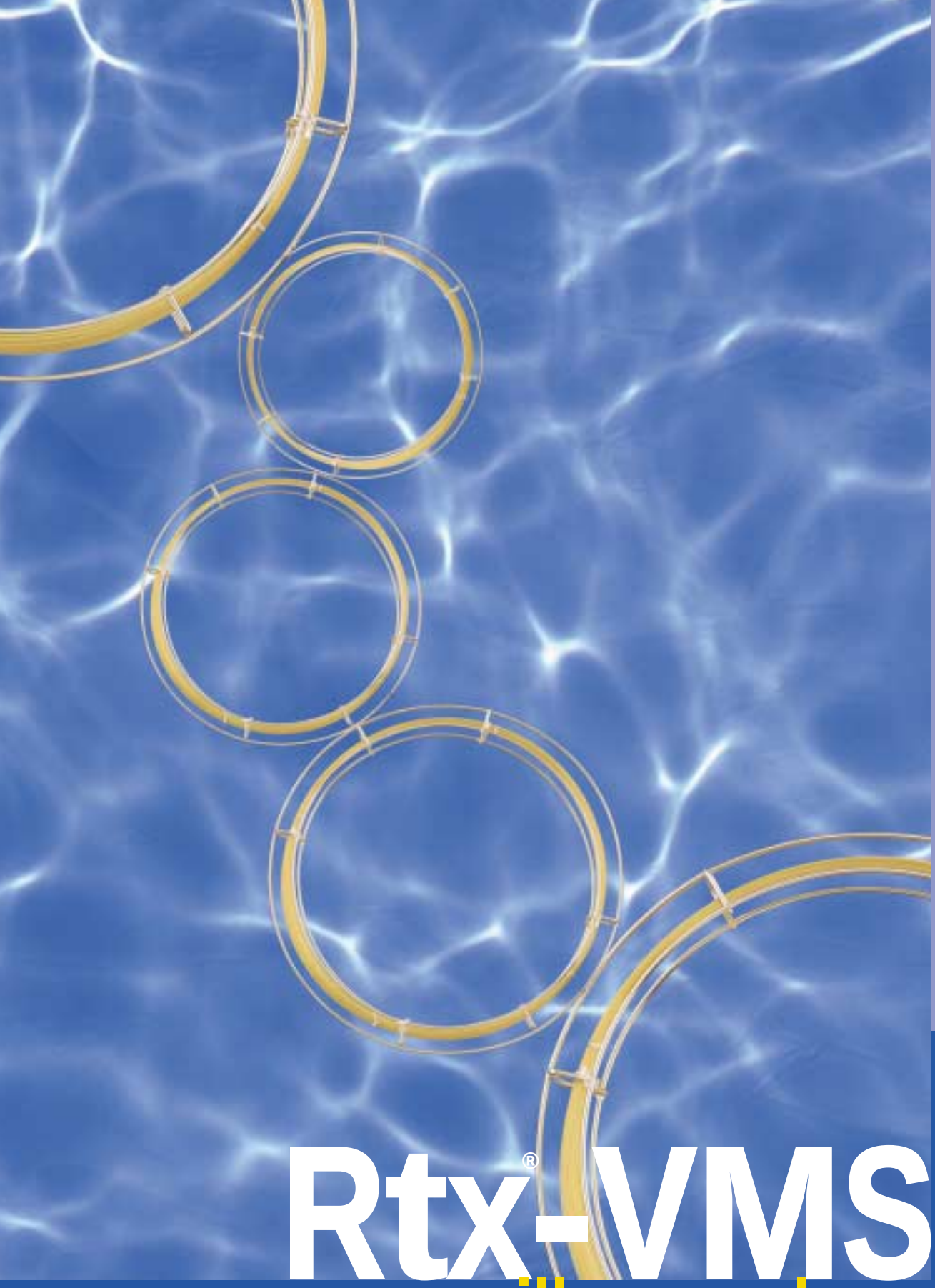

Rtx®-VMS

capillary columns

from RESTEK

Rtx®-VMS capillary columns

- *Faster analyses.*
- *Faster cycle times.*
- *Better resolution of listed and unlisted analytes.*

Rtx®-VMS columns address the increasing number of analytes listed in US EPA Methods 524.2, 624, and 8260, as well as unlisted but often added compounds, such as acetates and oxygenates. The major difference between the performance of the Rtx®-VMS phase and that of other phases, such as "502.2", "624", or "VRX" phases, is in overall selectivity and separation. The final oven programming rate can be faster, because these compounds elute farther apart on the Rtx®-VMS phase. The chromatograms in this flyer are optimized for run times of 18 minutes or less—the normal cycle time for a purge & trap system. Using the EPA-suggested surrogates the run time for Rtx®-VMS columns can be under 10 minutes.

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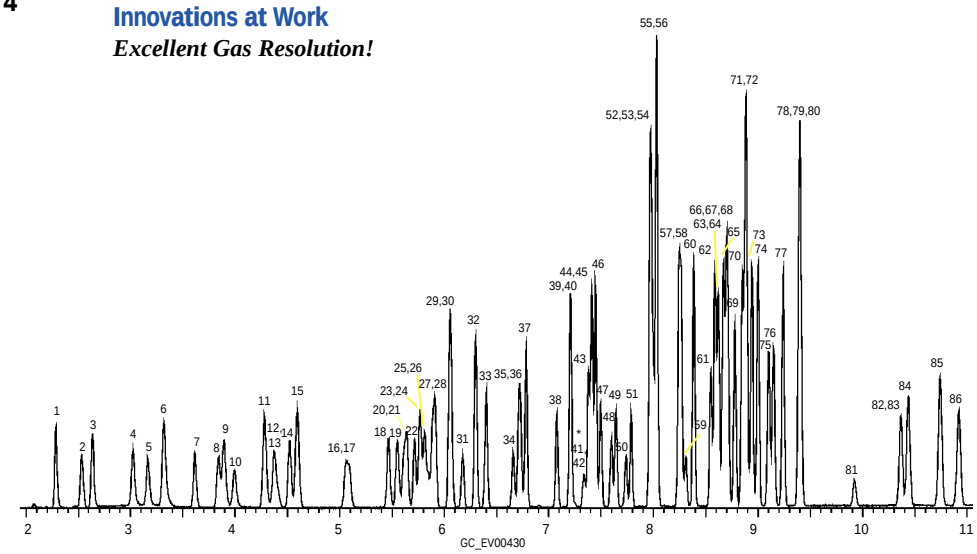
Figure 1:
Rtx®-VMS columns were designed specifically to improve selectivity, minimize bleed, and shorten analysis time for VOCs.

EPA Method 524.2, Revision 4
Rtx®-VMS

1. dichlorodifluoromethane
2. chloromethane
3. vinyl chloride
4. bromomethane
5. chloroethane
6. trichlorofluoromethane
7. diethyl ether
8. 1,1-dichloroethene
9. carbon disulfide (40ppb)
10. iodomethane (40ppb)
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 (40ppb)
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*

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

Innovations at Work
Excellent Gas Resolution!



42. 1,1-dichloropropanone*
43. 4-methyl-2-pentanone
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. styrene
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

Conditions

30m, 0.25mm ID, 1.4µm Rtx®-VMS (cat.# 19915)

Carrier gas:	helium @ ~1.3mL/min. constant flow Adjust dichlorodifluoromethane to a retention time of 2.29 min. @ 45°
Concentrator:	Tekmar LSC-3000 Purge and Trap
Oven temp.:	45°C (hold 2 min.) to 85°C @ 14°C/min. to 210°C @ 40°C/min. (hold 4 min.)
GC:	Agilent 6890 Series II
Trap:	Vocarb 3000
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:	5m, 0.32mm ID Siltek™ tubing (cat.# 10027)
Detector:	Agilent 5973 MSD
Scan range:	35-300amu

Standards:
20ppb in 5mL of reverse osmosis water (unless otherwise noted); ketones at 40ppb.
502.2 Cal Mix #1 (cat.# 30042)
502.2 Cal2000 MegaMix™ (cat.# 30431)
524 Cal Mix 7A & 7B (cat.# 30202)
524 Cal Mix #8 (cat.# 30203)
524 IS/SS Mix (cat.# 30201)

An Rtx® -VMS column improves quantification in analyses of drinking water.

US Environmental Protection Agency (EPA) Method 524.2 was created to monitor the most common contaminants in drinking water supplies. The compounds in the latest revision to this method can be analyzed in 11 minutes on a 0.25mm ID Rtx®-VMS column (Figure1, previous page).

The 30-meter Rtx®-VMS column is compatible with a starting temperature of 45°C. This ensures a faster oven cycle time, relative to columns that require a starting temperature of 35°C, without sacrificing resolution of the early eluting gases. Since the Rtx®-VMS column reduces the GC cycle time, the limiting factor is the purge and trap cycle time. The total oven cycle time for the analysis shown in Figure1 was less than 17 minutes. Using a Vocarb™ 3000 trap, changes in dry purge time did not significantly affect the amount of methanol and water transferred to the column. The 35°C "purge ready" temperature increased the concentrator cycle time, but prevented breakthrough of the gases.

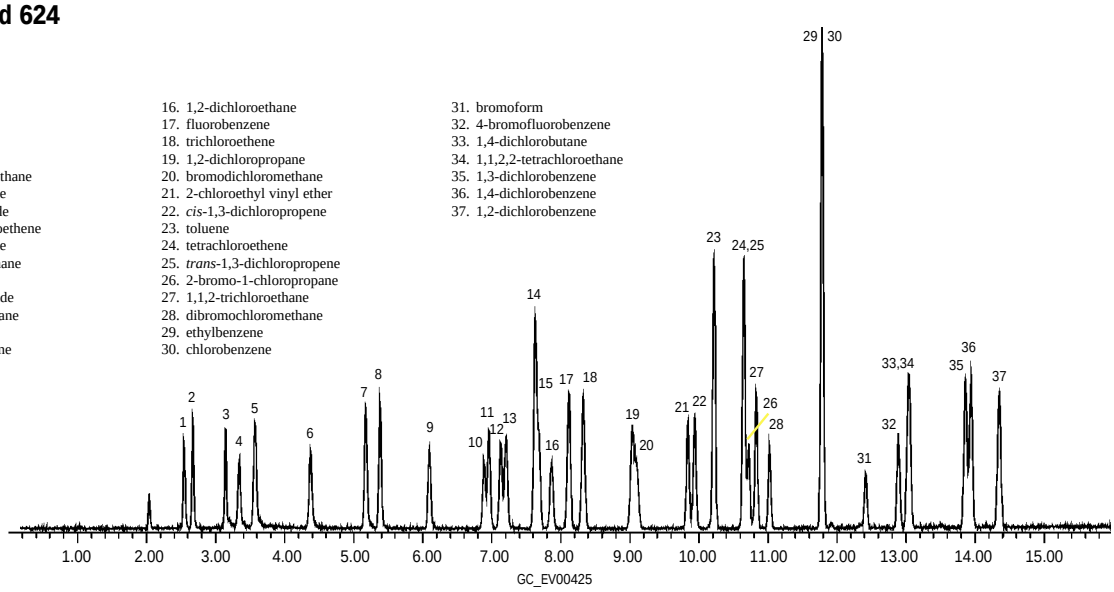
Municipal waste analysis, using an Rtx® -VMS column.

The goal of EPA Method 624 is to analyze volatile organic pollutants in industrial and municipal wastewater discharges. The Rtx®-VMS column excels at this application, providing excellent resolution of the gases, separating critical compounds such as 1,1,1-trichloroethane/carbon tetrachloride (Figure 2), and resolving isomeric pairs. The GC cycle time is far shorter than the cycle time for the purge and trap concentrator.

Figure 2:
An Rtx®-VMS column resolves critical pairs, such as carbon tetrachloride (12) and 111-trichloroethane (13).

EPA Method 624
Rtx®-VMS

1. chloromethane
2. vinyl chloride
3. bromomethane
4. chloroethane
5. trichlorofluoromethane
6. 1,1-dichloroethene
7. methylene chloride
8. *trans*-1,2-dichloroethene
9. 1,1-dichloroethane
10. bromochloromethane
11. chloroform
12. carbon tetrachloride
13. 1,1,1-trichloroethane
14. benzene
15. pentafluorobenzene
16. 1,2-dichloroethane
17. fluorobenzene
18. trichloroethene
19. 1,2-dichloropropane
20. bromodichloromethane
21. 2-chloroethyl vinyl ether
22. *cis*-1,3-dichloropropene
23. toluene
24. tetrachloroethene
25. *trans*-1,3-dichloropropene
26. 2-bromo-1-chloropropane
27. 1,1,2-trichloroethane
28. dibromochloromethane
29. ethylbenzene
30. chlorobenzene
31. bromoform
32. 4-bromofluorobenzene
33. 1,4-dichlorobutane
34. 1,1,2,2-tetrachloroethane
35. 1,3-dichlorobenzene
36. 1,4-dichlorobenzene
37. 1,2-dichlorobenzene



Conditions

30m, 0.25mm ID, 1.40µm Rtx®-VMS (cat#19915)

Conc.:	20 ppb in 5mL of reverse osmosis water
Concentrator:	Tekmar LSC-3000 Purge and Trap
Trap:	Vocarb 3000 (type K)
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.
GC Interface:	1:10 split at injection port. 1mm ID sleeve.
GC:	HP 6890
Oven temp.:	40°C (hold 4 min.) to 95°C @ 24°C/min. (hold 3 min.), to 210°C @ 40°C/min. (hold 6 min.)
Carrier gas:	helium @ ~1mL/min. constant flow Adjust dichlorodifluoromethane to a retention time of 2.54 min. @ 40°C
Detector:	HP 5973 MSD
Scan range:	25-300amu

800-356-1688
814-353-1300
www.restekcorp.com

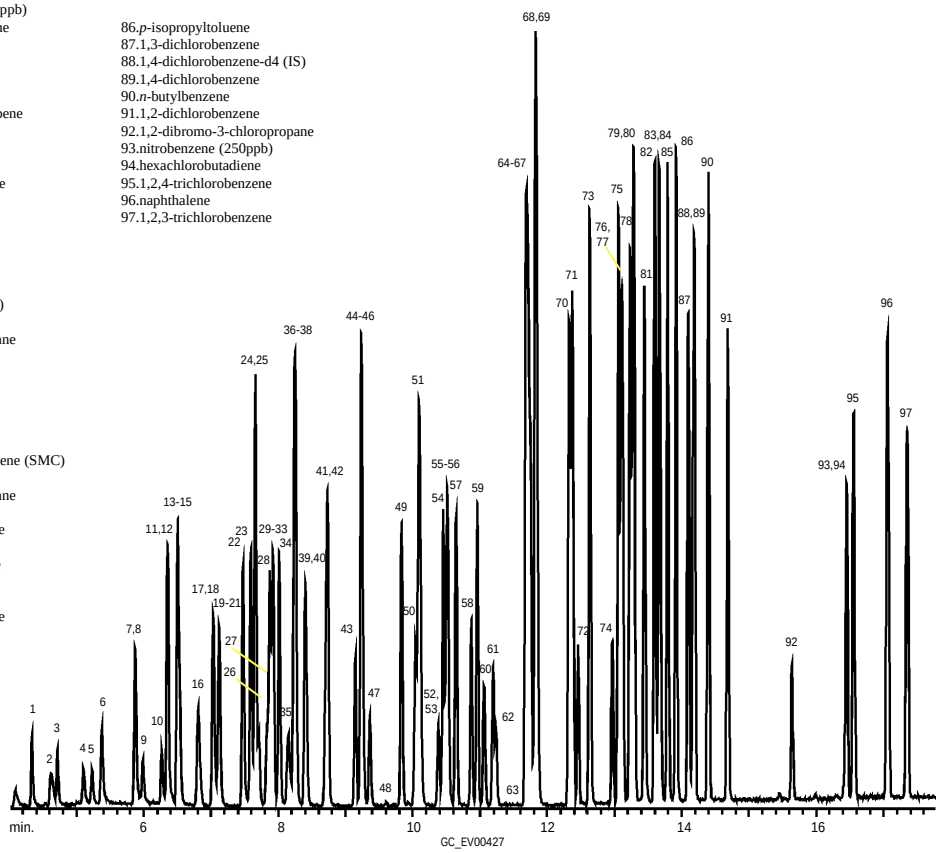
Figure 3:
Use a 60-meter Rtx®-VMS column with an initial oven temperature as high as 60°C without sacrificing resolution of early-eluting gases.

Volatile Organics
EPA Method 8260B
Rtx®-VMS

Innovations at Work

60°C starting temperature

1.dichlorodifluoromethane
2.chloromethane
3.vinyl chloride
4.bromomethane
5.chloroethane
6.trichlorofluoromethane
7.ethanol (2500ppb)
8.1,1-dichloroethene
9.carbon disulfide (40ppb)
10.allyl chloride
11.methylene chloride
12.acetone
13.*trans*-1,2-dichloroethene
14.*tert*-butyl alcohol (100ppb)
15.methyl *tert*-butyl ether
16.diisopropyl ether
17.1,1-dichloroethane
18.acrylonitrile
19.vinyl acetate*
20.allyl alcohol (250ppb)*
21.ethyl-*tert*-butyl ether*
22.*cis*-1,2-dichloroethene
23.2,2-dichloropropane
24.bromochloromethane
25.chloroform
26.ethyl acetate
27.methyl acrylate
28.propargyl alcohol (500ppb)
29.dibromofluoromethane (SMC)
30.tetrahydrofuran
31.carbon tetrachloride
32.2-butanone
33.1,1,1-trichloroethane
34.1,1-dichloropropene
35.pentafluorobenzene (IS)
36.*tert*-amyl methyl ether
37.benzene
38.isobutyl alcohol (500ppb)
39.1,2-dichloroethane
40.isopropyl acetate
41.1,1,4-difluorobenzene (SMC)
42.trichloroethene
43.dibromomethane
44.bromodichloromethane
45.1,2-dichloropropane
46.methyl methacrylate
47.*n*-propyl acetate
48.2-chloroethanol (2500ppb)
49.*cis*-1,3-dichloropropene
50.toluene-d8 (SMC)
51.toluene
52.4-methyl-2-pentanone
53.pyridine (250ppb)
54.*trans*-1,3-dichloropropene
55.ethyl methacrylate
56.tetrachloroethene
57.1,1,2-trichloroethane
58.dibromochloromethane
59.1,3-dichloropropane
60.*n*-butyl acetate
61.1,2-dibromoethane
62.2-hexanone
63.2-picoline (250ppb)
64.ethylbenzene
65.chlorobenzene-D5 (IS)
66.chlorobenzene
67.1,1,1,2-tetrachloroethane
68.*m*-xylene
69.*p*-xylene
70.*o*-xylene
71.styrene
72.bromoform
73.isopropylbenzene
74.4-bromo-1-fluorobenzene (SMC)
75.*n*-propylbenzene
76.1,1,2,2-tetrachloroethane
77.bromobenzene
78.1,3,5-trimethylbenzene
79.2-chlorotoluene
80.1,2,3-trichloropropane
81.4-chlorotoluene
82.*tert*-butylbenzene
83.1,2,4-trimethylbenzene
84.pentachloroethane
85.*sec*-butylbenzene
86.*p*-isopropyltoluene
87.1,3-dichlorobenzene
88.1,4-dichlorobenzene-d4 (IS)
89.1,4-dichlorobenzene
90.*n*-butylbenzene
91.1,2-dichlorobenzene
92.1,2-dibromo-3-chloropropane
93.nitrobenzene (250ppb)
94.hexachlorobutadiene
95.1,2,4-trichlorobenzene
96.naphthalene
97.1,2,3-trichlorobenzene



**These compounds can be resolved by using a lower initial temperature.*

Conditions

60m, 0.25 mm ID, 1.40µm Rtx®-VMS (cat.# 19916)
Compounds at 10ppb in 5mL of reverse osmosis water
(unless noted) ketones 2.5X

Concentrator:	Tekmar LSC-3100 Purge and Trap
Trap:	Vocarb 3000 (type K)
Purge:	11 min. @ 40mL/min. @ ambient temperature
Dry purge:	1 min. @ 40mL/min.
Desorb preheat:	245°C
Desorb:	250°C for 2 min., Flow 26mL/min.
Bake:	260°C for 8 min.
Interface:	transfer line 0.53mm ID Silcosteel® tubing 1:20 split at injection port. 1mm ID sleeve.
Oven temp.:	60°C (hold 2 min.) to 180°C @ 12°C/min. (hold 0 min.) to 225°C @ 45°C/min. (hold 6 min.)
Carrier gas:	helium @ ~1.3mL/min. constant flow. Adjust dichlorodifluoromethane to a retention time of 4.03 min. @ 60°C.
Detector:	HP 5973 MSD
Scan range:	35-300amu

Optimizing analyses of hazardous waste with an Rtx® -VMS column

US EPA SW-846 outlines testing procedures for hazardous waste, sludges, or other discarded material. US EPA Method 8260B, described in SW-846, is a guideline to setting acceptable standards.

A challenge to environmental laboratories is the accurate and rapid analysis of almost 100 volatile organic compounds (VOCs) in a wide range of matrices. The stationary phase for Rtx®-VMS columns was tuned specifically to resolve the compounds that share common quantification ions. This has improved selectivity, reduced bleed, and shortened analysis time, relative to traditional "624/1301" phases. The design of this stationary phase takes into account unconventional contaminants that are not target compounds in the usual test methods, such as ethers and acetates, because many of these compounds have been discovered in ground water, and environmental laboratories often add them to calibration mixes.

Initial oven temperatures of up to 60°C provide the required separation (Figure 3) and allow faster oven cycling. Start at 50°C to enhance resolution between chloromethane and vinyl chloride (peaks 2 and 3).

Interfacing Two Purge and Trap Concentrators to One GC/MS

Automated water and soil samplers enable environmental laboratories to operate purge and trap systems around the clock. This has produced a demand for columns that can drastically reduce separation time and instrumentation that can accommodate rapid cycle times. The limiting factor in VOA throughput is, by far, the cycle time of the purge and trap unit: an 11-minute purge is required, followed by a 6-12 minute bake-out time. The GC, on the other hand, can acquire a sample in 10 minutes or less.

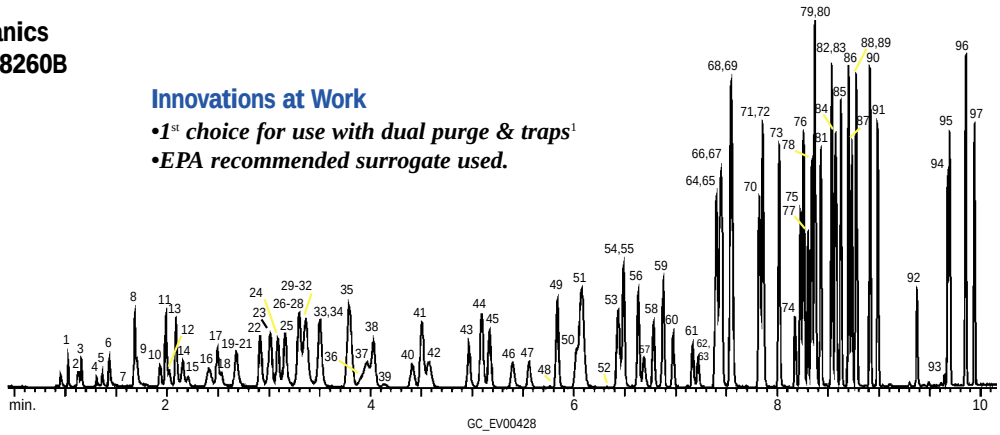
This disparity can be overcome by connecting two purge and trap units, each with its own autosampler unit to one GC/MS operating system. While the first system is desorbing the sample and the GC/MS analysis is starting, the second system is completing the bake cycle and starting to purge the next sample to be desorbed onto the column. It is possible to process 80 samples in 24 hours—a significant increase in output without an additional GC/MS instrument. Figure 4 illustrates the analysis, using an Rtx®-VMS column and the internal standards and surrogates for EPA Method 8260B. Both 8260 analyses were optimized to resolve the most difficult pair of compounds, chlorobenzene-d5 and 1,1,1,2-tetrachloroethane, which share ion 117. The 20m x 0.18mm ID column resolves these two analytes to baseline in less than 10 minutes.

Figure 4:
Sequentially desorb two purge and trap units to the same Rtx®-VMS column to greatly increase throughput from one GC/MS unit.

Volatile Organics
EPA Method 8260B
Rtx®-VMS

Innovations at Work

- ***1st choice for use with dual purge & traps***[1]
- ***EPA recommended surrogate used.***



1. dichlorodifluoromethane
2. chloromethane
3. vinyl chloride
4. bromomethane
5. chloroethane
6. trichlorofluoromethane
7. ethanol (2500ppb)
8. 1,1-dichloroethene
9. carbon disulfide (40ppb)
10. allyl chloride
11. methylene chloride
12. acetone
13. *trans*-1,2-dichloroethene
14. methyl *tert*-butyl ether
15. *tert*-butyl alcohol (100ppb)
16. diisopropyl ether
17. 1,1-dichloroethane
18. acrylonitrile
19. vinyl acetate
20. allyl alcohol (250ppb)
21. ethyl-*tert*-buyl ether
22. *cis*-1,2-dichloroethene
23. 2,2-dichloropropane
24. bromochloromethane
25. chloroform
26. ethyl acetate
27. carbon tetrachloride
28. methyl acrylate
29. proparyl alcohol (500ppb)
30. dibromofluoromethane (SMC)
31. tetrahydrofuran
32. 1,1,1-trichloroethane
33. 2-butanone
34. 1,1-dichloropropene
35. benzene
36. pentafluorobenzene (IS)
37. *tert*-amyl-methyl ether
38. 1,2-dichloroethane
39. isobutyl alcohol (500ppb)
40. isopropyl acetate
41. trichloroethene
42. 1,4-difluorobenzene (SMC)
43. dibromomethane
44. 1,2-dichloropropane
45. bromodichloromethane
46. methyl methacrylate
47. *n*-propyl acetate
48. 2-chloroethanol (2500ppb)
49. *cis*-1,3-dichloropropene
50. toluene-d8(SMC)
51. toluene
52. pyridine (250ppb)
53. tetrachloroethene
54. 4-methyl-2-pentanone
55. *trans*-1,3-dichloropropene
56. 1,1,2-trichloroethane
57. ethyl methacrylate
58. dibromochloromethane
59. 1,3-dichloropropane
60. 1,2-dibromoethane
61. *n*-butyl acetate
62. 2-hexanone
63. 2-picoline (250ppb)
64. chlorobenzene-D5 (IS)
65. chlorobenzene
66. ethylbenzene
67. 1,1,1,2-tetrachloroethane
68. *m*-xylene
69. *p*-xylene
70. *o*-xylene
71. stryrene
72. bromoform
73. isopropylbenzene
74. 4-bromo-1-fluorobenzene (SMC)
75. bromobenzene
76. *n*-propylbenzene
77. 1,1,2,2-tetrachloroethane
78. 2-chlorotoluene
79. 1,3,5-trimethylbenzene
80. 1,2,3-trichloropropane
81. 4-chlorotoluene
82. *tert*-butylbenzene
83. pentachloroethane
84. 1,2,4-trimethylbenzene
85. *sec*-butylbenzene
86. *p*-isopropyltoluene
87. 1,3-dichlorobenzene
88. 1,4-dichlorobenzene-d4 (IS)
89. 1,4-dichlorobenzene
90. *n*-butylbenzene
91. 1,2-dichlorobenzene
92. 1,2-dibromo-3-chloropropane
93. nitrobenzene (250ppb)
94. hexachlorobutadiene
95. 1,2,4-trichlorobenzene
96. naphthalene
97. 1,2,3-trichlorobenzene

[1]*A.L. Hilling and G. Smith, Environmental Testing & Analysis, 10(3), 15-19, 2001.*

Conditions

20m, 0.18 mm ID, 1.00µm Rtx®-VMS (cat.# 49914)
Compounds at 10ppb in 5mL of reverse osmosis water
unless otherwise noted, ketones 2.5X

Concentrator:	Tekmar LSC-3100 Purge and Trap
Trap:	Vocarb 3000 (type K)
Purge:	11 min. @ 40mL/min. @ ambient temperature
Dry purge:	1 min. @ 40mL/min.
Desorb preheat:	245°C
Desorb:	250°C for 2 min., Flow 40mL/min.
Bake:	260°C for 8 min.
Interface:	transfer line 0.53mm ID Silcosteel® tubing 1:40 split at injection port. 1mm ID sleeve.
Oven temp.:	50°C (hold 4 min.) to 100°C @ 18°C/min. (hold 0 min.) to 230°C @ 40°C/min. (hold 3 min.)
Carrier gas:	helium @ ~1.0mL/min. constant flow. Adjust dichlorodifluoromethane to a retention time of 1.03 min. @50°C.
Detector:	HP 5973 MSD
Scan range:	35-300amu

In Summary: What Do We Know?

In volatiles analyses, cycle times—oven cycle time and/or purge and trap cycle time—not analysis time—are the bottlenecks to productivity. Restek's unique Rtx®-VMS columns were designed for higher starting temperatures, allowing shorter oven cycle times and consequently an increase in sample throughput without sacrificing resolution of gaseous analytes. Whether you are testing for volatiles in drinking water, wastewater, or hazardous waste, an Rtx®-VMS column will reduce analysis time and improve resolution.

Rtx®-VMS columns are available in a range of internal diameters (ID) and lengths, to meet the requirements of most methods for analyzing volatile organic compounds.

Product Listing

Metric conversion:

6ft.	*1.8m*
25ft.	*7.6m*
50ft.	*15.2m*
200ft.	*61m*
>400ft.	*>122m*

Ordering Information | Rtx®-VMS Columns (Fused Silica)

Stable to 260°C

ID	df (µm)	temp. limits	30-Meter	60-Meter	75-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	
0.53mm	3.00	-40 to 240/260°C	19985	19988	19974
ID	**df (µm)**	**temp. limits**	**20-Meter**	**40-Meter**	
0.18mm	1.00	-40 to 240/260°C	49914	49915	

Silcosteel® Transfer Line

Silcosteel®-treated tubing offers all of the advantages of glass or fused silica transfer tubing, but is durable and rugged stainless steel, and ensures inert transport without the fear of tubing breakage.

ID	OD	cat.#
0.021" (0.53mm)	0.029" (0.74mm)	20591

8260B Calibration Mix #1B

2,000µg/mL 2-chloroethyl vinyl ether in P&T methanol, 1mL/ampul

	Each	5-pk.	10-pk.
	30475	30475-510	
w/data pack	30475-500	30475-520	30575

California Oxygenates Mix

In P&T methanol, 1mL/ampul

	Each	5-pk.	10-pk.
	30465	30465-510	
w/data pack	30465-500	30465-520	30565

8260A/B Internal Standard Mix

2,500µg/mL each component in P&T methanol, 1mL/ampul

	Each	5-pk.	10-pk.
	30241	30241-510	
w/data pack	30241-500	30241-520	30341

8260B Acetate Mix

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

	Each	5-pk.	10-pk.
	30477	30477-510	
w/data pack	30477-500	30477-520	30577

8260 Internal Standard Mix

2,500µg/mL each component in P&T methanol, 1mL/ampul

	Each	5-pk.	10-pk.
	30074	30074-510	
w/data pack	30074-500	30074-520	30174

8260 Surrogate Mix

2,500µg/mL each component in P&T methanol, 1mL/ampul

	Each	5-pk.	10-pk.
	30073	30073-510	
w/data pack	30073-500	30073-520	30173

8260A/B Surrogate Mix

2,500µg/mL each component in P&T methanol, 1mL/ampul

	Each	5-pk.	10-pk.
	30240	30240-510	
w/data pack	30240-500	30240-520	30340

For components of reference standards, please visit our website, ***www.restekcorp.com***

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Restek GmbH:
phone: 49 06172 2797 0 •
fax: 49 06172 2797 77 •
e-mail: RESTEK-GMBH@t-online.de

Thames Restek U.K. LTD:
phone: 01753 624111 •
fax: 01753 624666 •
e-mail: Sales@Thamesrestek.co.uk

France:
phone: 01 60 78 32 10 •
fax: 01 60 78 70 90 •
e-mail: restekfr@club-internet.fr

Restek Ireland:
phone: 44 28 9081 4576 •
fax: 44 28 9081 4576 •
e-mail: restekeurope@aol.com

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