

Residual Solvent Analysis

Complete Solutions for Residual Solvent Testing

- How to successfully implement the USP <467> revision.
- Improve system suitability pass rates with an optimized system.
- Save column evaluation time and expense using a retention time index.



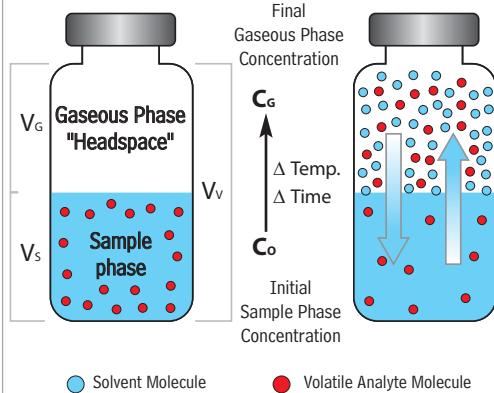
Chromatography Products



The Chemistry of Static Headspace Gas Chromatography

Improve Method Performance with Fundamentals

Figure 1 Volatile components partition into gaseous phase until equilibrium is reached.



Once the sample phase is introduced into the vial and the vial is sealed, volatile components diffuse into the gas phase until the headspace has reached a state of equilibrium as depicted by the arrows. The sample is then taken from the headspace.

Figure 2 Fundamental headspace relationship.

The diagram illustrates the fundamental headspace relationship. It starts with the equation $A \propto C_G = \frac{C_0}{K + \beta}$, where $\beta = V_g / V_s$ is the Phase Ratio, described as volume dependent. This leads to the Partition Coefficient $K = C_s / C_G$, which is concentration dependent. Below this, the Vapor Pressure P_i^0 is shown as affected by temperature, and the Activity Coefficient γ_i is shown as affected by salting-out, foreign solvent, and derivitization. A note specifies: Where: A = area; V_g = volume of gas phase; V_s = volume of sample phase; V_v = total vial volume; C₀ = initial analyte concentration in sample; C_G = analyte concentration in gas phase; C_s = analyte concentration in sample phase; P_i⁰ = analyte vapor pressure; γ = activity coefficient.

Technical Opportunities

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- Request our free Technical Guide for Static Headspace Analysis. cat.# 59895A
- Review our technical poster on dual column analysis of residual solvents.

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Organic volatile impurities (OVIs), commonly referred to as residual solvents, are trace level chemical residues in drug substances and drug products that are byproducts of manufacturing or that form during packaging and storage. Drug manufacturers must ensure that these residues are removed, or are present only in limited concentrations. The International Conference on Harmonization (ICH) Q3C guideline lists the acceptable amounts of solvent residues that can be present. Methodology, both independently developed and compendial, should strive to coincide with this guideline. In this guide, we will take a comprehensive look at residual solvent analysis, in both theory and practice, and illustrate options for the practicing chromatographer.

The analysis of residual solvents is commonly performed using static headspace gas chromatography (HS/GC). The basic premise behind headspace analysis begins with the addition of an exact, known volume or weight of sample into a closed, sealed vial. This creates two distinct phases in the vial—a sample phase and a gaseous phase, or “headspace”. Volatile components inside the sample phase, whether a solid or solution, can be extracted, or partitioned, from the sample phase into the headspace. An aliquot of the headspace can then be taken and delivered into a GC system for separation and detection. If we look at the anatomy of a headspace vial (Figure 1), we can begin to see the relationship of the vial components and how we can control these parameters to create analytical methods.

Residual solvent analysis by static HS/GC can be enhanced by careful consideration of two basic concepts—partition coefficient (K) and phase ratio (β). Partition coefficients and phase ratios work together to determine the final concentration of volatile compounds in the headspace of sample vials. Volatile components partition from the sample phase and equilibrate in the vial headspace. Striving for the lowest values for both K and β when preparing samples will result in higher concentrations of volatile analytes in the gas phase and, therefore, better sensitivity (Figure 2).

Controlling the Partition Coefficient

The partition coefficient (K) is defined as the equilibrium distribution of an analyte between the sample and gas phases. Compounds that have low K values will tend to partition more readily into the gas phase, and have relatively high responses and low limits of detection. K can be further described as a relationship between analyte vapor pressure (p_i^0) and activity coefficient (γ_i). In practice, K can be lowered by increasing the temperature at which the vial is equilibrated (vapor pressure) or by changing the composition of the sample matrix (activity coefficient) by adding an inorganic salt or a solvent of lesser solubility, often referred to as a foreign solvent. High salt concentrations and foreign solvents decrease analyte solubility in the sample phase (decrease activity) and promote transfer into the headspace, thus resulting in lower K values. The magnitude of this effect on K is not the same for all analytes. Compounds with inherent low K values in the matrix will experience little change in partition coefficient in response to the addition of a salt and temperature, while volatile compounds in a matrix of similar polarity will show the largest responses.

Adjusting the Phase Ratio

The phase ratio (β) is defined as the volume of the headspace over the volume of the sample in the vial. Lower values for β (i.e., larger sample sizes) will yield higher responses for compounds with inherently low K values. However, decreasing β will not always yield the increase in response needed to improve sensitivity. When β is decreased by increasing sample size, compounds with high K values will partition less into the headspace compared to compounds with low K values and yield correspondingly smaller changes in sensitivity.

Achieving USP<467> Compliance

Your Guide to Successfully Implementing the Revised Method

The USP general chapter <467> Residual Solvents is a widely used compendial method for identifying and quantifying residual solvents when no information is available on what solvents are likely to be present. In an attempt to harmonize with the ICH guidelines, the USP has proposed a more comprehensive method in the current USP 30/NF 25. This revision significantly increases the number of residual solvents to be routinely tested and includes three distinct procedures.¹

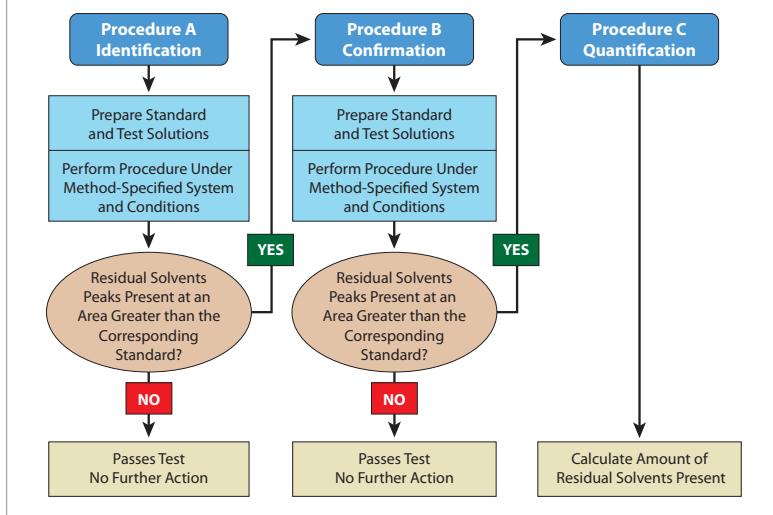
Initially set to become effective July 1, 2007, the implementation of the current version of USP <467> has been delayed until July 1, 2008. Until that time, the Other Analytical Procedures section of the previous version will be retained. However, in preparation for the implementation of the revised method, this application will comply with the procedure and criteria set forth in the USP30/NF25, second supplement (effective December 1, 2007) and the interim revision announcement.

Overview of Method

The revised USP <467> method consists of a static headspace extraction coupled with a gas chromatographic separation and flame ionization detection. In this guide we demonstrate the USP <467> application using two different types of headspace autosamplers. Procedure A was performed using a pressured loop autosampler and transfer line. Procedure B was performed using a heated syringe injection. Either system can be used to meet method requirements.

USP <467> is divided into two separate sections based upon sample solubility: water-soluble and water-insoluble articles. The methodology for both types of articles is similar, but the diluent used in both standard and sample preparations differs based upon the solubility of the test article. The test method consists of three procedures (A, B, and C), that are designed to identify, confirm, and then quantify residual solvents in drug substances and products (Figure 3).

Figure 3 Analytical flow chart for residual solvent testing under the revised USP <467> method.



¹This number of analytes to be tested represents the sum of Class 1 and 2 residual solvents that can be effectively assayed using HS/GC. The actual number of analytes may be more if xylenes, ethyl benzene and *cis/trans* 1,2 dichloroethylene are differentiated, or if circumstances require the quantification of specific Class 3 residual solvents.

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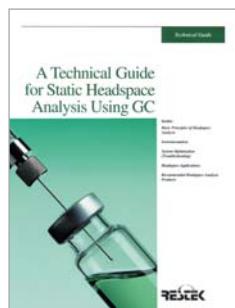
tech tip

Compatibility concerns?

Refer to the Septum Selection Guide
at www.restek.com/septaguide

free literature

Download your free copy of
our Technical Guide for Static
Headspace Analysis from
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Achieving USP<467> Compliance (continued from page 3)

USP-equivalent standards

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Residual Solvents - Class 1

benzene	10mg/mL	1,1-dichloroethene	40
carbon tetrachloride	20	1,1,1-trichloroethane	50
1,2-dichloroethane	25		
In dimethyl sulfoxide, 1mL/ampul			
cat. # 36279 (ea.)			

Quantity discounts not available.

Residual Solvents Class 2 - Mix A (15 components)

acetonitrile	2.05mg/mL	methylcyclohexane	5.90
chlorobenzene	1.80	methylene chloride	3.00
cyclohexane	19.40	tetrahydrofuran	3.45
cis-1,2-dichloroethene	4.70	toluene	4.45
trans-1,2-dichloroethene	4.70	m-xylene	6.51
1,4-dioxane	1.90	o-xylene	0.98
ethylbenzene	1.84	p-xylene	1.52
methanol	15.00		

In dimethyl sulfoxide, 1mL/ampul	
cat. # 36271 (ea.)	

Residual Solvents Class 2 - Mix B (8 components)

chloroform	60 μ g/mL	nitromethane	50
1,2-dimethoxyethane	100	pyridine	200
n-hexane (C6)	290	tetralin	100
2-hexanone	50	trichloroethene	80

In dimethyl sulfoxide, 1mL/ampul	
cat. # 36280 (ea.)	

Quantity discounts not available.

Residual Solvents Class 2 - Mix C (8 components)

2-ethoxyethanol	800 μ g/mL	2-methoxyethanol (methyl	
ethylene glycol	3,100	Cellosolve®)	250
formamide	1,100	N-methylpyrrolidone	2,650
N,N-dimethylacetamide	5,450	sulfolane	800
N,N-dimethylformamide	4,400		

In dimethyl sulfoxide, 1mL/ampul	
cat. # 36273 (ea.)	

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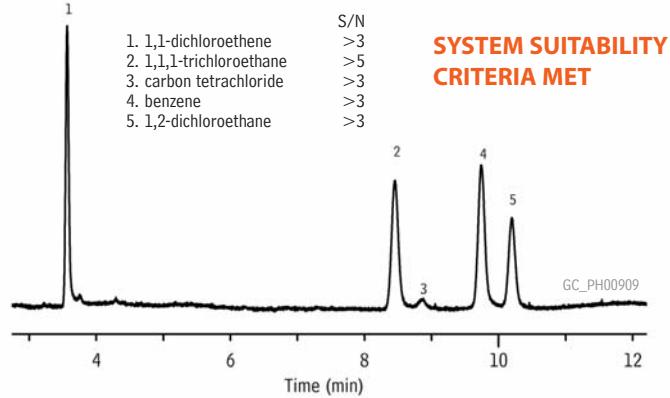
Analytical Reference Materials

The ICH guideline classifies residual solvents by class according to toxicity. Class 1 compounds are carcinogenic and pose a risk to both the consumer and the environment. The use of these solvents must be avoided or tightly controlled. Class 2 compounds are nongenotoxic animal carcinogens and their concentration should be limited. Both Class 1 and 2 compounds require chromatographic determination and are separated into 3 test mixes: Class 1 Mixture, Class 2 Mixture A, and Class 2 Mixture B. Class 3 compounds have low toxic potential. Concentration levels of up to 0.5% are acceptable and, therefore, they can be assayed by nonspecific techniques, such as weight loss on drying. Class 2 Mixture C is not used in the second supplement of USP 30/NF 25, but contains solvents that are not readily detectable by headspace analysis. These solvents should be assayed by other appropriately validated procedures.

Procedure A - Identification

Procedure A is the first step in the identification process and is performed on a G43 column to determine if any residual solvents are present in the sample at detectable levels. First, Class 1 standard and system suitability solutions and Class 2 Mix A standard solutions are assayed under the method-specified operating conditions to establish system suitability. All peaks in the Class 1 system suitability solution must have a signal-to-noise ratio not less than 3, the Class 1 standard solution must have a 1,1,1-trichloroethane response greater than 5, and the resolution of acetonitrile and dichloromethane must be not less than 1 in the Class 2 Mixture A solution. When system suitability has been achieved, the test solutions are assayed along with the Class 1 and Class 2 Mixtures A and B standard solutions. If a peak is determined in the sample that matches a retention time and has a greater response than that of a corresponding reference material, then Procedure B is performed for verification of the analyte. In the second supplement of USP 30/NF 25, an exemption is made for 1,1,1-trichloroethane, where a response greater than 150 times the peak response denotes an amount above the percent daily exposure limit. Figures 4 through 6 illustrate the analysis of Class 1, Class 2 Mixture A, and Class 2 Mixture B residual solvent mixes by Procedure A. The resolution between acetonitrile and dichloromethane was easily achieved using an Rtx®-1301 column.

Figure 4 USP residual solvent Class 1 standard solution on an Rtx®-1301 column (G43).



Column:	Rtx®-1301, 30m, 0.32mm ID, 1.8 μ m (cat.# 16092)	Headspace Conditions:	Tekmar HT3
Sample:	USP <467> Class 1 standard solution (cat.# 36279) in 20mL headspace vial	Instrument:	105°C
Inj.:	headspace injection (split ratio 1:5), 1mm split liner, Siltek® deactivated (cat.# 20972-214.1)	Transfer line temp.:	105°C
Inj. temp.:	140°C	Valve oven temp.:	80°C
Carrier gas:	helium, constant flow	Sample temp.:	45 min.
Flow rate:	2.16mL/min., 35.3cm/sec.	Sample equil. time:	10°C/min. (hold for 20 min.)
Oven temp.:	40°C for 20 min. to 240°C @	Vial pressure:	10psi
Det.:	FID @ 240°C	Pressurize time:	0.5 min.
		Loop fill pressure:	5psi
		Loop fill time:	2.00 min.
		Inject time:	1.00 min.

Figure 5 USP residual solvent Class 2 Mixture A standard solution on an Rtx®-1301 column (G43).

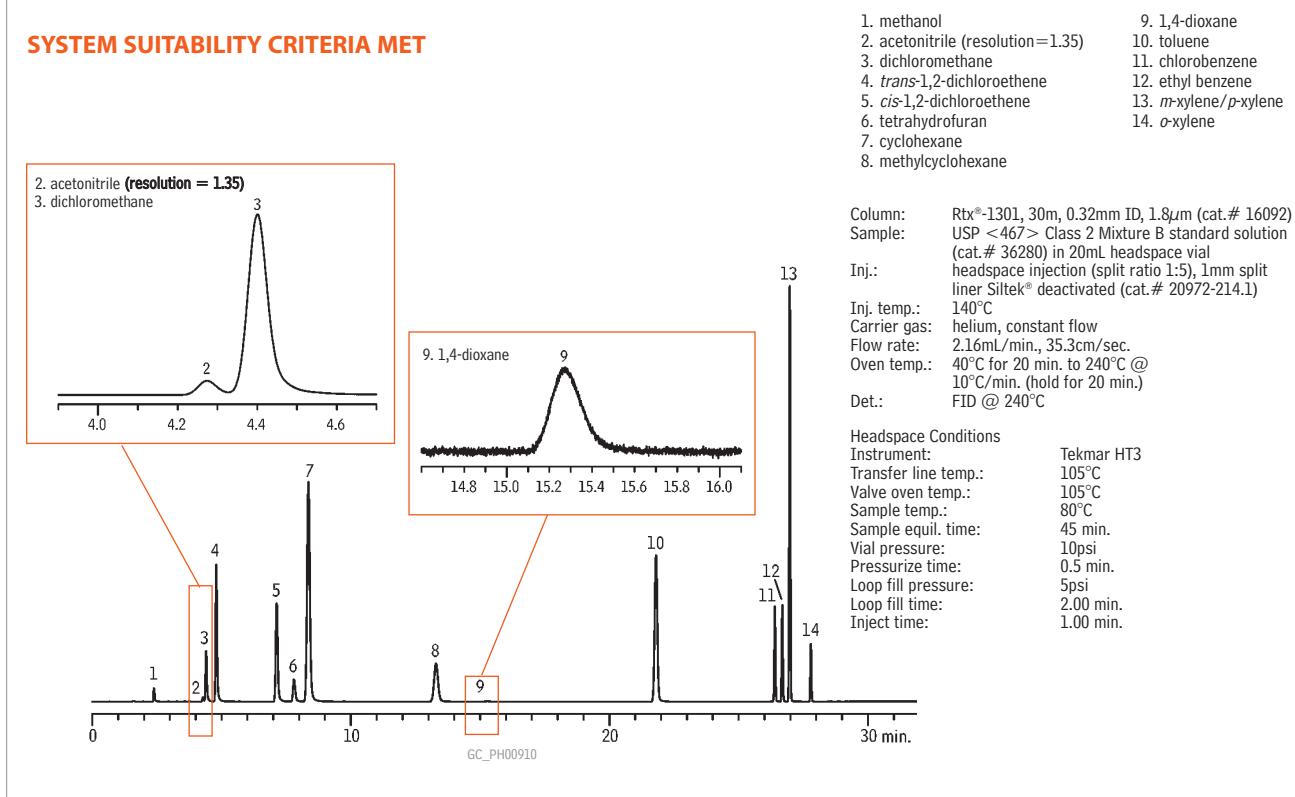
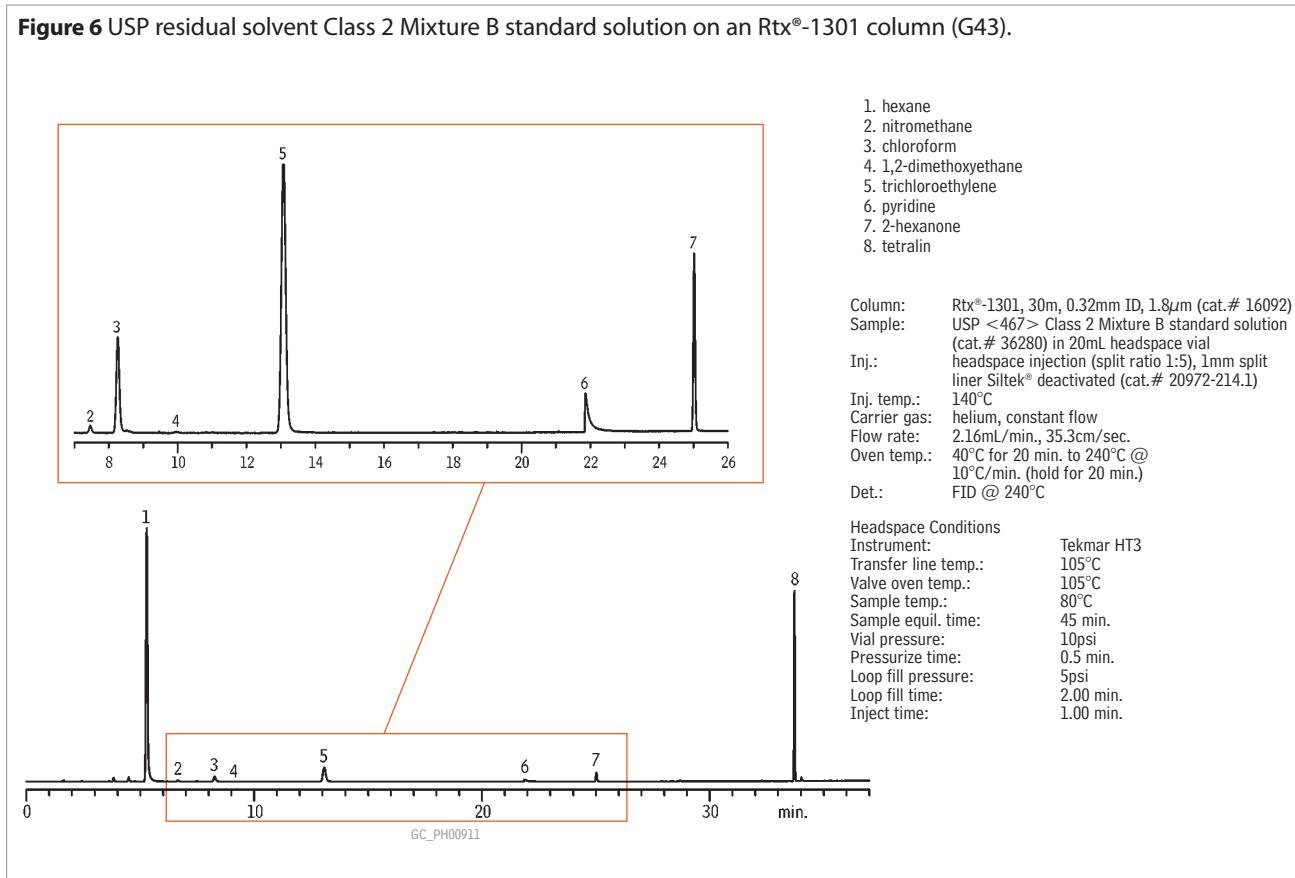


Figure 6 USP residual solvent Class 2 Mixture B standard solution on an Rtx®-1301 column (G43).



Achieving USP<467> Compliance (continued from page 5)

Capillary Column—Procedure A

Rtx®-1301 (G43) Columns (fused silica)

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

ID	df (µm)	temp. limits	length	cat. #
0.32mm	1.80	-20 to 240°C	30-Meter	16092
0.53mm	3.00	-20 to 240°C	30-Meter	16085

Capillary Column—Procedure B

0.32mm	0.25	40 to 250°C	30-Meter	10624
0.53mm	0.25	40 to 250°C	30-Meter	10625

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Procedure B - Confirmation

Once a residual solvent is identified and found to be above the percent daily exposure limit, Procedure B is performed to confirm analyte identity. A G16 capillary column is used here as a confirmation column, because it yields an alternate selectivity compared to a G43 column. The same standard and system suitability preparations are used in Procedures A and B. The system suitability requirements differ here in that the Class 1 standard solution must have a benzene response greater than 5 and the resolution of acetonitrile and *cis*-dichloroethene must not be less than 1 in the Class 2 Mixture A solution, a change from the original version. If the analyte identified in Procedure A again matches the retention time and exceeds the peak response of the reference materials (with the same exception to 1,1,1-trichloroethane), the analyst must quantify the analyte using Procedure C. Figures 7 through 9 illustrate the analysis of Class 1, Class 2 Mixture A, and Class 2 Mixture B residual solvent mixes on a Stabilwax® column. Again, the system suitability requirements were easily met.

Procedure C – Quantification

Once a residual solvent has been identified and verified, Procedure C is used to quantify the analyte by analyzing the sample against compound-specific reference materials. Individual standards are prepared by diluting the analyte in solution to a concentration of 1/20 of the concentration limit given under concentration limit Table 1 or 2 of the method. Following the procedure and instrument conditions in either Procedure A or B (whichever provides the most definitive results), a quantifiable result is produced. For water-insoluble articles, the same procedure is followed, except dimethylformamide or dimethylsulfoxide is used as the diluent.

Figure 7 USP residual solvent Class 1 standard solution on a Stabilwax® column (G16).

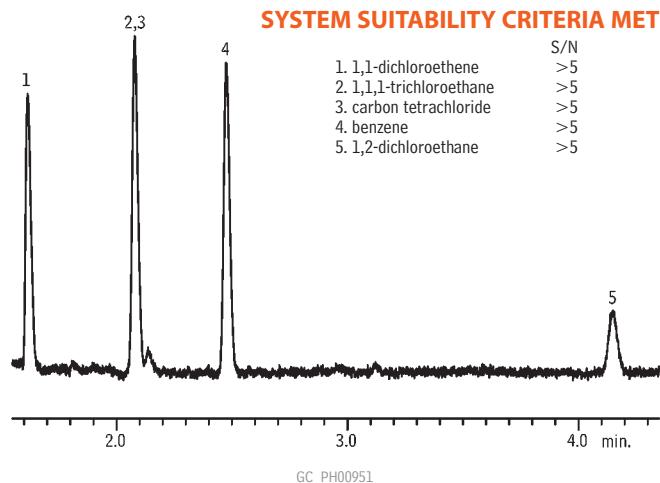


Figure 8 USP residual solvent Class 2 Mixture A standard solution on a Stabilwax® column (G16).

**SYSTEM SUITABILITY CRITERIA MET—
RESOLUTION BETWEEN PEAKS 7 & 8 > 1.0**

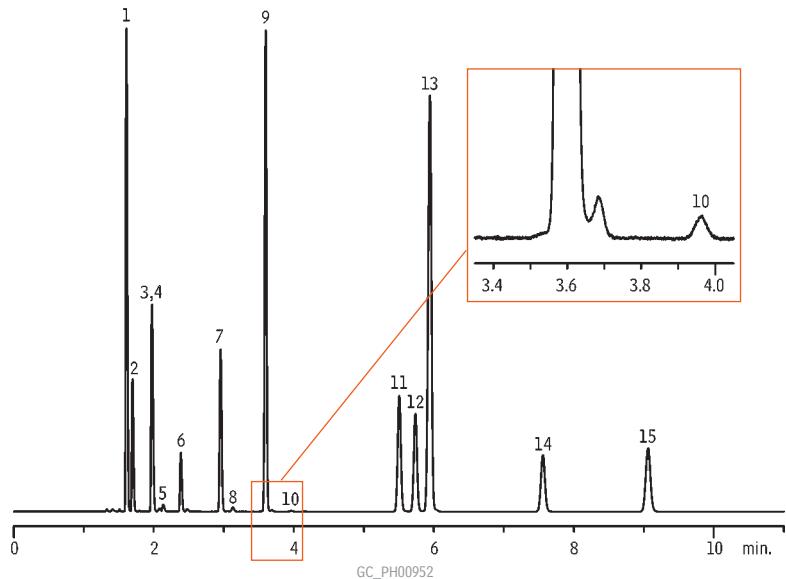
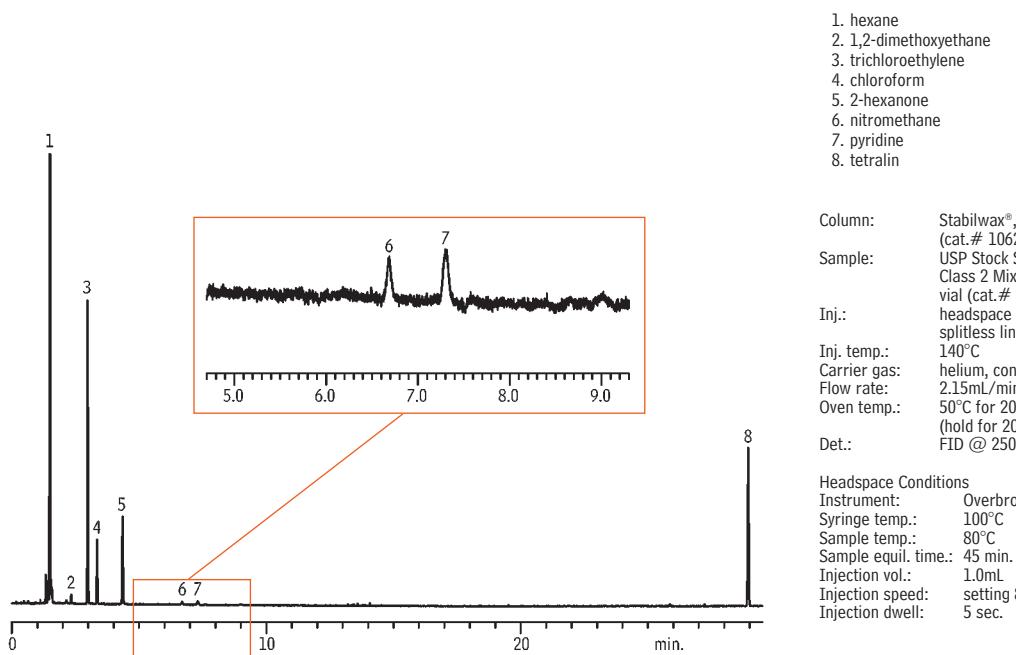


Figure 9 USP residual solvent Class 2 Mixture B standard solution on a Stabilwax® column (G16).



Optimize Your Testing Procedure

Tools, Tips, & Techniques for Improving Method Performance

Use Smaller Bore Liners for Better Efficiency

1mm Split Liners for Agilent GCs

ID* x OD & Length	qty.	cat.#
1mm Split**		
1.0mm x 6.3mm x 78.5mm	ea.	20972
1.0mm x 6.3mm x 78.5mm	5-pk.	20973

2mm Splitless Liners for Agilent GCs

ID* x OD & Length	qty.	cat.#
2mm Splitless		
2.0mm x 6.5mm x 78.5mm	ea.	20712
2.0mm x 6.5mm x 78.5mm	5-pk.	20713
2.0mm x 6.5mm x 78.5mm	25-pk.	20714

Split Liners for Varian 1075/1077 GCs

ID* x OD & Length	qty.	cat.#
1mm Split		
1.0mm x 6.3mm x 72mm	ea.	20970
1.0mm x 6.3mm x 72mm	5-pk.	20971

Split Liners for Shimadzu GCs

ID* x OD & Length	qty.	cat.#
1mm Split		
1.0mm x 5.0mm x 95mm	ea.	20976
1.0mm x 5.0mm x 95mm	5-pk.	20977
1.0mm x 5.0mm x 95mm	25-pk.	20978

SPME Liners for Shimadzu 17A, 2010, and 2014 GCs

ID* x OD & Length	qty.	cat.#
SPME Liner		
.75mm x 5.0mm x 95mm	ea.	22278
.75mm x 5.0mm x 95mm	5-pk.	22279

Zero Dilution Liners for PerkinElmer Auto SYS™ and Clarus GCs

ID* x OD & Length	qty.	cat.#
Zero Dilution Inner Liner		
1.0mm x 2.0mm x 73mm	ea.	22990
1.0mm x 2.0mm x 73mm	5-pk.	22991
Zero Dilution Outer Liner		
2.5mm x 6.2mm x 90mm	ea.	22992
2.5mm x 6.2mm x 90mm	5-pk.	22993

*Nominal ID at syringe needle expulsion point.

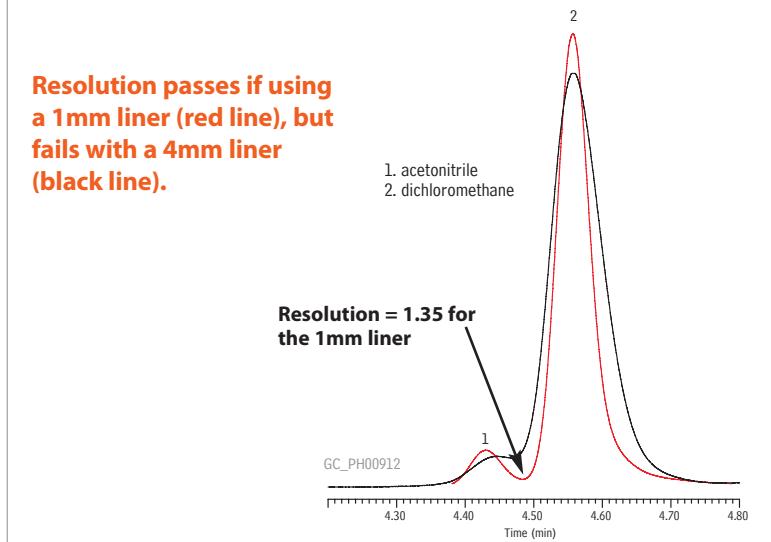
**Use this liner for increased sensitivity.

Implementing the revised method for USP<467> can be difficult if the instrument is not optimized correctly. Key issues to address when setting up headspace GC systems include minimizing system dead volume, maintaining inert sample flow paths, and achieving efficient sample transfer. While the second supplement contains a change that allows for modifications to the split ratio, column and liner choices are critical to analytical success.

Use Smaller Bore Liners for Better Resolution

The function of an injection port in headspace analysis is very different than in direct liquid injection. In direct injection, the sample is vaporized in the injection port and larger volume liners (e.g., 4mm) are typically used since the liner must be able to accommodate the solvent expansion volume. In contrast, in headspace analysis, the sample is vaporized inside the headspace vial and the resulting gas sample is simply transferred into the injection port via a transfer line or syringe injection. Since solvent vaporization does not occur in the liner, a large volume liner is not needed and, in fact, the use of one can cause deleterious effects such as band broadening and decreased peak efficiency. For headspace applications, a smaller bore liner, preferably 1mm, is recommended. The smaller liner volume reduces band broadening by increasing linear velocity in the liner allowing faster sample transfer and improving resolution (Figure 10).

Figure 10 Improve system suitability pass rates using smaller bore liners.



Speed Up Method Development Using a Retention Time Index

ICH guideline Q3C states that residual solvents need only be tested when production or purification processes are known to result in the presence of such solvents. Therefore, in many cases exhaustive testing is not needed and individual validated methods for smaller, specific analyte lists are an option. To simplify column selection and reduce method development time, Restek has created a retention time index for ICH Class 1, 2, and 3 residual solvents on various phases (Table I). To use this index, simply locate the analytes of interest on the list and determine which phase gives the optimal amount of resolution—or difference in retention time—between your target compounds. A critical coelution is indicated by a failure to achieve a retention time difference of greater than 1.5 minutes.

Table I Reduce method development time—use a retention time index for column selection.

Retention time data collected using the following conditions:

G16 Stabilwax®: 30m, 0.25mm ID, 0.5 μ m df, Phase ratio: 125, Oven program: 40°C, hold 1 min., to 190°C @ 4°C/min., hold 15 min., Carrier flow: 1.2mL/min., Dead time: 1.38 min. @ 45°C
G16 Rtx®-WAX: 30m, 0.25mm ID, 0.5 μ m df, Phase ratio: 125, Oven program: 40°C, hold 1 min., to 190°C @ 4°C/min., hold 15 min., Carrier flow: 1.2mL/min., Dead time: 1.40 min. @ 45°C
G43 Rtx®-1301: 30m, 0.25mm ID, 1.0 μ m df, Phase ratio: 63, Oven program: 40°C, hold 1 min., to 190°C @ 4°C/min., hold 15 min., Carrier flow: 1.2mL/min., Dead time: 1.40 min. @ 45°C
G27 Rtx®-5ms: 30m, 0.25mm ID, 1.0 μ m df, Phase ratio: 63, Oven program: 40°C, hold 1 min., to 190°C @ 4°C/min., hold 15 min., Carrier flow: 1.1mL/min., Dead time: 1.49 min. @ 45°C
G1 Rtx®-1: 60m, 0.53mm ID, 3.00 μ m df, Phase ratio: 43, Oven program: 30°C, hold 4 min., to 220°C @ 4°C/min., Carrier flow: 6.3mL/min., Dead time: 2.54 min. @ 35°C
Rtx®-200: 60m, 0.53mm ID, 3.00 μ m df, Phase ratio: 43, Oven program: 30°C, hold 4 min., to 220°C @ 4°C/min., Carrier flow: 7.8mL/min., Dead time: 2.22 min. @ 35°C

Carrier gas: helium Compound	ICH Class	G16 Stabilwax® Retention Time	G16 Rtx®-WAX Retention Time	G43 Rtx®-1301 Retention Time	G27 Rtx®-5ms Retention Time	G1 Rtx®-1 Retention Time	NA Rtx®-200 Retention Time
1,1,1-trichloroethane	1	3.96	3.49	5.43	5.40	10.82	8.35
1,1,2-trichloroethene	2	15.72	14.28	10.99	9.77	16.75	14.94
1,1-dichloroethene	1	2.23	2.04	2.79	4.41	5.73	4.16
1,2-dichloroethane	1	8.80	7.68	6.15	5.46	10.38	9.74
cis-1,2-dichloroethene	2	6.50	5.65	4.79	2.88	8.71	7.11
trans-1,2-dichloroethene	2	3.63	3.20	3.55	3.54	7.17	5.16
1,2-dimethoxyethane	2	4.80	4.18	6.03	5.54	10.98	10.63
1,4-dioxane	2	8.55	7.49	7.86	7.26	13.54	14.34
1-butanol	3	11.13	10.08	7.18	5.76	11.49	10.13
1-pentanol	3	14.95	13.75	11.19	9.44	16.99	14.95
1-propanol	3	7.69	6.80	4.20	3.37	6.81	6.13
2-butanol	3	7.25	6.44	5.08	4.16	8.51	7.69
2-ethoxyethanol	2	13.99	12.70	8.69	7.36	13.91	13.99
2-methoxyethanol	2	12.42	11.11	6.02	5.14	9.83	10.74
2-methyl-1-propanol	3	9.32	8.40	6.00	4.79	*	*
2-propanol	3	4.81	4.25	3.00	2.55	4.91	4.69
3-methyl-1-butanol	3	13.42	12.25	9.86	8.26	15.28	13.55
acetic acid	3	22.47	20.34	6.52	4.61	8.84	8.96
acetone	3	3.02	2.64	2.89	2.50	4.64	7.68
acetonitrile	2	6.91	5.83	3.28	2.47	4.32	8.89
anisole	3	18.65	17.09	17.12	16.28	25.00	22.84
benzene	1	5.23	4.54	5.98	3.83	11.63	9.17
butyl acetate	3	8.86	7.88	12.12	11.38	19.43	19.63
carbon tetrachloride	1	3.96	3.49	5.61	5.90	11.89	7.42
chlorobenzene	2	13.91	12.54	13.55	13.14	21.56	18.48
chloroform	2	7.31	6.41	5.23	4.64	9.18	6.66
cumene	3	12.36	11.17	16.66	16.69	25.88	20.90
cyclohexane	2	2.16	2.01	5.37	5.89	*	*
dichloromethane	2	5.01	4.33	3.31	3.06	5.87	4.88
dimethylsulfoxide	3	26.47	24.43	16.62	13.01	18.81	30.95
ethanol	3	4.98	4.37	2.52	2.19	4.03	3.80
ethyl acetate	3	4.08	3.56	4.87	4.44	9.04	10.35
ethyl benzene	2	10.72	9.58	13.86	13.81	22.54	18.18
ethyl ether	3	1.72	1.63	2.58	2.67	5.34	3.87
ethyl formate	3	3.16	2.78	3.00	2.78	5.46	6.48
ethylene glycol	2	28.06	26.23	10.77	6.63	12.59	13.86
formamide	2	32.99	30.93	11.85	7.30	12.72	19.93
formic acid	3	24.64	22.09	5.19	2.60	5.59	5.06
heptane	3	1.98	1.86	6.34	6.98	14.18	7.84
hexane	2	1.65	1.58	3.77	4.11	9.06	4.86
isobutyl acetate	3	6.99	6.18	10.39	9.69	17.35	18.02
isopropyl acetate	3	4.26	3.74	6.19	5.71	11.47	12.38
methanol	2	4.23	3.64	1.96	1.80	3.14	2.93
methyl acetate	3	3.19	2.80	3.17	2.93	5.80	7.10
methylbutyl ketone	2	9.10	8.05	11.81	10.50	17.94	20.81
methylcyclohexane	2	2.50	2.30	7.31	7.95	15.49	9.21
methylethyl ketone	3	4.33	3.76	4.90	4.09	7.99	11.55
methylisobutyl ketone	3	6.84	5.97	9.64	8.49	15.35	18.41
m-xylene	2	11.21	10.04	15.46	14.17	23.01	18.78
N,N-dimethylacetamide	2	20.75	19.01	12.95	13.96	21.42	30.00
N,N-dimethylformamide	2	18.04	16.26	13.09	10.23	16.52	26.19
nitromethane	2	11.82	10.31	4.84	3.53	6.30	12.01
N-methylpyrrolidone	2	29.84	27.86	25.09	21.85	29.99	38.08
o-xylene	2	12.79	11.51	15.46	15.26	24.23	20.33
pentane	3	1.49	1.45	2.39	2.62	5.36	3.29
propyl acetate	3	5.98	5.29	8.03	7.44	*	*
p-xylene	2	10.98	9.82	14.29	15.27	22.99	18.69
pyridine	2	12.64	11.24	9.60	8.57	15.40	16.45
sulfolane	2	47.62	43.31	34.02	28.90	36.76	48.67
tert-butylmethyl ether	3	1.94	1.82	3.50	3.59	7.52	5.73
tetrahydrofuran	3	3.63	3.19	5.12	4.90	9.81	9.48
tetralin	2	25.12	23.48	27.49	27.44	37.27	31.72
toluene	2	7.86	6.91	9.80	9.66	17.36	14.00
1,1-dethoxypropane	—	5.42	4.84	11.39	11.38	19.82	15.08
2,2-dimethoxypropane	—	3.11	2.79	5.48	5.55	11.37	8.67
2-chloropropane	—	1.96	1.82	2.67	2.66	5.20	4.61
2-methylpentane	—	1.58	1.52	3.22	3.56	7.72	4.32
acetaldehyde	—	2.05	1.85	1.86	1.84	3.14	3.90
chloroethane	—	1.83	1.71	2.14	2.10	3.97	3.55
chloromethane	—	1.63	1.55	1.70	1.70	3.01	2.73
ethylene oxide	—	2.05	1.86	1.89	2.02	3.59	3.92
formaldehyde	—	2.25	1.57	1.68	1.58	2.66	2.59
isoamyl acetate	—	10.51	9.43	14.84	14.18	22.80	22.62
isoctane	—	1.85	1.75	5.84	6.59	13.66	8.07
isopropyl ether	—	1.86	1.76	4.03	4.23	9.03	5.83
methyl cyclopentane	—	1.91	1.79	4.50	4.93	10.41	5.81
methyl isopropyl ketone	—	4.93	4.29	6.58	5.69	11.04	14.47
methylal	—	2.26	2.06	2.84	2.82	5.65	5.09
trichloroethene	—	6.50	5.70	7.07	7.05	13.58	9.75
water	—	8.24	7.18	1.74	1.68	2.75	2.57

* Not determined

Restek Offers An Extensive Selection of Capillary Columns

For Successful Method Development & Validation

free literature



Genuine Restek Replacement Parts

Use our handy new Genuine Restek Replacement Parts (GRRP) mini-catalogs to help you select the supplies and replacement parts you need for your specific GC. We now have customized GRRP mini-catalogs for each major instrument manufacturer to simplify your product search. Download these and other pieces from our website at www.restek.com/grrp.

For Agilent GCs (lit. cat.# 5962F)

For Agilent 5890 GCs (lit. cat.# 580216)

For PerkinElmer GCs (lit. cat.# 580038)

For Shimadzu GCs (lit. cat.# 580037)

For Thermo Scientific GCs (lit. cat.# 580039)

For Varian GCs (lit. cat.# 59224A)

Rtx®-624 Columns (fused silica)

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

ID	df (µm)	temp. limits	30-Meter	60-Meter
0.25mm	1.40	-20 to 240°C	10968	10969
0.32mm	1.80	-20 to 240°C	10970	10972
0.53mm	3.00	-20 to 240°C	10971	10973
ID	df (µm)	temp. limits	20-Meter	40-Meter
0.18mm	1.00	-20 to 240°C	40924	40925

G43

Rxi®-5ms Columns (fused silica)

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

ID	df (µm)	temp. limits	30-Meter	60-Meter
0.25mm	0.50	-60 to 330/350°C	13438	13441
	1.00	-60 to 330/350°C	13453	13456
0.32mm	0.50	-60 to 330/350°C	13439	13442
	1.00	-60 to 330/350°C	13454	13457
0.53mm	1.00	-60 to 330/350°C	13455	
	1.50	-60 to 330/350°C	13470	
ID	df (µm)	temp. limits	20-Meter	
0.18mm	0.18	-60 to 330/350°C	13402	
	0.30	-60 to 330/350°C	13409	
	0.36	-60 to 330/350°C	13411	

G27

Rtx®-1301 Columns (fused silica)

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

ID	df (µm)	temp. limits*	30-Meter	60-Meter
0.25mm	0.50	-20 to 270°C	16038	16041
	1.00	-20 to 260°C	16053	16056
	1.40	-20 to 240°C	16016	
0.32mm	0.50	-20 to 270°C	16039	16042
	1.00	-20 to 260°C	16054	16057
	1.50	-20 to 250°C	16069	16072
	1.80	-20 to 240°C	16092	16093
0.53mm	0.50	-20 to 270°C	16040	16043
	1.00	-20 to 260°C	16055	16058
	1.50	-20 to 250°C	16070	16073
	3.00	-20 to 240°C	16085	16088

G43

Rtx®-1 Columns (fused silica)

(Crossbond® 100% dimethyl polysiloxane)

ID	df (µm)	temp. limits	30-Meter	60-Meter
0.25mm	0.50	-60 to 330/350°C	10138	10141
	1.00	-60 to 320/340°C	10153	10156
0.32mm	1.00	-60 to 320/340°C	10154	10157
	1.50	-60 to 310/330°C	10169	10172
	3.00	-60 to 280/300°C	10184	10187
	4.00	-60 to 280/300°C	10198	
	5.00	-60 to 260/280°C	10178	10180
0.53mm	1.50	-60 to 310/330°C	10170	10173
	3.00	-60 to 270/290°C	10185	10188
	5.00	-60 to 270/290°C	10179	10183
	7.00	-60 to 240/260°C	10192	10193
ID	df (µm)	temp. limits	20-Meter	40-Meter
0.18mm	0.20	-60 to 330/350°C	40102	40103
	0.40	-60 to 320/340°C	40111	40112

G1

Stabilwax® Columns (fused silica)

(Crossbond® Carbowax® polyethylene glycol)

ID	df (µm)	temp. limits	30-Meter	60-Meter
0.25mm	0.25	40 to 250°C	10623	10626
	0.50	40 to 250°C	10638	10641
0.32mm	0.25	40 to 250°C	10624	10627
	0.50	40 to 250°C	10639	10642
	1.00	40 to 240/250°C	10654	10657
0.53mm	1.00	40 to 240/250°C	10655	10658
	1.50	40 to 230/240°C	10669	10672
	2.00	40 to 220/230°C	10670	

G16

Rtx®-200 Columns (fused silica)

(Crossbond® trifluoropropylmethyl polysiloxane)

ID	df (µm)	temp. limits*	30-Meter	60-Meter
0.25mm	0.50	-20 to 310/330°C	15038	15041
	1.00	-20 to 290/310°C	15053	15056
0.32mm	1.00	-20 to 290/310°C	15054	15057
	1.50	-20 to 280/300°C	15069	15072
0.53mm	1.00	-20 to 290/310°C	15055	15058
	1.50	-20 to 280/300°C	15070	15073
	3.00	-20 to 260/280°C	15085	15088
ID	df (µm)	temp. limits	20-Meter	40-Meter
0.18mm	0.20	-20 to 310/330°C	45002	45003
	0.40	-20 to 310/330°C	45011	45012

also available

Custom Column Lengths:

If you do not see the column dimension you need, call our customer service team, and we will make the column for you.

*Maximum temperatures listed are for 15- and 30-meter lengths. Longer lengths may have a slightly reduced maximum temperature.

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Dual Vespel® Ring Inlet Seals for Agilent GCs

- Vespel® ring embedded in bottom surface eliminates need for washer.
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Washerless, leak-tight seals for Agilent GCs

0.8mm ID Dual Vespel Ring Inlet Seal	2-pk./price	10-pk./price
Gold-Plated	21240	21241
Siltek Treated	21242	21243
Stainless Steel	21238	21239
1.2mm ID Dual Vespel Ring Inlet Seal	2-pk./price	10-pk./price
Gold-Plated	21246	21247
Siltek Treated	21248	21249
Stainless Steel	21244	21245



Patented.

Dual Vespel® Ring Cross-Disk Inlet Seals for Agilent GCs

- Ideal for high-flow split applications.
- Washerless, leak-tight seals.

0.8mm ID Dual Vespel Ring Cross-Disk Inlet Seal	2-pk./price	10-pk./price
Gold-Plated	22083	22084
Siltek Treated	22085	22086
Stainless Steel	22087	22088

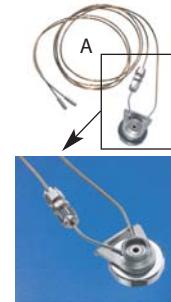


Injection Port Weldments for Agilent GCs

Easily attach your autosampler with pre-installed low dead volume fittings.

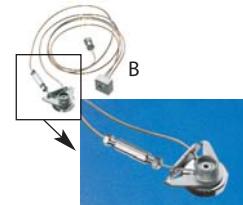
For Agilent GCs with Tekmar Transfer Lines

Description	qty.	cat.#
A) Weldment for Agilent 6890 GCs	ea.	22664
Weldment for Agilent 6890 GCs with optional canister filter	ea.	22668
Weldment for Agilent 5890 GCs	ea.	22666



For Agilent GCs with OI Purge and Trap Systems

Description	qty.	cat.#
B) Weldment for Agilent 6890 GCs	ea.	22665
Weldment for Agilent 6890 GCs with optional canister filter	ea.	22669
Weldment for Agilent 5890 GCs	ea.	22667



FID Replacement Jets

Standard Version

- Engineered with a fluted tip to guide the capillary column into the jet.
- Threads specially coated for easy installation and removal.
- Special processing ensures the highest degree of cleanliness.

High-Performance Version

- Similar to the standard version, but Siltek® treated.
- Extremely inert, for use with active compounds.



Capillary Adaptable FID Replacement Jet for Agilent 5890/6890/6850 GCs

0.011-Inch ID Tip	Similar to Agilent part #	qty.	cat.#	qty.	cat.#
Standard, 0.011-Inch ID Tip	19244-80560	ea.	20670	3-pk.	20671
High-Performance Siltek Treated, 0.011-Inch ID Tip	19244-80560	ea.	20672	3-pk.	20673

Capillary Dedicated FID Replacement Jet for Agilent 6890/6850/7890 GCs

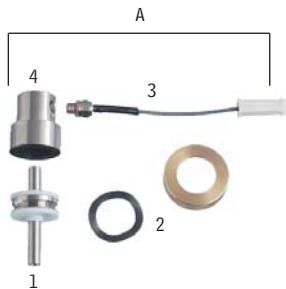
0.011-Inch ID Tip	Similar to Agilent part #	qty.	cat.#	qty.	cat.#
Standard, 0.011-Inch ID Tip	G1531-80560	ea.	21621	3-pk.	21682
High-Performance Siltek Treated, 0.011-Inch ID Tip	G1531-80560	ea.	21620	3-pk.	21683

did you know?

Restek carries a full line of FID replacement jets. Visit www.restek.com for a complete selection.

Direct Replacement FID Collector Assembly Kit for Agilent 6890/6850/7890 GCs

- Constructed of high-quality stainless steel.
- Meets or exceeds manufacturer's performance.



Replacement FID Parts for Agilent 6890/6850/7890 GCs

- Meets or exceeds manufacturer's performance.

Description	Similar to Agilent part #	qty.	cat.#
A) FID Collector Assembly Kit (includes insulator)	G1531-60690	kit	21699
FID Collector Assembly Kit w/Siltex Ignitor Castle	—	kit	21132
1) FID Collector (includes insulators)	G1531-20690 G1531-20700	ea.	21139
2) FID Collector Nut and Washer	19231-20940 5181-3311	set	21136
3) FID Ignitor*	19231-60680	ea.	21001
4) FID Ignitor Castle	19231-20910	ea.	21137
Siltex FID Ignitor Castle	—	ea.	21135

*Also fits OI Analytical 4410 detector (similar to OI part # 191833).

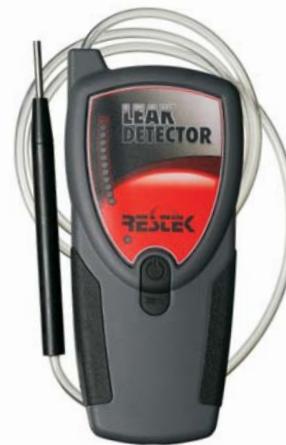
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Volatiles

Volatile organic compounds (VOCs) are usually analyzed using a purge and trap system connected to a GC. The column used must have a selective stationary phase to resolve the volatile pollutants, have a sufficient film thickness to retain and resolve the low boiling volatile compounds (i.e., dichlorodifluoromethane), and must be thermally stable to elute the high boiling volatiles compounds (i.e., hexachlorobutadiene & naphthalene).

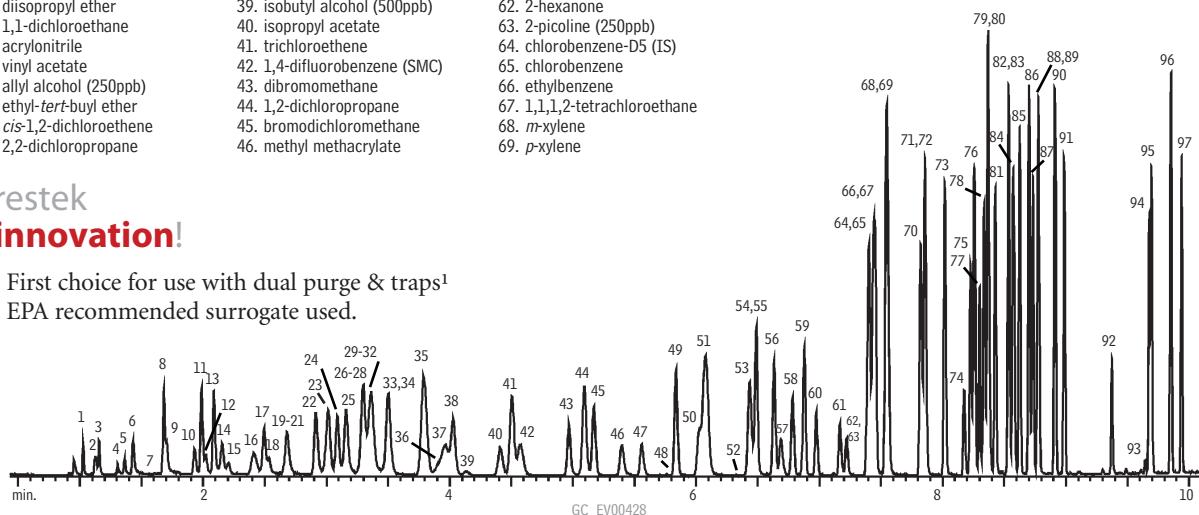
The first fused silica columns used for analyzing volatiles were based on diphenyl/dimethyl polysiloxane stationary phases. However, resolution of gases has always been problematic with these phases. Restek designed the Rtx®-VMS column specifically to optimize separation of volatiles in the most commonly used EPA volatiles methods. A faster oven ramp rate is possible because these compounds elute farther apart on the Rtx®-VMS phase, eliminating partial coelutions that interfere with quantification. Using the EPA suggested surrogates (i.e., chlorobenzene-d5) analysis time can be less than 10 minutes with a narrow bore column, allowing you to connect two purge and trap units to one GC/MS instrument – significantly increasing sample throughput.

Figure 1 Excellent resolution of bromomethane and chloroethane, as well as challenging isomer pairs like 2-/4-chlorotoluene on the Rtx®-VMS column.

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

**restek
innovation!**

- First choice for use with dual purge & traps¹
- EPA recommended surrogate used.



Column: Rtx®-VMS 20m, 0.18 mm ID, 1.00 μ m (cat.# 49914)
Conc.: 10ppb in 5mL of RO water unless otherwise noted; ketones at 2.5X

Concentrator: Tekmar LSC-3100 Purge and Trap

Trap: Vocab 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: 0.53mm ID Silcosteel® tubing transfer line
1:40 split at injection port. 1mm ID liner.
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: Agilent 5973 MSD
Scan range: 35-300amu

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

Recommended Column



Rtx®-VMS Columns (fused silica)

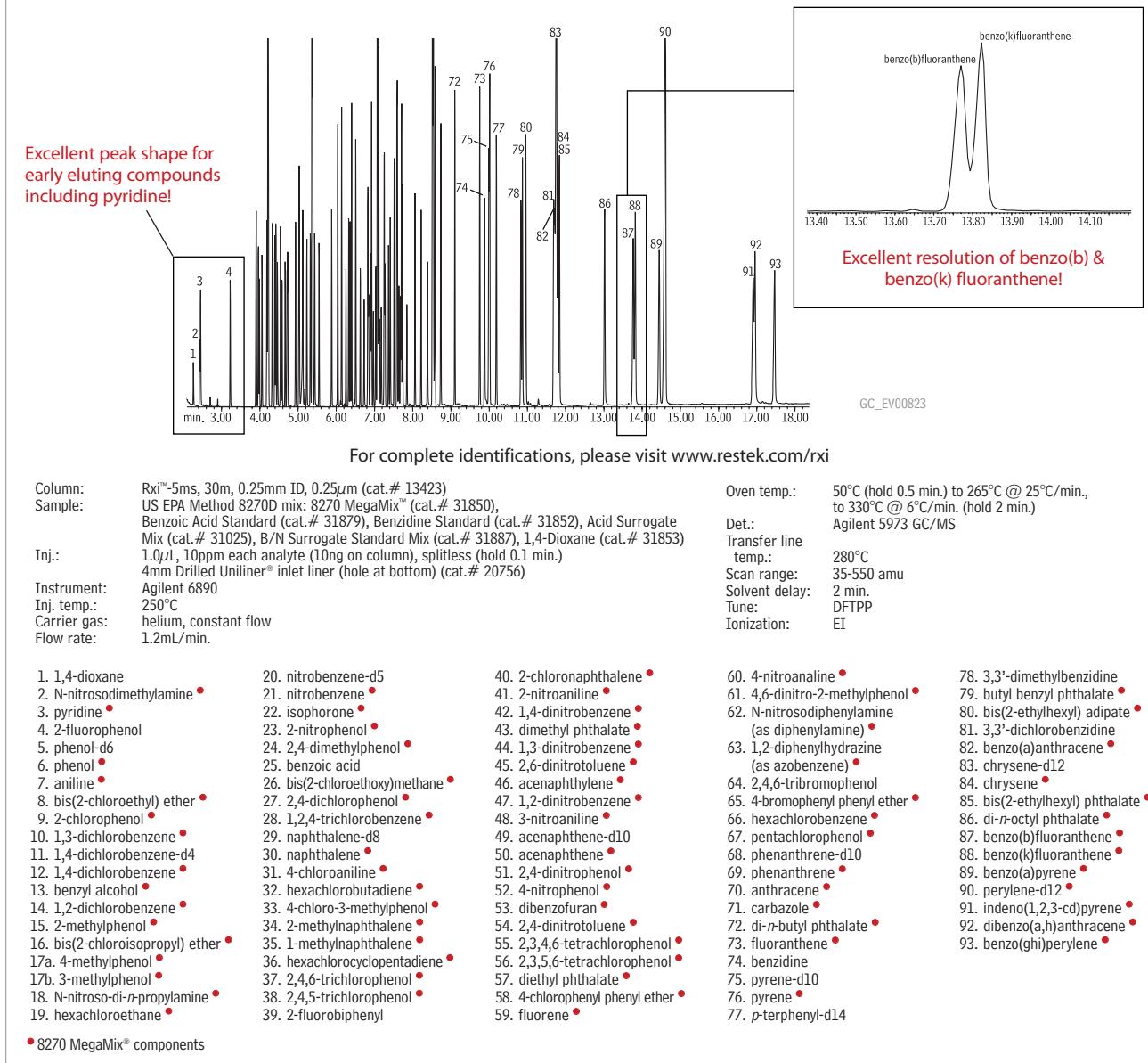
(proprietary Crossbond® phase)

ID	df (μ m)	temp. limits	length	cat. #
0.18mm	1.00	-40 to 240/260°C	20-Meter	49914

Semivolatiles

Semivolatile analysis is a challenging area covering a wide range of compound classes – neutral, acidic, and basic compounds, including anilines, phenols, PAHs, and more – that differ in both volatility and reactivity. While the chromatography is complicated by a broad list of target analytes, many problems can be avoided by proper attention to the inlet system and an informed column choice.

Figure 1 Separate greater than 90 semivolatile compounds in less than 18 minutes, using an Rx™-5ms column.



Recommended Columns

Rxi™-5ms Columns (fused silica)

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

ID	df (µm)	temp. limits	length	cat. #
0.18mm	0.18	-60 to 330/350°C	20-Meter	13402
0.18mm	0.30	-60 to 330/350°C	20-Meter	13409
0.25mm	0.25	-60 to 330/350°C	30-Meter	13423
0.25mm	0.40	-60 to 330/350°C	30-Meter	13481

Rtx®-5Sil MS Columns (fused silica)

(Crossbond®, selectivity similar to 5% diphenyl/95% dimethyl polysiloxane)

ID	df (µm)	temp. limits	length	cat. #
0.18mm	0.18	-60 to 330/350°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

Analytical Reference Materials

SV Internal Standard Mix

acenaphthene-d10	naphthalene-d8
chrysene-d12	perylene-d12
1,4-dichlorobenzene-d4	phenanthrene-d10
2,000 μ g/mL each in methylene chloride, 1mL/ampul	
cat. # 31206 (ea.)	
4,000 μ g/mL each in methylene chloride, 1mL/ampul	
cat. # 31006 (ea.)	

B/N Surrogate Mix (4/89 SOW)

2-fluorobiphenyl	<i>p</i> -terphenyl-d14
nitrobenzene-d5	
1,000 μ g/mL each in methylene chloride, 1mL/ampul	
cat. # 31024 (ea.)	
5,000 μ g/mL each in methylene chloride, 1mL/ampul	
cat. # 31062 (ea.)	
5,000 μ g/mL each in methylene chloride, 5mL/ampul	
cat. # 31086 (ea.)	
5,000 μ g/mL each in methylene chloride, 10mL/ampul	
cat. # 33028 (ea.)	

Acid Surrogate Mix (4/89 SOW)

2-fluorophenol	2,4,6-tribromophenol
phenol-d6	
2,000 μ g/mL each in methanol, 1mL/ampul	
cat. # 31025 (ea.)	
10,000 μ g/mL each in methanol, 1mL/ampul	
cat. # 31063 (ea.)	
10,000 μ g/mL each in methanol, 5mL/ampul	
cat. # 31087 (ea.)	
10,000 μ g/mL each in methylene chloride, 10mL/ampul	
cat. # 33029 (ea.)	

GC/MS Tuning Mixture

benzidine	DFTPP
4,4-DDT	pentachlorophenol
1,000 μ g/mL each in methylene chloride, 1mL/ampul	
cat. # 31615 (ea.)	

605 Benzidines Calibration Mix

benzidine	3,3'-dichlorobenzidine
2,000 μ g/mL each in methanol, 1mL/ampul	
cat. # 31030 (ea.)	
2,000 μ g/mL each in methylene chloride, 1mL/ampul	
cat. # 31834 (ea.)	

8270 Matrix Spike Mix (76 components)

200 μ g/mL each in methanol:methylene chloride (80:20), 5mL/ampul	
cat. # 31687 (ea.)	

8270 MegaMix® (76 components)

1,000 μ g/mL each in methylene chloride, 1mL/ampul,	•
cat. # 31850 (ea.)	

• Refer to figure for compound list

Inert Sample Path Increases Accuracy

Injection port liners are designed in many configurations, four of which are commonly used for semivolatiles analysis: the single gooseneck, double gooseneck, cyclo double gooseneck, and the Drilled Uniliner®. While all four liner types are used for 8270 analysis, we recommend the Drilled Uniliner® when using constant flow, and the cyclo double gooseneck with pressure pulse conditions.

Liners shown are for Agilent instruments; liners for other instrument brands also are available. For a complete list of liners and seals refer to our catalog or website.

Gooseneck Splitless (4mm)

4.0 ID 6.5 OD x 78.5	20799	5 pk.
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Cyclo Double Gooseneck (4mm)

4.0 ID 6.5 OD x 78.5	20896	5 pk.
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Double Gooseneck Splitless (4mm)

4.0 ID 6.5 OD x 78.5	20785	5 pk.
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Drilled Uniliner® (hole on bottom)

4.0 ID 6.3 OD x 78.5	20771	5 pk.
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The Drilled Uniliner® is the most inert liner because the metal injection port outside the glass liner does not contact the sample path – the sample is virtually “funneled” into the column. Also, when using the Drilled Uniliner® inlet seals do not need to be replaced – a savings in maintenance cost and time. The cyclo double gooseneck liner is recommended with pressure pulse conditions. Its corkscrew type sample path enhances sample vaporization and helps prevent sample contact with metal surfaces below the liner. When using a gooseneck type liner, however, routinely replacing the inlet seal below the liner is critical. Gold plated and Siltek® treated liners and seals both ensure an inert sample path, however, Siltek® treated surfaces are more resistant to abrasion during cleaning.



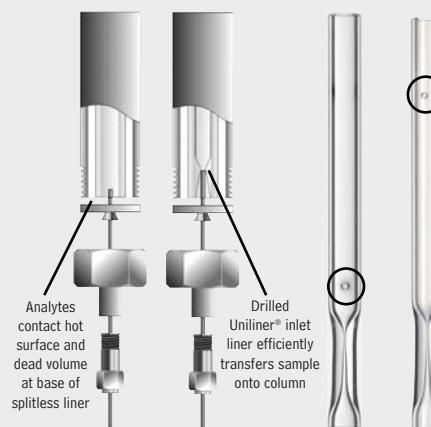
0.8mm ID Dual Vespel® Ring Inlet Seal

Siltek® Treated	21242	2-pk.
Stainless Steel	21238	2-pk.
Gold Plated	21240	2-pk.

restek innovation!

The Drilled Uniliner®

The Drilled Uniliner® provides the most inert sample pathway of all inlet liners for splitless injection techniques. This liner connects directly to the column, eliminating contact between the active compounds and active metal surfaces in the injector, and ensuring an inert sample pathway for analyte transfer from the injection port to the column.



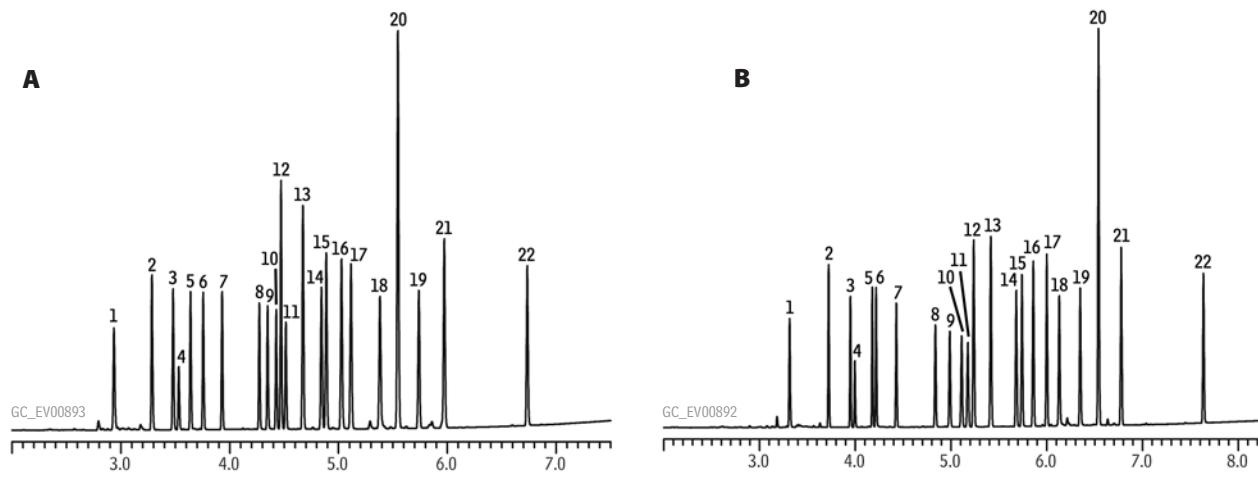
Organochlorine Pesticides and PCB

In organochlorine pesticide analysis, careful consideration of the instrument set-up and column choice can greatly improve sample throughput – reducing costs and saving time. The most critical aspects of the inlet system are inertness and efficiency of target analyte transfer to the analytical column. For pesticide and PCB analysis we recommend the Drilled Uniliner® for its unsurpassed inertness (see page 5).

In the analysis shown, 20m x 0.18mm ID Rtx®-CLPesticides and Rtx®-CLPesticides2 primary and confirmation columns were used. We connected a 5m x 0.53mm guard column to the dual analytical columns, using a SeCure™ "Y" connector kit. These columns have been specifically designed to resolve the chlorinated pesticides when used in parallel under the same temperature program and inlet backpressure. As shown in Figure 1, all the organochlorine pesticide compounds are baseline resolved in less than 8 minutes.

Figure 1 Organochlorine pesticides on Rtx®-CLPesticides and Rtx®-CLPesticides2 columns.

5%Column:	A: Rtx®-CLPesticides, 20m, 0.18mm ID, 0.18 μ m (cat.# 42102) and B: Rtx®-CLPesticides2, 20m, 0.18mm ID, 0.14 μ m (cat.# 42302) with 5m x 0.53mm ID intermediate-polarity deactivated guard tubing (cat.# 10045), connected using SeCure™ "Y" Connector Kit (cat.# 20276) with Universal "Y" Press-Tight® Connector	1. 2,4,5,6-tetrachloro-m-xylene (surr.) 2. α -BHC 3. γ -BHC 4. β -BHC 5. δ -BHC 6. heptachlor 7. aldrin 8. heptachlor epoxide 9. γ -chlordane 10. α -chlordane 11. endosulfan I 12. 4,4' DDE 13. dieldrin 14. endrin 15. 4,4' DDD 16. endosulfan II 17. 4,4' DDT 18. endrin aldehyde 19. endosulfan sulfate 20. methoxychlor 21. endrin ketone 22. decachlorobiphenyl (surr.)
Sample:	Organochlorine Pesticide Mix AB #2 (cat.# 32292), 8-80 μ g/mL each component in hexane/toluene,	
Inj.:	Pesticide Surrogate Mix (cat.# 32000), 200 μ g/mL each component in acetone	
Inj. temp.:	0.5 μ L splitless (hold 0.75 min.), 2mm single gooseneck inlet liner (cat.# 20796)	
Carrier gas:	helium, constant flow	
Linear velocity:	20cm/sec. @ 140°C	
Oven temp.:	140°C (hold 1 min.) to 250°C @ 35°C/min. (hold 1 min.) to 330°C @ 35°C/min. (hold 3 min.)	
Det.:	ECD @ 350°C	



Recommended Columns

Rtx®-CLPesticides Columns (fused silica)

ID	df (μ m)	temp. limits	length	cat. #
0.18mm	0.18	-60 to 310/330°C	20-Meter	42102
0.25mm	0.25	-60 to 320/340°C	30-Meter	11123
0.32mm	0.50	-60 to 320/340°C	30-Meter	11139
0.53mm	0.50	-60 to 300/320°C	30-Meter	11140

Rtx®-CLPesticides2 Columns (fused silica)

ID	df (μ m)	temp. limits	length	cat. #
0.18mm	0.14	-60 to 310/330°C	20-Meter	42302
0.25mm	0.20	-60 to 320/340°C	30-Meter	11323
0.32mm	0.50	-60 to 320/340°C	30-Meter	11325
0.53mm	0.42	-60 to 300/320°C	30-Meter	11340



did you know?

We can supply all your sample extract clean-up needs.
See our catalog or website for details.

Analytical Reference Materials

Organochlorine Pesticide Mix AB #1

(20 components)

aldrin	ieldrin
α-BHC	endosulfan I
β-BHC	endosulfan II
δ-BHC	endosulfan sulfate
γ-BHC (lindane)	endrin
α-chlordane	endrin aldehyde
γ-chlordane	endrin ketone
4,4'-DDD	heptachlor
4,4'-DDE	heptachlor epoxide (B)
4,4'-DDT	methoxychlor
200µg/mL each in hexane:toluene (1:1), 1mL/ampul	
cat. # 32291 (ea.)	

Organochlorine Pesticide Mix AB # 3

(20 components)

same listing as Organochlorine Pesticide Mix AB #1,
shown above.

2,000µg/mL each in hexane:toluene (1:1), 1mL/ampul
cat. # 32415 (ea.)

Pesticide Surrogate Mix

decachlorobiphenyl	2,4,5,6-tetrachloro- <i>m</i> -xylene
200µg/mL each in acetone, 1mL/ampul	
cat. # 32000 (ea.)	

Pesticide Surrogate Mix

decachlorobiphenyl	200µg/mL
2,4,5,6-tetrachloro- <i>m</i> -xylene	100
In P&T methanol, 1mL/ampul	
cat. # 32453 (ea.)	

Organochlorine Pesticide System Evaluation Mix

4,4'-DDT	200µg/mL	endrin	100µg/mL
In MTBE, 1mL/ampul			
cat. # 32417 (ea.)			

508.1 GC Degradation Check Mix

4,4'-DDT	endrin
100µg/mL each in ethyl acetate, 1mL/ampul	
cat. # 32093 (ea.)	

Technical Chlordane, Toxaphene Solutions

Compound	cat.# (ea.)
1,000µg/mL in hexane, 1mL/ampul	
chlordanne (technical)	32021
toxaphene	32005
2,000µg/mL in methanol, 1mL/ampul	
chlordanne (technical)	32016
toxaphene	32015
5,000µg/mL in isoctane, 1mL/ampul	
chlordanne (technical)	32072
toxaphene	32071

also available

Aroclor® Solutions!

Visit our website, see our newest catalog, or call your Restek representative for details.



Increase Sample Throughput Using Dual Analytical Columns and a "Y" Connector Union

Most laboratories need to confirm the compound identification obtained on one column with a second column of different selectivity. This is best achieved by making a single injection onto a guard column which is connected to two analytical columns, using a "Y" splitter. This allows data to be collected from both columns simultaneously, allowing samples to be processed without waiting for the confirmation result.

Rtx®-CLPesticides Column Kits

0.25mm ID Rtx®-CLPesticides Kit cat. # 11199 (kit),

Includes:	cat.#
30m, 0.25mm ID, 0.25µm Rtx®-CLPesticides Column	11123
30m, 0.25mm ID, 0.20µm Rtx®-CLPesticides2 Column	11323
Universal Angled "Y" Press-Tight® Connector	20403
5m, 0.25mm ID Siltek® Guard Column	10026

0.32mm ID Rtx®-CLPesticides Kit cat. # 11198 (kit),

Includes:	cat.#
30m, 0.32mm ID, 0.50µm Rtx®-CLPesticides Column	11139
30m, 0.32mm ID, 0.25µm Rtx®-CLPesticides2 Column	11324
Universal Angled "Y" Press-Tight® Connector	20403
5m, 0.32mm ID Siltek® Guard Column	10027

0.53mm ID Rtx®-CLPesticides Kit cat. # 11197 (kit),

Includes:	cat.#
30m, 0.53mm ID, 0.50µm Rtx®-CLPesticides Column	11140
30m, 0.53mm ID, 0.42µm Rtx®-CLPesticides2 Column	11340
Universal Angled "Y" Press-Tight® Connector	20403
5m, 0.53mm ID IP Deactivated Guard Column	10045

"Y" connectors

"Y" connectors are available in both metal and glass. Glass connectors offer the best chromatography, but are prone to leaks. To eliminate leaks we developed the SeCure™ "Y" connector, which takes advantage of our Press-Tight® connector and adds mechanical strength to hold the columns in place. A second connector, the MXT™ "Y"-Union, is available for fused silica columns.



SeCure™ "Y" - The most secure connector available!

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

Ferrules Fit Column ID	qty.	cat.#
0.25/0.28mm	kit	20276
0.32mm	kit	20277
0.45/0.53mm	kit	20278

MXT™ "Y"-Union Connector Kits for Fused Silica Columns

Each kit contains the MXT™ union, three 1/2-inch nuts and three one-piece fused silica adaptors.

Description	qty.	cat.#
For 0.25mm ID Fused Silica Columns	kit	21389
For 0.32mm ID Fused Silica Columns	kit	21388
For 0.53mm ID Fused Silica Columns	kit	21387



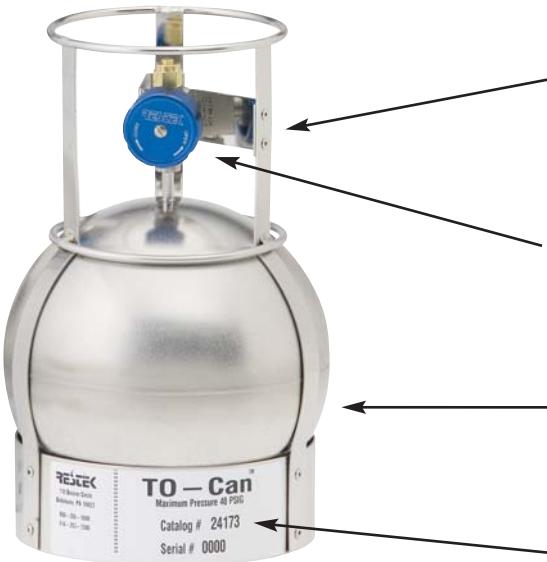
Volatile Organic Compounds in Air

One of the most widely used VOC methods for ambient air monitoring specifies sample collection with a specially prepared stainless steel canister, followed by GC/MS analysis. Restek can support all facets of your air monitoring program – from state-of-the-art sampling equipment to high quality analytical reference standards.

An inert canister surface is critical to obtaining accurate sample results. Restek offers a complete line of TO-Cans™ (Summa® canisters) which are electropolished and extensively cleaned prior to shipping to ensure a high-quality passivated surface for improved analyte stability. No weld marks on the spheres further reduce the occurrence of active sites. For reactive compounds, such as sulfur-containing components, a SilcoCan™ is your best canister choice. SilcoCan™ canisters are deactivated with Siltek® surface treatment resulting in exceptional inertness and maximum sample stability, even for low level sulfur compounds.

Optional gauge

- Quickly confirm vacuum or pressure inside canister.
- Monitor pressure changes.
- Fully protected by canister frame.
- Can be heated to 90°C during cleaning.



Enhanced valve and canister bracket

Canister holder and valve bracket protect canister, tube stub, and valve.

2-3 Port high quality valve

Metal-to-metal seal, 2/3 turn with stainless steel diaphragm.

We consider your TO-Cans™ and SilcoCans™ to be an investment and offer check-ups and reconditioning when needed.

Serial-controlled label
For quick, sure identification.

TO-Can™ Air Monitoring Canisters

Optimized for US EPA Methods TO-14 and TO-15, and ASTM D5466

Description	qty.	cat.#
6L Volume*		
TO-Can™ Canister, 1/4" Valve	ea.	24174
TO-Can™ Canister with Gauge, 1/4" Valve	ea.	24178
TO-Can™ Canister with No Valve	ea.	22096

SilcoCan™ Air Monitoring Canisters

Ideal for low-level reactive sulfur (1-20 ppb), TO-14, or TO-15 compounds

Description	qty.	cat.#
6L Volume*		
SilcoCan™ Canister, 1/4" Valve	ea.	24182
SilcoCan™ Canister, Siltek® Treated 1/4" Valve	ea.	24182-650
SilcoCan™ Canister with Gauge, 1/4" Valve	ea.	24142
SilcoCan™ Canister with Gauge, Siltek® Treated 1/4" Valve	ea.	24142-650
SilcoCan™ Canister with No Valve	ea.	22092
Replacement 1/4" Valves for Air Monitoring Canisters		
1/4" Replacement Valve (2-port)	ea.	24145
1/4" Siltek® Replacement Valve (2-port)	ea.	24144
1/4" Replacement Valve (3-port)	ea.	24147
1/4" Siltek® Replacement Valve (3-port)	ea.	24146

Restek canisters are originally equipped with high-quality Parker Hannifin diaphragm valves. Each valve is helium leak-tested to 4 x 10⁻⁹cc/sec. The all-stainless steel construction eliminates contamination and withstands temperatures from -100°C to 250°C. Compression outlet fitting, indicator plate to display open or closed position, 1/4" inlet and outlet.

*All configurations also available in 1L, 3L, and 15L volumes.

Recommended Columns

Rxi™-1ms Columns (fused silica)

(Crossbond® 100% dimethyl polysiloxane)

ID	df (µm)	temp. limits	length	cat. #
0.32mm	1.00	-60 to 330/350°C	60-Meter	13357

Analytical Reference Materials

TO-15 62 Component Mix (62 components)

Cylinder Construction:	aluminum
Cylinder Size:	8 x 24 cm.
Volume/Pressure:	104 liters of gas @ 1800psig
Cylinder Fitting:	CGA-180 outlet
Weight:	1.5 lbs./0.7 kg
acetone	trichlorofluoromethane
benzene	(Freon® 11)
benzyl chloride*	dichlorodifluoromethane
bromodichloromethane	(Freon® 12)
bromoform	1,1,2-trichloro-1,2,2-trifluoroethane
bromomethane	roethane (Freon® 113)
1,3-butadiene	1,2-dichlorotetrafluoroethane
2-butanone (MEK)	(Freon® 114)
carbon disulfide*	heptane
carbon tetrachloride	hexachloro-1,3-butadiene
chlorobenzene	hexane
chloroethane	2-hexanone (MBK)
chloroform	4-methyl-2-pentanone (MIBK)
chloromethane	methylene chloride
cyclohexane	methyl tert-butyl ether
dibromochloromethane	(MTBE)
1,2-dichlorobenzene	2-propanol
1,3-dichlorobenzene	propylene
1,4-dichlorobenzene	styrene
1,1-dichloroethane	1,1,2,2-tetrachloroethane
1,2-dichloroethane	tetrachloroethene
1,1-dichloroethene	tetrahydrofuran
cis-1,2-dichloroethene	toluene
trans-1,2-dichloroethene	1,2,2-trichlorobenzene
1,2-dichloropropane	1,1,1-trichloroethane
cis-1,3-dichloropropene	1,1,2-trichloroethane
trans-1,3-dichloropropene	trichloroethene
1,4-dioxane	1,2,4-trimethylbenzene
ethanol*	1,3,5-trimethylbenzene
ethyl acetate	vinyl acetate
ethyl benzene	vinyl chloride
ethylene dibromide	m-xylene
(1,2-dibromoethane)	o-xylene
4-ethyltoluene	p-xylene

In nitrogen, 104 liters @ 1800psig

1ppm cat. # 34436 (ea.)

100ppb cat. # 34437 (ea.)

*Stability of this compound cannot be guaranteed.

TO-14A Internal Standard/Tuning Mix

Cylinder Construction:	aluminum
Cylinder Size:	8 x 24 cm.
Volume/Pressure:	104 liters of gas @ 1800psig
Cylinder Fitting:	CGA-180 outlet
Weight:	1.5 lbs./0.7 kg
bromochloromethane	chlorobenzene-d5
1-bromo-4-fluorobenzene (4-	1,4-difluorobenzene
bromofluorobenzene)	

In nitrogen, 104 liters @ 1800psig

1ppm cat. # 34408 (ea.)

100ppb cat. # 34425 (ea.)

Simplify Sampling, Increase Accuracy & Efficiency

Air Canister Heating Jacket

Our heating jackets can help you prepare your canisters for sampling faster and more efficiently. The jacket's novel design ensures complete cleaning by heating the canister and valve together and prevents condensation, ensuring more accurate results. Two temperature settings, 75°C and 150°C. Fits all canisters up to 6L in size.

Description	qty.	cat.#
Air Canister Heating Jacket	ea.	24123

*Not CE certified.

The ultimate in controlled heating, for reliably cleaning your air canisters!



Passive Air Sampling Kits

Our passive sampling kits include all hardware required for field sampling (except the canister) and assemble easily. Our kit was designed to reduce the number of potential leak sites and is available in seven flow ranges, and in stainless steel or with Siltek® surface treatment. Individual parts are also available.

1. Veriflo™ SC423XL flow controller

This flow controller is the heart of the sampling train. It is a high-quality device designed to maintain a constant mass flow as the pressure changes from 30" Hg to 5" Hg (we recommend you stop sampling at or before 5" Hg of vacuum). All wetted parts of the flow controller can be Siltek® treated.

2. Stainless steel vacuum gauge

Fitted to the flow controller, the gauge monitors canister vacuum change during sampling.

3. 1/4-inch Siltek® sample inlet

The 0.3m x 1/4-inch tubing includes a stainless steel nut on the inlet end, to prevent water droplets from accumulating at the edge of the tubing, where they could be pulled into the sampling train.

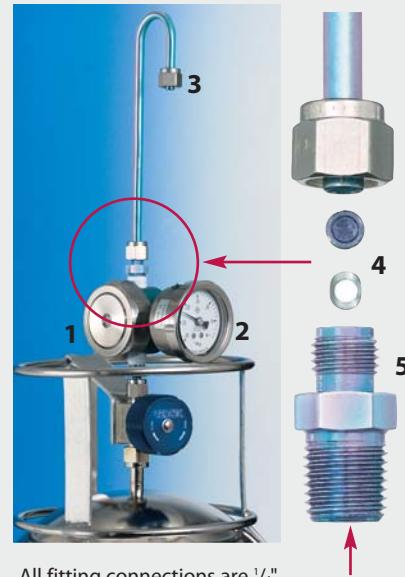
4. 2-micron frit filter and washer

Located prior to the critical orifice to prevent airborne particles from clogging the critical orifice.

Replaceable. Available in stainless steel, or Siltek® treated for optimum inertness.

5. Interchangeable critical orifice

An interchangeable ruby critical orifice allows you to control the flow with very high precision. To select the correct critical orifice for your sample, see table below. Available in stainless steel, or Siltek® treated for optimum inertness.



All fitting connections are 1/4" tube, except where noted.

1/4" NPT

See our catalog for other canister volumes and sampling times.

Sampling Time

6 Liter

Flow (sccm)

Orifice size

Siltek® Treated Sampling Kits*

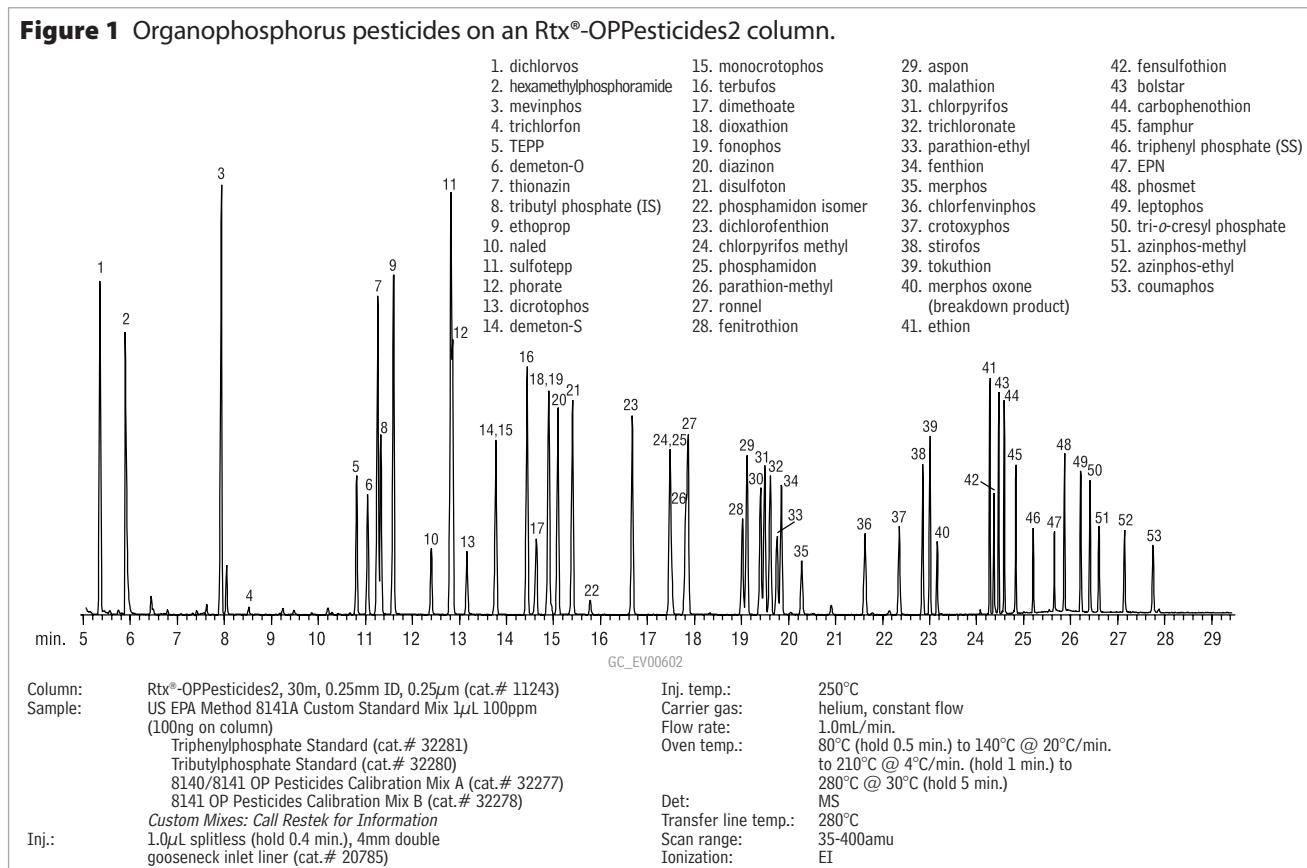
Sampling Time	6 Liter	Flow (sccm)	Orifice size	Siltek® Treated Sampling Kits*	Stainless Steel Sampling Kits*
	125 hour	0.5–2	0.0008"	24217	24216
	24 hour	2–4	0.0012"	24160	24165
	12 hour	4–8	0.0016"	24161	24166
	8 hour	8–20	0.0020"	24162	24167
	3 hour	20–40	0.0030"	24163	24168
	1.5 hour	40–80	0.0060"	24164	24169
	0.5 hour	80–350	0.0090"	22101	22100

*Air sampling canisters sold separately. Available in 400cc, 1L, 3L, 6L, and 15L volumes.

Organophosphorus Pesticides

Organophosphorus pesticides (OPPs) are commonly used as insecticides, fungicides, and herbicides. Due to their widespread use however, they have become an environmental concern. We recommend the Rtx®-OPPesticides2 column for separating organophosphorus pesticides (OPP). Separation is improved, and analysis time is significantly reduced, compared to other columns. The extended upper temperature limit of this phase (330°C) allows analysts to bake out high molecular weight contamination typically associated with pesticide samples. The low bleed column is a perfect match for sensitive detection systems.

Figure 1 Organophosphorus pesticides on an Rtx®-OPPesticides2 column.



Recommended Columns

Rtx®-OPPesticides2 Columns (fused silica)

ID	df (μm)	temp. limits	length	cat. #
0.18mm	0.20	-20 to 310/330°C	20-Meter	11244
0.25mm	0.25	-20 to 310/330°C	30-Meter	11243
0.32mm	0.32	-20 to 310/330°C	30-Meter	11241
0.53mm	0.50	-20 to 310/330°C	30-Meter	11242

Sample Preparation

CarboPrep™ Cartridges

SPE Cartridge	Tube Volume, Bed Weight	qty.	cat#
CarboPrep™ 90	3mL, 250mg	50-pk.	26091
CarboPrep™ 90	6mL, 500mg	30-pk.	26092

Excellent for Pesticide Residue Cleanup!



Carbamates by HPLC

Carbamates are widely used insecticides that pose a health risk as endocrine disruptors. Our Ultra Carbamate column, in a 50mm length, separates common carbamates in less than 10 minutes (Figure 1), significantly less than the time required by traditional C18 columns. In addition to the best column choice for the analysis, we offer reference mixes for Method 531 carbamates, a performance check mix, and the specified internal standard, 4-bromo-3,5-dimethylphenyl-N-methylcarbamate (BDMC).

Figure 1 Carbamate pesticides on an Ultra Carbamate column.

Peak List:
1. aldicarb sulfone
2. aldicarb sulfoxide
3. oxamyl
4. methomyl
5. 3-hydroxycarbofuran
6. aldicarb
7. propoxur
8. carbofuran
9. carbaryl
10. methiocarb
11. 4-bromo-3,5-dimethylcarbamate

Sample:

Inj.: 5µL cat. # 32274 and cat. # 32273 mixed 50:50

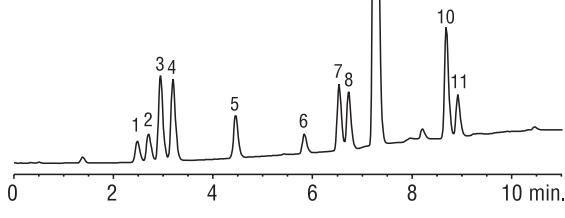
Conc.: 50µg/mL each methanol

Column: **Ultra Carbamate**
Cat. #: 9177355
Dimensions: 50 x 4.6mm
Particle size: 3µm
Pore size: 100Å

Conditions:
Mobile phase: A: 90:10 water:methanol
B: 90:10 methanol:
acetonitrile

Time (min.) %B
0 10
10 90

Flow: 1.5mL/min.
Temp.: 27°C
Det.: UV @ 220nm



free literature

Simple, Sensitive HPLC/UV Analysis for Paraquat and Diquat

These highly charged quaternary amines are poorly retained on alkyl stationary phases. Using only acetonitrile, water, and a solvation-blocking reagent, our separation system alters the interactions among analyte, mobile phase, and stationary phase, and promotes solubility of the analytes in the stationary phase. In our system, the detection limit is 6ppb for either herbicide, and the analysis is completed in less than 10 minutes. An optimized solid phase extraction cartridge concentrates the herbicides for the analysis.

Lit. cat. # 580006

Recommended Columns

Ultra Carbamate Columns

Physical Characteristics:

particle size: 3µm or 5µm, spherical
pore size: 100Å
pH range: 2.5 to 7.5
temperature limit: 80°C

3µm Column	cat. #
50mm (2.1mm ID)	9177352
50mm (4.6mm ID)	9177355
5µm Column	cat. #
250mm (4.6mm ID)	9177575

*For post-column derivatization / fluorescence detection applications for a 4.6mm ID column the total system dead volume, including the post-column reactor, must be less than 650µL. For standard post-column reactor systems, we recommend a 250 x 4.6mm, 5µm column. Call Restek technical service for more information.

ordering note

For guard cartridges for these columns, visit our website at www.restek.com.

Analytical Reference Materials

531.1 Carbamate Pesticide Calibration Mixture

(10 components)

aldicarb	3-hydroxycarbofuran
aldicarb sulfone	methiocarb
aldicarb sulfoxide	methomyl
carbaryl (Sevin®)	oxamyl
carbofuran	propoxur (Baygon®)
100µg/mL each in methanol, 1mL/ampul	
	cat. # 32273 (ea.)

531.2 Carbamate Pesticide Calibration Mixture

(11 components)

aldicarb	methiocarb
aldicarb sulfone	methomyl
aldicarb sulfoxide	1-naphthol
carbaryl (Sevin®)	oxamyl
carbofuran	propoxur (Baygon®)
3-hydroxycarbofuran	
100µg/mL in acetonitrile, 1mL/ampul	
	cat. # 32435 (ea.)

Internal Standard

4-bromo-3,5-dimethylphenyl-N-methylcarbamate (BDMC)

100µg/mL in methanol, 1mL/ampul

cat. # 32274 (ea.)

531.1 Performance Check Mix

aldicarb sulfoxide	100µg/mL	3-hydroxycarbofuran	2
BDMC	10	methiocarb	20
In methanol, 1mL/ampul			
		cat. # 32275 (ea.)	

Polyaromatic Hydrocarbons (PAHs) by HPLC

Most HPLC PAH methods recommend using a C18 column with fluorescence and/or UV/VIS detection. Our Pinnacle™ II PAH columns have a highly reproducible modified alkyl phase on Restek manufactured silica, specifically developed for this application. Figure 1 shows the analysis of 16 target PAHs in less than 18 minutes, and Figure 2 shows a separation of 20 target PAHs and related compounds, in less than 6 minutes, using a 5cm column.

Figure 1 Baseline separation of 16 PAHs in less than 18 minutes on a Pinnacle™ II PAH column.

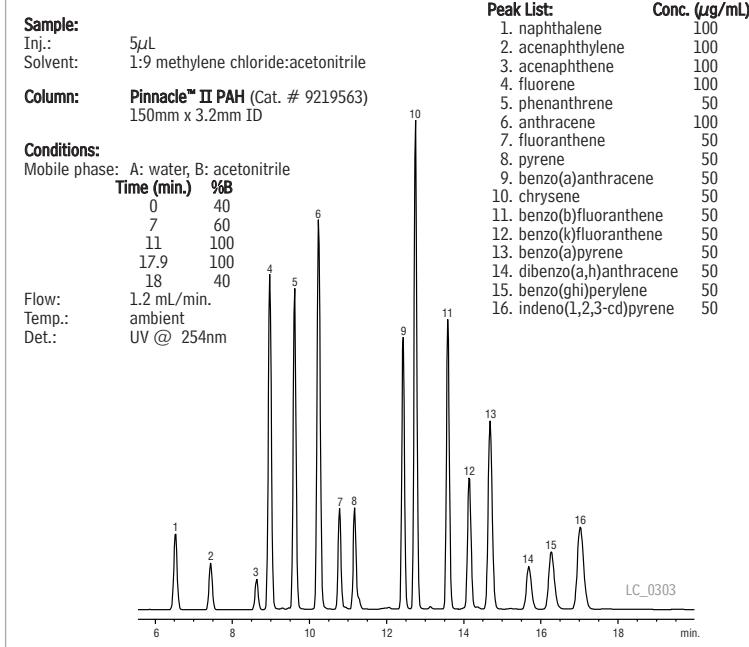
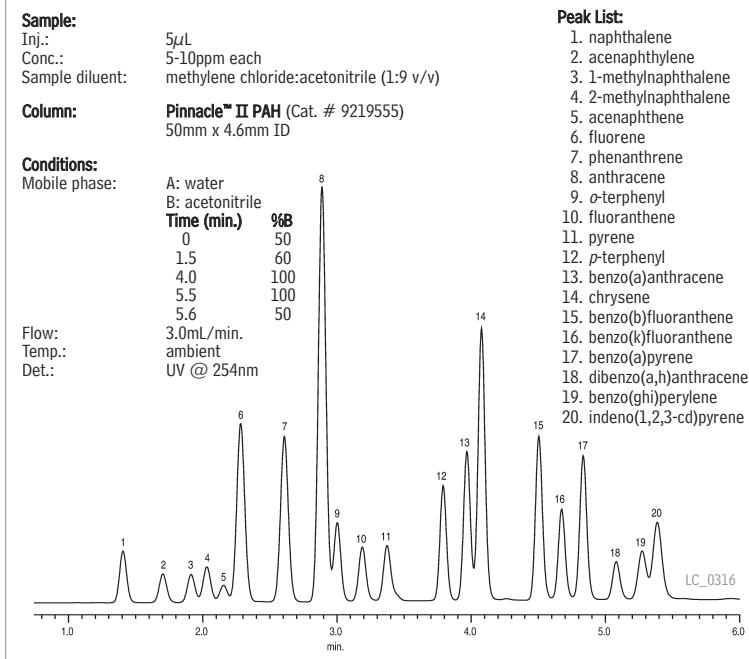


Figure 2 Fast, efficient separation of 20 target PAHs and related compounds using a 5cm Pinnacle™ II PAH column.



Recommended Columns

Pinnacle™ II PAH Columns

Physical Characteristics:

particle size: 5 μ m, endcap: fully endcapped
spherical pH range: 2.5 to 10
pore size: 110 \AA temperature limit: 80°C

Column	cat. #
50 x 2.1mm	9219552
50 x 3.2mm	9219553
150 x 3.2mm	9219563
50 x 4.6mm	9219555
150 x 4.6mm	9219565
10 x 2.1mm	921950212
10 x 4.0mm	921950210
20 x 2.1mm	921950222
20 x 4.0mm	921950220

ordering note

For guard cartridges for these columns, visit our website at www.restek.com.

Analytical Reference Materials

EPA Method 8310 PAH Mixture (18 components)

acenaphthene	dibenzo(a,h)anthracene
acenaphthylene	fluoranthene
anthracene	fluorene
benzo(a)anthracene	indeno(1,2,3-cd)pyrene
benzo(a)pyrene	1-methylnaphthalene
benzo(b)fluoranthene	2-methylnaphthalene
benzo(ghi)perylene	naphthalene
benzo(k)fluoranthene	phenanthrene
chrysene	pyrene
500 μ g/mL each in acetonitrile, 1mL/ampul	
cat. # 31841 (ea.)	

EPA Method 8310 Quality Control Check (18 components)

acenaphthene	100 μ g/mL	dibenzo(a,h)anthracene	10
acenaphthylene	100	fluoranthene	10
anthracene	100	fluorene	100
benzo(a)anthracene	10	indeno(1,2,3-cd)pyrene	10
benzo(a)pyrene	10	1-methylnaphthalene	100
benzo(b)fluoranthene	10	2-methylnaphthalene	100
benzo(ghi)perylene	10	naphthalene	100
benzo(k)fluoranthene	5	phenanthrene	100
chrysene	10	pyrene	10
In acetonitrile, 1mL/ampul			
cat. # 31843 (ea.)			

EPA Method 8310 Surrogate Standard

decafluorobiphenyl	1,000 μ g/mL in acetonitrile, 1mL/ampul
cat. # 31842 (ea.)	

free literature

Environmental Flyer

HPLC analyses described in this 8-page publication include carbamates, carbonyls, explosives, paraquat/diquat, phenoxyacid herbicides, and polyaromatic hydrocarbons.

Lit. cat. # 59741A

Explosives by HPLC

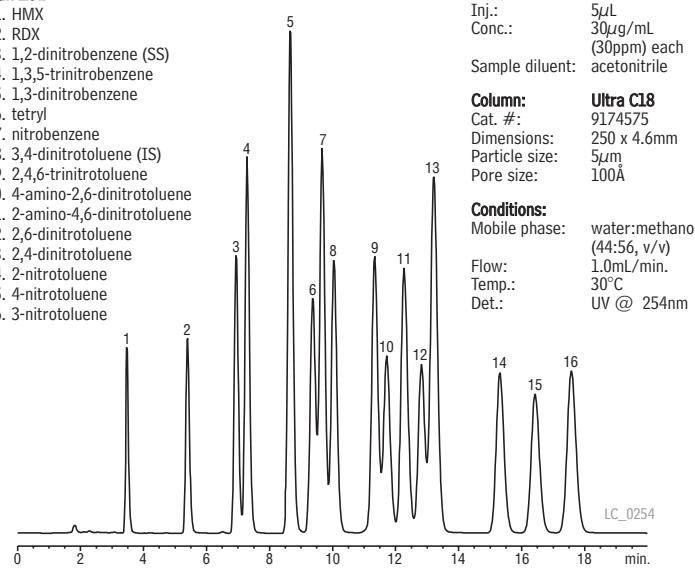
Common methods for quantifying explosives call for reversed phase HPLC with UV detection, using a primary column and a confirmation column. While cyano phases typically have been used for the confirmation column, resolution of the target explosive compounds is poor. The Pinnacle™ II Biphenyl column provides excellent resolution of Method 8330 explosives, as shown in Figure 1, and selectivity is markedly different from C18 phases, making the Pinnacle™ II Biphenyl column an ideal confirmation column. If a cyano phase must be used for confirmation, we recommend a Pinnacle™ II Cyano column.

Figure 1 An outstanding column pair for explosives analysis.

For superior performance, use an Ultra C18 primary column...

Peak List:

1. HMX
2. RDX
3. 1,2-dinitrobenzene (SS)
4. 1,3,5-trinitrobenzene
5. 1,3-dinitrobenzene
6. tetryl
7. nitrobenzene
8. 3,4-dinitrotoluene (IS)
9. 2,4,6-trinitrotoluene
10. 4-amino-2,6-dinitrotoluene
11. 2-amino-4,6-dinitrotoluene
12. 2,6-dinitrotoluene
13. 2,4-dinitrotoluene
14. 2-nitrotoluene
15. 4-nitrotoluene
16. 3-nitrotoluene

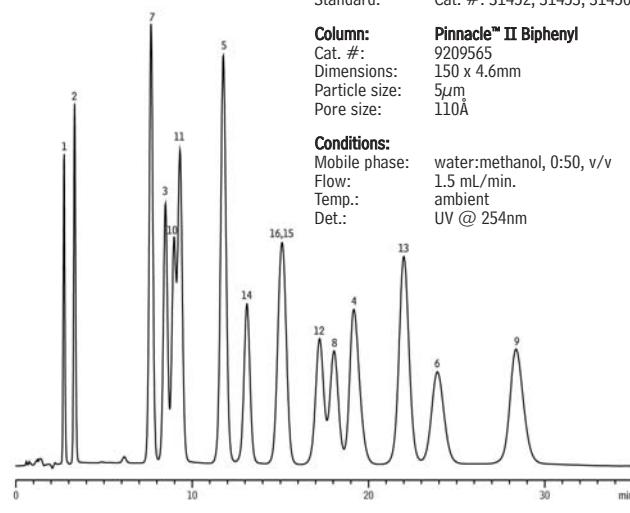


...coupled with a Pinnacle II™ Biphenyl column.

Sample:
Inj.: 10 μ L
Conc.: 30 μ g/mL (30ppm) each
Sample diluent: acetonitrile
Sample temp.: ambient
Standard: Cat. #: 31452, 31453, 31450, 31451

Column: Pinnacle™ II Biphenyl
Cat. #: 9209565
Dimensions: 150 x 4.6mm
Particle size: 5 μ m
Pore size: 110 \AA

Conditions:
Mobile phase: water:methanol, 0.50, v/v
Flow: 1.5 mL/min.
Temp.: ambient
Det.: UV @ 254nm



Recommended Columns

Ultra C18 Columns (USP L1)

Physical Characteristics:

particle size: 3 μ m or 5 μ m, spherical
pore size: 100 \AA
carbon load: 20%
endcap: fully endcapped
pH range: 2.5 to 7.5
temperature limit: 80°C

5 μ m Column, 4.6mm	cat. #
150mm	9174565
250mm	9174575

Pinnacle™ II Biphenyl Columns (USP L11)

Physical Characteristics:

particle size: 5 μ m, spherical
pore size: 110 \AA
endcap: yes
pH range: 2.5 to 7.5
temperature limit: 80°C

5 μ m Column, 4.6mm	cat. #
150mm	9209565
250mm	9209575

ordering note

For guard cartridges for these columns, visit our website at www.restek.com.

Analytical Reference Materials

Nitroaromatics and Nitramine

Explosives by HPLC (14 components)

1,3-dinitrobenzene	2-nitrotoluene
2-amino-4,6-dinitrotoluene	3-nitrotoluene
4-amino-2,6-dinitrotoluene	4-nitrotoluene
2,4-dinitrotoluene	RDX
2,6-dinitrotoluene	tetryl
HMX	1,3,5-trinitrobenzene
nitrobenzene	2,4,6-trinitrotoluene
1,000 μ g/mL each in acetonitrile, 1mL/ampul	
	cat. # 33905 (ea.)

8095 Internal Standard

3,4-dinitrotoluene
1,000 μ g/mL in methanol, 1mL/ampul
cat. # 31452 (ea.)

8330 Surrogate

1,2-dinitrobenzene
1,000 μ g/mL in methanol, 1mL/ampul
cat. # 31453 (ea.)

free literature

HPLC Analysis of Trace-Level Explosives Using Pinnacle II™ C18 and Cyano Columns

Pinnacle II™ C18 reversed phase columns and Pinnacle II™ Cyano normal phase columns are effective primary and confirmation columns for analyzing explosives according to US EPA Method 8330A. Analytical conditions and example chromatograms are presented in this 2-page note. Per recommendation in the method, the same mobile phase is used for the primary and confirmation analysis.

Lit. cat. # 59361

Environmental Essentials

Direct Injection Liners - What's a drilled uniliner? See page 5.

COLUMN INSTALLS THIS END

Description	ID*/OD & Length (mm)	ea.	cat.#	5-pk.
DI Liners for Agilent 5890 & 6890 GCs (For 0.25/0.32/0.53mm ID Columns)				
Drilled Uniliner®▲	4.0 ID 6.3 OD x 78.5	21054	21055	
Siltek® Drilled Uniliner®▲	4.0 ID 6.3 OD x 78.5	21054-214.1	21055-214.5	
Drilled Uniliner®▼	4.0 ID 6.3 OD x 78.5	20756	20771	
Double Gooseneck Drilled Uniliner®▲	4.0 ID 6.3 OD x 78.5	20508	20509	
Double Gooseneck Drilled Uniliner®▼	4.0 ID 6.3 OD x 78.5	20954	20989	
Siltek® 1mm Drilled Uniliner®▲	1.0 ID 6.3 OD x 78.5	21390-214.1	21391-214.5	
DI Liners for Varian 1177 GCs (For 0.25/0.32/0.53mm ID Columns)				
Drilled Uniliner®▲	4.0 ID 6.3 OD x 78.5	21470	21471	
Drilled Uniliner®▼	4.0 ID 6.3 OD x 78.5	21468	21469	
DI Liners for Shimadzu 17A, 2010, and 2014 GCs (For 0.32/0.53mm ID Columns)				
Open-top Drilled Uniliner®▲	3.5 ID 5.0 OD x 95	21285	21286	
Open-top Drilled Uniliner®▼	3.5 ID 5.0 OD x 95	21287	21288	
Gooseneck Drilled Uniliner®▲	3.5 ID 5.0 OD x 95	21289	21290	
Gooseneck Drilled Uniliner®▼	3.5 ID 5.0 OD x 95	21291	21292	
DI Liners for PerkinElmer GCs (For 0.32/0.53mm ID Columns)				
Auto SYS™ Drilled Uniliner®▲	4.0 ID 6.2 OD x 92.1	20819	20822	
Auto SYS™ Drilled Uniliner®▼	4.0 ID 6.2 OD x 92.1	21293	21294	
Auto SYS™ Gooseneck Drilled Uniliner®▲	4.0 ID 6.2 OD x 92.1	21295	21296	
Auto SYS™ Gooseneck Drilled Uniliner®▼	4.0 ID 6.2 OD x 92.1	21297	21298	
Direct Injection Liners for Thermo Electron TRACE™ & Focus SSL (0.32 & 0.53mm ID columns)				
Drilled Uniliner®▲	5.0 ID 8.0 OD x 105	22411	22412	
Drilled Uniliner®▼	5.0 ID 8.0 OD x 105	22413	22414	

*Nominal ID at syringe needle expulsion point. ▲ Hole on top. ▼ Hole on bottom.

O-Rings



	Max. temp.	qty.	cat.#
A) Viton® O-Rings for Agilent GCs	250°C	25-pk.	20377
B) Graphite O-rings for Agilent & Varian split liners (6.35mm ID)	450°C	10-pk.	20296
B) Graphite O-rings for Agilent & Varian splitless liners (6.5mm ID)	450°C	10-pk.	20298
C) 5mm Graphite Liner Seals for Varian 1078/1079 GCs	450°C	10-pk.	22683
D) Viton® O-Rings for Shimadzu 17A, 2010, and 2014 GCs	250°C	10-pk.	21477
E) Graphite O-Rings for Shimadzu 17A, 2010, & 2014 Split Liners	450°C	5-pk.	20243
E) Graphite O-Rings for Shimadzu 17A, 2010, & 2014 Splitless Liners	450°C	5-pk.	20244
F) Silicone O-Rings for PerkinElmer Auto SYS™ GCs	250°C	10-pk.	20262
G) Viton® O-Rings for PerkinElmer PSS	250°C	10-pk.	20366
H) Inlet Liner Seals for TRACE™ PTV	450°C	2-pk.	21392
I) Graphite Sealing Ring for TRACE™ and Focus SSL Instruments	450°C	ea.	21898
I) Graphite Sealing Rings for TRACE™ and Focus SSL Instruments	450°C	2-pk.	21899



did you know?

We can supply all your sample extract clean-up needs.
See our catalog or website for details.

Restek Septa

- Precision molding assures consistent, accurate fit.
- Ready to use.
- Do not adhere to hot metal surfaces.
- Packaged in non-contaminating glass jars.

Septum Diameter	25-pk.	50-pk.	100-pk.
Thermolite® Septa			
5mm (1/16")	27120	27121	27122
6mm (1/4")	27123	27124	27125
7mm	27126	27127	27128
8mm	27129	27130	27131
9mm	27132	27133	27134
9.5mm (5/16")	27135	27136	27137
10mm	27138	27139	27140
11mm (13/16")	27141	27142	27143
11.5mm	27144	27145	27146
12.5mm (1/2")	27147	27148	27149
17mm	27150	27151	27152
Shimadzu Plug	27153	27154	27155
IceBlue™ Septa			
9mm	27156	27157	
9.5mm (5/16")	27158	27159	
10mm	27160	27161	
11mm (13/16")	27162	27163	
11.5mm	27164	27165	
12.5mm (1/2")	27166	27167	
17mm	27168	27169	
Shimadzu Plug	27170	27171	
BTO® Septa			
5mm CenterGuide™	27100	27101	
6mm (1/4")	27102	27103	
9mm CenterGuide™	27104	27105	
9.5mm (5/16")	27106	27107	
10mm	27108	27109	
11mm (13/16") CenterGuide™	27110	27111	
11.5mm CenterGuide™	27112	27113	
12.5mm (1/2") CenterGuide™	27114	27115	
17mm CenterGuide™	27116	27117	
Shimadzu Plug	27118	27119	

Dual Vespel® Ring Inlet Seals - Eliminates the need for a washer!

0.8mm ID Dual Vespel® Ring Inlet Seal	2-pk.	10-pk.
Siltek® Treated	21242	21243
Gold-Plated	21240	21241
Stainless Steel	21238	21239
1.2mm ID Dual Vespel® Ring Inlet Seal		
	2-pk.	10-pk.
Siltek® Treated	21248	21249
Gold-Plated	21246	21247
Stainless Steel	21244	21245

Replacement Inlet Seals with Washers

Single-Column Installation, 0.8mm Opening*		0.25/0.32mm ID Dual-Column Installation, 1.2mm Opening		0.53mm ID Dual-Column Installation (1/16-inch opening)	
2-pk.	10-pk.	2-pk.	10-pk.	2-pk.	10-pk.
Stainless Steel Inlet Seal					
21315	21316	20390	20391	20392	20393
Gold-Plated Inlet Seal					
21317	21318	21305	21306	—	—
Siltek® Treated Inlet Seal					
21319	21320	21307	21308	—	—

*0.8mm ID stainless steel inlet seal is similar to Agilent part #18740-20880,
0.8mm ID gold-plated inlet seal is similar to Agilent part #18740-20885.



Thermolite® Septa

- Usable to 340°C inlet temperature.
- Excellent puncturability.



IceBlue™ Septa

- Usable to 250°C inlet temperature.
- General-purpose septa.
- Excellent puncturability.
- Ideal for SPME.



BTO® Septa

- CenterGuide™ design—requires less force for initial penetration.
- Usable to 400°C inlet temperature.
- Each batch GC-FID tested.
- Bleed and temperature optimized; ideal for demanding GC and GC/MS applications.



HANDY septum size chart

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



septum handling tips

- Handle septa carefully, to prevent contamination.
- Minimize bleed—use preconditioned, low-bleed septa.
- Follow septum and instrument manufacturers' recommendations.



Restek Trademarks:

CarboPrep, Crossbond, IceBlue, MegaMix, MXT, Pinnacle, Press-Tight, Rtx, RxI, SeCure, SilcoCan, Silcosteel, Siltek, Sulfinert, Thermolite, TO-Can, Uniliner.

Other Trademarks:

BTO (Chromatography Research Supplies, Inc.), Freon, Vespel, Viton (E.I. du Pont de Nemours & Co., Inc.), QCQ (Finnigan Corp.), SUMMA (Moletrics), Auto SYS (Perkin-Elmer), Baygon (S.C. Johnson & Son, Inc.), TRACE (Thermo Scientific), Sevin (Union Carbide Corp.), Veriflo (Veriflo Corp.)



Lit. Cat.# 580127

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Biodiesel Solutions

Innovative Products for Simple,
Reliable Biodiesel Analysis

- MXT®, Rtx®, and Stabilwax® biodiesel columns—engineered specifically for high performance biodiesel analysis.
- GC accessories to simplify your lab work and increase productivity.
- Analytical reference materials—high quality standards for reliable results.

Integrated retention gaps—

**The Ultimate
Biodiesel Solution!**

See page 5 for details



Chromatography Products



Website NEW : www.chromalytic.com.au E-mail : info@chromtech.net.au Tel: 03 9762 2034 . . . in AUSTRALIA

Introduction to Biodiesel

Today, as oil prices climb and pollution levels soar, there is significant worldwide interest in alternative fuels. Biodiesel is one of the most popular alternative fuels available today. It may be used in engines, either pure or blended with diesel fuel, to reduce exhaust pollutants. It can be produced easily from sunflowers, soy, rapeseed, tallow, lard, yellow grease, and other sources. Chemically, it is the product obtained when a vegetable oil or animal fat is reacted with an alcohol in the presence of a catalyst, such as sodium or potassium hydroxide, to produce fatty acid methyl esters.

Methods used to test the quality of biodiesel fuels can be categorized into three types based on the target compounds: ASTM D6584 and EN 14105 test for total glycerin, EN 14103 tests for fatty acid methyl esters (FAMEs), and EN 14110 tests for residual methanol. These methods may be performed using either fused silica or metal columns, but the column chosen must have extremely high temperature tolerance. Restek offers both fused silica and metal columns designed specifically for high temperature biodiesel analysis. These columns, the Rtx®-Biodiesel TG, MXT®-Biodiesel TG, Stabilwax®, and Rtx-1® column lines, offer outstanding performance for biodiesel testing.

Rtx®-Biodiesel TG Columns (fused silica)

Rtx®-Biodiesel TG Columns:

- Low column bleed at high temperatures.
- Alumaseal™ connector provides leak-free connection, retention gap extends column life.
- Complete resolution for all compounds from interference peaks.

Description	temp. limits	cat.#
10m, 0.32mm ID, 0.10	to 330/380°C	10292
10m, 0.32mm ID, 0.10 w/2m x		
0.53mm retention gap**	to 330/380°C	10291
15m, 0.32mm ID, 0.10	to 330/380°C	10294
15m, 0.32mm ID, 0.10 w/2m x		
0.53mm retention gap**	to 330/380°C	10293

**Connected with low-dead-volume Alumaseal™ connector.

Biodiesel Calibration Standards

Concentration is $\mu\text{g}/\text{mL}$ in pyridine. Volume is 1mL/ampul unless otherwise noted.

Compound	Solvent	cat.#
(S)-(-)-1,2,4-butanetriol		1,000 33024
(S)-(-)-1,2,4-butanetriol (5mL)		1,000 33032
diolein [1,3-di[<i>cis</i> -octadecenoyl] glycerol]		5,000 33022
glycerin		500 33020
monoolein		
(1-mono[<i>cis</i> -9-octadecenoyl]-rac-glycerol)		5,000 33021
monopalmitin		5,000 33026
tricaprin (1,2,3-tricapryin) glycerol)		8,000 33025
tricaprin (1,2,3-tricapryin) (5mL)		8,000 33033
triolein (1,2,3-Tri[<i>cis</i> -octadecenoyl] glycerol)		5,000 33023

Silylation Derivatization Reagents

Compound	CAS#	cat.#
MSTFA (N-methyl-N-trimethylsilyltrifluoroacetamide)		
10-pk. (10x1g)	24589-78-4	35600
25g Flex Tube	24589-78-4	35601

Analyzing Total Glycerin in Biodiesel

Rtx®-Biodiesel TG Fused Silica Columns

Glycerin in biodiesel falls out of solution, causing gumming in fuel systems and malfunctioning of engine parts, which eventually leads to inferior engine performance. Total glycerin presents itself in two forms: free glycerin and bound glycerin in the form of glycerides. Derivatization is required for analysis, and both ASTM D6584 and EN 14105 use N-methyl-N-trimethylsilyltrifluoroacetamide derivatization reagent.

A 10m x 0.32mm ID Rtx®-Biodiesel TG column with a 2m x 0.53mm ID retention gap is ideal for glycerin analysis. The retention gap is factory coupled using Restek's unique Alumaseal™ connector (Figure 1). This innovative connector is leak-tight and low dead volume, making it advantageous for high temperature work. The data in Figure 2 show the elution of glycerin, monoglycerides, diglycerides, and triglycerides in B100 biodiesel following ASTM Method D6584, utilizing cool on-column injection. The Rtx®-Biodiesel TG column provides good resolution and signal-to-noise ratios for mono-, di-, and triglycerides.

Figure 1: The Alumaseal™ connector

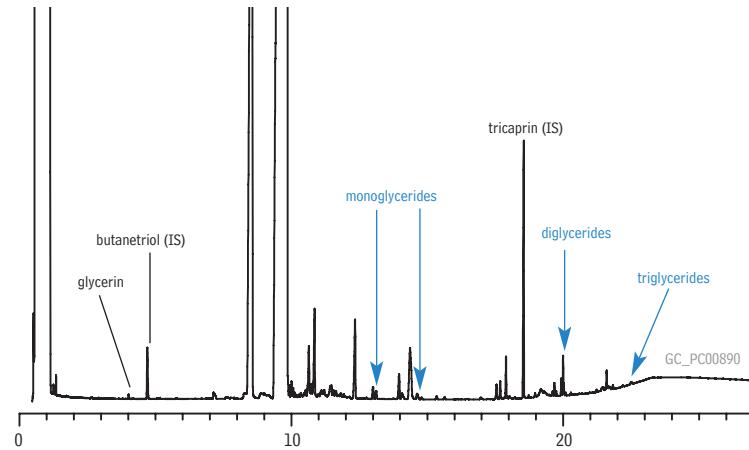
The Alumaseal™ connector is the best column connector for coupling fused silica and metal columns, even columns of different internal diameters. Made of aluminum, it is designed for high temperature performance. These connectors have been factory-coupled and tested using temperature programmed mass spectrometry and have shown no signs of leaks, even at 430°C.

The Alumaseal™ connector offers:

- A leak-tight connection.
- Low dead volume.
- Low thermal mass.
- High inertness.



Figure 2 The Rtx®-Biodiesel TG column meets resolution criteria and shows excellent response for determining glycerin in biodiesel.



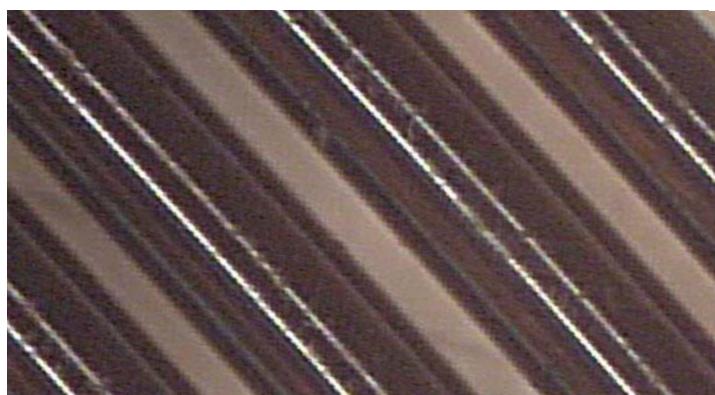
Column: Rtx®-Biodiesel TG, 10m, 0.32mm ID, 0.10 μm connected to 2m x 0.53mm Hydroguard™ tubing using Alumaseal™ connector (cat.# 10291)
Sample: biodiesel (B100) plus monoolein, diolein, triolein, glycerin, butanetriol, tricaprin
Inj.: 1 μL , cool on-column
Inj. temp.: oven track
Carrier gas: hydrogen, constant flow
Flow rate: 4mL/min.
Oven temp.: 50°C (hold 1 min.) to 180°C @ 15°C/min. (hold 7 min.) to 230°C @ 30°C/min. to 380°C @ 30°C/min. (hold 5 min.)
Det.: FID
Det. temp.: 380°C

Comparing Fused Silica to Metal

High temperature applications shorten the lifetime of fused silica columns due to deterioration of the polyimide resin used to make the columns. When fused silica columns are exposed to oven temperatures over 400°C the polyimide coating becomes brittle and the deactivation of the column is compromised. Figure 3 shows the effect of cycling a commercially available fused silica column to 430°C for 5 minutes 100 times. Although the column was labeled as stable up to 430°C, the polyimide coating shows damage. The inertness of the column also deteriorates as shown by the loss of peak symmetry for the internal standard butanetriol over multiple injections (Figure 4).

Metal MXT®-Biodiesel TG columns are a better alternative to fused silica columns. As shown in Figure 4, they clearly outperform high temperature fused silica columns under the cycling conditions required for biodiesel analysis. Metal MXT®-Biodiesel TG columns offer greater stability and longer column lifetimes compared to fused silica columns.

Figure 3 Fused silica columns, labeled as stable up to 430°C, show significant pitting and breakdown.



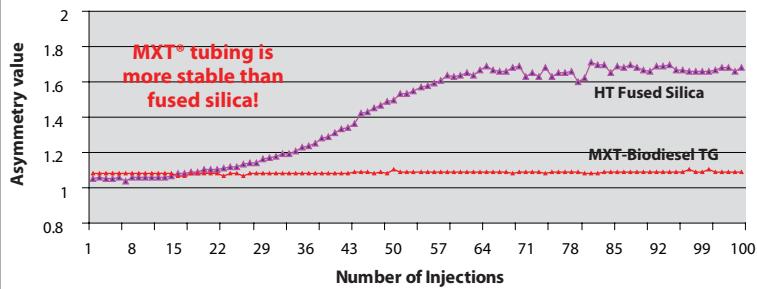
Before



After

100 temperature cycles to 430°C totaling 500 minutes at maximum temperature.

Figure 4 Stable peak shape for internal standard butanetriol on MXT®-Biodiesel TG columns gives more accurate quantification.



Metal Column Solutions: Two Options for Increased Stability and Performance

- 0.32mm MXT®-Biodiesel TG column with a 0.53mm retention gap, factory coupled with an Alumaseal™ connector
- 0.53mm MXT®-Biodiesel TG column with a built-in 0.53mm Integra-Gap™ integrated retention gap

The primary advantage of using metal MXT® columns is that they are more stable at high temperatures than fused silica columns. This means they will exhibit lower bleed, improving analytical performance, and have longer lifetimes, making them a cost-effective option. They also can be brought to high temperatures (430°C) allowing nonvolatile material to be baked off of the column, removing carryover contamination and improving cycle times.

Metal MXT®-Biodiesel TG columns are offered in the same column dimensions as their fused silica counterparts. Two different column configurations are available for cool on-column injection: 1) a 10m (or 15m) x 0.32mm ID MXT®-Biodiesel TG column factory coupled to a 2m x 0.53mm retention gap using an Alumaseal™ connector, and 2) a 14m x 0.53mm ID MXT®-Biodiesel TG column with a built-in 2m x 0.53mm ID Integra-Gap™ integrated retention gap.

Target analytes resolve well and the solvent and triglyceride peaks show excellent symmetry on both columns (Figures 5 and 6), but the 0.53mm MXT®-Biodiesel TG column with the Integra-Gap™ integrated retention gap eliminates the need for a connector, making connector-related leaks a thing of the past. Peak shape for butanetriol is very good, demonstrating inertness, and the resolution and response for the mono-, di- and triglycerides is excellent. The leak-proof 0.53mm MXT®-Biodiesel TG column with the Integra-Gap™ integrated retention gap is the ultimate biodiesel solution (Figure 7).

Figure 5 Derivatized B100 samples resolve well on the 15m x 0.32mm MXT®-Biodiesel TG column, which is factory coupled to a 0.53mm retention gap using an Alumaseal™ connector.

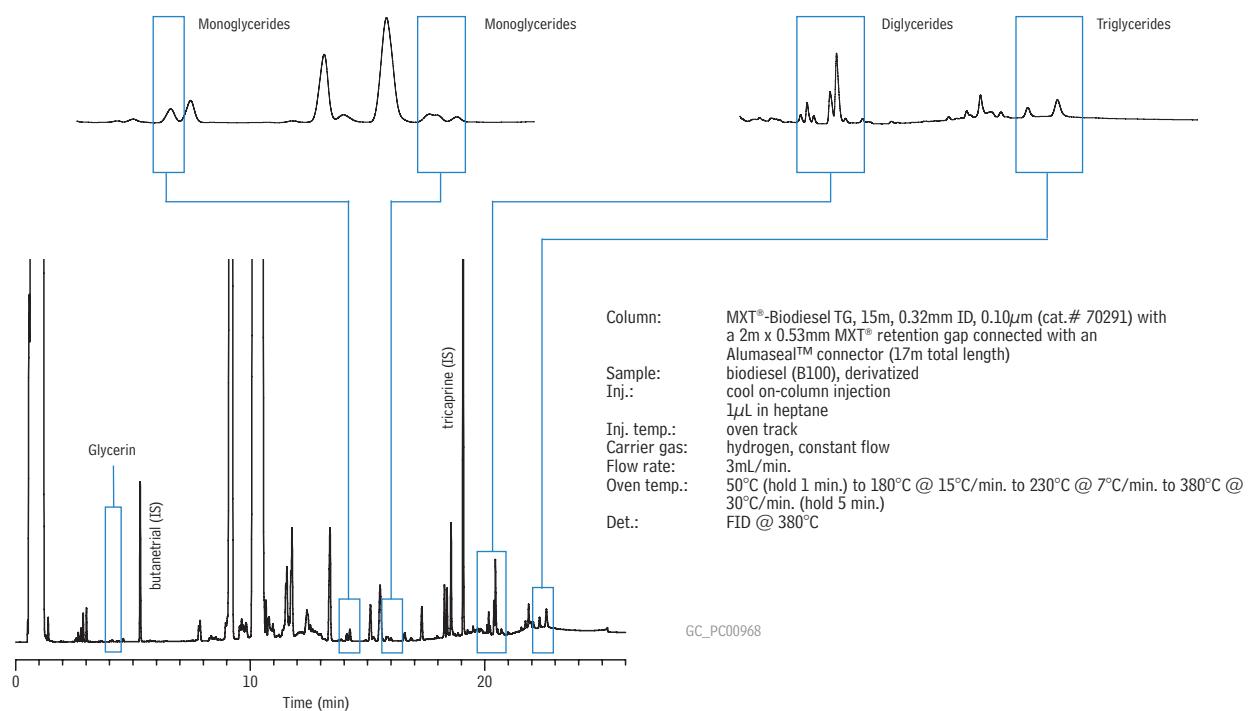


Figure 6 Excellent chromatographic quality and resolution on the 0.53mm MXT®-Biodiesel TG column, with the Integra-Gap™ integrated retention gap.

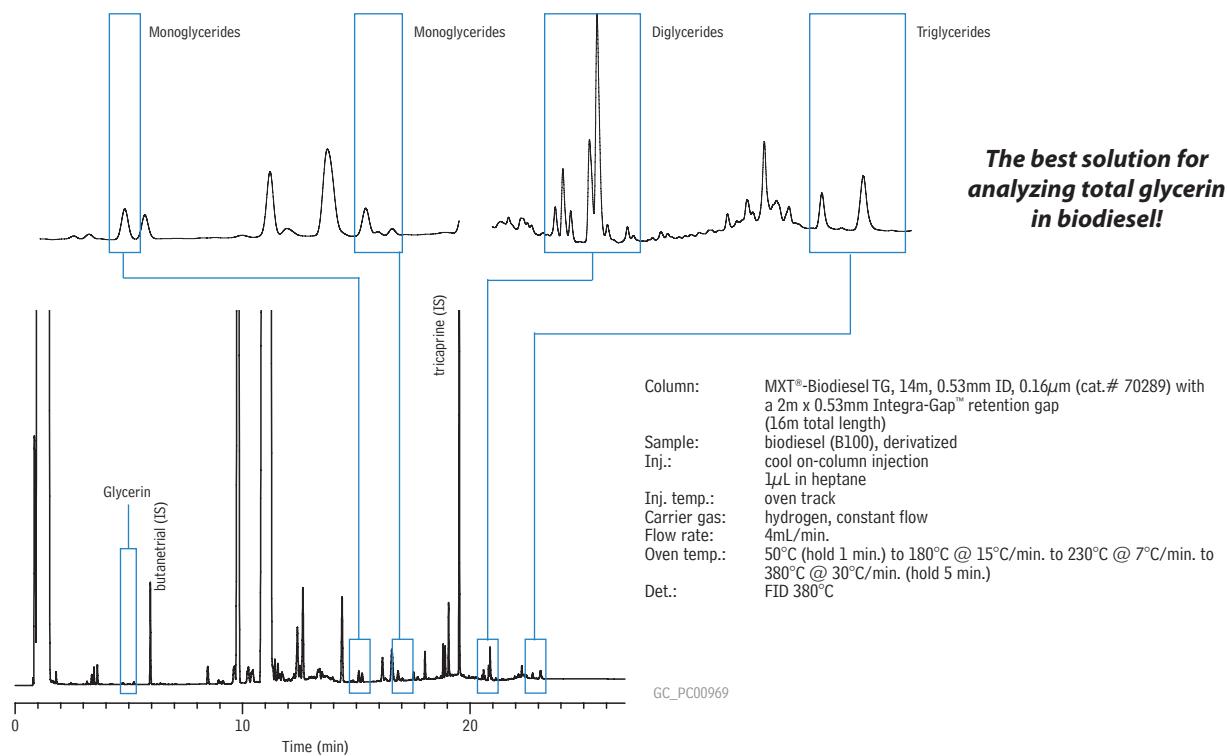
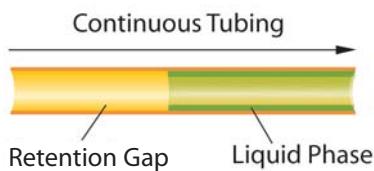


Figure 7 The Ultimate Biodiesel Solution: MXT®-Biodiesel TG column with Integra-Gap™ integrated retention gap.

The 0.53mm MXT®-Biodiesel TG columns are an innovative alternative to using a 0.32mm column coupled to a 0.53mm retention gap. Restek applied the Integra-Gap™ integrated retention gap technology to the 0.53mm MXT®-Biodiesel TG columns, eliminating the column coupling. These 100% leak-proof columns feature a built-in retention gap, reducing the risk of peak broadening and tailing, and guaranteeing the user many analyses without downtime.



MXT®-Biodiesel TG Columns

- Fast analysis times and sharp glyceride peaks.
- Stable at 430°C for reliable, consistent performance.
- Integra-Gap™ built-in retention gap eliminates manual connection.

MXT®-Biodiesel TG Columns (Siltek® treated stainless steel)

Description	temp. limits	cat.#
14m, 0.53mm ID, 0.16 w/2m Integra-Gap™	-60 to 380/430°C	70289
10m, 0.32mm ID, 0.10	-60 to 380/430°C	70292
10m, 0.32mm ID, 0.10 w/2m x 0.53mm retention gap**	-60 to 380/430°C	70290
15m, 0.32mm ID, 0.10	-60 to 380/430°C	70293
15m, 0.32mm ID, 0.10 w/2m x 0.53mm retention gap**	-60 to 380/430°C	70291

*Total column length=16 meters.

**Connected with low-dead-volume Alumaseal™ connector.

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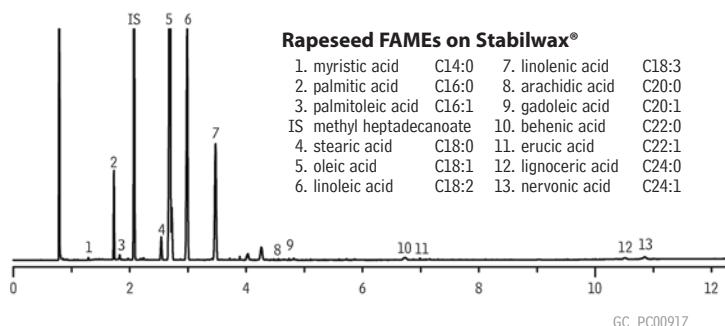


Analyzing FAMEs in Biodiesel

FAMEs are the desired end product of biodiesel production and they are analyzed to determine the percent of usable fuel in the final product. A Stabilwax® fused silica GC column affords excellent peak symmetry, resolution, and reproducibility for determining the FAMEs and linolenic acid methyl ester content in B100 biodiesel fuel, following European standard method EN 14103.

As shown in Figure 8, C14:0-C24:1 FAMEs and linolenic acid methyl ester can be determined in less than 11 minutes using a 30m x 0.32mm ID x 0.25µm Stabilwax® column. Particularly notable are the stability of the baseline, excellent peak symmetry, and baseline resolution of all compounds of interest. The Stabilwax® column shows excellent peak shape for all FAMEs, even at low concentrations, which is critical for accurate quantification (Table 1).

Figure 8 Stable baselines, excellent peak symmetry, and rapid, baseline resolution of all compounds characterize FAMEs analyses on a Stabilwax® column.



Column: Stabilwax®, 30m, 0.32mm ID, 0.25µm (cat.# 10624)
Sample: rapeseed source of biodiesel (B100), prepared according to European Method EN 14103
Inj.: 1.0µL split (split ratio 100:1), Cyclosplitter® inlet liner (cat.# 20706)
Inj. temp.: 250°C
Carrier gas: hydrogen, constant flow, 3mL/min.
Linear velocity: 60cm/sec.
Oven temp.: 210°C (hold 5 min.) to 230°C @ 20°C/min. (hold 5 min.)
Det.: FID
Det. temp.: 250°C

Analyzing Methanol in Biodiesel

Methanol is commonly used to produce biodiesel by derivatizing the fatty acids to methyl esters. The amount of residual methanol must be determined because engine performance can be negatively affected if the methanol concentration in the final product is too high. Methanol in biodiesel is quantified using a headspace method (e.g. EN 14110). We recommend an Rtx®-1 column (30m, 0.32mm ID, 3µm) for this analysis. The selectivity of the Rtx®-1 column is ideal for resolving methanol from interfering peaks in biodiesel fuels.

Conclusion

Whether testing for glycerin, FAMEs, or methanol, Restek can supply the high quality chromatography products required for biodiesel testing. We offer an array of metal and fused silica GC columns designed for high performance biodiesel analysis, including our innovative MXT®-Biodiesel TG column with an Integra-Gap™ integrated retention gap (Table II). Our columns, accessories, and analytical reference materials are designed to improve analytical quality, simplify lab work, and increase productivity. Rely on Restek for innovative solutions to your biodiesel testing needs.

Rtx®-1 Columns (fused silica)

(Crossbond® 100% dimethyl polysiloxane)

ID	df (µm)	temp. limits	length	cat. #
0.32mm	3.00	-60 to 280/300°C	30-Meter	10184

Table I Sources of FAMEs in B100 biodiesel fuel (% m/m).

	Soy	Tallow	Rapeseed	Yellow Grease
Myristic acid	C14:0	0.21	1.7	0.68
Palmitic acid	C16:0	11.24	25.5	4.1
Palmitoleic acid	C16:1	0.2	3.27	0.27
Stearic acid	C18:0	4.04	14.41	1.8
Oleic acid	C18:1	21.93	40.34	58.57
Linoleic acid	C18:2	53.84	12.02	22.2
Linolenic acid	C18:3	7.29	0.99	13.26
Arachidic acid	C20:0	0.36	0.4	0.79
Gadoleic acid	C20:1	0.26	1.03	1.79
Behenic acid	C22:0	0.45		0.57
Erucic acid	C22:1			0.13
Lignoceric acid	C24:0	0.16	0.34	0.3
Nervonic acid	C24:1		0.17	0.24

Stabilwax® Column (fused silica)

(Crossbond® Carbowax® polyethylene glycol)

ID	df (µm)	temp. limits	length	cat. #
0.32mm	0.25	40 to 250°C	30-Meter	10624

Table II GC Column Selection Guide for Biodiesel Fuel Methods.

			ASTM D6584	EN 4103	EN 14105	EN 14110	
Fused Silica		Description	Injection Type	Free and Total Glycerin	Ester and Linoleic acid methyl esters	Free and total glycerine and mono, di, and triglycerides	Methanol
Rtx-Biodiesel TG (max temp. 380°C)	15m, 0.32mm ID, 0.1μm w/ 2m x 0.53mm ID retention gap	cool on-column	10293	—	10293	—	—
Rtx-Biodiesel TG (max temp. 380°C)	15m, 0.32mm ID, 0.1μm	PTV**	10294	—	10294	—	—
Rtx-Biodiesel TG (max temp. 380°C)	10m, 0.32mm ID, 0.1μm w/ 2m x 0.53mm ID retention gap	cool on-column	10291	—	10291	—	—
Rtx-Biodiesel TG (max temp. 380°C)	10m, 0.32mm ID, 0.1μm	PTV**	10292	—	10292	—	—
Stabilwax	30m, 0.32mm ID, 0.25μm	split/splitless	—	10624	—	—	—
Rtx-1	30m, 0.32mm ID, 3.0μm	headspace	—	—	—	—	10184
Metal (MXT)							
GC Columns							
*MXT-Biodiesel TG (max temp. 430°C)	14m, 0.53mm ID, 0.16μm w/ 2m Integra Gap	cool on-column	70289	—	70289	—	—
MXT-Biodiesel TG (max temp. 430°C)	15m, 0.32mm ID, 0.1μm w/ 2m x 0.53mm ID retention gap	cool on-column	70291	—	70291	—	—
MXT-Biodiesel TG (max temp. 430°C)	15m, 0.32mm ID, 0.1μm	PTV**	70293	—	70293	—	—
MXT-Biodiesel TG (max temp. 430°C)	10m, 0.32mm ID, 0.1μm w/ 2m x 0.53mm ID retention gap	cool on-column	70290	—	70290	—	—
MXT-Biodiesel TG (max temp. 430°C)	10m, 0.32mm ID, 0.1μm	PTV**	70292	—	70292	—	—

*Recommended for total glycerin analysis.
**PTV=programmed temperature vaporizer.

GC Accessories

Thermolite® Septa

- Usable to 340°C inlet temperature.
- Preconditioned and precision molded.
- Do not adhere to hot metal surfaces.
- Packaged in precleaned glass jars.



Septum Diameter	25-pk.	50-pk.	100-pk.
9mm	27132	27133	27134
9.5mm (5/16")	27135	27136	27137
10mm	27138	27139	27140
11mm (11/16")	27141	27142	27143
11.5mm	27144	27145	27146
12.5mm (1/2")	27147	27148	27149
17mm	27150	27151	27152
Shimadzu Plug	27153	27154	27155

Parker Balston® Hydrogen Generators

- Proton Exchange Membrane (PEM) cell eliminates the need for liquid electrolytes.
- Reliably generate 99.9995% pure hydrogen, for better chromatography.
- Cost-effective, convenient, and safe alternative to high pressure cylinders.

Specifications

Purity:	99.9995% pure hydrogen
Delivery Pressure:	10-100psig ± 1psig (69-689kPa ± 7kPa)
Outlet Port:	1/8" compression
Electrical Requirements:	100-230VAC/50-60Hz

Physical Dimensions:	17.12" h x 13.46" w x 17.95" d (43.48 x 34.19 x 45.6cm)
Shipping Weight:	40 lbs. (18kg) dry

Description	Capacity	qty.	cat.#
H2PEM-100	100cc/min.	ea.	23065
H2PEM-165	165cc/min.	ea.	23066
H2PEM-260	260cc/min.	ea.	23067
H2PEM-510	510cc/min.	ea.	23068



- Dimensions: 17.12" h x 13.46" w x 17.95" d
- 40 lb. dry weight

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Small, compact unit—easy to hold and operate.



Also available in money-saving 50-packs!

tech tip

Which FID Jet Should I Use?

There are two FID jet configurations for Agilent GCs. The longer "adaptable" jet fits both 5890 and 6890 GCs, and can be used with capillary or packed columns. The shorter "dedicated" jet is for the FID in the 6890 GC that is designed only for use with capillary columns.

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Restek Electronic Leak Detector

- Reliable thermal conductivity leak detector.
- Responds to leaks in less than 2 seconds.
- Audible alarm plus LED readout.
- Auto zeros with the touch of a button.
- Built-in rechargeable 7.2-volt battery.

Leak Detector Facts

Detectable gases:	helium, nitrogen, argon, carbon dioxide
Battery:	Rechargeable Ni-MH, 7.2 volt
Operating Temperature Range:	32°-120°F (0°-48°C)
Humidity Range:	0-97%
CE Approved:	Yes

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 under any condition. The Restek Electronic Leak Detector may be used for determining trace amounts of hydrogen in a GC environment only.

Capillary Ferrules—For 1/16-Inch Compression-Type Fittings

Graphite Ferrules

- Preconditioned to eliminate out-gassing.
- High-purity, high-density graphite.
- Stable to 450°C.

Vespel®/Graphite Ferrules

- 60%/40% Vespel®/graphite blend, offering the best combination of sealing and workability.
- Stable to 400°C.

Ferrule ID	Fits Column ID	qty.	Graphite	Vespel®/Graphite
0.5mm	0.32mm	10-pk.	20201	20212
0.8mm	0.45/0.53mm	10-pk.	20202	20213

Replacement Jets

- Available untreated or Siltek® treated, for maximum inertness.



Capillary Adaptable FID Replacement Jet for Agilent 5890/6890/6850 GCs

0.011-Inch ID Tip	Similar to Agilent part #	qty.	cat.#	qty.	cat.#
Standard	19244-80560	ea.	20670	3-pk.	20671
High-Performance Siltek® Treated	19244-80560	ea.	20672	3-pk.	20673

Capillary Dedicated FID Replacement Jet for Agilent 6890/6850 GCs

0.011-Inch ID	Similar to Agilent part #	qty.	cat.#	qty.	cat.#
Standard	G1531-80560	ea.	21621	3-pk.	21682
High-Performance Siltek® Treated	G1531-80560	ea.	21620	3-pk.	21683

FID Jet Removal Tool for Agilent 5890/6890/6850 FIDs

- Securely grips jet in socket for easy removal or installation.
- Unique, ergonomic handle—easy to hold.



Description	qty.	cat.#
FID Jet Removal Tool for Agilent 5890/6890/6850 FIDs	ea.	22328



Lit. Cat.# 580207

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