Rugged Method for Semivolatile Organic Compounds Analysis

Abstract

Semivolatile organic compounds (SVOC) analysis is one of the most common gas chromatographic (GC) tests performed in environmental labs globally. It is challenging, in part because it covers a broad range of target analytes, including polycyclic aromatic hydrocarbons (PAH); phenols; ethers; anilines; and a variety of halogenated compounds. While this application note evaluates method performance relative to the criteria listed in U.S. EPA Method 8270D revision 5 (July 2014), the ability to meet those criteria using a high-performing Rxi-SVOCms column will allow labs running other global methods to apply this information to their procedures and successfully analyze semivolatiles.

Featured Products

- *Rxi-SVOCms column, 30 m, 0.25 mm, 0.25 µm (cat. # 16623)*
- *Topaz 4.0 mm ID single taper inlet liner with wool (cat. # 23303)*
- *SVOC MegaMix 150 kit (cat. # 31907)*
- *SVOC MegaMix 100 kit (cat. # 31908)*
- *8270 MegaMix standard (cat. # 31850)*
- *8270 Benzidines mix (cat. # 31852)*
- *Benzoic acid (cat. # 31879)*
- *Revised SV internal standard mix (cat. # 31886)*
- *Revised B/N surrogate mix (cat. # 31888)*
- *Acid surrogate mix (cat. # 31063)*
- *9 mm short-cap, screw-thread vials (cat. # 21143)*
- *Big Mouth inserts (cat. # 21782)*
- *9 mm short-cap, screw-vial closures (cat. # 23842)*

Introduction

The analysis of semivolatile organic compounds using capillary chromatography is performed on a variety of sample matrixes, including drinking water, wastewater, and solid waste. In addition, PAH, PCB, and pesticides analysis can be performed using similar extraction procedures. These analyses are some of the most common tests performed by environmental laboratories worldwide, yet there are many analytical challenges of which the analyst needs to be aware. For example, the samples often are highly contaminated with nontarget compounds (e.g., hydrocarbons), and the quality assurance/control (QA/QC) requirements in test methods are rigorous. To reliably meet these requirements so that more samples can be analyzed before maintenance and recalibration is needed, strategies can be employed in several areas: standard preparation, injection port optimization, and column selection.

Standard Preparation

Calibration standards are purchased as high concentration mixtures that are divided into separate ampuls to limit compound cross-reactivity. To ensure accuracy, it is important when making the working standards that the solutions are stored under refrigerated conditions in a Mininert vial (cat.# 21050 & 21051) due to the volatility of some of the compounds. Failure to properly store the calibration standards will result in evaporative loss of the early eluting compounds as well as evaporative loss of methylene chloride, which may concentrate the less volatile compounds. Even under ideal conditions, several compounds may degrade during storage, such as benzidine, 3,3'-dichlorobenzidine, 4-chloroanaline, *N*-nitrosodiphenylamine and, to a lesser extent, pentachlorophenol and 2,4-dinitrophenol. These standards are stable in the separate ampuls supplied by the manufacturer, but problems arise when all the compounds are mixed together to make the working calibration standards. Therefore, to ensure accurate semivolatile organic compounds analysis, it is important to monitor the response of the more active compounds and make fresh mixtures when the calibration standards degrade.

Injection Port Optimization

There are five common techniques for vaporizing a sample and transferring it onto the analytical column: split, splitless, direct, PTV, and on-column injections. Of these, the most frequently used are split and splitless injections where the sample is vaporized using heat and then transferred to the head of the column. In splitless injection, the split valve is closed long enough to allow most of the vaporized sample and solvent to be transferred from the injection port liner onto the analytical column, which can take anywhere from 30 to 90 seconds. Since the split valve is closed, sample transfer moves at the speed of the column flow, typically in the 1-2 mL/min range. Splitless injection can be advantageous for trace-level semivolatile organic compounds analysis because more of the sample is transferred onto the column. However, the longer residence time in the liner can cause degradation of active analytes through adsorption and/or breakdown. Alternatively, split injection may be preferred, especially when analyzing highly contaminated samples, because sample transfer is faster and less sample matrix builds up on the column, but detector sensitivity and analyte concentrations must be high enough to allow dilution via the split ratio.

In the inlet, there are two different approaches for focusing the vaporized sample onto the head of the column: solvent focusing and analyte focusing. The difference between these two techniques is the initial temperature of the column oven. Analyte focusing begins with an oven temperature high enough to allow the solvent to move through the column as a vapor at the time of the injection, and it requires a large difference in boiling point between the solvent and the higher molecular weight analytes. In contrast, solvent focusing requires an oven temperature 20 °C below the boiling point of the sample solvent, causing the solvent and analytes to condense and wet the stationary phase. This can result in a solvent effect where the solvent acts as a temporary stationary phase, which results in distorted peak shapes and nonlinear response for early eluting compounds.

For this method, solvent focusing is not possible because the boiling point of methylene chloride is 39 °C, and most laboratories cannot set the oven below 35 °C and still obtain acceptable oven cycle times. In splitless mode, the oven starting temperature is generally 40 °C or less to minimize solvent interference with the first eluting analytes. However, with split injection approach used here, because less solvent is reaching the column (10 times less in this case), it is possible to program the oven to start at 60 °C. The higher starting temperature allows for a faster overall oven cycle time using analyte focusing.

Column Selection

Columns chosen for semivolatile organic compounds analysis must be low bleed; stable at high temperatures; exhibit high efficiency (plates per meter); and resolve a diverse range of analytes that vary considerably in chemical functionality, volatility, and polarity. Since compound identification and quantification is performed using a mass spectrometer, it is essential that the analytical column be able to chromatographically separate compounds that share quantification ions. An Rxi-SVOCms column was selected for this work because it was designed specifically for the analysis of semivolatile organic compounds. It is low bleed, highly inert, and reliably resolves critical compound pairs, so more samples can be analyzed between maintenance events. Rxi-SVOCms columns are available in 15, 20, and 30 m formats across a range inner diameters and film thicknesses with or without pre-connected guard columns.

Experimental

This application note follows U.S. EPA Method 8270D, Revision 5, July 2014 (SW-846 Update V) guidelines, which provide information on the analysis of 242 compounds. In addition, this method can be used for many other compounds that are soluble in methylene chloride.

Reference Standards

A seven-point calibration curve was prepared at 1.0, 5.0, 10, 20, 40, 80, 120 µg/mL using Restek 8270 reference materials (cat.# 31850, 31852, 31879, 31886, 31888, 31063), giving an on-column range of 0.091 to 11 ng. Since this work was conducted, Restek developed two new reference standard kits that are designed to improve lab efficiency for semivolatile organic compounds analysis: SVOC MegaMix 150 kit (cat.# 31907) and SVOC MegaMix 100 kit (cat.# 31908). These kits are formulated for greater stability, contain 150 or 100 of the most commonly analyzed semivolatiles, and are designed to make it easy to construct a 200 µg/mL working standard, which allows for wider calibration ranges and less need for sample dilution.

Column and Instrument Conditions

The Rxi-SVOCms column was tested in the 30 meter format with a 0.25 mm internal diameter and a 0.25 µm film thickness (cat.# 16623). An Agilent 7890A GC equipped with a split/splitless injection port was used in split mode (10:1) to make 1 µL injections into a Topaz 4.0 mm internal diameter single taper inlet liner with wool (cat.# 23303) at 250 °C. The oven program was optimized using Pro *EZ*GC chromatogram modeling software and was as follows: 60 °C (hold 0.5 min) to 285 °C at 25 °C/min to 305 °C at 3 °C/min to 330 °C at 20 °C/min (hold 5 min). Ultra-high purity (UHP) grade 5.0 helium carrier gas was used with a triple gas filter (cat.# 22020) mounted on a baseplate (cat.# 22025). Helium flow was adjusted to 1.2 mL/min (constant flow). An Agilent 5975C mass spectrometer (MS) was used under the following settings: a scan range of 35 to 500 amu; a scan rate of 5.9 scans per second; a solvent delay time of 1.55 min; an MS transfer line temperature of 280 °C; an inert source with a 6 mm internal diameter drawout plate; a source temperature of 330 °C; and a quadrupole temperature of 180 °C using 70 electron volts for electron ionization (EI).

Results and Discussion

Instrument Tuning

The GC-MS was tuned using perfluorotributylamine (PFTBA); evaluated using 50 ng/µL of (DFTPP); and found to meet the requirements in section 11.3.1 of the method. Three additional compounds in the tuning mix (cat.# 31615) were evaluated to assess injection port and column inertness. DDT breakdown was found to be less than 0.5% as measured by the most common breakdown products, which are 4,4'-dichlorodiphenyldichloroethylene (DDE) and 4,4'-dichlorodiphenyldichloroethane (DDD). Benzidine and pentachlorophenol had tailing factors of 1.10 and 0.96, respectively, which passed the criteria of less than 2. Failure to meet the inertness criteria would have necessitated time-consuming injection port maintenance and clipping or replacing the column. In addition, phenol and 2,4-dinitrophenol, which are notoriously difficult to analyze, had peak tailing factors of less than 1.3.

Critical Separations

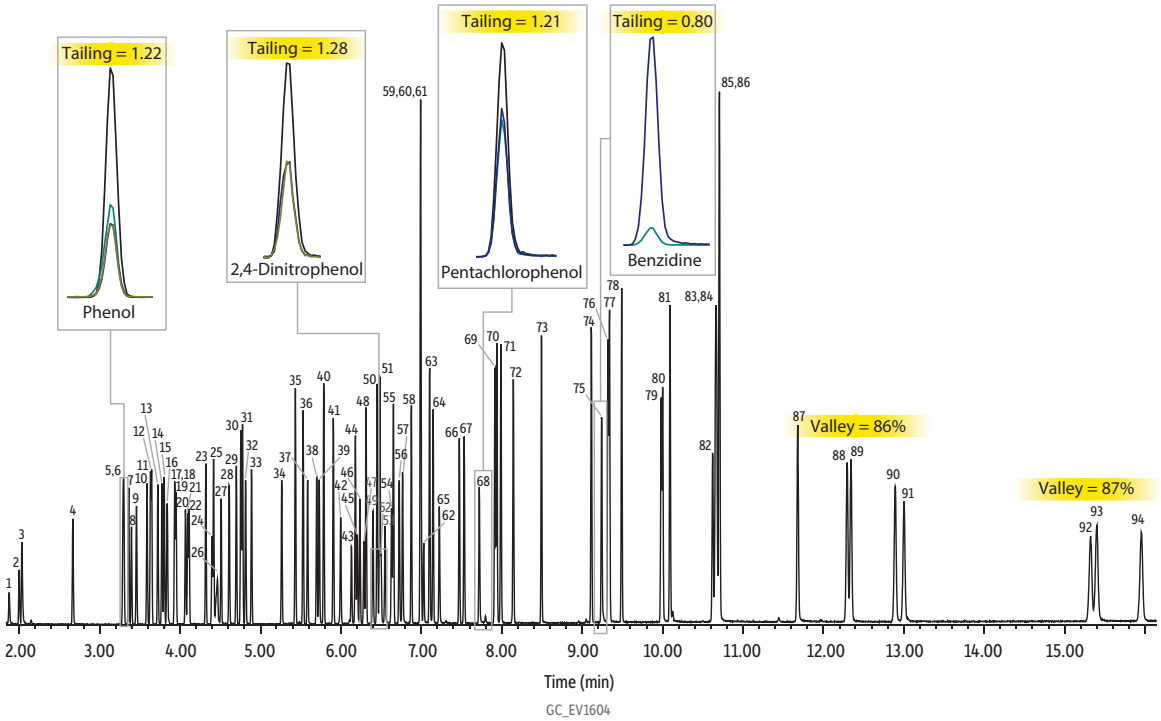
Benzo(b)fluorathene/benzo(k)fluoranthene and indeno(1,2,3,-cd)pyrene/dibenz(a,h)anthracene are structural isomer pairs and should be identified as individual compounds with a minimum resolution of 50%. Under the optimized GC conditions used here, greater than 85% valley was achieved for both isomeric pairs (Figure 1). This degree of resolution afforded by the Rxi-SVOCms column allows method criteria to still be met, even after repeated maintenance has been performed resulting in a meter or more of column having been trimmed off.

Calibration Stability

For the analysis of semivolatile organic compounds by Method 8270D, instrument calibration requires five or more calibration standards covering the sample concentration range to be analyzed without saturating the MS. If more than 10% of the compounds exceed 20% relative standard deviation (RSD) of their mean response factors and do not meet the correlation coefficient requirement (>0.99) for alternative curve fits, then samples cannot be analyzed until maintenance is performed to restore the analytical system. To assess calibration stability, a seven-point calibration curve was prepared at 1.0, 5.0, 10, 20, 40, 80, 120 µg/mL and injected on six Rxi-SVOCms columns. The mean response factor %RSD was an average of 6% across all the target compounds and columns, and all compounds individually met the method criteria except for benzoic acid, which had a response factor %RSD of 25.00%. Calibration ranges and average response factor %RSDs are presented for individual compounds in Table I and demonstrate the consistent calibration performance of Rxi-SVOCms columns.

(Continued on page 4)

Figure 1: Rxi-SVOCms columns provide outstanding chromatographic performance for semivolatile organic compounds analysis, reliably producing good peak shape and resolution even for problematic compounds.



Peaks	t_R (min)	Peaks	t_R (min)	Peaks	t_R (min)	Peaks	t_R (min)
1. (IS) 1,4-Dioxane-d8	1.87	25. 2,4-Dimethylphenol	4.42	49. 3-Nitroaniline	6.40	73. di-*n*-Butyl phthalate	8.49
2. *N*-Nitrosodimethylamine	2.00	26. Benzoic acid	4.46	50. (IS) Acenaphthene-D10	6.45	74. Fluoranthene	9.12
3. Pyridine	2.03	27. Bis(2-chloroethoxy)methane	4.51	51. Acenaphthene	6.48	75. Benzidine	9.24
4. (SS) 2-Fluorophenol	2.67	28. 2,4-Dichlorophenol	4.61	52. 2,4-Dinitrophenol	6.50	76. (SS) Pyrene-D10	9.32
5. (SS) Phenol-d6	3.29	29. 1,2,4-Trichlorobenzene	4.70	53. 4-Nitrophenol	6.55	77. Pyrene	9.34
6. Phenol	3.30	30. (IS) Naphthalene-D8	4.76	54. 2,4-Dinitrotoluene	6.63	78. (SS) *p*-Terphenyl-d14	9.49
7. Aniline	3.36	31. Naphthalene	4.78	55. Dibenzofuran	6.65	79. 3,3'-Dimethylbenzidine	9.98
8. Bis(2-chloroethyl) ether	3.40	32. 4-Chloroaniline	4.82	56. 2,3,5,6-Tetrachlorophenol	6.73	80. Butyl benzyl phthalate	10.00
9. 2-Chlorophenol	3.46	33. Hexachlorobutadiene	4.89	57. 2,3,4,6-Tetrachlorophenol	6.77	81. Bis(2-ethylhexyl) adipate	10.09
10. 1,3-Dichlorobenzene	3.59	34. 4-Chloro-3-methylphenol	5.26	58. Diethyl phthalate	6.88	82. 3,3'-Dichlorobenzidine	10.62
11. (IS) 1,4-Dichlorobenzene-D4	3.63	35. 2-Methylnaphthalene	5.43	59. 4-Chlorophenyl phenyl ether	6.99	83. Benz[a]anthracene	10.66
12. 1,4-Dichlorobenzene	3.65	36. 1-Methylnaphthalene	5.53	60. Fluorene	6.99	84. (IS) Chrysene-D12	10.67
13. Benzyl alcohol	3.72	37. Hexachlorocyclopentadiene	5.59	61. 4-Nitroaniline	7.00	85. Chrysene	10.71
14. 1,2-Dichlorobenzene	3.78	38. 2,4,6-Trichlorophenol	5.70	62. 4,6-Dinitro-2-methylphenol	7.03	86. Bis(2-ethylhexyl) phthalate	10.71
15. 2-Methylphenol	3.80	39. 2,4,5-Trichlorophenol	5.73	63. *N*-Nitrosodiphenylamine	7.10	87. Di-*n*-octyl phthalate	11.68
16. Bis(2-Chloroisopropyl)ether	3.84	40. (SS) 2-Fluorobiphenyl	5.79	64. *N,N*-Diphenylhydrazine	7.15	88. Benzo[b]fluoranthene	12.30
17. 4-Methylphenol	3.93	41. 2-Chloronaphthalene	5.91	65. (SS) 2,4,6-Tribromophenol	7.23	89. Benzo[k]fluoranthene	12.34
18. 3-Methylphenol	3.93	42. 2-Nitroaniline	6.00	66. 4-Bromophenyl phenyl ether	7.47	90. Benzo[a]pyrene	12.89
19. *N*-Nitrosodi-*N*-propylamine	3.95	43. 1,4-Dinitrobenzene	6.13	67. Hexachlorobenzene	7.53	91. (IS) Perylene-D12	13.00
20. Hexachloroethane	4.07	44. Dimethyl phthalate	6.18	68. Pentachlorophenol	7.72	92. Indeno[1,2,3-cd]pyrene	15.32
21. (SS) Nitrobenzene-D5	4.10	45. 1,3-Dinitrobenzene	6.20	69. (IS) Phenanthrene-D10	7.92	93. Dibenz[a,h]anthracene	15.40
22. Nitrobenzene	4.11	46. 2,6-Dinitrotoluene	6.24	70. Phenanthrene	7.94	94. Benzo[ghi]perylene	15.95
23. Isophorone	4.32	47. 1,2-Dinitrobenzene	6.29	71. Anthracene	7.99		
24. 2-Nitrophenol	4.40	48. Acenaphthylene	6.31	72. Carbazole	8.15	All compounds are 2 ng on column.	

Column	Rxi-SVOCms, 30 m, 0.25 mm ID, 0.25 µm (cat.# 16623)
Standard/Sample	8270 MegaMix standard (cat.# 31850) 8270 Benzidines mix (cat.# 31852) Benzoic acid (cat.# 31879) Revised SV internal standard mix (cat.# 31886) Revised B/N surrogate mix (cat.# 31888) Acid surrogate mix (cat.# 31063)
Diluent:	Dichloromethane
Conc.:	20 µg/mL
Injection	
Inj. Vol.:	1 µL split (split ratio 10:1)
Liner:	Topaz 4.0 mm ID single taper inlet liner with wool (cat.# 23303)
Inj. Temp.:	250 °C
Split Vent Flow Rate:	12 mL/min
Oven	
Oven Temp.:	60 °C (hold 0.5 min) to 285 °C at 25 °C/min to 305 °C at 3 °C/min to 330 °C at 20 °C/min (hold 5 min)
Carrier Gas	He, constant flow
Flow Rate:	1.2 mL/min
Detector	MS
Mode:	Scan

Scan Program:

Group	Start Time (min)	Scan Range (amu)	Scan Rate (scans/sec)
1	1.55	35-500	5.9

Transfer Line Temp.:	280 °C
Analyzer Type:	Quadrupole
Source Type:	Inert
Drawout Plate:	6 mm ID
Source Temp.:	330 °C
Quad Temp.:	180 °C
Electron Energy:	70 eV
Tune Type:	DFTPP
Ionization Mode:	EI
Instrument	Agilent 7890A GC & 5975C MSD
Sample Preparation	Samples were aliquoted into amber 2 mL, 9 mm short-cap, screw-thread vials (cat.# 21143) containing glass Big Mouth inserts (cat.# 21782) and sealed with 2.0 mL, 9 mm short-cap, screw-vial closures (cat.# 23842).

Table I: Stable performance means fewer recalibrations and more time available for running samples, which improves lab productivity. Green indicates passing initial calibrations (n = 6 columns).

Compound	Calibration Range (µg/mL)	Average %RSD of Response Factors
N-Nitrosodimethylamine	1 - 120	4.70%
Pyridine	1 - 120	6.10%
(SS) 2-Fluorophenol	1 - 120	1.70%
(SS) Phenol-d6	1 - 120	2.10%
Phenol	1 - 120	3.20%
Aniline	1 - 120	3.10%
Bis(2-chloroethyl)ether	1 - 120	2.40%
2-chlorophenol	1 - 120	2.80%
1,3-dichlorobenzene	1 - 120	2.60%
1,4-Dichlorobenzene	1 - 120	2.10%
Benzyl alcohol	1 - 120	3.30%
1,2-Dichlorobenzene	1 - 120	2.70%
2-Methylphenol	1 - 120	3.30%
Bis(2-chloroisopropyl)ether	1 - 120	2.40%
4-Methylphenol/3-methylphenol	1 - 120	3.30%
N-nitroso-di-*n*-propylamine	1 - 120	3.80%
Hexachloroethane	1 - 120	3.00%
(SS) Nitrobenzene-D5	1 - 120	1.60%
Nitrobenzene	1 - 120	2.60%
Isophorone	1 - 120	3.40%
2-Nitrophenol	1 - 120	7.00%
2,4-Dimethylphenol	1 - 120	3.70%
Benzoic acid	2.5 - 120	25.00%
Bis(2-chloroethoxy)methane	1 - 120	3.60%
2,4-Dichlorophenol	1 - 120	4.10%
1,2,4-Trichlorobenzene	1 - 120	2.80%
Naphthalene	1 - 120	3.20%
4-Chloroaniline	1 - 120	3.90%
Hexachlorobutadiene	1 - 120	3.70%

Compound	Calibration Range (µg/mL)	Average %RSD of Response Factors
4-Chloro-3-methylphenol	1 - 120	4.40%
2-Methylnaphthalene	1 - 120	3.40%
1-Methylnaphthalene	1 - 120	3.60%
Hexachlorocyclopentadiene	1 - 120	6.90%
2,4,6-Trichlorophenol	1 - 120	5.90%
2,4,5-Trichlorophenol	1 - 120	6.20%
(SS) 2-Fluorobiphenyl	1 - 120	1.10%
2-Chloronaphthalene	1 - 120	2.80%
2-Nitroaniline	1 - 120	7.80%
1,4-Dinitrobenzene	1 - 120	11.10%
Dimethyl phthalate	1 - 120	3.40%
1,3-Dinitrobenzene	1 - 120	10.80%
2,6-Dinitrotoluene	1 - 120	7.80%
Acenaphthylene	1 - 120	4.10%
1,2-Dinitrobenzene	1 - 120	8.10%
3-Nitroaniline	1 - 120	5.80%
Acenaphthene	1 - 120	3.30%
2,4-Dinitrophenol	2.5 - 120	17.30%
4-Nitrophenol	1 - 120	7.90%
Dibenzofuran	1 - 120	3.50%
2,4-Dinitrotoluene	1 - 120	11.60%
2,3,5,6-Tetrachlorophenol	1 - 120	10.40%
2,3,4,6-Tetrachlorophenol	1 - 120	7.30%
Diethyl phthalate	1 - 120	4.50%
4-Chlorophenyl phenyl ether	1 - 120	3.60%
Fluorene	1 - 120	4.40%
4-Nitroaniline	1 - 120	9.10%
4,6-Dinitro-2-methylphenol	2.5 -120	15.10%
N-nitrosodiphenylamine	1 - 120	4.60%

Compound	Calibration Range (µg/mL)	Average %RSD of Response Factors
Diphenylhydrazine	1 - 120	4.60%
(SS) 2,4,6-Tribromophenol	1 - 120	5.50%
4-Bromophenyl phenyl ether	1 - 120	5.50%
Hexachlorobenzene	1 - 120	4.30%
Pentachlorophenol	1 - 120	10.60%
Phenanthrene	1 - 120	3.70%
Anthracene	1 - 120	4.80%
Carbazole	1 - 120	5.30%
di-*n*-Butyl phthalate	1 - 120	7.90%
Fluoranthene	1 - 120	5.10%
Benzidine	1 - 120	9.30%
(SS) Pyrene-D10	1 - 120	1.50%
Pyrene	1 - 120	4.30%
(SS) *p*-Terphenyl-d14	1 - 120	1.80%
3,3'-Dimethylbenzidine	1 - 120	9.50%
Butyl benzyl phthalate	1 - 120	8.60%
Bis(2-ethylhexyl)adipate	1 - 120	10.50%
3,3'-Dichlorobenzidine	1 - 120	8.50%
Benz[a]anthracene	1 - 120	3.20%
Chrysene	1 - 120	3.70%
Bis(2-ethylhexyl)phthalate	1 - 120	10.40%
Di-*n*-octyl phthalate	1 - 120	13.20%
Benzo[b]fluoranthene	1 - 120	5.60%
Benzo[k]fluoranthene	1 - 120	4.90%
Benzo[a]pyrene	1 - 120	6.30%
Indeno[123-cd]pyrene	1 - 120	7.20%
Dibenz[a,h]anthracene	1 - 120	7.50%
Benzo[ghi]perylene	1 - 120	6.40%
	Average %RSD:	**6.00%**

Conclusions

As demonstrated here, Rxi-SVOCms columns provided rugged performance for semivolatile organic compounds analysis, reliably resolving critical pairs and meeting method requirements. Under the instrument conditions used here, which were optimized using Pro *EZ*GC chromatogram modeling software, these highly inert GC columns, with selectivity developed specifically for semivolatiles, provide exceptional performance for a wide range of acidic, basic, and neutral compounds. By using Rxi-SVOCms columns to keep calibration checks passing longer, labs can improve productivity by reducing the frequency of maintenance and recalibration.

Named Best New Separations Product of the Year in SelectScience Scientists' Choice Awards, as voted by scientists around the world.

Rxi-SVOCms GC Capillary Column

- Column chemistry optimized specifically to give premium performance for semivolatiles in complex matrices.
- Long column lifetime—restore performance with a quick trim instead of a time-consuming replacement.
- Outstanding inertness keeps calibrations passing and samples running.
- Excellent resolution of critical pairs for improved accuracy.
- Consistent column-to-column performance.
- Engineered to be a low-bleed GC-MS column.
- Temperature range: -60 °C to 340 °C.
- Equivalent to USP G27 and G36 phases.

Internal Diameter (ID)	df (Film Thickness)	Length	Units.	Modification	cat.#
0.25 mm	0.25 µm	30 m	ea.	-	16623
0.25 mm	0.25 µm	30 m	ea.	w/5 m, 0.25 mm ID Rxi guard column pre-connected w/SilTite µ-Union connector	16623-371

Topaz 4.0 mm ID Single Taper Inlet Liner w/ Wool

for Agilent GCs equipped with split/splitless inlets

ID x OD x Length	Packing	qty	Similar to Part #	cat.#
4.0 mm x 6.5 mm x 78.5 mm	Quartz Wool	5-pk.	Agilent 5062-3587 (ea.); 5183-4693 (5-pk.); 5183-4694 (25-pk.); 5190-2293 (ea.); 5190-3163 (5-pk.); 5190-3167 (25-pk.); 5190-3171 (100-pk.)	23303

GC_MS Mass Spec Cleaning Kit with Rotary Tool

Poor sensitivity, loss of sensitivity at high masses, or high multiplier gain during an auto-tune are all indicators that your mass spectrometer source may need to be cleaned. Restek has assembled all of the necessary components for cleaning and polishing your ion source.

Description	Units	cat.#
GC_MS Mass Spec Cleaning Kit with Rotary Tool	Kit	27194

Restek Electronic Leak Detector

- Detects a broad range of gases and indicates leak severity with both an LED display and audible tone.
- No more waiting for a full charge—can be operated during charging or used up to 12 hours between charges.
- Charging kit includes both universal AC power adaptor and USB charging cable, so you can charge anywhere, anytime.
- Pinpoint very small gas leaks quickly and accurately before they cause damage and downtime.
- Compact, handheld unit is easy to operate and convenient to use anywhere you need to check for leaks.

Description	Units	cat.#
Restek Electronic Leak Detector (includes: carrying case, universal AC power adaptor [U.S., UK, Europe, Australia, Japan], 6-ft USB charging cable)	ea.	28500

SVOC MegaMix 150 Kit (150 components)

- Streamline operations: kit contains 150 of the most frequently analyzed semivolatiles.
- Designed to make it easy to construct a 200 µg/mL working standard, allowing for wider calibration ranges, and reducing the need for sample dilution.
- Formulated for greater stability to ensure more accurate data.
- Available in two independently manufactured lots with verified lot-to-lot agreement, reducing uncertainty and improving quality.

Contains one ampul of each of the following: 8270 MegaMix (cat.# 31850); SVOC Additions standard (cat.# 31909); Appendix IX mix #1, revised (cat.# 32459); Methapyrilene (cat.# 32460); Appendix IX mix #2 (cat.# 31806); Benzoic acid (cat.# 31879)

U.S. DEA-exempted formulation—no additional customer permits or licensing are required to purchase within the U.S.

Also available: SVOC MegaMix 100 kit (cat.# 31908) contains 100 of the most frequently analyzed semivolatiles (does not contain Appendix IX mixes or methapyrilene).

Cat.# 31850—8270 MegaMix: 1000 µg/mL each in methylene chloride (3-methylphenol and 4-methylphenol at 500 µg/mL); 1 mL/ampul
Acenaphthene (83-32-9)
Acenaphthylene (208-96-8)
Aniline (62-53-3)
Anthracene (120-12-7)
Azobenzene (103-33-3)*
Benz[a]anthracene (56-55-3)
Benzo[a]pyrene (50-32-8)
Benzo[b]fluoranthene (205-99-2)
Benzo[g,h,i]perylene (191-24-2)
Benzo[k]fluoranthene (207-08-9)
Benzyl alcohol (100-51-6)
Benzyl butyl phthalate (85-68-7)
Bis(2-chloroethoxy)methane (111-91-1)
Bis(2-chloroethyl)ether (111-44-4)
Bis(2-ethylhexyl)adipate (103-23-1)
Bis(2-ethylhexyl)phthalate (117-81-7)
4-Bromophenyl phenyl ether (101-55-3)
Carbazole (86-74-8)
4-Chloroaniline (106-47-8)
4-Chloro-3-methylphenol (59-50-7)
2-Chloronaphthalene (91-58-7)
2-Chlorophenol (95-57-8)
4-Chlorophenyl phenyl ether (7005-72-3)
Chrysene (218-01-9)
Dibenz[a,h]anthracene (53-70-3)
Dibenzofuran (132-64-9)
1,2-Dichlorobenzene (95-50-1)
1,3-Dichlorobenzene (541-73-1)
1,4-Dichlorobenzene (106-46-7)
2,4-Dichlorophenol (120-83-2)
Diethylphthalate (84-66-2)
2,4-Dimethylphenol (105-67-9)
Dimethylphthalate (131-11-3)
Di-*n*-butyl phthalate (84-74-2)
1,2-Dinitrobenzene (528-29-0)
1,3-Dinitrobenzene (99-65-0)
1,4-Dinitrobenzene (100-25-4)
4,6-Dinitro-2-methylphenol (Dinitro-*o*-cresol) (534-52-1)
2,4-Dinitrophenol (51-28-5)
2,4-Dinitrotoluene (121-14-2)
2,6-Dinitrotoluene (606-20-2)
Di-*n*-octyl phthalate (117-84-0)
Diphenylamine (122-39-4)†
Fluoranthene (206-44-0)
Fluorene (86-73-7)
Hexachlorobenzene (118-74-1)
Hexachlorobutadiene (87-68-3)
Hexachlorocyclopentadiene (77-47-4)
Hexachloroethane (67-72-1)
Indeno[1,2,3-cd]pyrene (193-39-5)
Isophorone (78-59-1)
1-Methylnaphthalene (90-12-0)
2-Methylnaphthalene (91-57-6)
2-Methylphenol (*o*-cresol) (95-48-7)
3-Methylphenol (*m*-cresol) (108-39-4)
4-Methylphenol (*p*-cresol) (106-44-5)
Naphthalene (91-20-3)
2-Nitroaniline (88-74-4)
3-Nitroaniline (99-09-2)
4-Nitroaniline (100-01-6)
Nitrobenzene (98-95-3)
2-Nitrophenol (88-75-5)
4-Nitrophenol (100-02-7)
N-Nitrosodimethylamine (62-75-9)
N-Nitroso-di-*n*-propylamine (621-64-7)
2,2'-Oxybis(1-chloropropane) (108-60-1)
Pentachlorophenol (87-86-5)
Phenanthrene (85-01-8)
Phenol (108-95-2)
Pyrene (129-00-0)
Pyridine (110-86-1)
2,3,4,6-Tetrachlorophenol (58-90-2)
2,3,5,6-Tetrachlorophenol (935-95-5)
1,2,4-Trichlorobenzene (120-82-1)
2,4,5-Trichlorophenol (95-95-4)
2,4,6-Trichlorophenol (88-06-2)

*1,2-diphenylhydrazine (8270-listed analyte) decomposes to azobenzene (mix component) in the injector.
†N-nitrosodiphenylamine (8270-listed analyte) decomposes to diphenylamine (mix component) in the injector.

Cat.# 31909—SVOC Additions; 1000 µg/mL each in methylene chloride; 1 mL/ampul
Acrylamide (79-06-1)
Benzidine (92-87-5)
n-Decane (C10) (124-18-5)
Dibenz(a,h)acridine (226-36-8)
2,3-Dichloroaniline (608-27-5)
3,3'-Dichlorobenzidine (91-94-1)
Dimethoate (60-51-5)
Dinoseb (88-85-7)
Disulfoton (298-04-4)
Famphur (52-85-7)
n-Hexadecane (C16) (544-76-3)
Indene (95-13-6)
Methyl parathion (298-00-0)
6-Methylchrysene (1705-85-7)
4,4'-Methylene-bis(2-chloroaniline) (101-14-4)
n-Octadecane (C18) (593-45-3)
Parathion (ethyl parathion) (56-38-2)
Phorate (298-02-2)
Quinoline (91-22-5)
Sulfotepp (3689-24-5)
α-Terpineol (98-55-5)
O,O,O-Triethyl phosphorothioate (126-68-1)
Zalophus (thionazine) (297-97-2)

Cat.# 32459—Appendix IX mix #1, revised; 2000 µg/mL each in methylene chloride; 1 mL/ampul
2-Acetylaminofluorene (53-96-3)
4-Aminobiphenyl (92-67-1)
p-Dimethylaminoazobenzene (60-11-7)
3,3'-Dimethylbenzidine (*o*-tolidine) (119-93-7)
α,α-Dimethylphenethylamine (phentermine) (122-09-8)
1-Naphthylamine (1-aminonaphthalene) (134-32-7)
2-Naphthylamine (2-aminonaphthalene) (91-59-8)
N-Nitrosodibutylamine (924-16-3)
N-Nitrosodiethylamine (55-18-5)
N-Nitrosomethylethylamine (10595-95-6)
N-Nitrosomorpholine (59-89-2)
N-Nitrosopiperidine (100-75-4)
N-Nitrosopyrrolidine (930-55-2)
5-Nitro-*o*-toluidine (99-55-8)
1,4-Phenylenediamine (106-50-3)
2-Picoline (109-06-8)
o-Toluidine (95-53-4)

Cat.# 32460—Methapyrilene; 2000 µg/mL in methylene chloride; 1 mL/ampul
Methapyrilene hydrochloride (135-23-9)

Cat.# 31806—Appendix IX mix #2; 1000 µg/mL each in methylene chloride; 1 mL/ampul
Acetophenone (98-86-2)
Aramite (140-57-8)
Atrazine (1912-24-9)
Benzaldehyde (100-52-7)
Biphenyl (92-52-4)
ε-Caprolactam (105-60-2)
Chlorobenzilate (510-15-6)
1-Chloronaphthalene (90-13-1)
Diallate (2303-16-4)
Dibenz[a,j]acridine (224-42-0)
2,6-Dichlorophenol (87-65-0)
7,12-Dimethylbenz[a]anthracene (57-97-6)
1,4-Dioxane (123-91-1)
Diphenyl ether (101-84-8)
Ethyl methacrylate (97-63-2)
Ethyl methanesulfonate (62-50-0)
Hexachloropropene (1888-71-7)
Isodrin (465-73-6)
Isosafrole (*cis* & *trans*) (120-58-1)
Kepone (143-50-0)
3-Methylcholanthrene (56-49-5)
Methyl methanesulfonate (66-27-3)
1,4-Naphthoquinone (130-15-4)
4-Nitroquinoline-N-oxide (56-57-5)
Pentachlorobenzene (608-93-5)
Pentachloroethane (76-01-7)
Pentachloronitrobenzene (Quintozene) (82-68-8)
Phenacetin (62-44-2)
Propyzamide (23950-58-5)
Safrole (94-59-7)
1,2,4,5-Tetrachlorobenzene (95-94-3)
1,3,5-Trinitrobenzene (99-35-4)

Cat.# 31879—Benzoic acid: 2000 µg/mL in methylene chloride; 1 mL/ampul
Benzoic acid (65-85-0)

Description	Conc. in Solvent	CRM?	DEA Status	Min Shelf Life on Ship Date	Max Shelf Life on Ship Date	Shipping Conditions	Storage Temp.	qty.	cat.#
SVOC MegaMix 150 kit	1 mL/ampul; 6 ampuls/kit	Yes	Exempt	6 months	18 months	Ambient	0 °C or colder	kit	31907

ordering notes

Ships under Restek's USDOT explosives approval.

SVOC MegaMix 100 Kit (100 components)

- Streamline operations: kit contains 100 of the most frequently analyzed semivolatiles.
- Designed to make it easy to construct a 200 µg/mL working standard, allowing for wider calibration ranges, and reducing the need for sample dilution.
- Formulated for greater stability to ensure more accurate data.
- Available in two independently manufactured lots with verified lot-to-lot agreement, reducing uncertainty and improving quality.

Contains one ampul of each of the following: 8270 MegaMix (cat.# 31850); SVOC Additions standard (cat.# 31909); Benzoic acid (cat.# 31879)

Also available: SVOC MegaMix 150 kit (cat.# 31907) contains 150 of the most frequently analyzed semivolatiles.

Cat.# 31850—8270 MegaMix: 1000 µg/mL each in methylene chloride (3-methylphenol and 4-methylphenol at 500 µg/mL); 1 mL/ampul
Acenaphthene (83-32-9)
Acenaphthylene (208-96-8)
Aniline (62-53-3)
Anthracene (120-12-7)
Azobenzene (103-33-3)*
Benz[a]anthracene (56-55-3)
Benzo[a]pyrene (50-32-8)
Benzo[b]fluoranthene (205-99-2)
Benzo[g,h,i]perylene (191-24-2)
Benzo[k]fluoranthene (207-08-9)
Benzyl alcohol (100-51-6)
Benzyl butyl phthalate (85-68-7)
Bis(2-chloroethoxy)methane (111-91-1)
Bis(2-chloroethyl)ether (111-44-4)
Bis(2-ethylhexyl)adipate (103-23-1)
Bis(2-ethylhexyl)phthalate (117-81-7)
4-Bromophenyl phenyl ether (101-55-3)
Carbazole (86-74-8)
4-Chloroaniline (106-47-8)
4-Chloro-3-methylphenol (59-50-7)
2-Chloronaphthalene (91-58-7)
2-Chlorophenol (95-57-8)
4-Chlorophenyl phenyl ether (7005-72-3)
Chrysene (218-01-9)
Dibenz[a,h]anthracene (53-70-3)
Dibenzofuran (132-64-9)
1,2-Dichlorobenzene (95-50-1)
1,3-Dichlorobenzene (541-73-1)
1,4-Dichlorobenzene (106-46-7)
2,4-Dichlorophenol (120-83-2)
Diethylphthalate (84-66-2)
2,4-Dimethylphenol (105-67-9)
Dimethylphthalate (131-11-3)
Di-*n*-butyl phthalate (84-74-2)
1,2-Dinitrobenzene (528-29-0)
1,3-Dinitrobenzene (99-65-0)
1,4-Dinitrobenzene (100-25-4)
4,6-Dinitro-2-methylphenol (Dinitro-*o*-cresol) (534-52-1)
2,4-Dinitrophenol (51-28-5)
2,4-Dinitrotoluene (121-14-2)
2,6-Dinitrotoluene (606-20-2)
Di-*n*-octyl phthalate (117-84-0)
Diphenylamine (122-39-4)†
Fluoranthene (206-44-0)
Fluorene (86-73-7)
Hexachlorobenzene (118-74-1)
Hexachlorobutadiene (87-68-3)
Hexachlorocyclopentadiene (77-47-4)
Hexachloroethane (67-72-1)
Indeno[1,2,3-cd]pyrene (193-39-5)
Isophorone (78-59-1)
1-Methylnaphthalene (90-12-0)
2-Methylnaphthalene (91-57-6)
2-Methylphenol (*o*-cresol) (95-48-7)
3-Methylphenol (*m*-cresol) (108-39-4)
4-Methylphenol (*p*-cresol) (106-44-5)
Naphthalene (91-20-3)
2-Nitroaniline (88-74-4)
3-Nitroaniline (99-09-2)
4-Nitroaniline (100-01-6)
Nitrobenzene (98-95-3)
2-Nitrophenol (88-75-5)
4-Nitrophenol (100-02-7)
N-Nitrosodimethylamine (62-75-9)
N-Nitroso-di-*n*-propylamine (621-64-7)
2,2'-Oxybis(1-chloropropane) (108-60-1)
Pentachlorophenol (87-86-5)
Phenanthrene (85-01-8)
Phenol (108-95-2)
Pyrene (129-00-0)
Pyridine (110-86-1)
2,3,4,6-Tetrachlorophenol (58-90-2)
2,3,5,6-Tetrachlorophenol (935-95-5)
1,2,4-Trichlorobenzene (120-82-1)
2,4,5-Trichlorophenol (95-95-4)
2,4,6-Trichlorophenol (88-06-2)

*1,2-diphenylhydrazine (8270-listed analyte) decomposes to azobenzene (mix component) in the injector.
†N-nitrosodiphenylamine (8270-listed analyte) decomposes to diphenylamine (mix component) in the injector.

Cat.# 31909—SVOC Additions: 1000 µg/mL each in methylene chloride; 1 mL/ampul
Acrylamide (79-06-1)
Benzidine (92-87-5)
n-Decane (C10) (124-18-5)
Dibenz(a,h)acridine (226-36-8)
2,3-Dichloroaniline (608-27-5)
3,3'-Dichlorobenzidine (91-94-1)
Dimethoate (60-51-5)
Dinoseb (88-85-7)
Disulfoton (298-04-4)
Famphur (52-85-7)
n-Hexadecane (C16) (544-76-3)
Indene (95-13-6)
Methyl parathion (298-00-0)
6-Methylchrysene (1705-85-7)
4,4'-Methylene-bis(2-chloroaniline) (101-14-4)
n-Octadecane (C18) (593-45-3)
Parathion (ethyl parathion) (56-38-2)
Phorate (298-02-2)
Quinoline (91-22-5)
Sulfotepp (3689-24-5)
α-Terpineol (98-55-5)
O,O,O-Triethyl phosphorothioate (126-68-1)
Zalophus (thionazine) (297-97-2)

Cat.# 31879—Benzoic acid: 2000 µg/mL in methylene chloride; 1 mL/ampul
Benzoic acid (65-85-0)

Description	Conc. in Solvent	CRM?	Min Shelf Life on Ship Date	Max Shelf Life on Ship Date	Shipping Conditions	Storage Temp.	qty.	cat.#
SVOC MegaMix 100 kit	1 mL/ampul: 3 ampuls/kit	Yes	6 months	18 months	Ambient	0 °C or colder	kit	31908

8270 MegaMix Standard (76 components)

Acenaphthene (83-32-9)
Acenaphthylene (208-96-8)
Aniline (62-53-3)
Anthracene (120-12-7)
Azobenzene (103-33-3)*
Benz[a]anthracene (56-55-3)
Benzo[a]pyrene (50-32-8)
Benzo[b]fluoranthene (205-99-2)
Benzo[g,h,i]perylene (191-24-2)
Benzo[k]fluoranthene (207-08-9)
Benzyl alcohol (100-51-6)
Benzyl butyl phthalate (85-68-7)
Bis(2-chloroethoxy)methane (111-91-1)
Bis(2-chloroethyl)ether (111-44-4)
Bis(2-ethylhexyl)adipate (103-23-1)
Bis(2-ethylhexyl)phthalate (117-81-7)
4-Bromophenyl phenyl ether (101-55-3)
Carbazole (86-74-8)
4-Chloroaniline (106-47-8)
4-Chloro-3-methylphenol (59-50-7)
2-Chloronaphthalene (91-58-7)
2-Chlorophenol (95-57-8)
4-Chlorophenyl phenyl ether (7005-72-3)
Chrysene (218-01-9)
Dibenz[a,h]anthracene (53-70-3)
Dibenzofuran (132-64-9)
1,2-Dichlorobenzene (95-50-1)
1,3-Dichlorobenzene (541-73-1)
1,4-Dichlorobenzene (106-46-7)
2,4-Dichlorophenol (120-83-2)
Diethylphthalate (84-66-2)
2,4-Dimethylphenol (105-67-9)
Dimethylphthalate (131-11-3)
Di-*n*-butyl phthalate (84-74-2)
1,2-Dinitrobenzene (528-29-0)
1,3-Dinitrobenzene (99-65-0)
1,4-Dinitrobenzene (100-25-4)
4,6-Dinitro-2-methylphenol (Dinitro-*o*-cresol) (534-52-1)
2,4-Dinitrophenol (51-28-5)
2,4-Dinitrotoluene (121-14-2)
2,6-Dinitrotoluene (606-20-2)
Di-*n*-octyl phthalate (117-84-0)
Diphenylamine (122-39-4)†
Fluoranthene (206-44-0)
Fluorene (86-73-7)
Hexachlorobenzene (118-74-1)
Hexachlorobutadiene (87-68-3)
Hexachlorocyclopentadiene (77-47-4)
Hexachloroethane (67-72-1)
Indeno[1,2,3-cd]pyrene (193-39-5)
Isophorone (78-59-1)
1-Methylnaphthalene (90-12-0)
2-Methylnaphthalene (91-57-6)
2-Methylphenol (*o*-cresol) (95-48-7)
3-Methylphenol (*m*-cresol) (108-39-4)
4-Methylphenol (*p*-cresol) (106-44-5)
Naphthalene (91-20-3)
2-Nitroaniline (88-74-4)
3-Nitroaniline (99-09-2)
4-Nitroaniline (100-01-6)
Nitrobenzene (98-95-3)
2-Nitrophenol (88-75-5)
4-Nitrophenol (100-02-7)
N-Nitrosodimethylamine (62-75-9)
N-Nitroso-di-*n*-propylamine (621-64-7)
2,2'-Oxybis(1-chloropropane) (108-60-1)
Pentachlorophenol (87-86-5)
Phenanthrene (85-01-8)
Phenol (108-95-2)
Pyrene (129-00-0)
Pyridine (110-86-1)
2,3,4,6-Tetrachlorophenol (58-90-2)
2,3,5,6-Tetrachlorophenol (935-95-5)
1,2,4-Trichlorobenzene (120-82-1)
2,4,5-Trichlorophenol (95-95-4)
2,4,6-Trichlorophenol (88-06-2)

Conc. in Solvent	CRM?	Min Shelf Life on Ship Date	Max Shelf Life on Ship Date	Shipping Conditions	Storage Temp.	qty.	cat.#
1000 µg/mL each in methylene chloride (3-methylphenol and 4-methylphenol at 500 µg/mL); 1 mL/ampul	Yes	6 months	18 months	Ambient	0 °C or colder	ea.	31850

*1,2-diphenylhydrazine (8270-listed analyte) decomposes to azobenzene (mix component) in the injector.
†N-nitrosodiphenylamine (8270-listed analyte) decomposes to diphenylamine (mix component) in the injector.

8270 Benzidines Mix (3 components)

Benzidine (92-87-5) 3,3'-Dichlorobenzidine (91-94-1) 3,3'-Dimethylbenzidine (*o*-tolidine) (119-93-7)

Conc. in Solvent	CRM?	Min Shelf Life on Ship Date	Max Shelf Life on Ship Date	Shipping Conditions	Storage Temp.	qty.	cat.#
2000 µg/mL each in methylene chloride; 1 mL/ampul	Yes	6 months	55 months	Ambient	10 °C or colder	ea.	31852

Benzoic Acid

Benzoic acid (65-85-0)

Description	CAS #	Conc. in Solvent	CRM?	Min Shelf Life on Ship Date	Max Shelf Life on Ship Date	Shipping Conditions	Storage Temp.	qty.	cat.#
Benzoic acid	65-85-0	2000 µg/mL in methylene chloride; 1 mL/ampul	Yes	6 months	48 months	Ambient	10 °C or colder	ea.	31879

Revised SV Internal Standard Mix

(7 components)

Acenaphthene-d10 (15067-26-2)
Chrysene-d12 (1719-03-5)
1,4-Dichlorobenzene-d4 (3855-82-1)
1,4-Dioxane-d8 (17647-74-4)
Naphthalene-d8 (1146-65-2)
Perylene-d12 (1520-96-3)
Phenanthrene-d10 (1517-22-2)

Conc. in Solvent	CRM?	Min Shelf Life on Ship Date	Max Shelf Life on Ship Date	Shipping Conditions	Storage Temp.	qty.	cat.#
4000 µg/mL each in methylene chloride; 1 mL/ampul	Yes	6 months	71 months	Ambient	10 °C or colder	ea.	31886

Revised B/N Surrogate Mix

(4 components)

2-Fluorobiphenyl (321-60-8) Nitrobenzene-d5 (4165-60-0) *p*-Terphenyl-d14 (1718-51-0) Pyrene-d10 (1718-52-1)

Conc. in Solvent	CRM?	Min Shelf Life on Ship Date	Max Shelf Life on Ship Date	Shipping Conditions	Storage Temp.	qty.	cat.#
5000 µg/mL each in methylene chloride; 1 mL/ampul	Yes	6 months	71 months	Ambient	10 °C or colder	ea.	31888

Acid Surrogate Mix (4/89 SOW)

(3 components)

2-Fluorophenol (367-12-4) Phenol-d6 (13127-88-3) 2,4,6-Tribromophenol (118-79-6)

Conc. in Solvent	CRM?	Min Shelf Life on Ship Date	Max Shelf Life on Ship Date	Shipping Conditions	Storage Temp.	qty.	cat.#
10,000 µg/mL each in methanol; 1 mL/ampul	Yes	6 months	60 months	Ambient	10 °C or colder	ea.	31063

2.0 mL, 9 mm Short-Cap, Screw-Thread Vials (vial only)

Fit all 2.0 mL, 12 x 32 mm, screw-thread 9 mm/425 vial-based autosamplers.

Description	Type	Volume	Color	Size	qty.	Similar to Part #	cat.#
Short-Cap Vial, w/White Graduated Marking Spot	9-425 Screw-Thread	2.0 mL	Amber	12 x 32 mm	1000-pk.	Agilent 5183-2069	21143

Inserts for 2.0 mL, 11 mm Crimp-Top, 2.0 mL, 9 mm Short-Cap, Screw-Thread, and 2.0 mL, 10 mm Big Mouth Screw-Thread Vials

Description	Volume	Material	Used with	qty.	cat.#
Big Mouth Insert, w/Bottom Spring	50 µL	Glass	2.0 mL, 11 mm Crimp-Top, 2.0 mL, 9 mm Short-Cap, Screw-Thread Vials	1000-pk.	21782

2.0 mL, 9 mm Short-Cap, Screw-Vial Closures (Polypropylene, preassembled)

Type	Cap Size	Color	Septa Material	qty.	cat.#
Ribbed, Screw-Thread	9-425	Blue	PTFE/Silicone, for Agilent 7693A	1000-pk.	23842

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