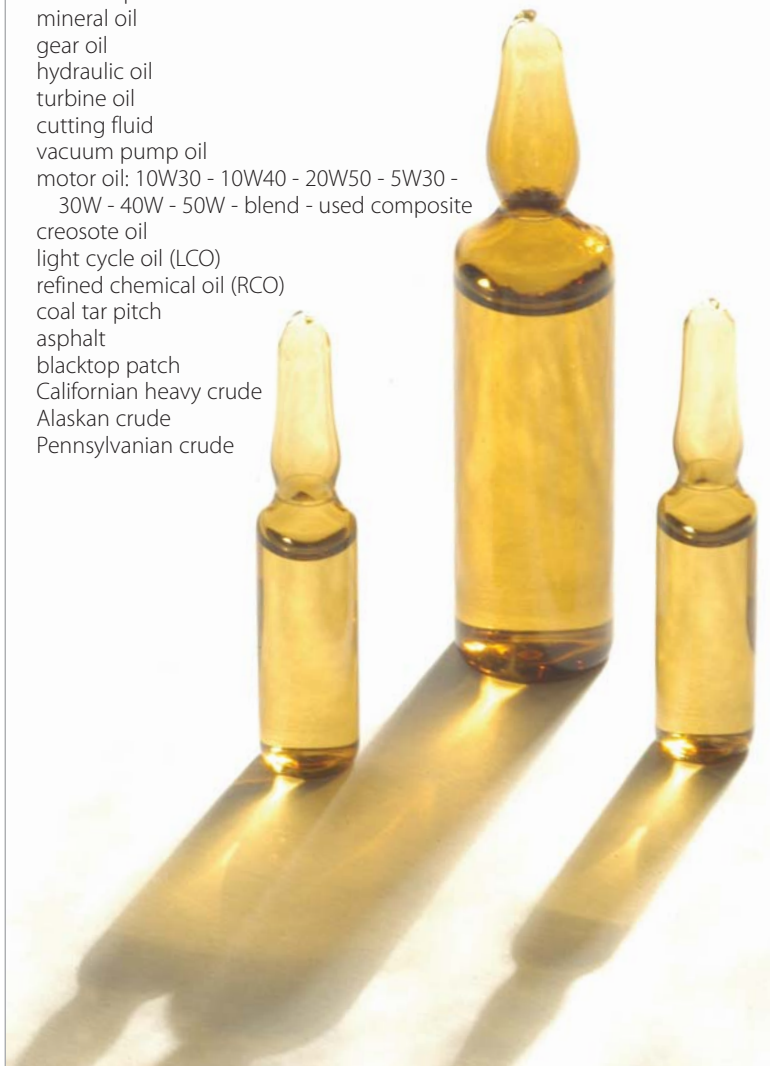
Compound	cat.# (ea.)
5,000µg/mL in methylene chloride, 1mL/ampul	
mineral spirits: unweathered	31225
50,000µg/mL in methylene chloride, 1mL/ampul	
mineral spirits: unweathered	31260
50,000µg/mL in methylene chloride, 5mL/ampul	
mineral spirits: unweathered (5mL/ampul)	31261
5,000µg/mL in methylene chloride, 1mL/ampul	
mineral spirits: 25% weathered	31226
5,000µg/mL in methylene chloride, 1mL/ampul	
mineral spirits: 50% weathered	31227
5,000µg/mL in methylene chloride, 1mL/ampul	
mineral spirits: 75% weathered	31228

## Distillates and Crude Oils

In addition to our stock products, we offer the following materials as custom products.

For details, visit our website: [www.restek.com/standards](http://www.restek.com/standards)

biodiesel (methyl soyate)  
diesel #1  
diesel #2: straight run - low sulfur - weathered - single source - composite  
fuel oil #4  
fuel oil #5  
fuel oil #6  
kerosene: unweathered - weathered  
aviation gasoline, 100 octane  
jet A: straight run - additized  
JP-4  
JP-5  
JP-8  
JP-10  
RP-1  
unleaded gasoline: oxygenate free - weathered - single source - composite  
naphtha cut  
charcoal lighter fluid  
Stoddard solvent  
mineral spirits: unweathered - weathered  
mineral oil  
gear oil  
hydraulic oil  
turbine oil  
cutting fluid  
vacuum pump oil  
motor oil: 10W30 - 10W40 - 20W50 - 5W30 - 30W - 40W - 50W - blend - used composite  
creosote oil  
light cycle oil (LCO)  
refined chemical oil (RCO)  
coal tar pitch  
asphalt  
blacktop patch  
Californian heavy crude  
Alaskan crude  
Pennsylvanian crude



## for more info

For blended/composite materials, refer to our catalog, or visit our website at [www.restek.com/standards](http://www.restek.com/standards)



## Superior Moisture Dry-Down and Corrosion Resistance

Restek treated tubing and system components improve analytical reliability and prolong lifetimes.

By Gary Barone, Restek Performance Coatings Division Manager, David Smith, RPC Chief Scientist, and Martin Higgins, RPC Chief Engineer

- Up to three times faster response to moisture changes in process streams.
- Corrosion resistance improved tenfold, or more—prolongs component lifetime and maintains pure product stream.
- Custom services: can be applied to existing equipment.



### did you know?

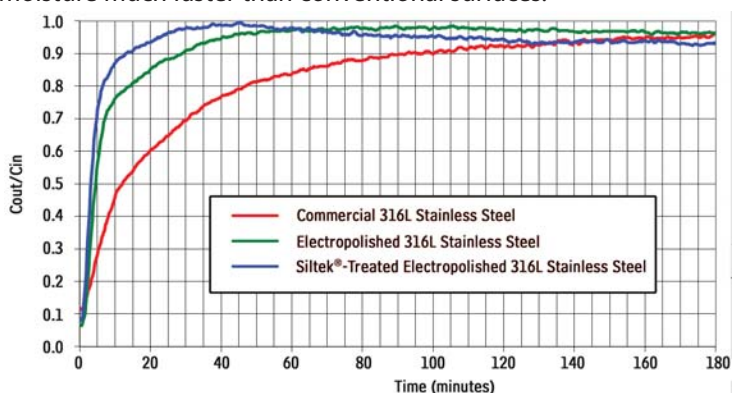
Restek surface treatments deposit an amorphous silicon based layer onto, and into, the steel surface through a chemical vapor deposition (CVD) process. All exposed surfaces are coated. For corrosion resistance, layer depth is optimized at 5 to 10 microns. The amorphous silicon layer can be further functionalized using the patented Siltek® process (US Patent #6,444,326), which reduces moisture hold-up and improves surface inertness.

### Introduction

Often, gas transfer systems require low moisture content, low moisture retention, and high resistance to corrosion. The current substrates of choice, including electropolished VIM/VAR (vacuum induction melt/vacuum arc melt) 316L stainless steel, typically are insufficient in these capacities, increasing periodic maintenance, prolonging equilibration times, and allowing system contamination and inaccurate analytical results. In contrast, surface treatments available through the Restek Performance Coatings Group greatly accelerate wet-up and dry-down times and dramatically improve corrosion resistance.

Experiments measuring the response time for moisture content change in Restek treated electropolished stainless steel tubing, untreated electropolished stainless steel tubing, and standard 316L stainless steel tubing, demonstrate a significant advantage in Restek treated substrates.<sup>1</sup> Wet-up curves for Siltek®

**Figure 1** Restek treated electropolished tubing stabilizes at 1ppm moisture much faster than conventional surfaces.<sup>1</sup>

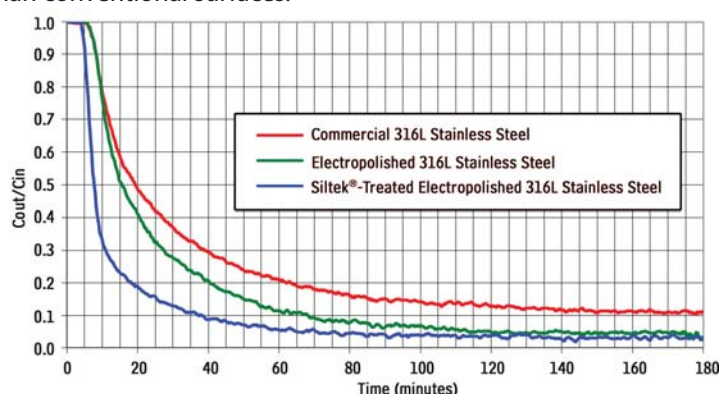


**Table I** Restek treated electropolished tubing provides the shortest drying times.<sup>1</sup>

		Time Required to Detect Change (min.)		
Moisture Concentration		Treated Electropolished Tubing	Untreated Electropolished Tubing	Standard Tubing
From	To			
10ppm*	5ppm	4	5	13
5ppm	1ppm	22	46	71
1ppm	500ppb	40	63	96
500ppb	100ppb	80	103	153
100ppb	50ppb	98	121	—

\*Initial moisture concentration.

**Figure 2** Restek treated electropolished tubing dries much faster than conventional surfaces.<sup>1</sup>



treated electropolished, electropolished, and standard tubing are compared in Figure 1. Treated electropolished tubing reached the 98% saturation limit in 30 minutes, compared to 60 minutes for electropolished tubing. Standard tubing could only achieve a 96% uptake, after 180 minutes.

After the tubing was stabilized with 1ppm of moisture, dry-down properties were measured. Moisture dry-down curves for the three tubing treatments show treated electropolished tubing achieved dry-down in 35 minutes, electropolished tubing required 65 minutes, and standard tubing required 175 minutes (Figure 2). Table 1 compares time to various dry-down levels for tubing saturated with 10ppm of moisture.

#### Superior Corrosion Resistance: Silcosteel®-CR

In addition to rapid wet-up and dry-down, the other key advantage of Restek treatment for 316L stainless steel is a dramatic improvement in corrosion resistance. The amorphous silicon layer is insoluble in many acidic environments. Figures 3, 4, and 5 briefly summarize the results of corrosion testing by ASTM methods. Comparisons between treated and untreated test samples illustrate the improvements in corrosion resistance offered by Silcosteel®-CR treatment. For more information about corrosion resistance, request information packet 59048, or visit our website.

When moisture considerations and corrosion concerns arise in transfer of ultra-high purity gas streams, Restek treated tubing and system components will dramatically improve dry-down, reduce contamination from moisture carryover, and extend periodic maintenance cycles.

#### Reference

1. *Relative Response Time of True Tube™ when Measuring Moisture Content in a Sample Stream* Test Report, Haritec Scientific & Engineering Support, Calgary, Alberta, Canada, May 2004.

Tubing used in the wet-up / dry-down experiments was supplied by Cardinal UHP (St. Louis, MO). All tubing was tested as 100 foot coils of 1/4" OD x 0.020" wall 316L stainless steel. Electropolished tubing had a surface roughness of 10 to 15 microinches. Siltek® treated tubing was finished with 5µm of amorphous silicon, followed by a surface functionalization to increase inertness and hydrophobicity.

Reference courtesy of O'Brien Corporation, available on request from Restek.

#### Siltek®- and Silcosteel®-CR-Treated Electropolished Tubing

- Exceptional inertness.
- Improved reliability and reproducibility; longer lifetime.
- Use with treated fittings for the most inert sample pathway available.

ID	OD	cat.#	5-24 ft.	Price-per-foot		
				25-99 ft.	100-299 ft.	> 300 ft.
Siltek®-Treated Electropolished Tubing						
0.085"	1/8"	22538				
0.180"	1/4"	22539				
Silcosteel®-CR-Treated Electropolished Tubing						
0.085"	1/8"	22536				
0.180"	1/4"	22537				

#### Coiled, Treated, Seamless 316 Grade Stainless Steel Tubing

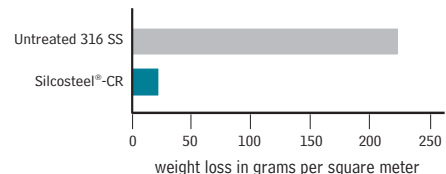
ID	OD	cat.#	5-24 ft.	Price-per-foot		
				25-199 ft.	200-399 ft.	>400 ft.
Silcosteel®-CR -Treated 316L Tubing**						
0.055" (1.40mm)	1/8" (3.18mm)	22896				
0.180" (4.57mm)	1/4" (6.35mm)	22897				
Siltek® Treated 316L Tubing**						
0.055" (1.40mm)	1/8" (3.18mm)	22508				
0.180" (4.57mm)	1/4" (6.35mm)	22509				

1/8" OD: 5 ft. to 100 ft. in one continuous coil; 1/4" OD: 5 ft. to 300 ft. in one continuous coil. Longer lengths will be more than one coil.

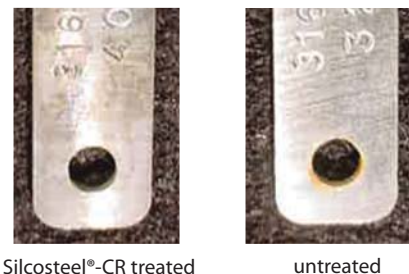
\*\*0.035" wall thickness

Note: (required length in meters) x (3.2808) = length in feet.

**Figure 3** In chloride environments, Silcosteel®-CR treated stainless steel outperforms untreated metal by an order of magnitude (ASTM G 48, Method B).



**Figure 4** Silcosteel®-CR treated 316L stainless steel shows no sign of attack after 4000-hour salt spray exposure (ASTM B117).



**Figure 5** Silcosteel®-CR treated 316L stainless steel shows no crevice corrosion and only slight pitting corrosion after 72-hour exposure to ferric chloride; untreated steel exhibits severe crevice corrosion.



for **more info**

Learn more about our precisely applied, highly durable surface treatments:  
[www.restekcoatings.com](http://www.restekcoatings.com)



# Simple HPLC Analysis for Sudan Dyes

## Monitor Sudan I, II, III, and IV in a Single, Isocratic Analysis

By Julie Kowalski, Innovations Chemist

- Ultra Aqueous C18 HPLC column separates the four Sudan dyes in 20 minutes.
- Simple methanol and water mobile phase; two wavelengths detect all four dyes.
- Two wavelengths detect all four dyes.

Sudan dyes are synthetic industrial azo-dyes traditionally used in waxes, plastics, oils, and polishes. Although recognized as carcinogens, Sudan dyes recently have been found in food products in some European countries. They are added to foods such as chili powders to mimic, intensify, and prolong the appearance of natural red hues. In the UK, more than six hundred products containing Sudan dyes have been recalled, the largest food recall in British history.<sup>1</sup>

Sudan dyes are categorized as Class 3 carcinogens by the International Agency for Research on Cancer (IARC) and, therefore, are illegal as food additives according to both the FDA and the EU. The European Commission requires products to have documentation confirming the absence of Sudan dyes.<sup>2,3</sup> Since 2003, European nations have required random product testing and testing of suspected adulterated products. Items found to contain Sudan dyes must be disposed of as hazardous waste.<sup>4</sup>

Laboratories performing analyses for Sudan dyes are not required to follow defined methods. The EU has set detection limits at 0.5-1 mg/kg, and any food material containing more than the limit should be withdrawn from the market.<sup>1</sup> Here, we describe a simple reversed phase HPLC separation of Sudan I, Sudan II, Sudan III, and Sudan IV (Scarlet Red).

We prepared 1mg/mL stock solutions of Sudan I or Sudan II in HPLC grade methanol, and equivalent solutions of Sudan III or Sudan IV in ethyl acetate. To avoid reductive cleavage, we stored the stock solutions at 4°C in foil-wrapped containers. We prepared sample solutions by combining the four stock solutions and diluting with methanol to 20µg/mL each dye. We used a 150 x 4.6mm Ultra Aqueous C18 HPLC column (cat.# 9178565) for the analysis.

### Results

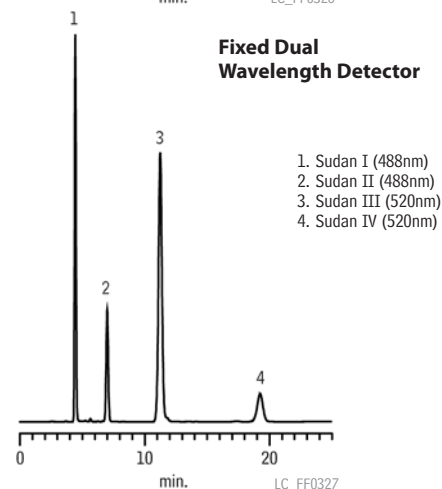
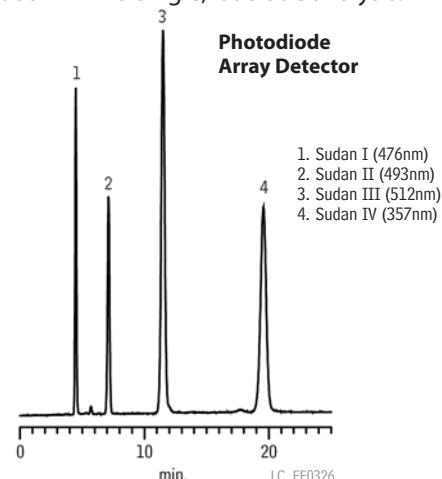
Figure 1 shows the Ultra Aqueous C18 column separates the four dyes in approximately 20 minutes. Sudan I can be detected at 476nm or 418nm, Sudan II at 493nm or 604nm, Sudan III at 508nm to 512nm, and Sudan IV at 357nm or 520nm. For each dye except Sudan III, we observed the higher response at the first listed wavelength; for Sudan III there was little difference. The dyes can be detected by monitoring at 488nm for Sudan I and II and at 520nm for Sudan III and IV, allowing all four dyes to be detected with a fixed dual wavelength instrument.

This method is simple, yet efficient, requiring only a simple mobile phase, isocratic elution, and detection at two wavelengths. The Ultra Aqueous C18 column provides the selectivity needed to assure the separation.

### References

1. [http://www.ift.org/news\\_bin/news/newsBody.shtml](http://www.ift.org/news_bin/news/newsBody.shtml)
2. Commission Decision of 20 June 2003 on emergency measures regarding hot chili and hot chili products, notified under document number C(2003) 1970, (2003/460/EC), OJ L 154/114, 21.6.2003.
3. Implementation of Commission Decision 2003/460/EC of 21 January 2004.
4. <http://www.food.gov.uk/foodindustry/guidancenotes/foodguid/sudanguidance>

**Figure 1** Monitor Sudan I, II, III and Sudan IV in a single, isocratic analysis.



**Sample:**  
Inj.: 20µL, mixture of Sudan I, Sudan II, Sudan III, Sudan IV  
Conc.: 20µg/mL each component  
Sample diluent: methanol

**Column:** Ultra Aqueous C18 (cat.# 9178565)  
Dimensions: 150 x 4.6 mm  
Particle size: 5µm  
Pore size: 100Å

**Conditions:**  
Mobile phase: methanol:water, 97:3  
Flow: 1mL/min.  
Temp.: ambient  
Det.: UV @ 476 / 493 / 512 / 357 nm (top) or UV @ 488 / 520 nm (bottom)

### for more info

For other column dimensions, please refer to our catalog, or visit our website.

### Ultra Aqueous C18 Column (USP L1)

5µm Column, 4.6mm  
150mm

cat. #  
9178565



## Enhanced Electronic Leak Detector

A Leak-Free System Stabilizes Baselines and Lengthens Column Life

By Donna Lidgett, GC Accessories Product Marketing Manager



- Reliable thermal conductivity leak detector—every analyst should have one.
- Compact, portable, ergonomic design—easy to hold and operate.
- Sensitive—detects helium or hydrogen at  $1 \times 10^{-4}$  cc/sec\*.
- Fast results—responds to leaks in less than 2 seconds, zeros with the touch of a button.
- Built-in rechargeable battery—charging adaptor included.



### tech tip

Avoid poor chromatography caused by leaks—check for leaks with the Restek Leak Detector

In continuing our efforts to provide chromatographers with the best available columns, tools, and accessories, we have enhanced our popular Restek Electronic Leak Detector. New features include internal battery charge capability, a low-battery indicator, a battery charge indicator light, yellow lights to signal a nitrogen leak, a repositioned on/off switch, to eliminate accidentally powering on the unit, and a new probe tip design that prevents debris from entering the unit. The new leak detector retains the microchip technology that enables high sensitivity in a compact unit, the autozero feature that allows instantaneous zeroing with the touch of a button, and the ergonomic design that puts all controls at your fingertips, for maximum ease of use.

The new Restek Electronic Leak Detector is the affordable solution for detecting helium, hydrogen, or nitrogen leaks in your GC system. Leaks can cause detector noise and baseline instability, waste carrier gas, and shorten column lifetimes. The leak detector responds in less than 2 seconds to leaks of gases with thermal conductivities different from air, indicating leaks with both an audible alarm and an LED readout. The leak detector detects minute gas leaks that can go undetected by liquid leak detectors. And, remember—you should never use liquid leak detectors on a capillary system, because liquids drawn into the system through the leaks will contaminate the system.



Easy-to-clean probe assembly.

Description	qty.	cat.#
Leak Detector with 110Volt Battery Charger	ea.	22451
Leak Detector with 220Volt European Battery Charger	ea.	22451-EUR
Leak Detector with 220Volt UK Battery Charger	ea.	22451-UK

Caution: The Restek Electronic Leak Detector is NOT designed for determining leaks of combustible gases. A combustible gas detector should be used for determining combustible gas leaks in possibly hazardous conditions.

\*Sensitivity measured using helium.



Verify pinpoint leaks with the adaptor fitting.

### Leak Detector Accessory Kit

The kit includes an adaptor fitting that fits over the probe assembly to detect very small leaks in hard-to-reach locations, and a mounting bracket that can be affixed to the wall or GC.

Description	qty.	cat.#
Leak Detector Accessory Kit (adaptor fitting for probe, mounting bracket)	kit	22453



Leak Detector is easily accessed when stored in the mounting bracket.

## Genuine Restek HPLC Parts and Accessories

The parts and tools you need to keep your HPLC systems running smoothly

By Becky Wittrig, Ph.D., HPLC Products Marketing Manager

- Restek quality and reliability.
- Renowned Restek Plus 1™ service.



### Genuine Restek Replacement Parts for ThermoSeparation Products HPLC Systems

Restek offers replacement parts for Agilent, Beckman, Hitachi, PerkinElmer, Shimadzu, Waters, and ThermoSeparation Products HPLC systems—all designed to equal or exceed the performance of original equipment manufacturers' parts. We've listed parts for ThermoSeparation Products HPLC Systems here. For parts for other systems, refer to our catalog, or visit our website. Use Genuine Restek Replacement Parts to keep your system in peak condition!

Description	Model #	Similar to SP/TSP part #	qty.	cat.#
Inlet Check Valve Assembly	SP8800 & P-Series Pumps	A3495-010	ea.	25474
Outlet Check Valve Assembly	SP8800 Series Pumps	A3490-010	ea.	25475
Piston	SP8800 & P-Series Pumps	A3102-010	ea.	25476
Back-up Seal	SP8800 & P-Series Pumps	A2963-010	ea.	25477
Plunger Seal, Gold Superseal	SP8800 & P-Series Pumps	A2962-010	ea.	25478
Check Valve and Transducer Assembly	P-Series Pumps	A3990-010	ea.	25479
Kel-F® Washer	P-Series Pumps	A2973-010	ea.	25480
Rotor Seal Assembly, Rheodyne® 7010	TSP AS100, 300, 1000, 3000, 3500, 8875, and 8880 Autosamplers	7010-039	ea.	25481
Syringe Assembly, 250µL	TSP AS100, 300, 1000, 3000, 3500, 8875, and 8880 Autosamplers	A3588-020	ea.	25482
Syringe, 500µL	TSP AS100, 300, 1000, 3000, 3500, 8875, and 8880 Autosamplers	A3588-010	ea.	25483
Lamp, UV	Linear UV-200, 203, 204, 205, 206, and UV 100, 150, 1000, and 2000 Detectors	9551-0023	ea.	25484

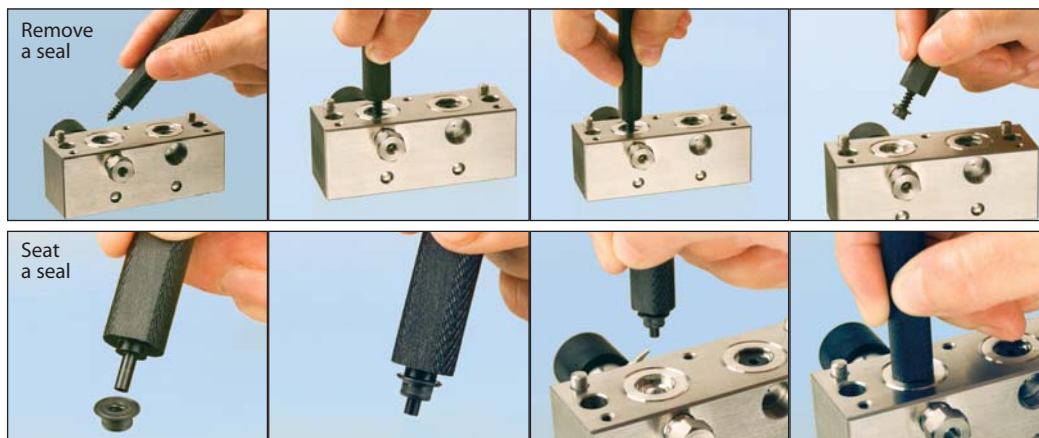
Description	Model #	Similar to TSP part #	qty.	cat.#
Check Valve Cartridge	LDC Constametric Pumps	900946	ea.	25485
Sapphire Plunger	LDC Constametric Pumps	801306	ea.	25486
Plunger Seal Kit, Gold	LDC Constametric Pumps	31-36-00754	ea.	25487
Plunger Seal, Black	LDC Constametric Pumps	206129001	ea.	25488
Plunger Seal, Gold	LDC Constametric Pumps	206156001	ea.	25489
Lamp, Deuterium	LDC SM-I, II, III, 3000, 3100, 3100X, and 4000 Detectors	108035	ea.	25490
Lamp, Deuterium Pre-aligned	LDC 3200 and 4100 Detectors	900918001	ea.	25491

### HPLC Piston Seal Insertion Tool

Simplify pump maintenance: use one end to remove your old seal, then simply slip your new seal on the other end and push it flush into position. The tool cannot mar the surrounding metal surface of the pump housing.



Use the flat side of the Piston Seal Insertion Tool to seat a Waters face seal.



Description	qty.	cat.#
HPLC Piston Seal Insertion Tool	ea.	21356



## PEEK® Unions, Connectors, and Tubing

Restek offers a wide range of PEEK® and stainless steel unions, connectors, and tubing, for installing and maintaining your HPLC systems. For complete listings, see our current catalog, or visit our website.

### PEEK® Union Connector

Allows you to quickly and reliably connect two pieces of 1/16-inch tubing. End fittings included.

Description	qty.	cat.#
PEEK® Union Connector 1/16"	2-pk.	25323

### Universal 10-32 PEEK® Column Connectors and Plugs

Universal PEEK® Connectors allow easy installation of all 1/16-inch tubing, including stainless steel.

Description	qty.	cat.#
PEEK® Column Connector (beige, round body)	10-pk.	25015
PEEK® Column Plug (black)	10-pk.	25016
PEEK® Fingertight Fittings (blue, flat-sided)	10-pk.	25324

### Inert PEEK® Tubing

- Replaces stainless steel, titanium, Teflon® or Tefzel® tubing.
- Less oxygen permeable and more temperature resistant (to 250°C) than Teflon® or Tefzel® tubing.
- Use with PEEK® fingertight or flangeless fittings.
- Use to 7,000psi.

Description	Color Code	qty.	cat.#
PEEK® Tubing, 1/16" OD x 0.0025" ID x 1m	natural	3-pk.	25320
PEEK® Tubing, 1/16" OD x 0.005" ID x 3m	red stripe	ea.	25065
PEEK® Tubing, 1/16" OD x 0.007" ID x 3m	yellow stripe	ea.	25066
PEEK® Tubing, 1/16" OD x 0.010" ID x 3m	blue stripe	ea.	25067
PEEK® Tubing, 1/16" OD x 0.020" ID x 3m	orange stripe	ea.	25068

### HPLC 30-Column Storage Cabinet

Tired of stacks of HPLC columns on your lab benches? This easy-to-install cabinet saves space and protects columns; the hinged door is clear to allow quick identification of column labels or tags.

Description	dimensions	qty.	cat.#
30 Column Cabinet	17 7/8 x 15 x 2 7/8"	ea.	25159

\*Please note: Columns in photograph are not included.

### Teflon® Tubing

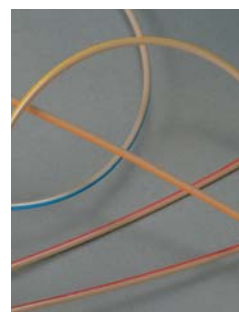
- Ideal for mobile phase inlet lines.
- Chemically inert.
- Use to 500psi and 80°C.

Description	qty.	cat.#
Teflon® Tubing, 1/8" OD x 0.063" ID x 3m (1.6mm ID)	3m	25306
Teflon® Tubing, 1/8" OD x 0.094" ID x 3m (2.4mm ID)	3m	25307

### Opti-Cap™ Bottle Top

The most economical way to helium-sparge and deliver HPLC mobile phases. The Opti-Cap™ top fits all standard GL-45 bottles and has two 1/8-inch holes and one 1/16-inch hole for tubing.

Description	qty.	cat.#
Opti-Cap™ (Cap and PEEK® Plug)	ea.	25300
Opti-Cap™ Kit (Opti-Cap™, 3 meters of tubing, sparging filters)	kit	25301
Opti-Cap™ Kit with 1L Bottle	kit	25302
Opti-Cap™ Kit with 2L Bottle	kit	25303
Related items and replacement parts	qty.	cat.#
Mobile Phase Sparge Filter: 2µm, stainless steel	ea.	25311
Mobile Phase Inlet Filter: 10µm	ea.	25312
Teflon® Tubing, 1/8" OD x 0.094" ID x 3m (2.4mm ID)	3m	25307
Teflon® Tubing, 1/8" OD x 0.063" ID x 3m (1.6mm ID)	3m	25306
PEEK® Plug, 1/4"-28 threads	3-pk.	25319
1L Graduated Safety-Coated Bottle – GL-45 threads	ea.	25304
2L Graduated Safety-Coated Bottle – GL-45 threads	ea.	25305



Opti-Cap™ Kit with bottle

# Genuine Restek Supplies & Accessories for ASE® Systems

## Extraction Cell Parts, Collection Vials, PEEK® Washers, Filters

By Neil Mosesman, Sample Preparation Product Marketing Manager

save!

Economical pricing.

### Extraction Cell Parts for ASE® Systems

- Designed to meet or exceed performance of original manufacturer's parts.
- Polished inner surfaces for easier cleaning; Siltek® deactivation available.

In addition to stainless steel extraction cell parts, we offer bodies, caps, and frits finished with our innovative Siltek® treatment, to greatly improve inertness and, therefore, the reliability of analytical results for active compounds.

		Stainless Steel		Siltek®-Treated	
Description	Similar to Dionex part #	qty.	cat.#	qty.	cat.#
Parts for ASE® 200 Extraction Cells					
Extraction Cell Body for ASE® 200, 1mL	054973	ea.	26110	ea.	26111
Extraction Cell Body for ASE® 200, 5mL	054974	ea.	26112	ea.	26113
Extraction Cell Body for ASE® 200, 11mL	048820	ea.	26114	ea.	26115
Extraction Cell Body for ASE® 200, 22mL	048821	ea.	26098	ea.	26099
Extraction Cell Body for ASE® 200, 33mL	048822	ea.	26116	ea.	26117
Replacement Extraction Cell End Caps for ASE® 200	049450	2-pk.	26096	2-pk.	26097
Replacement Frits for ASE® 200	049453	10-pk.	26100	10-pk.	26101
Parts for ASE® 300 Extraction Cells					
Extraction Cell Body for ASE® 300, 10mL		ea.	26172	ea.	26173
Extraction Cell Body for ASE® 300, 34mL		ea.	26176	ea.	26177
Extraction Cell Body for ASE® 300, 66mL	056696	ea.	26178	ea.	26179
Extraction Cell Body for ASE® 300, 100mL	056693	ea.	26132	ea.	26133
Replacement Extraction Cell End Caps for ASE® 300	056921	2-pk.	26170	2-pk.	26171
Replacement Frits for ASE® 300/100		6-pk.	26174	6-pk.	26175

### Accessories for ASE® Systems

Meet original equipment manufacturer's performance.

Description	Similar to Dionex part #	qty.	cat.#
<b>Accessories for ASE® 200 Systems</b>			
PEEK® Washers for ASE® 200	049454	12-pk.	25256
PEEK® Washers for ASE® 200	049454	48-pk.	25257
PEEK® Washers for ASE® 200	049454	250-pk.	26120
Snap Rings for Caps for ASE® 200	049456	10-pk.	26184
Funnel for ASE® 200	056958	ea.	26180
<b>Accessories for ASE® 300/100 Systems</b>			
PEEK® Washers for ASE® 300	061687	12-pk.	25393
PEEK® Washers for ASE® 300	061687	48-pk.	25394
Snap Rings for Caps for ASE® 300/100	056778	12-pk.	26134

### 20mm Filters for ASE® 200 Extraction Cells

Consistent porosity, to deliver rapid flow rates and protect the metal frit in the cell from contamination.

Description	Similar to Dionex part #	qty.	cat.#
Cellulose Filters for ASE® 200	049458	100-pk.	26118
Glass Fiber Filters for ASE® 200	047017	100-pk.	26119

### Diatomaceous Earth

Mix with densely packed samples such as clays to improve extraction efficiencies and absorb excess moisture.

Description	Similar to Dionex part #	qty.	cat.#
Diatomaceous Earth, 30/40 mesh	062819	1kg	26033

### 60mL Sample Collection Vials

Cleaned to EPA specifications and supplied assembled with caps and septa.

Description	Similar to Dionex part #	qty.	cat.#
60mL Collection Vials, Clear Glass, for ASE® Systems	048784	72-pk.	26121
60mL Collection Vials, Amber Glass, for ASE® Systems	048781	72-pk.	26122



PEEK® Washers for ASE®  
Extraction Units



## Syringe Filters

### Top-Quality Filters—Great Prices

By Neil Mosesman, Sample Preparation Products Marketing Manager

- Nylon - PTFE - PVDF membranes.
- 13mm and 25mm diameter.
- 0.22µm and 0.45µm porosity.
- Color coded for easy identification.
- 100 filters, reusable storage container.

	Size	Porosity	qty.	cat.#
<b>Nylon</b>				
	13mm	0.22µm	100-pk.	26146
	13mm	0.45µm	100-pk.	26147
	25mm	0.22µm	100-pk.	26148
	25mm	0.45µm	100-pk.	26149
<b>PTFE (polytetrafluoroethylene)</b>				
	13mm	0.22µm	100-pk.	26142
	13mm	0.45µm	100-pk.	26143
	25mm	0.22µm	100-pk.	26144
	25mm	0.45µm	100-pk.	26145
<b>PVDF (polyvinylidene fluoride)</b>				
	13mm	0.22µm	100-pk.	26150
	13mm	0.45µm	100-pk.	26151
	25mm	0.22µm	100-pk.	26152
	25mm	0.45µm	100-pk.	26153



## Bulk Adsorbents

### For Thorough Sample Preparation and Reliable Results

By Neil Mosesman, Sample Preparation Products Marketing Manager

#### Florisil® PR

- Pesticide residue grade.
- Each lot certified to meet the requirements of AOAC methodology.
- Packaged in glass containers.

Florisil® PR is commonly used to remove polar interferences from pesticide residues. This bulk material is ideal for labs packing their own chromatography columns for pesticide residue extractions.

Description	qty.	cat.#
Florisil® PR, 60/100 mesh	500gms	26135

#### Granulated Activated Copper

- Convenient form for removing sulfur from environmental extracts.
- Acidified and activated—ready for use.

Activated copper effectively removes elemental sulfur from environmental extracts. Our acid washed and activated material can be used right out of the package. The 30 mesh granular material eliminates the potential for fine copper particles in filtered extracts.

Description	qty.	cat.#
Granulated Activated Copper, 30 mesh	1kg	26136

#### Ottawa Sand

- Sample medium for matrix spikes and laboratory control blanks.
- Packaged in convenient 5kg buckets.

Ottawa sand is organics free and is listed in several US EPA methods as the specified medium for matrix spike and laboratory control blanks.

Description	qty.	cat.#
Ottawa Sand	5kg	26137



# Instrument Innovations!

## Simplify Your Analyses for Volatile Organic Compounds

by Donna Lidgett, GC Accessories Product Marketing Manager



### Purge-and-Trap Spargers for Tekmar 2000, 3000, or 3100 GCs

- Available with uniform frits, to ensure maximum purging efficiency.
- Use non-fritted spargers for wastewater samples.
- Manufactured to tight tolerances to ensure a leak-tight seal.

Description	qty.	cat.#
<b>Fritted Spargers, 1/2-inch mount</b>		
5mL Fritted Sparger	ea.	21150
10mL Fritted Sparger	ea.	26138
25mL Fritted Sparger	ea.	21151
<b>Non-Fritted Spargers, 1/2-inch mount</b>		
5mL Non-Fritted Sparger	ea.	26139
10mL Non-Fritted Sparger	ea.	26140
25mL Non-Fritted Sparger	ea.	26141

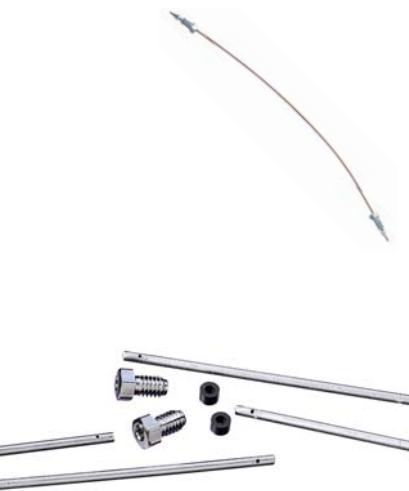
### Moisture Control By-Pass Lines for Tekmar Instruments

- Increase response for ketones, alcohols, and acetates.
- Silcosteel®-deactivated tubing for increased inertness.
- Suitable for US EPA Methods 8260, 524.2, and OLM4.1.
- Easily attaches in minutes.

Description	qty.	cat.#
Moisture Control By-Pass Line for Tekmar 3000 Purge & Trap	ea.	21035
Moisture Control By-Pass Line for Tekmar 3100 Purge & Trap	ea.	21109

### ELCD Nickel Reaction Tubes

- Pretreated for maximum sensitivity.
- Quality-controlled for reliability.
- Available for many popular models.



To replace these instrument part numbers:

Order these  
Restek part numbers:

ELCD Model #	Tremetrics	Varian	PerkinElmer	Shimadzu	O.I. Analytical	qty.	cat.#
Hall 700A	115439-0003	00-996724-14	0330-2675	—	—	2-pk.	21580
Hall 1000	117459-0003	00-997625-12	N660-1072	220-90435-00	—	2-pk.	21581
O.I. 4420	—	—	—	—	260323	2-pk.	21582

### Cleaned Teflon® Transfer Lines for ELCDs

We stringently clean our ELCD Teflon® transfer lines with an HCl solution to remove any contaminants, then rinse with methanol. Convenient 6.5-inch precut pieces that directly interface the nickel reaction tube and conductivity cell in Tracor, Tremetrics, O.I., and many other ELCDs.



Description	qty.	cat.#
Teflon® Transfer Lines for ELCDs (five 6.5-inch lines)	5-pk.	20121

### Replacement Accessories for Hall 1000

#### ELCD Nickel Reaction Tube Nut

High-quality stainless steel ELCD nut mounts nickel reaction tube into ELCD.

Description	qty.	cat.#
ELCD Nickel Reaction Tube Nut	2-pk.	21584



#### 1/16-Inch Vespel®/Graphite Sealing Ring

Installs onto the nickel reaction tube after the screw. Easily compresses on the reaction tube to provide a leak-tight seal and prevent detector oxidation.

Description	qty.	cat.#
1/16-Inch Vespel®/Graphite Sealing Ring	2-pk.	21583



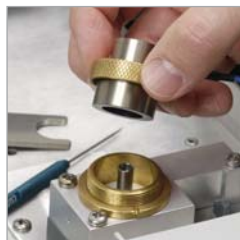


# Cool Tools!

Restek Innovations Save You Time and Money

## Spanner Wrench for Agilent 5890/6890 FID Collector Assembly

- Easily remove the nut from the FID collector without damaging the nut.
- Unique, ergonomic handle—easy to grip.



Remove the collector housing...



...easily loosen the nut by aligning the two pins on the bottom of the wrench with the two open slots on the nut...



...then turn counterclockwise...



...and remove.



Description	Similar to Agilent part #	qty.	cat.#
Spanner Wrench for Agilent 5890/6890 FID Collector Assembly	19231-00130	ea.	22329

## Injector Wrench for Agilent 5890/6890/6850 GCs

- Use to remove the septum nut and weldments during GC maintenance.
- High-quality stainless steel construction.
- Meets original equipment performance.



Use the smaller end to remove the septum nut.



Use the larger end to tighten the split/splitless weldment nut.



Description	Similar to Agilent part #	qty.	cat.#
Injector Wrench for Agilent 5890/6890/6850 GCs	19251-00100	ea.	22065

## Injector Wrench for Shimadzu 17A and 2010 GCs

- Designed specifically for removing Shimadzu injection ports.
- High-quality stainless steel construction.



Description	Similar to Shimadzu part #	qty.	cat.#
Injector Wrench for Shimadzu 17A and 2010 GCs	221-46977-00	ea.	21159

## 1/4- to 5/16-inch Open-End Wrench Set

We examined many different wrenches before we decided to offer this high-quality pair for tightening capillary fittings.



Description	qty.	cat.#
Open-End Wrenches (1/4" X 5/16")	2-pk.	20110



Need a conversion factor in a hurry? Want to see where the sample goes in a capillary GC split injection? Visit the Expert Center on the Restek website. Located in the "Info. & Support" menu, the Expert Center includes a tremendous variety of useful information. Our **calculators**, for example, are extremely handy tools. Use the Backflash Calculator to determine how much sample in a particular solvent you can introduce into a capillary inlet liner without the expanding sample backflashing into, and contaminating, the system. Use the Pressure Calculator to quickly interconvert among the various measurements of pressure: psi, atm, kg/cm<sup>2</sup>, Torr, inches Hg, kPa, bar.

The **animations** of capillary GC injection techniques and operation of a 6-port HPLC valve enable you to view these processes, and help you appreciate the benefits, and potential problems, associated with each. The subjects in the Expert Center include:

#### Troubleshooting

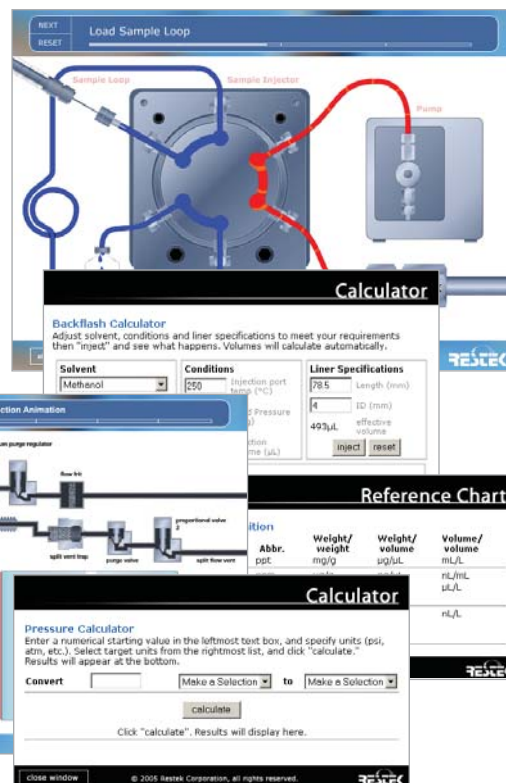
Chromatogram Archive  
Optimization Calculators  
GC Column Selection  
Capillary Column Installation Guide  
Free Technical Literature  
and more

#### Optimization Calculators and Reference Charts

Backflash Calculator  
GC Column Characteristics  
Pressure Calculator  
Reference Charts for Setting Deadtime  
Methane Retention  
Pressure Conversion  
Weight/Volume Composition Measures  
Mesh Size Conversions  
Septum Size Chart  
GC Retention Time Indexes

#### Animations

Direct Injection  
Split Injection  
Splitless Injection  
HPLC 6-Port Valve



Restek Trademarks/Service Marks: Crossbond, Hydroguard, MegaMix, Plus 1, Press-Tight, Rtx, SeCure, Silcosteel, Siltek, Turning Visions into Reality, Restek logo.

Other Trademarks: Agilent (Agilent Technologies, Inc.), ASE (Dionex Corporation), Chromosorb (Manville Corp.), Florisil (US Silica Co.), Freon, Teflon, Tefzel, Vespel (E.I. du Pont de Nemours & Co. Inc.), Kel-F (3M Company), Opti-Cap (Jour Research), OV (Ohio Valley Specialty Chemical Co.) PEEK (Vicatex plc), Rheodyne (Rheodyne LP), Waters (Waters Corporation). List is accurate to the best of our knowledge at the time of printing. For specific information, consult trademark owner(s).



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have been since been progressively superceded  
/ UPDATED OR Since Discontinued

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... Or The Restek Catalog ... Or other Restek publications for updates  
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Lit. Cat.# 59946

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