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GC Columns

Detailed Table of Contents 18-19

Capillary Columns

Selecting a GC Column	21-25
GC Column Cross-References	26-27
GC Column Installation	28
Guard/Retention Gap Columns	29-33, 40
Fast GC/Comprehensive GC Columns	34-35
High-Performance RxI Columns	36-45
General Purpose Columns	46-57

Application-Specific Columns

Specially Deactivated	59-62
Chiral Compounds	63
Foods, Flavors, & Fragrances	64-67
Petrochemical	68-72
Clinical/Forensic	73
Pharmaceutical	74-77
Environmental	78-93

PLOT Columns

PLOT Columns	94-101
--------------------	--------

Metal (MXT) Columns

Metal (MXT) Columns	102-111
---------------------------	---------

Packed Columns & Packing Materials

Bonded Stationary Phases	113-114,116
Packed Column Tubing	115
Stock Packed Columns	116-117
Specialty Packed Columns	118-121
Micropacked Columns	120-122
Packed/Micropacked Column Installation Kits	123
Packed Column Packing Materials	124-127
Liquid Phases	128
USP Cross-Reference	129
Custom Packed/Micropacked Columns	130-132
Packed Column Configurations	133

GC Applications	534-703
------------------------------	----------------

Detailed Table of Contents

Can't find the column that you're looking for?

Check out our website at
www.restek.com.



Capillary Columns

Selecting a GC Column	21-25
GC Column Cross-References	26-27
GC Column Installation	28
Guard/Retention Gap Columns	29-33, 40
Fast GC/Comprehensive GC Columns	34-35

High-Performance Rxi Columns

Overview	36-39
Guard Columns	40
Rxi-1ms	40
Rxi-5ms	41
Rxi-5Sil MS	42, 78, 88
Rxi-XLB	44, 85
Rxi-35Sil MS	44
Rxi-5HT	44
Rxi-17	45

General Purpose Columns

Rtx-1	47
Rtx-5, Rtx-5MS	48, 76
Rtx-20	49
Rtx-35	49
Rtx-50	50
Rtx-65	50
Rtx-440	51
Rtx-200, Rtx-200MS	52
Rtx-1301	53, 74
Rtx-225	53
Rtx-1701	54
Rtx-2330	55
Rt-2560	55
Rtx-Wax	56
Stabilwax	57, 75
Rtx-624	74, 93

Application-Specific Columns

Specially Deactivated

Basic Compounds Analysis	59-61
Rtx-5 Amine, Rtx-35 Amine, Stabilwax-DB	

Acidic Compounds Analysis	62
Stabilwax-DA	

Chiral Compounds

Enantiomers Analysis	63
Rt- β DEXm, Rt- β DEXsm, Rt- β DEXse, Rt- β DEXsp, Rt- β DEXsa, Rt- β DEXcst, Rt- γ DEXsa	

Foods, Flavors, & Fragrances

cis/trans FAMEs	64
Rt-2560	

Polyunsaturated FAME Analysis	65
FAMEWAX	

Flavor and Fragrance Compound Analysis	66
Rt-CW20M F&F, Rtx-1 F&F	

Triglycerides in Foods Analysis	67
Rtx-65TG	

Petrochemical

Detailed Hydrocarbon Analysis (DHA)	68
Rtx-1PONA, Rtx-SPONA (Tuning Column)	

Simulated Distillation (C5-C44 Analysis)	69
Rtx-2887, MXT-2887	

Simulated Distillation (C44-C100) Analysis	70
MXT-1HT Sim Dist, MXT-1 Sim Dist, MXT-500 Sim Dist	

Aromatics & Oxygenates in Gasoline Analysis	71
Rt-TCEP	

Biodiesel Fuels Analysis	72
Rtx-Biodiesel TG, MXT-Biodiesel TG	

Clinical/Forensic

Blood Alcohol Analysis	73
Rtx-BAC1, Rtx-BAC2	

Pharmaceutical

Organic Volatile Impurities (OVI) Analysis	74-77
Rtx-1301, Rtx-624, Stabilwax, Rtx-5, Rtx-G27, Rtx-G43	

Environmental

Semivolatiles Analysis	78
Rxi-5Sil MS	

Organophosphorus Pesticides Analysis	79
Rtx-OPPesticides, Rtx-OPPesticides2	

Chlorinated Pesticides Analysis	80-82
Rtx-CLPesticides, Rtx-CLPesticides2, Stx-CLPesticides, Stx-CLPesticides2	

Brominated Flame Retardants Analysis	83
Rtx-1614	

PCB Congeners Analysis	84-85
Rtx-PCB, Rxi-XLB	

Dioxin & Furans Congeners Analysis	86-87
Rtx-Dioxin, Rtx-Dioxin2	

Polycyclic Aromatic Hydrocarbons (PAHs) Analysis	88-89
Rxi-55iL MS, Rt-PAH, Rt-LC50	
Volatile Organics Analysis	90-93
Rtx-VMS, Rtx-VRX, Rtx-502.2, Rtx-Volatiles, Rtx-624	
Explosives Analysis	93
Rtx-TNT, Rtx-TNT2	

PLOT Columns

Features and Benefits, Quick Reference Chart, Phase Cross-Reference Chart	95
PLOT Column Selection	96-97
Rt-Alumina BOND	98
Rt-Msieve 5A, MXT-Msieve 5A	99
Porous Polymers	100-101
Rt-Q-BOND, Rt-QS-BOND, Rt-S-BOND, Rt-U-BOND	

Metal (MXT) Columns

Overview	103
Guard/Retention Gap Columns	104
Tubing Scorer for MXT Columns	105
MXT-1	105
MXT-5	106
MXT-2887	69, 106
MXT-Biodiesel TG	72, 107
MXT-1HT Sim Dist, MXT-1 Sim Dist, MXT-500 Sim Dist	70, 107
MXT-20	108
MXT-35	108
MXT-50	108
MXT-65, MXT-65 TG	109
MXT-1301	109
MXT-1701	110
MXT-200	110
MXT-WAX	110
MXT-502.2	111
MXT-Volatiles	111
MXT-624	111

Packed/Micropacked Columns & Packing Materials

Bonded Stationary Phases	113-114, 116
Packed Column Tubing	115
Stock Packed Columns	
Bonded	116
Chromosorb-Based	116
Porous Polymers	116
CarboBlack	117
Molecular Sieves	117
Specialty Packed Columns	
Aromatics Analysis: D3606 Application Column	118
Light Hydrocarbon Analysis	119
Permanent Gases & Hydrocarbon Analysis: ShinCarbon ST	120
Sulfur Analysis: Rt-XLSulfur	121
Micropacked Columns	
ShinCarbon ST	120
Rt-XLSulfur	121
Micropacked	122
Packed/Micropacked Column Installation Kits	123
Packed Column Packing Materials	
Silcopor	124
CarboBlack	124
Res-Sil C	125
Chromosorb	126-127
Porapak	127
HayseSep	127
Tenax	127
Liquid Phases	128
USP Cross-Reference	129
Custom Packed/Micropacked Columns	
Custom Coated Packing Materials	130
Custom Packed/Micropacked Columns	131-132
Custom Order Form	132
Packed Column Configurations	133

**GC Applications**

Applications by Phase Index	535-536
Applications by Compound Class Index	704-705
Compound Index for GC Applications	708-715
Environmental Applications	534-611
Foods, Flavors, & Fragrances Applications	612-644
Personal Care Applications	645-646
Petroleum & Petrochemical Applications	647-666
Forensics Applications	667-676
Pharmaceutical Applications	677-697
Solvents/Chemicals Applications	698-703

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General Purpose Columns	46-57
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Pharmaceutical	74-77
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Top: Henry Knepp and Tim Wilson, Manufacturing Technicians
Bottom: Trisha Houser, Quality Assurance



Selecting a GC Column

Several simple principles can be used to simplify the selection process and find the correct column for the analytical task at hand. When selecting the proper capillary column, the chromatographer is faced with choices that require informed decisions when optimizing analysis speed, retention or capacity, and resolution. These three analysis goals are affected by several factors or variables that are contained in the resolution equation:

$$R = \frac{1}{4} \sqrt{\frac{L}{H}} \times \frac{k}{k+1} \times \frac{\alpha - 1}{\alpha}$$

↑ Efficiency ↑ Retention ↑ Selectivity

R=resolution
L=column length
H=HETP
k=capacity factor
 α =selectivity

The resolution equation is divided roughly into three sections consisting of variables affecting selectivity, efficiency, and capacity or retention. Looking at how each section of the resolution equation influences the analytical separation will make column selection less difficult.



"Our goal is to develop products that will help solve analytical challenges, while making both chemists and laboratories more efficient. If you have a difficult separation, call us—we can help!"

Restek's Research & Development Group

pictured: Steve Allison, Lisa Pantzar, Jarl Snider, Mike Wittrig,
Donald Rhoads, Valerie Strohm, Doug Smith, Jack Cochran

Selecting a GC Column

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Description	qty.	cat.#	price
Pro ezGC Method Development Software CD-ROM	ea.	21487	

Selectivity, α

The selectivity of the capillary column is directly related to how the analyte molecule interacts with the stationary phase being considered. If the analyte strongly interacts with the stationary phase, it can be said that strong "intermolecular" forces exist. These intermolecular forces of attraction of the analyte for the stationary phase are a function of the structure of both the analyte molecule and the stationary phase. If these two structures are similar, then these attractive forces for one another are strong. If they are weak, then analyte to stationary phase attraction is weak, and retention is less. Therefore, when selecting a stationary phase, knowledge of the structure of the analytes of interest and the stationary phase is crucial. Table II provides the chemical structure of Restek's most common stationary phases.

An example of selectivity can be shown using benzene and butanol (both have nearly the same boiling point) eluting through the 20% diphenyl/80% dimethyl polysiloxane stationary phase (Rtx®-20). The benzene molecule will dissolve into the stationary phase more readily than the butanol based on the concept that "likes dissolve likes". Benzene solvates more readily with the stationary phase results in more interactions with the stationary phase as it elutes through the column. Therefore, the elution order of these two compounds on the Rtx®-20 stationary phase will be butanol first and benzene second.

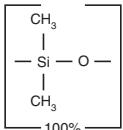
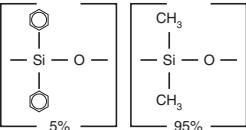
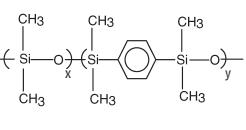
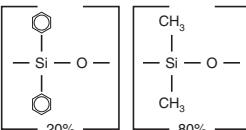
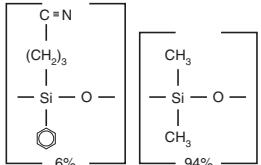
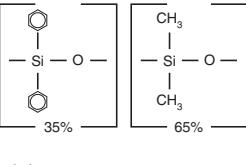
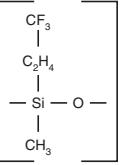
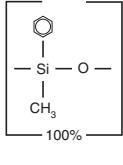
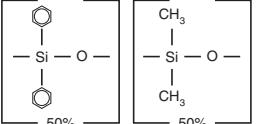
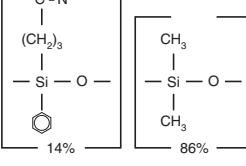
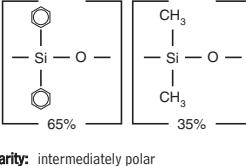
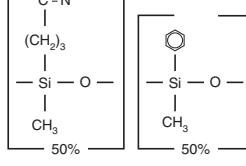
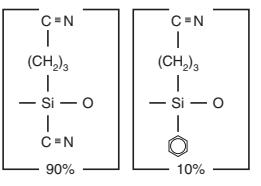
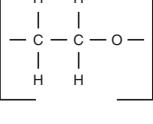
As methyl groups are replaced by different functionalities such as phenyl or cyanopropyl pendant groups, the selectivity of the column shifts towards compounds that will have a better solubility in the stationary phase. For example the Rtx®-200 stationary phase provides high selectivity for analytes containing lone pair electrons, such as halogens, nitrogen, or carbonyl groups. Polyethylene glycol columns, such as the Stabilwax® and Rtx®-Wax columns are highly selective towards polar compounds such as alcohols. Again using the example above, the butanol more readily solvates into the polyethylene glycol stationary phase; therefore, the butanol will have more interaction with the phase and elute after benzene.

Table I lists the Kovats retention indices for the stationary phases in Table II. Assigning a retention index to each probe listed provides a basis for comparing several stationary phases and their relative retention to one another for a set of molecular probes. For example, when Kovats indices are identical on two column phases, then the resulting separations will be identical. If, however, a Kovats value of one probe varies significantly from the value on another phase for the same probe, then the resulting compound elution order will differ. Thus, the Kovats indices are useful for comparing selectivity of different types of compounds among different phases.

Table I Retention indices for Restek phases

Phase	Benzene	Butanol	Pentanone	Nitropropane
Rtx-1	651	651	667	705
Rtx-5/Rtx-5MS	667	667	689	743
Rtx-20	711	704	740	820
Rtx-1301/Rtx-624	689	729	739	816
Rtx-35	746	733	773	867
Rtx-200	738	758	884	980
Rtx-50	778	769	813	921
Rtx-1701	721	778	784	881
Rtx-65TG	794	779	825	938
Rtx-225	847	937	958	958
Stabilwax	963	1158	998	1230

Table II Structures, polarities, properties, and uses for Restek capillary column phases, in order of increasing polarity

Rxi®-1ms, Rtx®-1 100% dimethyl polysiloxane	Rxi®-5ms, Rtx®-5, Rtx®-5MS 5% diphenyl 95% dimethyl polysiloxane	Rxi®-5Sil MS, Rtx®-5Sil MS proprietary	Rtx®-20 20% diphenyl 80% dimethyl polysiloxane
 100%	 5% 95%	 x y	 20% 80%
Polarity: nonpolar Uses: solvents, petroleum products, pharmaceutical samples, waxes [G1]	Polarity: slightly polar Uses: flavors, environmental, aromatic hydrocarbons [G27]	Polarity: slightly polar Uses: flavors, environmental, pesticides, PCBs, aromatic hydrocarbons	Polarity: slightly polar Uses: volatile compounds, alcohols [G32]
Rtx®-1301, Rtx®-624, Rtx®-G43 6% cyanopropylphenyl 94% dimethyl polysiloxane	Rtx®-35 35% diphenyl 65% dimethyl polysiloxane	Rtx®-200 trifluoropropylmethyl polysiloxane	Rtx®-50 100% methylphenyl polysiloxane
 6% 94%	 35% 65%	 CF_3 C_2H_4 —Si—O— CH ₃	 100%
Polarity: slightly polar Uses: volatile compounds, insecticides, residue solvents in pharmaceutical products [G43]	Polarity: intermediately polar Uses: pesticides, Aroclor PCBs, amines, nitrogen-containing herbicides [G42]	Polarity: selective for lone pair electrons Uses: environmental, solvents, Freon® gases, drugs, ketones, alcohols [G6]	Polarity: intermediately polar Uses: FAMEs, carbohydrates [G3]
Rxi®-17 50% diphenyl 50% dimethyl polysiloxane	Rtx®-1701 14% cyanopropylphenyl 86% dimethyl polysiloxane	Rtx®-65TG 65% diphenyl 35% dimethyl polysiloxane	Rtx®-225 50% cyanopropylmethyl 50% phenylmethyl polysiloxane
 50% 50%	 14% 86%	 65% 35%	 50% 50%
Polarity: intermediately polar Uses: triglycerides, phthalate esters, steroids, phenols [G3]	Polarity: intermediately polar Uses: pesticides, Aroclor PCBs, alcohols, oxygenates [G46]	Polarity: intermediately polar Uses: triglycerides, rosin acids, free fatty acids	Polarity: polar Uses: FAMEs, carbohydrates [G7]
Rt®-2330 90% biscyanopropyl 10% cyanopropylphenyl polysiloxane	Stabilwax®, Rtx®-Wax Carbowax® PEG	ordering note	
 90% 10%	 H H —C—C—O— H H	Designations in [brackets] are USP codes. We recommend this phase when your application calls for this code.	
Polarity: polar Uses: cis/trans FAMEs, dioxin isomers, rosin acids [G48]	Polarity: polar Uses: FAMEs, flavors, acids, amines, solvents, xylene isomers [G16]		

Selecting a GC Column

Retention, k

The capacity of the column relates to how much material a column can chromatograph without adversely affecting peak shape. If the amount of a compound (mass) exceeds the capacity of a wall coated open tubular column (WCOT), the peak will front, i.e., the column will exhibit peak symmetry of less than 1, a characteristic "shark fin" shaped peak. The goal is to select a column with sufficient capacity such that peak shape will not suffer.

There are two primary column-related dimensions that affect capacity, assuming the proper column phase was selected: column internal diameter (ID) and phase film thickness (μ).

When selecting column ID, consideration should include the type of injection, the detector being used, and the concentration of sample (amount on-column). The injection technique is an important consideration because the ID of the column may need to be selected based on whether a split, splitless, cool on-column injection, or other sample transfer to the column is being used. The second consideration is how much flow the detector can optimally work under. For example, some MS detectors can only handle column flow up to 1.5mL/min.; therefore, a 0.53mm ID column, which requires higher flows for proper chromatography, is not an option for this detector. The third consideration is sample capacity. If the concentration of the sample exceeds the column capacity, loss of resolution, poor reproducibility, and peak distortion will result. Table III shows several typical column characteristics.

Film thickness (μ) has a direct effect on the retention and elution temperature for each sample component. Extremely volatile compounds should be analyzed on thick-film columns to increase the time the compounds spend in the stationary phase, allowing them to separate. High molecular weight compounds must be analyzed on thinner film columns. This reduces the length of time the analytes stay in the column, and minimizes bleed at required higher elution temperatures. Film thickness also affects the amount of material that can be injected onto the column without overloading. A thicker film column can be used for higher concentration samples.

Table III Typical column characteristics

Characteristic	0.10mm	0.18mm	0.25mm	0.32mm	0.53mm
Helium Flow (@ 20cm/sec.)	0.05mL/min.	0.3mL/min.	0.7mL/min.	1.2mL/min.	2.6mL/min.
Hydrogen Flow (@ 40cm/sec.)	0.09mL/min.	0.6mL/min.	1.4mL/min.	2.4mL/min.	5.2mL/min.
Sample Capacity (max load per component)	<10ng	<50ng	50–100ng	400–500ng	1000–2000ng
Theoretical Plates/Meter	8000	3700	2700	2100	1300

Efficiency, N

Column efficiency (N) is the column length divided by the height equivalent to a theoretical plate (HETP). The effective theoretical plates are affected by how well the phase has been coated onto the column walls and is measured by how narrow the peaks are when they are eluted at the end of the column. Therefore, the higher the column efficiency (N), the better resolution power the column will have.

Capillary columns are made in various lengths, typically in standard lengths of 10, 15, 30, 60, and 105 meters. Longer columns provide more resolving power, but increase analysis time. Doubling the column length increases resolution by approximately 41% (note: the column length is under the square root function). However, under isothermal conditions, it will double analysis time. In temperature-programmed analyses, retention times are more dependent on temperature than column length, with a marginal increase (approx. 10-20%) in analysis time upon doubling the column length.



Restek training seminars are full-day courses presented in an engaging multimedia format. They are equally valuable to beginning chromatographers, those who have moderate experience and want a better understanding of the subject matter, and those interested in the "best practices" and latest technologies. **No sales pitch is presented**, just the facts on how to make your chromatography results better. Visit www.restek.com/seminars for more information.

What Are the Operating Temperatures for My Column?

All Restek columns have published minimum and maximum operating temperatures that establish the working range for the stationary phase. Note that these ranges vary with the thickness of the coating.

Rtx®-VMS (fused silica)

ID	df (μm)	temp. limits
0.25mm	1.40	-40 to 240/260°C
0.32mm	1.80	-40 to 240/260°C
0.45mm	2.55	-40 to 240/260°C
0.53mm	3.00	-40 to 240/260°C

The minimum operating temperature defines the lowest usable temperature before the stationary phase solidifies. Operating the column below the minimum temperature will not harm the phase, but poor peak shape and other chromatography problems may occur.

Many phases list 2 maximum operating temperatures. The first temperature is the maximum isothermal operating temperature. This is the temperature to which the columns are guaranteed to meet the minimum bleed specification (i.e., lowest bleed level). The second temperature is the maximum temperature-programmed operating temperature, the temperature to which the column can be heated for short periods of time (i.e., during a temperature-programmed analysis). If only one temperature is listed, it is both the isothermal and the maximum temperature.

Selection of Capillary Column Summary

Selecting a capillary column for an analysis can be done by utilizing the resources available. This includes the following steps:

1) Choose the proper phase for the compounds being chromatographed

- Review the application section of this catalog or www.restek.com for similar compound list.
- Call Restek's experienced technical support team (800-356-1688, ext. 4) or e-mail us at:
 - support@restek.com (in the USA)
 - intltechsupp@restek.com (international)
 - or contact your Restek representative.

2) Select column ID, film thickness, and length

- Base consideration on:
 - Injection technique (split, splitless, cool on-column, etc.)
 - Detector type (is low flow required?)
 - Amount of analyte being injected onto column (sample capacity)

3) Set optimum parameters for your analysis

- Optimize column flow (mL/min.)
- Choose appropriate carrier gas (hydrogen, helium, or nitrogen)
- Optimize oven temperature program



GC COLUMNS | CAPILLARY COLUMNS
Column Cross-Reference

Columns by Phase

Restek	Phase Composition	USP Nomenclature*	Agilent	Varian	SGE	Phenomenex	Macherey-Nagel	Supelco	Alltech	Quadrex
Rtx-1 (p. 47)	100% dimethyl polysiloxane	G1, G2, G38	HP-1 / DB-1	CP Sil 5 CB	BP-1	ZB-1	Optima-1	SPB-1	AT-1	007-1
Rxi-1ms (p. 40)	100% dimethyl polysiloxane (low bleed)		HP-1/ HP-1ms DB-1/ DB-1ms Ultra-1	VF-1ms / CP-Sil 5 CB Low Bleed/MS		ZB-1ms	Optima-1/ Optima-1ms	SPB-1, Equity-1	AT-1	007-1
Rtx-5 (p. 48, 76)	5% diphenyl 95% dimethyl polysiloxane	G27, G36	HP-5 / DB-5	CP-Sil 8 / CP Sil 8 CB	BP-5	ZB-5	Optima-5	SPB-5	AT-5	007-2
Rxi-5HT (p. 44)	5% phenyl 95% dimethyl polysiloxane		DB-5HT	VF-5HT		ZB-5HT				
Rxi-5ms (p. 41)	5% diphenyl 95% dimethyl polysiloxane (low bleed)	G27, G36	HP-5/ HP-5ms DB-5, Ultra-2					SPB-5, Equity-5	AT-5ms	007-2
Rxi-5Sil MS (p. 42, 78, 88)	5% phenyl arylene 95% dimethyl polysiloxane		DB-5ms	VF-5ms / CP-Sil 8 CB Low Bleed/MS	BPX-5	ZB-5ms	Optima-5ms	SLB-5		
Rxi-XLB (p. 44, 85)	Arylene/methyl modified polysiloxane		DB-XLB	VF-XMS		MR1				
Rtx-20 (p. 49)	20% diphenyl 80% dimethyl polysiloxane	G28, G32						SPB-20	AT-20	007-7
Rtx-35 (p. 49)	35% diphenyl 65% dimethyl polysiloxane	G42	HP-35, DB-35	VF-35ms	BPX-35, BPX-608	ZB-35		SPB-35, SPB-608	AT-35	007-11
Rxi-35Sil MS (p. 44)	35% phenyl arylene polysiloxane		DB-35ms			MR2				
Rtx-50 (p. 50)	100% phenyl methyl polysiloxane (50% phenyl)	G3	HP-50		AT-50		Optima-17	SPB-50	AT-50	007-17
Rxi-17 (p. 45)	50% diphenyl 50% dimethyl polysiloxane		HP-17, DB-17	CP-Sil 24 CB / VF-17ms		ZB-50				
Rtx-65 (p. 50)	65% diphenyl 35% dimethyl polysiloxane	G17								400-65HT, 007-65HT
Rtx-1301 (p. 53, 74) Rtx-624 (p. 74)	6% cyanopropyl phenyl 94%dimethyl polysiloxane	G43	HP-1301, HP-624, DB-1301, DB-624	CP-1301, VF-1301ms, VF-624ms	BP-624	ZB-624	Optima-1301, Optima-624	SPB-1301	AT-624	007-1301
Rtx-1701 (p. 54)	14% cyanopropyl phenyl 86%dimethyl polysiloxane	G46	HP-1701, PAS-1701, DB-1701	CP Sil 19 CB, VF-1701ms	BP-10	ZB-1701, ZB-1701P	Optima-1701	SPB-1701	AT-1701	007-1701
Rtx-200 (p. 52)	trifluoropropyl methyl polysiloxane	G6	DB-210, DB-200	VF-200ms			Optima-210		AT-210	007-210
Rtx-200ms (p. 52)	trifluoropropyl methyl polysiloxane (low bleed)			VF-200ms						
Rtx-225 (p. 53)	50% cyanopropyl 50% phenylmethyl polysiloxane	G7, G19	HP-225, DB-225	CP Sil 43 CB	BP-225		Optima-225		AT-225	007-225
Rtx-440 (p. 51)	modified polysiloxane (unique phase)						unique column			
Rt-2330 (p. 55)	90% biscyanopropyl 10% cyanopropyl phenyl polysiloxane	G48			BPX-70			SP-2330, SP-2331, SP-2380	AT-Silar	
Rt-2560 (p. 55)	bicyanopropyl polysiloxane		HP-88	CP Sil 88				SP-2560		
Rtx-Wax (p. 56)	polyethylene glycol	G14, G15, G16, G20, G39	HP-Wax, DB-Wax	CP Wax 52 CB	BP-20	ZB-Wax	Optima Wax		AT-Wax	
Stabilwax (p. 57, 75)	polyethylene glycol	G14, G15, G16, G20, G39	Innowax	CP Wax 52 CB				Supelcowax-10		
Restek	Phase Composition	USP Nomenclature	Agilent	Varian	SGE	Phenomenex	Macherey-Nagel	Supelco	Alltech	Quadrex
Rt-Alumina BOND (p. 98)	Na ₂ SO ₄ deactivation		GS-Alumina, HP PLOT S	CP-AL203 / Na ₂ SO ₄				Alumina-PLOT	AT-Alumina	
Rt-Msieve 5A (p. 99)			GS-Msieve, HP PLOT	Molsieve	CP-Molsieve 5A			Molsieve 5A	AT-Molsieve	PLT-5A
Rt-Q-BOND (p. 100)	100% divinylbenzene			CP-PoraPLOT Q, CP-PoraBond Q				Supel-Q-PLOT	AT-Q	
Rt-QS-BOND (p. 100)	porous divinyl benzene homopolymer		GS-Q							
Rt-S-BOND (p. 100)	divinylbenzene 4-vinylpyridine			CP-PoraPLOT S				Supel-G45		
Rt-U-BOND (p. 100)	divinylbenzene ethylene glycol/dimethylacrylate		HP-PLOT U	CP-PoraPLOT U, CP-PoraBond U				Supel-N PLOT		

*See page 129 for our USP Liquid Phase and Solid Support Cross-Reference.

Columns by Application

Restek	Applications	Agilent	Supelco	Macherey-Nagel	SGE	Varian	Phenomenex
Specialty deactivated phases							
Rtx-5Amine (p. 59)	Amines					CP-Sil 8 CB	
Rtx-35Amine (p. 60)	Amines				unique column		
Stabilwax-DB (p. 61)	Amines	CAM	Carbowax Amine			CP WAX 51	
Stabilwax-DA (p. 62)	Free acids	HP-FFAP, DB-FFAP	Nukol	Permabond FFAP, Optima FFAP	BP-21	CP WAX 58 CB	
Chiral Columns							
Rt-βDEXm (p. 63)	Chiral						
Rt-βDEXsm (p. 63)	Chiral						
Rt-βDEXse (p. 63)	Chiral						
Rt-βDEXsp (p. 63)	Chiral						
Rt-βDEXsa (p. 63)	Chiral						
Rt-βDEXcst (p. 63)	Chiral						
Rt-γDEXsa (p. 63)	Chiral						
Foods, Flavors, & Fragrances							
Rt-2560 (p. 64)	cis/trans FAMEs	HP-88	SPB-2560				
FAMEWAX (p. 65)	Marine oils			Omegawax			
Rt-CW20M F&F (p. 66)	Flavors & fragrance	HP-20m, CarboWax 20			BP-20M	007-CW	
Rtx-1 F&F (p. 66)	Flavors & fragrance						
Rtx-65 TG (p. 67)	Triglycerides				unique column		
Petrochemical							
Rtx-1PONA (p. 68)	Detailed hydrocarbon analysis	HP-PONA, DB-Petro	Petrocol DH		BP1-PONA	CP Sil PONA CB	
Rtx-2887 (p. 69)	Hydrocarbons - ASTM 2887	DB-2887	Petrocol 2887, Petrocol EX2887				
MXT-2887 (p. 69,106)	Hydrocarbons - ASTM 2887						
D3606 (p. 118)	Ethanol - ASTM 3606				unique column		
Rt-TCEP (p. 71)			TCEP			CP-TCEP	
MXT-1 Sim Dist (p. 70,107)	Simulated distillation	DBHT-SMD				CP-SIMDIST	
MXT-500 Sim Dist (p. 70,107)	Simulated distillation				unique column		
Rtx-Biodiesel TG (p. 72)	Triglycerides in biodiesel				unique column		
MXT-Biodiesel TG (p. 72,107)							
Clinical/Forensic - Blood Alcohol Testing							
Rtx-BAC1 (p. 73)	Blood alcohol testing	DB-ALC1					
Rtx-BAC2 (p. 73)	Blood alcohol testing	DB-ALC2					
Pharmaceutical							
Rtx-G27 w/IntegraGuard (p. 77)	Organic volatile impurities (OVI) - USP 467						
Rtx-G43 w/IntegraGuard (p. 77)	Organic volatile impurities (OVI) - USP 467		OVI-G43				
Rtx-1301 (p. 53, 74) Rtx-624 (p. 74, 93) (G43)	Organic volatile impurities (OVI) - USP 467	HP-1301, HP-624, DB-1301, DB-624	SPB-1301		BP-624	CP-1301, VF-1301ms, VF-624	ZB-624
Rtx-5 (p. 48, 76) (G27)	Organic volatile impurities (OVI) - USP 467	HP-5/ DB-5	SPB-5, Equity-5	Optima-1301, Optima-624	BP-5	CP-Sil 8, CP Sil 8 CB	ZB-5
Stabilwax (p. 57, 75) (G16)	Organic volatile impurities (OVI) - USP 467	Innowax	Supelcowax-10		BP-624	CP Wax 52 CB	
Environmental							
Rxi-5Sil MS (p. 42, 78, 88)	Semivolatiles - EPA Methods 8270, 625, 525	DB-5ms	SLB-5	Optima-5ms		VF-5ms	
Rtx-VMS (p. 90)	Volatiles - EPA Methods 8260, 624, 524			unique column			
Rtx-624 (p. 74, 93)	Volatiles - EPA Method 624	HP-624, DB-624	SPB-1301	Optima-624		VF-1301ms	ZB-624
Rtx-502.2 (p. 92)	Volatiles - EPA Methods 8010, 8020, 502.2, 601, 602	DB-502.2	VOCOL				
Rtx-VRX (p. 91)	Volatiles - EPA Methods 8010, 8020, 502.2, 601, 602	DB-VRX					
Rtx-CLPesticides (p. 80)	Organochlorine pesticides - EPA Methods 8081, 8082, 608, 505, 508				unique column		
Rtx-CLPesticides2 (p. 80)	Organochlorine pesticides - EPA Methods 8081, 8082, 608, 505, 508				unique column		
Stx-CLPesticides (p. 82)	Organochlorine pesticides - EPA Methods 8081, 8082, 608, 505, 508				unique column		
Stx-CLPesticides2 (p. 82)	Organochlorine pesticides - EPA Methods 8081, 8082, 608, 505, 508				unique column		
Rtx-1614 (p. 83)	Brominated flame retardants				unique column		
Rtx-PCB (p. 84)	Polychlorinated biphenyl - EPA Methods 8082, 608, PCB congeners				unique column		
Rxi-XLB (p. 44, 85)	Polychlorinated biphenyl - EPA Methods 8082, 608, PCB congeners	DB-XLB				VF-XMS	
Rtx-OPPesticides (p. 79)	Organophosphorus pesticides - EPA Method 8141				unique column		
Rtx-OPPesticides2 (p. 79)	Organophosphorus pesticides - EPA Method 8141				unique column		
Rtx-Dioxin2 (p. 87)	Dioxin & Furans - EPA Methods				unique column		
Rtx-Dioxin (p. 86)	Dioxin & Furans - EPA Methods				unique column		
Rt-PAH (p. 89)	Polycyclic aromatic hydrocarbons				unique column		
Rtx-TNT & Rtx-TNT2 (p. 93)	Explosives - EPA Method 8095				unique column		

Column Installation



Trisha Houser, Quality Assurance



Scott Grossman, Applications Chemist
Checking for leaks, using a thermal conductivity leak detector (step 13).

GC Column Installation Checklist

The Restek Innovations and Technical Services specialists have found this to be a reliable sequence for avoiding problems when installing a capillary GC column.

Instrument Preparation & Column Installation

1. Cool all heated zones.
2. Visually inspect indicating oxygen and moisture traps. Replace saturated traps.
3. Examine the inlet and the detector. Clean or replace all dirty or corroded parts.
4. Replace the inlet liner and septum, and the injector seals (O-rings, inlet seals, ferrules, etc.).
5. Mount the column in the oven with a support that protects it from scratches. Center the column in the oven. This ensures uniform heat exposure generating consistent retention times.
 - Restek has two types of cages for fused silica columns, an 11-pin cage and the original cage that uses high temperature string to hold the column in place. **If you have the cage with high temperature string, do not remove the string that holds the column in the cage!**
6. Uncoil the ends to make sure the ends are long enough to reach the injector and detector. Cut 10cm from each end of the column.
 - To cut a fused silica column, use the smooth edge of a ceramic scoring wafer (cat.# 20116).
7. While pointing the inlet end of the column downward (to prevent shards from falling into the column), slide the nut and appropriate size ferrule onto the inlet end of the column. Cut an additional 2cm from the end of the column to remove any material scraped from the ferrule onto the edge of the column.
8. Install the column the appropriate distance in the injector, as indicated in your instrument manual.
9. Set the carrier gas to the flow rate or inlet pressure recommended for the column or to your method flow rate/pressure. Confirm presence of column flow by immersing the column outlet in a vial of solvent.
10. Flush the column at ambient temperature with carrier gas: at least 5 minutes for a 25-30m column and 10 minutes for a 50-60m column.
11. Set the injector temperatures. Do not exceed the column's maximum operating temperature (listed on the column tag). Check inlet for leaks.
12. Install the column into the detector as described in the instrument manual. Set the detector gases and temperatures to proper settings.
13. Check the detection connections for leaks, using a thermal conductivity leak detector (cat.# 22839).
14. Verify the carrier gas flow is at the rate you intend to use for your analysis. Set the split vent, septum purge, and any other applicable gas rates as appropriate.
15. Inject an unretained compound, to verify the column is installed correctly and to determine the dead volume time for checking column flow. A symmetric peak indicates the column is installed correctly. Adjust the carrier gas flow as necessary.
16. Condition the column 20°C above the final analysis temperature of your method. Do not exceed the column's maximum operating temperature. For most applications, 1 hour of conditioning is sufficient. For sensitive detectors or low level analysis, longer conditioning times or conditioning the column at the maximum temperature may be beneficial. Extended time at high temperatures will not adversely affect column performance as long as precautions are taken to make sure the carrier gas is clean and is filtered for oxygen and water.
17. To check for instrument performance, analyze a column test mix for a new method, or a known standard to confirm proper column and system performance.
18. Your GC system is now ready to be calibrated and acquire samples.

Note 1: For some types of sensitive detection systems, like MS, PID and PDD, it is recommended to condition the column as listed in Step 16 without making the connection to the detector. In this case, plug off the detector during conditioning. After conditioning, continue with Step 12.

Note 2: Also when you intend to condition thick-film coated columns (film thickness > 1µm) at temperatures near the maximum operation temperature, it is recommended to do the initial 1-2 hrs conditioning without a connection to the detector and repeat procedure above, starting at Step 12.

Standby Conditions

Short-Term: leave the column in the GC with the carrier gas flow on at an oven temperature of 100-150°C.

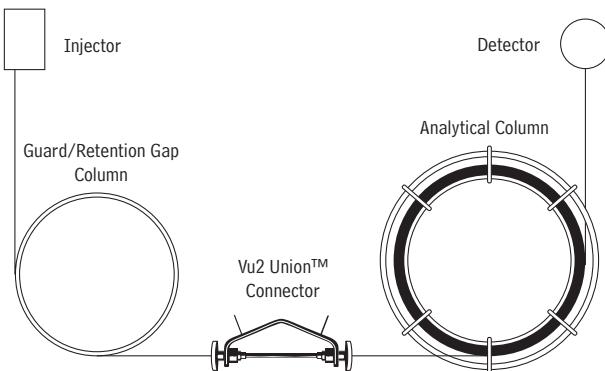
Long-Term: remove the column from the GC and seal the ends by gently and carefully pushing each end into the curved edge of a septum. Store the column in the original box away from strong lighting.

If you have any questions or problems installing a Restek column, visit www.restek.com/gcinstall or call Technical Service at 800-356-1688 or 814-353-1300, ext. 4, or contact your Restek representative.

Guard Columns and Retention Gaps

Guard columns and retention gaps are widely used in gas chromatography. The concept of the guard column is to trap nonvolatile material at the head of the column, not allowing the material to reach the analytical column. The concept of the retention gap is to help focus the compounds transferred from the inlet to a small band at the head of the analytical column in order to reduce chromatographic peak broadening. Both concepts (trapping nonvolatile material and refocusing the target analytes) may take place when a piece of deactivated tubing is connected to an analytical column as in Figure 1.

Figure 1 A guard/retention gap column connected to an analytical column



Analyte Focusing

There are two injection techniques where the retention gap is used to help focus target analytes at the beginning of the analytical column, cool on-column injection and split-less injection.

For cool on-column injection, the purpose of a retention gap is to help focus the sample components when introducing a liquid sample directly into the retention gap. The cool on-column injection is performed by inserting the syringe needle into the retention gap (this can be accomplished with a 0.53mm ID retention gap and a 26s gauge syringe) and transferring the liquid sample directly into the retention gap. The injection is made with the injector and column oven set below the boiling point of the solvent. As the solvent is evaporated, the volatile target analytes migrate in the solvent towards the analytical column, and the heavier analytes will be distributed over the retention gap. As the oven temperature increases, the target analytes vaporize and move unretained down the retention gap column until the compounds reach the liquid stationary phase of the analytical column. At this juncture, the target analytes are trapped/focused by the liquid phase and form a narrow injection band.

The retention gap may also be useful in hot vaporization injections when the transfer of the compounds from the inlet to the column does not form a focused band. Typical applications include water injections or injections using small ID columns, where split or tailing peaks would indicate an unfocused band. In these applications, the target analytes are trapped in a nonuniform or longitudinally diffuse band at the head of the retention gap (Figure 2a, next page). As the oven temperature is increased, the solvent and target compounds are vaporized and move unretained through the retention gap (Figure 2b, next page). When the target compounds come in contact with the stationary phase, they are refocused in a narrow band (Figure 2c, next page), improving the chromatography.

please note

For superior inertness, try our Siltek® guard columns!

See [page 31](#) for details.

Having trouble making a leak-free connection?
Try our "built in" Integra-Guard™ columns!

See [page 33](#) for details.

did you know?

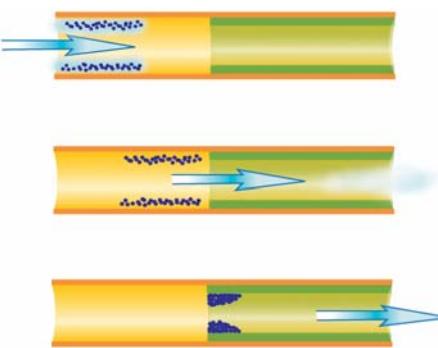
We test our guard columns/ transfer lines with the Grob test mix to ensure high inertness.



it's a fact

To eliminate connections, use our unique Integra-Guard™ Column. See page 33.

Figure 2 Retention gaps are used to focus components in a tight band at the beginning of the analytical column



a) Sample introduction: a liquid film of solvent and sample is deposited in the first length of capillary.

b) As oven temperature increases, the solvent evaporates and the target compounds elute unretained through the retention gap until they contact the analytical column.

c) When target compounds come in contact with the stationary phase, they are refocused on the analytical column, resulting in a narrow initial band width.

Protecting the Analytical Column

The concept of a guard column is to protect the analytical column from becoming contaminated with nonvolatile compounds. The guard column is used to retain non-volatile material, usually in the first 10-20cm, not allowing this material to elute onto the liquid phase of the analytical column. As the oven temperature increases, the more volatile target compounds vaporize, elute down the guard column, and refocus at the head of the analytical column without interference from the nonvolatile material left behind.

Contamination can cause active sites as well as change the conditions of the focusing zone of the analytical column. Both conditions will adversely affect the chromatography. Another advantage of the guard column is when a section is removed for maintenance the resolution of closely eluting compounds will not be affected because the guard column is not a contributor to the resolving power of the analytical column. This allows for a longer lifetime of the analytical column, and replacing only the guard column when it becomes too short.

In summary, the retention gap and guard column are essentially the same products, but are used for different purposes. The deactivated tubing helps focus target analytes at the head of the analytical column for on-column and splitless injections, and also prevents nonvolatile material from contaminating the head of the analytical column.

What type of guard column should be used?

When using a guard column, it is important to match the polarity of the solvent and the polarity of the surface deactivation. Rxi® Guard tubing is good for a wide variety of applications and allows most common solvents (methylene chloride, hexane, isoctane, toluene) to easily wet and create a uniform film on the tubing surface. If more polar solvents such as methanol or water are used, a polar-deactivated guard column is recommended to allow the solvent to wet the tubing surface. Polar-deactivated guard columns are not resistant to harsh “water vaporization” that occurs when water in the liquid state is injected into the tubing and rapidly vaporizes (such as in steam cleaning). Hydroguard™ deactivation is an alternative for direct aqueous injections. However, a Hydroguard™-deactivated guard column will not allow polar solvents to wet the tubing surface, and may cause beading of the solvent if the oven temperature is 20°C below the solvent boiling point.

Siltek® deactivation creates a highly inert surface for very active compounds such as chlorinated and organophosphorus pesticides. Base-deactivated guard columns reduce adsorption and tailing for amines and other basic compounds.

How is a guard column connected to the analytical column?

To connect the guard column to the analytical column, Vu2-Union™, Press-Tight®, and other connectors are available. MXT™ unions, typically used for connecting metal columns together, are now available for fused silica columns. See pages 215 to 219 for information about these connectors.

Connectors for Fused Silica Columns



Vu2 Union™ Connector



Press-Tight® Connector



MXT™ Union Connector Kit
for Fused Silica

**Rxi® Guard/Retention Gap Columns (Fused Silica)**

- Extend column lifetime.
- Excellent inertness—obtain lower detection limits for active compounds.
- Sharper chromatographic peaks by utilizing retention gap technology.
- Maximum temperature: 360°C.

Nominal ID	Nominal OD	5-Meter	5-Meter/6-pk.	10-Meter	10-Meter/6-pk.
0.25mm	0.37 ± 0.04mm	10029	10029-600	10059	10059-600
0.32mm	0.45 ± 0.04mm	10039	10039-600	10064	10064-600
0.53mm	0.69 ± 0.05mm	10054	10054-600	10073	10073-600

Intermediate-Polarity Deactivated Guard/Retention Gap**Columns/Transfer Lines (Fused Silica)**

Diameters greater than 0.10mm are tested with the Grob test mix, to ensure high inertness.

- Useful for a wide range of applications.
- Use with most common solvents.
- Maximum temperature: 325°C

Nominal ID	Nominal OD	1-Meter	5-Meter	5-Meter/6-pk.
0.025mm*	0.363 ± 0.012mm	10097		
0.05mm*	0.363 ± 0.012mm	10098	10040	10040-600
0.075mm*	0.363 ± 0.012mm	10099		
0.10mm*	0.363 ± 0.012mm	10100	10041	
0.15mm	0.363 ± 0.012mm	10101	10042	
0.18mm	0.37 ± 0.04mm	10102	10046	
0.25mm	0.37 ± 0.04mm		10043	10043-600
0.28mm	0.37 ± 0.04mm		10003	10003-600
0.32mm	0.45 ± 0.04mm		10044	10044-600
0.45mm	0.69 ± 0.04mm		10005	10005-600
0.53mm	0.69 ± 0.05mm		10045	10045-600

Nominal ID	Nominal OD	10-Meter	10-Meter/6-pk.	30-Meter**	60-Meter**†
0.25mm	0.37 ± 0.04mm	10049	10049-600	10012	10013
0.32mm	0.45 ± 0.04mm	10048	10048-600	10022	10023
0.53mm	0.69 ± 0.05mm	10047		10032	10033

Siltek®-Deactivated Guard/Retention Gap Columns/Transfer Lines**(Fused Silica)**

Tested with the Grob test mix, to ensure high inertness.

- Revolutionary deactivation process for superior inertness.
- Analyze active samples accurately; ideal for chlorinated pesticide analysis (reduces endrin breakdown to less than 1%).
- Maximum temperature: 380°C.

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

Polar-Deactivated Guard/Retention Gap Columns (Fused Silica)

Tested with the Grob test mix, to ensure high inertness.

- Polyethylene glycol deactivation layer provides optimum wettability for polar compounds.
- Minimize peak splitting when using polar solvents such as methanol or water.
- Compatible with Stabilwax®, Rtx®-225, and Rt®-2330 capillary columns.
- Maximum temperature: 280°C.

Nominal ID	Nominal OD	5-Meter	10-Meter	30-Meter**	60-Meter**†
0.25mm	0.37 ± 0.04mm	10065	10068	10014	10015
0.32mm	0.45 ± 0.04mm	10066	10069	10024	10025
0.53mm	0.69 ± 0.05mm	10067	10070	10034	10035

*Not tested with the Grob test mix because of a large pressure drop.

**30- and 60-meter lengths are banded in 5-meter sections.

†Recommendation: Cut 60m guard columns into shorter lengths. Using full length may cause peak distortion.

it's a fact

To eliminate connections, use an Integra-Guard™ Column. See page 33.

also available**MXT® Guard/Retention Gap Columns**

Rugged, flexible, Siltek® treated stainless steel tubing; inertness comparable to fused silica tubing. See page 104 for our Intermediate-Polarity Deactivated MXT® Guard/ Retention Gap Columns/ Transfer Lines.

it's a fact

Use guard columns to:

- Reduce effects of dirty samples on column performance.
- Reduce downtime and maintenance.

**did you know?**

Siltek®-deactivated guard columns minimize breakdown and improve recovery of analytes!

Guard/Retention Gap Columns



Base-Deactivated Guard/Retention Gap Columns (Fused Silica)

- Tested with a basic amine test mix.
- Excellent inertness for basic compounds.
- Recommended for use with Rtx®-5 Amine, Rtx®-35 Amine, and Stabilwax®-DB capillary columns.
- Batch test chromatogram included.
- Maximum temperature: 315°C.

Chemists using guard columns in analyses of basic compounds frequently observe peak tailing and low recovery. This happens because conventionally deactivated tubing surfaces can be adsorptive to basic compounds. Restek offers base-deactivated guard columns for completely inert sample pathways.

Nominal ID	Nominal OD	5-Meter	5-Meter/6-pk.
0.25mm	0.37 ± 0.04mm	10000	10000-600
0.32mm	0.45 ± 0.04mm	10001	10001-600
0.53mm	0.69 ± 0.05mm	10002	10002-600

did you know?

We test our guard columns/ transfer lines with the Grob test mix to ensure high inertness.

Hydroguard™ Water-Resistant Guard/Retention Gap Columns/Transfer Lines (Fused Silica)

- Extend analytical column lifetime by preventing degradation by harsh “steam-cleaning” water injections.
- Maximum temperature: 325°C.

When transfer lines from purge & trap systems, air monitoring equipment, or other instruments carry condensed water vapor, deactivated column tubing quickly becomes active because of the creation of free silanol groups. These silanol groups adsorb active oxygenated compounds such as alcohols and diols.

also available

MXT® Guard Columns

Rugged, flexible, Siltek® treated stainless steel tubing; inertness comparable to fused silica tubing. See page 104 for our Hydroguard™ MXT® Guard Tubing/Transfer Lines.

Restek chemists have addressed this concern and found a solution—the Hydroguard™ deactivation process. A unique deactivation chemistry creates a high-density surface that is not readily attacked by aggressive hydrolysis. The high-density surface coverage of the Hydroguard™ deactivation layer effectively prevents water vapor from reaching the fused silica surface beneath. Use Hydroguard™ tubing for connecting GCs to:

- Purge & trap systems.
- Headspace analyzers.
- Air analysis equipment and concentrator units.

Nominal ID	Nominal OD	5-Meter	5-Meter/6-pk.	10-Meter	30-Meter**	60-Meter**†
0.05mm*	0.363 ± 0.012mm	10075				
0.10mm*	0.363 ± 0.012mm	10076				
0.15mm	0.363 ± 0.012mm	10077				
0.18mm	0.37 ± 0.04mm	10078				
0.25mm	0.37 ± 0.04mm	10079	10079-600	10082	10085	10088
0.32mm	0.45 ± 0.04mm	10080	10080-600	10083	10086	10089
0.53mm	0.69 ± 0.05mm	10081	10081-600	10084	10087	10090

*Not tested with the Grob test mix because of a large pressure drop.

**30- and 60-meter lengths are banded in 5-meter sections.

†Recommendation: Cut 60m guard columns into shorter lengths. Using full length may cause peak distortion.

best choice

Siltek® treated tubing (cat.# 22505, page 244) is recommended for purge and trap transfer lines.

Innovative Integra-Guard™ Columns

For analysts who find it inconvenient to make a leak-free connection between the guard column and the analytical column, we offer Integra-Guard™ columns. These innovative columns incorporate both guard column and analytical column in a continuous length of tubing, eliminating the connection and all connection-associated problems! The guard column section is marked separately from the analytical column, using high-temperature string.

A wide variety of our Integra-Guard™ capillary columns are listed below. The Integra-Guard™ column is so economical that we challenge you to compare our price against that of a conventional connection, even if you assemble it yourself. If you are currently using a guard column, or are considering using one, call today and ask about Integra-Guard™ columns.

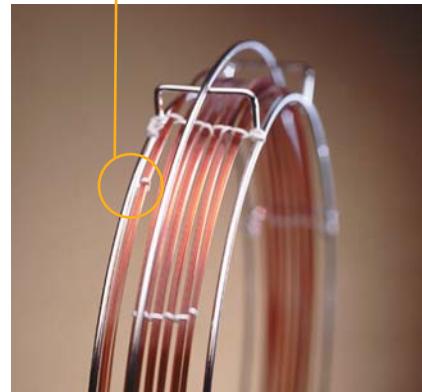
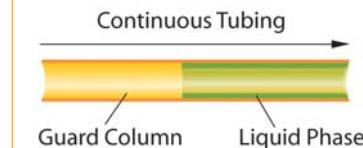
Description	qty.	cat.#	price
Rtx-1			
30m, 0.25mm ID, 0.25µm Rtx-1 w/5m Integra-Guard Column	ea.	10123-124	
30m, 0.53mm ID, 1.00µm Rtx-1 w/5m Integra-Guard Column	ea.	10155-126	
30m, 0.53mm ID, 5.00µm Rtx-1 w/5m Integra-Guard Column	ea.	10179-126	
Rtx-5			
30m, 0.25mm ID, 0.25µm Rtx-5 w/5m Integra-Guard Column	ea.	10223-124	
30m, 0.25mm ID, 0.25µm Rtx-5 w/10m Integra-Guard Column	ea.	10223-127	
30m, 0.25mm ID, 1.00µm Rtx-5 w/5m Integra-Guard Column	ea.	10253-124	
30m, 0.32mm ID, 0.25µm Rtx-5 w/5m Integra-Guard Column	ea.	10224-125	
30m, 0.32mm ID, 1.00µm Rtx-5 w/5m Integra-Guard Column	ea.	10254-125	
30m, 0.53mm ID, 5.00µm Rtx-5 w/5m Integra-Guard Column (Rtx-G27)	ea.	10279-126	
60m, 0.32mm ID, 0.25µm Rtx-5 w/5m Integra-Guard Column	ea.	10227-125	
Rtx-5MS			
15m, 0.25mm ID, 0.25µm Rtx-5MS w/5m Integra-Guard Column	ea.	12620-124	
15m, 0.25mm ID, 0.50µm Rtx-5MS w/10m Integra-Guard Column	ea.	12635-127	
30m, 0.25mm ID, 0.10µm Rtx-5MS w/5m Integra-Guard Column	ea.	12608-124	
30m, 0.25mm ID, 0.25µm Rtx-5MS w/5m Integra-Guard Column	ea.	12623-124	
30m, 0.25mm ID, 0.25µm Rtx-5MS w/10m Integra-Guard Column	ea.	12623-127	
30m, 0.25mm ID, 0.50µm Rtx-5MS w/5m Integra-Guard Column	ea.	12638-124	
30m, 0.25mm ID, 0.50µm Rtx-5MS w/10m Integra-Guard Column	ea.	12638-127	
30m, 0.32mm ID, 0.25µm Rtx-5MS w/5m Integra-Guard Column	ea.	12624-125	
30m, 0.32mm ID, 1.00µm Rtx-5MS w/5m Integra-Guard Column	ea.	12654-125	
Rxi-5Sil MS			
15m, 0.25mm ID, 0.25µm Rxi-5Sil MS w/10m Integra-Guard Column	ea.	13620-127	enquire
30m, 0.25mm ID, 0.25µm Rxi-5Sil MS w/5m Integra-Guard Column	ea.	13623-124	
30m, 0.25mm ID, 0.25µm Rxi-5Sil MS w/10m Integra-Guard Column	ea.	13623-127	
30m, 0.25mm ID, 0.50µm Rxi-5Sil MS w/5m Integra-Guard Column	ea.	13638-124	
30m, 0.25mm ID, 0.50µm Rxi-5Sil MS w/10m Integra-Guard Column	ea.	13638-127	
30m, 0.32mm ID, 0.50µm Rxi-5Sil MS w/5m Integra-Guard Column	ea.	13639-125	enquire
Rtx-624			
30m, 0.25mm ID, 1.40µm Rtx-624 w/5m Integra-Guard Column	ea.	10968-124	
30m, 0.32mm ID, 1.80µm Rtx-624 w/5m Integra-Guard Column	ea.	10970-125	
30m, 0.53mm ID, 3.00µm Rtx-624 w/5m Integra-Guard Column	ea.	10971-126	
Rtx-1301			
30m, 0.53mm ID, 3.00µm Rtx-1301 w/5m Integra-Guard Column (Rtx-G43)	ea.	16085-126	
Rtx-1701			
30m, 0.25mm ID, 0.25µm Rtx-1701 w/5m Integra-Guard Column	ea.	12023-124	
Stabilwax			
30m, 0.25mm ID, 0.25µm Stabilwax w/5m Integra-Guard Column	ea.	10623-124	
30m, 0.32mm ID, 1.00µm Stabilwax w/5m Integra-Guard Column	ea.	10654-125	
30m, 0.53mm ID, 1.00µm Stabilwax w/5m Integra-Guard Column	ea.	10655-126	
Rtx-BAC1 & Rtx-BAC2			
30-Meter, 0.32mm ID, 1.80µm Rtx-BAC1 w/5m Integra-Guard	ea.	18003-125	
30-Meter, 0.32mm ID, 1.20µm Rtx-BAC2 w/5m Integra-Guard	ea.	18002-125	
30-Meter, 0.53mm ID, 3.00µm Rtx-BAC1 w/5m Integra-Guard	ea.	18001-126	
30-Meter, 0.53mm ID, 2.00µm Rtx-BAC2 w/5m Integra-Guard	ea.	18000-126	

restek innovation!

Integra-Guard™ Columns: guard columns WITHOUT connections—protecting your analytical column has never been this easy!

similar products

DuraGuard, EZ-Guard, Guardian

Integra-Guard™ built-in guard column**Phases currently available as Integra-Guard™ columns**

Rtx®-1	Rtx®-1701
Rtx®-5	Rtx®-Volatiles
Rtx®-5MS	Rtx®-20
Rxi®-5Sil MS	Rtx®-35
Rtx®-1301	Rtx®-BAC 1 & 2
Rtx®-624	Stabilwax®

Integra-Guard™ columns are available for all phases listed, for columns with 0.25, 0.32 or 0.53mm ID.

If you don't see what you need here, contact us.

Fast GC/Comprehensive GC Columns



Fast GC Using 0.10mm and 0.18mm ID Capillary Columns and Comprehensive GC

- Significantly reduces analysis time without sacrificing resolution.
- Highest column efficiencies, great for GC/MS.
- Excellent for comprehensive GC (GCxGC) as second dimension column.

Narrow bore (0.10mm ID) columns are attractive alternatives to conventional-diameter capillary columns because they provide faster analysis times and higher resolving power. As column ID decreases, column efficiency (plates/meter) greatly increases. For instance, a 0.18mm ID column (5,150 plates/meter) is much more efficient than a 0.25mm ID column (2,500 plates/meter). Therefore, resolution can be achieved with a shorter column, which decreases the analysis time. When switching from a 0.25mm ID column to a 0.10mm ID column (8,500 plates/meter), the improvement in column efficiency is even more dramatic.

Typically, 0.18mm ID columns are used for fast GC analysis, and methods are easily converted. The 0.10mm ID columns require more research to switch methods to the smaller ID due to higher back pressures and lower column capacity.

The outer diameter of the 0.10mm and 0.18mm ID tubing is the same as 0.25mm ID tubing, which makes connections less complicated.

Rxi®-1ms Columns (fused silica)

(Crossbond® 100% dimethyl polysiloxane)

ID	df (µm)	temp. limits	10-Meter	20-Meter
0.10mm	0.10	-60 to 330/350°C	13301	
0.18mm	0.18	-60 to 330/350°C		13302

Rxi®-5ms Columns (fused silica)

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

ID	df (µm)	temp. limits	10-Meter	20-Meter
0.10mm	0.10	-60 to 330/350°C	13401	
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	

Rxi®-5Sil MS Columns (fused silica)

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

ID	df (µm)	temp. limits	10-Meter	20-Meter
0.10mm	0.10	-60 to 330/350°C	43601	
0.18mm	0.18	-60 to 330/350°C		43602
	0.36	-60 to 330/350°C	43604	

Rxi®-17 Columns (fused silica)

(Crossbond® 50% diphenyl/50% dimethyl polysiloxane)

ID	df (µm)	temp. limits	10-Meter	20-Meter
0.10mm	0.10	40 to 280/320°C	13501	
0.18mm	0.18	40 to 280/320°C		13502



tech tip

Operating considerations for 0.10mm ID columns

The small degree of extra care involved in using 0.10mm ID columns will be more than repaid by faster analyses and higher column efficiencies. 0.10mm ID columns require higher operating pressures (>40psig), which can result in more ferrule leaks, septum leaks, and sample flashback through leaking syringe plungers. Connections must be monitored and leak-checked more often. Operating a 0.10mm ID column below optimum pressure will cause poor resolution and other poor performance. Sample capacity also is reduced, relative to wider-bore columns. Take care to not overload the column, and make sure you inject quickly when using split injection.

Stabilwax® Columns (fused silica)

(Crossbond® Carbowax® polyethylene glycol)

ID	df (µm)	temp. limits	10-Meter	20-Meter
0.10mm	0.10	40 to 250°C	42601	
0.18mm	0.18	40 to 250°C		40602

Rt®-LC50 Columns (fused silica)

ID	df (µm)	temp. limits	10-Meter
0.10mm	0.10	100°C to 270°C	19736
0.18mm	0.10	100°C to 270°C	19735

Rtx®-CLPesticides (fused silica)

ID	df (µm)	temp. limits	10-Meter	20-Meter
0.10mm	0.10	-60 to 310/330°C	43101	
0.18mm	0.18	-60 to 310/330°C	42101	42102

Rtx®-CLPesticides2 (fused silica)

ID	df (µm)	temp. limits	10-Meter	20-Meter
0.10mm	0.10	-60 to 310/330°C	43301	43302
0.18mm	0.14	-60 to 310/330°C	42301	42302

GCxGC Selectivity Kit A

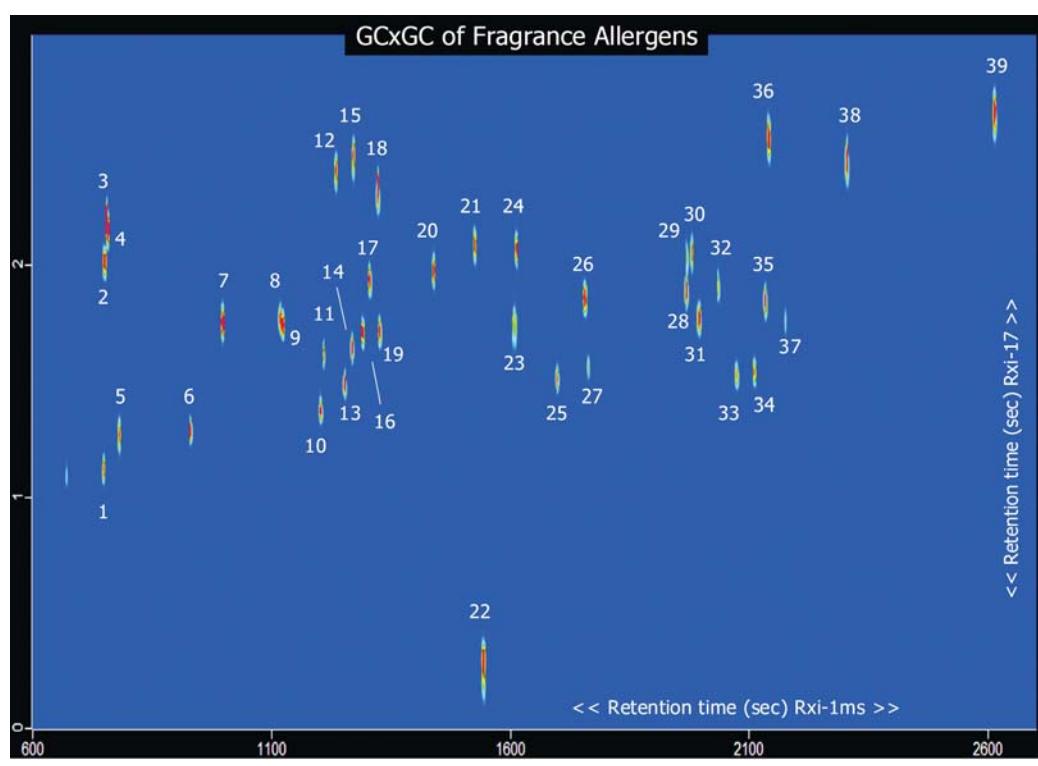
The selectivity kit contains four columns of different selectivity for method development. Includes one each of the following:



- Rxi®-17, 1.1m (±3cm), 0.10mm ID, 0.10µm, 50% diphenyl dimethylpolysiloxane
- Rtx®-CLPesticides, 1.1m (±3cm), 0.10mm ID, 0.10µm, trifluoropropyl containing polymer
- Stabilwax®, 1.1m (±3cm), 0.10mm ID, 0.10µm, polar polyethylene glycol
- Rt®-LC350, 1.1m (±3cm), 0.15mm ID, 0.10µm, liquid crystalline phase selective for aromatic compounds

Description	qty.	cat.#	price
GCxGC Selectivity Kit A	kit	15105	
Columns can also be purchased individually.			
Rxi-17, 1.1m (±3cm), 0.10mm ID, 0.10µm	ea.	15104	
Rtx-CLPesticides, 1.1m (±3cm), 0.10mm ID, 0.10µm	ea.	15103	
Stabilwax, 1.1m (±3cm), 0.10mm ID, 0.10µm	ea.	15102	
Rt-LC350, 1.1m (±3cm), 0.15mm ID, 0.10µm	ea.	15101	

Fragrance Allergens on RxI®-1ms & RxI®-17 (GC x GC)



1. limonene
2. 1-fluoronaphthalene
3. benzyl alcohol
4. phenyl acetaldehyde
5. eucalyptol
6. linalool
7. camphor
8. methyl-2-octynoate
9. estragole
10. citronellol
11. citral 1
12. *trans*-cinnamaldehyde
13. geraniol
14. citral 2
15. anise alcohol
16. hydroxycitronellol
17. safrole
18. cinnamyl alcohol
19. methyl-2-nonynoate
20. eugenol
21. methyl eugenol
22. coumarin
23. hydroxycitronellol contaminant
24. isoeugenol
25. α -isomethyl ionone 1
26. lilial
27. α -isomethyl ionone 2
28. amyl cinnamal
29. lyral 1
30. lyral 2
31. amylcinnamyl alcohol 1
32. amylcinnamyl alcohol 2
33. farnesol 1
34. farnesol 2
35. hexyl cinnamal
36. benzyl benzoate
37. hexyl cinnamal 2
38. benzyl salicylate
39. benzyl cinnamate

Columns: RxI®-1ms, 30m, 0.25mm ID, 0.25 μ m (cat.# 13323)

Rxi®-17, 1m, 0.10mm ID, 0.10 μ m (10m, cat.# 13501)

Sample: fragrance allergens in MTBE

Instrument: LECO Corporation GCxGC/FID with quad-jet, dual-stage modulator and secondary oven

Inj.: 0.2 μ L split (split ratio 1:200), 4mm laminar cup splitter (cat.# 20801)

Inj. temp.: 250°C

Carrier gas: helium, corrected constant flow via pressure ramps

Flow rate: 2mL/min.

Oven temp.: RxI®-1ms: 40°C (hold 1 min.) to 240°C @ 4°C/min.

Rxi®-17: 45°C (hold 1 min.) to 245°C @ 4°C/min.

Modulation: modulator temperature offset: 20°C

second dimension separation time: 3 sec.

hot pulse time: 0.8 sec.

cool time between stages: 0.7 sec.

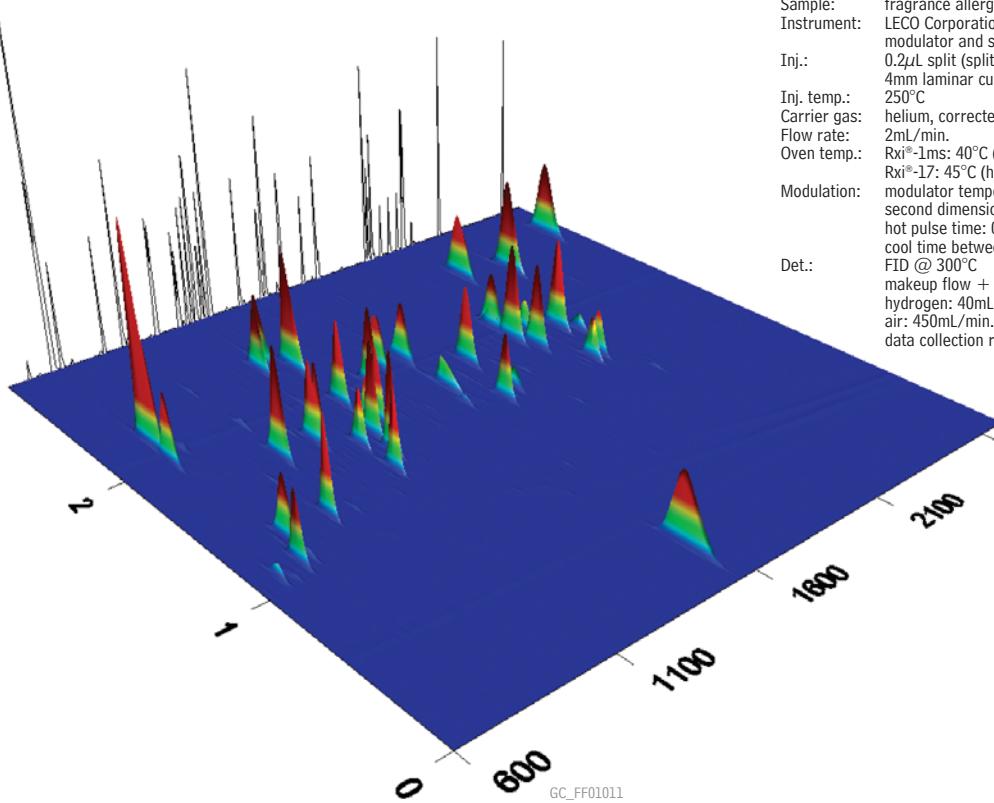
FID @ 300°C

makeup flow + column flow: 50mL/min.

hydrogen: 40mL/min.

air: 450mL/min.

data collection rate: 200 Hz



High-Performance Rxi® Columns

Exceptionally Inert Capillary Columns



Unsurpassed inertness

An Rxi® column's inertness allows analysis of active compounds at levels not attainable with other manufacturers' columns. Basic and acidic compounds can be analyzed on the same column, often under the same conditions.

Ultra-low bleed

Save time and money through faster baseline stabilization. With the lowest column bleed in the industry, Rxi® columns improve detection for trace level GC/MS analysis. Ultra-low bleed also reduces conditioning time after instrument maintenance.

Guaranteed reproducibility

Consistency is everything. With Rxi® column technology, we guarantee it: every new column will perform exactly as the column it replaces.

Unmatched performance

Every Rxi® column is held to stringent performance specifications for coating efficiency, selectivity, film thickness, inertness, and bleed. This guarantees you the most reliable columns available anywhere.



Restek's Exceptionally Inert Rxi® Capillary GC Columns

As GC detectors become more sensitive, accurately quantifying low concentrations of target compounds becomes much more challenging. We developed the Rxi® column line specifically to improve low-level quantification. Our goal was to develop a superior column that had the highest inertness, lowest bleed, and greatest reproducibility of any column available.

The exceptionally low bleed levels of Rxi® columns improve low-level analysis by reducing detector noise. This improves signal-to-noise ratios for low-level compounds leading to more accurate and reproducible results. A highly inert column improves results for active compounds by preventing adsorption of target analytes in the system. The inertness of Rxi® columns allows analysis of acidic and basic compounds on the same column—often under the same conditions—without the peak tailing, that can skew results for low-level analytes.

Finally, consistent column performance is critical to low-level analysis. In developing the Rxi® columns we wanted to guarantee reproducibility, so customers would always receive a column that worked as well as their previous column. To guarantee column-to-column reproducibility we redesigned the entire manufacturing process and used strict quality specifications. Every Rxi® column is individually tested for coating efficiency, selectivity, film thickness, inertness, and bleed level. As a result, Rxi® columns offer the most consistent retention times and highest level of inertness on the market. The data presented here demonstrate the unmatched performance of the Rxi® columns; we guarantee these columns, engineered to improve low-level analyses, are the most reliable columns available.

Low Bleed

Our bleed test is performed using a flame ionization detector with a compound marker to ensure the accuracy of the comparison. Column bleed was evaluated at 330°C and also at 350°C. As shown in Figure 1, the Rxi®-5ms column exhibits the lowest bleed of any column at both 330°C and 350°C. Note that at 350°C the variation in the bleed levels of the columns tested increases significantly. This increase is due to the difference in how the stationary phases are cross-linked by different manufacturers. As shown, the Rxi® technology used for Restek columns results in a very stable stationary phase that does not degrade, or bleed, compared to other columns on the market.

Highly Inert

We used pyridine (a basic compound) and 2,4-dinitrophenol (an acidic compound) to evaluate the activity level of our Rxi® columns. In this test, if the column was too acidic the pyridine peak would tail, whereas if the column was too basic the 2,4-dinitrophenol peak would tail and exhibit a low response factor. The excellent peak symmetry shown in Figure 2 demonstrates the neutrality of the Rxi®-5ms column for both acidic and basic compounds. Additionally, while many other commercially available columns are not able to detect 2,4-dinitrophenol at 0.5ng on-column, the Rxi®-5ms column produces a response factor of 0.14.

Figure 1 Rxi®-5ms columns have the lowest bleed among all major column brands.

Comparison of 30m x 0.25mm ID, 0.25μm columns at 330°C through 350°C; hydrogen carrier gas; flame ionization detection.

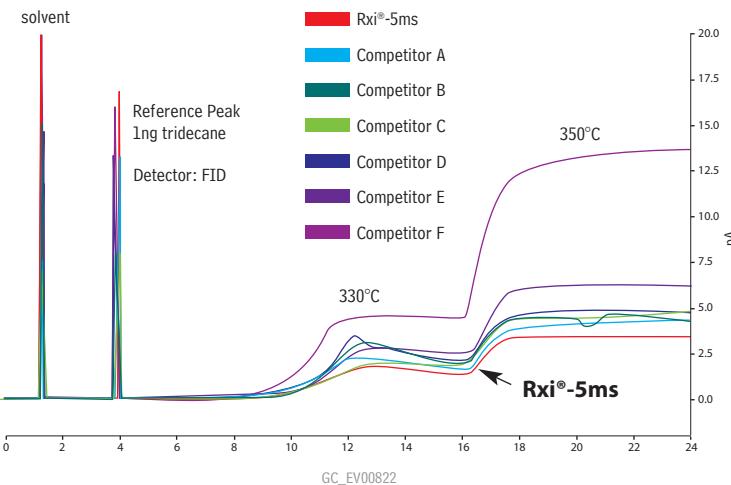
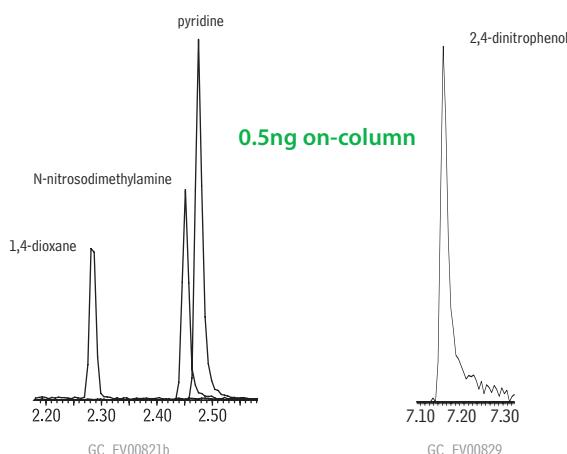


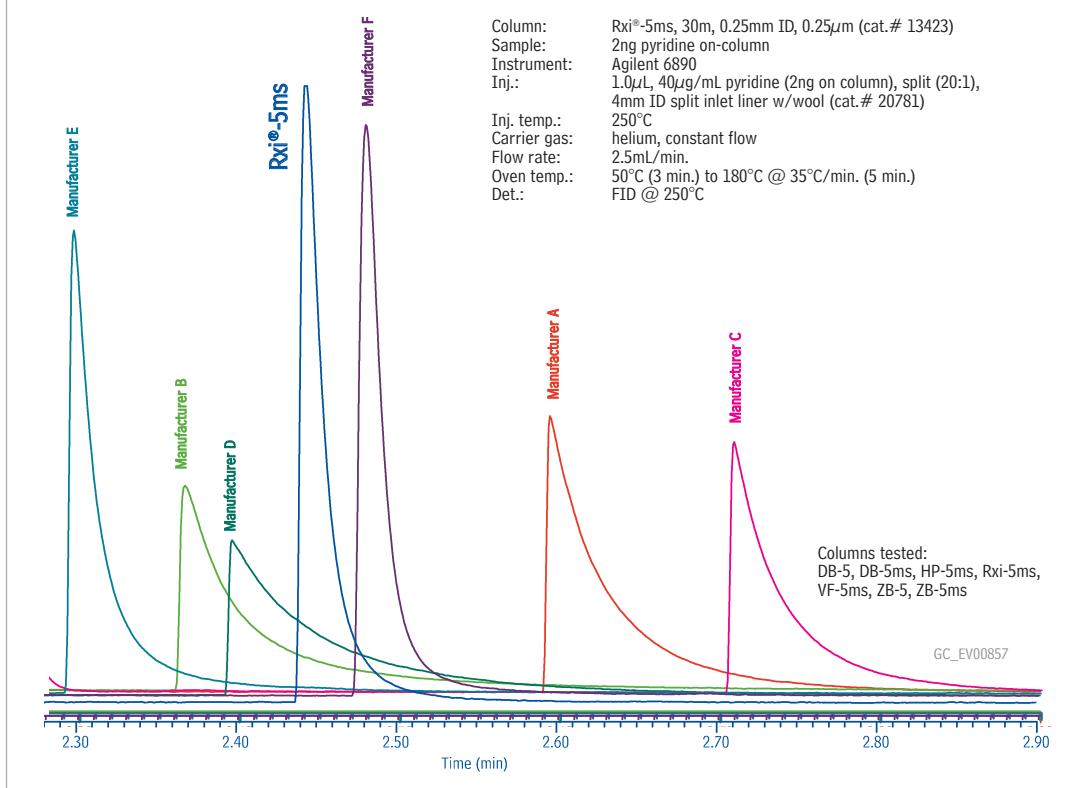
Figure 2 Peak symmetry for pyridine or 2,4-dinitrophenol is excellent from an Rxi®-5ms column, even with 0.5ng on-column!



Rxi® Columns Overview

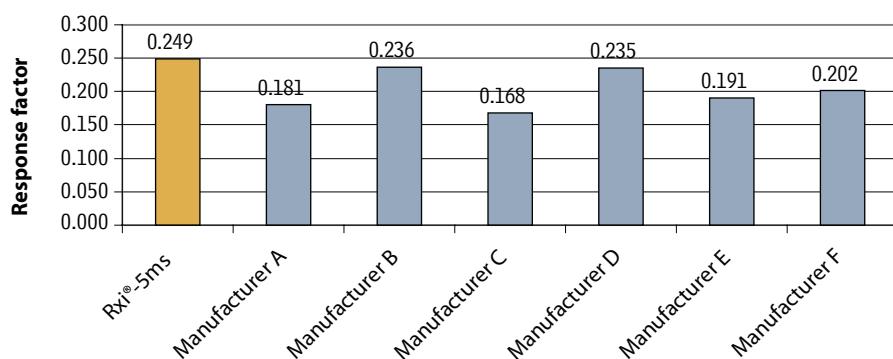
To further compare the inertness of the Rxi®-5ms column toward basic compounds to other columns on the market, 2ng of pyridine was used as a test probe. As shown in Figure 3, the tailing of pyridine is a very sensitive marker for inertness, and the excellent peak symmetry on the Rxi®-5ms column demonstrates its inertness for basic compounds.

Figure 3 An Rxi®-5ms column provides the most symmetric peak for the basic compound pyridine.



Another comparison of column inertness to acidic compounds was made with 2ng of 2,4-dinitrophenol. Figure 4 compares the mean response factors obtained on several columns and demonstrates that the Rxi®-5ms column is the most sensitive and gives the highest response factor for 2,4-dinitrophenol. In summary, Rxi®-5ms is the most inert column available for both basic and acidic compounds.

Figure 4 The Rxi®-5ms column gives the highest response factor for the acidic compound 2,4-dinitrophenol.



Column-to-Column Reproducibility

Column-to-column reproducibility is critical to obtaining consistent, reliable results for low-level analytes. We re-engineered our column manufacturing process to guarantee column-to-column reproducibility. The data in Figure 5 compare column performance from three separate production lots that were manufactured independently over a three-month period. The inertness and retention time of the probes match exactly across all three column batches. This means the responses and peak characteristics of active compounds will not vary from column-to-column, or lot-to-lot.

Summary

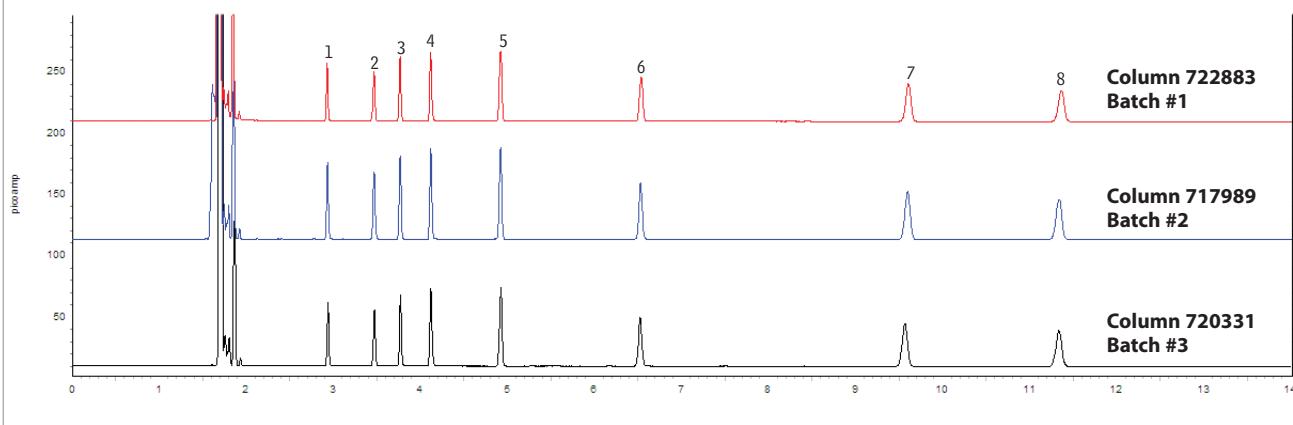
Rxi® columns offer unmatched performance in the three areas most critical to the accurate analysis of low-level analytes: bleed, inertness and reproducibility. Whether you are pursuing lower detection limits or simply looking for greater column-to-column consistency, Rxi® columns will outperform any column in the industry. Try these columns for yourself. We are sure you will be 100% satisfied, guaranteed.



Restek's Research & Development Group

pictured: Roy Lautamo, Bill Bromps, Ryan Smith, Shawn Reese

Figure 5 Rxi® column technology assures reliable column-to-column performance.



Column: Rxi®-5ms, 30m, 0.25mm ID, 0.25µm (cat.# 13423)
 Sample: 500µg/mL Isothermal Column Test Mix in toluene
 Inj.: 1.0µL, split injection (split ratio 1:100), 4mm single gooseneck inlet liner
 with wool (cat.# 22405)
 Inj. temp.: 250°C
 Carrier gas: hydrogen, constant flow
 Linear velocity: 38cm/sec. @ 135°C
 Oven temp.: 135°C
 Det.: FID @ 330°C

GC_EV00819

1. 1,6-hexanediol
2. 4-chlorophenol
3. methyl nonanoate
4. 1-decyldamine
5. tridecane
6. 1-undecanol
7. acenaphthylene
8. pentadecane

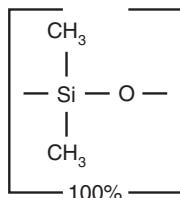
Guard Columns, RxI®-1ms

Rxi® Guard/Retention Gap Columns

- Extend column lifetime.
- Excellent inertness—obtain lower detection limits for active compounds.
- Sharper chromatographic peaks by utilizing retention gap technology.
- Maximum temperature: 360°C.

Fused Silica

Nominal ID	Nominal OD	5-Meter	5-Meter/6-pk.	10-Meter	10-Meter/6-pk.
0.25mm	0.37 ± 0.04mm	10029	10029-600	10059	10059-600
0.32mm	0.45 ± 0.04mm	10039	10039-600	10064	10064-600
0.53mm	0.69 ± 0.05mm	10054	10054-600	10073	10073-600

Rxi®-1ms Structure**Rxi®-1ms (nonpolar phase, Crossbond® 100% dimethyl polysiloxane)**

- General purpose columns for drugs of abuse, essential oils, hydrocarbons, pesticides, PCB congeners or (e.g.) Aroclor mixes, sulfur compounds, amines, solvent impurities, simulated distillation, oxygenates, gasoline range organics (GRO), refinery gases.
- Ultra-low bleed—improved signal-to-noise ratio, for better sensitivity and mass spectral integrity.
- Temperature range: -60°C to 330/350°C (bleed tested temperature/maximum operating temperature).
- Equivalent to USP G2 phase.

Rxi®-1ms Columns (fused silica)

(Crossbond® 100% dimethyl polysiloxane)

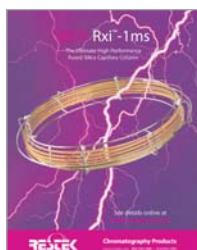
similar phases

DB-1, DB-1ms, HP-1, HP-1ms, Ultra-1, SPB-1, Equity-1, VF-1ms, CP-Sil 5 CB Low Bleed/MS

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literature****Rxi®-1ms: The Ultimate
High Performance Fused
Silica Capillary Column**Download your free copy
from www.restek.com.

Flyer

lit. cat.# 580075B



ID	df (µm)	temp. limits	15-Meter	30-Meter	60-Meter
0.25mm	0.25	-60 to 330/350°C	13320	13323	13326
	0.50	-60 to 330/350°C	13335	13338	13341
	1.00	-60 to 330/350°C	13350	13353	13356
0.32mm	0.25	-60 to 330/350°C	13321	13324	13327
	0.50	-60 to 330/350°C	13336	13339	13342
	1.00	-60 to 330/350°C	13351	13354	13357
0.53mm	4.00	-60 to 330/350°C		13396	
	0.50	-60 to 330/350°C	13337	13340	
	1.00	-60 to 330/350°C	13352	13355	
0.53mm	1.50	-60 to 330/350°C	13367	13370	13373

ID	df (µm)	temp. limits	10-Meter	12-Meter	20-Meter	25-Meter	50-Meter
0.10mm	0.10	-60 to 330/350°C	13301				
0.18mm	0.18	-60 to 330/350°C			13302		
0.20mm	0.33	-60 to 330/350°C		13397		13398	13399



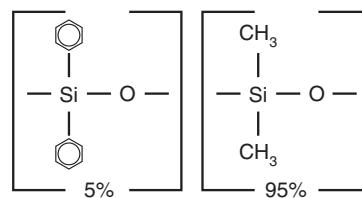
Searching for a chromatogram?

www.restek.com

Rxi[®]-5ms (low polarity phase, Crossbond[®] 5% diphenyl/95% dimethyl polysiloxane)

- General purpose columns for semivolatiles, phenols, amines, residual solvents, drugs of abuse, pesticides, PCB congeners or (e.g.) Aroclor mixes, solvent impurities.
- Most inert column on the market.
- Ultra-low bleed—improved signal-to-noise ratio, for better sensitivity and mass spectral integrity.
- Temperature range: -60°C to 330/350°C (bleed tested temperature/maximum operating temperature).
- Equivalent to USP G27 phase.

Rxi[®]-5ms Structure

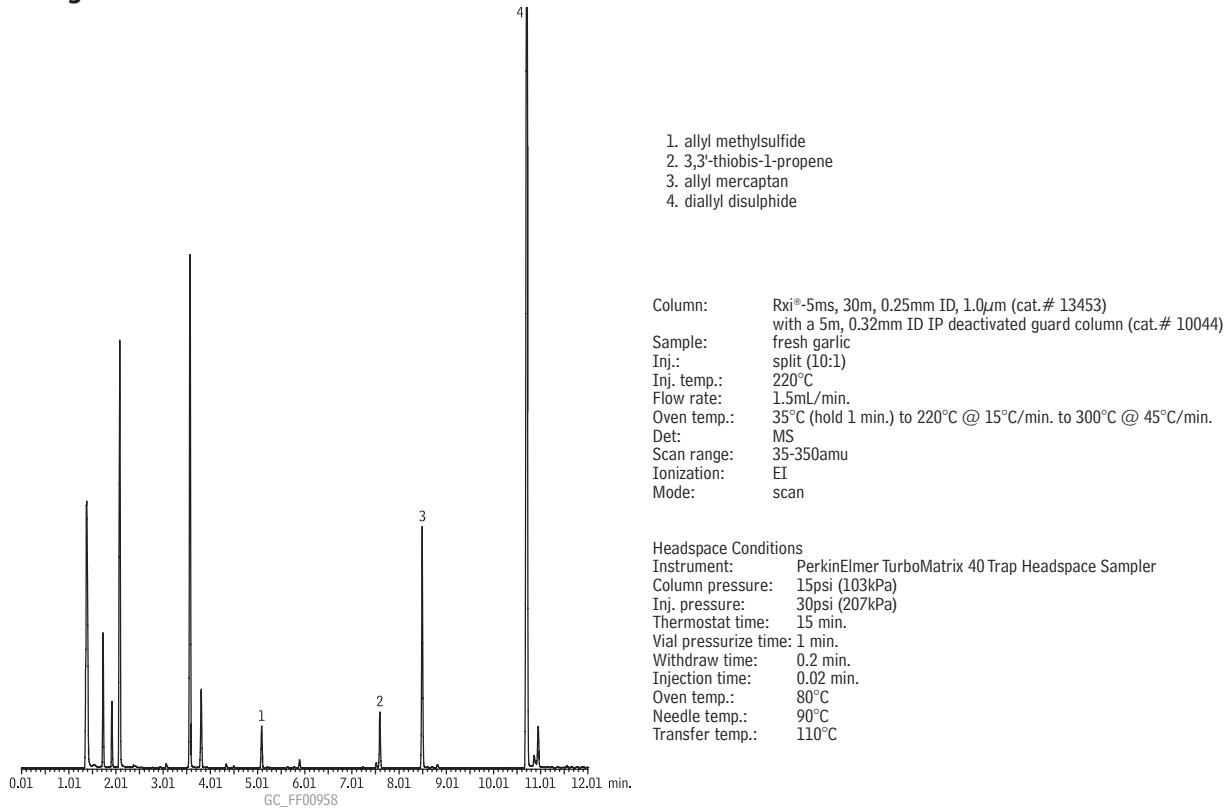


Rxi[®]-5ms Columns (fused silica)

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

ID	df (μm)	temp. limits	15-Meter	30-Meter	60-Meter
0.25mm	0.25	-60 to 330/350°C	13420	13423	13426
	0.40	-60 to 330/350°C		13481	
	0.50	-60 to 330/350°C	13435	13438	13441
	1.00	-60 to 330/350°C	13450	13453	13456
0.32mm	0.25	-60 to 330/350°C	13421	13424	13427
	0.50	-60 to 330/350°C	13436	13439	13442
	1.00	-60 to 330/350°C	13451	13454	13457
0.53mm	0.25	-60 to 330/350°C	13422	13425	
	0.50	-60 to 330/350°C	13437	13440	
	1.00	-60 to 330/350°C	13452	13455	
	1.50	-60 to 330/350°C	13467	13470	
ID	df (μm)	temp. limits	10-Meter	12-Meter	20-Meter
0.10mm	0.10	-60 to 330/350°C	13401		
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	
0.20mm	0.33	-60 to 330/350°C		13497	13498
ID	df (μm)	temp. limits	25-Meter	50-Meter	
			13498	13499	

Fresh garlic on an Rxⁱ[®]-5ms column.



similar phases

DB-5, HP-5, HP-5ms, Ultra-2, SPB-5, Equity-5, CP-Sil 8

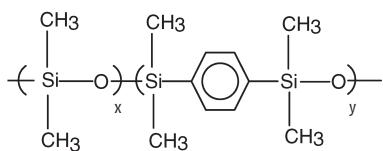
free literature



Rxi[®]-5ms Columns

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Flyer
lit. cat.# 580046A

Rxi®-5Sil MS**Rxi®-5Sil MS Structure**

Rxi®-5Sil MS (low polarity Crossbond® silarylene phase; selectivity close to 5% diphenyl/95% dimethyl polysiloxane)

- Engineered to be a low bleed GC/MS column.
- Excellent inertness for active compounds.
- General purpose columns—ideal for GC/MS analysis of polycyclic aromatic compounds, chlorinated hydrocarbons, phthalates, phenols, amines, organochlorine pesticides, organophosphorus pesticides, drugs, solvent impurities, and hydrocarbons.
- Temperature range: -60°C to 350°C.

The Rxi®-5Sil MS stationary phase incorporates phenyl groups in the polymer backbone. This improves thermal stability, reduces bleed, and makes the phase less prone to oxidation. Rxi®-5Sil MS columns are ideal for GC/MS applications requiring high sensitivity, including use in ion trap systems.

Rxi®-5Sil MS Columns (fused silica)

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

similar phases

DB-5MS, VF-5ms, CP-Sil 8 Low-Bleed/MS

ID	df (μm)	temp. limits	15-Meter	30-Meter	60-Meter
0.25mm	0.10	-60 to 330/350°C	13605	13608	
	0.25	-60 to 330/350°C	13620	13623	13626
	0.50	-60 to 330/350°C	13635	13638	
	1.00	-60 to 325/350°C	13650	13653	13697
0.32mm	0.25	-60 to 330/350°C	13621	13624	
	0.50	-60 to 330/350°C		13639	
	1.00	-60 to 325/350°C		13654	
0.53mm	1.50	-60 to 310/330°C		13670	

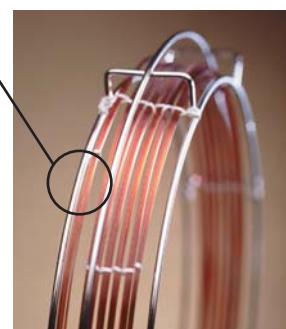
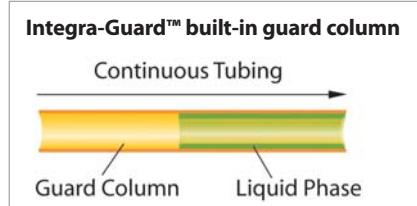
ID	df (μm)	temp. limits	10-Meter	20-Meter
0.10mm	0.10	-60 to 330/350°C	43601	
0.18mm	0.18	-60 to 330/350°C		43602
	0.36	-60 to 330/350°C		43604

Rxi®-5Sil MS with Integra-Guard™

Get the protection without the connection!

- Extend column lifetime.
- Eliminate leaks with a built-in retention gap.
- Inertness verified by isothermal testing.

Description	qty.	cat.#	price
15m, 0.25mm ID, 0.25μm Rxi-5Sil MS w/10m Integra-Guard Column	ea.	13620-127	enquire
30m, 0.25mm ID, 0.25μm Rxi-5Sil MS w/5m Integra-Guard Column	ea.	13623-124	
30m, 0.25mm ID, 0.25μm Rxi-5Sil MS w/10m Integra-Guard Column	ea.	13623-127	
30m, 0.25mm ID, 0.50μm Rxi-5Sil MS w/5m Integra-Guard Column	ea.	13638-124	
30m, 0.25mm ID, 0.50μm Rxi-5Sil MS w/10m Integra-Guard Column	ea.	13638-127	
30m, 0.32mm ID, 0.50μm Rxi-5Sil MS w/5m Integra-Guard Column	ea.	13639-125	enquire

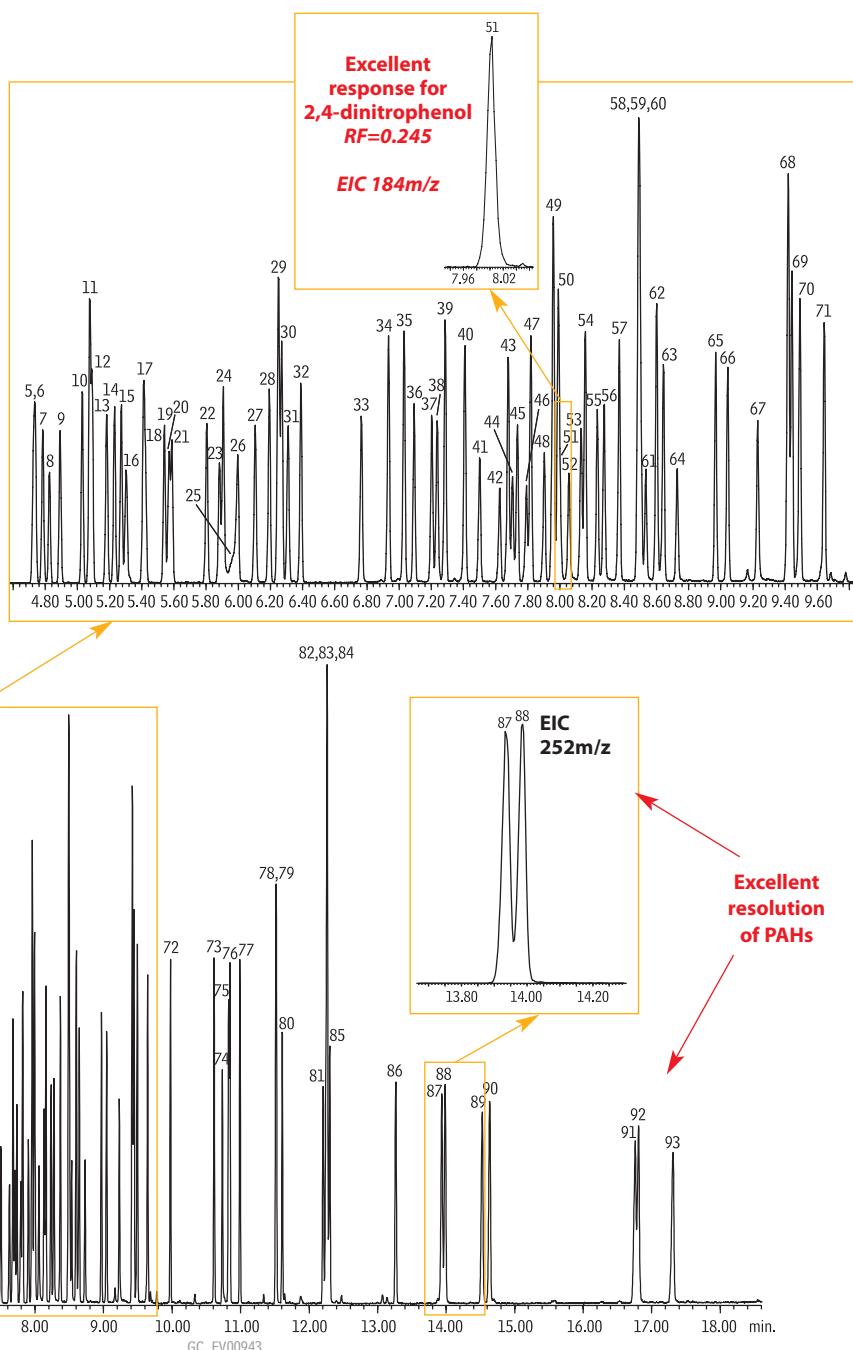
Phases currently available as Integra-Guard™ columns

Rtx®-1
Rtx®-5
Rtx®-5MS
Rxi®-5Sil MS
Rtx®-1301
Rtx®-624
Rtx®-1701
Rtx®-Volatiles
Rtx®-20
Rtx®-35
Rtx®-BAC 1 & 2
Stabilwax®

Integra-Guard™ columns are available for all phases listed, for columns with 0.25, 0.32 or 0.53mm ID and lengths to 75 meters.

Semivolatile organics for US EPA Method 8270 on an Rxⁱ[®]-5Sil MS column.

Column: Rxⁱ[®]-5Sil MS, 30m, 0.25mm ID, 0.25 μ m (cat.# 13623)
 Sample: US EPA Method 8270D Mix, 1 μ L of 10 μ g/mL (IS 40 μ g/mL) 8270 MegaMix[®] (cat.# 31850)
 Benzoin Acid (cat.# 31879)
 8270 Benzidines Mix (cat.# 31852)
 Acid Surrogate Mix (4/89 SOW) (cat.# 31025)
 Revised B/N Surrogate Mix (cat.# 31887)
 1,4-Dioxane (cat.# 31853)
 SV Internal Standard Mix (cat.# 31206)
 1.0 μ L (10ng on-column concentration), 4mm Drilled Uniliner[®] (hole near bottom) inlet liner (cat.# 20756), pulsed splitless: pulse 25psi @ 0.2 min., 60mL/min. @ 0.15 min.
 Inj. temp.: 250°C
 Carrier gas: helium, constant flow
 Flow rate: 1.2mL/min.
 Oven temp.: 40°C (hold 1.0 min.) to 280°C @ 25°C/min. to 320°C @ 5°C/min. (hold 1 min.)
 Det.: MS
 Transfer line temp: 280°C
 Scan range: 35-550amu
 Ionization: EI
 Mode: scan



1. 1,4-dioxane	17. 4-methylphenol/3-methylphenol	34. 2-methylnaphthalene	51. 2,4-dinitrophenol	66. hexachlorobenzene	83. bis(2-ethylhexyl) phthalate
2. n-nitrosodimethylamine	18. n-nitroso-di-n-propylamine	35. 1-methylnaphthalene	52. 4-nitrophenol	67. pentachlorophenol	84. chrysene-d12 (IS)
3. pyridine	19. hexachloroethane	36. hexachlorocyclopentadiene	53. 2,4-dinitrotoluene	68. phenanthrene-d10 (IS)	85. chrysene
c. toluene	20. nitrobenzene-d5 (SS)	37. 2,4,6-trichlorophenol	54. dibenzofuran	69. phenanthrene	86. di-n-octyl phthalate
4. 2-fluorophenol (SS)	21. nitrobenzene	38. 2,4,5-trichlorophenol	55. 2,3,5,6-tetrachlorophenol	70. anthracene	87. benzo(k)fluoranthene
5. phenol-d6 (SS)	22. isopropene	39. 2-fluorobiphenyl (SS)	56. 2,3,4,6-tetrachlorophenol	71. carbazole	88. benzo(k)fluoranthene
6. phenol	23. 2-nitrophenol	40. 2-chloronaphthalene	57. diethyl phthalate	72. di-n-butyl phthalate	89. benzo(a)pyrene
7. aniline	24. 2,4-dimethylphenol	41. 2-nitroaniline	58. 4-chlorophenyl phenyl ether	73. fluoranthene	90. perylene-d12 (IS)
8. bis(2-chloroethyl) ether	25. benzoin acid	42. 1,4-dinitrobenzene	59. fluorene	74. benzidine	91. indeno(1,2,3-cd)perylene
9. 2-chlorophenol	26. bis(2-chloroethoxy)methane	43. dimethyl phthalate	60. 4-nitroaniline	75. pyrene-d10 (SS)	92. dibenz(a,h)anthracene
10. 1,2-dichlorobenzene	27. 2,4-dichlorophenol	44. 1,3-dinitrobenzene	61. 4,6-dinitro-2-methylphenol	76. pyrene	93. benzo(ghi)perylene
11. 1,4-dichlorobenzene-d4 (IS)	28. 1,2,4-trichlorobenzene	45. 2,6-dinitrotoluene	62. n-nitrosodiphenylamine (diphenylamine)	77. p-terphenyl-d14 (SS)	c = contaminant
12. 1,4-dichlorobenzene	29. naphthalene-d8 (IS)	46. 1,2-dinitrobenzene	63. 1,2-diphenylhydrazine	78. 3,3'-dimethylbenzidine	
13. benzyl alcohol	30. naphthalene	47. acenaphthylene	64. 2,4-dinitrophenol (SS)	79. butyl benzyl phthalate	
14. 1,2-dichlorobenzene	31. 4-chloroaniline	48. 3-nitroaniline	65. 4-bromophenyl phenyl ether	80. bis(2-ethylhexyl) adipate	
15. 2-methylphenol	32. hexachlorobutadiene	49. acenaphthene-d10 (IS)	66. 2,4,6-tribromophenol (SS)	81. 3,3'-dichlorobenzidine	
16. bis(2-chloroisopropyl) ether	33. 4-chloro-3-methylphenol	50. acenaphthene	67. benzo(a)anthracene	82. benzo(a)anthracene	

GC COLUMNS | HIGH-PERFORMANCE RXI COLUMNS

Rxi®-XLB, Rxi®-35Sil MS, Rxi®-5HT



similar phases

DB-XLB, VF-Xms

tech tip

In combination with an Rxi®-XLB column, simple adjustments to the injection conditions can greatly improve sensitivity for active and high molecular weight Method 525.2 target compounds.

- By eliminating contact between the sample and the hot metal surfaces in the injection port, a Drilled Uniliner® inlet liner prevents analytes from degrading in the injection port.
- A pulsed injection (30psi/0.4 min.) reduces the time the analytes spend in the injection port, and helps to minimize breakdown.

Rxi®-XLB (low polarity proprietary phase)

- General purpose columns exhibiting extremely low bleed. Ideal for many GC/MS applications, including pesticides, PCB congeners or (e.g.) Aroclor mixes, PAHs.
- Unique selectivity.
- Temperature range: 30°C to 360°C.

Improvements in polymer synthesis and tubing deactivation enable us to make inert, stable Rxi®-XLB columns especially well-suited for analyzing active, high molecular weight compounds with sensitive GC/MS systems, including ion trap detectors. Excellent efficiency, coupled with inertness, low bleed, and high thermal stability, make Rxi®-XLB columns ideal for analyzing semivolatile compounds in drinking water (e.g., US EPA Method 525).

Rxi®-XLB Columns (fused silica)

(low polarity proprietary phase)

ID	df (µm)	temp. limits*	15-Meter	30-Meter	60-Meter
0.25mm	0.10	30 to 340/360°C	13705	13708	
	0.25	30 to 340/360°C	13720	13723	13726
	0.50	30 to 340/360°C		13738	
	1.00	30 to 340/360°C	13750	13753	
0.32mm	0.10	30 to 340/360°C		13709	
	0.25	30 to 340/360°C	13721	13724	13727
	0.50	30 to 340/360°C		13739	
	1.00	30 to 340/360°C		13754	
0.53mm	0.50	30 to 340/360°C		13740	
	1.50	30 to 320/340°C	13767	13770	

ID	df (µm)	temp. limits	10-Meter	20-Meter
0.10mm	0.10	30 to 340/360°C	43701	
0.18mm	0.18	30 to 340/360°C		43702

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



similar phases

DB-35ms, MR2

Rxi®-35Sil MS (midpolarity phase; equivalent to 35% phenyl methylpolysiloxane)

- Excellent inertness for active compounds.
- Very low bleed phase for GC/MS analysis.
- Extended temperature range: 50°C to 340/360°C.

Rxi®-35Sil MS Columns (fused silica)

(midpolarity phase; equivalent to 35% phenyl methylpolysiloxane)

ID	df (µm)	temp. limits	30-Meter
0.25mm	0.25	50 to 340/360°C	13823
0.32mm	0.25	50 to 340/360°C	13824
0.53mm	0.50	50 to 320/340°C	13840



Lowest bleed, most inert high-temperature column available!

similar phases

DB-5HT, VF-5HT, ZB-5HT

Rxi®-5HT (nonpolar phase; 5% diphenyl/95% dimethylpolysiloxane)

- 40% longer lifetime from specially designed fused silica tubing.
- Columns processed for high temperature applications.
- Temperature range: -60 to 400°C*.

Rxi®-5HT Columns (fused silica)

(nonpolar phase; 5% diphenyl/95% dimethylpolysiloxane)

ID	df (µm)	temp. limits	15-Meter	30-Meter
0.25mm	0.10	-60 to 380/400°C	13905	13908
	0.25	-60 to 380/400°C		13923
0.32mm	0.10	-60 to 380/400°C	13906	13909
	0.25	-60 to 380/400°C		13924
0.53mm	0.15	-60 to 380/400°C		13910

*Column is capable of going to 430°C, but column lifetime will be reduced.

Rxi®-17 (midpolarity phase; Crossbond® 50% diphenyl/50% dimethyl polysiloxane)

- General purpose columns for pesticides, herbicides, rosin acids, phthalate esters, triglycerides, sterols.
- Temperature range: 0°C to 320°C.

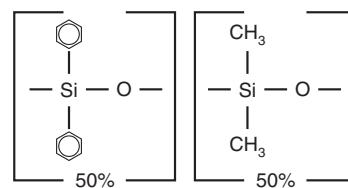
Rxi®-17 Columns (fused silica)

(Crossbond® 50% diphenyl/50% dimethyl polysiloxane)

ID	df (μm)	temp. limits	15-Meter	30-Meter
0.25mm	0.25	40 to 280/320°C	13520	13523
	0.50	40 to 280/320°C	13535	13538
	1.00	40 to 280/320°C	13550	13553
0.32mm	0.25	40 to 280/320°C	13521	13524
	0.50	40 to 280/320°C	13536	13539
	1.00	40 to 280/320°C	13551	13554
0.53mm	0.25	40 to 280/320°C	13522	13525
	0.50	40 to 280/320°C	13537	13540
	0.83	40 to 280/320°C		13569
	1.00	40 to 280/320°C	13552	13555
	1.50	40 to 280/320°C	13567	13570

ID	df (μm)	temp. limits	10-Meter	20-Meter
0.10mm	0.10	40 to 280/320°C	13501	
0.18mm	0.18	40 to 280/320°C		13502

Rxi®-17 Structure

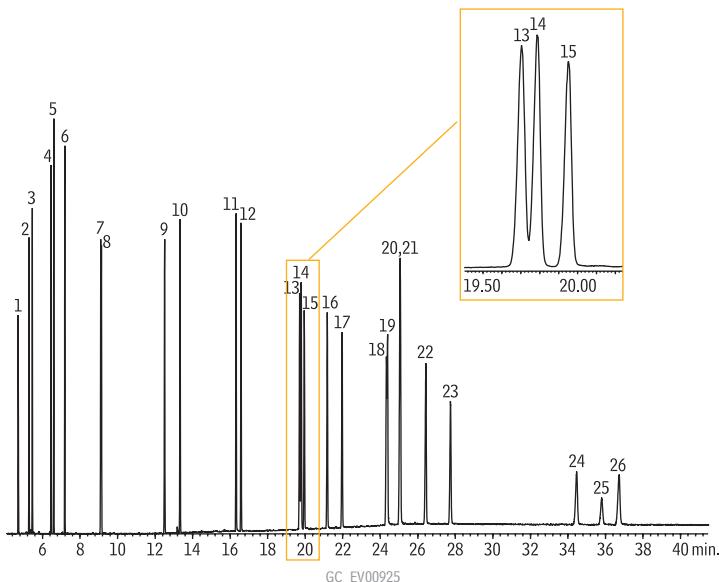


similar phases

DB-17, DB-608, VF-17ms, CP-Sil 24 CB

NEW!

Polycyclic aromatic hydrocarbons on an Rxi®-17 column.



Completely resolve benzo(j)fluoranthene.

Peak List	Ret. Time (min.)
1. naphthalene	4.70
2. 1-methylnaphthalene	5.28
3. 2-methylnaphthalene	5.46
4. acenaphthylene	6.45
5. acenaphthene	6.60
6. fluorene	7.18
7. phenanthrene	9.10
8. anthracene	9.14
9. fluoranthene	12.50
10. pyrene	13.33
11. benzo(a)anthracene	16.32
12. chrysene	16.58
13. benzo(b)fluoranthene	19.70
14. benzo(k)fluoranthene	19.78
15. benzo(j)fluoranthene	19.95
16. benzo(a)pyrene	21.17
17. 3-methylcholanthrene	21.97
18. dibenzo(a,h)acridine	24.33
19. dibenzo(a,j)acridine	24.39
20. indeno(1,2,3-cd)pyrene	25.04
21. dibenzo(a,h)anthracene	25.07
22. benzo(gh)perylene	26.43
23. 7H-dibenzo(c,g)carbazole	27.75
24. dibenzo(a,e)pyrene	34.46
25. dibenzo(a,i)pyrene	35.80
26. dibenzo(a,h)pyrene	36.73

Column: Rxi®-17, 30m, 0.25mm ID, 0.25μm (cat.# 13523)
 Sample: PAH mix, 20μg/mL each component:
 EPA Method 610 Mix (cat.# 31011), PAH Supplement Mix (cat.# 31857)
 1-methylnaphthalene (cat.# 31283), 2-methylnaphthalene (cat.# 31285)
 Inj.: 1.0μL pulsed splitless injection (20ng each component on column),
 4mm Drilled Uniliner® inlet liner with hole near top (cat.# 21055);
 pulse: 20psi @ 0.3 min., 40mL/min. @ 0.2 min.
 Inj. temp.: 300°C
 Carrier gas: helium, constant flow
 Flow rate: 1.2mL/min.
 Oven temp.: 90°C (hold 1.0 min.) to 215°C @ 25°C/min. (hold 0.5 min.) to
 235°C @ 4°C/min., to 280°C @ 15°C/min., to 320°C @ 4°C/min. (hold 20 min.)
 Det.: Agilent 5973 GC/MS
 Scan range: 50-550amu
 Solvent delay: 4.0 min.
 Tune: DFTPP
 Ionization: EI

General Purpose Columns



Chemically bonded capillary columns

- Allow for direct solvent injection onto column.
- Columns can be solvent rinsed.

Comprehensive GC column selection

- Available in many dimensions, including variations in length, internal diameter, and film thickness.
- Internal diameters include 0.10mm and 0.18mm for faster analysis time and greater resolution.

Broad range of stationary phases

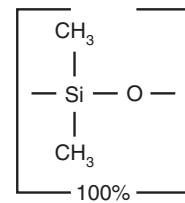
- Columns based on polysiloxane backbone; functional groups added to the polymers to vary selectivity.
- Polyethylene glycol (PEG) phases.



Rtx®-1 (nonpolar phase; Crossbond® 100% dimethyl polysiloxane)

- General purpose columns for solvent impurities, PCB congeners or (e.g.) Aroclor mixes, simulated distillation, drugs of abuse, gases, natural gas odorants, sulfur compounds, essential oils, hydrocarbons, semivolatiles, pesticides, oxygenates.
- Temperature range: -60°C to 350°C.
- Equivalent to USP G1, G2, G38 phases.

Rtx®-1 columns exhibit long lifetime and very low bleed at high operating temperatures. A proprietary synthesis process eliminates residual catalysts that could cause degradation and increase bleed.

Rtx®-1 Structure**Rtx®-1 Columns (fused silica)**

(Crossbond® 100% dimethyl polysiloxane)

ID	df (µm)	temp. limits*	15-Meter	30-Meter	60-Meter	105-Meter
0.25mm	0.10	-60 to 330/350°C	10105	10108	10111	
	0.25	-60 to 330/350°C	10120	10123	10126	10129
	0.50	-60 to 330/350°C	10135	10138	10141	10144
	1.00	-60 to 320/340°C	10150	10153	10156	10159
0.32mm	0.10	-60 to 330/350°C	10106	10109	10112	
	0.25	-60 to 330/350°C	10121	10124	10127	10130
	0.50	-60 to 330/350°C	10136	10139	10142	
	1.00	-60 to 320/340°C	10151	10154	10157	10160
	1.50	-60 to 310/330°C	10166	10169	10172	10175
	3.00	-60 to 280/300°C	10181	10184	10187	10190
	4.00	-60 to 280/300°C		10198		
	5.00	-60 to 260/280°C	10176	10178	10180	
	7.00	-60 to 270/290°C				
0.45mm	0.10	-60 to 320/340°C	10107	10110		
	0.25	-60 to 320/340°C	10122	10125	10128	
	0.50	-60 to 310/330°C	10137	10140	10143	
	1.00	-60 to 310/330°C	10152	10155	10158	
	1.50	-60 to 310/330°C	10167	10170	10173	
	3.00	-60 to 270/290°C	10182	10185	10188	10189
	5.00	-60 to 270/290°C	10177	10179	10183	10194
	7.00	-60 to 240/260°C	10191	10192	10193	

ID	df (µm)	temp. limits	10-Meter	20-Meter	40-Meter
0.10mm	0.10	-60 to 330/350°C	41101	41102	
	0.40	-60 to 320/340°C	41103	41104	
0.18mm	0.20	-60 to 330/350°C	40101	40102	40103
	0.40	-60 to 320/340°C	40110	40111	40112

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

Rtx®-1 with Integra-Guard™ Column

Get the protection without the connection!

- Extend column lifetime.
- Eliminate leaks with a built-in retention gap.
- Inertness verified by isothermal testing.

Description	qty.	cat.#	price
30m, 0.25mm ID, 0.25µm Rtx-1 w/5m Integra-Guard Column	ea.	10123-124	
30m, 0.53mm ID, 1.00µm Rtx-1 w/5m Integra-Guard Column	ea.	10155-126	
30m, 0.53mm ID, 5.00µm Rtx-1 w/5m Integra-Guard Column	ea.	10179-126	

similar phases

DB-1, DB-1MS, HP-1, HP-1MS, Ultra-1, SPB-1, Equity-1, MDN-1, VF-1ms, CP-Sil 5 CB

also available**MXT® Columns**

Rugged, flexible, Siltek® treated stainless steel tubing; inertness comparable to fused silica tubing. See page 105 for our MXT®-1 columns.

it's a fact

For exceptional inertness, ultra-low bleed, and unsurpassed performance, choose Rxi®-1ms columns! See pages 36-40.

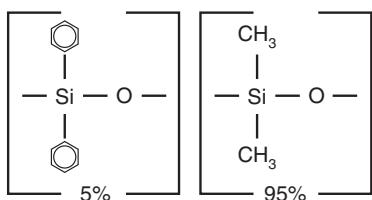
crossbond® technology

reduces bleed, prolongs column lifetime, and allows rejuvenation through solvent rinsing.

**Catch the Buzz**Sign up for Restek's e-newsletter, *The Buzz*www.restek.com/buzz

Rtx®-5, Rtx®-5MS

Rtx®-5/Rtx®-5MS Structure



Rtx®-5/Rtx®-5 MS (low polarity phase; Crossbond® 5% diphenyl/95% dimethyl polysiloxane)

- General purpose columns for drugs, solvent impurities, pesticides, hydrocarbons, PCB congeners or (e.g.) Aroclor mixes, essential oils, semivolatiles.
- Temperature range: -60°C to 350°C.
- Equivalent to USP G27 and G36 phases.

The 5% diphenyl/95% dimethyl polysiloxane stationary phase is the most popular GC stationary phase and is used in a wide variety of applications. All residual catalysts and low molecular weight fragments are removed from the Rtx®-5 polymer, providing a tight mono-modal distribution and extremely low bleed.

Rtx®-5 Columns (fused silica)

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

ID	df (µm)	temp. limits*	15-Meter	30-Meter	60-Meter	105-Meter
0.25mm	0.10	-60 to 330/350°C	10205	10208	10211	10214
	0.25	-60 to 330/350°C	10220	10223	10226	10229
	0.50	-60 to 330/350°C	10235	10238	10241	10244
	1.00	-60 to 320/340°C	10250	10253	10256	10259
0.32mm	0.10	-60 to 330/350°C	10206	10209	10212	10215
	0.25	-60 to 330/350°C	10221	10224	10227	10230
	0.50	-60 to 330/350°C	10236	10239	10242	10245
	1.00	-60 to 330/350°C	10251	10254	10257	10260
0.53mm	1.50	-60 to 310/330°C	10266	10269	10272	10275
	3.00	-60 to 280/300°C	10281	10284	10287	10290
	0.10	-60 to 320/340°C	10207	10210	10213	
	0.25	-60 to 320/340°C	10222	10225	10228	
0.53mm	0.50	-60 to 310/330°C	10237	10240	10243	
	1.00	-60 to 310/330°C	10252	10255	10258	
	1.50	-60 to 310/330°C	10267	10270	10273	
	3.00	-60 to 270/290°C	10282	10285	10288	
0.53mm	5.00	-60 to 270/290°C	10277	10279	10283	

ID	df (µm)	temp. limits	10-Meter	20-Meter	40-Meter
0.10mm	0.10	-60 to 330/350°C	41201	41202	
	0.40	-60 to 320/340°C	41203	41204	
0.18mm	0.20	-60 to 325/340°C	40201	40202	40203
	0.40	-60 to 315/330°C	40210	40211	40212

30-meter	6-pack cat.#	6-pack price
0.25mm ID, 0.25µm	10223-600	
0.25mm ID, 0.50µm	10238-600	
0.32mm ID, 1.00µm	10254-600	
0.53mm ID, 1.50µm	10270-600	

Six columns
for the price
of five!

Other phases and configurations available on request.

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

Rtx®-5MS—Low-bleed GC/MS Columns (fused silica)

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

Column specifically tested for low bleed performance.

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

it's a fact

For exceptional inertness, ultra-low bleed, and unsurpassed performance, choose Rxi®-5ms columns! See pages 36-39, 41.

Rtx®-20 (low to midpolarity phase; Crossbond® 20% diphenyl/80% dimethyl polysiloxane)

- General purpose columns for volatile compounds, flavor compounds, alcoholic beverages.
- Temperature range: -20°C to 320°C.
- Equivalent to USP G28, G32 phases.

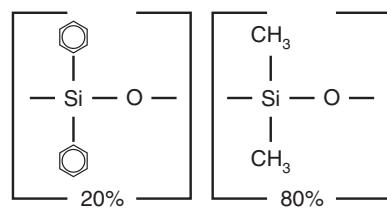
Rtx®-20 polymer is synthesized to exacting standards. All residual catalysts and low molecular weight fragments are removed from the polymer, providing a tight mono-modal distribution and extremely low bleed.

Rtx®-20 Columns (fused silica)

(Crossbond® 20% diphenyl/80% dimethyl polysiloxane)

ID	df (μm)	temp. limits	15-Meter	30-Meter
0.25mm	0.25	-20 to 300/320°C	10320	10323
	0.50	-20 to 290/310°C	10335	10338
	1.00	-20 to 280/300°C	10350	10353
0.32mm	0.25	-20 to 300/320°C	10321	10324
	0.50	-20 to 290/310°C	10336	10339
	1.00	-20 to 280/300°C	10351	10354
0.53mm	0.25	-20 to 260/280°C	10322	10325
	1.00	-20 to 260/280°C	10352	10355

Rtx®-20 Structure



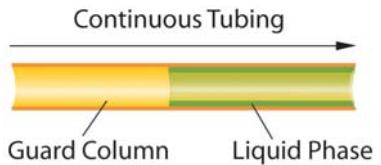
similar phase

SPB-20

Integra-Guard™ built-in guard column

Get the protection without the connection!

For Rtx®-20 and Rtx®-35 columns with built-in Integra-Guard™ guard columns, see page 33.



Rtx®-35 (midpolarity phase; Crossbond® 35% diphenyl/65% dimethyl polysiloxane)

- General purpose columns for organochlorine pesticides, PCB congeners or (e.g.) Aroclor mixes, herbicides, pharmaceuticals, sterols, rosin acids, phthalate esters.
- Temperature range: 40°C to 320°C.
- Equivalent to USP G42 phase.

An Rtx®-35 column is a popular confirmation column for pesticides and herbicides, in conjunction with an Rtx®-5 or Rtx®-1701 column. The higher phenyl content causes useful elution order and retention time changes.

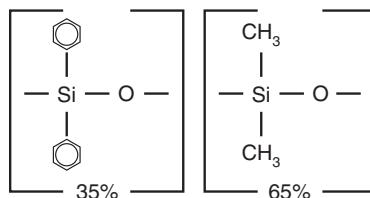
Rtx®-35 Columns (fused silica)

(Crossbond® 35% diphenyl/65% dimethyl polysiloxane)

ID	df (μm)	temp. limits	15-Meter	30-Meter
0.25mm	0.25	40 to 320°C	10420	10423
	0.50	40 to 310°C	10435	10438
	1.00	40 to 290°C	10450	10453
0.32mm	0.25	40 to 320°C	10421	10424
	0.50	40 to 310°C	10436	10439
	1.00	40 to 290°C	10451	10454
0.53mm	0.25	40 to 260/280°C	10422	10425
	0.50	40 to 300°C	10437	10440
	1.00	40 to 290°C	10452	10455
	1.50	40 to 280°C	10467	10470

ID	df (μm)	temp. limits	10-Meter	20-Meter
0.18mm	0.20	40 to 300/320°C	40401	40402
	0.40	40 to 290/310°C	40410	40411

Rtx®-35 Structure



similar phases

DB-35, HP-35, SPB-35, SPB-608

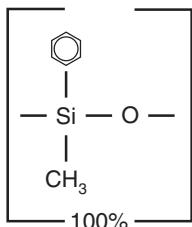
also available

MXT® Columns

Rugged, flexible, Siltek® treated stainless steel tubing; inertness comparable to fused silica tubing. See page 108 for our MXT®-20 columns and page 108 for our MXT®-35 columns.

Rtx®-35 Amine Columns

See page 60.

Rtx®-50, Rtx®-65**Rtx®-50 Structure****Rtx®-50 (midpolarity phase; Crossbond® 100% methylphenyl polysiloxane)**

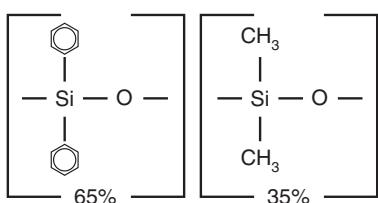
- General purpose columns for pesticides, herbicides, rosin acids, phthalate esters, triglycerides, sterols.
- Temperature range: 40°C to 320°C.
- Equivalent to USP G3 phase.

The high thermal stability of Rtx®-50 columns makes possible dual-column analysis with common phases such as Rtx®-1MS or Rtx®-5MS. Between analyses, high temperatures can be used to drive less volatile contaminants off of the column.

Rtx®-50 Columns (fused silica)

(Crossbond® 100% methylphenyl polysiloxane)

ID	df (µm)	temp. limits	15-Meter	30-Meter
0.25mm	0.25	40 to 300/320°C	10520	10523
	0.50	40 to 290/310°C	10535	10538
	1.00	40 to 280/300°C	10550	10553
0.32mm	0.25	40 to 300/320°C	10521	10524
	0.50	40 to 290/310°C	10536	10539
	1.00	40 to 280/300°C	10551	10554
0.53mm	0.25	40 to 280/300°C	10522	
	0.50	40 to 270/290°C	10537	10540
	0.83	40 to 270/290°C		10569
	1.00	40 to 260/280°C	10552	10555
	1.50	40 to 250/270°C	10567	10570
ID	df (µm)	temp. limits	10-Meter	20-Meter
0.18mm	0.20	40 to 310/330°C	40501	40502
	0.40	40 to 300/320°C	40510	40511

Rtx®-65 Structure**Rtx®-65 (mid to high polarity phase; Crossbond® 65% diphenyl/35% dimethyl polysiloxane)**

- General purpose columns for phenols, fatty acids.
- Temperature range: 50°C to 300°C.
- Equivalent to USP G17 phase.

The Rtx®-65 phase contains the highest phenyl content of any bonded stationary phase available, to improve separation of aromatic compounds through increased phase-analyte interaction. A unique polarity makes these columns ideal for a variety of analyses, from phenols to FAMEs. As a confirmation column for EPA Method 604 phenols, an Rtx®-65 column produces a different elution order, compared to the primary Rtx®-5 column. Rtx®-65 columns elute FAMEs according to equivalent chain length, similar to bonded Carbowax® columns, but the Rtx®-65 phase does not suffer the thermal stability limitations of other polar stationary phases.

Rtx®-65 Columns (fused silica)

(Crossbond® 65% diphenyl/35% dimethyl polysiloxane)

ID	df (µm)	temp. limits	30-Meter
0.25mm	0.25	50 to 300°C	17023
	0.50	50 to 280/300°C	17038
	1.00	50 to 260/280°C	17053
0.32mm	0.25	50 to 300°C	17024
	0.50	50 to 280/300°C	17039
	1.00	50 to 260°C	17054
0.53mm	0.25	50 to 290/300°C	17025
	0.50	50 to 270/290°C	17040
	1.00	50 to 250/270°C	17055

similar phases

TAP-CB, 400-65HT, 007-65HT

also available**MXT® Columns**

Rugged, flexible, Siltek® treated stainless steel tubing; inertness comparable to fused silica tubing. See page 109 for our MXT®-65 columns.

also available**Rtx®-65TG Columns**

See page 67.

crossbond® technology

reduces bleed, prolongs column lifetime, and allows rejuvenation through solvent rinsing.

Rtx®-440 (intermediate polarity proprietary Crossbond® phase)

- General purpose columns for pesticides, PAHs, or other semivolatiles. Ideal for low/trace level analyses.
- Low bleed, high-resolution columns with unique selectivity.
- Temperature range: 20°C to 340°C.

restek innovation!

Rtx®-440 Columns (fused silica)

(intermediate polarity proprietary Crossbond® phase)

ID	df (μm)	temp. limits	30-Meter
0.25mm	0.25	20°C to 320/340°C	12923
	0.50	20°C to 320/340°C	12938
0.32mm	0.25	20°C to 320/340°C	12924
	0.50	20°C to 320/340°C	12939
0.53mm	0.50	20°C to 320/340°C	12940
	1.00	20°C to 320/340°C	12955

ID	df (μm)	temp. limits	20-Meter	40-Meter
0.18mm	0.18	20°C to 320/340°C	42902	42903

Organochlorine Pesticides (US EPA Method 8081A) on an Rtx®-440 column.

Column: Rtx®-440 30m, 0.25mm ID, 0.50μm (cat.# 12939)

Sample: Organochlorine Pesticides Mix AB #2 (cat.# 32292),
8-80μg/ml each component in ethyl acetate
Chlorobenzilate (cat.# 32211) 1,000μg/mL in methanol
Diallate (*cis* & *trans*) (custom) 1,000μg/mL in hexane
Hexachlorobenzene (cat.# 32231) 1,000μg/mL in acetone
Hexachlorocyclopentadiene (cat.# 32232) 1,000μg/mL in methanol
Isodrin (custom) 1,000μg/mL in hexane
Kepone (custom) 1,000μg/mL in hexane
Mirex (custom) 1,000μg/mL in hexane
2,4'-DDD (cat.# 32098) 1,000μg/mL in methanol
2,4'-DDE (cat.# 32099) 1,000μg/mL in methanol
2,4'-DDT (cat.# 32200) 1,000μg/mL in methanol
TCMX (cat.# 32027) 200μg/ml in acetone
DCB (cat.# 32029) 200μg/ml in acetone

Inj.: 1.0μL splitless (hold 0.75 min.), 2mm Siltek®
treated single gooseneck inlet liner (cat.# 20961-214.1)

Inj. temp.: 275°C

Carrier gas: hydrogen, constant pressure

Linear velocity: 51 cm/sec. @ 140°C

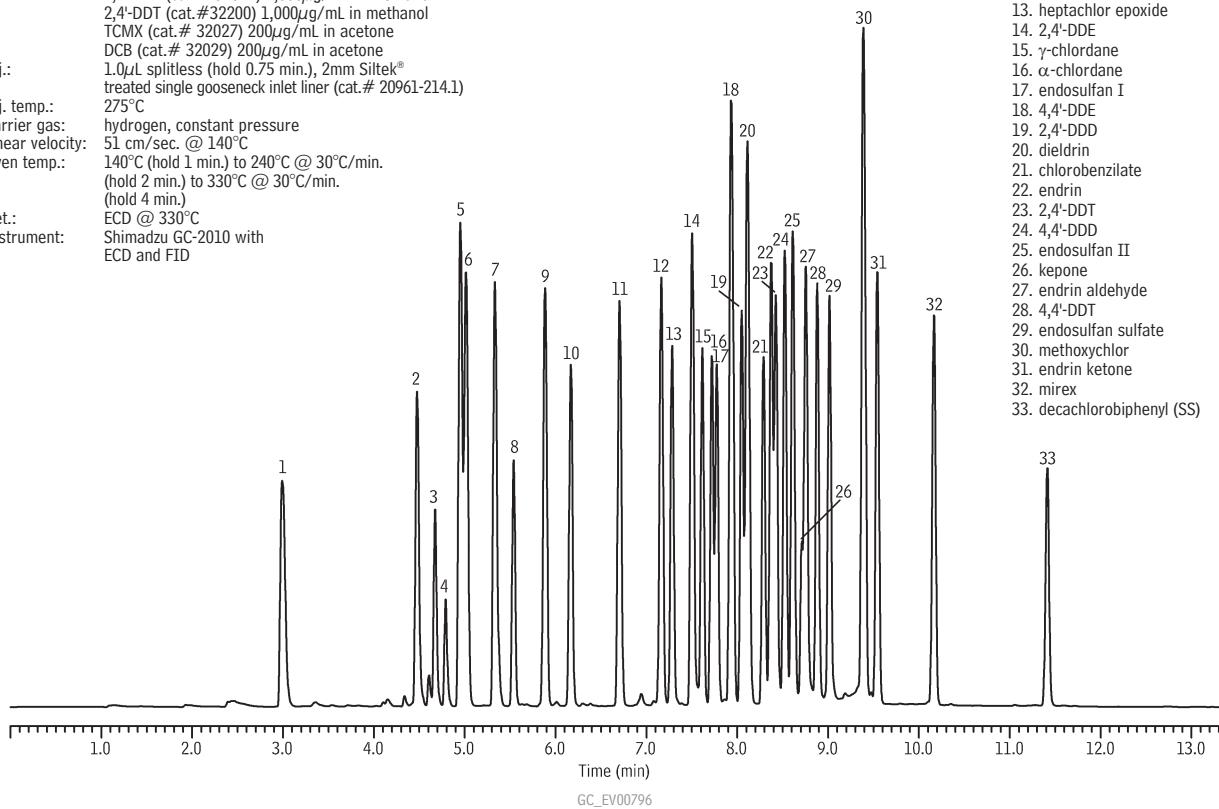
Oven temp.: 140°C (hold 1 min.) to 240°C @ 30°C/min.
(hold 2 min.) to 330°C @ 30°C/min.
(hold 4 min.)

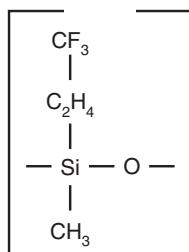
Det.: ECD @ 330°C

Instrument: Shimadzu GC-2010 with

ECD and FID

1. hexachlorocyclopentadiene
2. 2,4,5,6-tetrachloro-m-xylene (SS)
3. *cis*-diallate
4. *trans*-diallate
5. α-BHC
6. hexachlorobenzene
7. γ-BHC
8. β-BHC
9. δ-BHC
10. heptachlor
11. aldrin
12. isodrin
13. heptachlor epoxide
14. 2,4'-DDE
15. γ-chlordane
16. α-chlordane
17. endosulfan I
18. 4,4'-DDE
19. 2,4'-DDD
20. dieldrin
21. chlorobenzilate
22. endrin
23. 2,4'-DDT
24. 4,4'-DDD
25. endosulfan II
26. kepone
27. endrin aldehyde
28. 4,4'-DDT
29. endosulfan sulfate
30. methoxychlor
31. endrin ketone
32. mirex
33. decachlorobiphenyl (SS)



Rtx®-200 Structure**Rtx®-200 (midpolarity phase; Crossbond® trifluoropropylmethyl polysiloxane)**

- General purpose columns for solvents, Freon® fluorocarbons, alcohols, ketones, silanes, glycols. Excellent confirmation column, with an Rtx®-5 column, for phenols, nitrosamines, organochlorine pesticides, chlorinated hydrocarbons, and chlorophenoxy herbicides.
- Temperature range: -20°C to 340°C.
- Equivalent to USP G6 phase.

Rtx®-200 columns have accomplished many difficult separations not possible on any other bonded stationary phase. Many analysts consider these the best, most inert mid-polarity columns available. The trifluoropropyl stationary phase has a unique selectivity that changes elution orders and resolves compounds that phenyl, cyano, or Carbowax® phases can not. The Rtx®-200 column offers exceptional thermal stability, low bleed, and superior inertness—even for active compounds such as phenols, and with sensitive detectors such as ECDs, NPDs, and MSDs.

Rtx®-200 Columns (fused silica)

(Crossbond® trifluoropropylmethyl polysiloxane)

similar phases

DB-200, DB-210

ID	df (µm)	temp. limits*	15-Meter	30-Meter	60-Meter	105-Meter
0.25mm	0.25	-20 to 320/340°C	15020	15023	15026	15029
	0.50	-20 to 310/330°C	15035	15038	15041	15044
	1.00	-20 to 290/310°C	15050	15053	15056	15059
0.32mm	0.25	-20 to 320/340°C	15021	15024	15027	15030
	0.50	-20 to 310/330°C	15036	15039	15042	15045
	1.00	-20 to 290/310°C	15051	15054	15057	15060
0.53mm	1.50	-20 to 280/300°C	15066	15069	15072	15075
	0.25	-20 to 310/330°C	15022	15025	15028	
	0.50	-20 to 300/320°C	15037	15040	15043	
0.53mm	1.00	-20 to 290/310°C	15052	15055	15058	
	1.50	-20 to 280/300°C	15067	15070	15073	
	3.00	-20 to 260/280°C	15082	15085	15088	15091

ID	df (µm)	temp. limits	10-Meter	20-Meter	40-Meter
0.18mm	0.20	-20 to 310/330°C	45001	45002	45003
	0.40	-20 to 310/330°C	45010	45011	45012

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

also available**MXT® Columns**

Rugged, flexible, Siltek® treated stainless steel tubing; inertness comparable to fused silica tubing.
See page 110 for our MXT®-200 columns.

Rtx®-200MS—Low-bleed GC/MS Columns (fused silica)

(Crossbond® trifluoropropylmethyl polysiloxane)

Column specifically tested for low bleed performance.

ID	df (µm)	temp. limits	30-Meter
0.25mm	0.10	-20 to 320/340°C	15608
	0.25	-20 to 320/340°C	15623
	0.50	-20 to 310/330°C	15638
	1.00	-20 to 290/310°C	15653
0.32mm	0.10	-20 to 320/340°C	15609
	0.25	-20 to 320/340°C	15624
	0.50	-20 to 310/330°C	15639
	1.00	-20 to 290/310°C	15654

Rtx®-1301 (low to midpolarity phase; Crossbond® 6% cyanopropylphenyl/94% dimethyl polysiloxane)

- General purpose columns for residual solvents, alcohols, oxygenates, and volatile organic compounds.
- Temperature range: -20°C to 280°C.
- Equivalent to USP G43 phase.

Many analysts feel the Rtx®-1301 column has the best cyanosilicone bonded stationary phase available, with no other column manufacturer providing lower bleed, longer lifetime, or better inertness. Our polymer is fully characterized to ensure long-term reproducibility, column-to-column consistency, and low bleed—even with sensitive detectors such as ECDs and MSDs.

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

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

ID	df (µm)	temp. limits*	15-Meter	30-Meter	60-Meter	75-Meter	105-Meter
0.25mm	0.25	-20 to 280°C	16020	16023	16026		
	0.50	-20 to 270°C	16035	16038	16041		
	1.00	-20 to 260°C	16050	16053	16056		
	1.40	-20 to 240°C			16016		
0.32mm	0.25	-20 to 280°C	16021	16024	16027		
	0.50	-20 to 270°C	16036	16039	16042		
	1.00	-20 to 260°C	16051	16054	16057		
	1.50	-20 to 250°C	16066	16069	16072		
	1.80	-20 to 240°C		16092	16093		
0.53mm	0.25	-20 to 280°C	16022	16025	16028		
	0.50	-20 to 270°C	16037	16040	16043		
	1.00	-20 to 260°C	16052	16055	16058		
	1.50	-20 to 250°C	16067	16070	16073		
	3.00	-20 to 240°C	16082	16085	16088	16076	16091

Rtx®-225 (polar phase; Crossbond® 50% cyanopropylmethyl/50% phenylmethyl polysiloxane)

- General purpose columns for FAMEs, carbohydrates, sterols, flavor compounds.
- Temperature range: 40°C to 240°C.
- Equivalent to USP G7, G19 phases.

The cyanopropyl-containing Rtx®-225 phase is slightly less polar than bonded polyethylene glycol (PEG) phases, but it can be used for many of the same applications.

Improvements to the Rtx®-225 polymer have increased thermal stability, reduced bleed, and improved inertness. The Rtx®-225 column provides a 20°C thermal stability advantage over other "225" columns because of our unique polymer synthesis technology and proprietary siloxane deactivation. In most similar columns, the Carbowax® deactivation layer is not fully compatible with the cyanopropyl siloxane polymer, which can cause adsorption, tailing of active compounds, and lower efficiency.

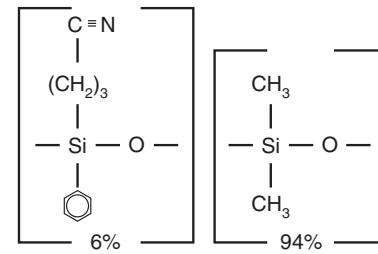
Rtx®-225 Columns (fused silica)

(Crossbond® 50% cyanopropylmethyl/50% phenylmethyl polysiloxane)

ID	df (µm)	temp. limits*	15-Meter	30-Meter	60-Meter
0.25mm	0.10	40 to 220/240°C	14005	14008	
	0.25	40 to 220/240°C	14020	14023	14026
	0.50	40 to 220/240°C	14035	14038	14041
0.32mm	0.10	40 to 220/240°C	14006	14009	
	0.25	40 to 220/240°C	14021	14024	14027
	0.50	40 to 220/240°C	14036	14039	14042
	1.00	40 to 200/220°C	14051	14054	14057
0.53mm	0.10	40 to 200/220°C	14007	14010	
	0.25	40 to 200/220°C	14022	14025	
	0.50	40 to 200/220°C	14037	14040	14043
	1.00	40 to 200/220°C	14052	14055	14058

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

Rtx®-1301 Structure

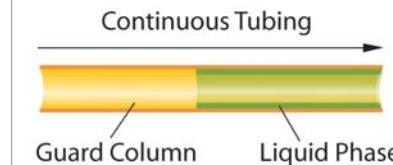


similar phases

DB-1301, DB-624, HP-1301, HP-624, SPB-1301, SPB-624, VF-1301, VF-624ms, CP-1301, CP-Select 624 CB

See Rtx-624, pages 74 and 93.

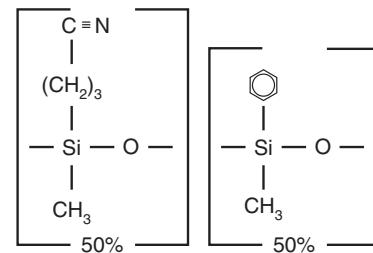
Integra-Guard™ built-in guard column



Get the protection without the connection!

For Rtx®-1301 columns with built-in Integra-Guard™ guard columns, see page 33.

Rtx®-225 Structure

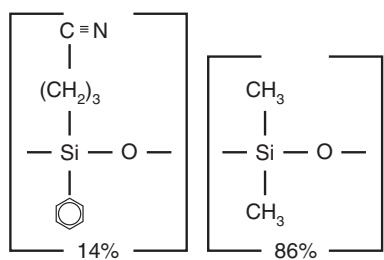


similar phases

DB-225, HP-225, SPB-225

Rtx®-1701

Rtx®-1701 Structure



Rtx®-1701 (midpolarity phase; Crossbond® 14% cyanopropylphenyl/86% dimethyl polysiloxane)

- General purpose columns for alcohols, oxygenates, PCB congeners or (e.g.) Aroclor mixes, pesticides.
- Temperature range: -20°C to 280°C.
- Equivalent to USP G46 phase.

Rtx®-1701 is one of the more popular stationary phases used in capillary GC. The mix of cyano and phenyl functional groups increases the polarity and offers a different elution order relative to less polar Rtx®-1 or Rtx®-5 columns. An Rtx®-1701 column is ideal for confirmation analysis, in combination with an Rtx®-35 or Rtx®-5 column. The polymer is fully characterized to ensure long-term reproducibility, column-to-column consistency, and low bleed, even with sensitive detectors such as ECDs and MSDs.

Rtx®-1701 Columns (fused silica)

(Crossbond® 14% cyanopropylphenyl/86% dimethyl polysiloxane)

similar phases

DB-1701, HP-1701, SPB-1701, VF-1701, CP-Sil 19 CB

Integra-Guard™ built-in guard column

Continuous Tubing

Get the protection without the connection!
For Rtx®-1701 columns with built-in
Integra-Guard™ guard columns, see page 33.

ID	df (μm)	temp. limits*	15-Meter	30-Meter	60-Meter
0.25mm	0.10	-20 to 280°C			12011
	0.25	-20 to 280°C	12020	12023	12026
	0.50	-20 to 270/280°C	12035	12038	12041
	1.00	-20 to 260/280°C	12050	12053	12056
0.32mm	0.10	-20 to 280°C		12009	
	0.25	-20 to 280°C	12021	12024	12027
	0.50	-20 to 270/280°C	12036	12039	12042
	1.00	-20 to 260/280°C	12051	12054	12057
	1.50	-20 to 240/260°C	12066	12069	12072
0.53mm	0.10	-20 to 270/280°C	12007		
	0.25	-20 to 270/280°C	12022	12025	12028
	0.50	-20 to 260/270°C	12037	12040	12043
	1.00	-20 to 250/270°C	12052	12055	12058
	1.50	-20 to 240/260°C	12067	12070	12073
	3.00	-20 to 230/250°C	12082	12085	12088

ID	df (μm)	temp. limits	10-Meter	20-Meter
0.10mm	0.10	-20 to 280°C	42201	42202
0.18mm	0.20	-20 to 280°C	42001	42002
	0.40	-20 to 270/280°C	42010	42011

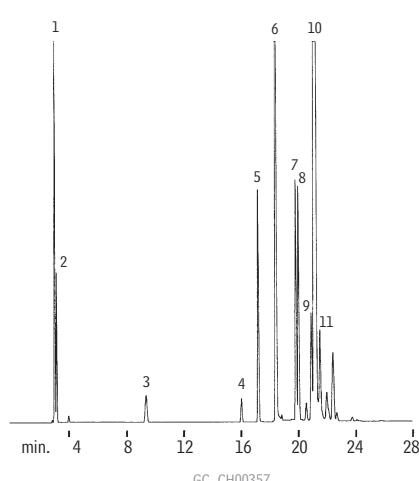
*Maximum temperatures listed are for 15- and 30-meter lengths. Longer lengths may have a slightly reduced maximum temperature.

also available

MXT® Columns

Rugged, flexible, Siltek® treated stainless steel tubing; inertness comparable to fused silica tubing. See page 110 for our MXT®-1701 columns.

Styrene impurities on an Rtx®-1701 column.



1. 1,3-butadiene
2. butene
3. acrylonitrile
4. diethylhydroxylamine
5. toluene
6. vinylcyclohexene
7. ethylbenzene
8. m-xylene
9. o-xylene
10. styrene
11. cumene

Column: Rtx®-1701, 30m, 0.53mm ID, 3.0μm (cat.# 12085)
Inj.: 0.5mL split injection of a 95% pure styrene
Oven temp.: 40°C (hold 10 min.) to 150°C (@ 12°C/min. (hold 15 min.)
Inj./det. temp.: 150°C
Carrier gas: helium
Linear velocity: 20cm/sec. set @ 40°C
FID sensitivity: 16 x 10⁻¹¹ AFS
Split vent: 40cc/min.

Permission to publish this chromatogram granted by Copolymer Rubber and Chemical Corp.

Rt®-2330 (highly polar phase; 90% biscyanopropyl/10% phenylcyanopropyl polysiloxane—not bonded)

- General purpose columns for *cis/trans* FAMEs, dioxin isomers.
- Temperature range: 0°C to 275°C.
- Equivalent to USP G8 and G48 phase.

Rt®-2330 is one of the most polar capillary column stationary phases. Cyano groups on both sides of the polymer backbone give the phase a strong dipole moment and high selectivity for *cis/trans* compounds or compounds with conjugated double bonds. Highly polar columns typically exhibit poor column efficiencies, high bleed, and short column lifetimes when thermally cycled. To overcome some of these problems, we developed a surface treatment that is more compatible with the Rt®-2330 phase. In addition, our improved polymer produces columns with improved column efficiency and lower bleed.

Because the Rt®-2330 stationary phase is not bonded, it should not be solvent rinsed.

Rt®-2330 Columns (fused silica)

(90% biscyanopropyl/10% phenylcyanopropyl polysiloxane)

ID	df (μm)	temp. limits*	30-Meter	60-Meter	105-Meter
0.25mm	0.10	0 to 260/275°C	10708	10711	10714
	0.20	0 to 260/275°C	10723	10726	10729
0.32mm	0.20	0 to 260/275°C	10724	10727	10730
0.53mm	0.10	0 to 260/275°C	10710	10713	
	0.20	0 to 260/275°C	10725	10728	

ID	df (μm)	temp. limits	10-Meter	20-Meter	40-Meter
0.18mm	0.10	0 to 260/275°C	40701	40702	40703

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

Rt®-2560 (highly polar phase; biscyanopropyl polysiloxane—not bonded)

- Application-specific column for *cis/trans* FAMEs.
- Stable to 250°C.

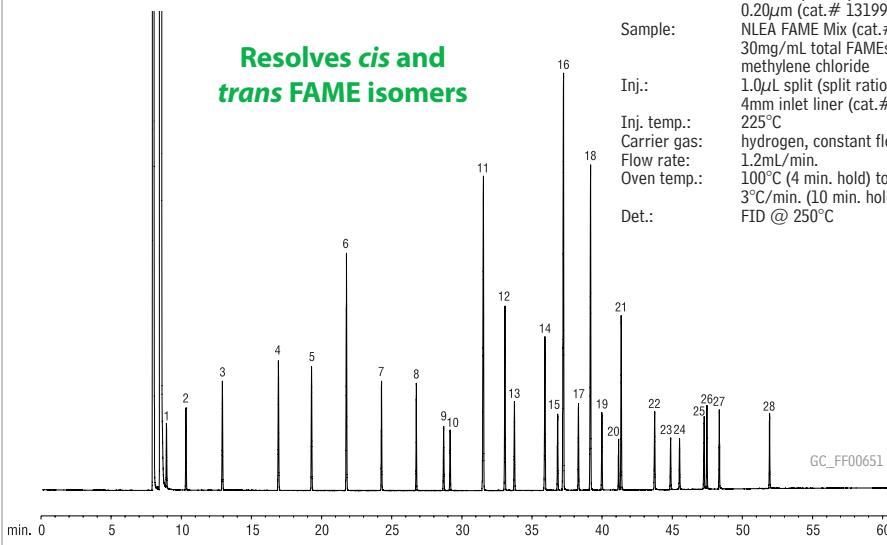
Because the Rt®-2560 stationary phase is not bonded, it should not be solvent rinsed.

Rt®-2560 Column (fused silica)

(biscyanopropyl polysiloxane)

ID	df (μm)	temp. limits	100-Meter
0.25mm	0.20	20 to 250°C	13199

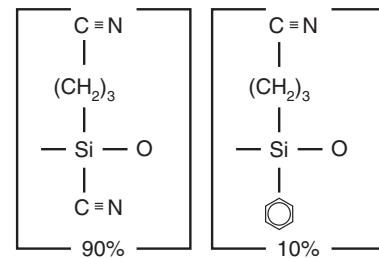
NLEA FAMEs resolved on an Rt®-2560 column.



Column: Rt®-2560, 100m, 0.25mm ID, 0.20μm (cat.# 13199)
 Sample: NLEA FAME Mix (cat.# 35078), 30mg/mL total FAMEs in methylene chloride
 Inj.: 1.0μL split (split ratio 100:1), 4mm inlet liner (cat.# 20814)
 Inj. temp.: 225°C
 Carrier gas: hydrogen, constant flow
 Flow rate: 1.2mL/min.
 Oven temp.: 100°C (4 min. hold) to 240°C @ 3°C/min. (10 min. hold)
 Det.: FID @ 250°C

1. C4:0 methyl butyrate
2. C6:0 methyl hexanoate
3. C8:0 methyl octanoate
4. C10:0 methyl decanoate
5. C11:0 methyl undecanoate
6. C12:0 methyl laurate
7. C13:0 methyl tridecanoate
8. C14:0 methyl myristate
9. C14:1 methyl myristoleate (*cis*-9)
10. C15:0 methyl pentadecanoate
11. C16:0 methyl palmitate
12. C16:1 methyl palmitoleate (*cis*-9)
13. C17:0 methyl heptadecanoate
14. C18:0 methyl stearate
15. C18:1 methyl elaidate (*trans*-9)
16. C18:1 methyl oleate (*cis*-9)
17. C18:2 methyl linoleaidate (*trans*-9,12)
18. C18:2 methyl linoleate (*cis*-9,12)
19. C20:0 methyl arachidate
20. C20:1 methyl eicosenoate (*cis*-11)
21. C18:3 methyl linolenate (*cis*-9,12,15)
22. C22:0 methyl behenate
23. C22:1 methyl erucate (*cis*-13)
24. C23:0 methyl tricosanoate
25. C24:0 methyl lignocerate
26. C20:5 methyl eicosapentaenoate (*cis*-5,8,11,14,17)
27. C24:1 methyl nervonate (*cis*-15)
28. C22:6 methyl docosahexaenoate (*cis*-4,7,10,13,16,19)

Rt®-2330 Structure



similar phases

DB-23, HP-23, SP-2330, SP-2380

Doing Dioxin Analysis?

Rtx®-Dioxin and Rtx®-Dioxin2 columns provide better resolution and higher maximum temperatures than conventional columns. See pages 86 and 87.

similar phases

SPB-2560, HP-88, Silar 10C, CP-Sil 88 FAME, CP-Sil 88

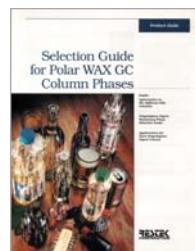
a plus 1 story

"For many years, I have searched the market place for a bonded polar GC phase that delivered the chemical inertness, long-term phase stability and practical robustness necessary to meet my operational requirements. Only after an extensive nine month in-house testing programme, can I say that I have finally found that phase in Rtx®-Wax."

Steve Rowlands, Quest International (Kent UK)

similar phases

DB-WAX, HP-Wax

**free literature****Selection Guide for Polar Wax GC Column Phases**

Download your free copy from www.restek.com.

Technical Guide
lit. cat.# 59890

Rtx®-Wax (polar phase; Crossbond® Carbowax® polyethylene glycol)

- General purpose columns for FAMEs, solvents, BTEX aromatics, flavor compounds, alcohols.
- Temperature range: 20°C to 250°C.
- Equivalent to USP G14, G15, G16, G20, G39 phases.

Rtx®-Wax columns are the most inert and efficient PEG columns currently available. The extended operating temperature range allows analysis of compounds having a wide volatility range, and ensures low bleed at temperatures as high as 250°C. Selectivity is comparable to other Carbowax® columns, for compounds of intermediate to high polarity. Selectivity data available on request.

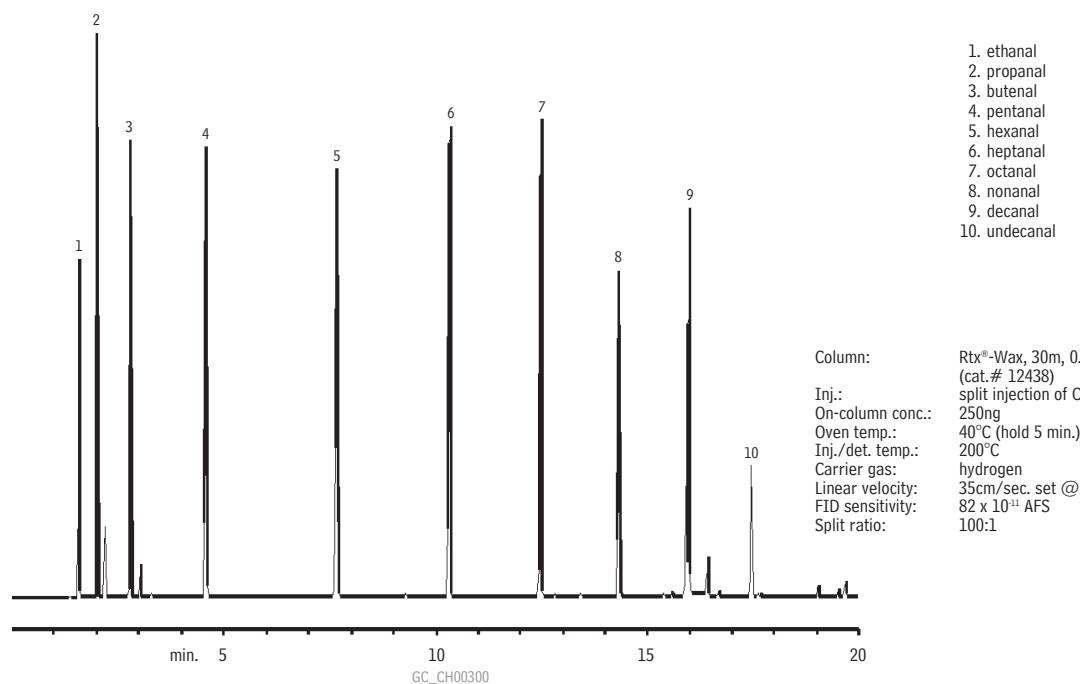
Rtx®-Wax Columns (fused silica)

(Crossbond® Carbowax® polyethylene glycol)

ID	df (µm)	temp. limits*	15-Meter	30-Meter	60-Meter
0.25mm	0.25	20 to 250°C	12420	12423	12426
	0.50	20 to 250°C	12435	12438	12441
0.32mm	0.25	20 to 250°C	12421	12424	12427
	0.50	20 to 250°C	12436	12439	12442
1.00	20 to 240/250°C	12451	12454	12457	
	0.25	20 to 250°C	12422	12425	
0.53mm	0.50	20 to 250°C	12437	12440	12443
	1.00	20 to 240/250°C	12452	12455	12458

ID	df (µm)	temp. limits	10-Meter	20-Meter
0.10mm	0.10	20 to 250°C	41601	41602
	0.20	20 to 240/250°C	41603	41604

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

Sharp, well-resolved peaks for aldehydes, using an Rtx®-Wax column.

Stabilwax® (polar phase; Crossbond® Carbowax® polyethylene glycol)

- General purpose columns for FAMEs, flavor compounds, essential oils, solvents, xylene isomers, and US EPA Method 603 (acrolein/acrylonitrile).
- Resistant to oxidative damage.
- Temperature range: 40°C to 260°C.
- Equivalent to USP G14, G15, G16, G20, and G39 phases.

Our polar-deactivated surface tightly binds the Carbowax® polymer and increases thermal stability, relative to competitive columns. The bonding mechanisms produce a column that can be rejuvenated by solvent washing. Compared to silicone stationary phases, PEG phases are more resistant to damage from strongly acidic or basic volatile compounds.

Stabilwax® Columns (fused silica)

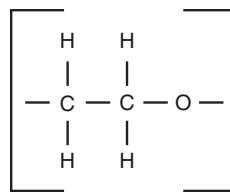
(Crossbond® Carbowax® polyethylene glycol)

ID	df (μm)	temp. limits	15-Meter	30-Meter	60-Meter
0.25mm	0.10	40 to 250/260°C	10605	10608	10611
	0.25	40 to 250/260°C	10620	10623	10626
	0.50	40 to 250/260°C	10635	10638	10641
0.32mm	0.25	40 to 250/260°C	10621	10624	10627
	0.50	40 to 250/260°C	10636	10639	10642
	1.00	40 to 240/260°C	10651	10654	10657
0.53mm	0.25	40 to 250/260°C	10622	10625	10628
	0.50	40 to 250/260°C	10637	10640	10643
	1.00	40 to 240/260°C	10652	10655	10658
	1.50	40 to 230/240°C	10666	10669	10672
	2.00	40 to 220/230°C	10667	10670	
ID	df (μm)	temp. limits	10-Meter	20-Meter	
0.10mm	0.10	40 to 250/260°C	42601		
0.18mm	0.18	40 to 250/260°C		40602	

also available

MXT® Columns

Rugged, flexible, Silcosteel® treated stainless steel tubing; inertness comparable to fused silica tubing.
See page 110 for our MXT®-WAX columns.

Stabilwax® Structure

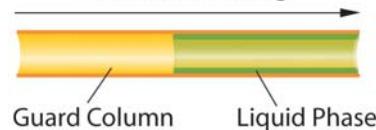
manufacturing procedure

Better column-to-column reproducibility

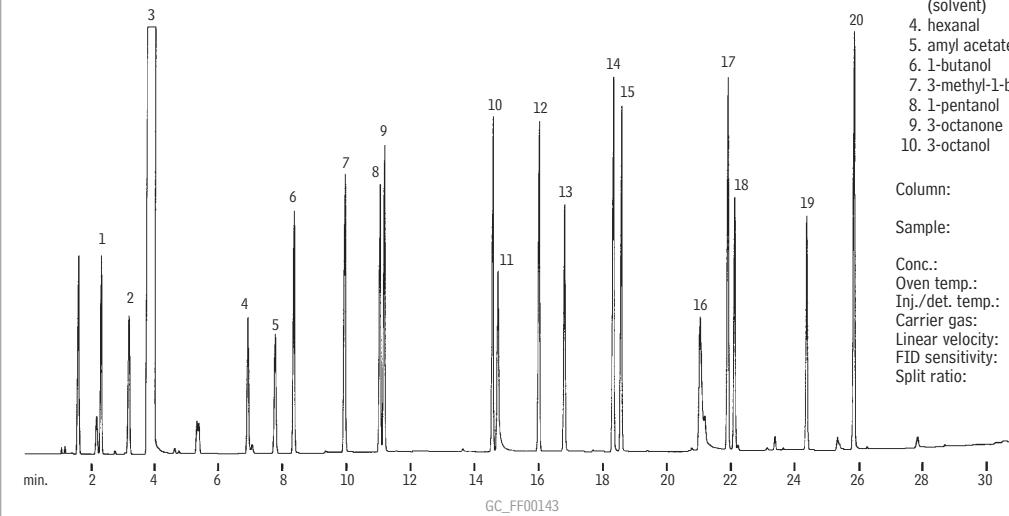
similar phases

DB-WAX, DB-WAXetr, HP-Wax, HP-Innowax,
Supelcowax 10, CP-Wax 52 CB**Integra-Guard™ built-in guard column**

Continuous Tubing



Get the protection without the connection!

For Stabilwax® columns with built-in
Integra-Guard™ guard columns, see page 33.**Synthetic mushroom aroma on a Stabilwax® column.**

1. acetone
2. ethyl acetate
3. methylene chloride (solvent)
4. hexanal
5. amyl acetate
6. 1-butanol
7. 3-methyl-1-butanol
8. 1-pentanol
9. 3-octanone
10. 3-octanol
11. nonanal
12. 1-octen-3-ol
13. furfural
14. benzaldehyde
15. octyl alcohol
16. phenylacetaldehyde
17. α-terpineol
18. 2,4-nonadienal
19. 2,4-decadienal
20. benzyl alcohol

Column: Stabilwax®, 30m, 0.32mm ID, 1.0μm (cat.# 10654)
Sample: 1.0μL split injection of a synthetic mushroom aroma
Conc.: 10ng per component
Oven temp.: 40°C to 220°C @ 6°C/min.
Inj./det. temp.: 260°C
Carrier gas: hydrogen
Linear velocity: 40cm/sec.
FID sensitivity: 4 x 10¹¹ AFS
Split ratio: 100:1

Application-Specific Columns



Application-specific columns

- Designed for specific classes of compounds and methods.
- Includes specially deactivated columns.

Many chromatography markets and applications represented

- Foods, Flavors, & Fragrances.
- Petrochemical.
- Clinical/Forensic.
- Pharmaceutical.
- Environmental.

Unique stationary phases and applications

- Designed to help solve chromatographic challenges.



Basic Compounds Analysis

Rtx®-5 Amine (low polarity phase; Crossbond® 5% diphenyl/95% dimethyl polysiloxane)

- Application-specific columns for amines and other basic compounds, including alkylamines, diamines, triamines, ethanolamines, and nitrogen-containing heterocyclics.
- Stable to 315°C.

Active basic compounds that otherwise require derivatization, or an alternative analytical technique, can be analyzed on an Rtx®-5 Amine column. The tubing surface is chemically altered to reduce tailing of basic compounds, eliminating the need for column priming. An Rtx®-5 Amine column is ideal for analyzing a wide variety of basic compounds, but breakthrough technology also allows the analysis of neutral compounds, adsorptive compounds with oxygen groups susceptible to hydrogen bonding, or even weakly acidic compounds such as phenols. Every Rtx®-5 Amine column is tested to ensure that it exceeds the requirements for analyzing ppm levels of amines, without priming, and to ensure low bleed at maximum operating temperature.

Rtx®-5 Amine Columns (fused silica)

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

ID	df (μm)	temp. limits	15-Meter	30-Meter
0.25mm	0.25	-60 to 300/315°C	12320	12323
	0.50	-60 to 300/315°C	12335	12338
	1.00	-60 to 300/315°C	12350	12353
0.32mm	1.00	-60 to 300/315°C	12351	12354
	1.50	-60 to 290/305°C	12366	12369
0.53mm	1.00	-60 to 290/305°C	12352	12355
	3.00	-60 to 280/295°C	12382	12385

restek
innovation!

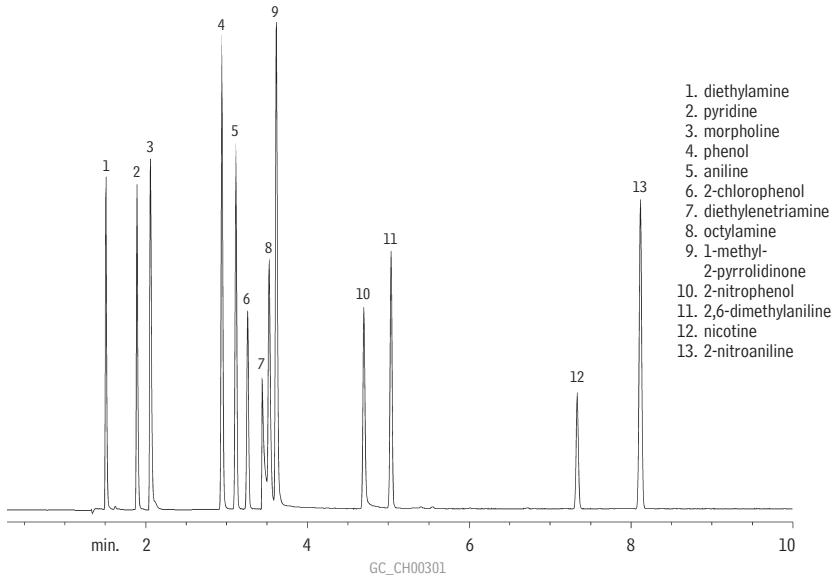
similar phase

PTA-5

also available

See page 60 for Rtx®-35 Amine columns.

Excellent peak shapes for amines & phenols on an Rtx®-5 Amine column.



1. diethylamine
2. pyridine
3. morpholine
4. phenol
5. aniline
6. 2-chlorophenol
7. diethylenetriamine
8. octylamine
9. 1-methyl-2-pyrrolidinone
10. 2-nitrophenol
11. 2,6-dimethylaniline
12. nicotine
13. 2-nitroaniline

Column: Rtx®-5 Amine, 30m, 0.32mm ID, 1.0μm (cat.# 12354)
 Sample: 1.0μL split injection of amines and phenols in water
 On-column conc.: 22ng
 Oven temp.: 120°C to 220°C @ 10°C/min.
 Inj./det. temp.: 305°C
 Carrier gas: hydrogen
 Linear velocity: 38cm/sec. set @ 120°C
 FID sensitivity: 6.4 x 10¹¹ AFS
 Split ratio: 25:1

please note

We recommend using base-deactivated fused silica guard columns ([page 32](#)) and base-deactivated liners (www.restek.com) with Rtx®-5 Amine columns.

Table of Contents for
Applications

see page 489



Basic Compounds Analysis

Rtx®-35 Amine (midpolarity phase; Crossbond® 35% diphenyl/65% dimethyl polysiloxane)

- Application-specific columns for amines and other basic compounds, including alkylamines, diamines, triamines, ethanolamines, and nitrogen-containing heterocyclics.
- Stable to 220°C.

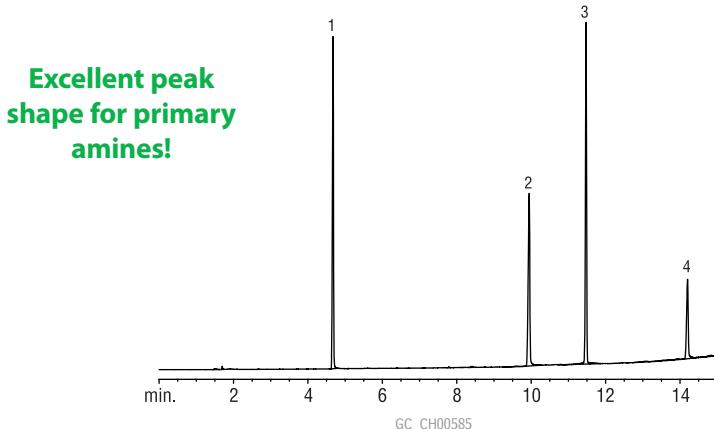
Active basic compounds that otherwise require derivatization, or an alternative analytical technique, can be analyzed on an Rtx®-35 Amine column. The tubing surface is chemically altered to reduce tailing of basic compounds, eliminating the need for column priming. An Rtx®-35 Amine column is ideal for analyzing a wide variety of basic compounds, but breakthrough technology also allows the analysis of neutral compounds, adsorptive compounds with oxygen groups susceptible to hydrogen bonding. Every Rtx®-35 Amine column is tested to ensure that it meets the requirements for analyzing ppm levels of amines, without priming, and to ensure low bleed at maximum operating temperature.

Rtx®-35 Amine Columns (fused silica)

(Crossbond® 35% diphenyl/65% dimethyl polysiloxane)

ID	df (μm)	temp. limits	15-Meter	30-Meter
0.25mm	0.50	0 to 220°C	11335	11338
	1.00	0 to 220°C	11350	11353
0.32mm	1.00	0 to 220°C	11351	11354
	1.50	0 to 220°C	11366	11369
0.53mm	1.00	0 to 220°C	11352	11355
	3.00	0 to 220°C	11382	11385

Sharp ethanolamine peaks, low bleed: Rtx®-35 Amine column.



1. monoethanolamine
2. diethanolamine
3. triethylene glycol monomethylether
4. triethanolamine

Column: Rtx®-35 Amine, 30m, 0.32mm ID, 1.0μm (cat.# 11354)
 Sample: 500μg/mL ethanolamine standard in water
 Inj.: 1.0μL split (split ratio 10:1), cup splitter inlet liner (cat.# 20709)
 Inj. temp.: 300°C
 Carrier gas: helium, constant pressure
 Linear velocity: 40cm/sec. @ 50°C
 Oven temp.: 50°C (hold 0.50 min.) to 280°C @15°C/min.
 Det.: FID @ 300°C

Basic Compounds Analysis

Stabilwax®-DB (polar phase; Crossbond® base-deactivated Carbowax® polyethylene glycol)

- Application-specific columns for underivatized amines and other basic compounds, including alkylamines, diamines, triamines, nitrogen-containing heterocyclics. No need for column priming.
- Temperature range: 40°C to 220°C.

Stabilwax®-DB columns reduce adsorption and improve responses for many basic compounds, without analyte derivatization or column priming. For different selectivity of basic compounds, or higher oven temperatures, use an Rtx®-5 Amine column.

Stabilwax®-DB is a bonded stationary phase, but avoid rinsing these columns with water or alcohols.

Stabilwax®-DB Columns (fused silica)

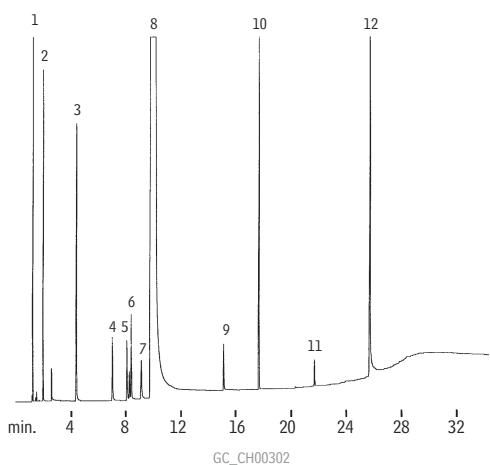
(Crossbond® Carbowax® polyethylene glycol for amines and basic compounds)

ID	df (μm)	temp. limits	15-Meter	30-Meter	60-Meter
0.25mm	0.25	40 to 210/220°C	10820	10823	
	0.50	40 to 210/220°C			10838
0.32mm	0.25	40 to 210/220°C	10821	10824	
	0.50	40 to 210/220°C			10839
0.53mm	1.00	40 to 210/220°C	10851	10854	10857
	1.00	40 to 210/220°C			
1.50	0.50	40 to 210/220°C		10840	
	1.00	40 to 210/220°C	10852		10855
	1.50	40 to 210/220°C			10869

similar phases

DB-CAM, Carbowax® Amine, CP Wax 51 for amines

Hexamethylenediamine (HMD) on a Stabilwax®-DB column.



**Excellent resolution
and peak shape for
impurities in HMD!**

- cyclohexane
- hexamethyleneimine
- 1,4-diaminobutane
- pentamethylenediamine
- 1,2-diaminocyclohexane
- 1,5-diamino-2-methylpentane
- aminomethylcyclopentylamine
- hexamethylenediamine
- 6-aminocapronitrile
- n-valeramide
- adiponitrile
- bis-hexamethylenetriamine

Column: Stabilwax®-DB, 30m, 0.32mm ID, 0.25μm (cat.# 10824)
 Sample: 0.4μL direct injection of a neat hexamethylenediamine (HMD) sample
 On-column conc.: 10 to 1,000ng/component
 Oven temp.: 95°C (hold 6 min.) to 235°C @ 7°C/min. (hold 4 min.)
 Inj./det. temp.: 250°C
 Carrier gas: hydrogen
 Linear velocity: 40cm/sec.
 FID sensitivity: 2 x 10⁻¹¹ AFS

Acidic Compounds Analysis

Stabilwax®-DA (polar phase; Crossbond® acid-deactivated Carbowax® polyethylene glycol)

- Application-specific columns for free (underivatized) acids, some inorganic acids.
- Resistant to oxidative damage.
- Temperature range: 40°C to 250°C.
- Equivalent to USP G25, G35 phases.

Stabilwax®-DA bonded polyethylene glycol has an acidic functionality incorporated into the polymer structure. This permits analysis of acidic compounds without derivatization, significantly reduces adsorption of acids, and increases sample capacity for volatile free acids. Stabilwax®-DA columns last longer and give better peak shapes for high molecular weight acids. Some inorganic acids also chromatograph well on a Stabilwax®-DA column; the limitation is the volatility of the acidic compound.

Stabilwax®-DA Columns (fused silica)

(Crossbond® Carbowax® polyethylene glycol for acidic compounds)

similar phases

DB-FFAP, HP-FFAP, NUKOL, OV-351, CP-Wax 58 CB, FFAP

crossbond® technology

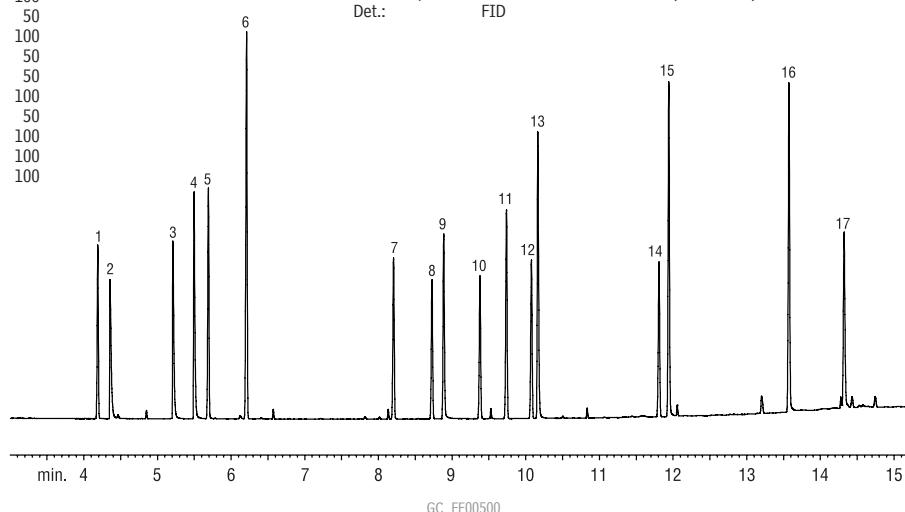
reduces bleed, prolongs column lifetime, and allows rejuvenation through solvent rinsing.

ID	df (μm)	temp. limits	15-Meter	30-Meter	60-Meter
0.25mm	0.10	40 to 250°C	11005	11008	11011
	0.25	40 to 250°C	11020	11023	11026
	0.50	40 to 250°C	11035	11038	11041
0.32mm	0.10	40 to 250°C	11006	11009	11012
	0.25	40 to 250°C	11021	11024	11027
	0.50	40 to 250°C	11036	11039	11042
	1.00	40 to 240/250°C	11051	11054	11057
0.53mm	0.10	40 to 250°C	11007	11010	11013
	0.25	40 to 250°C	11022	11025	11028
	0.50	40 to 250°C	11037	11040	11043
	1.00	40 to 240/250°C	11052	11055	11058
	1.50	40 to 230/240°C	11062	11065	11068

Underivatized alcoholic beverage acids and methyl esters on a Stabilwax®-DA column.

Peak List	Conc. (ppm)
1. ethyl octanoate	100
2. acetic acid	100
3. propionic acid	100
4. isobutyric acid	100
5. 3-decanol	50
6. ethyl decanoate	50
7. ethyl laurate	50
8. cis-lactone	100
9. 2-phenylethanol	50
10. trans-lactone	100
11. methyl myristate	50
12. ethyl myristate	50
13. octanoic acid	100
14. ethyl palmitate	50
15. decanoic acid	100
16. dodecanoic acid	100
17. vanillin	100

Column:
Inj.: Stabilwax®-DA, 30m, 0.18mm ID, 0.18 μm (cat.# 550752)
1 μL splitless (hold 0.5 min.) at conc. shown in
peak list, in ethyl acetate, 4mm ID splitless liner
w/wool (cat.# 20814-202.1)
Inj. temp.: 240°C
Carrier gas: hydrogen
Make-up gas: nitrogen
Linear velocity: 28psi @ 240°C
Oven temp.: 70°C to 240°C at 12°C/min. (hold 3 min.)
Det.: FID



Enantiomers Analysis

Cyclodextrin Columns for Analyzing Many Chiral Compounds

By adding β or γ cyclodextrin to our bonded Rtx[®]-1701 stationary phase, we greatly enhance overall utility and column lifetime for our chiral columns, compared to columns that have pure cyclodextrin stationary phases. Separations of more than one hundred chiral compounds have been achieved using our unique DEX columns, and our columns continue to demonstrate stability after hundreds of temperature program cycles. Refer to the applications section of this catalog for examples, or call our Technical Service chemists or your Restek representative for assistance in matching a column to your chiral analysis.

Rt[®]- β DEXm Columns (fused silica)

(permethylated beta cyclodextrin doped into 14% cyanopropylphenyl/86% dimethyl polysiloxane)

ID	df (μm)	temp. limits	30-Meter
0.25mm	0.25	40 to 230°C	13100
0.32mm	0.25	40 to 230°C	13101

Uses: General purpose chiral phase with many published applications.

Rt[®]- β DEXsm Columns (fused silica)

(2,3-di-O-methyl-6-O-*tert*-butyl dimethylsilyl beta cyclodextrin doped into 14% cyanopropylphenyl/86% dimethyl polysiloxane)

ID	df (μm)	temp. limits	30-Meter
0.25mm	0.25	40 to 230°C	13105
0.32mm	0.25	40 to 230°C	13104

Uses: Excellent column for most chiral compounds in essential oils.

Rt[®]- β DEXse Columns (fused silica)

(2,3-di-O-ethyl-6-O-*tert*-butyl dimethylsilyl beta cyclodextrin doped into 14% cyanopropylphenyl/86% dimethyl polysiloxane)

ID	df (μm)	temp. limits	30-Meter
0.25mm	0.25	40 to 230°C	13107
0.32mm	0.25	40 to 230°C	13106

Uses: Similar in performance to Rt[®]- β DEXsm but provides better resolution for limonene, linalool, linalyl acetate, ethyl-2-methylbutyrate, 2,3-butane diol, and styrene oxides.

Rt[®]- β DEXsp Columns (fused silica)

(2,3-di-O-propyl-6-O-*tert*-butyl dimethylsilyl beta cyclodextrin doped into 14% cyanopropylphenyl/86% dimethyl polysiloxane)

ID	df (μm)	temp. limits	30-Meter
0.25mm	0.25	40 to 230°C	13111
0.32mm	0.25	40 to 230°C	13110

Uses: Often useful in dual-column configurations, with the Rt[®]- β DEXsm column, for complex enantiomeric separations.

Rt[®]- β DEXsa Columns (fused silica)

(2,3-di-acetoxy-6-O-*tert*-butyl dimethylsilyl beta cyclodextrin doped into 14% cyanopropylphenyl/86% dimethyl polysiloxane)

ID	df (μm)	temp. limits	30-Meter
0.25mm	0.25	40 to 230°C	13109
0.32mm	0.25	40 to 230°C	13108

Uses: Unique selectivity for esters, lactones, and other fruit flavor components.

Rt[®]- β DEXcst Columns (fused silica)

(Proprietary cyclodextrin material doped into 14% cyanopropylphenyl/86% dimethyl polysiloxane)

ID	df (μm)	temp. limits	30-Meter
0.25mm	0.25	40 to 230°C	13103
0.32mm	0.25	40 to 230°C	13102

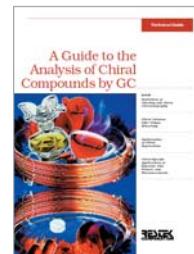
Uses: Proprietary stationary phase, developed specifically for the fragrance industry. Also used for pharmaceutical applications.

Rt[®]- γ DEXsa Columns (fused silica)

(2,3-di-acetoxy-6-O-*tert*-butyl dimethylsilyl gamma cyclodextrin doped into 14% cyanopropylphenyl/86% dimethyl polysiloxane)

ID	df (μm)	temp. limits	30-Meter
0.25mm	0.25	40 to 230°C	13113
0.32mm	0.25	40 to 230°C	13112

Uses: Larger organic molecules. Also useful for flavor compounds in fruit juices.



free literature

A Guide to the Analysis of Chiral Compounds by GC

Download your free copy from www.restek.com.

Technical Guide
lit. cat.# 59889

please note

Application-specific chiral column kits are available! See www.restek.com.



tech tip

Chiral selectivity improves significantly by realizing lower elution temperatures. This can be achieved by:

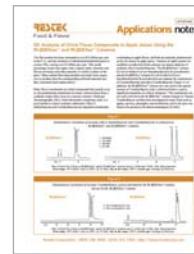
- Faster linear velocities (80cm/sec.) with hydrogen carrier gas.
- Slower temperature ramp rates (1–2°C/min.).
- Appropriate minimum operating temperature (40 or 60°C).
- On-column concentrations of 50ng or less.



free literature

Grape Flavor Analysis, Using an Rt[®]- γ DEXsa GC Column

Applications Note
lit. cat.# 59553



GC Analysis of Chiral Flavor Compounds in Apple Juices, Using Rt[®]- β DEXsm and Rt[®]- β DEXse Columns

Applications Note
lit. cat.# 59546

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cis/trans FAMEs**Rt®-2560** (highly polar phase; biscyanopropyl polysiloxane—not bonded)

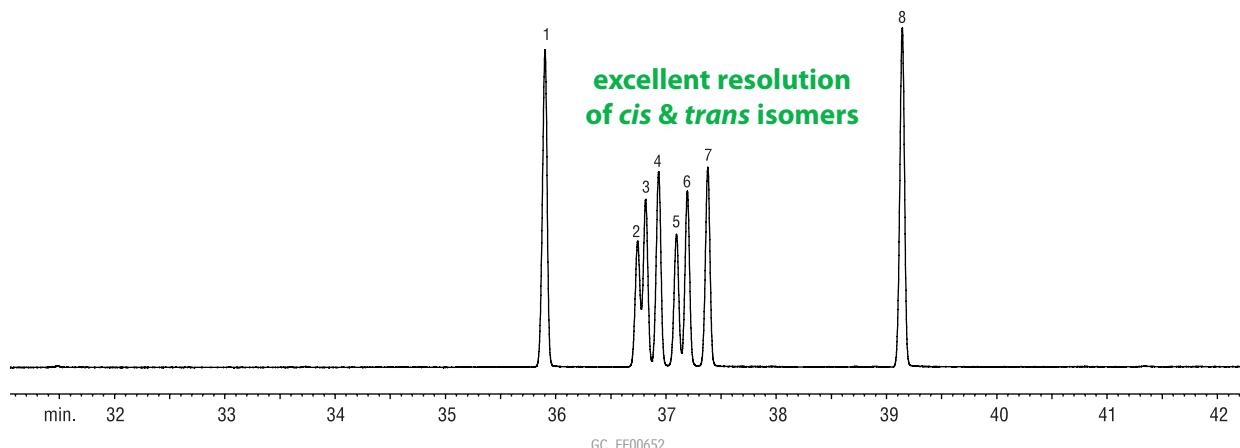
- Application-specific column for *cis/trans* FAMEs.
- Stable to 250°C.

Because the Rt®-2560 stationary phase is not bonded, it should not be solvent rinsed.

similar phases

SPB-2560, HP-88, Silar 10C, CP-Sil 88 FAME,
CP-Sil 88**Rt®-2560 Column** (fused silica)
(biscyanopropyl polysiloxane)

ID	df (μm)	temp. limits	100-Meter
0.25mm	0.20	20 to 250°C	13199

FAMEs (*cis/trans* isomers) on an Rt®-2560 column.

Column: Rt®-2560, 100m, 0.25mm ID, 0.2μm (cat.# 13199)
 Sample: *cis/trans* FAME Mix (cat.# 35079), 10mg/mL total FAMEs in methylene chloride
 Inj.: 1.0μL split (split ratio 20:1), 4mm inlet liner (cat.# 20814)
 Inj. temp.: 225°C
 Carrier gas: hydrogen, constant flow
 Flow rate: 1.2mL/min.
 Oven temp.: 100°C (4 min. hold) to 240°C @ 3°C/min. (10 min. hold)
 Det.: FID @ 250°C

Compound	% in Mix
1. C18:0 methyl stearate	20.0
2. C18:1 methyl petroselaidate (<i>trans</i> -6)	8.0
3. C18:1 methyl elaidate (<i>trans</i> -9)	10.0
4. C18:1 methyl transvacenate (<i>trans</i> -11)	12.0
5. C18:1 methyl petroselinate (<i>cis</i> -6)	8.0
6. C18:1 methyl oleate (<i>cis</i> -9)	10.0
7. C18:1 methyl vaccenate (<i>cis</i> -11)	12.0
8. C18:2 methyl linoleate (<i>cis</i> -9,12)	20.0

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Polyunsaturated FAME Analysis

FAMEWAX (polar phase; Crossbond® polyethylene glycol)

- Application-specific columns for FAMEs, specially tested with a FAME mixture.
- Temperature range: 20°C to 250°C.

The elution order of polyunsaturated FAMEs on FAMEWAX columns is comparable to that on other Carbowax® columns, but baseline resolution is achieved in significantly less time.

FAMEWAX Columns (fused silica)

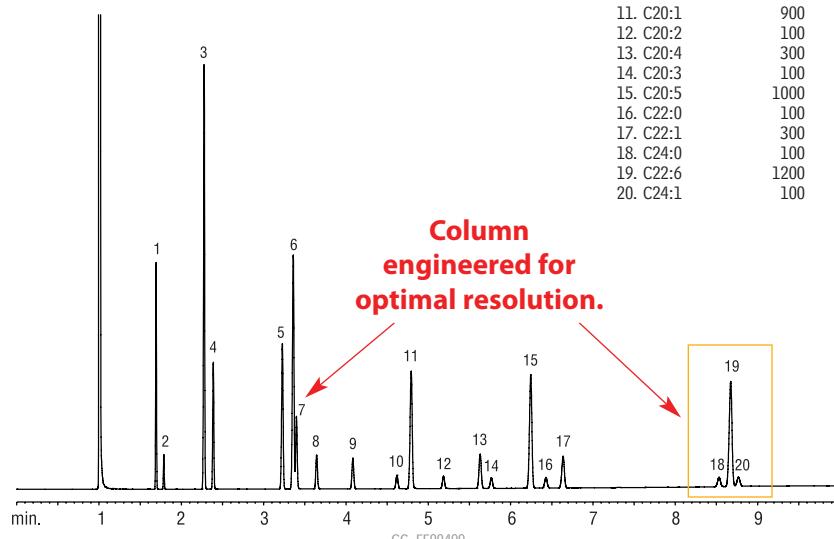
(Crossbond® polyethylene glycol)

ID	df (μm)	temp. limits	30-Meter
0.25mm	0.25	20 to 250°C	12497
0.32mm	0.25	20 to 250°C	12498
0.53mm	0.50	20 to 250°C	12499

FAMEs (marine oil standard) on a FAMEWAX column.

Column: FAMEWAX, 30m, 0.32mm ID, 0.25μm (cat.# 12498)
 Inj.: 1μL
 Conc.: 10,000μg/mL in isoctane (total FAMES; see breakdown in peak list)
 Oven temp.: 195–240°C at 5°C/min., 1 min. hold
 Inj./det. temp.: 250°C/275°C
 Carrier gas: hydrogen
 Flow rate: 3mL/min. (constant flow)
 Split ratio: 100:1

Peak List	Conc. (μg/mL)
1. C14:0	600
2. C14:1	100
3. C16:0	1600
4. C16:1	500
5. C18:0	800
6. C18:1 (oleate)	1300
7. C18:1 (vaccenate)	400
8. C18:2	200
9. C18:3	200
10. C20:0	100
11. C20:1	900
12. C20:2	100
13. C20:4	300
14. C20:3	100
15. C20:5	1000
16. C22:0	100
17. C22:1	300
18. C24:0	100
19. C22:6	1200
20. C24:1	100



similar phase

Omegawax

free literature

Foods, Flavors, and Fragrances

Includes important analysis tips and chromatograms for analysis of fats and oils, carbohydrates, vitamins, amino acids, organic acids, preservatives, flavors and fragrances, essential oils, and chiral separations. Retention time indices and complete product listings for all relevant GC and HPLC products also are included.



Minicatalog
lit. cat.# 59260A



Monitoring Volatile Compounds in Food Contact Packaging, Using Purge and Trap GC/MS and an Rtx®-5MS Capillary Column
Applications Note
lit. cat.# 59348

Download your free copies from www.restek.com.

Perfect confirmation column for F&F analysis!


similar phases

HP-20M, Carbowax® 20M

Flavor & Fragrance Compounds Analysis

Rt®-CW20M F&F (polar phase; Carbowax® polyethylene glycol—not bonded)

- Application-specific columns for flavor and fragrance compounds, specially tested.
- True nonbonded Carbowax® 20M polarity.
- Temperature range: 60°C to 220°C.

Rt®-CW20M F&F Columns (fused silica)

(Carbowax® polyethylene glycol)

ID	df (µm)	temp. limits	30-Meter	50-Meter
0.25mm	0.25	60 to 220°C	12523	
0.32mm	0.33	60 to 220°C		12539

Rtx®-1 F&F (nonpolar phase; Crossbond® 100% dimethyl polysiloxane)

- Application-specific columns for flavor and fragrance compounds.
- Stable to 350°C.

Retention index libraries in the flavor and fragrance industry have been compiled from years of data and thousands of compounds. Any slight variation in column selectivity could render the column useless. Rtx®-1 F&F columns are tailored to match the selectivity required in the industry, while offering excellent thermal stability. Our stringent quality testing ensures column-to-column reproducibility and extended column lifetimes over conventional 100% dimethyl polysiloxane columns.

Rtx®-1 F&F Columns (fused silica)

(Crossbond® 100% dimethyl polysiloxane)

similar phase

HP-1

ID	df (µm)	temp. limits	30-Meter	50-Meter
0.25mm	0.25	-60 to 330/350°C	18023	
	0.50	-60 to 330/350°C	18038	
	1.00	-60 to 320/340°C	18053	
0.32mm	0.25	-60 to 330/350°C	18024	
	0.50	-60 to 330/350°C	18039	18010
	1.00	-60 to 320°C	18054	



"Our Innovations chemists come from industry and regularly collaborate with government and industry leaders in order to continually develop new methods and optimize market-specific applications. When you work with Restek, you work with experienced chromatographers who practice in your field."

Restek's Innovations Group

pictured: Silvia Martinez, Kristi Sellers, Julie Kowalski, Chris English, Barry Burger, Amanda Rigdon, Jason Thomas, Scott Grossman, Michelle Misselwitz (not pictured: Ty Kahler, Rick Morehead)

Triglycerides in Foods Analysis

Rtx®-65TG (high polarity phase; Crossbond® 65% diphenyl/35% dimethyl polysiloxane)

- Application-specific columns, specially tested for triglycerides.
- Stable to 370°C.

The Rtx®-65TG phase resolves triglycerides by degree of unsaturation as well as by carbon number. Because of the chemistry required to achieve 370°C thermal stability, an Rtx®-65TG column should not be used for analyses of polar compounds.

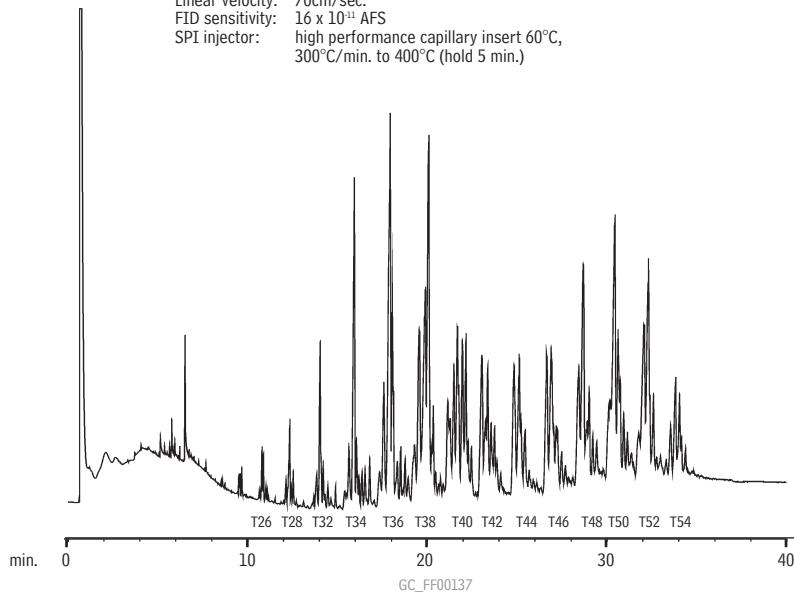
Rtx®-65TG Columns (fused silica)

(Crossbond® 65% diphenyl/35% dimethyl polysiloxane)

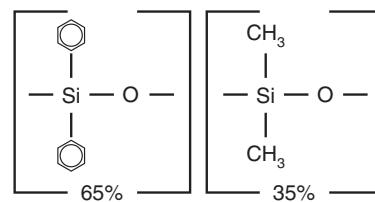
ID	df (μm)	temp. limits	15-Meter	30-Meter
0.25mm	0.10	40 to 370°C	17005	17008
0.32mm	0.10	40 to 370°C	17006	17009
0.53mm	0.10	40 to 370°C	17007	17010

Sharp resolution of butter triglycerides on an Rtx®-65TG column.

Column: Rtx®-65TG, 30m, 0.25mm ID, 0.10μm (cat.# 17008)
 Sample: 0.2μL cold on-column injection of 1% butterfat in isoctane
 Oven temp.: 80°C (hold 1 min.) to 240°C @ 30°C/min.
 to 360°C @ 4°C/min. (hold 5 min.)
 Det. temp.: 380°C
 Carrier gas: hydrogen
 Linear velocity: 70cm/sec.
 FID sensitivity: 16 x 10⁻¹¹ AFS
 SPI injector: high performance capillary insert 60°C,
 300°C/min. to 400°C (hold 5 min.)



Rtx®-65TG Structure



save money!

Get six columns for the price of five. Call 800-356-1688, ext. 4, or your Restek representative for details!

crossbond® technology

reduces bleed, prolongs column lifetime, and allows rejuvenation through solvent rinsing.

please note

Triglycerides are often injected via on-column injection. Use 0.53mm retention gaps and appropriate connectors.

- Vu2 Union® (see page 215)
- MXT™-Union Connector Kits for Fused Silica (see page 218)

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Rtx®-1PONA column now available in 50 and 150 meter lengths.

similar phases

Petrocol DH, DB-Petro, HP-PONA

please note

To achieve critical resolutions, a 5-meter tuning column is connected to the analytical column and adjusted to the needed length through a series of trial analyses.

Detailed Hydrocarbon Analysis (DHA)

Rtx®-1PONA (nonpolar phase; Crossbond® 100% dimethyl polysiloxane)

- Application-specific columns meet ASTM and CGSB requirements for detailed hydrocarbon analysis.
- Stable to 340°C.

The Rtx®-1PONA polymer was designed to offer the exact polarity necessary to resolve hydrocarbons in the specific order requested by petrochemical companies. In order to meet the demanding resolution and retention criteria of the American Society for Testing and Materials (ASTM) and the Canadian General Standards Board (CGSB), Restek has developed unique quality control tests and specifications for the Rtx®-1PONA column. The measured values for retention (k), efficiency (n), and stationary phase selectivity (RI) are controlled so that each column exceeds the requirements of the ASTM and CGSB methods.

Rtx®-1PONA Column (fused silica)

(Crossbond® 100% dimethyl polysiloxane—optimized for hydrocarbon analysis)

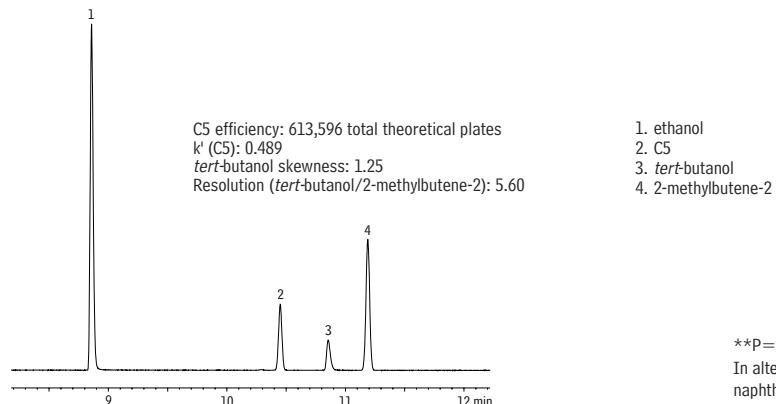
ID	df (μm)	temp. limits	50-Meter	100-Meter	150-Meter
0.25mm	0.50	-60 to 300/340°C	10186	10195	10197

Rtx®-5PONA Tuning Column (fused silica)

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

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

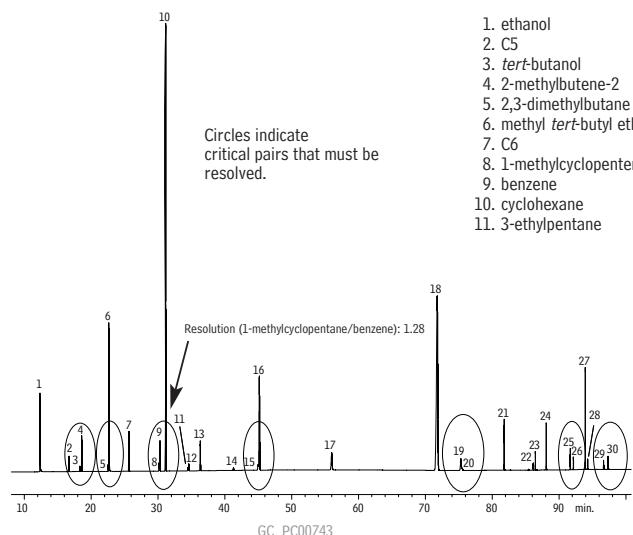
Sharp, symmetric peak for ethanol (gasoline oxygenate), using an Rtx®-1PONA column.**



Rtx®-1PONA column produces symmetrical alcohol peaks!

**P=paraffins; O=olefins; N=naphthenes; A=aromatics.
In alternate terminology: paraffins & isoparaffins = alkanes;
naphthenes = cyclic alkanes; olefins = alkenes.

Critical pairs of gasoline components resolved per ASTM specifications, using an Rtx®-1PONA column.



Column: Rtx®-1PONA, 100m, 0.25mm ID, 0.5μm (cat.# 10195) plus Rtx®-5PONA tuning column, 2.62m, 0.25mm ID, 1.0μm, connected via Press-Tight® connector (cat.# 20446)
Sample: custom detailed hydrocarbon analysis (DHA) mix, neat
Inj.: 0.01μL, split (split ratio 150:1), 4mm cup inlet liner (cat.# 20709)
Inj. temp.: 200°C
Carrier gas: helium, constant flow
Linear velocity: 28cm/sec. (2.3mL/min.)
Oven temp.: 5°C (hold 15 min.) to 50°C @ 5°C/min. (hold 50 min.) to 200°C @ 8°C/min. (hold 10 min.)
Det.: FID @ 250°C

Simulated Distillation (C5-C44) Analysis

Rtx®-2887 (nonpolar phase; Crossbond® 100% dimethyl polysiloxane)

- Application-specific column for simulated distillation.
- Stable to 360°C.

The Rtx®-2887 column's stationary phase, column dimensions, and film thickness have been optimized to exceed the resolution and skewing factor requirements currently specified in ASTM method D2887. Each column is individually tested to guarantee a stable baseline with low bleed and reproducible retention times. The Crossbond® methyl silicone stationary phase has increased stability compared to packed columns, ensuring stable baselines and shorter conditioning times.

Rtx®-2887 Column (fused silica)

(Crossbond® 100% dimethyl polysiloxane—for simulated distillation)

ID	df (μm)	temp. limits	10-Meter
0.53mm	2.65	-60 to 360°C	10199

MXT®-2887 Column (Siltek® treated stainless steel)

(Crossbond® 100% dimethyl polysiloxane—for simulated distillation)

ID	df (μm)	temp. limits	10-Meter
0.53mm	2.65	-60 to 400°C	70199

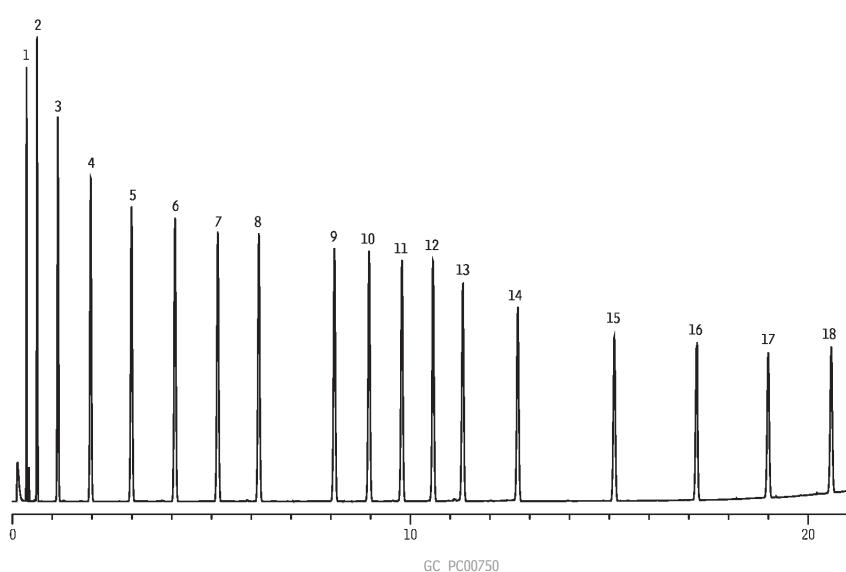
also available

Rtx®-1 SimDist 2887—a packed column for process instrumentation. See page 116.

similar phases

DB-2887, Petrocol EX2887

Negligible baseline rise for C5 to C44 hydrocarbons on an Rtx®-2887 column.



1. C5
2. C6
3. C7
4. C8
5. C9
6. C10
7. C11
8. C12
9. C14
10. C16
11. C18
12. C20
13. C24
14. C28
15. C32
16. C36
17. C40
18. C44

Column: Rtx®-2887, 10m, 0.53mm ID, 2.65μm (cat.# 10199)
 Sample: 1μL direct injection of 0.01-0.1 wt. % C5 to C44 hydrocarbon standard
 in carbon disulfide
 Inj. temp.: 360°C
 Det. temp.: 360°C
 Carrier gas: helium (constant flow)
 Linear velocity: 15mL/min. (112cm/sec.)
 Oven temp.: 35°C to 360°C @ 15°C/min. (hold 5 min.)

Simulated Distillation (C44-C100) Analysis

MXT®-1HT Sim Dist/MXT®-1 Sim Dist/MXT®-500 Sim Dist (nonpolar phases)

- Application-specific columns in unbreakable Siltek® treated stainless steel tubing meet all resolution criteria for high temperature simulated distillation (e.g., ASTM Method D2887 Extended).
- MXT®-1HT Sim Dist and MXT®-1 Sim Dist phases offer true methyl silicone polarity; MXT®-500 Sim Dist phase is a carborane siloxane polymer.
- Stable to 430°C.

Manufactured from Siltek® treated stainless steel tubing, MXT® columns are the most durable high temperature GC columns available. As outlined in ASTM Method D6352, high temperature simulated distillation requires a column that can withstand temperatures to 430°C. MXT®-1HT Sim Dist and MXT®-500 Sim Dist columns exhibit excellent peak shape and low bleed, even at 430°C! The unique MXT®-1HT Sim Dist methyl silicone polymer gives the correct retention time/boiling point curve. The MXT®-500 Sim Dist carborane siloxane polymer offers a slight shift in the calculated boiling range distribution for petroleum samples containing aromatic hydrocarbons.



MXT®-1HT Sim Dist column now available in 0.20 μ m film thickness.

MXT®-1HT Sim Dist Column (Siltek® treated stainless steel)

ID	df (μ m)	temp. limits	5-Meter
0.53mm	0.10	-60 to 430°C	70100
	0.20	-60 to 400/430°C	70103

MXT®-1 Sim Dist Column (Siltek® treated stainless steel)

ID	df (μ m)	temp. limits	6-Meter
0.53mm	0.15	-60 to 430°C	70101

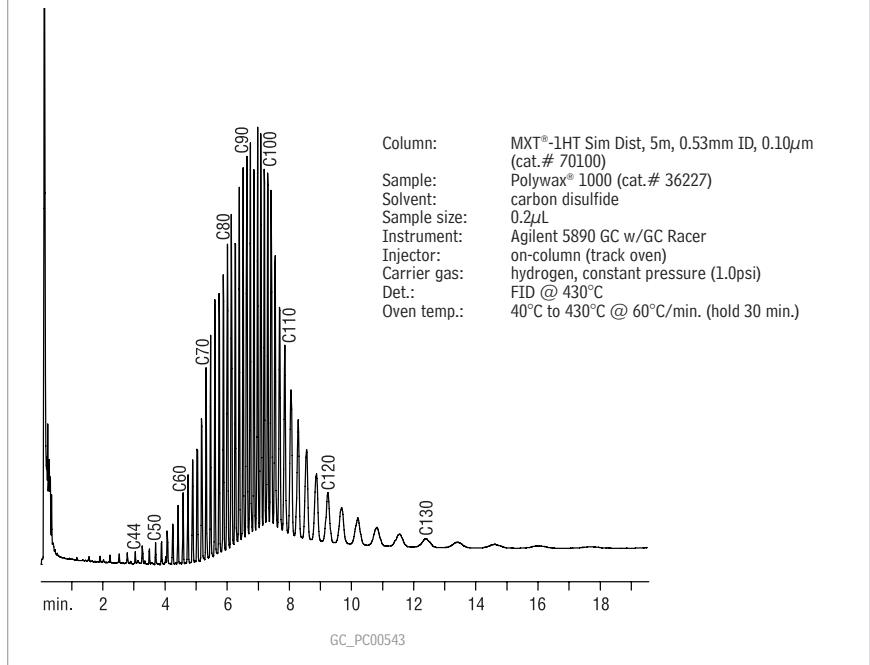
MXT®-500 Sim Dist Column (Siltek® treated stainless steel)

ID	df (μ m)	temp. limits	6-Meter
0.53mm	0.15	-60 to 430°C	70104

Polywax® Calibration Materials

Description	qty.	cat.#	price
Polywax 655 calibration material	1g	36225	
Polywax 1000 calibration material	1g	36227	

C44-C130 hydrocarbons on an MXT®-1HT Sim Dist column.



Aromatics & Oxygenates in Gasoline Analysis

Rt[®]-TCEP (highly polar phase; 1,2,3-tris[2-cyanoethoxy]propane—not bonded)

- General purpose columns, ideal for aromatics and oxygenates in gasoline.
- Temperature range: 0°C to 135°C.

Most gasolines contain aliphatic hydrocarbons up to *n*-dodecane (C12). To improve identification of the aromatics and oxygenates, it is desirable to elute benzene after C11 and toluene after C12. The extremely polar Rt[®]-TCEP stationary phase provides a retention index for benzene greater than 1100 and permits the separation of alcohols and aromatics from the aliphatic constituents in gasoline.

Rt[®]-TCEP columns have the same high polarity as TCEP packed columns (precolumns in ASTM Method D4815 for the analysis of petroleum oxygenates), with the efficiency of a capillary column. The result is a column that can separate a wide variety of compounds with an elution pattern unattainable using other high polarity siloxanes.

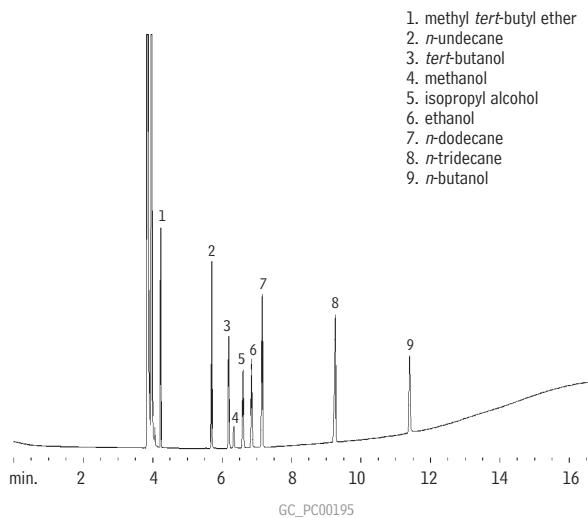
The Rt[®]-TCEP column incorporates a nonbonded stationary phase coated on a surface specialized for enhanced polymer stability and extended column lifetime. Solvent rinsing should be avoided. Conditioning is necessary only if the column is to be used at temperatures near the maximum operating temperature.

Rt[®]-TCEP Columns (fused silica)

(1,2,3-tris[2-cyanoethoxy]propane)

ID	df (μm)	temp. limits	30-Meter	60-Meter
0.25mm	0.40	0 to 135°C	10998	10999

Petroleum oxygenates on an Rt[®]-TCEP column.



Column: Rt[®]-TCEP 60m, 0.25mm ID, 0.4μm (cat.# 10999)
Inj.: 1.0μL split injection, components @ 500ppm.
Oven temp.: 60°C (hold 5 min.) to 100°C @ 5°C/min. (hold 10 min.)
Inj./det. temp.: 200°C
Carrier gas: helium
Linear velocity: 30cm/sec. set @ 80°C
FID sensitivity: 6.4 x 10¹¹ AFS
Split flow: 46mL/min.

similar phases

SPB-TCEP, CP-TCEP

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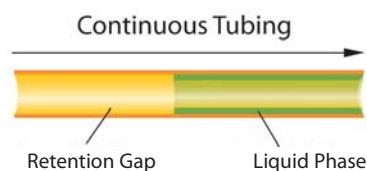




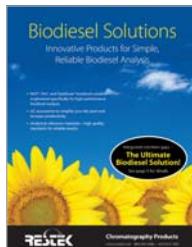
Rtx®-Biodiesel TG and MXT®-Biodiesel TG columns now available in more dimensions.

Integra-Gap™ technology

- Built-in retention gap
- Eliminates connector



free literature



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lit. cat.# 580207

Biodiesel Fuels Analysis

Rtx®-Biodiesel TG

- Linearity for all reference compounds exceeds method requirements.
- Alumaseal™ connector provides leak-free connection; guard column extends column life.
- Low column bleed at high temperatures.
- For glycerine and glyceride analysis, according to ASTM D6584 and EN 14105 methods.

Rtx®-Biodiesel TG Columns (fused silica)

Description	temp. limits	cat.#	price
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	

MXT®-Biodiesel TG

- Fast analysis times and sharp mono-, di-, and triglyceride peaks.
- Stable at 430°C for reliable, consistent performance.
- Integra-Gap™ built-in retention gap on 0.53mm ID column eliminates column coupling completely.

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

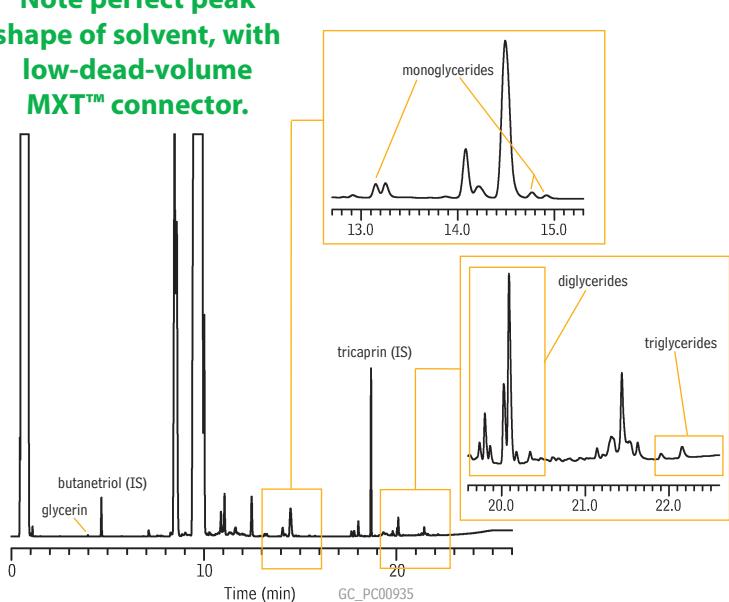
Description	temp. limits	cat.#	price
14m, 0.53mm ID, 0.16 w/2m Integra-Gap*	-60 to 380/430°C	70289	
10m, 0.32mm ID, 0.10	-60 to 380/430°C	70292	
10m, 0.32mm ID, 0.10 w/2m x 0.53mm Retention Gap**	-60 to 380/430°C	70290	
15m, 0.32mm ID, 0.10	-60 to 380/430°C	70293	
15m, 0.32mm ID, 0.10 w/2m x 0.53mm Retention Gap**	-60 to 380/430°C	70291	
2m x 0.53mm MXT Biodiesel TG Retention Gap	-60 to 380/430°C	70294	

*Total column length=16 meters.

**Connected with low-dead-volume MXT connector.

Derivatized B100 and internal standards on an MXT®-Biodiesel TG column with 2m x 0.53mm ID retention gap, according to ASTM D6584.

Note perfect peak shape of solvent, with low-dead-volume MXT™ connector.



Column:
Sample:
Inj.:
Inj. temp.:
Carrier gas:
Flow rate:
Oven temp.:
Det.:

MXT®-Biodiesel TG, 10m, 0.32mm ID, 0.1μm with 2m x 0.53mm retention gap (cat.# 70290)
B100 + IS butanetriol & tricaprin derivatized with MSTFA as per ASTM D-6584
1.0μL cool on-column oven track
hydrogen, constant flow 4mL/min.
50°C (hold 1 min.) to 180°C @ 15°C/min., to 230°C @ 7°C/min., to 430°C @ 30°C/min. (hold 5 min.)
FID @ 430°C

Blood Alcohol Analysis

Rtx®-BAC1/Rtx®-BAC2 (proprietary Crossbond® phase)

- Application-specific columns for blood alcohol analysis—achieve baseline resolution in less than 3 minutes. Also excellent for abused inhalant anesthetics, γ -hydroxybutyrate (GHB)/ γ -butyrolactone (GBL), glycols, and common industrial solvents.
- Rtx®-BAC2 confirmation column provides four elution order changes under the same conditions.
- Stable to 260°C.

These columns separate to baseline all blood alcohol compounds in blood, breath, or urine, in less than 3 minutes, under isothermal conditions. Isothermal analysis increases productivity by eliminating the need for oven cycling. Confirmation is easily achieved with this tandem set because there are four elution order changes between the two columns.

Rtx®-BAC1 Columns (fused silica)

ID	df (μm)	temp. limits	30-Meter
0.32mm	1.80	-20 to 240/260°C	18003
0.53mm	3.00	-20 to 240/260°C	18001

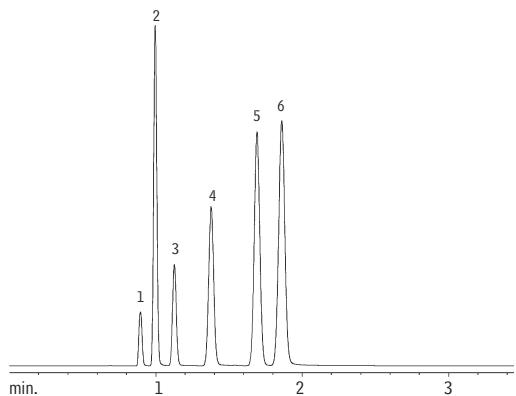
Rtx®-BAC2 Columns (fused silica)

ID	df (μm)	temp. limits	30-Meter
0.32mm	1.20	-20 to 240/260°C	18002
0.53mm	2.00	-20 to 240/260°C	18000

Rapid, reliable blood alcohol testing, using Rtx®-BAC 1 and Rtx®-BAC2 columns.

Rtx®-BAC1

30m, 0.53mm ID, 3.0 μm (cat.# 18001)

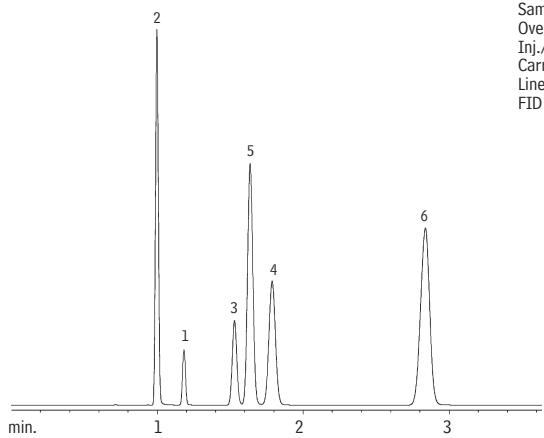


Blood alcohol analysis in less than 3 minutes!

1. methanol
2. acetaldehyde
3. ethanol
4. isopropanol
5. acetone
6. *n*-propanol

Rtx®-BAC2

30m, 0.53mm ID, 2.0 μm (cat.# 18000)



Inj.: 1.0mL headspace sample of a blood alcohol mix
Sample conc.: 0.1% per compound
Oven temp.: 40°C
Inj./det. temp.: 200°C
Carrier gas: helium
Linear velocity: 80cm/sec. set @ 40°C
FID sensitivity: 1.28×10^{-10} AFS

restek innovation!

Baseline resolution in less than 3 minutes.

similar phases

DB-ALC1, DB-ALC2

ordering note

Get the protection without the connection!

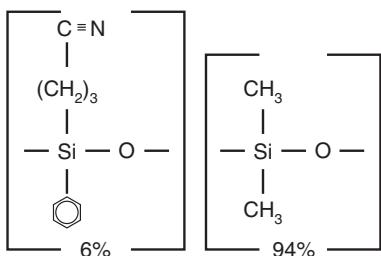
For Rtx®-BAC1 and Rtx®-BAC2 columns with built-in Integra-Guard™ guard columns, see page 33.

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G43 phase**Rtx®-1301/Rtx®-624 Structure****similar phases**

DB-1301, DB-624, HP-1301, HP-624, SPB-1301, SPB-624, VF-1301, VF-624ms, CP-1301, CP-Select 624 CB

ordering note

Get the protection without the connection!
For Rtx®-1301 and Rtx®-624 columns with built-in
Integra-Guard™ guard columns, see [page 33](#).

Organic Volatile Impurities (OVI) Analysis**Rtx®-1301/Rtx®-624 (low to midpolarity phase; Crossbond®**

6% cyanopropylphenyl/94% dimethyl polysiloxane)

- General purpose columns for residual solvents, alcohols, oxygenates, and volatile organic compounds.
- Temperature range: -20°C to 240°C.
- Equivalent to USP G43 phase.



Many analysts feel the Rtx®-1301 and Rtx®-624 columns have the best cyanosilicone bonded stationary phase available, with no other column manufacturer providing lower bleed, longer lifetime, or better inertness. Our polymer is fully characterized to ensure long-term reproducibility, column-to-column consistency, and low bleed—even with sensitive detectors such as ECDs and MSDs.

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

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

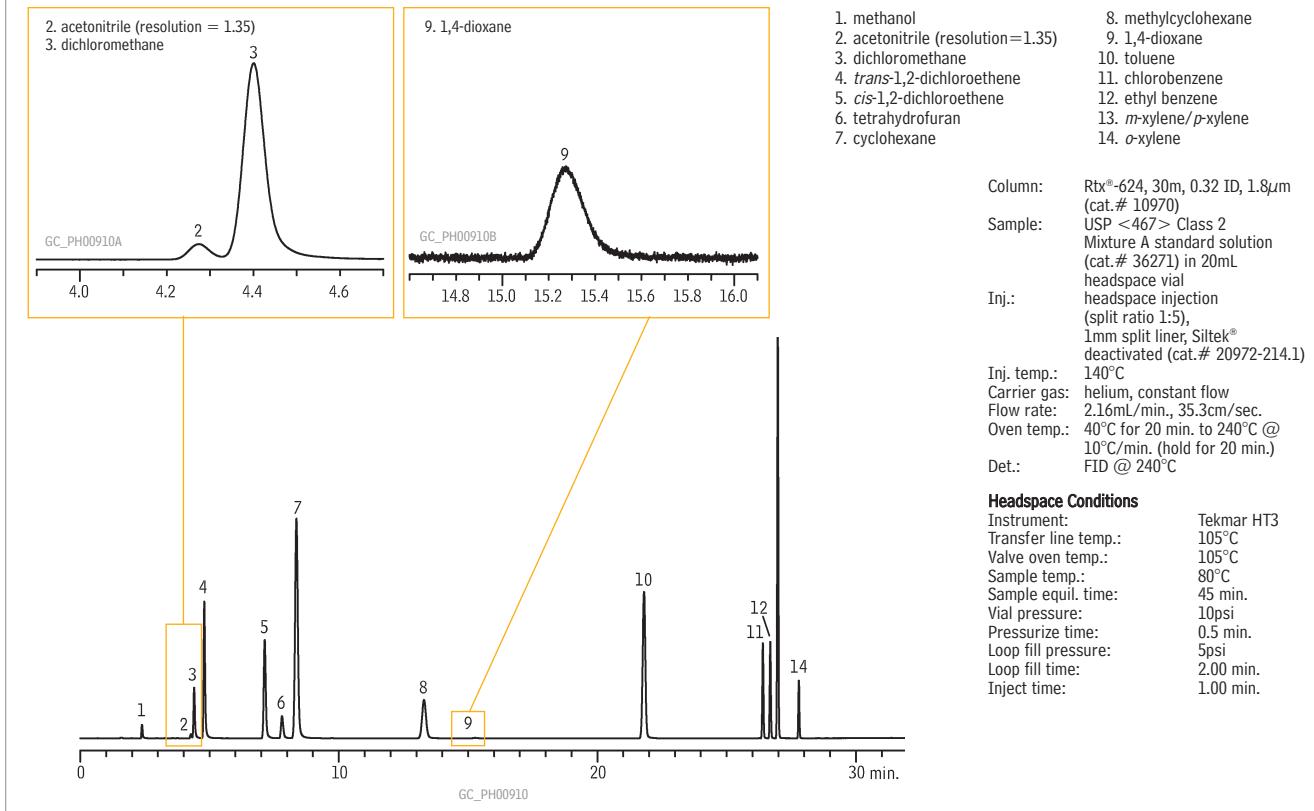
ID	df (µm)	temp. limits*	30-Meter	60-Meter
0.32mm	1.80	-20 to 240°C	16092	16093
0.53mm	3.00	-20 to 240°C	16085	16088

Rtx®-624 Columns (fused silica)

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

ID	df (µm)	temp. limits	30-Meter
0.32mm	1.80	-20 to 240°C	10970

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

USP Residual Solvent Class 2 Mixture A standard solution on an Rtx®-624 (G43) column.

Organic Volatile Impurities (OVI) Analysis

Stabilwax® (polar phase; Crossbond® Carbowax® polyethylene glycol)

- General purpose columns for FAMEs, flavor compounds, essential oils, solvents, xylene isomers, and US EPA Method 603 (acrolein/acrylonitrile).
- Resistant to oxidative damage.
- Temperature range: 40°C to 260°C.
- Equivalent to USP G14, G15, G16, G20, and G39 phases.

Our polar-deactivated surface tightly binds the Carbowax® polymer and increases thermal stability, relative to competitive columns. The bonding mechanisms produce a column that can be rejuvenated by solvent washing. Compared to silicone stationary phases, PEG phases are more resistant to damage from strongly acidic or basic volatile compounds.

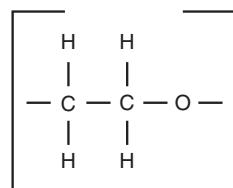
Stabilwax® Columns (fused silica)

(Crossbond® Carbowax® polyethylene glycol)

ID	df (µm)	temp. limits	30-Meter
0.32mm	0.25	40 to 250/260°C	10624
0.53mm	0.25	40 to 250/260°C	10625

G16 phase

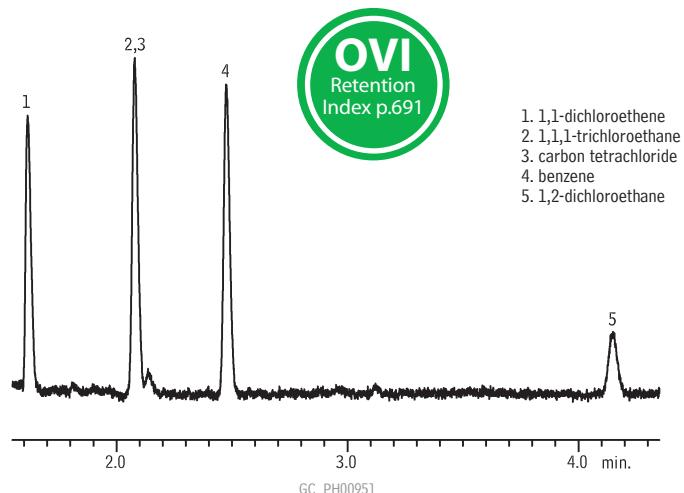
Stabilwax® Structure



similar phases

DB-WAX, DB-WAXetr, HP-Wax, HP-Innowax,
Supelcowax 10, CP-Wax 52 CB

Residual solvents class 1 on a Stabilwax® (G16) column.



Column: Stabilwax®, 30m, 0.32mm ID, 0.25µm (cat.# 10624)
Sample: USP Stock Mixture USP<467> Residual Solvents Class 1 Mix (cat.# 36279) in 20mL headspace vial (cat.# 24685), water diluent
Inj.: headspace injection (split ratio 1:5), 2mm splitless liner IP deactivated (cat.# 20712)
Inj. temp.: 140°C
Carrier gas: helium, constant flow
Flow rate: 2.15ml/min., 35.2cm/sec.
Oven temp.: 50°C for 20 min. to 165°C @ 6°C/min. (hold for 20 min.)
Det.: FID @ 250°C

Headspace Conditions
Instrument: Overbrook Scientific HT200H
Syringe temp.: 100°C
Sample temp.: 80°C
Sample equil. time.: 45 min.
Injection vol.: 1.0mL
Injection speed: setting 8
Injection dwell: 5 sec.

ordering note

Get the protection without the connection!

For Stabilwax® columns with built-in Integra-Guard™ guard columns, see page 33.

also available

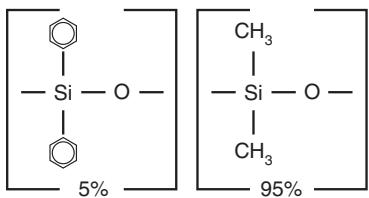
Other Dimensions!

For our complete listing of Stabilwax® columns, see page 57.



Searching for a chromatogram?

www.restek.com

G27 phase**Rtx®-5 Structure****similar phases**

DB-5, HP-5, HP-5MS, Ultra-2, SPB-5, Equity-5, MDN-5

super performer

For exceptional inertness, ultra-low bleed, and unsurpassed performance, choose Rxi®-5ms columns!
See pages 36-39, 41.

Organic Volatile Impurities (OVI) Analysis**Rtx®-5 (low polarity phase; Crossbond® 5% diphenyl/95% dimethyl polysiloxane)**

- General purpose columns for drugs, solvent impurities, pesticides, hydrocarbons, PCB congeners or (e.g.) Aroclor mixes, essential oils, semivolatiles.
- Temperature range: -60°C to 290°C.
- Equivalent to USP G27 and G36 phases.

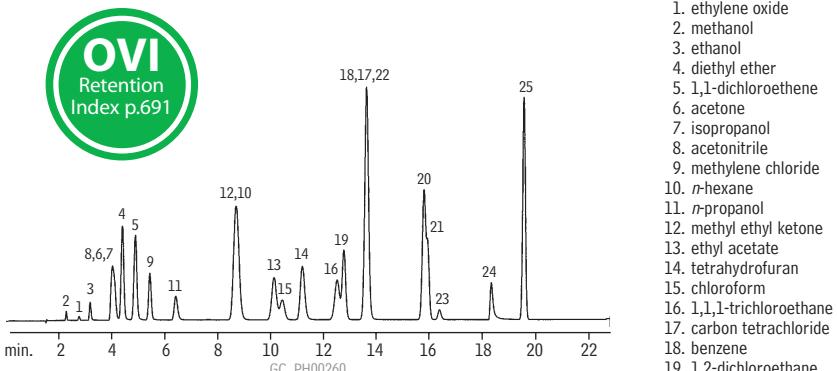
The 5% diphenyl/95% dimethyl polysiloxane stationary phase is the most popular GC stationary phase and is used in a wide variety of applications. All residual catalysts and low molecular weight fragments are removed from the Rtx®-5 polymer, providing a tight mono-modal distribution and extremely low bleed.

Rtx®-5 Columns (fused silica)

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

ID	df (μm)	temp. limits*	30-Meter
0.53mm	5.00	-60 to 270/290°C	10279

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

Organic volatile impurities on an Rtx®-5 (Rtx®-G27) column.

Inj.: Headspace injection of common solvents for pharmaceutical processing. Prepared to equal about 500ppm in the bulk pharmaceutical. Samples shaken and heated at 90°C for 15 minutes, 1mL headspace injection.
 Oven temp.: 35°C (hold 10 min.) to 100°C @ 5°C/min., to 240°C @ 25°C/min. (hold 5 min.)
 Inj./det. temp.: 220°C/240°C
 FID sensitivity: 1.05 x 10¹¹ AFS
 Carrier gas: helium, 35cm/sec. set @ 35°C
 Split ratio: 2:1

1. ethylene oxide
2. methanol
3. ethanol
4. diethyl ether
5. 1,1-dichloroethene
6. acetone
7. isopropanol
8. acetonitrile
9. methylene chloride
10. n-hexane
11. n-propanol
12. methyl ethyl ketone
13. ethyl acetate
14. tetrahydrofuran
15. chloroform
16. 1,1,1-trichloroethane
17. carbon tetrachloride
18. benzene
19. 1,2-dichloroethane
20. heptane
21. trichloroethylene
22. n-butanol
23. 1,4-dioxane
24. pyridine
25. toluene

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Organic Volatile Impurities (OVI) Analysis

Rtx®-G27 (Crossbond® 5% diphenyl/95% dimethyl polysiloxane)

with Integra-Guard™ Guard Column

Rtx®-G43 (Crossbond® 6% cyanopropylphenyl/94% dimethyl polysiloxane)

with Integra-Guard™ Guard Column

- Analytical column with Integra-Guard™ guard column eliminates connecting problems and leaks.

• Rtx®-G27 stable to 290°C; Rtx®-G43 stable to 240°C.

Rtx®-G27 Column (fused silica with 5-meter Integra-Guard™ guard column)

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

ID	df (μm)	temp. limits	30-Meter with 5-Meter, 0.53mm ID Integra-Guard Guard Column	
0.53mm	5.00	-60 to 270/290°C	10279-126	

Rtx®-G43 Column (fused silica with 5-meter Integra-Guard™ guard column)

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

ID	df (μm)	temp. limits	30-Meter with 5-Meter, 0.53mm ID Integra-Guard Guard Column	
0.53mm	3.00	-20 to 240°C	16085-126	

please note

Analytical Reference Materials for USP <467> are available. See [pages 479-480](#).

free literature



A Technical Guide for Static Headspace Analysis Using GC

Download your free copy from www.restek.com.

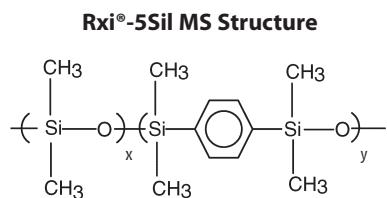
Technical Guide lit. cat.# 59895A



"We work hard to ensure the products you receive are of the highest quality. We are ISO 9001 certified and take pride in making the best columns on the market."

Restek's GC Columns Manufacturing Group

pictured: (top row) Linda Holden, David Rhodes, Sheldon McMurtrie, Kelsea Miller, Tom Barone, Ken Kline, Aaron Decker, Carolyn Williams, Raymond Ciampichini, Pete Rose, Dale Lucas, (bottom row) Tom Gurecki, Jack Haesler, Jackie Glasgow, Tim Wilson, David W. Rhodes, Henry Knepp, Russ Stewart, Jessica Andrus, Kim Shaffer, Santina Newlen (not pictured: Paul Kline, Robert Mattus, Russ Myers, Jessie Sproul, Ron Stricek, Tina Walters, Pat Reed, Shawn Giffin)

**similar phases**

DB-5MS, VF-5ms, CP-Sil 8 Low-Bleed/MS

ordering note**Get the protection without the connection!**For Rxi®-5Sil MS columns with built-in
Integra-Guard™ guard columns, see page 33.

The Rxi®-5Sil MS column is recommended for US EPA Method 8270.

Semivolatiles Analysis

Rxi®-5Sil MS (low polarity Crossbond® silarylene phase; selectivity close to 5% diphenyl/95% dimethyl polysiloxane)

- Engineered to be a low bleed GC/MS column.
- Excellent inertness for active compounds.
- General purpose columns—ideal for GC/MS analysis of polycyclic aromatic compounds, chlorinated hydrocarbons, phthalates, phenols, amines, organochlorine pesticides, organophosphorus pesticides, drugs, solvent impurities, and hydrocarbons.
- Temperature range: -60°C to 350°C.

The Rxi®-5Sil MS stationary phase incorporates phenyl groups in the polymer backbone. This improves thermal stability, reduces bleed, and makes the phase less prone to oxidation. Rxi®-5Sil MS columns are ideal for GC/MS applications requiring high sensitivity, including use in ion trap systems.

Rxi®-5Sil MS Columns (fused silica)

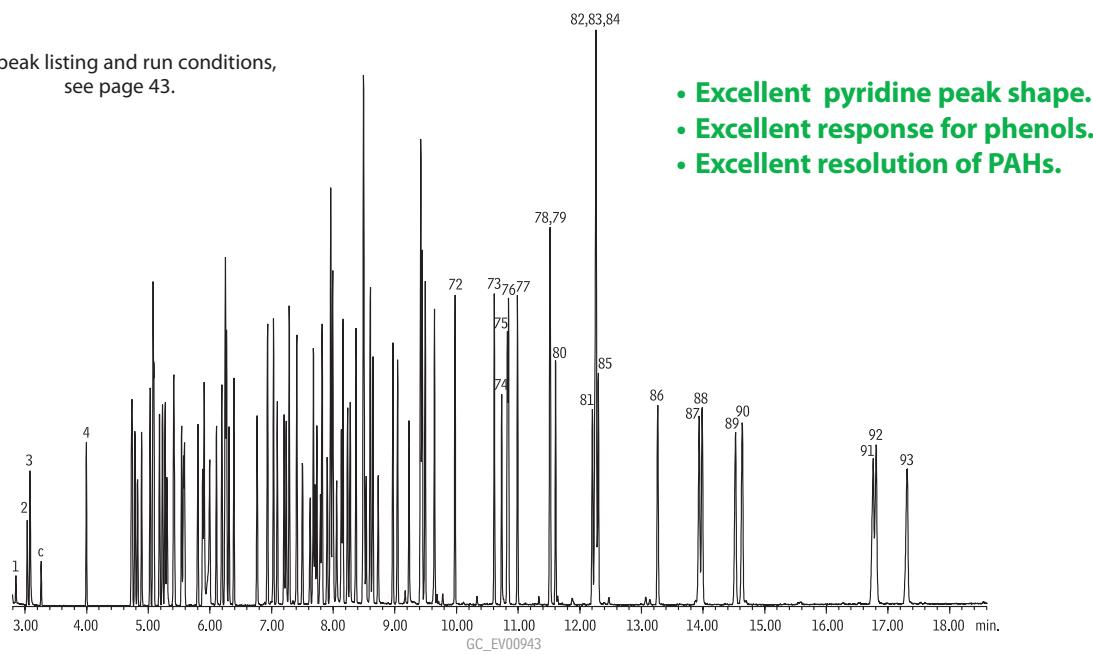
(Crossbond®, selectivity close to 5% diphenyl/95% dimethyl polysiloxane)

ID	df (μm)	temp. limits	15-Meter	30-Meter	60-Meter
0.25mm	0.10	-60 to 330/350°C	13605	13608	
	0.25	-60 to 330/350°C	13620	13623	13626
	0.50	-60 to 330/350°C	13635	13638	
	1.00	-60 to 325/350°C	13650	13653	13697
0.32mm	0.25	-60 to 330/350°C	13621	13624	
	0.50	-60 to 330/350°C		13639	
	1.00	-60 to 325/350°C		13654	
0.53mm	1.50	-60 to 310/330°C		13670	

ID	df (μm)	temp. limits	10-Meter	20-Meter
0.10mm	0.10	-60 to 330/350°C	43601	
0.18mm	0.18	-60 to 330/350°C		43602
	0.36	-60 to 330/350°C		43604

Semivolatile organics by US EPA Method 8270 on an Rxi®-5Sil MS column.

For peak listing and run conditions,
see page 43.



Organophosphorus Pesticides Analysis

Rtx®-OPPesticides/Rtx®-OPPesticides2 (proprietary Crossbond® phases)

- Application-specific columns for organophosphorus pesticides; best column combination for US EPA Method 8141A.
- Low bleed—ideal for GC/FPD, GC/NPD, or GC/MS analyses.
- Stable to 330°C.



Using sophisticated computer modeling software, we created two stationary phases for separating the 55 organophosphorus pesticides (OPP) listed in EPA Method 8141A. Separation is improved, and analysis time is significantly reduced, compared to other columns. The extended upper temperature limit of these phases (330°C) allows analysts to bake out high molecular weight contamination typically associated with pesticide samples. The low bleed columns are a perfect match for sensitive detection systems.

Rtx®-OPPesticides Columns (fused silica)

ID	df (µm)	temp. limits	30-Meter
0.32mm	0.50	-20 to 310/330°C	11239
0.53mm	0.83	-20 to 310/330°C	11240

restek innovation!

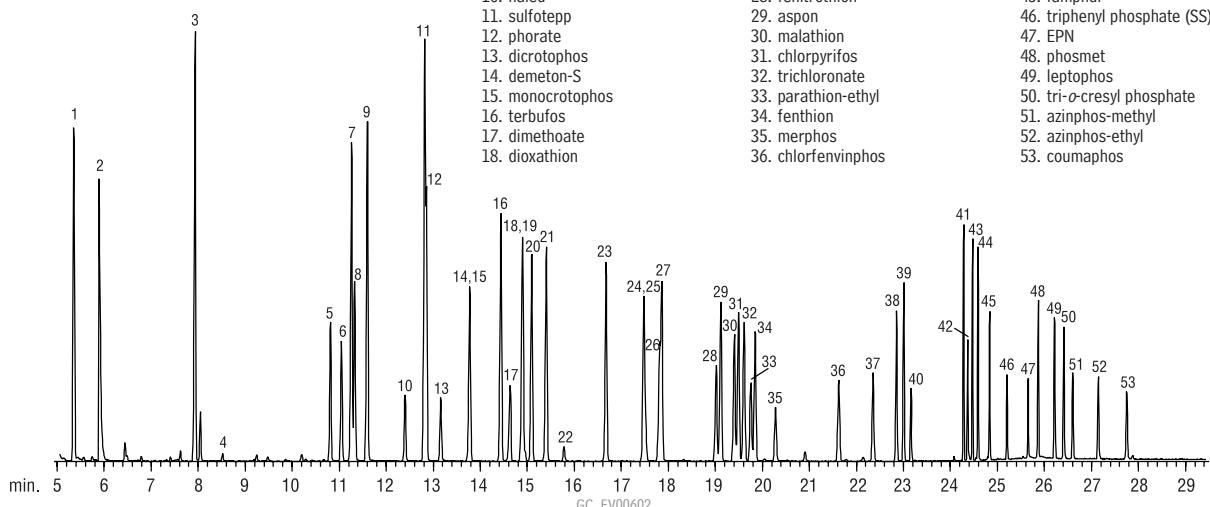
- Better separations
- Faster analysis

Rtx®-OPPesticides2 Columns (fused silica)

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

Organophosphorus pesticides by US EPA Method 8141A on an Rtx®-OPPesticides2 column.

Best column choice to resolve Method 8141A compounds!



1. dichlorvos
2. hexamethylphosphoramide
3. mevinphos
4. trichlorfon
5. TEPP
6. demeton-O
7. thionazin
8. tributyl phosphate (IS)
9. ethoprop
10. naled
11. sulfotep
12. phorate
13. dicrotophos
14. demeton-S
15. monocrotophos
16. terbufos
17. dimethoate
18. diaxathion
19. fonophos
20. diazinon
21. disulfoton
22. phosphamidon isomer
23. dichlorofenthion
24. chlorpyrifos methyl
25. phosphamidon
26. parathion-methyl
27. ronnel
28. fenitrothion
29. aspon
30. malathion
31. chlorpyrifos
32. trichloronate
33. parathion-ethyl
34. fenthion
35. merphos
36. chlorgenvinphos
37. crot oxyphos
38. stirofos
39. tokuthion
40. merphos oxone (breakdown product)
41. ethion
42. fensulfothion
43. bolstar
44. carbophenothion
45. famphur
46. triphenyl phosphate (SS)
47. EPN
48. phosmet
49. leptophos
50. tri-o-cresyl phosphate
51. azinphos-methyl
52. azinphos-ethyl
53. coumaphos

Column: Rtx®-OPPesticides2, 30m, 0.25mm ID, 0.25µm (cat.# 11243)
Sample: US EPA Method 8141A Custom Standard Mix 1µL 100ppm (1.00ng on column)

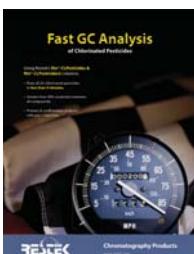
Triphenylphosphate Standard (cat.# 32281)
Tributylphosphate Standard (cat.# 32280)
8140/8141 OP Pesticides Calibration Mix A (cat.# 32277)
8141 OP Pesticides Calibration Mix B (cat.# 32278)
Custom Mixes: Call Restek for Information
1.0µL splitless (hold 0.4 min.), 4mm double gooseneck inlet liner (cat.# 20785)

Inj. temp.: 250°C
Carrier gas: helium, constant flow
Flow rate: 1.0mL/min.
Oven temp.: 80°C (hold 0.5 min.) to 140°C @ 20°C/min.
to 210°C @ 4°C/min. (hold 1 min.) to 280°C @ 30°C (hold 5 min.)

Det: MS
Transfer line temp.: 280°C
Scan range: 35-400amu
Ionization: EI

restek innovation!

- Very low bleed
- Faster analysis

**free literature****Fast GC Analysis of Chlorinated Pesticides**

Download your free copy from www.restek.com

Flyer

lit. cat.# 59547A

also available

For a wide variety of column connectors, see **pages 213-219**.

Purchase one of these recommended combinations of guard and analytical columns and save money.

Chlorinated Pesticides Analysis**Rtx®-CLPesticides/Rtx®-CLPesticides2 (proprietary Crossbond® phases)**

- Application-specific columns for organochlorine pesticides and herbicides.
- Low bleed—ideal for GC/ECD or GC/MS analyses.
- Baseline separations in less than 10 minutes.
- Stable to 340°C.

Improved resolution and faster analyses, compared to 1701 or phenyl phases, make these the pesticide columns of choice. Rtx®-CLPesticides columns are specially designed to overcome the coelutions and analyte breakdown typically encountered in chlorinated pesticide analyses for EPA Methods 8081, 608, and CLP. By achieving baseline resolution of the 20 target analytes, more accurate qualitative data can be obtained, providing reliable identification without GC/MS.

Rtx®-CLPesticides Columns (fused silica)

ID	df (μm)	temp. limits	10-Meter	15-Meter	20-Meter	30-Meter	60-Meter
0.10mm	0.10	-60 to 310/330°C	43101				
0.18mm	0.18	-60 to 310/330°C	42101		42102		
0.25mm	0.25	-60 to 320/340°C		11120		11123	11126
0.32mm	0.32	-60 to 320/340°C			11141		
	0.50	-60 to 320/340°C		11136		11139	
0.53mm	0.50	-60 to 300/320°C		11137		11140	

Rtx®-CLPesticides2 Columns (fused silica)

ID	df (μm)	temp. limits	10-Meter	15-Meter	20-Meter	30-Meter	60-Meter
0.10mm	0.10	-60 to 310/330°C	43301		43302		
0.18mm	0.14	-60 to 310/330°C	42301		42302		
0.25mm	0.20	-60 to 320/340°C		11320		11323	11326
0.32mm	0.25	-60 to 320/340°C		11321		11324	
	0.50	-60 to 320/340°C			11325		
0.53mm	0.42	-60 to 300/320°C		11337		11340	

Rtx®-CLPesticides Column Kits

(Note: Columns are not preconnected in these kits.)

0.25mm ID Rtx-CLPesticides Kit cat.# 11199 (kit), 1081.10

Includes:	cat.#	price
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.# 11196 (kit), 1112.00

Includes:	cat.#	price
30m, 0.32mm ID, 0.32μm Rtx-CLPesticides Column	11141	
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), 1189.20

Includes:	cat.#	price
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	

Add a reference mix to your kit order and save!

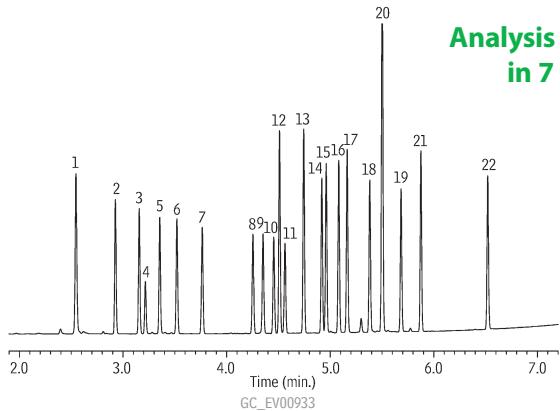
Description	list price	price with/kit	suffix #
Organochlorine Pesticide Mix AB #1 (cat.# 32291)	enquire		-530
Organochlorine Pesticide Mix AB #2 (cat.# 32292)	enquire		-535

Chlorinated Pesticides Analysis

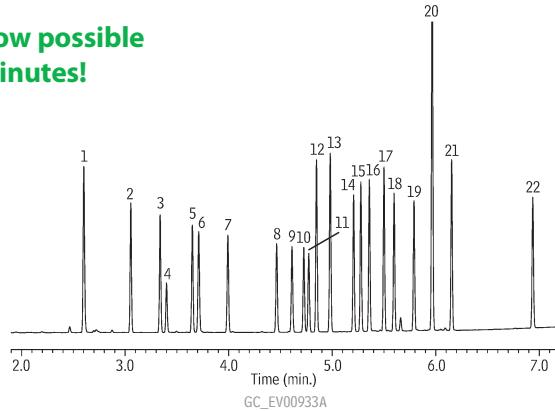
Fast GC analyses of chlorinated pesticides on Rtx®-CLPesticides and Rtx®-CLPesticides2 columns.

Rtx®-CLPesticides & Rtx®-CLPesticides2 columns (0.32mm ID)

Rtx®-CLPesticides



Rtx®-CLPesticides2



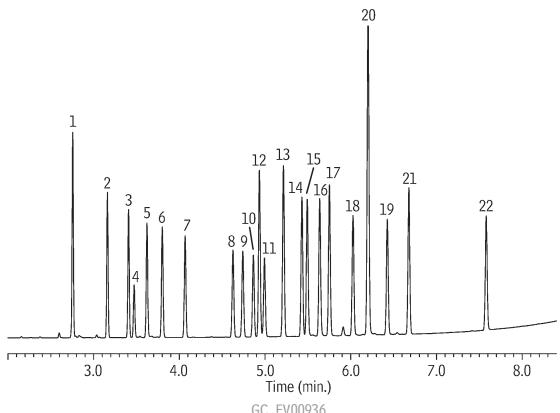
**Analysis now possible
in 7 minutes!**

Columns: Rtx®-CLPesticides, 30m, 0.32mm ID, 0.32 μ m (cat.# 11141) and Rtx®-CLPesticides2, 30m, 0.32mm ID, 0.25 μ m (cat.# 11324) with 5m x 0.32mm ID RxI® deactivated guard tubing (cat.# 10039), connected using Deactivated Universal "Y" Press-Tight® connector (cat.# 20405-261)
 Sample: Organochlorine Pesticide Mix AB #2, 8-80 μ g/mL each component in hexane/toluene (cat.# 32292), Pesticide Surrogate Mix, 200 μ g/mL each component in acetone (cat.# 32000)
 Inj.: 1.0 μ L splitless (hold 0.3 min.), 4mm single gooseneck inlet liner (cat.# 20799)
 Inj. temp.: 250°C
 Carrier gas: helium, constant flow
 Linear velocity: 60cm/sec. @ 120°C
 Oven temp.: 120°C to 200°C @ 45°C/min. to 230°C @ 15°C/min. to 330°C (hold 2 min.) @ 30°C/min.
 Det.: ECD @ 330°C

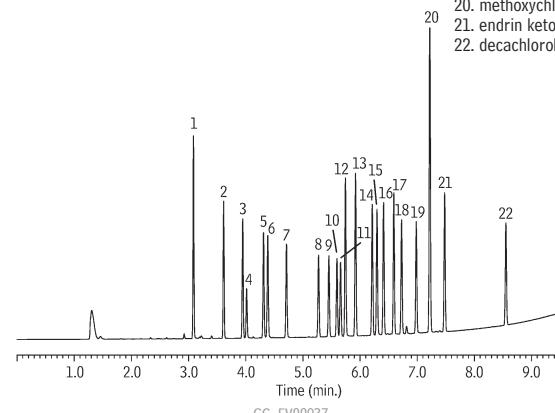
1. 2,4,5,6-tetrachloro-*m*-xylene (SS)
2. α -BHC
3. γ -BHC
4. β -BHC
5. δ -BHC
6. heptachlor
7. aldrin
8. heptachlor epoxide (isomer B)
9. γ -chlordane
10. α -chlordane
11. endosulfan I
12. 4,4'-DDE
13. dieldrin
14. endrin
15. 4,4'-DDD
16. endosulfan II
17. 4,4'-DDT
18. endrin aldehyde
19. endosulfan sulfate
20. methoxychlor
21. endrin ketone
22. decachlorobiphenyl (SS)

Rtx®-CLPesticides & Rtx®-CLPesticides2 columns (0.53mm ID)

Rtx®-CLPesticides



Rtx®-CLPesticides2



Columns: Rtx®-CLPesticides, 30m, 0.53mm ID, 0.50 μ m (cat.# 11140) and Rtx®-CLPesticides2, 30m, 0.53mm ID, 0.42 μ m (cat.# 11340) with 5m x 0.53mm ID RxI® deactivated guard tubing (cat.# 10054), connected using Siltek® Treated Universal "Y" Press-Tight® connector (cat.# 20486)
 Sample: Organochlorine Pesticide Mix AB #2, 8-80 μ g/mL each component in hexane/toluene (cat.# 32292), Pesticide Surrogate Mix, 200 μ g/mL each component in acetone (cat.# 32000)
 Inj.: 1.0 μ L splitless (hold 0.3 min.), 4mm single gooseneck inlet liner (cat.# 20799)
 Inj. temp.: 250°C
 Carrier gas: helium, constant flow
 Linear velocity: 45cm/sec. @ 120°C
 Oven temp.: 120°C to 200°C @ 45°C/min. to 230°C @ 12.5°C/min. to 325°C (hold 2 min.) @ 30°C/min.
 Det.: ECD @ 330°C

restek innovation!

Chlorinated Pesticides Analysis

Stx™-CLPesticides/Stx™-CLPesticides2 (proprietary Crossbond® phases)

- Application-specific columns for organochlorine pesticides and herbicides.
- Baseline separations in less than 10 minutes.
- Siltek® surface deactivation enhances responses for endrin, DDT, methoxychlor.
- Stable to 330°C.

Many laboratories analyzing organochlorine pesticides struggle with breakdown and adsorption of endrin, DDT, and methoxychlor caused by active sites throughout the analytical system. Siltek® passivation technology enables these columns to offer unsurpassed inertness and the highest responses for active pesticides.

Stx™-CLPesticides Columns (fused silica with Siltek® deactivation)

it's a fact

These columns are treated with Siltek® deactivation, which provides better responses for endrin, DDT, and methoxychlor.

ID	df (µm)	temp. limits	15-Meter	30-Meter
0.25mm	0.25	-60 to 310/330°C	11540	11543
0.32mm	0.32	-60 to 310/330°C	11546	
	0.50	-60 to 310/330°C	11541	11544

Stx™-CLPesticides2 Columns (fused silica with Siltek® deactivation)

ID	df (µm)	temp. limits	15-Meter	30-Meter
0.25mm	0.20	-60 to 310/330°C	11440	11443
0.32mm	0.25	-60 to 310/330°C	11441	11444

Stx™-CLPesticides Kits

(Note: Columns are not preconnected in these kits.)



0.25mm ID Stx-CLPesticides Kit cat.# 11190 (kit), 1081.10

Includes:	cat.#	price
30m, 0.25mm ID, 0.25µm Stx-CLPesticides Column	11543	
30m, 0.25mm ID, 0.20µm Stx-CLPesticides2 Column	11443	
Universal Angled "Y" Press-Tight Connector	20403	
5m, 0.25mm ID Siltek Guard Column	10026	



0.32mm ID Stx-CLPesticides Kit cat.# 11193 (kit), 1112.00

Includes:	cat.#	price
30m, 0.32mm ID, 0.32µm Stx-CLPesticides Column	11546	
30m, 0.32mm ID, 0.25µm Stx-CLPesticides2 Column	11444	
Universal Angled "Y" Press-Tight Connector	20403	
5m, 0.32mm ID Siltek Guard Column	10027	

ordering note

Kits include Siltek® deactivated guard column.

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www.restek.com/environmental



Brominated Flame Retardants Analysis

Rtx®-1614 (5% phenyl methyl)

- Optimized for PBDE analysis by EPA Method 1614.
- Short column option resolves BDE-209 3 times faster, with less thermal breakdown.
- Unique deactivation gives higher BDE-209 response, compared to DB-5HT columns, for greater analytical sensitivity.
- Exceeds EPA Method 1614 resolution criteria for BDE-49 and BDE-71.

NEW!

Rtx®-1614 Columns (fused silica)

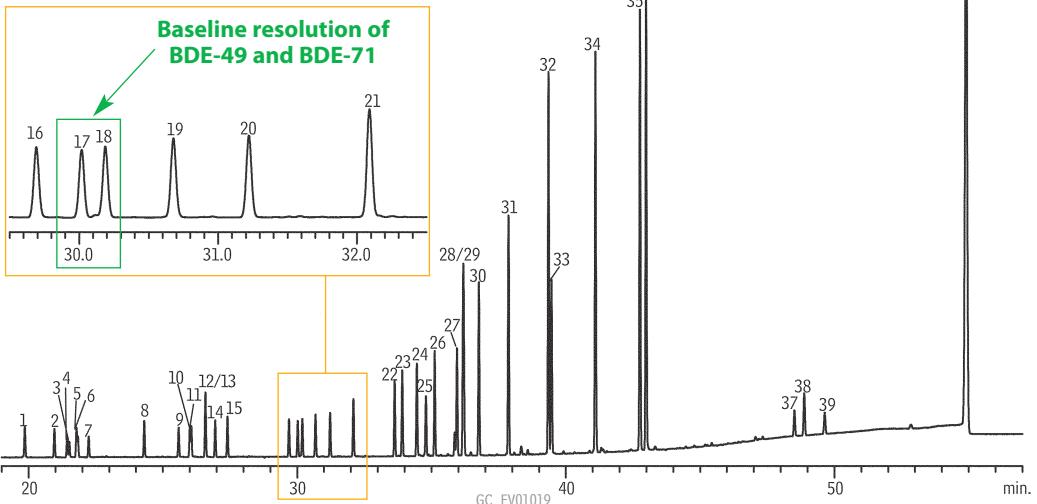
(5% phenyl methyl)

ID	df (μm)	temp. limits	15-Meter	30-Meter
0.25mm	0.10	-60 to 330/360°C	10296	10295

Separate PBDEs accurately and reliably on an Rtx®-1614 column.

Column: Rtx®-1614, 30m, 0.25mm ID, 0.10μm (cat.# 10295)
 Sample: 100-300ppb PBDE PAR Solution (cat.# EO-5113, Cambridge Isotope Laboratories Inc.), 500ppb decabromodiphenyl ether (cat.# BDE-209, Wellington Laboratories)
 Inj.: 1μL splitless (hold 1 min.), 4mm cyclo double gooseneck liner (cat.# 20896)
 Inj. temp.: 300°C
 Carrier gas: helium, constant flow
 Linear velocity: 20cm/sec. @ 100°C
 Oven temp.: 100°C (hold 3 min.) to 320°C @ 5°C/min. (hold 15 min.)
 Detector temp.: μ-ECD @ 340°C

Greater response and
higher inertness for
BDE-209!



1. BDE-10
2. BDE-7
3. BDE-8
4. BDE-11
5. BDE-12
6. BDE-13
7. BDE-15
8. BDE-30
9. BDE-32
10. BDE-17
11. BDE-25
12. BDE-28
13. BDE-33
14. BDE-35
15. BDE-37
16. BDE-75
17. BDE-49
18. BDE-71
19. BDE-47
20. BDE-66
21. BDE-77
22. BDE-100
23. BDE-119
24. BDE-99
25. BDE-116
26. BDE-118
27. BDE-85
28. BDE-155
29. BDE-126
30. BDE-154
31. BDE-153
32. BDE-138
33. BDE-166
34. BDE-183
35. BDE-181
36. BDE-190
37. BDE-208
38. BDE-207
39. BDE-206
40. BDE-209

Table of Contents for
Applications

see page 489



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PCB Congeners Analysis

Rtx®-PCB (proprietary Crossbond® phase)

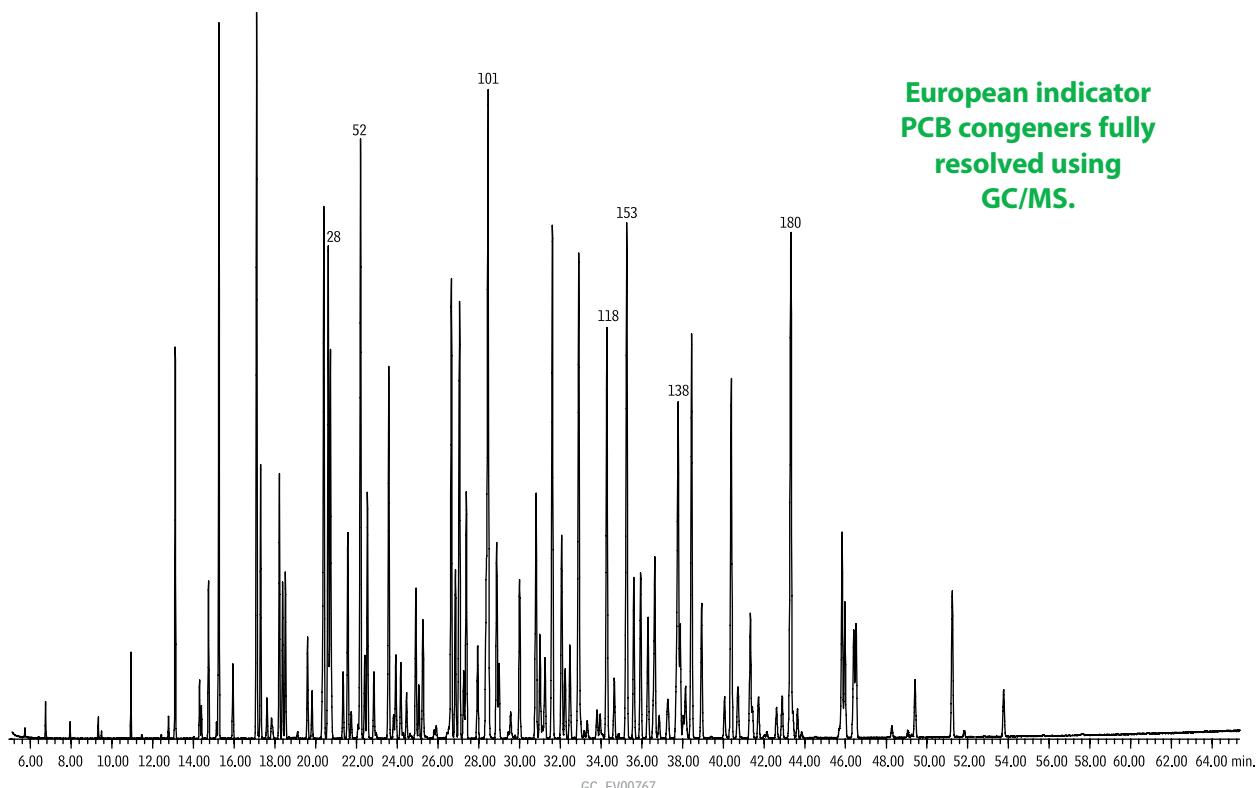
- Unique polymer for PCBs analysis by GC/ECD or GC/MS.
- Good results for other semivolatiles.
- Low polarity; inert to active compounds.
- Stable to 340°C.

Rtx®-PCB Columns (fused silica)

ID	df (μm)	temp. limits*	20-Meter	30-Meter	40-Meter	60-Meter
0.18mm	0.18	30°C to 320/340°C	41302		41303	41304
0.25mm	0.25	30°C to 320/340°C		13223		13226
0.32mm	0.50	30°C to 320/340°C		13239		

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

**Aroclor 1242/1254/1262 PCBs on Rtx®-PCB:
best available resolution of individual congeners.**



Column: Rtx®-PCB, 60m, 0.25mm ID, 0.25μm (cat.# 13226)
 Sample: Aroclor 1242 (cat.# 32009), 1254 (cat.# 32011), 1262 (cat.# 32409), 333ppm each
 Inj.: 1.0μL splitless (hold 0.75 min.), 4mm single gooseneck inlet liner w/wool (cat.# 22405)
 Inj. temp.: 280°C
 Carrier gas: helium, constant flow
 Flow rate: 1.1mL/min.
 Oven temp.: 100°C (hold 1 min.) to 200°C @ 30°C/min., to 320°C @ 2°C/min. (hold 1 min.)
 Det.: MS
 Transfer line temp.: 280°C
 Scan range: 50 to 550amu
 Ionization: EI
 Mode: scan

PCB Congeners Analysis

Rxi®-XLB (low polarity proprietary phase)

- General purpose columns exhibiting extremely low bleed. Ideal for many GC/MS applications, including pesticides, PCB congeners or (e.g.) Aroclor mixes, PAHs.
- Unique selectivity.
- Temperature range: 30°C to 360°C.

Improvements in polymer synthesis and tubing deactivation enable us to make inert, stable Rxi®-XLB columns especially well-suited for analyzing active, high molecular weight compounds with sensitive GC/MS systems, including ion trap detectors. Excellent efficiency, coupled with inertness, low bleed, and high thermal stability, make Rxi®-XLB columns ideal for analyzing semivolatile compounds in drinking water (e.g., US EPA Method 525).

Rxi®-XLB Columns (fused silica)

(low polarity proprietary phase)

ID	df (µm)	temp. limits*	15-Meter	30-Meter	60-Meter
0.25mm	0.10	30 to 340/360°C	13705	13708	
	0.25	30 to 340/360°C	13720	13723	13726
	0.50	30 to 340/360°C		13738	
	1.00	30 to 340/360°C	13750	13753	

ID	df (µm)	temp. limits	10-Meter	20-Meter
0.10mm	0.10	30 to 340/360°C	43701	
0.18mm	0.18	30 to 340/360°C		43702

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

also available

Other Dimensions!

See page 44 for our complete listing of Rxi®-XLB columns.

similar phases

DB-XLB, VF-Xms

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also available

Rtx®-Dioxin2 columns.
See page 87.

Dioxin & Furan Congeners Analysis

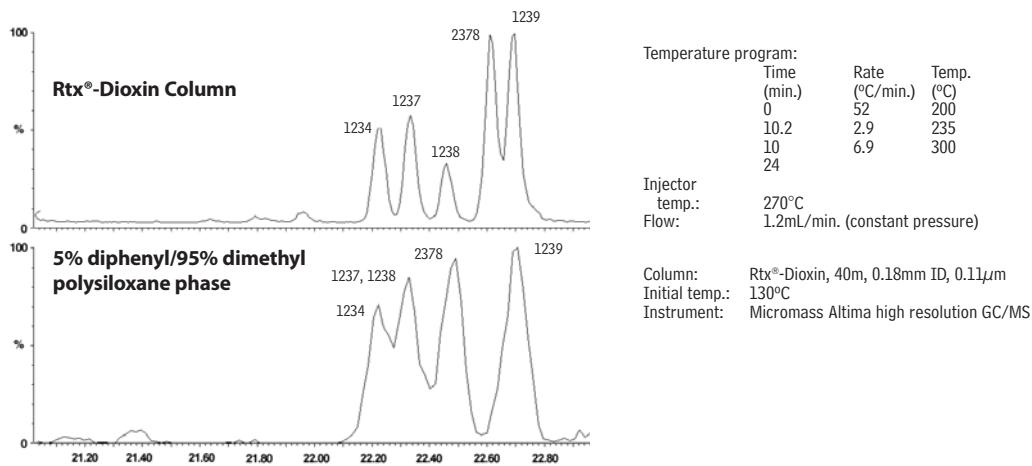
Rtx®-Dioxin (proprietary Crossbond® phase)

- Replacement column for 5% diphenyl phases.
- Improved separations of dioxin or furan congeners.
- Greater thermal stability than 5% diphenyl phases or high-cyano confirmation columns.

Rtx®-Dioxin Columns (fused silica)

ID	df (μm)	temp. limits	60-Meter
0.25mm	0.15	-60°C to 380°C	10755

Rtx®-Dioxin column separates all five components in the TCDD resolution check mixture.



Chromatography courtesy of Karen MacPherson and Eric Reiner, Ontario Ministry of the Environment, Etobicoke, ON, Canada.



"We test every fused silica, PLOT, and MXT® column against stringent quality standards to ensure you get the best columns on the market."

Restek's Quality Assurance Group

pictured: Sara Eyster, Dianne Shaffer, Lenny Miller, Corby Hillard, Glenn Gerhab, Chris Zucco, Deb Conklin, Trisha Houser, John Kalmbach (not pictured: Kayne Milhomme, Adam Clark, Tyler Brown, Abby Caporuscio, Brett Ripka)

Dioxin & Furan Congeners Analysis

Rtx®-Dioxin2 (proprietary Crossbond® phase)

- Isomer specificity for 2,3,7,8-TCDD and 2,3,7,8-TCDF achieved with one GC column.
- Thermally stable to 340°C for longer lifetime.
- Unique selectivity for toxic dioxin and furan congeners allow use as a primary or confirmation GC column.

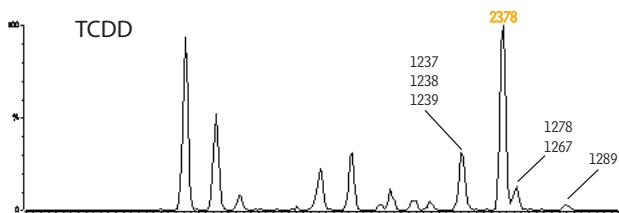
restek innovation!

Excellent for dioxins or furans.

Rtx®-Dioxin2 Columns (fused silica)

ID	df (μm)	temp. limits	40-Meter	60-Meter
0.18mm	0.18	20°C to 340°C	10759	—
0.25mm	0.25	20°C to 340°C	—	10758

2,3,7,8-Tetrachlorodibenzodioxin resolved from other TCDD congeners, using an Rtx®-Dioxin2 column.

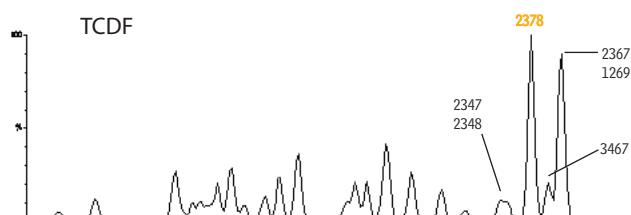


Other peak identifications available upon request.

GC_EV00948

Column: Rtx®-Dioxin2, 60m, 0.25mm ID, 0.25μm (cat.# 10758)
Sample: WMS-01 Reference Material, Wellington Laboratories
Inj.: Splitless
Inj. temp.: 250°C
Carrier gas: helium, constant flow
Flow rate: 1.5mL/min.
Oven temp.: 130°C (hold 1.0 min.) to 200°C @ 40°C/min. to 235°C @ 3.0°C/min. to 300°C @ 5°C/min. (hold 10 min.)
Det.: Micromass Ultima high-resolution mass spectrometer
Ionization: EI
Mode: SIR

Tetrachlorodibenzofuran congeners on an Rtx®-Dioxin2 column.

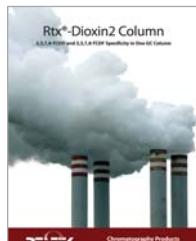


Other peak identifications available upon request.

GC_EV00949

Column: Rtx®-Dioxin2, 60m, 0.25mm ID, 0.25μm (cat.# 10758)
Sample: WMS-01 Reference Material, Wellington Laboratories
Inj.: Splitless
Inj. temp.: 250°C
Carrier gas: helium, constant flow
Flow rate: 1.5mL/min.
Oven temp.: 130°C (hold 1.0 min.) to 200°C @ 40°C/min. to 235°C @ 3.0°C/min. to 300°C @ 5°C/min. (hold 10 min.)
Det.: Micromass Ultima high-resolution mass spectrometer
Ionization: EI
Mode: SIR

Chromatograms courtesy of Terry Kolic, Karen MacPherson, Eric Reiner, Ontario Ministry of the Environment, Toronto, Ontario, Canada



free literature

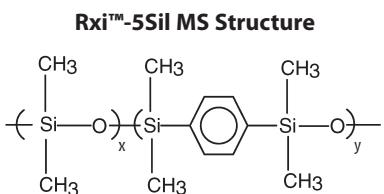
Rtx®-Dioxin2 Column: 2,3,7,8-TCDD and 2,3,7,8-TCDF Specificity in One GC Column

All 128 tetra through octa dioxin and furan congeners acquired on the Rtx®-Dioxin2 column.

Download your free copy from www.restek.com

Flyer

lit. cat.# 580119A

**similar phases**

DB-5MS, VF-5ms, CP-Sil 8 Low-Bleed/MS

also available**Get the protection without the connection!**For Rxi®-5Sil MS columns with built-in
Integra-Guard™ guard columns, see page 33.**Other Dimensions!**See page 42 for our complete listing of Rxi®-5Sil MS
columns.

Polycyclic Aromatic Hydrocarbon (PAH) Analysis

Rxi®-5Sil MS (low polarity Crossbond® silarylene phase; selectivity close to 5% diphenyl/95% dimethyl polysiloxane)

- Engineered to be a low bleed GC/MS column.
- Excellent inertness for active compounds.
- General purpose columns—ideal for GC/MS analysis of polycyclic aromatic compounds, chlorinated hydrocarbons, phthalates, phenols, amines, organochlorine pesticides, organophosphorus pesticides, drugs, solvent impurities, and hydrocarbons.
- Temperature range: -60°C to 350°C.

Rxi®-5Sil MS Columns (fused silica)

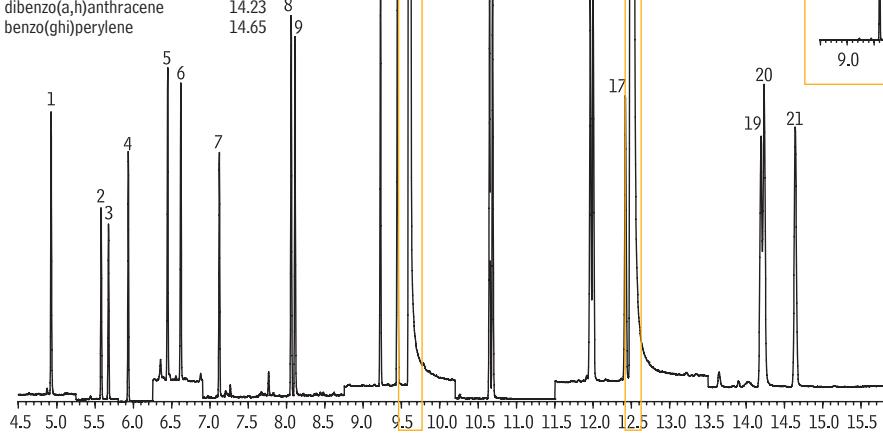
(Crossbond®, selectivity close to 5% diphenyl/95% dimethyl polysiloxane)

ID	df (μm)	temp. limits	15-Meter	30-Meter	60-Meter
0.25mm	0.10	-60 to 330/350°C	13605	13608	
	0.25	-60 to 330/350°C	13620	13623	13626
	0.50	-60 to 330/350°C	13635	13638	

ID	df (μm)	temp. limits	10-Meter	20-Meter
0.10mm	0.10	-60 to 330/350°C	43601	
0.18mm	0.18	-60 to 330/350°C		43602
	0.36	-60 to 330/350°C		43604

Polycyclic aromatic hydrocarbons on an Rxi®-5Sil MS column.

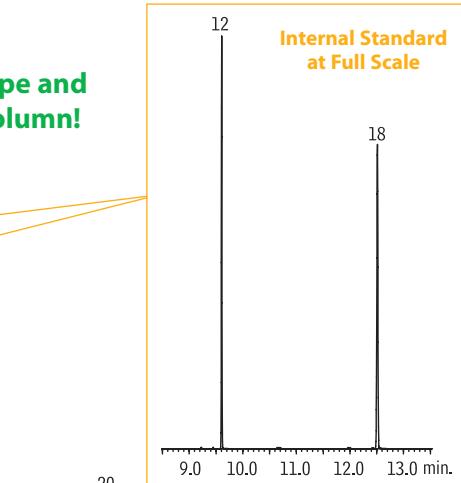
Peak List	Retention Time
1. naphthalene	4.93
2. 2-methylnaphthalene	5.58
3. 1-methylnaphthalene	5.68
4. 2-fluorobiphenyl (SS)	5.93
5. acenaphthylene	6.45
6. acenaphthene	6.62
7. fluorene	7.12
8. phenanthrene	8.06
9. anthracene	8.11
10. fluoranthene	9.23
11. pyrene	9.45
12. p-terphenyl-d14 (IS)	9.61
13. benzo(a)anthracene	10.65
14. chrysene	10.69
15. benzo(b)fluoranthene	11.96
16. benzo(k)fluoranthene	12.00
17. benzo(a)pyrene	12.42
18. perylene-d12 (IS)	12.51
19. indeno(1,2,3-cd)pyrene	14.19
20. dibenzo(a,h)anthracene	14.23
21. benzo(ghi)perylene	14.65



Column: Rxi®-5Sil MS, 30m, 0.25mm ID, 0.25μm (cat.# 13623)
Sample: PAH mix, 1μL of 0.005μg/mL (IS 2μg/mL)

SV Calibration Mix #5 (cat.# 31011)
1-methylnaphthalene (cat.# 31283)
2-methylnaphthalene (cat.# 31285)

2-fluorobiphenyl (cat.# 31091)
Inj.: 1.0μL (5pg on-column concentration),
4mm Drilled Uniliner® (hole near top) inlet liner w/wool (cat.# 21055-200.5),
pulsed splitless; pulse 20psi @ 0.2 min., 60mL/min. @ 0.15 min.



Single Ion Monitoring Program	Group	Time	Ion(s)	Dwell (ms)
	1	4.00	128	100
	2	5.25	142	100
	3	5.80	172	100
	4	6.25	152	100
	5	6.90	166	100
	6	7.60	178	100
	7	8.75	202, 244	100
	8	10.2	228	100
	9	11.5	252, 264	100
	10	13.5	276, 278	100

GC_EV00970

Inj. temp.: 300°C
Carrier gas: helium, constant flow
Flow rate: 1.4mL/min.
Oven temp.: 50°C (hold 0.5 min.) to 290°C @ 25°C/min. to 320°C @ 5°C/min.
Det.: MS
Transfer line temp: 290°C
Ionization: EI
Mode: SIM

Polycyclic Aromatic Hydrocarbon (PAH) Analysis

Rt®-PAH (polar, proprietary liquid crystalline phase)

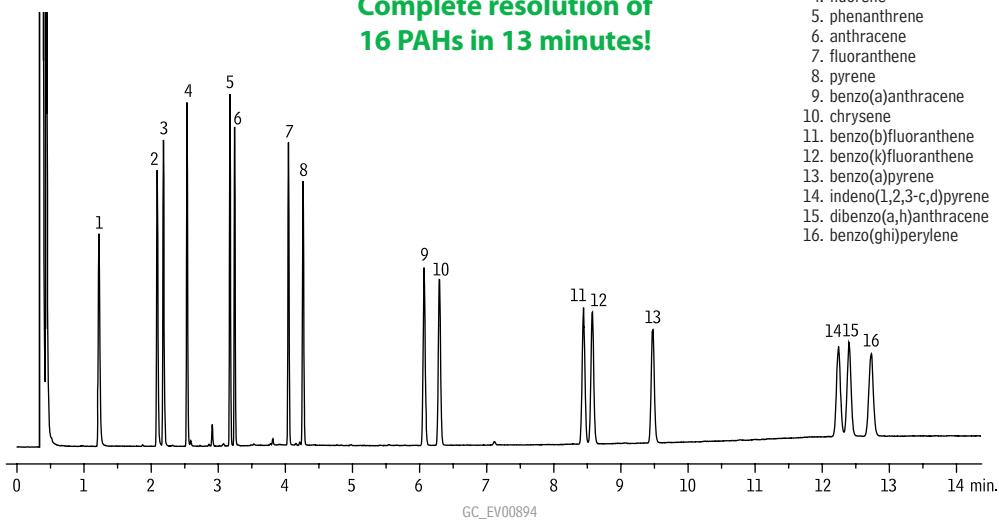
- Specially designed for the analysis of polycyclic aromatic hydrocarbons (PAHs) listed in US EPA methods 610 and 8100.
- Low bleed at 285°C.
- Temperature range: 80°C to 285°C.

Rt®-PAH Columns (fused silica)

ID	df (μm)	temp. limits	12-Meter
0.25mm	0.15	80°C to 285°C	19733

Separation of 16 regulated polycyclic aromatic hydrocarbons (PAHs) in less than 15 minutes on an Rt®-PAH column.

Complete resolution of 16 PAHs in 13 minutes!



1. naphthalene
2. acenaphthylene
3. acenaphthene
4. fluorene
5. phenanthrene
6. anthracene
7. fluoranthene
8. pyrene
9. benzo(a)anthracene
10. chrysene
11. benzo(b)fluoranthene
12. benzo(k)fluoranthene
13. benzo(a)pyrene
14. indeno(1,2,3-c,d)pyrene
15. dibenz(a,h)anthracene
16. benzo(ghi)perylene

Column: Rt®-PAH, 12m, 0.25mm ID, 0.15μm (cat.# 19733)
 Sample: 16 component EPA Method 610 PAH standard
 (20ng/μL of each component in dichloromethane)
 Inj.: 1.0μL split (split ratio 10:1)
 Inj. temp.: 225°C
 Carrier gas: helium, 110kPa column head pressure
 Open temp.: 80°C to 220°C @ 40°C/min., 220°C to 285°C @ 8°C/min. (hold 5 min.)
 Detector: FID @ 290°C

Chromatogram courtesy of J&K Scientific.

Rt®-LC50 (polar, dimethyl (50% liquid crystal) polysiloxane)

- General purpose column with selectivity for dioxin or furan congeners, or PCB congeners.
- Low bleed at 270°C.
- Temperature range: 100°C to 270°C.

The unique liquid crystalline Rt®-LC50 stationary phase resolves compounds of similar structure and boiling point. It has proven effective for resolving many polycyclic aromatic hydrocarbons; other potential applications include dioxin, furan, or PCB congeners.

Rt®-LC50 Columns (fused silica)

ID	df (μm)	temp. limits	10-Meter	20-Meter
0.10mm	0.10	100°C to 270°C	19736	—
0.18mm	0.10	100°C to 270°C	19735	—
0.25mm	0.10	100°C to 270°C	—	19734

restek innovation!

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

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

Volatile Organics Analysis

Rtx®-VMS (proprietary Crossbond® phase)

- Application-specific columns for volatile organic pollutants by GC/MS.
- Complete separation of US EPA Method 8260B compounds in less than 10 minutes.
- Stable to 260°C.
- No known equivalent phases.

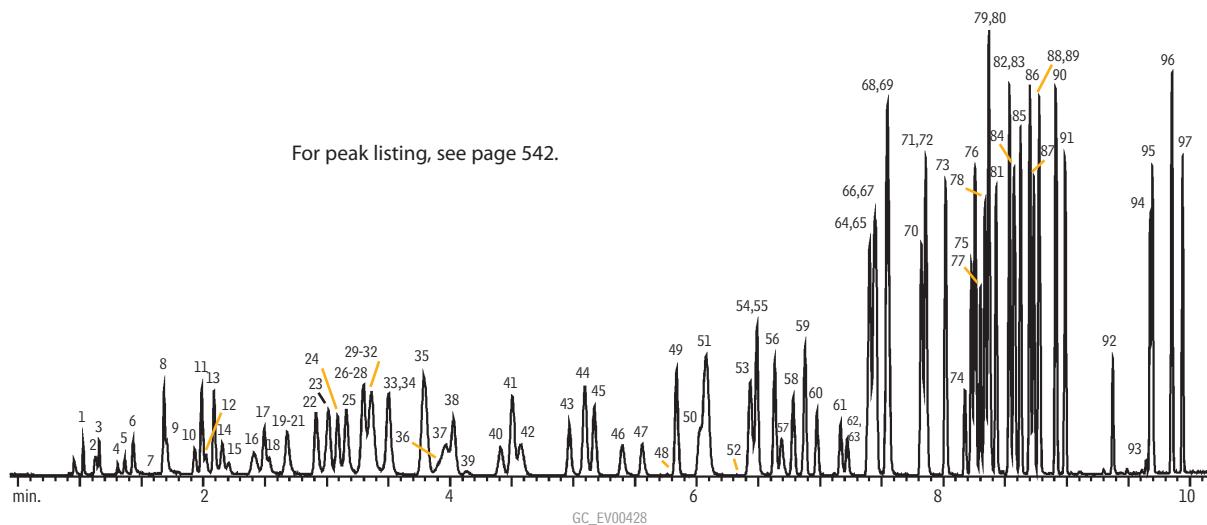
Rtx®-VMS columns offer lower bleed, better selectivity, and overall faster analysis for separating volatile organic compounds, such as those listed in US EPA Method 8260B. The Rtx®-VMS stationary phase is a highly stable polymer that provides outstanding analysis of volatile compounds, in combination with sensitive ion traps and Agilent 5973 mass spectrometers. 0.18 and 0.25mm ID columns allow sample splitting at the injection port, eliminating the added expense and maintenance of a jet separator. A 0.45mm or 0.53mm ID column can be directly connected to the purge & trap transfer line in a system equipped with a jet separator.

Rtx®-VMS Columns (fused silica)

ID	df (μm)	temp. limits	30-Meter	60-Meter	75-Meter
0.25mm	1.40	-40 to 240/260°C	19915	19916	
0.32mm	1.80	-40 to 240/260°C	19919	19920	
0.45mm	2.55	-40 to 240/260°C	19908	19909	
0.53mm	3.00	-40 to 240/260°C	19985	19988	19974

ID	df (μm)	temp. limits	20-Meter	40-Meter
0.18mm	1.00	-40 to 240/260°C	49914	49915

Rapid analysis of volatile organics in US EPA Method 8260B, on an Rtx®-VMS column.



Column: Rtx®-VMS, 20m, 0.18mm ID, 1.00μm (cat.# 49914)
 Conc.: 10ppb in 5mL of RO water
 unless otherwise noted; ketones at 2.5X
 Concentrator: Tekmar LSC-3100 Purge and Trap
 Trap: Vocarb 3000 (type K)
 Purge: 11 min. @ 40mL/min. (ambient temperature)
 Dry purge: 1 min. @ 40mL/min.
 Desorb preheat: 245°C
 Desorb: 250°C for 2 min., flow 40mL/min.
 Bake: 260°C for 8 min.
 Interface: 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

Volatile Organics Analysis

Rtx®-VRX (proprietary Crossbond® phase)

- Application-specific columns for volatile organic pollutants.
- Excellent for US EPA Method 8021 compounds.
- Stable to 260°C.

The Rtx®-VRX stationary phase and optimized column dimensions provide low bleed, excellent resolution, and fast analysis times for volatile compounds.

Rtx®-VRX Columns (fused silica)

(proprietary Crossbond® phase)

ID	df (μm)	temp. limits	30-Meter	60-Meter	75-Meter	105-Meter
0.25mm	1.40	-40 to 240/260°C	19315		19316	
0.32mm	1.80	-40 to 240/260°C	19319		19320	
0.45mm	2.55	-40 to 240/260°C	19308		19309	
0.53mm	3.00	-40 to 240/260°C	19385	19388	19374	19389

ID	df (μm)	temp. limits	20-Meter	40-Meter		
0.18mm	1.00	-40 to 240/260°C	49314	49315		

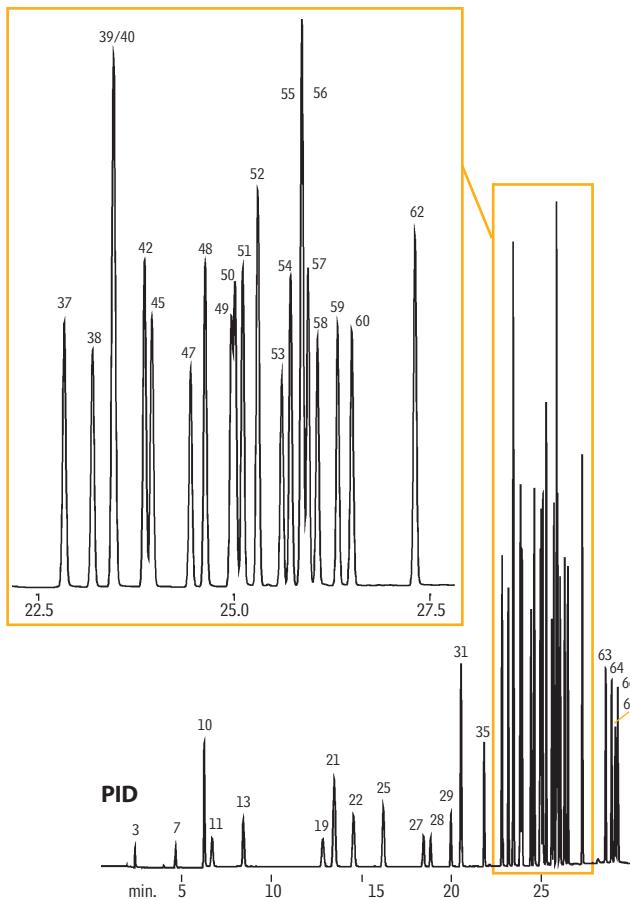
similar phases

DB-VRX

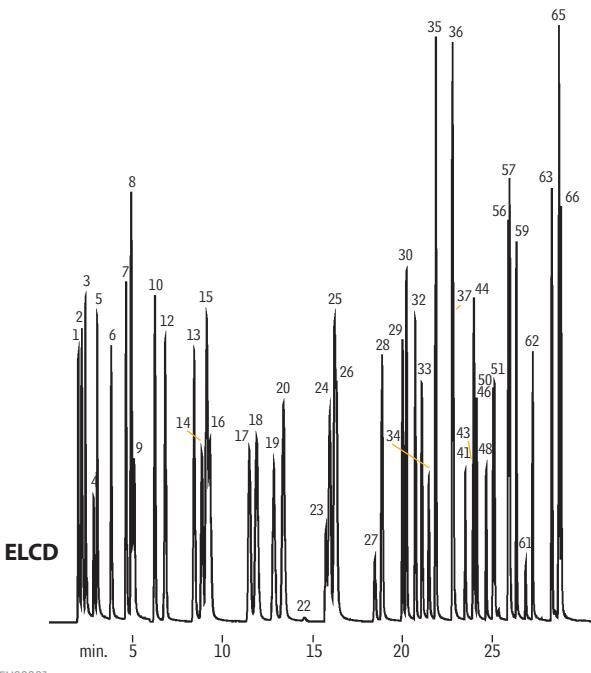
Need a column for a
volatiles analysis?

see page 537

Excellent resolution of EPA Method 8021 volatile organics on an Rtx®-VRX column.



For peak listing and run conditions,
please visit us at www.restek.com
Search for GC_EV00001



Acknowledgement: Finnigan 9001 GC, μGold Tandem Photoionization/HALL® 2000 Electrolytic Conductivity Detector provided courtesy of Thermo Electron GC & GC/MS Division, 2215 Grand Avenue Pkwy, Austin, Texas 78728

Volatile Organics Analysis

Rtx®-502.2 (proprietary Crossbond® diphenyl/dimethyl polysiloxane phase)

- Application-specific columns with unique selectivity for volatile organic pollutants. The Rtx®-502.2 column is cited in US EPA Method 502.2 and in many gasoline range organics (GRO) methods for monitoring underground storage tanks.
- Excellent separation of trihalomethanes; ideal polarity for light hydrocarbons and aromatics.
- Stable to 270°C.

An Rtx®-502.2 column will enable you to quantify all compounds listed in US EPA methods 502.2 or 524.2, whether you use a mass spectrometer or a PID in tandem with an ELCD. The diphenyl/dimethyl polysiloxane based Rtx®-502.2 stationary phase provides low bleed and thermal stability to 270°C. A 105-meter column can separate the light gases specified in EPA methods without subambient cooling. Narrow bore columns can interface directly in GC/MS systems.

Rtx®-502.2 Columns (fused silica)

(proprietary Crossbond® diphenyl/dimethyl polysiloxane phase)

similar phase

DB-502.2

ID	df (µm)	temp. limits	30-Meter	60-Meter	75-Meter	105-Meter
0.25mm	1.40	-20 to 250/270°C	10915	10916		
0.32mm	1.80	-20 to 250/270°C	10919	10920		10921
0.45mm	2.55	-20 to 250/270°C			10986	
0.53mm	3.00	-20 to 250/270°C	10908	10909		10910

ID	df (µm)	temp. limits	20-Meter	40-Meter
0.18mm	1.00	-20 to 250/270°C	40914	40915

also available

MXT® Columns

Rugged, flexible, Siltek® treated stainless steel tubing; inertness comparable to fused silica tubing. See [pages 111](#) for our MXT®-502.2 and MXT®- Volatiles columns.

Rtx®-Volatiles (proprietary Crossbond® diphenyl/dimethyl polysiloxane phase)

- Application-specific columns for volatile organic pollutants.
- Stable to 280°C.

Rtx®-Volatiles columns were the first columns designed specifically for analyses of the 34 volatile organic pollutants listed in US EPA methods 601, 602, and 624. With these columns, you can quantify all compounds listed in these methods, whether you use a mass spectrometer or a PID in tandem with an ELCD. The diphenyl/dimethyl polysiloxane based Rtx®-Volatiles stationary phase provides low bleed and thermal stability to 280°C. Narrow bore columns can interface directly in GC/MS systems.

Rtx®-Volatiles Columns (fused silica)

(proprietary Crossbond® diphenyl/dimethyl polysiloxane phase)

similar phase

VOCOL

ID	df (µm)	temp. limits*	30-Meter	60-Meter	105-Meter
0.25mm	1.00	-20 to 270/280°C	10900	10903	
0.32mm	1.50	-20 to 270/280°C	10901	10904	
0.53mm	2.00	-20 to 270/280°C	10902	10905	10906



Searching for a chromatogram?
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Volatile Organics Analysis

Rtx®-624 (low to midpolarity phase; Crossbond® 6% cyanopropylphenyl/94% dimethyl polysiloxane)

- Application-specific columns for volatile organic pollutants. Recommended in US EPA methods for volatile organic pollutants.
- Temperature range: -20°C to 240°C.
- Equivalent to USP G43 phase.

The unique polarity of the Rtx®-624 column makes it ideal for analyzing volatile organic pollutants. Although the Rtx®-502.2 column is recommended in many methods, the Rtx®-624 column offers better resolution of early eluting compounds. The Rtx®-624 phase produces greater than 90% resolution of the first six gases in EPA Methods 8260 and 524.2. This stationary phase is especially well-suited for EPA Method 524.2 revision IV since it resolves 2-nitropropane from 1,1-dichloropropanone, which share quantification ion m/z 43 and must be separated chromatographically.

Rtx®-624 Columns (fused silica)

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

ID	df (µm)	temp. limits	30-Meter	60-Meter	75-Meter	105-Meter
0.25mm	1.40	-20 to 240°C	10968	10969		
0.32mm	1.80	-20 to 240°C	10970	10972		
0.45mm	2.55	-20 to 240°C			10982	
0.53mm	3.00	-20 to 240°C	10971	10973	10974	10975

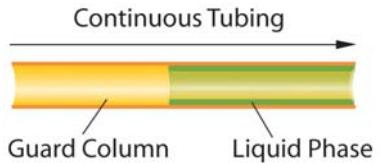
ID	df (µm)	temp. limits	20-Meter	40-Meter
0.18mm	1.00	-20 to 240°C	40924	40925

Integra-Guard™ built-in guard column

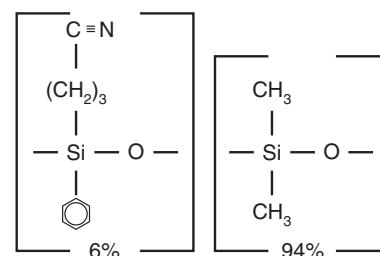
Get the protection without the connection!

For Rtx®-624 columns with built-in

Integra-Guard™ guard columns, see page 33.



Rtx®-624 Structure



similar phases

DB-1301, DB-624, HP-1301, HP-624, SPB-1301, SPB-624, VF-1301, VF-624ms, CP-1301, CP-Select 624 CB

also available

MXT® Columns

Rugged, flexible, Siltek® treated stainless steel tubing; inertness comparable to fused silica tubing. See page 111 for our MXT®-624 columns.

Explosives Analysis

Rtx®-TNT/Rtx®-TNT2 (proprietary Crossbond® phase)

- Application-specific columns for explosives in US EPA Method 8095.
- Low bleed—ideal for ECD analysis.
- Complete analysis in less than 20 minutes.
- Rtx®-TNT2 confirmation column provides 8 elution order changes under same conditions.
- Economical 3-packs.
- Stable to 310°C.

We designed Rtx®-TNT and Rtx®-TNT2 columns specifically for analyses of nitroaromatic compounds by GC/ECD, such as the 16 analytes listed in US EPA Method 8095. They provide better resolution and higher thermal stability than any other currently recommended columns. Operate the Rtx®-TNT primary column and Rtx®-TNT2 confirmation column under identical GC oven temperature programs.

Rtx®-TNT Columns (fused silica)

ID	df (µm)	temp. limits	6-Meter/3-pk.
0.53mm	1.50	-20 to 300/310°C	12998

Rtx®-TNT2 Columns (fused silica)

ID	df (µm)	temp. limits	6-Meter/3-pk.
0.53mm	1.50	-20 to 300/310°C	12999

restek innovation!

Improved resolution of nitroaromatic compounds such as those listed in US EPA Method 8095.

GC COLUMNS PLOT COLUMNS

PLOT Columns94-101
Features and Benefits, Quick Reference	
Chart, Phase Cross-Reference Chart95
PLOT Column Selection96-97
Rt-Alumina BOND98
Rt-Msieve 5A, MXT-Msieve 5A99
Porous Polymers100-101
<i>Rt-Q-BOND, Rt-QS-BOND, Rt-S-BOND, Rt-U-BOND</i>	



Top: Kelsea Miller, Caging Technician
Bottom: Kim Shaffer, Manufacturing Group Leader

What's
NEW?

look for this
circle

Features & Benefits of Restek PLOT Columns

Features	Benefits
Highest quality porous materials.	The most consistent and efficient analyses obtainable. Consistency in porosity and uniformity in particle and pore size are major concerns in designing the solid stationary phase. We developed a unique synthesis and selection technology to yield uniform, small diameter particles that are ideal for a specific separation.
Particles are 100% bonded to the tubing.	Reduced particle generation and flow restriction. Restek coating and bonding techniques produce strong, uniform particle adherence to the inside of the capillary tubing. Customers have described Restek's Rt®-Msieve 5A PLOT column as "bulletproof," meaning that the stationary phase is bonded so strongly that particle generation is minimized.
Reproducible quality.	Reproducible performance. Because we use advanced technology to make these columns, the entire manufacturing process is simple and stable. Each step of the column-making process is meticulously quality-checked, allowing Restek to offer the best quality PLOT columns available.

Quick Reference Chart

PLOT Column	Application	Page
Rt-Alumina BOND (Na ₂ SO ₄ deactivation)	C1–C5 hydrocarbons. Purity analysis of ethylene, propylene, butenes, butadiene	98
Rt-Msieve 5A	Permanent gas analysis. He, Ne, Ar, O ₂ , N ₂ , Xe, Rn, SF ₆ , and CH ₄ , C ₂ H ₆ , CO	99
Rt-Q-BOND	Nonpolar porous polymer. High retention for solvents, alcohols, polar volatiles, CO ₂ , sulfur, and ppm water in solvents	100
Rt-QS-BOND	Intermediate polarity porous polymer. Neutral solvents, ketones, esters, hydrocarbons, and baseline separation of ethane, ethene, acetylene	100
Rt-S-BOND	Intermediate polarity porous polymer. Light gases in ethylene and propylene, ketones, esters, hydrocarbons	100
Rt-U-BOND	Polar porous polymer. More retention for polar compounds	100

PLOT Column Phase Cross-Reference: Similar Selectivity

Restek	Porous Layer	Agilent/J&W	Supelco	Alltech	Varian/Chrompack	Quadrex
Rt-Alumina BOND (Na ₂ SO ₄ deactivation)	Aluminum oxide	GS-Alumina, HP PLOT S, HP PLOT M	Alumina-PLOT	AT-Alumina	CP-Al ₂ O ₃ /Na ₂ SO ₄	—
Rt-Msieve 5A	Molecular sieve 5A	GS-Molsieve, HP PLOT/Molesieve	Molsieve 5A PLOT	AT-Molesieve	CP-Molesieve 5A	PLT-5A
Rt-Q-BOND	DVB porous polymer	—	Supel-Q-PLOT	AT-Q	CP-PoraPlot Q, PoraBond Q	—
Rt-QS-BOND	Intermediate polarity porous polymer	GS-Q	—	—	—	—
Rt-S-BOND	DVB vinylpyridine polymer	—	—	—	CP-PoraPlot S	—
Rt-U-BOND	DVB ethyleneglycol- dimethylacrylate polymer	HP-UPLOT	—	—	CP-PoraPlot U, PoraBond U	—

New Generation Porous Layer Open Tubular (PLOT) Columns

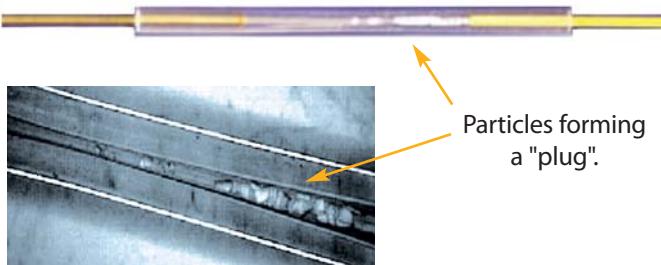
- Stabilized particle layers improve robustness and reproducibility of retention and flow; no retention time changes between columns.
- Fully compatible with valve switching and Deans switching systems.
- Highly efficient, reproducible analyses; ideal for permanent gases, solvents, and hydrocarbons.
- New manufacturing procedure improves performance of porous polymers and molecular sieves.

Porous layer open tubular (PLOT) columns are very beneficial for solving application problems, especially for the analysis of volatile compounds. PLOT columns have a unique selectivity, allowing for the separation of gaseous compounds at room temperature. Due to the adsorption mechanism of the supports used in PLOT columns, permanent gases and light hydrocarbons can be resolved at room temperature. Columns can then be programmed to higher temperatures to elute higher boiling compounds.

Traditional PLOT Columns Offer Poor Stability

The traditional PLOT column is built with a 5-50 μm layer of particles adhered to the tubing walls. Because this layer of particles generally lacks stability, PLOT columns must be used very carefully, as particle release is common and can cause unpredictable changes in retention time and flow behavior. PLOT columns generally must be used in conjunction with particle traps to prevent the contamination of valves, injectors, and GC detectors. Figure 1 shows an example of particle accumulation resulting in a blockage inside a Press-Tight® liner. If particle traps are not used, particles will hit the detector resulting in electronic noise, seen as spikes on the baseline. In the case of valves, particles can become lodged in the valve and result in leaks.

Figure 1 Particles released from traditional PLOT columns can cause blockages.

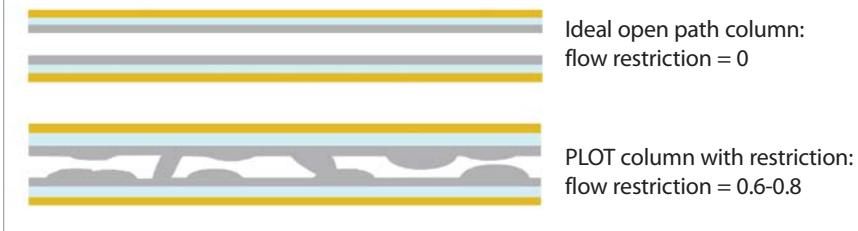
**New Stabilized PLOT Columns Minimize Particle Release**

Restek has developed new procedures to manufacture PLOT columns with concentric stabilized adsorption layers. The new generation PLOT columns show a constant flow behavior (permeability) and have significantly improved mechanical stability, resulting in easier operation, better chromatography, and reduced particle release. Greater particle stability means more reproducible retention times, virtually no spiking, and longer column lifetimes. This innovative stabilization chemistry technology is currently applied to Rt®-Alumina BOND, Rt®-MSieve 5A, Rt®-Q-BOND, Rt®-QS-BOND, Rt®-S-BOND, and Rt®-U-BOND columns.

Consistent Flow Restriction Factor (F) Guarantees Reproducible Flow

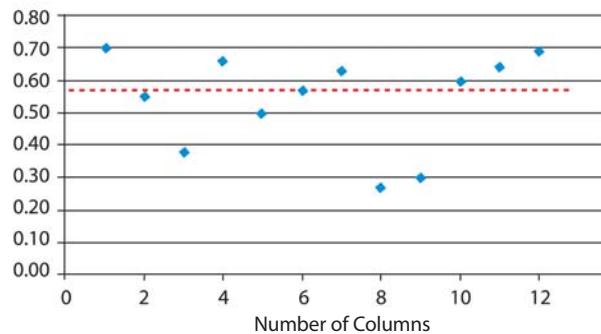
Thick layers of particles are difficult to deposit in a homogeneous layer and, in traditionally manufactured PLOT columns, this results in variable coating thicknesses. The positions where the layer is thicker act as restrictions and affect flow (Figure 2). Depending on the number and intensity of these restrictions, traditional PLOT columns often show greater variation in flow restriction than wall coated open tubular (WCOT) columns. In practice, conventional PLOT columns with the same dimensions can differ in flow by a factor of 4-6, when operated at the same nominal pressure. For applications where flow is important, such as with Deans switching, the nonreproducible flow behavior of most commercially available PLOT columns is a problem.

Figure 2 Inconsistent coating thicknesses result in restrictions that cause significant variation in flow.



In order to evaluate flow restriction reproducibility, Restek is introducing a new factor: the flow restriction factor (F). The flow restriction factor is based on the retention time of an unretained compound (Equation 1). It can be used to assess the degree of restriction of the column and to evaluate the reproducibility of the column coating process. Percent flow restriction can also be calculated as shown in Equation 2. Figure 3 shows what typically happens when a conventional PLOT column manufacturing process is used. Because of the difference in flow restriction, individual columns have very different flow characteristics. In contrast, Figure 4 shows results for columns generated using the new process (Rt®-QS-BOND, bonded porous polymer). Clearly, the new PLOT column process results in greater consistency in both column coating thickness and flow restriction.

Figure 3 Traditional PLOT columns show significant flow variability, indicating inconsistent column coating thicknesses (n=12).



Equation 1 Flow restriction factor (F) is used to demonstrate coating consistency.

$$F = \frac{t_{r1} \text{ of unretained component (uncoated tubing)}}{t_{r2} \text{ of unretained component (coated column)}}$$

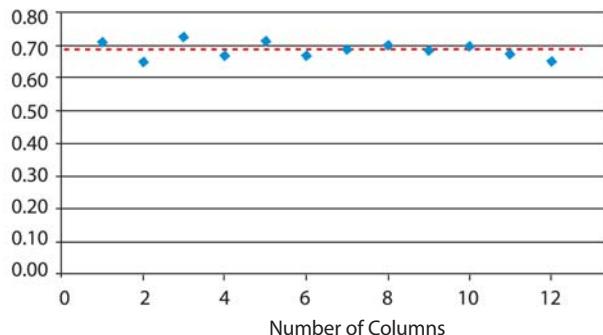
t_r = retention time

Note, F values will always be <1 as the coated column always has more restriction than the uncoated column.

Equation 2 Percent flow restriction of coated column.

$$\% \text{ restriction} = (1 - F) \times 100$$

Figure 4 Restek's new stabilized PLOT columns offer consistent flow resistance, giving more reproducible results column-to-column.



In summary, Restek's new PLOT column manufacturing process produces exceptionally robust PLOT columns, featuring concentric stabilized coating layers. These new columns have more consistent flow resistance and are recommended for applications sensitive to variation in retention time or flow. These columns are a significant advance in PLOT column technology and are ideal for more efficient, reproducible analyses of permanent gases, solvents, and hydrocarbons.

Rt®-Alumina BOND Columns



**advanced
technology**

Details on pages 96-97.

did you know?

Rt®-Alumina BOND columns show unique retention characteristics for hydrocarbons.



tech tip

Trace water in the carrier gas can affect the selectivity and retention of the Rt®-Alumina BOND column. The column can be regenerated by baking out the water (50°C to 200°C @ 8°C/min., 50cm/sec. flow rate). Periodic conditioning ensures excellent run-to-run retention time reproducibility.

The maximum programmable temperature for an Rt®-Alumina BOND column is 200°C. Higher temperatures cause irreversible changes to the porous layer adsorption properties.

NEW!
Rt®-Alumina BOND columns now available with KCl deactivation!

Rt®-Alumina BOND Column Characteristics

1. Highly selective for C1-C5 hydrocarbons; separates all unsaturated hydrocarbon isomers above ambient temperatures.
2. Reactivity of aluminum oxide stationary phase is minimized so that column response for polar unsaturates, such as dienes, is optimized. Column sensitivity or response ensures a linear and quantitative chromatographic analysis for these compounds.
3. Strong bonding prevents particle generation. The column can be used in valve switching operations, without release of particles that can harm the injection and detection systems.
4. The Rt®-Alumina BOND column is stable up to 200°C. If water is adsorbed on the column, it can be regenerated by conditioning at 200°C. Full efficiency and selectivity will be restored.

Guaranteed Reproducibility

Each Rt®-Alumina BOND column is tested with a hydrocarbon test mix to ensure proper phase thickness and selectivity. 1,3-Butadiene is used to calculate k (capacity factor), which is a measure of phase thickness. Selectivity is measured using retention indices for propadiene and methyl acetylene. The resolution of *trans*-2-butene and 1-butene is also verified. To measure coating efficiency, plates per meter are checked using 1,3-butadiene.

With our new technology, both Na₂SO₄ and KCl are available with the Rt®-Alumina BOND columns.

Rt®-Alumina BOND Columns (fused silica PLOT)

(Na₂SO₄ deactivation)

ID	df (µm)	temp. limits	30-Meter		50-Meter	
0.32mm	5	to 200°C	19757	enquire	19758	enquire
0.53mm	10	to 200°C	19755	enquire	19756	enquire

Rt®-Alumina BOND Columns (fused silica PLOT)

(KCl deactivation)

ID	df (µm)	temp. limits	30-Meter		50-Meter	
0.32mm	5	to 200°C	19761	enquire	19762	enquire
0.53mm	10	to 200°C	19759	enquire	19760	enquire

Restek Customer Service

In the U.S.

Call: 800-356-1688 (ext. 3) or 814-353-1300 (ext. 3)

Monday–Friday 8:00 a.m.–6:00 p.m. ET

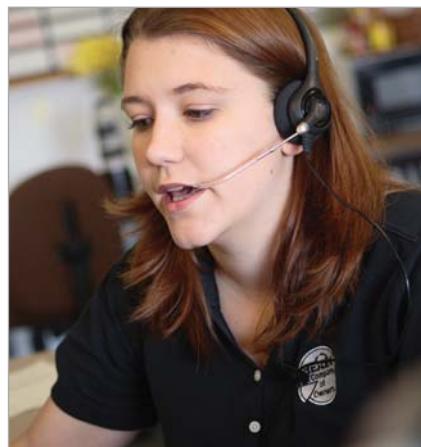
Fax: 814-353-1309—24-hours a day

Online: www.restek.com—24-hours a day

Outside the U.S.

Contact your Restek representative:

Refer to our list on pages 4-5 or visit our website at www.restek.com



Melissa Decker, Customer Service

Rt®-Msieve 5A PLOT Columns

Rt®-Msieve 5A PLOT columns are designed for efficient separation of Ar/O₂ and other permanent gases, including CH₄, C₂H₆, and CO. Special coating and deactivation procedures ensure chromatographic efficiency and the integrity of the porous layer coating. Molecular sieves have very high retention, allowing separations of permanent gases at temperatures above ambient. Additionally, Restek's unique immobilization process guarantees that the uniform particles remain adhered to the tubing—even after continuous valve-cycling.

Our revolutionary molecular sieve 5A PLOT columns separate Ar/O₂ and H₂/He at ambient temperature or above (see figure). These columns also are an excellent choice for rapid separation of permanent gases in refinery or natural gas.

Our deactivation technology also allows the CO peak to elute as a sharp peak. This is in contrast with other suppliers where CO often tails badly and cannot be quantified below % levels.

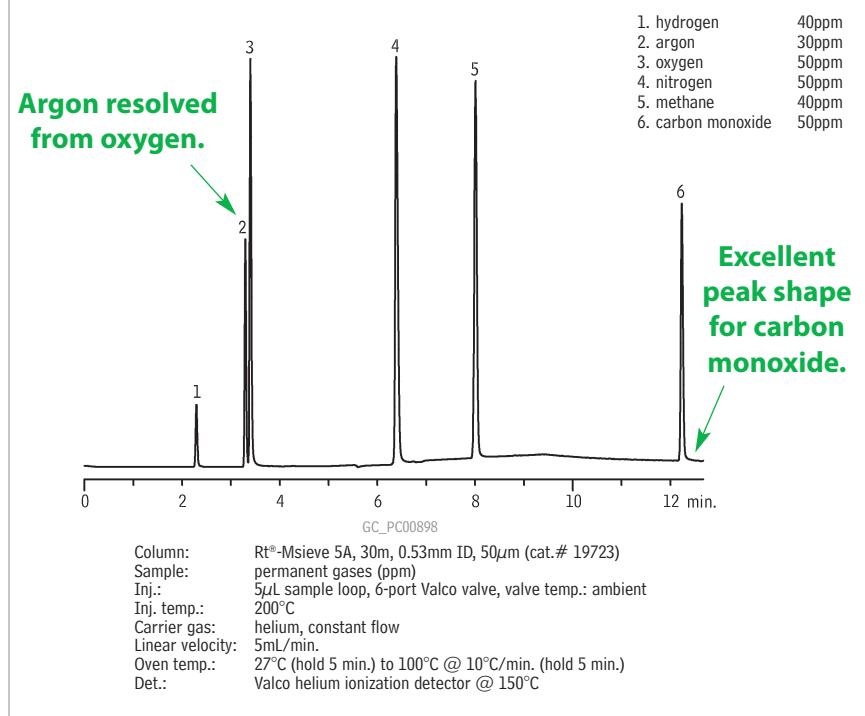
Rt®-Msieve 5A Columns (fused silica PLOT)

ID	df (μm)	temp. limits	15-Meter	30-Meter
0.32mm	30	to 300°C	19720	19722
0.53mm	50	to 300°C	19721	19723

MXT®-Msieve 5A (Siltek®-treated stainless steel PLOT)

ID	df (μm)	temp. limits	30-Meter
0.53mm	50	to 300°C	79723 enquire

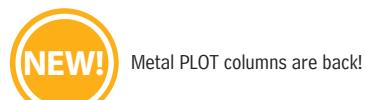
Permanent gases on an Rt®-Msieve 5A PLOT column.



Details on pages 96-97.

did you know?

Rt®-Msieve 5A PLOT columns are designed for efficient separation of Ar/O₂ and other permanent gases, including CH₄, C₂H₆, and CO.



Because molecular sieve materials are very hydrophilic, they will adsorb water from the sample or carrier gas. Water contamination can have a detrimental effect on peak symmetry and can reduce the resolution of all compounds. If water contamination occurs, reactivate your Rt®-Msieve 5A PLOT column by conditioning at 300°C with dry carrier gas flow for 3 hours.

did you know?

ShinCarbon ST micropacked columns are another alternative for analyzing permanent gases.

See page 120 for information.



Searching for a chromatogram?

www.restek.com

Porous Polymer PLOT Columns

Porous Polymers: Rt®-Q-BOND, Rt®-QS-BOND, Rt®-S-BOND, Rt®-U-BOND

Restek chemists have developed a new process for the manufacturing of porous polymer PLOT columns. The process incorporates the particles to the walls of the tubing, so there is virtually no particle generation. Because of the particle adhering to the walls of the tubing, there is reproducible performance from column to column, including selectivity and flow.



advanced
technology

Details on pages 96-97.

Rt®-Q-BOND Columns (fused silica PLOT)

100% divinylbenzene

- Nonpolar PLOT column incorporating 100% divinyl benzene.
- Excellent for analysis of C1 to C3 isomers and alkanes up to C12.
- CO₂ and methane separated from O₂/N₂/CO (Note: O₂/N₂/CO not separated at room temperature).
- Use for analysis of oxygenated compounds and solvents.
- Maximum temperature of 320°C.

ID	df (µm)	temp. limits	15-Meter	30-Meter
0.32mm	10	to 300/320°C	19743	19744
0.53mm	20	to 300/320°C	19741	19742

Rt®-QS-BOND Columns (fused silica PLOT)

porous divinyl benzene homopolymer

- Intermediate polarity PLOT column incorporating divinyl benzene homopolymer.
- Separates ethane, ethylene and acetylene to baseline.

ID	df (µm)	temp. limits	15-Meter	30-Meter
0.32mm	10	to 250°C	19739	19740
0.53mm	20	to 250°C	19737	19738

Rt®-S-BOND Columns (fused silica PLOT)

divinylbenzene 4-vinylpyridine

- Midpolarity PLOT column, incorporating divinyl benzene 4-vinylpyridine.
- Use for the analysis of nonpolar and polar compounds.

ID	df (µm)	temp. limits	15-Meter	30-Meter
0.32mm	10	to 250°C	19747	19748
0.53mm	20	to 250°C	19745	19746

Rt®-U-BOND Columns (fused silica PLOT)

divinylbenzene ethylene glycol/dimethylacrylate

- Polar PLOT column, incorporating divinylbenzene ethylene glycol/dimethylacrylate.
- Use for the analysis of polar and nonpolar compounds.

ID	df (µm)	temp. limits	15-Meter	30-Meter
0.32mm	10	to 190°C	19751	19752
0.53mm	20	to 190°C	19749	19750

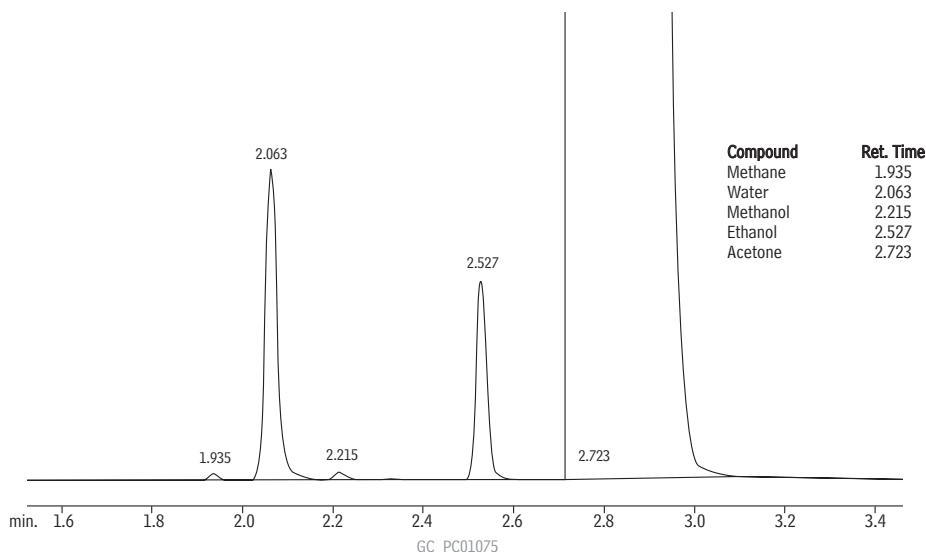


PLOT Column Particle Trap

- Includes two Press-Tight® connectors and a 2.5m column.
- Connect particle trap between column and detector or valve.
- Eliminates detector spikes and scratches in valve rotors.

The technology used to adhere particles in PLOT columns is excellent; however, there is still a possibility for particles to dislodge. When using PLOT columns with a valve-switching system or GC/MS, we recommend using a particle trap at the outlet end of the column.

Description	qty.	cat.#	PRICE
PLOT Column Particle Trap, 2.5m, 0.32mm ID w/2 Press-Tight Connectors	ea.	19753	enquire
PLOT Column Particle Trap, 2.5m, 0.53mm ID w/2 Press-Tight Connectors	ea.	19754	enquire

Water and ethanol in acetone on an Rt®-Q-BOND PLOT column.

Column: Rt®-Q-BOND, 30m, 0.53mm ID, 20 μ m (cat.# 19742)
 Sample: 0.5% water and ethanol in acetone
 Inj.: 3 μ L split (split ratio 11:1), 4mm single gooseneck liner w/ wool (cat.# 22405)
 Inj. temp.: 250°C
 Carrier gas: helium, constant flow
 Linear velocity: 28.7cm/sec. @ 200°C
 Oven temp.: 200°C, isothermal
 Det.: TCD @ 260°C



"Our chemists and process engineers are dedicated to effective scale-up and continuous process improvement. We make sure the exceptional performance of Restek products is maintained from development all the way through manufacturing."

Restek's Process Development Group
 pictured: Steve Constable, Wendy Henninger, Brian Salisbury, Rick Crago, Jennifer Weston, Tom Vezza (not pictured: Greg Hargrove)

GC COLUMNS

METAL (MXT[®])

COLUMNS

Metal (MXT) Columns	102-111
Overview	103
Guard/Retention Gap Columns	104
Tubing Scorer for MXT Columns	105
MXT-1	105
MXT-5	106
MXT-2887	71, 106
MXT-Biodiesel TG	74, 106
MXT-1HT Sim Dist/MXT-1 Sim Dist/	
MXT-500 Sim Dist	72, 107
MXT-20	108
MXT-35	108
MXT-50	108
MXT-65/MXT-65 TG	109
MXT-1301	109
MXT-1701	110
MXT-200	110
MXT-WAX	110
MXT-502.2	111
MXT-Volatiles	111
MXT-624	111



Top: Aaron Decker, Manufacturing Technician
Bottom: Bryan Wolcott, CFO and Tina Welch, HR Director



What is an MXT® column?

MXT® columns are made from stainless steel tubing that has had the internal surface treated with our exclusive Siltek® surface treatment. The Siltek® layer makes the surface as inert as deactivated fused silica. The unique Siltek® process enables us to offer MXT® columns in a wide range of internal diameters, including 0.18mm, 0.25mm, 0.32mm, and 0.53mm. Because the Siltek® layer permeates the stainless steel surface, rather than simply coating it, the layer is exceptionally flexible, so the tubing can be coiled to very small diameters. The standard coil diameter for MXT® columns is 4.5 inches. The minimum coil diameter for 0.53mm ID columns is 2.5 inches, and the minimum coil diameter for 0.25mm ID columns is 1.5 inches.

The unique properties of the Siltek® treated surface enable us to treat the tubing with a wide variety of polymer phases. The many choices of MXT® columns include:

- MXT®-1
- MXT®-5
- MXT®-1HT Sim Dist
- MXT®-2887
- MXT®-20
- MXT®-35
- MXT®-50
- MXT®-65
- MXT®-65TG
- MXT®-1301
- MXT®-1701
- MXT®-200
- MXT®-WAX
- MXT®-502.2
- MXT®-Volatile
- MXT®-624
- MXT®-Biodiesel TG
- Guard tubing



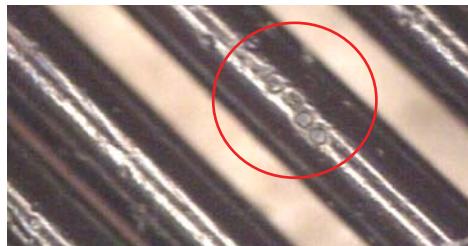
Compare MXT® columns and fused silica columns:

- Metal tubing allows MXT® columns to be used to higher temperatures (430°C) than fused silica columns (standard rating is 360°C). This is because the polyimide resin that encases the fused silica becomes brittle over time at high temperatures. MXT® columns do not become brittle over time.
- Inertness of MXT® columns and fused silica columns is similar, due to the unique properties of the Siltek® surface treatment in MXT® columns.
- Coating efficiency (plates/meter) of MXT® columns is equivalent to that of fused silica.
- MXT® columns will not break under stress, and they can be coiled to small diameters.

MXT®-Biodiesel TG columns are undamaged by high thermal cycles compared to high-temperature fused silica columns which break down under the same conditions.



MXT®-Biodiesel TG columns are undamaged by high thermal cycles.



HT fused silica columns, labeled as stable to 430°C, show pitting and breakdown.

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

MXT® columns are your best choice for:

- Situations in which the potential for column breakage is high:
 - field instruments
 - process GC
 - GCs with small ovens, such as portable instruments, requiring tightly coiled columns.
- High temperature chromatography. Siltek® deactivated stainless steel tubing can withstand temperatures exceeding 430°C; the only limitation to oven temperature is the polymer itself.

Custom MXT® columns

We are able to supply 0.18, 0.25, 0.28, 0.32, and 0.53mm ID columns with the phases listed above in many different configurations. If you do not see the column you need listed in the following pages, call us or your Restek representative, and we will be happy to help.

MXT® Guard/Retention Gap Columns

Intermediate-Polarity Deactivated MXT® Guard/Retention Gap Columns/Transfer Lines (passivated stainless steel)

- Useful for a wide range of applications.
- Use with most common solvents.
- Maximum temperature: 430°C

Nominal ID	Nominal OD	5-Meter	5-Meter/6-pk.	10-Meter
0.28mm	0.53 ± 0.025mm	70044	70044-600	70046
0.53mm	0.74 ± 0.025mm	70045	70045-600	70047

Hydroguard™ Treated MXT® Guard/Retention Gap Columns/Transfer Lines (passivated stainless steel)

- Extend analytical column lifetime by preventing degradation by harsh “steam-cleaning” water injections.
- Maximum temperature: 430°C.

When transfer lines from purge & trap systems, air monitoring equipment, or other instruments carry condensed water vapor, deactivated column tubing quickly becomes active because of the creation of free silanol groups. These silanol groups adsorb active oxygenated compounds such as alcohols and diols.

Restek chemists have addressed this concern and found a solution—the Hydroguard™ deactivation process. A unique deactivation chemistry creates a high-density surface that is not readily attacked by aggressive hydrolysis. The high-density surface coverage of the Hydroguard™ deactivation layer effectively prevents water vapor from reaching the fused silica surface beneath. Use Hydroguard™ tubing for connecting GCs to:

- Purge & trap systems.
- Headspace analyzers.
- Air analysis equipment and concentrator units.

Nominal ID	Nominal OD	5-Meter	10-Meter	30-Meter*	60-Meter†
0.28mm	0.53 ± 0.025mm	70080	70083	70086	70089
0.53mm	0.74 ± 0.025mm	70081	70084	70087	70090

*30- and 60-meter lengths are banded in 5-meter sections.

†Recommendation: Cut 60m guard columns into shorter lengths. Using full length may cause peak distortion.

a plus 1 story

“Since now almost 15 years , the Laboratoire Interuniversitaire des Systèmes Atmosphériques (LISA) of the University of Paris XII has been developing GC subsystems for on-board space probe GCMS experiments dedicated to the *in situ* analysis of extraterrestrial environments. Most of the capillary columns used in these subsystems were and still are provided by the Restek company.



One capillary column, MXT®-1701¹, was aboard the Huygens probe of the Cassini-Huygens mission which explored successfully in 2005 the atmosphere of Titan, the largest moon of Saturn. Four columns, MXT®-1, 20, 1701 and MXT®-UPLOT², are “en route” towards the comet Churyumov-Gerasimenko in the frame of the ESA Rosetta mission launched in 2004 to arrive by 2014. They will be used for the first time *in situ* analysis of a cometary nucleus. And finally, so far, 4 other PLOT (MXT® U) and WCOT^{3,4} (MXT®-1, 20 and CLP) columns have been selected and are currently being built in the GC of the Sample Analysis at Mars (SAM) Pyr/GCMS instrument, part of the payload of the NASA MSL 2009 Mars exploratory mission.

I would like to mention that all the columns selected for space mission are Silcosteel® treated metal capillary columns and they have all been submitted successfully to space qualification tests such as vibration, radiation and thermal cycles⁵, which demonstrated their robustness for space application.

Since the beginning, the Restek company has been more than a manufacturer providing LISA with columns. Indeed, it has been strongly collaborating and helping LISA to develop custom-made columns able to meet the requirements of such an unusual scientific goal for chromatographic columns. That is why LISA is very grateful to Restek for being this ideal partner without the help of which the study and development of chromatographic columns for space use could not have been possible.”

Robert STERNBERG

Responsible for the space GC team at LISA (Paris, France)

References

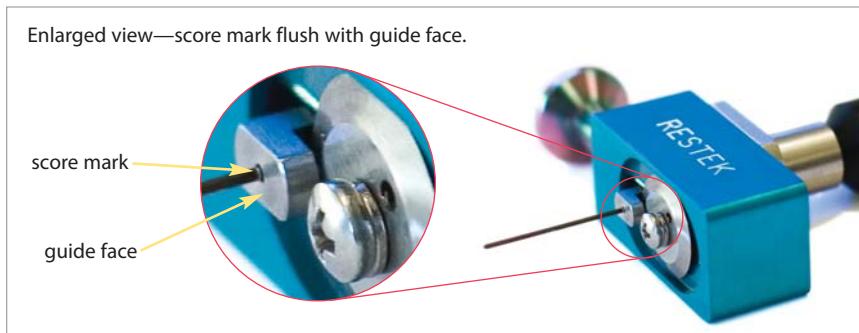
- ¹Sternberg, R., C. Szopa, D. Coscia, S. Zubrzycki, F. Raulin, C. Vidal-Madjar, H. Niemann and G. Israel *J. Chromatogr.*, 846, 307-315, (1999)
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Restek Tubing Scorer for MXT® Columns

- Makes perfect cuts every time.
- Easy to use.
- Leaves column entrance perfectly round.



Metal MXT® columns are easy to cut. Scoring wafers can be used, but may leave the column end irregularly shaped. The Restek tubing scorer is designed to make a perfect cut every time, leaving the column entrance perfectly round.



Make a perfect column cut every time!

Description	qty.	cat.#	price
Restek Tubing Scorer for MXT Columns (0.25-0.53mm ID & 0.5-0.8mm OD)	ea.	20523	
Replacement Scoring Wheel	ea.	20522	

MXT®-1 (nonpolar phase; Crossbond® 100% dimethyl polysiloxane)

- General purpose columns for solvent impurities, PCB congeners or (e.g.) Aroclor mixes, simulated distillation, drugs of abuse, gases, natural gas odorants, sulfur compounds, essential oils, hydrocarbons, semivolatiles, pesticides, and oxygenates.
- Temperature range: -60°C to 430°C.
- Equivalent to USP G1, G2, G38 phases.

MXT®-1 columns exhibit long lifetime and very low bleed at high operating temperatures. A proprietary synthesis process eliminates residual catalysts that could cause degradation and increase bleed.

MXT®-1 Columns (Siltek® treated stainless steel)

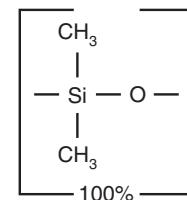
(Crossbond® 100% dimethyl polysiloxane)

ID	df (µm)	temp. limits	6-Meter	15-Meter	30-Meter	60-Meter	105-Meter
0.25mm	0.10	-60 to 330/430°C		70105	70116	70117	70114
	0.25	-60 to 430°C		70120	70123	70126	70129
	0.50	-60 to 400°C		70135	70138	70141	70144
	1.00	-60 to 340/360°C		70150	70153	70156	70159
0.28mm	0.10	-60 to 430°C	70102	70106	70109		
	0.25	-60 to 430°C		70121	70124	70127	
	0.50	-60 to 400°C		70136	70139	70142	
	1.00	-60 to 320/360°C		70151	70154	70157	
	3.00	-60 to 285/360°C		70181	70184	70187	
0.53mm	0.15	-60 to 430°C	70101*	70107			
	0.25	-60 to 430°C		70122	70125	70128	
	0.50	-60 to 400°C		70137	70140	70143	
	1.00	-60 to 320/360°C		70152	70155	70158	
	1.50	-60 to 310/360°C		70167	70170	70173	
	3.00	-60 to 285/360°C		70182	70185	70188	70189
	5.00	-60 to 270/360°C		70177	70179	70183	
	7.00	-60 to 250/360°C		70191	70192	70193	

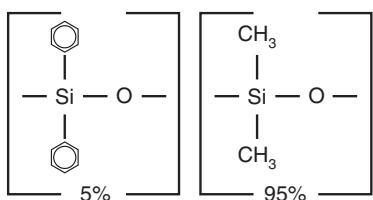
ID	df (µm)	temp. limits	10-Meter	20-Meter	40-Meter
0.18mm	0.20	-60 to 330/430°C	71811	71812	71813
	0.40	-60 to 320/400°C	71814	71815	71816

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

*For simulated distillation.

MXT®-1 Structure**similar phases**

DB-1, DB-1MS, HP-1, HP-1MS, Ultra-1, SPB-1,
Equity-1, MDN-1, CP-Sil 5 CB, VF-1ms

MXT®-5 Structure**MXT®-5 (low polarity phase; Crossbond® 5% diphenyl/95% dimethyl polysiloxane)**

- General purpose columns for drugs, solvent impurities, pesticides, hydrocarbons, PCB congeners or (e.g.) Aroclor mixes, essential oils, and semivolatiles.
- Temperature range: -60°C to 430°C.
- Equivalent to USP G27, G36 phases.

The 5% diphenyl/95% dimethyl polysiloxane stationary phase is the most popular GC stationary phase and is used in a wide variety of applications. All residual catalysts and low molecular weight fragments are removed from the MXT®-5 polymer, providing a tight monomodal distribution and extremely low bleed.

MXT®-5 Columns (Siltek® treated stainless steel)

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

ID	df (µm)	temp. limits*	15-Meter	30-Meter	60-Meter
0.25mm	0.10	-60 to 430°C	70205	70208	70211
	0.25	-60 to 430°C	70220	70223	70226
	0.50	-60 to 400°C	70235	70238	70241
	1.00	-60 to 340°C	70250	70253	70256
0.28mm	0.25	-60 to 430°C	70221	70224	70227
	0.50	-60 to 400°C	70236	70239	70242
	1.00	-60 to 325/360°C	70251	70254	70257
	3.00	-60 to 290/360°C	70281	70284	70287
0.53mm	0.25	-60 to 430°C	70222	70225	70228
	0.50	-60 to 400°C	70237	70240	70243
	1.00	-60 to 325/360°C	70252	70255	70258
	1.50	-60 to 300/360°C	70267	70270	70273
0.50mm	3.00	-60 to 290/360°C	70282	70285	70288
	5.00	-60 to 270/360°C	70277	70279	70283

ID	df (µm)	temp. limits	10-Meter	20-Meter	40-Meter
0.18mm	0.20	-60 to 325/430°C	71821	71822	71823
	0.40	-60 to 325/400°C	71824	71825	71826

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

MXT®-2887 (nonpolar phase; Crossbond® 100% dimethyl polysiloxane)

- Application-specific columns for simulated distillation.
- Stable to 400°C.

MXT®-2887 columns' stationary phase, column dimensions, and film thickness have been optimized to exceed the resolution and skewing factor requirements currently specified in ASTM method D2887. Each column is individually tested to guarantee a stable baseline with low bleed and reproducible retention times. The Crossbond® methyl silicone stationary phase has increased stability compared to packed columns, ensuring stable baselines and shorter conditioning times. Manufactured from Siltek®-treated stainless steel tubing, MXT® columns are the most durable high temperature GC columns available.

MXT®-2887 Column (Siltek® treated stainless steel)

(Crossbond® 100% dimethyl polysiloxane—for simulated distillation)

ID	df (µm)	temp. limits	10-Meter
0.53mm	2.65	-60 to 400°C	70199

similar phases

DB-2887, Petrocol EX2887, CP-HT-Simdist CB

MXT®-Biodiesel TG

- Fast analysis times and sharp mono-, di-, and triglyceride peaks.
- Stable at 430°C for reliable, consistent performance.
- Integra-Gap™ built-in retention gap on 0.53mm ID column eliminates column coupling completely.

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

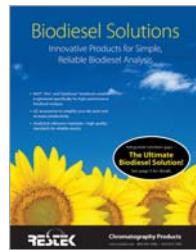
Description	temp. limits	cat.#	price
14m, 0.53mm ID, 0.16 w/2m Integra-Gap*	-60 to 380/430°C	70289	
10m, 0.32mm ID, 0.10	-60 to 380/430°C	70292	
10m, 0.32mm ID, 0.10 w/2m x 0.53mm Retention Gap**	-60 to 380/430°C	70290	
15m, 0.32mm ID, 0.10	-60 to 380/430°C	70293	
15m, 0.32mm ID, 0.10 w/2m x 0.53mm Retention Gap**	-60 to 380/430°C	70291	
2m x 0.53mm MXT Biodiesel TG Retention Gap		70294	

*Total column length = 16 meters.

**Connected with low-dead-volume MXT connector.



MXT®-Biodiesel TG column now available in more dimensions.

free literature


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MXT®-1HT Sim Dist/MXT®-1 Sim Dist/MXT®-500 Sim Dist (nonpolar phases)

- Application-specific columns in unbreakable Siltek® treated stainless steel tubing meet all resolution criteria for high temperature simulated distillation (e.g., ASTM Method D2887 Extended).
- MXT®-1HT Sim Dist and MXT®-1 Sim Dist phases offer true methyl silicone polarity; MXT®-500 Sim Dist phase is a carborane siloxane polymer.
- Stable to 430°C.

Manufactured from Siltek® treated stainless steel tubing, MXT® columns are the most durable high temperature GC columns available. As outlined in ASTM Method D6352, high temperature simulated distillation requires a column that can withstand temperatures to 430°C. MXT®-1HT Sim Dist and MXT®-500 Sim Dist columns exhibit excellent peak shape and low bleed, even at 430°C! The unique MXT®-1HT Sim Dist methyl silicone polymer gives the correct retention time/boiling point curve. The MXT®-500 Sim Dist carborane siloxane polymer offers a slight shift in the calculated boiling range distribution for petroleum samples containing aromatic hydrocarbons.

MXT®-1HT Sim Dist Column (Siltek® treated stainless steel)

ID	df (μm)	temp. limits	5-Meter
0.53mm	0.10	-60 to 430°C	70100
	0.20	-60 to 400/430°C	70103



MXT®-1HT Sim Dist column now available in 0.20μm film thickness.

MXT®-1 Sim Dist Column (Siltek® treated stainless steel)

ID	df (μm)	temp. limits	6-Meter
0.53mm	0.15	-60 to 430°C	70101

MXT®-500 Sim Dist Column (Siltek® treated stainless steel)

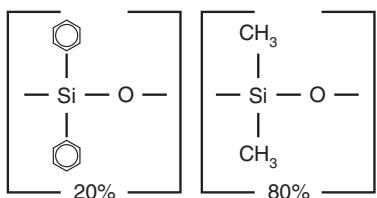
ID	df (μm)	temp. limits	6-Meter
0.53mm	0.15	-60 to 430°C	70104

similar phases

DB-1HT, CP-HT-Simdist CB

Polywax® Calibration Materials

Description	qty.	cat.#	price
Polywax 655 calibration material	1g	36225	
Polywax 1000 calibration material	1g	36227	

MXT®-20 Structure

MXT®-20 (low to midpolarity phase; Crossbond® 20% diphenyl/80% dimethyl polysiloxane)

- General purpose columns for volatile compounds, flavor compounds, and alcoholic beverages.
- Temperature range: -20°C to 340°C.
- Equivalent to USP G28, G32 phases.

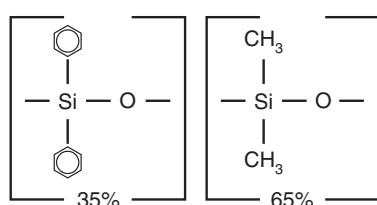
MXT®-20 polymer is synthesized to exacting standards. All residual catalysts and low molecular weight fragments are removed from the polymer, providing a tight monomodal distribution and extremely low bleed.

MXT®-20 Columns (Siltek® treated stainless steel)

(Crossbond® 20% diphenyl/80% dimethyl polysiloxane)

ID	df (µm)	temp. limits*	15-Meter	30-Meter	60-Meter
0.25mm	0.25	-20 to 320/340°C	70320	70323	70326
	1.00	-20 to 300/340°C	70350	70353	70356
0.28mm	0.25	-20 to 310/340°C	70321	70324	70327
	1.00	-20 to 295/340°C	70351	70354	70357
0.30mm	3.00	-20 to 260/340°C	70381	70384	70387
	3.00	-20 to 260/340°C	70382	70385	70388
0.53mm	0.25	-20 to 310/340°C	70322	70325	70328
1.00	-20 to 295/340°C	70352	70355	70358	
	3.00	-20 to 260/340°C	70382	70385	70388

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

MXT®-35 Structure

MXT®-35 (midpolarity phase; Crossbond® 35% diphenyl/65% dimethyl polysiloxane)

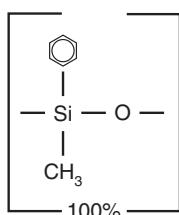
- General purpose columns for organochlorine pesticides, PCB congeners or (e.g.) Aroclor mixes, herbicides, pharmaceuticals, sterols, rosin acids, and phthalate esters.
- Temperature range: 0°C to 340°C.
- Equivalent to USP G42 phase.

MXT®-35 Columns (Siltek® treated stainless steel)

(Crossbond® 35% diphenyl/65% dimethyl polysiloxane)

ID	df (µm)	temp. limits*	15-Meter	30-Meter	60-Meter
0.25mm	0.50	0 to 310/340°C	70435	70438	
	1.00	0 to 300/340°C	70450	70453	
0.53mm	1.00	0 to 260/340°C	70452	70455	70458
	1.50	0 to 250/340°C	70467	70470	70473
1.00	3.00	0 to 240/340°C	70482	70485	70488

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

MXT®-50 Structure

MXT®-50 (midpolarity phase; Crossbond® 100% methylphenyl polysiloxane)

- General purpose columns for pesticides, herbicides, rosin acids, phthalate esters, triglycerides, and sterols.
- Temperature range: 0°C to 300°C.
- Equivalent to USP G3 phase.

MXT®-50 Columns (Siltek® treated stainless steel)

(Crossbond® 100% methylphenyl polysiloxane)

ID	df (µm)	temp. limits*	15-Meter	30-Meter	60-Meter
0.53mm	0.83	0 to 270/300°C	70569		
	1.00	0 to 260/280°C	70552	70555	70558
	1.50	0 to 250/280°C	70567	70570	70573

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

similar phases

HP-17, SPB-50, SP-2250

MXT®-65 (mid to high polarity phase; Crossbond® 65% diphenyl/35% dimethyl polysiloxane)

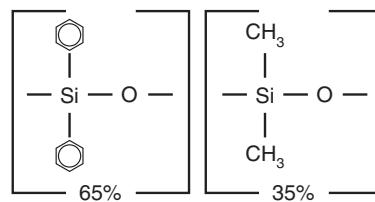
- General purpose columns for phenols and fatty acids.
- Temperature range: 50°C to 300°C.
- Equivalent to USP G17 phase.

MXT®-65 Columns (Siltek® treated stainless steel)

(Crossbond® 65% diphenyl/35% dimethyl polysiloxane)

ID	df (µm)	temp. limits	15-Meter	30-Meter
0.25mm	0.25	50 to 300°C	77020	77023
	0.50	50 to 300°C	77035	77038
	1.00	50 to 280/300°C	77050	77053

MXT®-65/MXT®-65TG Structure



similar phases

TAP-CB, 400-65HT, 007-65HT

MXT®-65TG (high polarity phase; Crossbond® 65% diphenyl/35% dimethyl polysiloxane)

- Application-specific columns, specially tested for triglycerides.
- Stable to 370°C.

The MXT®-65TG phase resolves triglycerides by degree of unsaturation as well as by carbon number. Because of the chemistry required to achieve 370°C thermal stability, an MXT®-65TG column should not be used for analyses of compounds that contain active oxygenated groups.

MXT®-65TG Columns (Siltek® treated stainless steel)

(Crossbond® 65% diphenyl/35% dimethyl polysiloxane)

ID	df (µm)	temp. limits	15-Meter	30-Meter
0.25mm	0.10	20 to 370°C	77005	77008
0.53mm	0.10	20 to 370°C	77007	77010

MXT®-1301 (low to midpolarity phase; Crossbond® 6% cyanopropylphenyl/94% dimethyl polysiloxane)

- General purpose columns for residual solvents, alcohols, oxygenates, and volatile organic compounds.
- Temperature range: -20°C to 280°C.
- Equivalent to USP G43 phase.

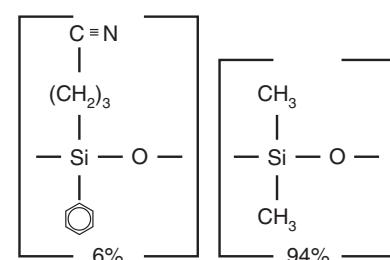
MXT®-1301 Columns (Siltek® treated stainless steel)

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

ID	df (µm)	temp. limits*	15-Meter	30-Meter	60-Meter
0.25mm	0.25	-20 to 280°C	76020	76023	76026
	1.00	-20 to 260/280°C	76050	76053	76056
0.28mm	0.25	-20 to 280°C	76021	76024	76027
	1.00	-20 to 260/280°C	76051	76054	76057
	1.50	-20 to 250/280°C	76066	76069	76072
0.53mm	0.25	-20 to 280°C	76022	76025	76028
	1.00	-20 to 260/280°C	76052	76055	76058
	1.50	-20 to 250/280°C	76067	76070	76073
	3.00	-20 to 240/280°C	76082	76085	76088

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

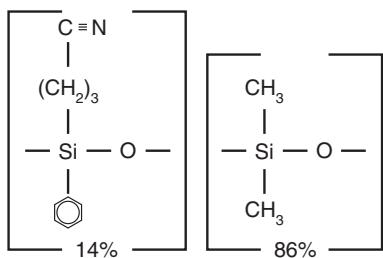
MXT®-1301 Structure



similar phases

DB-1301, DB-624, HP-1301, SPB-1301, SPB-624

MXT®-1701, MXT®-200, MXT®-WAX

MXT®-1701 Structure

MXT®-1701 (midpolarity phase; Crossbond® 14% cyanopropylphenyl/86% dimethyl polysiloxane)

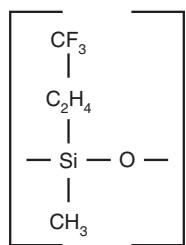
- General purpose columns for alcohols, oxygenates, PCB congeners or (e.g.) Aroclor mixes, and pesticides.
- Temperature range: -20°C to 280°C.
- Equivalent to USP G46 phase.

MXT®-1701 Columns (Siltek® treated stainless steel)

(Crossbond® 14% cyanopropylphenyl/86% dimethyl polysiloxane)

ID	df (µm)	temp. limits*	15-Meter	30-Meter	60-Meter
0.25mm	0.25	-20 to 280°C	72020	72023	72026
	1.00	-20 to 260°C	72050	72053	72056
0.28mm	0.25	-20 to 280°C	72021	72024	72027
	1.00	-20 to 260°C	72051	72054	72057
0.53mm	0.25	-20 to 280°C	72022	72025	72028
	0.50	-20 to 270/280°C	72037	72040	72043
1.00	0.25	-20 to 260°C	72052	72055	72058
	1.50	-20 to 250°C	72067	72070	72073
	3.00	-20 to 240°C	72082	72085	72088

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

MXT®-200 Structure

MXT®-200 (midpolarity phase; Crossbond® trifluoropropylmethyl polysiloxane)

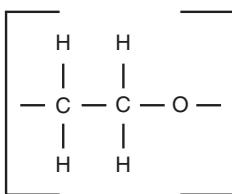
- General purpose columns for solvents, Freon® fluorocarbons, alcohols, ketones, silanes, and glycols. Excellent confirmation column with an Rtx®-5 column, for phenols, nitrosamines, organochlorine pesticides, chlorinated hydrocarbons, and chlorophenoxy herbicides.
- Temperature range: -20°C to 400°C.
- Equivalent to USP G6 phase.

MXT®-200 Columns (Siltek® treated stainless steel)

(Crossbond® trifluoropropylmethyl polysiloxane)

ID	df (µm)	temp. limits*	15-Meter	30-Meter	60-Meter
0.25mm	0.50	-20 to 400°C	75035	75038	
	1.00	-20 to 310/360°C	75050	75053	
0.53mm	1.00	-20 to 290/360°C	75052	75055	75058
	1.50	-20 to 280/360°C	75067	75070	75073
3.00	1.00	-20 to 260/360°C	75082	75085	75088
	2.00	-20 to 240/360°C			

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

MXT®-WAX Structure

MXT®-WAX (polar phase; Crossbond® Carbowax® polyethylene glycol)

- General purpose columns for FAMEs, flavor compounds, essential oils, amines, solvents, xylene isomers, and US EPA Method 603 (acrolein/acrylonitrile).
- Resistant to oxidative damage.
- Temperature range: 40°C to 260°C.
- Equivalent to USP G14, G15, G16, G20, and G39 phases.

MXT®-WAX Columns (Siltek® treated stainless steel)

(Crossbond® Carbowax® polyethylene glycol—provides oxidation resistance)

ID	df (µm)	temp. limits	15-Meter	30-Meter	60-Meter
0.25mm	0.10	40 to 260°C	70605	70608	70611
	0.25	40 to 260°C	70620	70623	70626
	0.50	40 to 260°C	70635	70638	70641
0.28mm	0.25	40 to 250/260°C	70621	70624	70627
	0.50	40 to 250/260°C	70636	70639	70642
	1.00	40 to 240/250°C	70651	70654	70657
0.53mm	0.25	40 to 250/260°C	70622	70625	70628
	0.50	40 to 250/260°C	70637	70640	70643
	1.00	40 to 240/250°C	70652	70655	70658
	1.50	40 to 230/250°C	70666	70669	70672
	2.00	40 to 220/250°C	70667	70670	

similar phases

DB-WAX, DB-WAXetr, HP-Wax, HP-Innowax, Supelcowax 10, CP-Wax 52 CB

MXT®-502.2 (proprietary Crossbond® diphenyl/dimethyl polysiloxane phase)

- Application-specific columns with unique selectivity for volatile organic pollutants, cited in US EPA Method 502.2 and in many gasoline range organics (GRO) methods for monitoring underground storage tanks. Excellent separation of trihalomethanes; ideal polarity for light hydrocarbons and aromatics.
- Temperature range: -20°C to 320°C.

An MXT®-502.2 column will enable you to quantify all compounds listed in US EPA methods 502.2 or 524.2, whether you use a mass spectrometer or a PID in tandem with an ELCD. The diphenyl/dimethyl polysiloxane based MXT®-502.2 stationary phase provides low bleed and thermal stability to 320°C. A 105-meter column can separate the light gases specified in EPA methods without subambient cooling.

MXT®-502.2 Columns (Siltek® treated stainless steel)

(proprietary Crossbond® diphenyl/dimethyl polysiloxane phase)

ID	df (µm)	temp. limits	30-Meter	60-Meter	105-Meter
0.25mm	1.40	-20 to 270/320°C	70915	70916	
0.28mm	1.60	-20 to 250/320°C	70919	70920	70921
0.53mm	3.00	-20 to 270/320°C	70908	70909	70910

ID	df (µm)	temp. limits	10-Meter	20-Meter
0.18mm	1.00	-20 to 270/320°C	71891	71892

similar phase

DB-502.2

MXT®-Volatiles (proprietary Crossbond® diphenyl/dimethyl polysiloxane phase)

- Application-specific columns for volatile organic pollutants.
- Temperature range: -20°C to 320°C.

MXT®-Volatiles columns were the first columns designed specifically for analyses of the 34 volatile organic pollutants listed in US EPA methods 601, 602, and 624. With these columns, you can quantify all compounds listed in these methods, whether you use a mass spectrometer or a PID in tandem with an ELCD. The diphenyl/dimethyl polysiloxane based MXT®-Volatiles stationary phase provides low bleed and thermal stability to 320°C.

MXT®-Volatiles Columns (Siltek® treated stainless steel)

(proprietary Crossbond® diphenyl/dimethyl polysiloxane phase)

ID	df (µm)	temp. limits*	30-Meter	60-Meter	105-Meter
0.25mm	1.00	-20 to 280/320°C	70900	70903	
0.28mm	1.25	-20 to 280/320°C	70924	70926	70928
0.53mm	2.00	-20 to 280/320°C	70925	70927	70929
	3.00	-20 to 250/320°C	70922	70923	

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

similar phase

VOCOL

MXT®-624 (low to midpolarity phase; Crossbond® 6% cyanopropylphenyl/94% dimethyl polysiloxane)

- Application-specific columns for volatile organic pollutants. Recommended in US EPA methods for volatile organic pollutants.
- Temperature range: -20°C to 280°C.
- Equivalent to USP G43 phase.

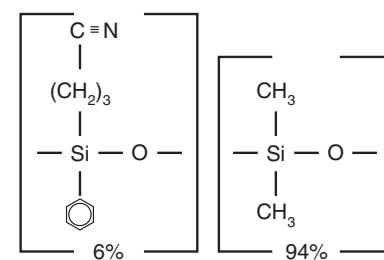
The unique polarity of "624" columns makes them ideal for analyses of volatile organic pollutants. Although the MXT®-502.2 column is recommended in many methods, MXT®-624 columns offer the best separation of the early-eluting gases.

MXT®-624 Columns (Siltek® treated stainless steel)

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

ID	df (µm)	temp. limits	30-Meter	60-Meter
0.25mm	1.40	-20 to 240/280°C	70968	70969
0.53mm	3.00	-20 to 240/280°C	70971	70973

ID	df (µm)	temp. limits	10-Meter	20-Meter
0.18mm	1.00	-20 to 240/280°C	71893	71894

MXT®-624 Structure

similar phases

DB-624, HP-624

GC COLUMNS PACKED/ MICROPACKED COLUMNS

Bonded Stationary Phases	113-114,116
Packed Column Tubing	115
Stock Packed Columns	116-117
Specialty Packed Columns	118-121
Micropacked Columns	120-122
Packed/Micropacked Column Installation Kits	123
Packed Column Packing Materials	124-127
Liquid Phases	128
USP Cross-Reference	129
Custom Packed/Micropacked Columns	130-132
Packed Column Configurations	133



Top: Scott Grossman, Applications Chemist
Bottom: Glenn Gerhab, Quality Assurance

**Restek's packed columns deliver the
1-2-3 PUNCH!**

1. Bonded stationary phases mean short conditioning times, low bleed, and unsurpassed column lifetimes.
2. SilcoSmooth™ tubing provides the inertness of glass and the durability of stainless steel.
3. Silcoport™ diatomaceous earth provides unsurpassed inertness for trace analysis.

Bonded Stationary Phases

We combined our stationary phase synthesis experience with our unique Silcoport™ packing deactivation process to create bonded phase packings that provide longer lifetimes, lower bleed, and shorter conditioning times.

Bonded methyl silicone phases (Rtx®-1 and Rtx®-5) and bonded Carbowax® phase (Stabilwax®) are completely cross-linked on Silcoport™ packing. We have evaluated Rtx®-1 and Rtx®-5 bonded packed column phases side-by-side with nonbonded phases of comparable polarity; the bonded phases last longer than the equivalent non-bonded packing materials. Table I shows that retention times on an Rtx®-1 bonded packed column are highly repeatable after only 30 minutes of conditioning.

Table I Retention data shows the perfect reproducibility of the bonded phase packed columns with respect to retention times.

Hydrocarbon	Min.	Max.	Mean	Stand. Dev.
C5	0.241	0.243	0.242	0.001
C6	0.493	0.497	0.495	0.002
C10	5.746	5.765	5.752	0.005
C20	18.482	18.491	18.486	0.004
C28	25.093	25.103	25.098	0.004
C40	32.160	32.171	32.166	0.004
C44	34.316	34.328	34.326	0.007

n=9 columns

Who says packed columns are old technology? Not Restek!

By combining flexible Siltek® tubing with low-bleed bonded phases, we have made the most significant improvements in packed column technology in more than 25 years!

Columns available in
0.53, 0.75, 1, 2, 3.2, & 5.2mm ID.

Bonded phase packings decrease conditioning times and bleed, and increase column lifetime.

Columns can be configured for all GC models.

Silcosmooth™ tubing has a Siltek® treated surface, which is more inert than glass.

The most complete line of packing materials available.

Bonded Stationary Phases

Bonded Packed Column Stationary Phases

- Short conditioning times.
- Low bleed levels.
- Higher sensitivities.
- Longer column lifetimes.
- Unsurpassed inertness for active compounds.

Bonded phases are used in capillary columns because they provide a dramatic increase in column quality. To truly bridge the gap between traditional packed columns and capillary columns, it was necessary to develop bonded liquid phases for packed columns. Packed column chromatographers can expect shorter conditioning times, lower bleed, and longer column lifetimes by using Restek bonded phase packed columns.

Restek's packed columns deliver the 1-2-3 PUNCH!

1. Bonded stationary phases mean short conditioning times, low bleed, and unsurpassed column lifetimes.
2. SilcoSmooth™ tubing provides the inertness of glass and the durability of stainless steel.
3. Silicopore™ diatomaceous earth provides unsurpassed inertness for trace analysis.

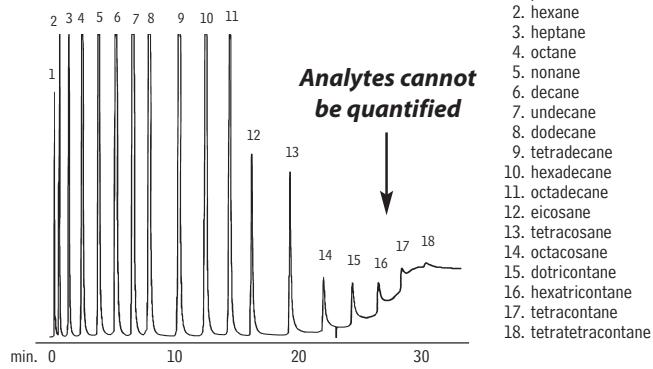
Bonded phases also last much longer than nonbonded phases. Bonded phases are more resistant to oxidation than nonbonded phases because of the stronger intermolecular forces produced by cross-linking. Because the material is thoroughly cross-linked, the phase will not migrate or puddle, as often happens with nonbonded phases. Figure 1 shows a comparison of a bonded and a nonbonded methyl silicone column after 170 temperature cycles. The results show the impressive durability of bonded phases.

Equivalent Liquid Phases

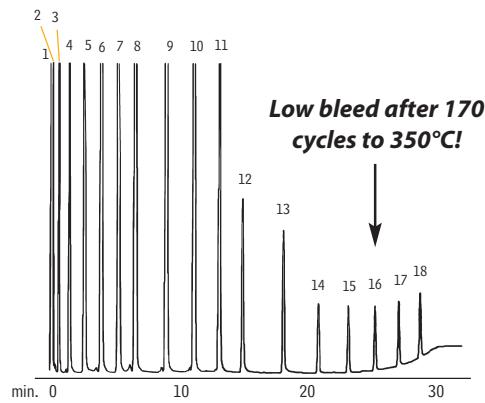
BP-1, CC-1, CP-Sil 5CB, DB-1, DC-200, GE-SF-96, HP-1, HP-101, OV-1, OV-101,
Rtx-1 RSK-150, RH-1, SE-30, SP-2100, SPB-1, UCC W-98
Rtx-5 BP-5, CB-5, CC-5, CP-Sil 8CB, DB-5, HP-5, OV-73, SE-52, SE-54, SPB-5, Ultra-5
Stabilwax BP-20, CP-Wax, CW-20, DB-Wax, HP-Innowax, PE-Wax, Supelcowax-10

Figure 1 Bonded packed columns exhibit longer lifetime than nonbonded packed columns.

Nonbonded Methyl Silicone



Bonded Rtx®-1



25" x 1/8" x 2mm ID Rtx®-1 Sim Dist 2887 SilcoSmooth™ stainless steel (cat.# 80000-800)

1.0µl direct injection, 1–12% (w/w) each component

Oven temp.: 35°C to 350°C @ 10°C/min. (hold 5 min.)

Inj. & det. temp.: 350°C

Carrier gas: helium @ 25mL/min.

FID sensitivity: 256 x 10¹¹ AFS

cat.# 31674 (1% each listed analyte in CS₂) and cat.# 31675 (5% each, neat) meet requirements of ASTM D2887-01.

Packed Column Tubing

Restek offers a wide range of tubing choices for our packed columns, including SilcoSmooth™ (Siltek®-treated stainless steel), stainless steel, Hastelloy®, nickel, copper, and Teflon® tubing. SilcoSmooth™ and stainless steel tubing are our two most popular column materials. SilcoSmooth™ tubing is an excellent replacement for fragile glass columns. Stainless steel tubing works well with most applications for nonreactive compounds.

SilcoSmooth™ Tubing

If your analysis involves reactive compounds, you can use fragile and inflexible glass columns, or you can step up to SilcoSmooth™ tubing which combines the inertness of glass with the strength and flexibility of stainless steel. Made from ultra-smooth, seamless 304 stainless steel and treated with Restek's innovative Siltek® deactivation process, SilcoSmooth™ tubing can replace glass columns for virtually any application.

Stainless Steel Tubing

If you are analyzing hydrocarbons or nonreactive compounds, you can use our rugged, flexible, and economical stainless steel columns. Restek stainless steel columns are made from high-quality weldrawn tubing.

Hastelloy® Tubing

Hastelloy® tubing is a nickel-chromium alloy with excellent inertness. It is normally used only for highly corrosive or oxidizing compounds or gases.

Nickel Tubing

Nickel tubing is often used for analyses of caustic or oxidizing compounds or gases.

Copper Tubing

Copper is a general purpose tubing that is only recommended for nonactive compounds.

Teflon® Tubing

Teflon® tubing is often used for reactive compounds or other special applications. Note that this tubing is permeable to gases.

Table I Packed column tubing dimensions

Material	1/4-inch OD x 5.3mm ID	3/16-inch OD x 3.1mm ID ¹	1/8-inch OD x 2.0mm ID ²	1/16-inch OD x 1.2mm ID ³	1/32-inch OD x 1.0mm ID ³	0.95mm OD x 0.75mm ID ⁴
SilcoSmooth	✓	✓	✓		✓	✓
Stainless Steel	✓	✓	✓	✓	✓	✓
Hastelloy			✓			
Nickel			✓			
Copper	✓		✓			
Teflon			✓			

¹ 3/16-inch OD x 3.1mm ID replaces 1/4-inch OD x 4mm ID glass columns.

² 1/8-inch OD x 2mm ID replaces 1/4-inch OD x 2mm ID glass columns.

³ 1/16-inch OD x 1.2mm and 1.0mm ID micropacked columns are designed for packed column injection systems.

⁴ 0.95mm OD x 0.75mm ID micropacked columns are designed for capillary injection systems.

1/8- or 3/16-inch OD columns are easily adaptable to 1/4-inch or 5mm ID injection ports, using inexpensive adaptors. All Restek packed columns can be coiled to fit any instrument configuration.

please note

We do not offer packed glass columns. SilcoSmooth™ columns offer the inertness of glass, without breakage problems.

did you know?

Restek's advanced packed column technology provides columns with unmatched inertness and efficiency.

Packed Column Reduction Fittings

We will weld tubing reducers or VCR fittings to your column. Call Customer Service (ext. 3), or your Restek representative, for pricing & availability.



Welded Tubing Reducers



Welded VCR Fittings

Stock Packed Columns

Bonded Packed Column Stationary Phases

- Low bleed levels.
- Longer column lifetimes.
- Short conditioning times.

Bonded Phase on 100/120 Silcoport W	Stainless Steel Tubing				SilcoSmooth Tubing**					
	L (ft.)	OD (in.)	ID (mm)	cat.#*	price	L (m)	OD (in.)	ID (mm)	cat.#*	price
3% Rtx-1	6	1/8	2.1	80441-		2	1/8	2	80401-	
10% Rtx-1	6	1/8	2.1	80442-		2	1/8	2	80405-	
20% Rtx-1	6	1/8	2.1	80443-		2	1/8	2	80409-	
3% Rtx-5	6	1/8	2.1	80444-		2	1/8	2	80477-	
10% Rtx-5	6	1/8	2.1	80445-		2	1/8	2	80478-	
20% Rtx-5	6	1/8	2.1	80446-		2	1/8	2	80479-	
5% Rtx-Stabilwax	6	1/8	2.1	80447-		2	1/8	2	80415-	
10% Rtx-Stabilwax	6	1/8	2.1	80448-		2	1/8	2	80416-	
20% Rtx-Stabilwax	6	1/8	2.1	80449-		2	1/8	2	80417-	
Rtx-1 SimDist 2887***	25"	1/8	2.1	80450-		25"	1/8	2	80000-	

please note

These columns are for on-column injections. For not-on-column configurations, add suffix -901.

Chromosorb®-Based Packed Columns

On 100/120 Silcoport W***	Stainless Steel Tubing				SilcoSmooth Tubing**					
	L (ft.)	OD (in.)	ID (mm)	cat.#*	price	L (m)	OD (in.)	ID (mm)	cat.#*	price
3% Rt-101	6	1/8	2.1	80461-		2	1/8	2	80400-	
3% Rt-2100	6	1/8	2.1	80462-		2	1/8	2	80420-	
5% Rt-1200/1.75% Bentone 34	6	1/8	2.1	80463-		2	1/8	2	80125-	
5% Rt-1200/5% Bentone 34	6	1/8	2.1	80464-		2	1/8	2	80129-	

for custom columns

see page 131

On Chromosorb PAW	Mesh	Stainless Steel Tubing				SilcoSmooth Tubing**					
		L (ft.)	OD (in.)	ID (mm)	cat.#*	price	L (m)	OD (in.)	ID (mm)	cat.#*	price
10% TCEP	100/120	8	1/8	2.1	80465-		2.5	1/8	2	80126-	
23% Rt-1700	80/100	30	1/8	2.1	80466-		9.2	1/8	2	80128-	

please note

Temperature limits for stationary phases are listed on page 128.

Porous Polymers

Restek offers a full range of porous polymers, including HayeSep®, Porapak, Chromosorb® Century Series polymers, and Tenax® TA packing, for analyses of volatile components and light solvents. Our QA procedures give you the confidence that every batch you purchase will deliver consistent column-to-column performance.

Porous Polymer Packed Columns

Porous Polymers	Stainless Steel Tubing				SilcoSmooth Tubing**					
	L (ft.)	OD (in.)	ID (mm)	cat.#*	price	L (m)	OD (in.)	ID (mm)	cat.#*	price
HayeSep Q	6	1/8	2.1	80467-		2	1/8	2	80433-	
Porapak Q	6	1/8	2.1	80468-		2	1/8	2	80427-	
Porapak QS	6	1/8	2.1	80469-		2	1/8	2	80426-	
Porapak R	6	1/8	2.1	80470-		2	1/8	2	80425-	
Chromosorb 101	6	1/8	2.1	80471-		2	1/8	2	80435-	
Chromosorb 102	6	1/8	2.1	80472-		2	1/8	2	80434-	

*Please add column instrument configuration suffix number to cat.# when ordering. See chart on the next page.

**Siltek-treated stainless steel.

***Modified version of Chromosorb W; highest inertness, most consistent performance.

also available

Chromosorb®, Porapak, HayeSep®, and Tenax® packing materials.

See pages 126-127.

CarboBlack Solid Supports

Graphitized carbon black offers unique selectivity and very little adsorption for alcohol analyses. Two types of CarboBlack supports are available, CarboBlack B and CarboBlack C. CarboBlack B support, with its higher surface area, can hold up to a 10% loading of a nonsilicone liquid phase. CarboBlack C support can hold up to a 1% loading of a nonsilicone liquid phase. Many Carbowax® 20M-loaded CarboBlack packings are available. CarboBlack packings are treated with KOH or picric acid for basic or acidic compounds, and special alcoholic beverage loadings are available. CarboBlack supports provide resolution and retention similar to Carbopack and Carbograph supports.

On CarboBlack B	Mesh	Stainless Steel Tubing				SilcoSmooth Tubing**				price
		L (ft.)	OD (in.)	ID (mm)	cat.#*	L (m)	OD (in.)	ID (mm)	cat.#*	
5% Carbowax 20M	80/120	—	—	—	—	2	1/8	2	80105-	
5% Carbowax 20M	60/80	6	1/8	2.1	88012-	1.8	1/8	2	80106-	
6.6% Carbowax 20M	80/120	6	1/8	2.1	80451-	2	1/8	2	80107-	
4% Carbowax 20M/ 0.8% KOH	60/80	—	—	—	—	2	1/8	2	80116-	
1% Rt-1000	60/80	8	1/8	2.1	88013-	2.4	1/8	2	80206-	
1% Rt-1000	60/80	6	1/8	2.1	80452-	2	1/8	2	80207-	
3% Rt-1500	80/120	10	1/8	2.1	80453-	3.05	1/8	2	80211-	
1% Rt-1510	60/80	10	1/8	2.1	80454-	3.05	1/8	2	80216-	
1.5% XE-60/1% H ₃ PO ₄	60/80	6	1/8	2.1	80455-	1.8	1/8	2	80305-	

Nickel 200 Tubing

On CarboBlack B	Mesh	L	OD	ID	price
		(m)	(in.)	(mm)	
5% Krytox (Ni 200 tubing)	60/80	3.05	1/8	2.1	80127-

On CarboBlack C	Mesh	Stainless Steel Tubing				SilcoSmooth Tubing**				price
		L (ft.)	OD (in.)	ID (mm)	cat.#*	L (m)	OD (in.)	ID (mm)	cat.#*	
0.2% Carbowax 1500	60/80	6	1/8	2.1	80456-	2	1/8	2	80121-	
0.2% Carbowax 1500	80/100	6	1/8	2.1	80457-	2	1/8	2	80122-	
0.1% Rt-1000	80/100	6	1/8	2.1	80458-	1.8	1/8	2	80205-	
0.19% picric acid	80/100	6	1/8	2.1	80459-	2	1/8	2	80311-	
0.3% Carbowax 20M/ 0.1% H ₃ PO ₄	60/80	2.5	3/16	3.1	80460-	0.75	3/16	3.1	80111-	

Improved Molecular Sieves

Molecular sieve packed columns easily separate permanent gases at above-ambient temperatures. Restek's R&D chemists have developed a process for preparing molecular sieve packings, which result in excellent batch-to-batch reproducibility. In addition, our molecular sieves are preactivated and ready to use. Each column comes with metal end-fittings to prevent water or carbon dioxide from adsorbing into the packing during shipment.

Molecular Sieve Packed Columns

Molecular Sieve	Mesh	Stainless Steel Tubing				SilcoSmooth Tubing**				price
		L (ft.)	OD (in.)	ID (mm)	cat.#*	L (m)	OD (in.)	ID (mm)	cat.#*	
Molesieve 5A	60/80	6	1/8	2.1	80473-	2	1/8	2	80428-	
Molesieve 5A	80/100	3	1/8	2.1	88015-	1	1/8	2	80440-	
Molesieve 5A	80/100	6	1/8	2.1	80474-	2	1/8	2	80429-	
Molesieve 5A	80/100	10	1/8	2.1	88014-	3.05	1/8	2	80430-	
Molesieve 13X	60/80	6	1/8	2.1	80475-	2	1/8	2	80480-	
Molesieve 13X	80/100	6	1/8	2.1	80476-	2	1/8	2	80439-	

*Please add column instrument configuration suffix number to cat.# when ordering. See chart on this page.

**Siltek-treated stainless steel.

also available

CarboBlack packing materials. See page 124.

Column Instrument Configurations

General Configuration
Suffix -800



Agilent 5880, 5890, 5987,
6890, 7890:
Suffix -810*



Varian 3700, Vista Series, FID:
Suffix -820



PE 900-3920, Sigma 1,2,3:
Suffix -830



PE Auto System 8300, 8400, 8700
(Not On-Column):
Suffix -840

See page 133 for additional configurations.

Note: Initial 2" of column will be empty, to accommodate a needle. For a completely filled column (not on-column) add suffix -901.

*-810 suffix also includes 1 1/4" void on detector side.

Specialty Packed Columns

Aromatics Analysis

D3606 Application Column (2 column set)

- Complete resolution of ethanol and benzene, with a resolution value > 3.00.
- Accurate quantification of benzene and toluene.
- Fully conditioned two column set—ready to use out of the box.
- A chromatogram is provided with each column set demonstrating conformance to the method.

Conforms to the specifications established in ASTM method D-3606-06 for the quantitation of benzene and toluene in spark ignition fuel containing ethanol.

free
literatureResolve Benzene and
Toluene in Spark Ignition
Fuels Containing Ethanol

Download your free copy
from www.restek.com

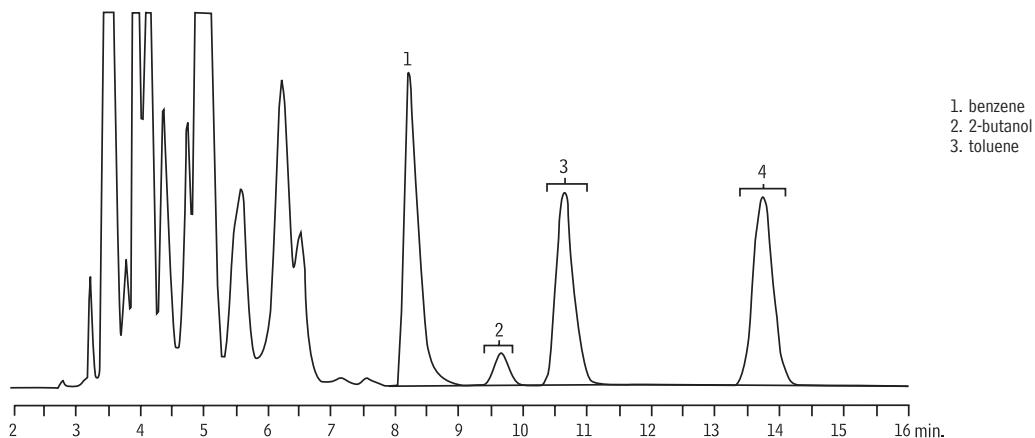
lit. cat.# 580227

Description	cat.#*	price
D3606 Application Column (2 column set)** Column 1: 6' (1.8m), $\frac{1}{8}$ " OD, 2.0mm ID, nonpolar Rtx-1 Column 2: 16' (4.9m), $\frac{1}{8}$ " OD, 2.0mm ID, proprietary packing material	83606-	

*Please add column instrument configuration suffix number to cat.# when ordering. See chart on page 133.

**The column set is designed to accommodate both valve injection and/or syringe injection. Column 1 is configured with a 2" inlet void to facilitate on-column injection. The inlet is identified on both column 1 and column 2. Note: The inlet of column 2 is identified for proper orientation for connection to the valve.

Gasoline on a D3606 Application Column Set.



GC_PC01079

Column: D3606 Application Column (2 column set, cat.# 83606-800)
Column 1: nonpolar Rtx®-1, 6' (1.8m), $\frac{1}{8}$ " OD, 2.0mm ID
Column 2: proprietary packing material, 16' (4.9m), $\frac{1}{8}$ " OD, 2.0mm ID

Sample: 1.5µL gasoline
Inj.: 200°C
Backflush: ~1 min.
Carrier gas: helium, constant flow
Flow rate: 25mL/min.
Oven temp.: 135°C, isothermal
Det.: TCD @ 200°C

Chromatogram courtesy of Boguslaw Dudek, Conoco Phillips, Linden, NJ.

Light Hydrocarbon Analysis

Special Columns for Unsaturated Light Hydrocarbons

- Faster separations of C1 to C4 hydrocarbons.
- Res-Sil™ packing replaces Porasil materials.

n-Octane on Res-Sil™ C Packed Column

This packed column has unique selectivity for resolving unsaturated light hydrocarbons (Figure 1).

OPN on Res-Sil™ C Packed Column

This column separates the light hydrocarbons, and baseline resolves *cis*-2-butene from 1,3-butadiene (Figure 2).

2abc Refinery Gas Column Set

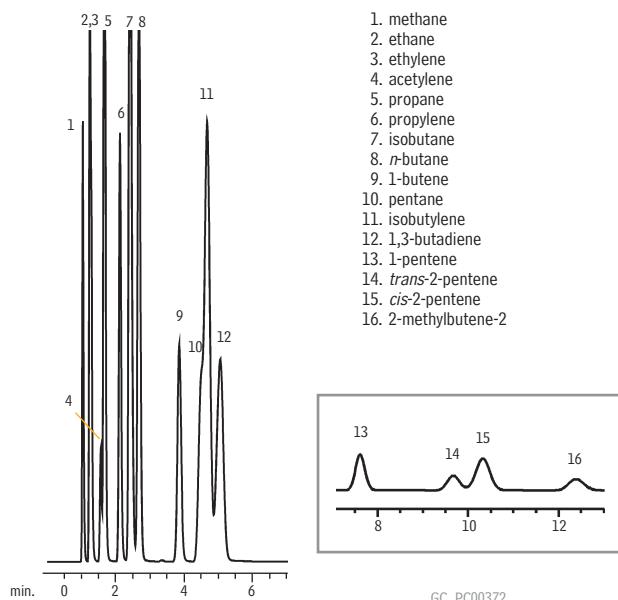
This 3-column set is finely tuned to resolve light hydrocarbons. When used in the proper valving system, it will elute C5+ hydrocarbons ahead of C1 through C4 hydrocarbons (Figure 3).

Description	cat.#*	price
<i>n</i> -Octane on Res-Sil™ C, 80/100 (20', 2.0mm ID, $\frac{1}{8}$ " Silcosmooth™ OD)	80436-	
OPN on Res-Sil™ C, 80/100 (12', 2.0mm ID, $\frac{1}{8}$ " Silcosmooth™ OD)	80437-	
2abc Refinery Gas Column Set (3 column set)*	88000-	

*Please add column instrument configuration suffix number to cat.# when ordering. See chart on page 133.

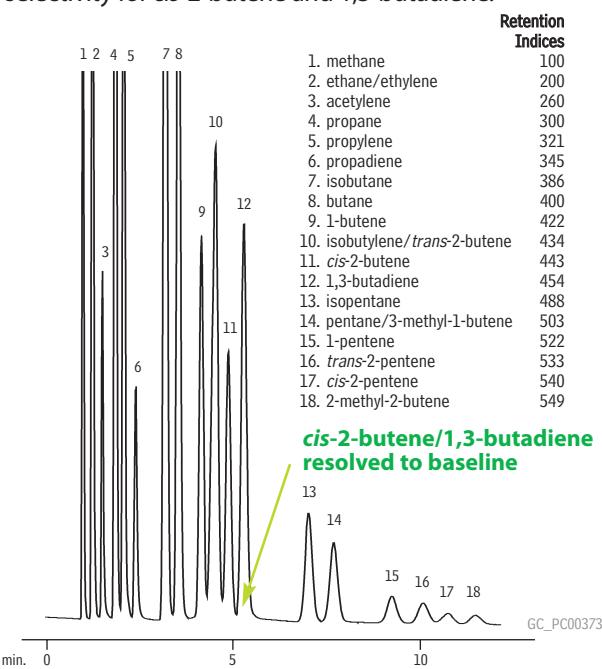
**This column set is for a valving system; therefore, packing material is filled to ends of columns.

Figure 1 *n*-Octane on Res-Sil™ C packing has unique selectivity for unsaturated light hydrocarbons.



n-octane 80/100 Res-Sil™ C
20', $\frac{1}{8}$ " OD x 2mm ID, SilcoSmooth™ tubing (cat. # 80436)
Oven temp.: 60°C
Inj. temp.: 150°C
Det. temp.: 150°C FID
Flow rate: 30mL/min. He
Sample: refinery gas C1-C5
Sample size: 20 μ L

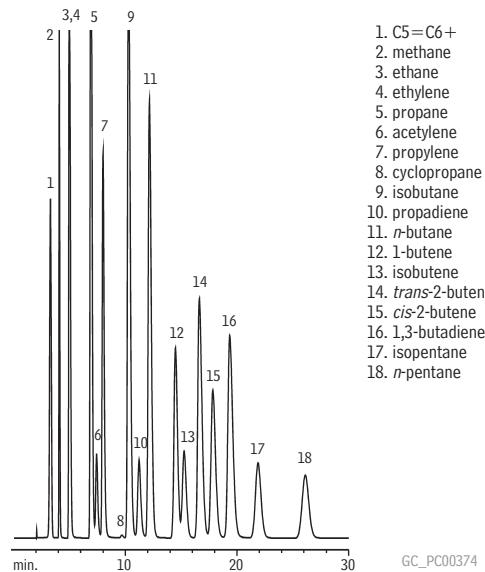
Figure 2 OPN on Res-Sil™ C packing has unique selectivity for *cis*-2-butene and 1,3-butadiene.



OPN on Res-Sil™ C, 80/100 mesh, 12' x 2mm ID x $\frac{1}{8}$ " OD in SilcoSmooth™ tubing (cat. # 80437). 20 μ L on-column injection of refinery gas.
Concentration: 0.1-6 absolute mole %
Oven temp.: 50°C
Inj. & det. temp.: 200°C
Carrier gas: helium
Flow rate: 30mL/min

Reference standard courtesy of AC Analytical Controls, Bensalem, PA.

Figure 3 Refinery gas calibration standard on a Restek refinery gas packed column set.



2abc Refinery Gas Column Set (cat. # 88000-875) (3 column set)
Oven temp.: 60°C
Inj. temp.: 150°C
Det. temp.: 150°C FID
Flow rate: 30mL/min., helium
Sample: refinery gas
Sample size: 1cc

for more info

See page 125 for more information on Res-Sil™ packing materials.

Specialty Packed/Micropacked Columns

Permanent Gases & Hydrocarbon Analysis

ShinCarbon ST Packed/Micropacked Columns

- Separate permanent gases, including CO/CO₂, without cryogenic cooling.
- Rapid separations of permanent gas/light hydrocarbon mixtures.
- Excellent compatibility with most GC detectors—minimal bleed, minimal baseline rise.
- Preconditioned, less than 30 minutes to stabilize.

it's a fact

ShinCarbon ST is an ideal packing material for permanent gases, low molecular weight hydrocarbons, sulfur dioxide, and Freon® gases.

Analyze oxygen, nitrogen, methane, carbon monoxide, and carbon dioxide with one column and at room temperature. ShinCarbon ST material, a high surface area carbon molecular sieve (~1,500 m²/g), is the ideal medium for separating gases and highly volatile compounds by GSC. The rapid, above-ambient analyses these columns provide will be a great convenience. Excellent thermal stability of the high surface area carbon, combined with careful conditioning during column manufacturing, ensures low-bleed operation and rapid stabilization when installing a new column. Custom-made ShinCarbon ST columns are available on request.

ShinCarbon ST is a highly stable material. Its 330°C upper temperature limit minimizes bleed and baseline rise during temperature programming, making the material compatible with most detection systems used for gas analysis, including TCD or HID. All ShinCarbon ST columns are fully conditioned in an oxygen/moisture free environment to prevent contamination. This minimizes stabilization time (less than 30 minutes) when installing a new column which, in turn, minimizes downtime.

ShinCarbon ST 80/100 Packed Columns (SilcoSmooth™ Stainless Steel)*

OD	ID	2-Meter
1/8" Silcosmooth	2.0mm	80486-

ShinCarbon ST 100/120 Micropacked Columns**

OD	ID	1-Meter	2-Meter
1/16"	1.0mm	19809	19808
0.95mm	0.75mm	19810	—

*Please add column instrument configuration suffix number to cat.# when ordering. See chart on the next page.

**Order installation kit separately. See page 123.

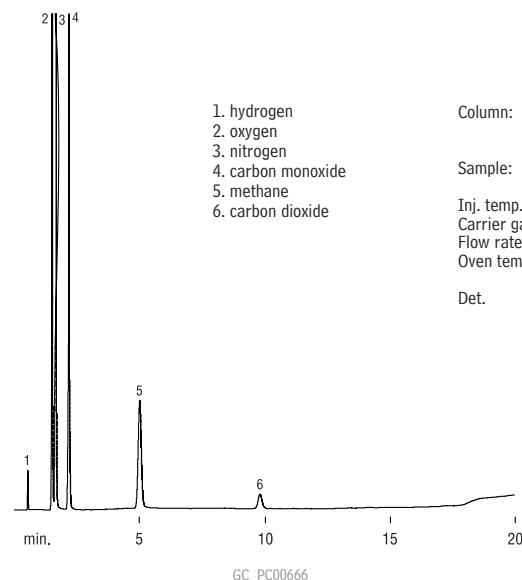
a plus 1 story

"Being one of the first labs to utilize the ShinCarbon column in a real working environment, I was pleased to find that I was able to do all my permanent gas analysis on one column instead of the customary two. The peaks were sharper than I had experienced in the past and run time was significantly reduced. We are extremely pleased with the performance of the ShinCarbon column and will continue to find even more applications for it."

Bruce Nasser,

Quality Control Chemist, Oxygen Service Spec Lab

Separate permanent gases in 10 minutes, without cryogenics.



please note

For additional example applications for ShinCarbon ST columns, see pages 650, 652, and 654 in the Applications section.

Sulfur Analysis

Rt®-XLSulfur Packed/Micropacked Columns

- Optimized columns for low ppbv sulfur analyses.
- Eliminate the need for Teflon® tubing.
- Column and end-fittings are Siltek® treated for maximum inertness.

Sulfur analyses are traditionally performed using Teflon® tubing to improve column inertness. Unfortunately, Teflon® tubing is gas permeable, difficult to pack with high efficiency, prone to shrinkage, and has poor thermal stability. The Rt®-XLSulfur packed or micropacked column eliminates these problems. The packing material for Rt®-XLSulfur columns is extensively deactivated for analysis of low ppbv levels of hydrogen sulfide and methyl mercaptan. It is then treated to achieve effective separation of hydrocarbons from sulfur compounds. The interior wall and the end-fittings of the Rt®-XLSulfur column are Siltek® treated, making the column as inert as Teflon®. The extra care taken to manufacture this column ensures more accurate analyses of sulfur compounds.

Rt®-XLSulfur Packed Columns*

OD	ID	1-Meter	2-Meter
1/8"	2.0mm	80484-	80485-
3/16"	3.1mm	80482-	80483-

Rt®-XLSulfur Micropacked Columns**

OD	ID	1-Meter	2-Meter
1/16"	1.0mm	19804	19805
0.95mm	0.75mm	19806	19807

*Please add column instrument configuration suffix number to cat.# when ordering. See chart on this page.

**Order installation kit separately. See page 123.

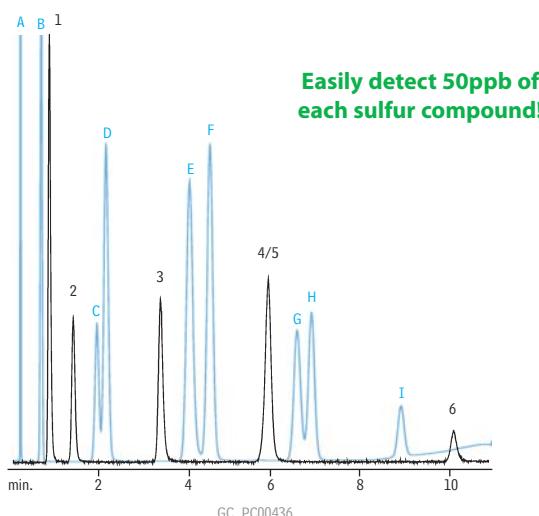
did you know?

Rt®-XLSulfur columns are optimized for low ppb-level sulfur analysis!

also available

For adapter kits for installing packed/micropacked columns, see page 123.

Rt®-XLSulfur micropacked column separates hydrocarbons from sulfur compounds.



Column: Rt®-XLSulfur micropacked column, 1m, 0.75mm ID
 (cat.# 19806)
 Conc.: 50ppb each
 Oven temp.: 60°C to 230°C @ 15°C/min.
 Carrier gas: helium
 Flow rate: 9mL/min.
 Det.: SCD/FID

Sulfur standards courtesy of DCG Partnership 1 Ltd., Pearland, TX.

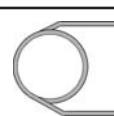
sulfurs
 1. hydrogen sulfide
 2. carbonyl sulfide
 3. methyl mercaptan
 4. ethyl mercaptan
 5. dimethyl sulfide
 6. dimethyl disulfide

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

Column Instrument Configurations



General Configuration
Suffix -800



Agilent 5880, 5890, 5987,
 6890, 7890:
Suffix -810*



Varian 3700, Vista Series, FID:
Suffix -820



PE 900-3920, Sigma 1,2,3:
Suffix -830



PE Auto System 8300, 8400, 8700
 (Not On-Column):
Suffix -840

See page 133 for additional configurations.

Note: Initial 2" of column will be empty, to accommodate a needle. For a completely filled column (not on-column) add suffix -901. *-810 suffix also includes 1 1/4" void on detector side.

Micropacked Columns

Micropacked Columns

- Increased efficiency over traditional packed columns.
- Higher capacity than PLOT columns.
- Made from inert, flexible Siltek®-treated stainless steel tubing.
- Siltek®-treated, braided-wire end plug keeps packing intact, even under intense pressure surges during valve switching.
- Wide range of packings available.

Efficient, inert, and flexible

Micropacked columns are highly efficient and provide good sample capacity. With our inert Siltek® treatment, micropacked columns are a powerful tool for solving many difficult application problems. Because the Siltek® treatment permeates the stainless steel surface, the column can be flexed and coiled without any fear of chipping or cracking the inert surface.

Easy to install—multiple internal diameters

Our micropacked columns are designed to fit packed and capillary injection systems. 1mm ID, standard wall ($\frac{1}{16}$ -inch OD) micropacked columns offer improved efficiency in packed column instruments, without the expense of converting to capillary injection systems. 0.75mm ID, thin wall (0.95mm OD) micropacked columns install easily into a capillary injector, using slightly larger ferrules. Micropacked columns operate at flows exceeding 10cc/min., for trouble-free operation.

Braided wire end plugs

Glass wool end plugs can be dislodged easily by carrier gas pressure surges. Restek's chemists insert braided wire into the column and secure it by making a small crimp near the column outlet. End plugs are Siltek® treated—the sample contacts only inert surfaces.



All micropacked columns are made with inert SilcoSmooth™ tubing,
see page 115.

also available

0.53mm ID micropacked columns. Please contact Technical Service for more information.

Micropacked Columns

	ID	OD	Temp. Range	0.56-Meter	
20% TCEP on 80/100 Chromosorb PAW	0.75mm	$\frac{1}{16}$ "	0–120°C	19040	
Mesh	ID	OD	Temp. Range	1-Meter	2-Meter
HayeSep R	100/120	0.75mm	0.95mm	up to 250°C	19014
HayeSep R	100/120	1.00mm	$\frac{1}{16}$ "	up to 250°C	19012
HayeSep Q	100/120	0.75mm	0.95mm	up to 275°C	19018
HayeSep Q	100/120	1.00mm	$\frac{1}{16}$ "	up to 275°C	19016
HayeSep N	100/120	0.75mm	0.95mm	up to 165°C	19022
HayeSep N	100/120	1.00mm	$\frac{1}{16}$ "	up to 165°C	19020
HayeSep S	100/120	0.75mm	0.95mm	up to 250°C	19010
HayeSep S	100/120	1.00mm	$\frac{1}{16}$ "	up to 250°C	19008
Molesieve 5A	80/100	0.75mm	0.95mm	up to 300°C	19002
Molesieve 5A	80/100	1.00mm	$\frac{1}{16}$ "	up to 300°C	19000
Molesieve 13X	80/100	0.75mm	0.95mm	up to 350°C	19006
Molesieve 13X	80/100	1.00mm	$\frac{1}{16}$ "	up to 350°C	19004

Searching for a product?

Don't see the column you need?

Contact our Technical Service team at 800-356-1688 or 814-353-1300, ext. 4, or contact your Restek representative, to obtain the column needed for your application.

Packed/Micropacked Column Installation Kits

Packed Column Inlet Adaptor Kits

- Use $\frac{1}{8}$ " and $\frac{3}{16}$ " OD columns in $\frac{1}{4}$ " on-column injection ports.
- Centers column perfectly in injection port to eliminate bent syringe needles.
- Slotted design prevents carrier gas occlusion.
- Vespel®/graphite reducing ferrules make installation easy.
- Includes all nuts & ferrules used to attach tubing to the injector or detector.



Adaptor kit centers the packed column in the injection port, so the syringe will not scrape the sides of the column.

Description	For $\frac{1}{8}$ " Columns			For $\frac{3}{16}$ " Columns		
	qty.	cat.#	price	qty.	cat.#	price
Packed Column Inlet Adaptor Kit for $\frac{1}{4}$ " Injection Ports	kit	21651		kit	21650	
Packed Column Inlet Adaptor Kit for Shimadzu 5mm Injection Ports	kit	21119		kit	21120	
Packed Column Inlet Adaptor Kit for Carlo-Erba GCs	kit	21129		kit	21130	

Installation Kits

Description	qty.	cat.#	price
Micropacked Column Installation Kit for 0.75mm ID columns; for valve applications.			
Kit contains: $\frac{1}{16}$ " Valco nut (1), $\frac{1}{16}$ " Vespel/graphite ferrule (1), $\frac{1}{16}$ " graphite ferrule (1), $\frac{1}{16}$ " Sulfinert union (1), $\frac{1}{16}$ " to $\frac{1}{16}$ " stainless steel union (1), Sulfinert tubing, $\frac{1}{8}$ " OD x 0.04" ID (1ft/0.3m), stainless steel ferrule (1), graphite ferrules (2), Vespel/graphite ferrules (2).			
kit 21062			
Micropacked Column Installation Kit for 0.75mm ID columns; for split applications.			
Kit contains: graphite ferrules (2), Vespel/graphite ferrules (2).			
kit 21063			
Micropacked Column Installation Kit for 0.75mm ID columns; for all Agilent GCs.			
Kit contains: graphite ferrule (1), graphite ferrule (1), Vespel/graphite ferrule (1), Vespel/graphite ferrule (1).			
kit 21064			
Micropacked Column Installation Kit for 1mm ID columns; for valve applications.			
Kit contains: $\frac{1}{16}$ " Valco nut (1), $\frac{1}{16}$ " stainless steel nut (1), $\frac{1}{16}$ " Vespel/graphite ferrule (1), $\frac{1}{16}$ " graphite ferrule (1), stainless steel ferrule (1), $\frac{1}{16}$ " stainless steel front ferrule (1), $\frac{1}{16}$ " stainless steel back ferrule (1).			
kit 21065			
Micropacked Column Installation Kit for 1mm ID columns; for direct injections.			
Kit contains: $\frac{1}{16}$ " stainless steel nuts (2), $\frac{1}{16}$ " Vespel/graphite ferrules (2), $\frac{1}{16}$ " graphite ferrules (2), $\frac{1}{16}$ " stainless steel front ferrules (2), $\frac{1}{16}$ " stainless steel back ferrules (2).			
kit 21066			
Packed Column Installation Kit for 2mm ID columns; for valve applications.			
Kit contains: $\frac{1}{8}$ " stainless steel nut (1), stainless steel Valco nut (1), $\frac{1}{8}$ " Vespel/graphite ferrule (1), stainless steel Valco ferrule (1), $\frac{1}{8}$ " stainless steel front ferrule (1), $\frac{1}{8}$ " stainless steel back ferrule (1).			
kit 21067			

Micropacked Inlet Conversion Kits

Convert a capillary GC split/splitless inlet for use with $\frac{1}{16}$ " OD micropacked columns.

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

Description	qty.	cat.#	price
Micropacked Column Adaptor Kit for Split/Splitless Injection*			
Complete kit with FID and injection port adaptors			
Kit includes: Dual Vespel Ring Inlet Seal, large bore; reducing nut, large bore; FID adaptor, large bore; $\frac{1}{16}$ " ferrule, Vespel/graphite; $\frac{1}{16}$ " nut, stainless steel; $\frac{1}{16}$ " ferrules, Vespel/graphite (2); Siltek treated metal liner installation guide; $\frac{1}{16}$ " nuts, stainless steel (2)			
kit 22424			
Micropacked Column Adaptor Kit for On-Column Injection*			
Complete kit with FID and injection port adaptors			
Kit includes: Dual Vespel Ring Inlet Seal, large bore; reducing nut, large bore; FID adaptor, large bore; $\frac{1}{16}$ " ferrule, Vespel/graphite; $\frac{1}{16}$ " nut, stainless steel; $\frac{1}{16}$ " ferrules, Vespel/graphite (2); Siltek treated metal liner installation guide; $\frac{1}{16}$ " nuts, stainless steel (2)			
kit 22425			
Micropacked Column Adaptor Kit for Split/Splitless Injection			
Injection Port Adaptor Kit			
Kit includes: Dual Vespel Ring Inlet Seal, large bore; reducing nut, large bore; $\frac{1}{16}$ " ferrule, Vespel/graphite; $\frac{1}{16}$ " nut, stainless steel; 4mm splitless liner, intermediate polarity deactivated			
kit 22426			
Micropacked Column Adaptor Kit for On-Column Injection			
Injection Port Adaptor Kit			
Kit includes: Dual Vespel Ring Inlet Seal, large bore; reducing nut, large bore; $\frac{1}{16}$ " ferrule, Vespel/graphite; Siltek treated metal liner installation guide; $\frac{1}{16}$ " nut, stainless steel			
kit 22427			
Micropacked Column Adaptor Kit for FID*			
FID Adaptor Kit			
Kit includes: FID adaptor, large bore; $\frac{1}{16}$ " ferrule, Vespel/graphite; $\frac{1}{16}$ " nut, stainless steel; $\frac{1}{16}$ " nut, stainless steel; $\frac{1}{16}$ " ferrule, Vespel/graphite			
kit 22428			
Replacement Inlet Seals for Micropacked Column Adaptor			
Dual Vespel Ring Inlet Seals, large bore (2)			
2-pk. 22429			
Replacement Metal Liner Installation Guide for On-Column Injection			
Siltek treated metal liner installation guide			
ea. 22430			
Replacement 4mm Splitless Liner			
4mm Splitless Liner			
ea. 20772			

*For use with packed column FIDs only.



Large-Bore Dual Vespel® Ring Inlet Seals



1/4" SS Nut

Large-Bore FID Adaptor



1/4" Vespel®/Graphite Ferrule

1/16" SS Nut



Large-Bore Reducing Nut



1/16" Vespel®/Graphite Ferrules



22430



20772

Packed Column Packing Materials



Silcoport™ Support Materials Outperform Any Deactivated Diatomaceous Earth Supports Available!

- Superior deactivation technology for improved inertness.
- Available in 80/100 and 100/120 mesh.
- Uniform particle distribution for maximum efficiency.

**restek
innovation!**

The increased sensitivity of modern detection systems and the desire to reduce detection limits requires a solid support to meet the challenging demands faced by analysts. Unlike conventional dimethyldichlorosilane (DMDCS) deactivation, Silcoport™ incorporates our proprietary fused silica deactivation technology on diatomaceous earth solid supports. Silcoport™ supports were developed using a special mixture of deactivants that yields the highest inertness without changing the polarity of the stationary phase. Silcoport™ supports from Restek are the perfect match for highly inert SilcoSmooth™ tubing.

did you know?

Silcoport support replaces

- Supelcoport
- Chromosorb W HP
- GasChrom Q 2

Silcoport W BW support replaces

- GasChrom Q

Silcoport™ Packing Materials

Description	Temp. Limit (°C)	Mesh	Min. Qty.†	cat.#	price/g
Silcoport P*	400	80/100	100g	25641	
	400	100/120	100g	25642	
Silcoport W**	400	80/100	100g	25689	
	400	100/120	100g	25673	
Silcoport W BW***	400	100/120	100g	25674	

*Prepared from Chromosorb P; Restek acid washed deactivation.

**Prepared from Chromosorb W; Restek acid washed deactivation.

***Prepared from Chromosorb W; Restek base washed deactivation.

†Bulk quantities are available.

please note

Silcoport™ is available uncoated or coated with the liquid stationary phase of your choice on 80/100 or 100/120 mesh sizes. Call Restek at 800-356-1688 or 814-353-1300, ext. 3, or contact your Restek representative, for pricing and availability.

CarboBlack Packing Materials

Description	Temp. Limit (°C)	Mesh	Min. Qty.	cat.#	price/g
CarboBlack B	500	60/80	10g	25500	
	500	80/120	10g	25501	
CarboBlack C	500	60/80	10g	25502	
	500	80/100	10g	25503	
CarboBlack BHT-100	150	40/60	10g	25504	
CarboBlack III (F)	175	80/100	10g	25506	
5% Carbowax 20m on CarboBlack B	225	80/120	10g	25507	
6.6% Carbowax 20m on CarboBlack B	225	80/120	10g	25508	
4% Carbowax 20m / 0.8% KOH on CarboBlack B	220	60/80	10g	25509	
0.19% picric acid on CarboBlack C	120	80/100	10g	25510	
4% Carbowax 20m on CarboBlack B-DA	200	80/120	10g	25511	

Res-Sil™ C Packings

- Unique separation of saturated and unsaturated hydrocarbons.
- Innovative bonding chemistry for batch-to-batch reproducibility, excellent thermal stability, and long life.
- Wide range of bonded phases available.
- Equivalent to Waters Durapak packings.

Bonded silica packings with *n*-octane or cyanopropyl (OPN) functional groups yield faster separations of C1 to C4 hydrocarbons, higher thermal stability, shorter conditioning times, and longer lifetimes than conventional packings. However, bonded silica packings have had inconsistent reproducibility and limited availability. Restek's research team has solved these age-old problems by developing Res-Sil™ C packings for consistent performance.

Unique Selectivity for Process GC and High-Speed Analysis of Petrochemicals

Res-Sil™ C bonded packings are ideal for fast resolution of difficult-to-separate saturated and unsaturated C4 hydrocarbons (e.g., see page 119). This unique selectivity, when combined with other columns in series, provides petroleum and petrochemical method developers with a powerful tool for fast determination of C1 to C5 hydrocarbons.¹

Innovative Research and Stringent QA Provide Batch-to-Batch Consistency

Restek's synthesis procedure eliminates batch-to-batch variations. The amount of bonded liquid phase is precisely controlled in every batch, for reproducible retention times and separations. Each production batch of Res-Sil™ C packing is tested with a complex hydrocarbon mixture to meet demanding retention time and retention index specifications. Column bleed is also evaluated to ensure that there are no retention shifts or high baselines.

OPN on Res-Sil™ C Packing—the Latest in a Line of Bonded GC Phases

Restek offers a wide range of bonded packings for packed column GC, including Rtx®-1, Stabilwax®, and Carbowax® phases. We have extended this technology to make *n*-octane on Res-Sil™ C packing, and OPN on Res-Sil™ C packing. Each of these packings has low bleed, conditioning times of less than 30 minutes, long lifetime, and consistent batch-to-batch reproducibility.

also available

Custom packing materials are also available.
See page 130.

Res-Sil™ Packing Materials

Description	Temp. Limit (°C)	Mesh	Min. Qty.	cat.#	price/g
Res-Sil C	300	60/80	10g	25400	
	300	80/100	10g	25028	
Res-Sil B	300	60/80	10g	25401	
	300	80/100	10g	25080	
1% TCEP on Res-Sil B	175	80/100	10g	25081	
OPN on Res-Sil C	150	80/100	10g	25042	
<i>n</i> -Octane on Res-Sil C	150	80/100	10g	25030	
2% Carbowax 1540 on Res-Sil C	150	80/100	10g	25044	

¹N.C. Saha, S.K. Jain, and R.K. Dua. J. Chromat. Sci. 1978, 323-328.

did you know?

Res-Sil replaces

- Porasil B
- Porasil C

Packed Column Packing Materials



Technical Service

Do you have a technical question? Restek's Technical Service group has answers! Drawing from our extensive libraries of technical information and many years of collective chromatography experience, the experts in Technical Service can help you from set-up to method development.

Contact us:

For quick answers to commonly asked questions any time of the day, visit www.restek.com/answers or contact us directly:

In the U.S.

Phone: 1-800-356-1688, ext. 4
Fax: 814-353-1568
e-mail: support@restek.com

Outside the U.S.

Contact your Restek representative.

Chromosorb® Diatomaceous Earth Supports

Restek offers the full line of Chromosorb® solid supports. Choosing the appropriate support will depend on your application. Need assistance? Call Technical Service at 800-356-1688 or 814-353-1300, ext. 4, or contact your Restek representative.

Chromosorb® P (used to prepare Silcoport™ P)

Chromosorb® P support is manufactured from hard firebrick, making it a rugged material. This support is available acid washed (AW), nonacid washed (NAW), and traditional dimethyldichlorosilane (DMDCS) treated. Chromosorb® P support can hold up to 30 weight% of liquid stationary phase, making it the highest loading support available.

Chromosorb® W (used to prepare Silcoport™ W and Silcoport™ BW)

Chromosorb® W support is a flux-calcinated diatomite. This solid support is very fragile but offers the highest inertness of all diatomaceous earth supports. It can be prepared with up to 25 weight% of liquid stationary phase. Chromosorb® W support is available in AW, NAW, and DMDCS, or treated with Restek's proprietary (Silcoport™) deactivation. Chromosorb® W-HP is an acid washed, silanized version of Chromosorb® W.

Chromosorb® G

Chromosorb® G support is the hardest support available and has the lowest surface area of all the diatomaceous earth supports. Chromosorb® G support is available as AW, NAW, and DMDCS-treated. It can hold up to 10 weight% of liquid stationary phase.

Chromosorb® T

Chromosorb® T support is made from Teflon® material and is an extremely inert solid support.

Chromosorb® G and Chromosorb® T are available as custom products. Contact us for more information.

Chromosorb® Packings

Description	Mesh	gm/btl.*	cat.#	price
Chromosorb PNAW	45/60	100g	25629	
	60/80	100g	25630	
	80/100	100g	25631	
	100/120	100g	25632	
Chromosorb PAW	60/80	100g	25634	
	80/100	100g	25635	
	100/120	100g	25636	
Chromosorb PAW/DMDCS	60/80	100g	25638	
	80/100	100g	25639	
	100/120	100g	25640	
Chromosorb WNAW	60/80	100g	25657	
	80/100	100g	25658	
	100/120	100g	25659	
Chromosorb WAW	60/80	100g	25661	
	80/100	100g	25662	
	100/120	100g	25663	
Chromosorb WAW/DMDCS	60/80	100g	25665	
	80/100	100g	25666	
	100/120	100g	25667	
Chromosorb W-HP	60/80	100g	25668	
	80/100	100g	25669	
	100/120	100g	25670	

*Please call for larger quantities (>100gm bottles) of Chromosorb packings.

NAW—nonacid washed

AW—acid washed

DMDCS—dimethyldichlorosilane

BW—base washed

Chromosorb® Century Packings

Description	Temp. Limits (°C)	Mesh 60/80		Mesh 80/100		Mesh 100/120	
		g/btl.	cat.#	price	cat.#	price	cat.#
Chromosorb 101	275/325	50g	25608		25609		25610
Chromosorb 102	250/300	50g	25611		25612		25613
Chromosorb 103	275/300	50g	25614		25615		25616
Chromosorb 104				(equivalent to HayeSep C)			
Chromosorb 105	250/275	50g	25617		25618		25619
Chromosorb 106	250/275	50g	25620		25621		25622
Chromosorb 107	250/275	50g	25623		25624		25625
Chromosorb 108	250/275	50g	25626		25627		25628

Porapak Series Packings

Description	Temp. Limit (°C)	Mesh 50/80		Mesh 80/100		Mesh 100/120	
		g/btl.	cat.#	price	cat.#	price	cat.#
Porapak P	250	20g	25576		25577		25578
Porapak PS	250	20g	25579		25580		25581
Porapak Q	250	26g	25582		25583		25584
Porapak QS	250	26g	25585		25586		25587
Porapak R	250	24g	25588		25589		25590
Porapak S	250	26g	25591		25592		25593
Porapak N	190	29g	25594		25595		25596
Porapak T	190	31g	25597		25598		25599

HayeSep® Series Packings

Description	Temp. Limit (°C)	Mesh 60/80		Mesh 80/100		Mesh 100/120	
		g/btl.	cat.#	price	cat.#	price	cat.#
HayeSep A	165	24g	22560		25032		25033
HayeSep B	190	24g	25561		25034		25035
HayeSep C	250	24g	25562		25036		25037
HayeSep D	290	24g	25563		25038		25039
HayeSep DIP	290	24g	25564		25565		25566
HayeSep DB	290	24g	25567		25568		25569
HayeSep DOX				(Use HayeSep DB)			
HayeSep N	165	24g	25570		25045		25046
HayeSep P	250	24g	25571		25047		25048
HayeSep Q	275	24g	25572		25049		25050
HayeSep R	250	24g	25573		25051		25052
HayeSep S	250	24g	25574		25053		25054
HayeSep T	165	24g	25575		25055		25056

Tenax® Packings

Description	Temp. Limit (°C)	Min. Qty.	Mesh 60/80		Mesh 80/100	
			cat.#	price/g	cat.#	price/g
Tenax-TA	350	10g	25550	/g	25551	/g
Tenax-GR	350	10g	25552	/g	25553	/g

also available

Custom packing materials are also available.
 See page 130.



Restek's Learning Network

Sign up for our widely acclaimed seminars today!

Visit www.restek.com/seminars

Liquid Phases

We can prepare packed columns from the extensive list of liquid phases shown here. We have many more liquid phases. If you don't see the phase you need, call technical service or contact your Restek representative for availability.

Phase	min./max. temp. (°C)	Phase	min./max. temp. (°C)
Apiezon L	50/300	OV-22, phenyl methyl diphenyl, 65% phenyl	0/350
p,p'-Azoxydiphenetole	132/140	OV-25, phenyl methyl diphenyl, 75% phenyl	0/350
BC-120	0/125	OV-61, diphenyl, 33% phenyl	0/350
Bentone-34	0/180	OV-73, 5.5% diphenyl	0/325
bis (2-ethoxyethyl) adipate	0/150	OV-101, dimethyl (fluid)	0/350
bis (2-ethylhexyl) phthalate	150 max.	OV-105, cyanopropyl methyl	0/275
bis (2-methoxyethyl) adipate	20/100	OV-202, trifluoropropyl (fluid)	0/275
<i>n,n</i> -Bis(<i>p</i> -methoxylbenzylidene)- α,α' -bi- <i>p</i> -toluidine (BMBT)	189/225	OV-210, trifluoropropyl (gum)	0/275
Carbowax 1000	40/150	OV-215, trifluoropropyl (gum)	0/275
Carbowax 1540	50/175	OV-225, cyanopropyl methylphenyl methyl	0/265
Carbowax 20M	60/225	OV-275, dicyanoallyl	25/250
Carbowax 20M-terephthalic acid	60/225	OV-330, silicone - Carbowax	0/250
Carbowax 400	10/100	OV-351	50/270
Carbowax 600	30/125	OV-1701, vinyl	0/250
Cyclohexanedimethanol succinate	100/250	Phenyl diethanolamine succinate	0/230
DC-11	0/300	Polyethylene glycol adipate (EGA)	100/225
DC-200	0/200	Polyphenyl ether (5 rings) OS-124	0/200
DC-550	20/250	Polyphenyl ether (6 rings) OS-138	0/225
DEGS-PS	20/200	Polypropylene glycol	0/150
Dexsil 300 carborane/methyl silicone	50/540	Rtx-1 (Rt-101)	0/350
Di(2-ethylhexyl)sebacate	0/125	Rt-1000	50/250
Diethylene glycol succinate (DEGS)	20/200	Rt-1200	25/200
Diethylene glycol adipate (DEGA)	0/200	Rt-1220	50/200
Diisodecyl phthalate	0/175	Rt-1500, Rt-1510	50/230
2,4-Dimethylsulfolane	0/50	Rt-2100	0/350
Di-n-decyl phthalate	10/175	Rt-2300	20/275
Dinonyl phthalate	20/150	Rt-2330, Rt-2340	25/275
Ethylene glycol adipate	100/225	Rt-608Pkd	0/275
Ethylene glycol phthalate	100/200	Rt-Sebaconitrile	25/110
Ethylene glycol succinate	100/200	Rt-XLSulfur	300 max.
FFAP	50/250	SE-30, SE-52, SE-54	50/300
Fluorad FC-431, 50% solution in ethyl acetate	40/200	Silar 5 CP, Silar 10 CP	0/250
Hallcomid M-18-OL	8/150	Sorbitol	150 max.
Halocarbon 10-25	20/100	Squalane	20/100
Halocarbon K-352	0/250	Squalene	0/100
Halocarbon wax	50/150	Stabilwax	40/240
Igepal CO-880 (Nonoxynol)	100/200	Tetracyanoethylated pentaerythritol	30/175
Igepal CO-890	100/200	THEED (Tetrahydroxyethylenediamine)	0/125
Krytox	-30/260	β,β -Thiodipropionitrile (TDPN)	100
Neopentyl glycol adipate	50/225	Tricesyl phosphate	20/125
Neopentyl glycol sebacate	50/225	1,2,3-Tris (2-cyanoethoxy) propane (TCEP)	0/175
Neopentyl glycol succinate	50/225	Triton X-100, Triton X-305	0/200
Nonoxynol (Igepal CO-880)	100/200	UCW982	0/300
β,β -Oxydipropionitrile	0/75	UCON 50-HB-2000	0/200
OV-1, dimethyl (gum)	100/350	UCON 50-HB-280-X	0/200
OV-1, vinyl	100/350	UCON 50-HB-5100	0/200
OV-3, phenyl methyl	0/350	UCON HB-1800-X	200 max.
OV-7, phenyl methyl dimethyl, 20% phenyl	0/350	UCON LB-550-X	0/200
OV-11, phenyl methyl dimethyl, 35% phenyl	0/350	Versamid 9000	190/275
OV-17, phenyl methyl, 50% phenyl	0/375		

Advantages of using Restek packed columns

- Reasonably priced.
- Low-bleed, long-lifetime bonded phases.
- Wide variety of supports and packings.
- Produced by experienced packed column chromatographers.

USP Liquid Phase & Solid Support Cross-Reference

Restek can meet all of your packed column needs for US Pharmacopeia methods. Commonly used USP liquid phases and supports are listed below. Call Restek or your representative for a quote on your next packed column for pharmaceuticals.

USP	Phase Description	Restek-Supplied Equivalent
G1	dimethylpolysiloxane oil	Rt-2100, OV-101, Rtx-1
G2	dimethylpolysiloxane gum	OV-1, Rtx-1
G3	50% phenyl-50% methylpolysiloxane	Rt-2250, OV-17
G4	diethylene glycol succinate polyester	Rt-DEGS
G5	3-cyanopropylpolysiloxane	Rt-2340
G6	trifluoropropylmethylpolysiloxane	Rt-2401, OV-210
G7	50% 3-cyanopropyl-50% phenylmethylsilicone	Rt-2300
G8	80% bis (3-cyanopropyl)-20% phenylpolysiloxane	Rt-2330
G9	methylvinylpolysiloxane	UCW 98
G10	polyamide	polyamide
G11	bis(2 ethylhexyl) sebacate polyester	bis(2 ethylhexyl) sebacate polyester
G12	phenyldiethanolamine succinate polyester	phenyldiethanolamine succinate polyester
G13	sorbitol	sorbitol
G14	polyethylene glycol (average mol. wt. 950-1050)	Carbowax 1000
G15	polyethylene glycol (average mol. wt. 3000-3700)	Carbowax 4000
G16	polyethylene glycol compound (average mol. wt. 15,000), a high molecular weight compound of polyethylene glycol and a diepoxide linker	Carbowax 20M
G17	75% phenyl-25% methylpolysiloxane	OV-25
G18	polyalkylene glycol	UCON LB 550X
G19	25% phenyl-25% cyanopropyl-50% methylsilicone	OV 225
G20	polyethylene glycol (average mol. wt. 380-420)	Carbowax 400
G21	neopentyl glycol succinate	neopentyl glycol succinate
G22	bis(2 ethylhexyl) phthalate	bis(2 ethylhexyl) phthalate
G23	polyethylene glycol adipate	EGA
G24	diisodecyl phthalate	diisodecyl phthalate
G25	polyethylene glycol compound TPA, a high molecular weight compound of a polyethylene glycol and a diepoxide that is esterified with terephthalic acid	Carbowax 20M TPA
G26	25% 2-cyanoethyl-75% methylpolysiloxane	Rt-XE 60
G27	5% phenyl-95% methylpolysiloxane	SE-52, Rtx-5
G28	25% phenyl-75% methylpolysiloxane	DC 550
G29	3,3'-thiodipropionitrile	TDPN
G30	tetraethylene glycol dimethyl ether	tetraethylene glycol dimethyl ether
G31	nonylphenoxy poly(ethyleneoxy)ethanol (average ethyleneoxy chain length is 30): nonoxynol 30	Igepal CO 880
G32	20% phenylmethyl-80% dimethylpolysiloxane	OV-7
G33	20% Carborane®-80% methylsilicone	Dexsil 300
G34	diethylene glycol succinate polyester stabilized with phosphoric acid	Rt-DEGS PS
G35	a high molecular weight compound of a polyethylene glycol and a diepoxide that is esterified with nitroterephthalic acid	Rt-1000
G36	1% vinyl-5% phenylmethylpolysiloxane	SE 54, Rtx-5
G37	polyimide	polyimide
G38	phase G1 containing a small amount of tailing inhibitor	Rt-2100/0.1% Carbowax 1500
G39	polyethylene glycol (average mol. wt. 1500)	Carbowax 1500
G40	ethylene glycol adipate	Rt-EGA
USP	Support Description	Restek-Supplied Equivalent
S1A	siliceous earth, see method for details on treatment	Silicopore W
S1AB	siliceous earth, treated as S1A and both acid- and base-washed	Silicopore WBW
S1C	crushed firebrick, calcined or burned with a clay binder >900°C, acid-washed, may be silanized	Chromosorb PAW or PAW DMDCS
S1NS	untreated siliceous earth	Chromosorb W- Non Acid Washed
S2	styrene-divinylbenzene copolymer with nominal surface area of less than 50m²/g and an average pore diameter of 0.3 to 0.4µm	Chromosorb 101
S3	ethylvinylbenzene-divinylbenzene copolymer with nominal surface area of 500 to 600m²/g and an average pore diameter of 0.0075µm	Hayesep Q
S4	styrene-divinylbenzene copolymer with aromatic -O and -N groups having a nominal surface area of 400 to 600m²/g and an average pore diameter of 0.0076µm	Hayesep R
S5	high molecular weight tetrafluoroethylene polymer, 40- to 60-mesh	Chromosorb T
S6	styrene-divinylbenzene copolymer having a nominal surface area of 250 to 350m²/g and an average pore diameter of 0.0091µm	Chromosorb 102
S7	graphitized carbon having a nominal surface area of 12m²/g	CarboBlack C
S8	copolymer of 4-vinyl-pyridine and styrene-divinylbenzene	Hayesep S
S9	porous polymer based on 2,6-diphenyl-p-phenylene oxide	Tenax TA
S10	highly cross-linked copolymer of acrylonitrile and divinylbenzene	HayeSep C
S11	graphitized carbon having a nominal surface area of 100m²/g, modified with small amounts of petrolatum and polyethylene glycol compound	CarboBlack B 80/120 3% Rt 1500
S12	graphitized carbon having a nominal surface area of 100m²/g	CarboBlack B

Custom Coated Packing Materials

Custom Coated Packing Materials

Custom coated packing materials can be made with any of the supports listed below. The liquid stationary phases available are listed on page 128 and the coating ranges are listed in the chart. Coated packings are available in minimum orders of 20 grams.

To order, please call your Restek representative for pricing and specify the following:

- 1) stationary phase and stationary phase concentration
- 2) support and support mesh size
- 3) amount of packing needed

Ordering Example: (3%) (Rtx®-1) (Silcoport™ P) (80/100) (20g).

Support	Max. Coating %	Mesh Sizes
CarboBlack B	1–10%*	60/80, 80/120
CarboBlack B HT	1–10%	40/60
CarboBlack C	0.1–1%*	60/80, 80/100
Chromosorb 101-108	5%*/10%**	60/80, 80/100, 100/120
Chromosorb W HP	20%	45/60, 60/80, 80/100, 100/120
Chromosorb G HP	20%	45/60, 60/80, 80/100, 100/120
Chromosorb G, P or W (AW or NAW)	10% (G) 25% (W) 30% (P)	45/60, 60/80, 80/100, 100/120
Chromosorb G, P or W (AW or DMDCS)	10% (G) 25% (W) 30% (P)	45/60, 60/80, 80/100, 100/120
Chromosorb T	15%	40/60
HayeSep	15%	60/80, 80/100, 100/120
Porapak	15%	50/80, 80/100, 100/120
Silcoport P	30%	80/100, 100/120
Silcoport W BW	20%	80/100, 100/120
Silcoport W (replacement for Chromosorb 750)	20%	80/100, 100/120

*Nonsilicone phase.

**Silicone phase.

ordering note

Mesh Size

When ordering a packed column solid support, please specify mesh size. Refer to this chart to convert microns to mesh size.

Example:

150–180 micron particles = 80/100 mesh

(μm)	Mesh Size
850	20
710	25
600	30
500	35
425	40
355	45
300	50
250	60
212	70
180	80
150	100
125	120
106	140
90	170
75	200
63	230
53	270

For coatings over 15% or quantities over 50 grams, please call your Restek representative.

please note

NAW—nonacid washed

AW—acid washed

DMDCS—dimethyldichlorosilane

BW—base washed

DA—deactivated for acidic compounds

Special phases that require a surcharge:

OV®-275, OV®-330, OV®-225, BMBT,

2,4-dimethylsulfolane, Silar, OV®-1701,

XE-60, and Dexsil®

Custom Packed Columns

To order, contact your Restek representative and specify the following:

- 1) column dimensions (length, ID) and tubing material
- 2) packing description (percent coating and phase, support mesh size, and treatment)
- 3) column configuration (instrument manufacturer, model number, on-column injection or not) and with or without nuts and ferrules

Ordering Example: (6' x 1/8") (stainless steel) (3%) (Rtx®-1) (Silcoport™ P) (80/100) (Agilent 6890) (on-column injection) (fittings kit).

Please use the custom order form on page 132.



ordering note

For international pricing on custom packed or micropacked columns, please contact your Restek representative.

Custom Micropacked Columns

To order, contact your Restek representative and specify the following:

- 1) physical dimensions (length, OD, ID, and tubing material)
- 2) packing description (percent coating and phase, support mesh size, and treatment)
- 3) installation kit (see page 123)

Ordering Example: (2m x 1/16" OD x 1.00mm ID) (Siltek®-treated tubing) (5%) (Carbowax® 20M) (CarboBlack B) (80/120) (installation kit for valve applications, cat. #21065)

Please use the custom order form on page 132.

Packed/Micropacked Column Custom Order Form

Order: _____ Quote: _____ Reference # from previous order (if available): _____

Date: _____

Restek Account #: _____

Contact: _____

Company: _____

Address: _____

Phone: _____

Fax: _____

Restek Use Only:

Custom No.: _____

Stock No.: _____

Price: _____

Fitting Costs: _____

Authorization: _____

Number of Columns: _____

1) Column Dimensions:

Length _____ OD x ID: _____

2) Tubing (choose one): SilcoSmooth™ Stainless Steel Hastelloy® Nickel Copper Teflon®

3) Packing Description:

Liquid Phase A (% + description): _____

Liquid Phase B (% + description): _____

Liquid Phase C (% + description): _____

Solid Support: _____ Mesh: _____

4) Column Configuration:

Instrument (mfr. + model): _____

Inlet: Packed Full? Yes No, leave _____ " void (for on-column injection)Outlet: Packed Full? Yes No, leave _____ " voidDo you want this column preconditioned? Yes (additional charge) No

Standard configuration suffix number (next page): _____

Special configuration (next page): Figure: _____ Dimensions: _____

Welded Tubing Reducers (additional charge)

Special Instructions: _____

Fittings (check appropriate circle) **KIT 1S**

1/4" brass nuts

1/4" to 1/8" V/G reducing ferrules

No additional charge

 KIT 2S

1/4" brass nuts

1/4" to 3/16" V/G reducing ferrules

No additional charge

 KIT A

1/8" brass nuts

1/8" V/G ferrules

No additional charge

 KIT B

1/8" brass nuts

1/8" brass front & back ferrules

No additional charge

V/G = Vespel®/graphite

 KIT C

1/8" stainless steel nuts

1/8" stainless steel front & back ferrules

Additional charge

 KIT D

1/8" stainless steel nuts

1/4" V/G ferrules

Additional charge

 KIT E

1/4" stainless steel nuts

1/4" to 1/8" V/G reducing ferrules

Additional charge

 KIT F

1/4" stainless steel nuts

1/4" to 3/16" V/G reducing ferrules

Additional charge

 KIT V

1/8" VCR fitting

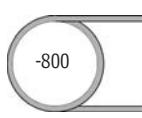
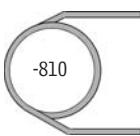
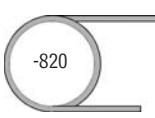
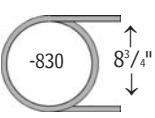
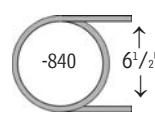
check appropriate circle:

 Stainless Steel (additional charge) Nickel (additional charge)**for a quote:**

Complete this form and fax to Restek at 814-353-1309, or to your Restek representative.

Standard Configurations (choose one)

General Configuration

Agilent 5880, 5890,
5987, 6890, 7890Varian 3700, Vista
Series, FIDPE 900-3920,
Sigma 1,2,3PE Auto System
8300, 8400, 8700

- 810 Agilent 5880, 5890, 5987, 6890, 7890
- 811 Agilent 6850
- 820 Varian 3700, Vista Series, FID
- 821 Varian 3800
- 830 PerkinElmer 900-3920, Sigma 1,2,3
- 840 PerkinElmer Auto System 8300, 8400, 8700, Clarus 500 (C500)
- 841 PerkinElmer Auto Sys XL
- 845 ABB 3100, AAI (4" coil)
- 850 Shimadzu 14A, 2014
- 851 Shimadzu 8A

- 852 Shimadzu 9A
- 853 Shimadzu 17A, 2010
- 854 Shimadzu Mini 2
- 860 Thermo Scientific - TRACE 2000
- 865 Carlo Erba
- 870 Tremetrics/Tracor
- 874 HNU 310 & 311 (4.5" coil)
- 875 Analytical Controls Configuration
- 880 Carle 40030
- 881 Hitachi 263
- 885 Pye Unicam 4500

- 890 Gow Mac 590
- 891 Gow Mac 550
- 892 Gow Mac 750
- 893 Gow Mac 816 (3" coil, 3" spread on the arms, and a total height of 5")
- 894 Gow Mac 580
- 895 SRI 8610C
- 895R SRI 8610C Dual GC Right Side
- 895L SRI 8610C Dual GC Left Side
- 896 SRI 9300

Custom Configurations (Please provide dimensions on order form, page 132.)

Figure 1

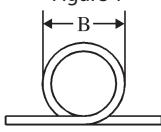


Figure 2

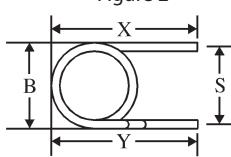


Figure 3

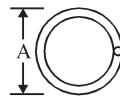


Figure 4

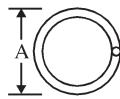


Figure 5

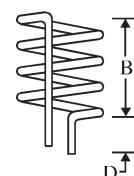
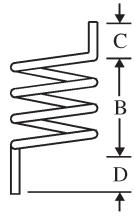
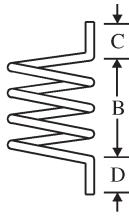
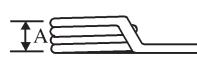
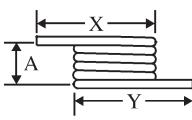
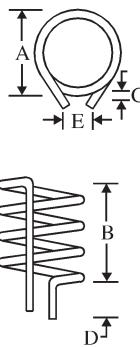


Figure 6

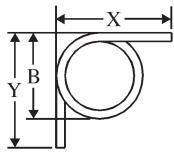


Figure 7

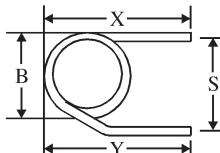


Figure 8

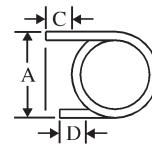


Figure 9

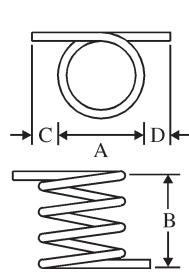


Figure 10

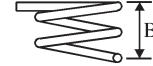
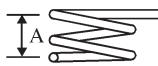


Figure 11

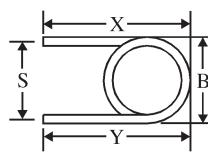


Figure 12

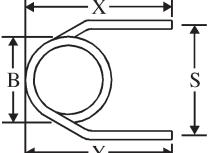


Figure 13

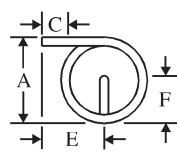


Figure 14

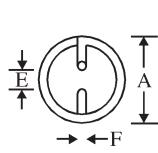
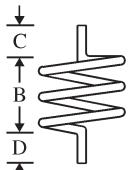
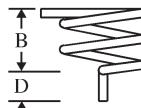


Figure 15



APPLICATIONS GC

GC Applications by Column Phase Index	535-536
EPA Method Chart	536
Environmental	537-611
Air, Brominated Flame Retardants, Chlorinated Disinfection Byproducts, Diesel Range Organics (DRO), Dioxins, Endocrine Disruptors, Explosives, Gasoline Range Organics (GRO), Glycols, Haloacetic Acids, Herbicides, Organo Tins, PCB Mixtures, Pesticides, Semivolatiles, Volatiles	
Foods, Flavors, & Fragrances	612-644
Antioxidants/Preservatives, Chiral Separations, Essential Oils, FAMEs, Fatty Acids, Flavors, Food Contaminants, Fragrances, Sterols, Sugars	
Personal Care & Cleaning Products	645-646
Cleaning Solvents, Fragrances	
Petroleum & Petrochemicals	647-666
Chlorofluorocarbon Gases, Fuels, Hydrocarbon Gases, Hydrocarbons, Hydrocarbons (Simulated Distillation), Permanent Gases, Sulfur Compounds	
Forensic	667-676
Abused Inhalants, Alkyl Nitrates, Anesthetics, Arson Accelerants, Blood Alcohols, Cannabinoids, Cocaine, GHB/GBL, Glycols, Opiates, PCP, Solvents	
Forensic/Pharmaceutical	677-685
Acidic/Neutral Drugs, Barbiturates, Basic Drugs, Benzodiazepines, Cold Medications, Phenothiazines, Sympathomimetic Amines	
Pharmaceutical	686-697
Anesthetics, Antidepressants, Antiepileptics, Antihistamines, Basic Drugs, Chiral Analyses, Organic Volatile Impurities/Residual Solvents, PGIs, Steroids	
Solvents & Chemicals	698-703
Alcohols, Amines, Chlorides, Chlorofluorocarbons, Cresylic Acids, Ketones, Nitrosamines, Phenols, Solvents	



Top: Silvia Martinez, Applications Chemist
Bottom: Jason Thomas, Applications Chemist

What's
NEW?
look for this circle

GC Applications by Column Phase (Alphabetical Order) - see pages 704-705 for our Applications by Compound Class Index

Fused Silica**FAMEWAX**

FAMEs 65, 624, 626

MXT®-1 Sim Dist

hydrocarbons (high temp.) 663

MXT®-1HT Sim Dist

hydrocarbons (high temp.) 70, 662

MXT®-500 Sim Dist

hydrocarbons (high temp.) 663

MXT®-Biodiesel TG

biodiesel oils 72, 647, 648

Rtx®-2330

Dioxins (TCDDs) 592

FAMEs 623, 625

sugars 644

Rtx®-2560

FAMEs 55, 64, 620 - 622

Rtx®-CW20M F&F

flavors, fragrances 637

Rtx®- β DEX_{cst}

flavors, fragrances 614

pharmaceuticals 686, 687

Rtx®- β DEX_{sxa}

flavors, fragrances 613, 614, 617

Rtx®- β DEX_{se}

flavors, fragrances 617

Rtx®- β DEX_{sm}

flavors, fragrances 613

pharmaceuticals 687

Rtx®- β DEX_{sp}

flavors, fragrances 614

Rtx®- γ DEX_{saa}

fruit juices 616

Rtx®- γ DEX_{sm}

peppermint oil 615

Rtx®-PAH

PAHs 89, 552

Rtx®-TCEP

aromatics 658

oxygenates 71

Rtx®-1301

chlorinated disinfection byproducts 591

flavor volatiles 634

solvents (organic volatile impurities) 697

Rtx®-1614

brominated flame retardants 83, 589

Rtx®-1701

fragrances 636

pharmaceuticals (acidic, neutral) 680, 690

pharmaceuticals (basic) 689

styrene 54

Rtx®-1/MXT®-1

air (Mass. APH) 611

air (TO-14/TO-15 compounds) 607, 609, 610

chlorofluorocarbons 703

essential oils 629, 631

fatty acids (free) 618

flavor volatiles 632

fragrances 636, 646

hydrocarbons 661

hydrocarbons (waxes) 661

ozone precursors 607

simulated distillation 664 - 666

sulfur compounds 666

Rtx®-1PONA

hydrocarbons (detailed gasoline analysis) 68, 660

Rtx®-20

antioxidants 612

essential oils 630

pharmaceuticals (acidic, neutral) 690

Rtx®-200

chlorinated disinfection byproducts 590

chlorofluorocarbons 703

explosives 594

fatty acids (free) 618

glycols 602

haloacetic acids 604

pharmaceuticals (basic) 678, 682, 684

phenols 547

potential genotoxic impurities 688

solvents (organic volatile impurities) 696

triazine herbicides 581

Rtx®-225

sugars 644

Rtx®-2887

simulated distillation 69, 663

Rtx®-35

endocrine disruptors 593

nitrogen herbicides 582

organo tins 594

pharmaceuticals (acidic, neutral) 680, 681

pharmaceuticals (basic) 683

Rtx®-35 Amine

amines 60, 699, 701

pharmaceuticals (basic) 677, 685

Rtx®-440

cocaine 674, 675

organochlorine pesticides 51

Rtx®-5/MXT®-5

bergamot oil 627

chlorinated disinfection byproducts 590

chlorophenoxyacid herbicides 580

Diesel range organics (DRO) 601

drugs of abuse 675, 676

endocrine disruptors 593

essential oils 628

gasoline range organics (GRO) 597, 598, 600

haloacetic acids 604

PCBs 587

pharmaceuticals (basic) 679, 683, 684

phenols 547

steroids 687

sterols 643

Rtx®-5 Amine

amines 699, 700

amines, phenols 59, 700

pharmaceuticals (basic) 678, 685, 689

Rtx®-5MS

endocrine disruptors 593

food contaminants 642

pharmaceuticals (basic) 677

semivolatiles 565

volatiles (food packaging) 639, 640

Rtx®-5Sil MS

phenols 555

polycyclic aromatic hydrocarbons 551

semivolatiles 548, 555, 562

Rtx®-50

antioxidants 612

triazine herbicides 581

Rtx®-502.2

air toxins 608

gasoline range organics (GRO) 596, 598

Rtx®-624

residual solvents 74, 692, 693

Rtx®-65TG

food testing 643

triglycerides 67

Rtx®-BAC1/Rtx®-BAC2

alkyl nitrates 673

anesthetics 673

blood alcohol 73, 669

butyrolactone, butanediol 671

glycols 603, 670

inhalants (abused) 672

solvents 674

Rtx®-Biodiesel TG

biodiesel oils 647

Rtx®-CLPesticides/Rtx®-CLPesticides2

dibromoethane (EDB), dibromochloropropane

(DBCP) 546

haloacetic acids 605

herbicides 579

nitrogen, phosphorus pesticides & herbicides 578

organochlorine pesticides 81, 566 - 568

organophosphorus pesticides 574, 576, 577

PCBs 584, 585

pesticides & herbicides 570, 571

Rtx®-Dioxin2

TCDD 87

TCDF 87

Rtx®-G27/Rtx®-G43

solvents (organic volatile impurities) 76, 697

Rtx®-OPPesticides/Rtx®-OPPesticides2

organophosphorus pesticides 79, 572, 573

triazine herbicides 582

Rtx®-PCB

PCBs 84, 583, 586

Rtx®-TNT/Rtx®-TNT2

explosives 595

Rtx®-VMS

solvents 645, 646

volatiles 90, 423, 540 - 543

Rtx®-VRX

volatiles 91, 539

Rtx®-WAX/MXT®-WAX

aldehydes 56

essential oils 629

FAMEs 622, 623, 625

glycols 602

solvents 645

solvents (organic volatile impurities) 696

Rtx®-XLB

organochlorine pesticides 569

PCBs 588

semivolatiles 563

Rxi®-1ms

diesel, motor oil 599, 668

fragrance allergens 35

hydrocarbons (accelerants) 667, 668

microbial volatile organic compounds 606

pesticides (Minnesota Ag List) 453, 575

petroleum hydrocarbons 599

phthalate & adipate esters 549

steroids (sex hormones) 688

sulfur compounds 666

Rxi®-17

fragrance allergens 35

polycyclic aromatic hydrocarbons 45, 553

Rxi®-5ms

cannabinoids 676

cholesterols 627

drugs (acidic, neutral) 681

drugs (basic) 682

flavors 41

GBL 670

local anesthetics 689

pesticides (organochlorine & organophosphorus) 641

polycyclic aromatic hydrocarbons 550

GC APPLICATIONS

GC Applications by Phase, EPA Methods Chart

GC Applications by Phase (cont'd)

Rxi®-5ms (cont'd)

pyridine	.38
semivolatiles	.37, 564
test mixes	.39

Rxi®-5Sil MS

polycyclic aromatic hydrocarbons	.88, 554
semivolatile organics	.43, 78, 556 - 558, 560, 561

Rxi®-50

polycyclic aromatic hydrocarbons	.551
Stabilwax®	
acrylamide	.637
amines, alcohols, chlorides	.702
essential oils	.57, 628, 630, 631
FAMEs	.623, 649
flavor volatiles	.632
glycols	.603
residual solvents	.75, 694, 695
solvents	.544

Stabilwax®-DA

cresylic acids	.703
fatty acids (free)	.618, 619
flavor volatiles	.62, 633, 635

Stabilwax®-DB

amines	.61, 700 - 702
solvents	.545

PLOT

Rt®-Alumina PLOT

hydrocarbon gases	.655
-------------------	------

Rt®-Msieve 5A PLOT

permanent gases	.99, 651
-----------------	----------

Rt®-Q-BOND

solvents	.101
----------	------

Rt®-QPLOT

hydrocarbon gases	.652 - 654
-------------------	------------

Rt®-QS-BOND

hydrocarbon gases	.654, 656, 657
-------------------	----------------

ketones	.699
---------	------

solvents	.699
----------	------

Rt®-UPLOT

hydrocarbon gases	.652
-------------------	------

solvents	.698
----------	------

Packed/Micropacked

CarboBlack B

blood alcohol	.669
---------------	------

flavor volatiles	.634
------------------	------

D3606 Application Column

gasoline	.118, 659
----------	-----------

HayeSep® Q

solvents	.698
----------	------

5% Krytox®/CarboBlack B

chlorofluorocarbons	.702
---------------------	------

Molesieve 5A

permanent gases	.650
-----------------	------

Molesieve 13X

permanent gases	.650
-----------------	------

Res-Sil™ C Packing

OPN	.119
-----	------

n-Octane	.119
----------	------

Rt®-1200/Bentone® 34

aromatics (BTEX)	.658
------------------	------

Rt®-XLsulfur

sulfur compounds	.121, 666
------------------	-----------

sulfurs in beverages	.638
----------------------	------

Rtx®-1 on Chromosorb® WAW

hydrocarbons (motor oil, aviation gas)	.659
--	------

Rtx®-1 SimDist 2887

simulated distillation	.664, 665
------------------------	-----------

ShinCarbon ST

fluorocarbons	.652
---------------	------

hydrocarbon gases	.650, 654
-------------------	-----------

permanent gases	.120, 650
-----------------	-----------

10% TCEP

aromatics, aliphatics	.657
-----------------------	------

20% TCEP

hydrocarbons (motor oil, aviation gas)	.659
--	------

HPLC & GC Applications Compound Index

starting on page 706

EPA Methods Chart

EPA 500 Series Methods

Method #	Method Title	Page #
502.2	Volatile Organic Compounds	.539
504.1	1,2-dibromoethane & 1,2-dibromo-3-chloropropane	.546
505	Organohalide Pesticides & PCBs	.570
506	Semivolatile Organics	.548, 549
508.1	Chlorinated Pesticides	.571
515	Chlorophenoxyacid Herbicides	.www.restek.com
524.2	Volatile Organics	.543
525.2	Semivolatile Organics	.564
526	Semivolatile Organics (screening)	.555
528	Phenols	.555
551.1	Chlorinated Disinfection Byproducts	.590, 591
552.2	Haloacetic Acids	.604, 605

EPA 600 Series Methods

Method #	Method Title	Page #
601	Purgeable Hydrocarbons	.www.restek.com
602	Purgeable Aromatics	.www.restek.com
604	Phenols	.547
605	Benzidines	.www.restek.com
606	Phthalate Esters	.www.restek.com
607	Nitrosamines	.www.restek.com
609	Nitroaromatics & Isophorone	.www.restek.com
610	Polycyclic Aromatic Hydrocarbons	.550-553
611	Haloethers	.www.restek.com
612	Chlorinated Hydrocarbons	.www.restek.com
615	Chlorophenoxyacid Herbicides	.580
619	Nitrogen/Phosphorus Herbicides & Pesticides	.578, 581
624	Purgeable Halocarbons	.www.restek.com
625	Base/Neutrals, Acids, & Pesticides	.www.restek.com

EPA 8000 Series Methods

Method #	Method Title	Page #
8021	Volatile Organics	.539
8060	Phthalate Esters	.www.restek.com
8081	Chlorinated Pesticides	.568, 569
8095	Explosives	.595
8100	Polycyclic Aromatic Hydrocarbons	.551
8140/8141/		
8141A	Organophosphorus Pesticides	.572-574
8151A	Chlorophenoxyacid Herbicides	.579
8240	Volatile Organics	.www.restek.com
8260	Volatile Organics	.540-542
8270	Semivolatile Organics	.556-558, 560-563

CLP Methods

Method #	Method Title	Page #
OLC 03.2	Volatile Organics	.www.restek.com
CLP	Semivolatile Organics	.565
Appendix		
IX	Semivolatile Organics	.558, 562
1671	Volatile Organics	.544, 545
	European OPs	.576, 577
	PCBs	.583-588
	Brominated Flame Retardants	.589
	Dioxins	.592

EPA TO (Air) Methods

Method #	Method Title	Page #
TO-14		.607, 609
TO-15		.609, 610



Searching for more chromatograms for EPA Methods?

www.restek.com

Choosing a Volatiles GC Column for PID/ELCD*

Restek Phase	Coelutions by Peak Numbers (Coelutions by PID/ELCD are indicated in BOLD)	Close Pairs by PID/ELCD	Suggested Confirmation Column	Poor Choice for Confirmation Column	Thick Phase Stable Temp. (°C)	Recommended High Temp. for VOA Work (°C)	Advantages	Page # for Chromatogram ²
Rtx-502.2	14/15, 33/34, 39/40	4/5, 44/45, 56/57, 52/55, 64/65	Rtx-VMS, Rtx-VRX, Rtx-1	Rtx-Volatiles, Vocal, Rtx-35, Rtx-20	270	240	low bleed	no
Rtx-Volatiles	14/15, 21/22, 38/40, 44/45, 53/55	56/57, 68/69	Rtx-VMS, Rtx-1, Rtx-624	Rtx-502.2, Vocal, Rtx-20, Rtx-35	270	240	low bleed	no
Rtx-624	7/8, 10/11, 52/53, 31/34, 53/55, 59/60	32/33, 44/45, 51/54	Rtx-VMS, Rtx-502.2	Rtx-1701	280	240		no
Rtx-VRX	11/13, 39/43, 46/50, 40/44	8/9, 15/17, 24/27, 58/60	Rtx-VMS, Rtx-502.2	Rtx-1	260	230		539
Rtx-1	9/12, 15/17, 25/26, 24/27, 33/36, 38/40, 40/44, 45/50, 56/57	7/12, 49/55	Rtx-502	Rtx-VRX	320	260		no
Rtx-1701	9/10, 18/19, 16/20, 50/53, 51/55, 54/56	5/6, 29/30, 32/33	Rtx-502.2	Rtx-624	270	240		no
Rtx-200	2/3, 5/6, 11/12, 14/16, 22/24, 28/35, 32/33/37, 43/44, 50/55/56, 57/58	13/17, 36/37	Rtx-VMS		320	240	m/p xylene separation	no
Rtx-35	4/5, 16/19, 18/20, 21/22, 34/31, 39/38/41/42/40, 46/51/49, 53/54, 48/52/53, 61/62, 66/67	2/3,	Rtx-VMS, Rtx-624	Rtx-502.2, Rtx-Volatiles, Rtx-20	270	240		no
Rtx-50	4/5/6, 8/7/12, 25/28, 32/33, 37/41/42, 38/40, 45/47, 46/54/52, 56/55/48, 57/58	2/3, 20/18, 31/32, 39/41/42	Rtx-VMS, Rtx-624	Rtx-35	280	240		no
Rtx-DXL (custom)	4/5, 9/10, 25/27, 38/39, 47/50, 49/46/48, 52/54, 53/55	27/28, 32/36/31, 65/67	Rtx-502.2	Rtx-VMS	220	200		no

¹ Can be resolved under different conditions. See application showing method 601/602 with the Rtx®-VGC column on www.restek.com/chromatograms (search: chromatogram number GC_EV00420).

² pages listed include GC/MS analyses.

Volatile Analytes:

1. dichlorodifluoromethane
2. chloromethane
3. vinyl chloride
4. bromomethane
5. chloroethane
6. trichlorofluoromethane
7. 1,1-dichloroethene
8. Freon ®113
9. methylene chloride
10. *trans*-1,2-dichloroethene
11. methyl *tert*-butyl ether
12. *tert*-butyl alcohol
13. 1,1-dichloroethane
14. *cis*-1,2-dichloroethene
15. 2,2-dichloropropane
16. bromochloromethane
17. chloroform
18. carbon tetrachloride
19. 1,1,1-trichloroethane
20. 1,1-dichloropropene
21. benzene
22. 1,2-dichloroethane
23. fluorobenzene
24. trichloroethene
25. dibromomethane
26. 1,2-dichloropropane
27. bromodichloromethane
28. 2-chloroethyl vinyl ether
29. *cis*-1,3-dichloropropene
30. toluene
31. tetrachloroethene
32. *trans*-1,3-dichloropropene
33. 2-bromo-1-chloropropane
34. 1,1,2-trichloroethane
35. dibromochloromethane
36. 1,3-dichloropropane
37. 1,2-dibromoethane
38. chlorobenzene
39. ethyl benzene
40. 1,1,2-tetrachloroethane
41. *m*-xylene
42. *p*-xylene
43. 1-chloro-2-fluorobenzene
44. *o*-xylene
45. styrene
46. bromoform
47. isopropyl benzene
48. bromobenzene
49. *n*-propylbenzene
50. 1,4-dichlorobutane
51. 1,1,2,2-tetrachloroethane
52. 2-chlorotoluene
53. 1,3,5-trimethylbenzene
54. 1,2,3-trichloropropane
55. 4-chlorotoluene
56. *tert*-butylbenzene
57. 1,2,4-trimethylbenzene
58. *sec*-butylbenzene
59. *p*-isopropyl toluene
60. 1,3-dichlorobenzene
61. 1,4-dichlorobenzene
62. *n*-butylbenzene
63. 1,2-dichlorobenzene
64. 4-bromo-1-chlorobenzene
65. 1,2-bromo-3-chloropropane
66. hexachlorobutadiene
67. 1,2,4-trichlorobenzene
68. naphthalene
69. 1,2,3-trichlorobenzene

Conditions for Rtx®-502.2, Rtx®-Volatiles, Rtx®-VRX and Rtx®-1: optimum conditions on 75m, 0.45mm ID, 2.55µm columns.

Conditions for all other columns: 60m, 0.53mm ID, 3.0µm column, flow 10mL/min., temp. program: 35°C (hold 9 min.) to 220°C @ 11°C/min. (hold 10 min.).

Analytes identified using Agilent 5971a mass selective detector with splitless injection or using Finnigan PID/ELCD

Please see chromatograms on pages 539–546 for more details, or call technical service at 800-356-1688 (ext. 4), or your Restek representative.

for **more info**

*For GC/MS analyses, see
Rtx®-VMS applications on pages
540–543.

Compounds listed in US EPA Methods 502.2, 8021, 8010, 8020, 601 & 602, plus commonly added compounds.

m/p xylene coelute on all phases listed above except Rtx®-200 in 60m, 0.25mm ID, 1.0µm under optimized conditions. See 8260 application, using the Rtx®-200 column, www.restek.com/chromatograms (search: chromatogram number GC_EV00429).

Volatiles

Volatile Organic Compounds Retention Time Index

Data collected using a 60m, 0.25mm ID, 1.4 μ m Rtx®-VMS column; Oven: 40°C (hold 6 min.) to 230°C @ 14°C/min. (hold 11 min.); Carrier gas: helium; Regulation: constant pressure; Flow rate: 1mL/min.; Linear velocity: 21cm/sec.; Dead time: 4.90 min.

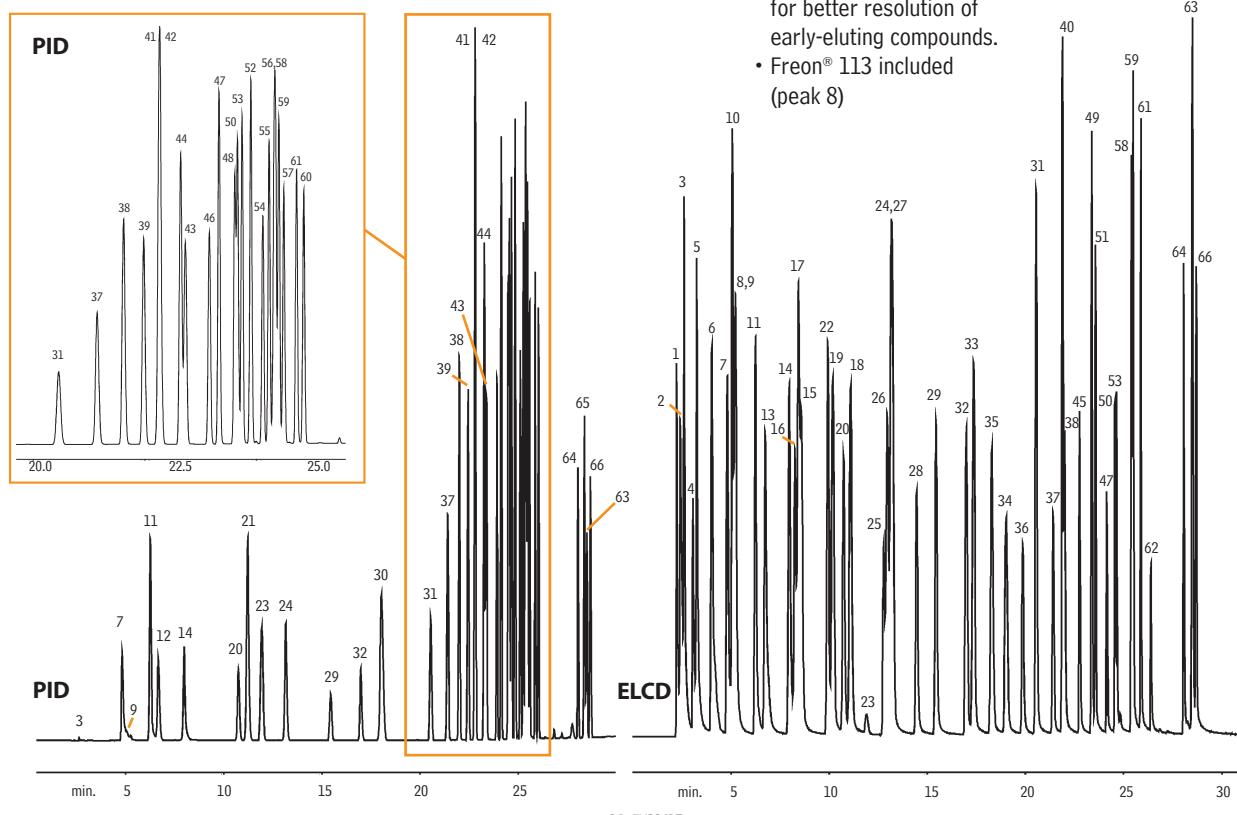
Component	Rtx®-VMS Ret. Time	Component	Rtx®-VMS Ret. Time	Component	Rtx®-VMS Ret. Time
dichlorodifluoromethane	5.52	benzene-d6	14.72	bromoform	20.30
chloromethane	6.26	pentafluorobenzene	14.75	isopropylbenzene	20.51
vinyl chloride	6.54	1,2-dichloroethane-d4	14.79	1,2-butanediol	20.82
water	6.70	1,2-dichloroethane	14.90	valeric acid	20.89
bromomethane	7.61	tert-amyl-methyl ether	15.00	1,4-dichlorobutane	20.90
methanol	7.93	isobutyl alcohol	15.06	bromobenzene	20.91
2-methylbutane	7.96	fluorobenzene	15.16	4-bromo-1-fluorobenzene	20.95
chloroethane	8.00	isopropyl acetate	15.34	cis-1,4-dichloro-2-butene	20.97
trichlorofluoromethane	8.41	formic acid	15.37	n-decane	21.04
n-pentane	8.61	trichloroethene	15.39	n-propylbenzene	21.07
diethylether	9.59	1,4-difluorobenzene	15.58	1,1,2,2-tetrachloroethane	21.10
1,1-dichloroethene	9.64	n-butanol	15.60	1,3,5-trimethylbenzene	21.30
carbon disulfide	9.65	methyl cyclohexane	15.78	1-ethyl-4-methylbenzene	21.33
Freon® 113	9.70	acetic acid	15.93	1,2,3-trichloropropane	21.39
ethanol	9.74	dibromomethane	16.05	trans-1,4-dichloro-2-butene	21.40
iodomethane	9.99	1,2-dichloropropane	16.17	2-chlorotoluene	21.40
3-chlorotrifluoropropane	10.45	bromodichloromethane	16.23	4-chlorotoluene	21.61
chloro-methyl-methylether	10.54	methyl methacrylate	16.28	cyclohexane	21.78
acrolein	10.57	α,α,α -trifluorotoluene	16.45	tert-butylbenzene	21.81
2-methylpentane	10.59	1,4-dioxane	16.49	1-ethyl-2-methylbenzene	21.82
allyl chloride	10.72	n-propyl acetate	16.70	1,2,4-trimethylbenzene	21.88
methylene chloride	10.98	2-chloroethyl-vinyl-ether	16.92	pentachloroethane	21.92
3-methylpentane	11.09	2-chloroethanol	16.93	1,3-dichloro-2-propanol	22.05
acetone	11.24	cis-1,3-dichloropropene	17.04	sec-butylbenzene	22.06
trans-1,2-dichloroethene	11.24	1-bromo-2-chloroethane	17.05	isocaproic acid	22.09
methyl tert-butyl ether	11.42	n-octane	17.17	p-isopropyltoluene	22.22
2-propanol	11.52	toluene-d8	17.28	1,3-dichlorobenzene	22.53
tert-butyl alcohol	11.56	propionic acid	17.36	caproic acid	22.55
methyl acetate	11.63	chloroacetonitrile	17.64	1,4-dichlorobenzene	22.64
hexane	11.64	4-methyl-2-pentanone	17.76	n-butylbenzene	22.88
acetonitrile	12.22	2-bromo-1-chloropropane	17.81	malononitrile	22.89
chloroprene	12.30	2-nitropropane	17.83	benzyl chloride	23.23
1,1-dichloroethane	12.42	pyridine	17.86	1,2-dichlorobenzene-d4	23.36
acrylonitrile	12.60	1,1-dichloropropanone	17.88	1,2-dichlorobenzene	23.38
diisopropyl ether	12.62	trans-1,3-dichloropropene	17.88	hexachloroethane	23.63
2,4-dimethylpentane	12.68	tetrachloroethene	17.89	1-octanol	23.70
vinyl acetate	13.02	ethyl methacrylate	17.92	bis-(2-chloro-isopropyl) ether	24.06
ethyl-tert-butyl ether	13.08	1,1,2-trichloroethane	18.11	4-bromo-1-chlorobenzene	24.09
1-propanol	13.18	dibromochloromethane	18.40	benzyl alcohol	24.23
cis-1,2-dichloroethene	13.32	1,3-dichloropropane	18.49	heptanoic acid	24.29
allyl alcohol	13.35	isobutyric acid	18.55	n-dodecane	24.54
2,2-dichloropropane	13.48	1,2-dibromoethane	18.78	3-bromochlorobenzene	24.61
bromochloromethane	13.62	n-butyl acetate	18.80	1,2-dibromo-3-chloropropane	24.78
chloroform	13.75	2-hexanone	18.82	2-bromochlorobenzene	25.54
cyclohexane	13.84	butyric acid	19.17	hexachlorobutadiene	25.99
methyl acrylate	13.87	1-chloro-3-fluorobenzene	19.17	nitrobenzene	26.02
carbon tetrachloride	13.94	ethylbenzene	19.36	1,2,4-trichlorobenzene	26.19
tetrahydrofuran	14.03	chlorobenzene	19.39	benzyl acetate	26.29
1,1,1-trichloroethane	14.06	1-chloro-4-fluorobenzene	19.39	n-tridecane	26.51
ethyl acetate	14.13	ethylbenzene-d10	19.40	naphthalene	27.01
2-butanone	14.18	1-chlorohexane	19.41	1,2,3-trichlorobenzene	27.46
dibromofluoromethane	14.18	1,1,1,2-tetrachloroethane	19.44	n-tetradecane	28.83
1,1-dichloropropene	14.20	m-xylene	19.53	2-methylnaphthalene	30.36
propargyl alcohol	14.35	p-xylene	19.54	1-methylnaphthalene	30.96
1-chlorobutane	14.51	chlorobenzene-d5	19.55	n-pentadecane	31.65
2,2,4-trimethylpentane	14.53	1-chloro-2-fluorobenzene	19.67	2-chloronaphthalene	33.36
propionitrile	14.59	o-xylene	20.13		
benzene	14.60	stryrene	20.17		
n-heptane (C7)	14.62	isovaleric acid	20.18		
methacrylonitrile	14.64				

for **more** info

See pages 540–543 for Rtx®-VMS applications.

Volatile Organics
US EPA Method 8021
Rtx®-VRX

Rtx®-VRX
75m, 0.45mm ID, 2.55 μ m (cat.# 19309)



Column: Rtx®-VRX, 75m, 0.45mm ID, 2.55 μ m (cat.# 19309)
Conc.: 20ppb in 5mL of RO water.
Concentrator: Tekmar LSC-3000 Purge and Trap
Trap: Vocabr 3000
Purge: 11 min. @ 40mL/min.
Dry purge: 1 min. @ 40mL/min. (MCS by-passed with SilcoSteel® tubing, cat.# 21035)
Desorb preheat: 245°C
Desorb: 250°C for 2 min.
Bake: 260°C for 8 min.
Interface: direct
Transfer line: 0.32mm ID Siltek® tubing

GC: Finnigan 9001
Oven temp.: 35°C (hold 4 min.) to 75°C @ 3°C/min. (hold 2 min.) to 175°C @ 21°C/min. to 205°C @ 35°C/min. (hold 5 min.)
Carrier: helium 11mL/min., constant pressure
Adjust dichlorodifluoromethane to a retention time of 2.28 min. @ 35°C on the Rtx®-VG column.
Detectors: μ Gold Tandem PID/HALL 2000
PID: makeup 7mL/min., purge 7mL/min., set @ 0.35mV,
base temp. 200°C.
ELCD HALL 2000: RxnGas 25mL/min., RxnTemp. 940°C,
propanol flow 470 μ L/min.

- | | | | |
|--------------------------------------|---------------------------------------|-----------------------------------|---------------------------------|
| 1. dichlorodifluoromethane | 18. carbon tetrachloride | 35. 1,3-dichloropropane | 52. 1,3,5-trimethylbenzene |
| 2. chloromethane | 19. 1,1,1-trichloroethane | 36. 1,2-dibromoethane | 53. 4-chlorotoluene |
| 3. vinyl chloride | 20. 1,1-dichloropropene | 37. 1-chloro-3-fluorobenzene (SS) | 54. <i>tert</i> -butylbenzene |
| 4. bromomethane | 21. benzene | 38. chlorobenzene | 55. 1,2,4-trimethylbenzene |
| 5. chloroethane | 22. 1,2-dichloroethane | 39. ethylbenzene | 56. <i>sec</i> -butylbenzene |
| 6. trichlorofluoromethane | 23. fluorobenzene (SS) | 40. 1,1,1,2-tetrachloroethane | 57. <i>p</i> -isopropyltoluene |
| 7. 1,1-dichloroethene | 24. trichloroethene | 41. <i>m</i> -xylene | 58. 1,3-dichlorobenzene |
| 8. Freon® 113 | 25. dibromomethane | 42. <i>p</i> -xylene | 59. 1,4-dichlorobenzene |
| 9. allyl chloride | 26. 1,2-dichloropropane | 43. <i>o</i> -xylene | 60. <i>n</i> -butylbenzene |
| 10. methylene chloride | 27. bromodichloromethane | 44. styrene | 61. 1,2-dichlorobenzene |
| 11. <i>trans</i> -1,2-dichloroethene | 28. 1-bromo-2-chloroethane (SS) | 45. bromoform | 62. 1,2-dibromo-3-chloropropane |
| 12. methyl <i>tert</i> -butyl ether | 29. <i>cis</i> -1,3-dichloropropene | 46. isopropylbenzene | 63. hexachlorobutadiene |
| 13. 1,1-dichloroethane | 30. toluene | 47. bromobenzene | 64. 1,2,4-trichlorobenzene |
| 14. <i>cis</i> -1,2-dichloroethene | 31. tetrachloroethene | 48. <i>n</i> -propylbenzene | 65. naphthalene |
| 15. 2,2-dichloropropane | 32. <i>trans</i> -1,3-dichloropropene | 49. 1,1,2,2-tetrachloroethane | 66. 1,2,3-trichlorobenzene |
| 16. bromochloromethane | 33. 1,1,2-trichloroethane | 50. 2-chlorotoluene | |
| 17. chloroform | 34. dibromochloromethane | 51. 1,2,3-trichloropropane | |

Acknowledgement: Finnigan 9001 GC, μ Gold Tandem Photoionization/HALL 2000 Electrolytic Conductivity Detector provided courtesy of Thermo Scientific GC & GC/MS Division, 2215 Grand Avenue Pkwy, Austin, Texas 78728

restek
innovation!

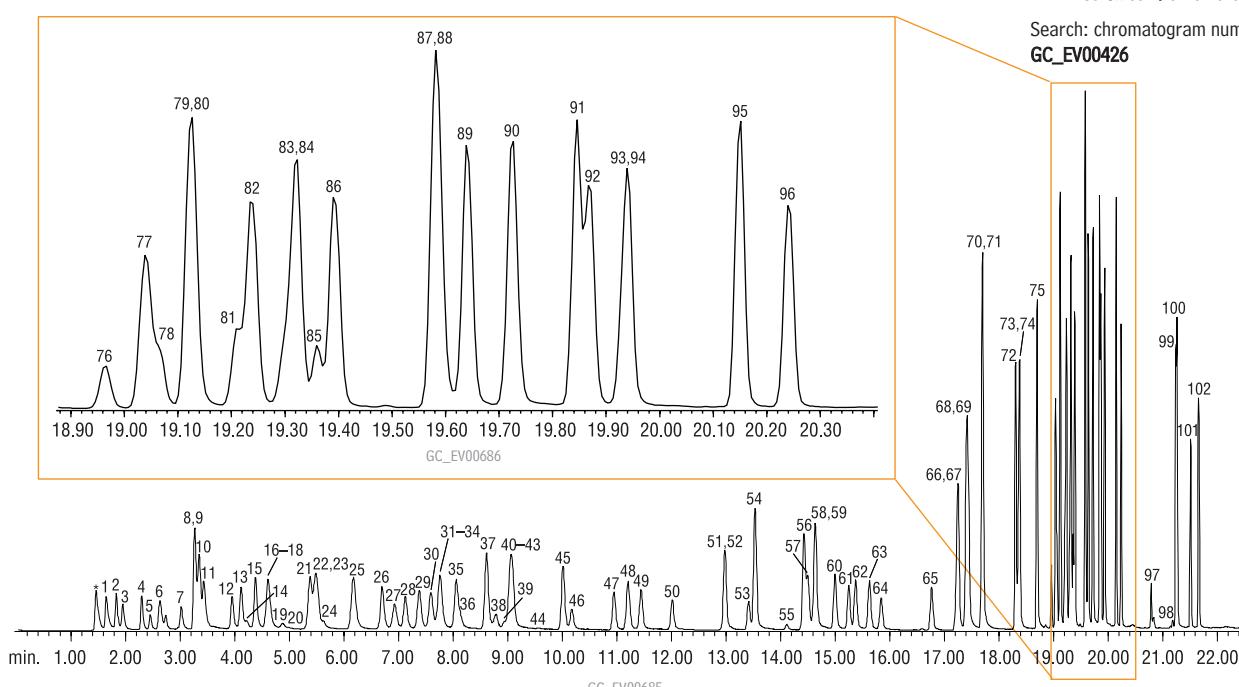
- 35°C starting temperature for better resolution of early-eluting compounds.
- Freon® 113 included (peak 8)



Volatile Organics

US EPA Method 8260 (80ppb Standard)

Rtx®-VMS



Column: Rtx®-VMS, 30m, 0.25mm ID, 1.4 μ m (cat.# 19915)
 Sample: Calibration, internal standard, surrogate standard mixes (cat.# 30475B, 30465, 30006, 30240, 30074)

Purge and trap conditions:

O.I. Analytical 4560 with 4551A Autosampler

Trap: #10 (Tenax®/silica gel/carbon molecular sieve)
 Purge time: 11 min.
 Purge flow rate: 38ml/min.
 Desorb flow rate: 32mL/min.
 Desorb time: 1.0 min.
 Bake time: 10 min.
 Sample size: 10mL
 Water management: 110°C purge, 0°C desorb, 240°C bake
 Split ratio: 1:25

Temperatures:

Sample: 40°C
 Trap: 20°C purge, 190°C desorb, 210°C bake

6-Port valve: 110°C
 Transfer line: 110°C
 Sparge mount: 45°C
 Desorb preheat: 150°C
 Valve manifold: 50°C

Other conditions: pre-purge, pre-heat, dry purge OFF
Chromatography:

Inj. temp.: 250°C
 Carrier gas: helium, constant flow
 Flow rate: 1.3 mL/min.
 Dead time: 1.47 min. @ 35°C
 Oven temp.: 35°C (hold 7 min.) to 90°C @ 4°C/min.(no hold) to 220°C @ 45°C/min. (hold 1 min.).
 Det.: Agilent 5971A GC/MS
 Transfer line temp.: 280°C
 Scan range: 35-260amu
 Tune: PFTBA/BFB

- *carbon dioxide
- 1. dichlorodifluoromethane
- 2. chloromethane
- 3. vinyl chloride
- 4. bromomethane
- 5. chloroethane
- 6. trichlorofluoromethane
- 7. diethyl ether
- 8. 1,1-dichloroethene
- 9. carbon disulfide
- 10. Freon® 113
- 11. iodomethane
- 12. allyl chloride
- 13. methylene chloride
- 14. acetone
- 15. trans-1,2-dichloroethene
- 16. methyl-d3-tert-butyl-ether
- 17. methyl acetate
- 18. methyl-tert-butyl-ether
- 19. tert-butyl alcohol
- 20. acetonitrile
- 21. diisopropyl ether
- 22. chloroprene
- 23. 1,1-dichloroethane
- 24. acrylonitrile
- 25. ethyl-tert-butyl ether
- 26. cis-1,2-dichloroethene
- 27. 2,2-dichloropropane
- 28. bromochloromethane
- 29. chloroform
- 30. carbon tetrachloride
- 31. tetrahydrofuran
- 32. methyl acrylate
- 33. 1,1,1-trichloroethane
- 34. dibromoform
- 35. 1,1-dichloropropene
- 36. 2-butanone
- 37. benzene
- 38. propionitrile
- 39. methacrylonitrile
- 40. 1,2-dichloroethane-d4
- 41. pentafluorobenzene
- 42. tert-amyl-methyl ether
- 43. 1,2-dichloroethane
- 44. isobutyl alcohol
- 45. trichloroethene
- 46. 1,2-difluorobenzene
- 47. dibromomethane
- 48. 1,2-dichloropropane
- 49. bromodichloromethane
- 50. methyl methacrylate
- 51. cis-1,3-dichloropropene

- 52. 2-chloroethyl vinyl ether
- 53. toluene-d8
- 54. toluene
- 55. 2-nitropropane
- 56. tetrachloroethene
- 57. 2-bromo-1-chloropropane
- 58. 4-methyl-2-pentanone
- 59. trans-1,3-dichloropropene
- 60. 1,1,2-trichloroethane
- 61. ethyl methacrylate
- 62. dibromochloromethane
- 63. 1,3-dichloropropane
- 64. 1,2-dibromoethane
- 65. 2-hexanone
- 66. chlorobenzene-d5
- 67. chlorobenzene
- 68. ethylbenzene
- 69. 1,1,1-tetrachloroethane
- 70. m-xylene
- 71. p-xylene
- 72. o-xylene
- 73. bromoform
- 74. styrene
- 75. isopropylbenzene
- 76. 4-bromo-1-fluorobenzene (SS)
- 77. bromobenzene
- 78. cis-1,4-dichloro-2-butene
- 79. 1,4-dichlorobutane
- 80. n-propylbenzene
- 81. 1,1,2,2-tetrachloroethane
- 82. 2-chlorotoluene
- 83. 1,2,3-trichloropropane
- 84. 1,3,5-trimethylbenzene
- 85. trans-1,4-dichloro-2-butene
- 86. 4-chlorotoluene
- 87. tert-butylbenzene
- 88. pentachloroethane
- 89. 1,2,4-trimethylbenzene
- 90. sec-butylbenzene
- 91. p-isopropyltoluene
- 92. 1,3-dichlorobenzene
- 93. 1,4-dichlorobenzene-d4
- 94. 1,4-dichlorobenzene
- 95. n-butylbenzene
- 96. 1,2-dichlorobenzene
- 97. 1,2-dibromo-3-chloropropane
- 98. nitrobenzene
- 99. hexachlorobutadiene
- 100. 1,2,4-trichlorobenzene
- 101. naphthalene
- 102. 1,2,3-trichlorobenzene

Acknowledgments: Purge & trap courtesy of O.I. Analytical.

for more info

EPA Method 8240 chromatograms
www.restek.com/chromatogramsSearch: chromatogram number
GC_EV00426restek
innovation!Good choice for alcohols &
oxygénates!

free literature

Analysis of Trace Oxygenates in Petroleum-Contaminated Wastewater, Using Purge-and-Trap/GC/MS (US EPA Methods 5030B & 8260)

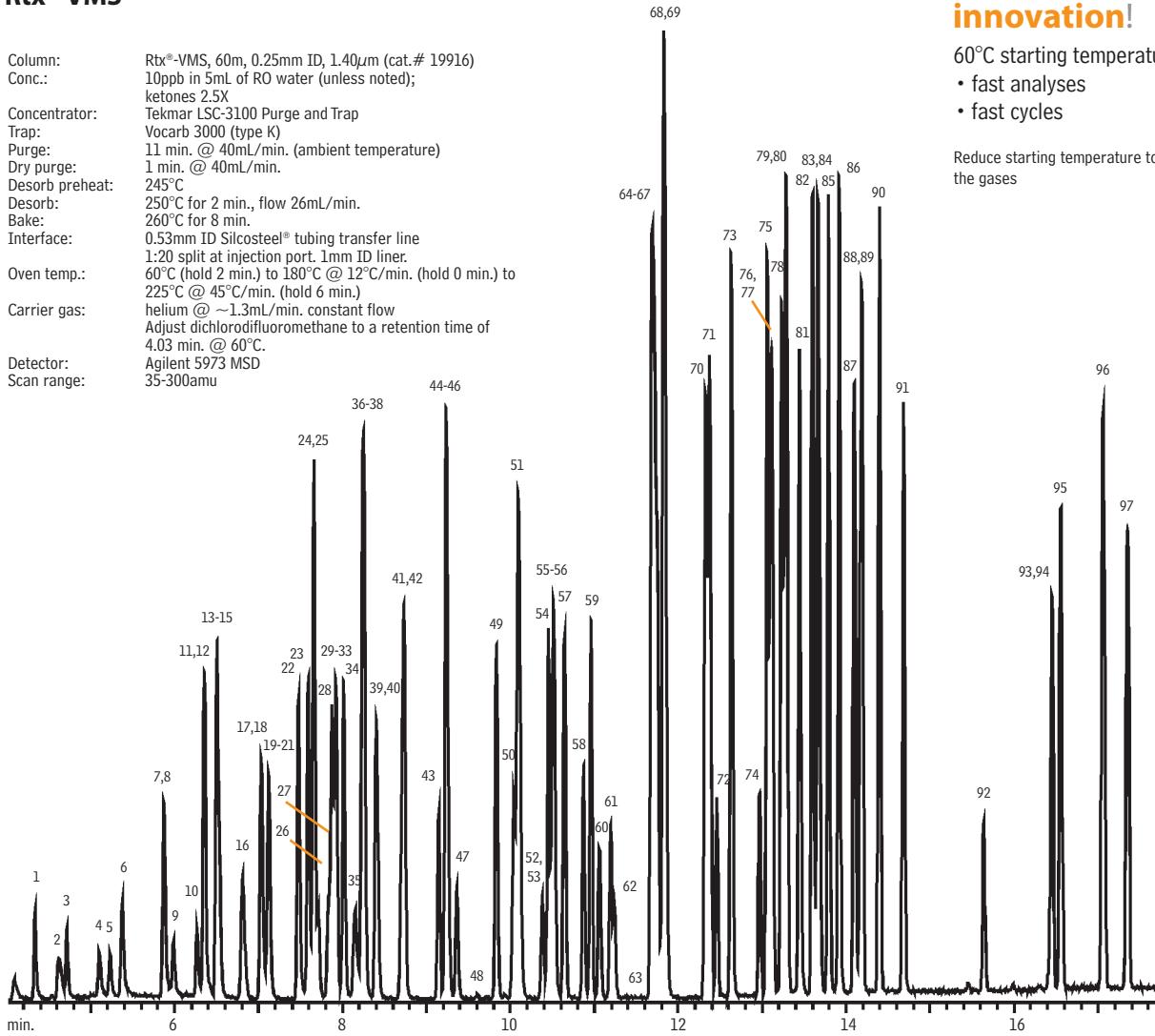
This 8-page note describes a practical, effective approach to monitoring oxygenates in wastewater. We evaluated the Rtx®-VMS stationary phase for oxygenates recovery, adjusted purge and trap conditions to increase responses for oxygenates, and optimized GC conditions to eliminate coelutions of ion-sharing analytes. The result is a sensitive, accurate analysis for gasoline oxygenates in wastewater, in the presence of much higher total gasoline content.

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Applications Note
 lit. cat.# 59856

Volatile Organics
US EPA Method 8260B
Rtx®-VMS

Column: Rtx®-VMS, 60m, 0.25mm ID, 1.40 μ m (cat.# 19916)
 Conc.: 10ppb in 5mL of RO water (unless noted);
 ketones 2.5X
 Concentrator: Tekmar LSC-3100 Purge and Trap
 Trap: Vocarb 3000 (type K)
 Purge: 11 min. @ 40mL/min. (ambient temperature)
 Dry purge: 1 min. @ 40mL/min.
 Desorb preheat: 245°C
 Desorb: 250°C for 2 min., flow 26mL/min.
 Bake: 260°C for 8 min.
 Interface: 0.53mm ID Silcosteel® tubing transfer line
 1:20 split at injection port. 1mm ID liner.
 Oven temp.: 60°C (hold 2 min.) to 180°C @ 12°C/min. (hold 0 min.) to
 225°C @ 45°C/min. (hold 6 min.)
 Carrier gas: helium @ ~1.3mL/min. constant flow
 Adjust dichlorodifluoromethane to a retention time of
 4.03 min. @ 60°C.
 Detector: Agilent 5973 MSD
 Scan range: 35-300amu



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

*Peaks 19 & 21 share an ion (43).

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60°C starting temperature

- fast analyses

- fast cycles

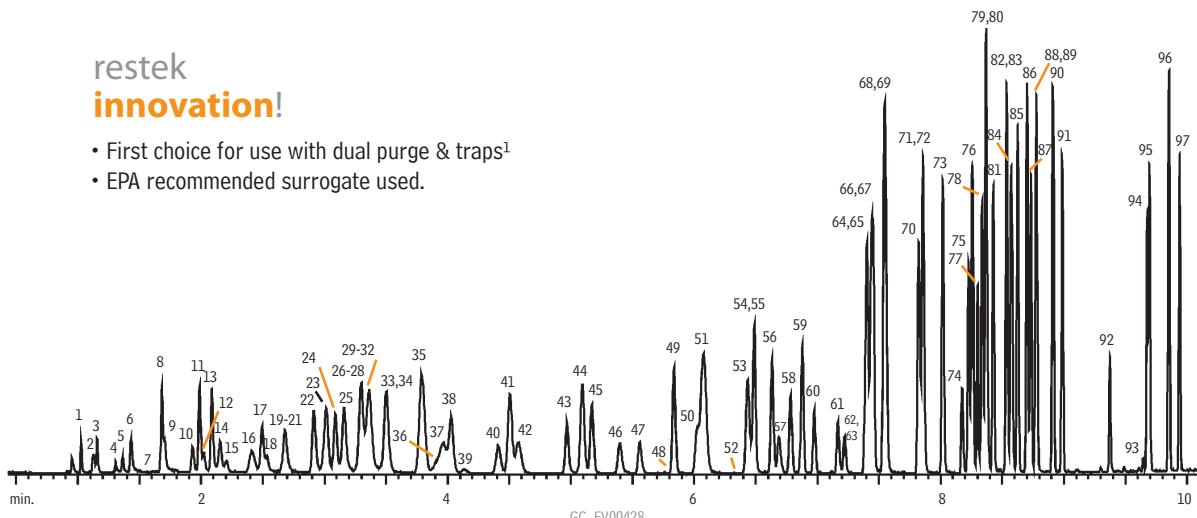
Reduce starting temperature to best focus the gases



Volatile Organics
US EPA Method 8260B
Rtx®-VMS

**restek
innovation!**

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



Column: Rtx®-VMS, 20m, 0.18mm 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: Vocarb 3000 (type K)
Purge: 11 min. @ 40mL/min. (ambient temperature)
Dry purge: 1 min. @ 40mL/min.
Desorb preheat: 245°C
Desorb: 250°C for 2 min., flow 40mL/min.
Bake: 260°C for 8 min.
Interface: 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
Detector: Adjust dichlorodifluoromethane to a retention time of 1.03 min. @ 50°C.
Scan range: 35-300amu

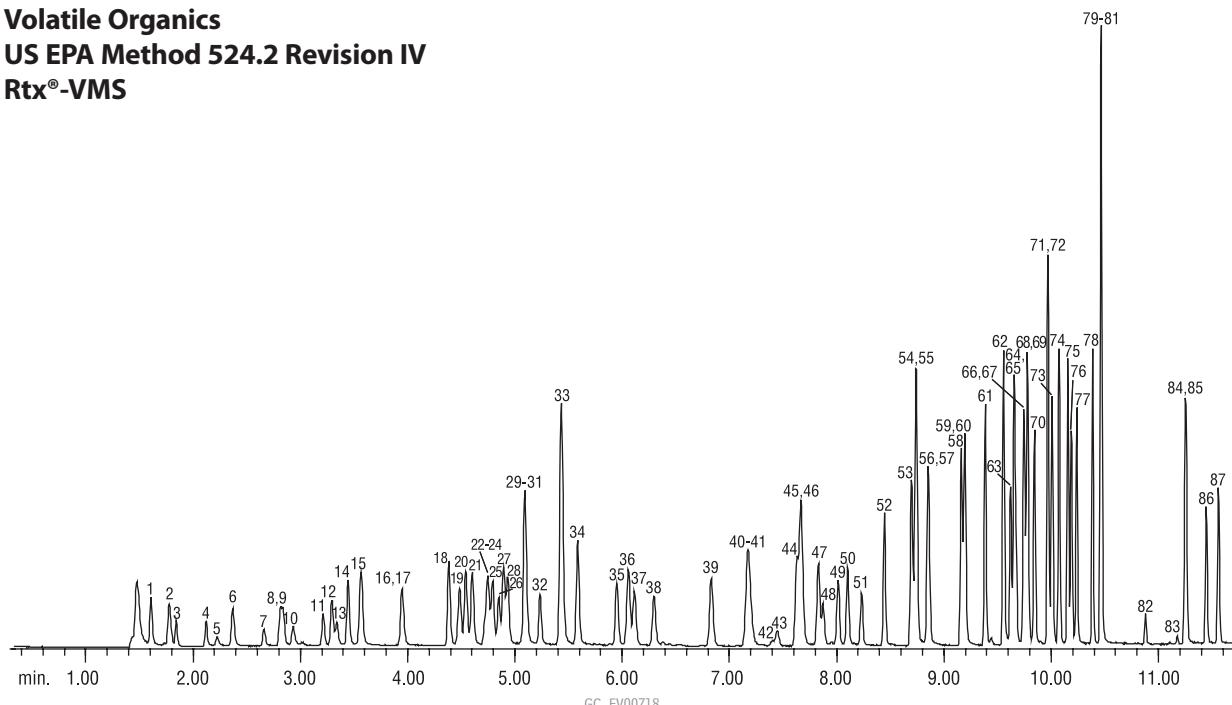
1. dichlorodifluoromethane	26. ethyl acetate	51. toluene	76. <i>n</i> -propylbenzene
2. chloromethane	27. carbon tetrachloride	52. pyridine (250ppb)	77. 1,1,2,2-tetrachloroethane
3. vinyl chloride	28. methyl acrylate	53. tetrachloroethene	78. 2-chlorotoluene
4. bromomethane	29. propargyl alcohol (500ppb)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

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

Volatile Organics

US EPA Method 524.2 Revision IV

Rtx®-VMS



Purge and Trap Conditions:

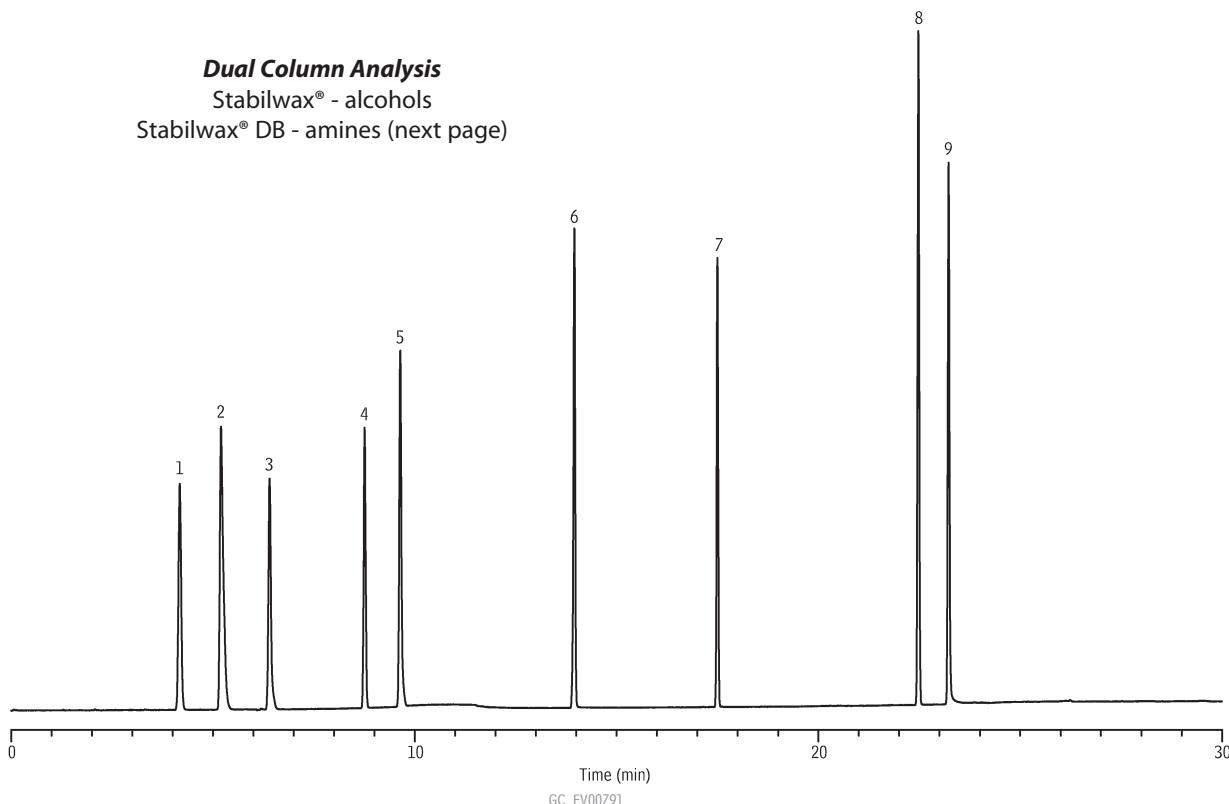
Concentrator: Tekmar LSC-3100 purge and trap
Trap: Vocarb 3000 (type K)
Purge: 11 min. @ 40mL/min. @ ambient temperature.
Dry purge: 1 min. @ 40mL/min. (MCS bypassed using SilcoSteel® tubing)
Desorb preheat: 245°C
Desorb: 250°C for 2 min., flow 33mL/min.
Bake: 260°C for 8 min.
Interface: SilcoSteel® transfer line
1:30 split at injection port, 1mm ID split inlet liner (cat.# 20972)

Column: Rtx®-VMS, 30m, 0.25mm ID, 1.4µm (cat.# 19915)
Sample: 502.2 Calibration Mix #1 (cat.# 30042)
Drinking Water VOA MegaMix®, 524 Rev 4 (cat.# 30601)
524 Internal Standard/Surrogate Mix (cat.# 30201)
Ketone Mix, EPA Method 524.2 Rev 4.1 (cat.# 30602)
Compounds at 20 ppb each in 5mL RO water
(ketones at 50ppb; internal standards at 40ppb)
Inj. temp.: 250°C
Carrier gas: helium, constant flow
Flow rate: 1.1mL/min.
Dead time: 1.48 min. @ 40°C
Oven temp.: 40°C (hold 2 min.) to 85°C @ 14°C/min. (hold 2 min.) to 220°C @ 30°C/min. (hold 4 min.).
Det: Agilent 5971A GC/MS
Transfer line temp.: 280°C
Scan range: 35-300amu
Tune: PFTBA/BFB
Ionization: EI

1. dichlorodifluoromethane	19. 2,2-dichloropropane	37. bromodichloromethane	55. 1,1,1,2-tetrachloroethane	73. 1,2,4-trimethylbenzene
2. chloromethane	20. bromochloromethane	38. methyl methacrylate	56. <i>m</i> -xylene	74. <i>sec</i> -butylbenzene
3. vinyl chloride	21. chloroform	39. <i>cis</i> -1,3-dichloropropene	57. <i>p</i> -xylene	75. <i>p</i> -isopropyltoluene
4. bromomethane	22. methyl acrylate	40. toluene	58. <i>o</i> -xylene	76. 1,3-dichlorobenzene
5. chloroethane	23. carbon tetrachloride	41. chloroacetonitrile	59. styrene	77. 1,4-dichlorobenzene
6. trichlorofluoromethane	24. tetrahydrofuran	42. 2-nitropropane	60. bromoform	78. <i>n</i> -butylbenzene
7. diethyl ether	25. 1,1,1-trichloroethane	43. 1,1-dichloropropanone	61. isopropylbenzene	79. hexachloroethane
8. 1,1-dichloroethene	26. 2-butanone	44. 4-methyl-2-pentanone	62. 4-bromofluorobenzene	80. 1,2-dichlorobenzene-d4
9. carbon disulfide	27. 1,1-dichloropropene	45. tetrachloroethene	63. bromobenzene	81. 1,2-dichlorobenzene
10. iodomethane	28. 1-chlorobutane	46. <i>trans</i> -1,3-dichloropropene	64. <i>n</i> -propylbenzene	82. 1,2-dibromo-3-chloropropane
11. allyl chloride	29. propionitrile	47. 1,1,2-trichloroethane	65. 1,1,2,2-tetrachloroethane	83. nitrobenzene
12. methylene chloride	30. methacrylonitrile	48. ethyl methacrylate	66. 2-chlorotoluene	84. hexachlorobutadiene
13. acetone	31. benzene	49. dibromochloromethane	67. 1,2,3-trichloropropane	85. 1,2,4-trichlorobenzene
14. <i>trans</i> -1,2-dichloroethene	32. 1,2-dichloroethane	50. 1,3-dichloropropane	68. 1,3,5-trimethylbenzene	86. naphthalene
15. methyl <i>tert</i> -butyl ether	33. fluorobenzene	51. 1,2-dibromoethane	69. <i>trans</i> -1,4-dichloro-2-butene	87. 1,2,3-trichlorobenzene
16. 1,1-dichloroethane	34. trichloroethene	52. 2-hexanone	70. 4-chlorotoluene	
17. acrylonitrile	35. dibromomethane	53. chlorobenzene	71. <i>tert</i> -butylbenzene	
18. <i>cis</i> -1,2-dichloroethene	36. 1,2-dichloropropane	54. ethylbenzene	72. pentachloroethane	

*Peaks 42 & 43 share an ion (43).

Volatile Organics
US EPA Method 1671
Stabilwax®



Peak	Retention Time (min.)
1. tetrahydrofuran (IS)	4.17
2. methanol	5.20
3. ethanol	6.40
4. acetonitrile	8.75
5. n-propanol	9.64
6. methyl Cellosolve®	13.95
7. formamide	17.50
8. dimethyl sulfoxide	22.47
9. ethylene glycol	23.22

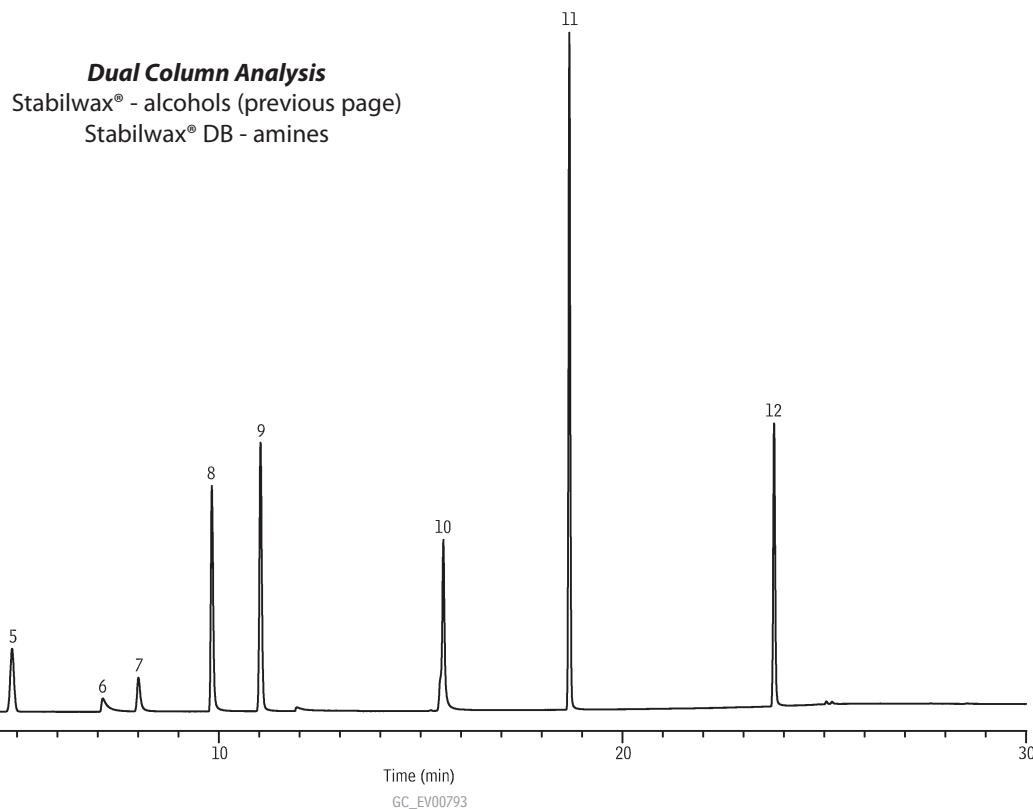
Columns: shown: Stabilwax®, 30m, 0.32mm ID, 1.0 μ m (cat.# 10654)
 (Column 2: Stabilwax® DB, 30m, 0.32mm ID, 1.0 μ m (cat.# 10854), next page)
 Flow from injector split to two columns using 0.53mm ID intermediate-polarity
 deactivated guard column (cat.# 10045), SeCure™ "Y" Connector (cat.#
 20278), and "Y" Press-Tight® Connector (cat.# 20405)
 Sample: 100 μ g/mL 1671 volatile organics mix in deionized water
 Inj.: 1.0 μ L, split (split ratio 12:1), 4mm gooseneck splitless inlet liner (cat.# 20798)
 Inj. temp.: 200°C
 Carrier gas: helium, constant pressure
 Linear velocity: 2.48mL/min. / 39.25cm/sec. @ 40°C
 (Column 2: 2.51mL/min. / 39.68cm/sec. @ 40°C)
 Oven temp.: 40°C (5 min.) to 180°C @ 7°C/min., hold 5 min.
 Det.: FID @ 250°C



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Volatile Organics
US EPA Method 1671
Stabilwax® DB



Peak	Retention Time (min.)	Concentration ($\mu\text{g/mL}$)
1. dimethylamine	1.71	200
2. methylamine	1.76	200
3. diethylamine	2.46	200
4. triethylamine	2.64	200
5. tetrahydrofuran (IS)	4.88	100
6. methanol	7.12	40
7. ethanol	8.01	40
8. acetonitrile	9.82	200
9. <i>n</i> -propanol	11.03	200
10. methyl Cellosolve®	15.56	200
11. formamide	18.68	500
12. dimethyl sulfoxide	23.75	100
ethylene glycol	no elution*	500

*Included in sample, but does not elute due to base deactivation in the DB phase.

Columns: shown: Stabilwax® DB, 30m, 0.32mm ID, 1.0 μm (cat.# 10854)
(Column 1: Stabilwax®, 30m, 0.32mm ID, 1.0 μm (cat.# 10654), previous page)
Flow from injector split to two columns using 0.53mm ID
intermediate-polarity deactivated guard column (cat.# 10045),
SeCure™ "Y" Connector (cat.# 20278), and "Y" Press-Tight®
Connector (cat.# 20405)

Sample: 1671 volatile organics mix in deionized water,
concentrations indicated on figure.

Inj.: 1.0 μL , split (split ratio 12:1), 4mm gooseneck splitless inlet liner
(cat.# 20798)

Inj. temp.: 200°C

Carrier gas: helium, constant pressure

Linear velocity: 2.51mL/min. / 39.68cm/sec. @ 40°C
(Column 1: 2.48mL/min. / 39.25cm/sec. @ 40°C)

Oven temp.: 40°C (5 min.) to 180°C @ 7°C/min., hold 5 min.

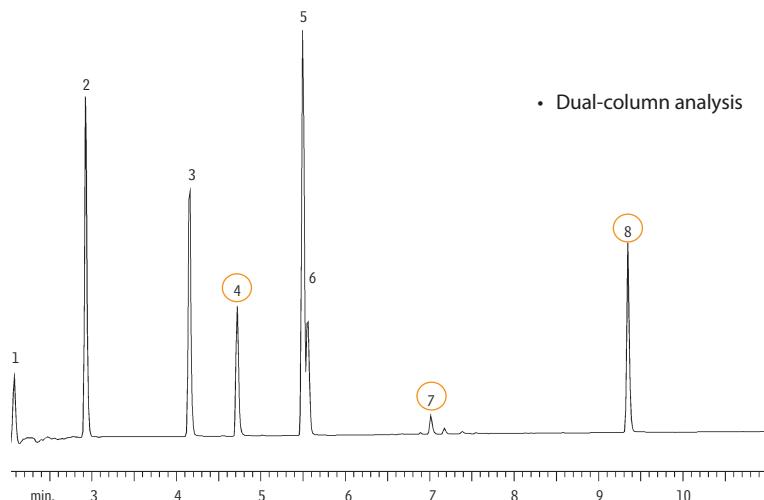
Det.: FID @ 250°C

EDB/DBCP

US EPA Method 504.1

Rtx®-CLPesticides & Rtx®-CLPesticides2

Rtx®-CLPesticides



free literature

**GC Analysis of US EPA Method 504.1
Organochlorine Pesticides, Using the
Rtx®-CLPesticides and Rtx®-CLPesticides2
Columns**

*A versatile column pair for analyzing
organochlorine pesticides, herbicides, or PCBs*

Analysts following Method 504.1 in monitoring 1,2-dibromoethane (EDB), 1,2-dibromo-3-chloropropane (DBCP), and 1,2,3-trichloropropane (TCP) in drinking water will value Rtx®-CLPesticides and Rtx®-CLPesticides2 columns because this same primary column/confirmation column pair can be used to perform numerous related analyses: organochlorine pesticides (e.g., by EPA Method 608 or 8081), herbicides, or polychlorinated biphenyls (PCBs). Details in this 2-page note show EDB, DBCP and TCP are fully resolved from common interference compounds, per requirements of Method 504.1.

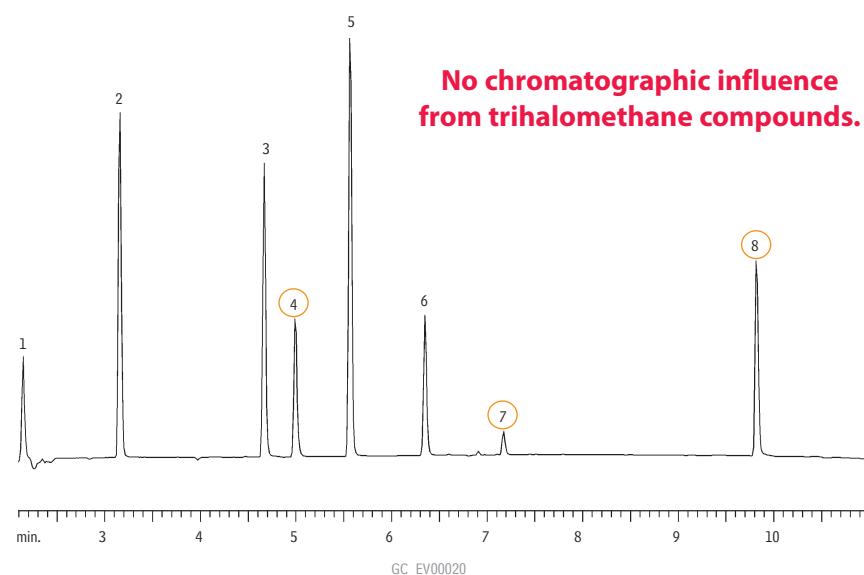
Applications Note
lit. cat.# 59539

Rtx®-CLPesticides and Rtx®-CLPesticides2 columns also are ideal for:

- *Triazine herbicides (lit. cat.# 59101)*
- *PCBs (lit. cat.# 59120)*
- *Haloacetic acids (lit. cat.# 59175)*
- *Polycyclic aromatic hydrocarbons (lit. cat.# 59196A)*

Download your free copy of the literature listed here from www.restek.com.

Rtx®-CLPesticides2



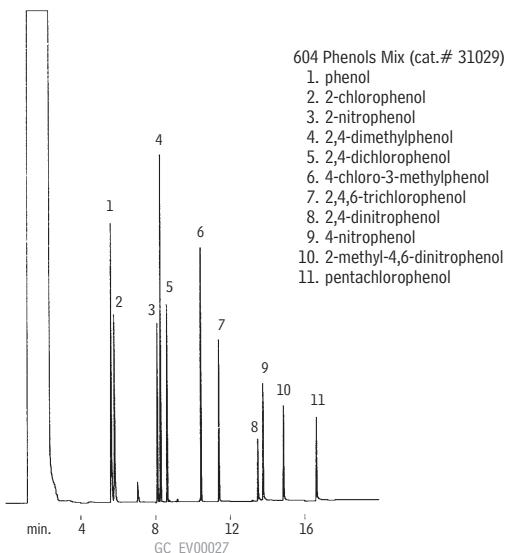
1. chloroform
2. bromodichloromethane
3. chlorodibromomethane
4. 1,2-dibromoethane (EDB)
5. 1,1,1,2-tetrachloroethane
6. bromoform
7. 1,2,3-trichloropropane
8. 1,2-dibromo-3-chloropropane (DBCP)

Columns: Rtx®-CLPesticides, 30m, 0.32mm ID, 0.50µm (cat.# 11139), Rtx®-CLPesticides2, 30m, 0.32mm ID, 0.25µm (cat.# 11324), 0.32mm ID guard column (cat.# 10044), universal angled "Y" Press-Tight® connector (cat.# 20403)
Inj. Direct injection using a Uniliner® inlet liner (cat.# 20335)
On-column conc.: 10pg each compound.
Oven temp.: 35°C (hold 2 min.) to 300°C @ 12°C/min.
Inj./det. temp.: 200°C/300°C
Carrier gas: helium, 12psi constant pressure

Phenols

US EPA Method 604

MXT®-5



Column: MXT®-5, 30m, 0.28mm ID, 0.25 μ m (cat.# 70224)
 Inj.: 1.0 μ L splitless injection of phenols
 Conc.: 25ng/ μ L per component
 Oven temp.: 40°C to 250°C @ 10°C/min.
 Inj./det. temp.: 280°C/300°C
 Carrier gas: hydrogen
 Linear velocity: 50cm/sec. set @ 40°C
 FID sensitivity: 2.56 x 10⁻¹⁰ AFS

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Environmental
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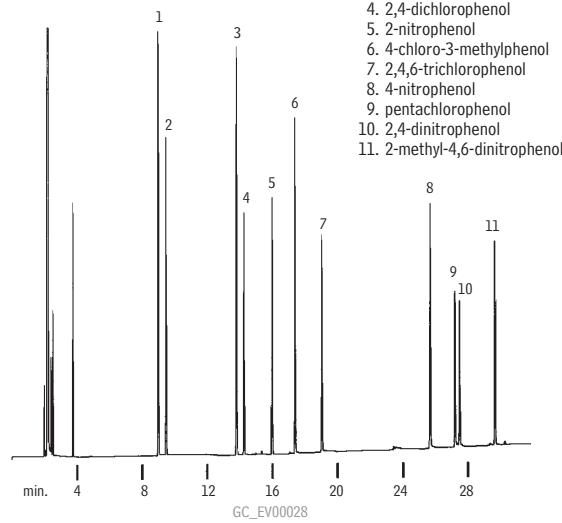
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Phenols

US EPA Method 604

Rtx®-200

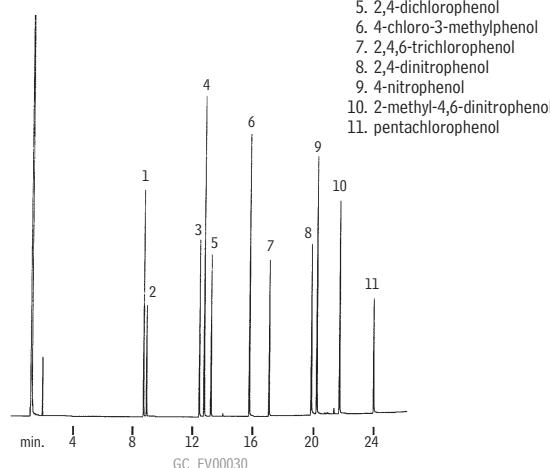


Column: Rtx®-200, 30m, 0.32mm ID, 0.25 μ m (cat.# 15024)
 Inj.: 1.0 μ L split injection of a 200ng standard
 Oven temp.: 50°C (hold 4 min.) to 250°C @ 6°C/min.
 Inj./det. temp.: 250°C
 Carrier gas: helium
 Linear velocity: 20cm/sec.
 FID sensitivity: 4 x 10⁻¹¹ AFS
 Split ratio: 40:1

Phenols

US EPA Method 604

Rtx®-5



Rtx®-5, 30m, 0.25mm ID, 0.25 μ m (cat.# 10223)
 1.0 μ L split injection of phenols.
 3-5ng/ μ L per component.
 50°C (hold 4 min.) to 250°C
 (@ 8°C/min.
 250°C
 Carrier gas:
 Linear velocity:
 FID sensitivity:
 Split ratio:

hydrogen
 40cm/sec. set @ 110°C
 8 x 10⁻¹¹ AFS
 40:1

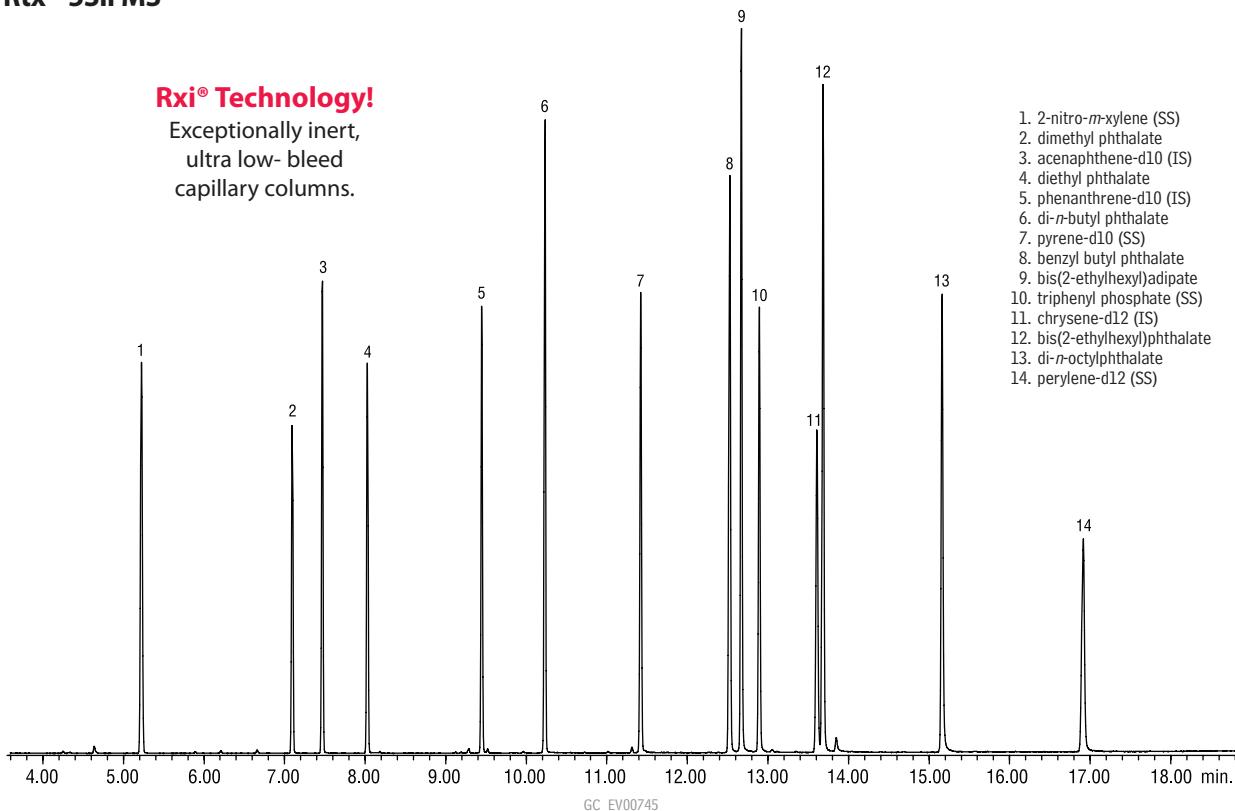
Semivolatile Organics

US EPA Method 506

Rtx®-5Sil MS

Rtx® Technology!

Exceptionally inert,
ultra low- bleed
capillary columns.



Column: Rtx®-5Sil MS, 30m, 0.25mm ID, 0.25 μ m (cat.# 12723)
 Sample: 506 Calibration Mix, 1000 μ g/mL each analyte (cat.# 31845)
 Method 525.2 Internal Standard Mix (cat.# 31825)
 Method 525.2 Surrogate Standard Mix (cat.# 31826)
 Inj.: 1.0 μ L, 20ppm each analyte (10ng on column)
 4mm splitless single gooseneck inlet liner (cat.# 20799)
 splitless hold time 0.40 min., 0.45 min. pressure pulse @ 50psi
 GC: Agilent 6890
 Inj. temp.: 270°C
 Carrier gas: helium, constant flow
 Flow rate: 1.0mL/min.
 Oven temp.: 80°C (hold 0.5 min.) to 260°C @ 18°C/min. (hold 1 min.)
 Det.: Agilent 5973 GC/MS
 Transfer
 line temp.: 280°C
 Scan range: 35–550amu
 Solvent delay: 3 min.
 Tune: DFTPP

a plus 1 story

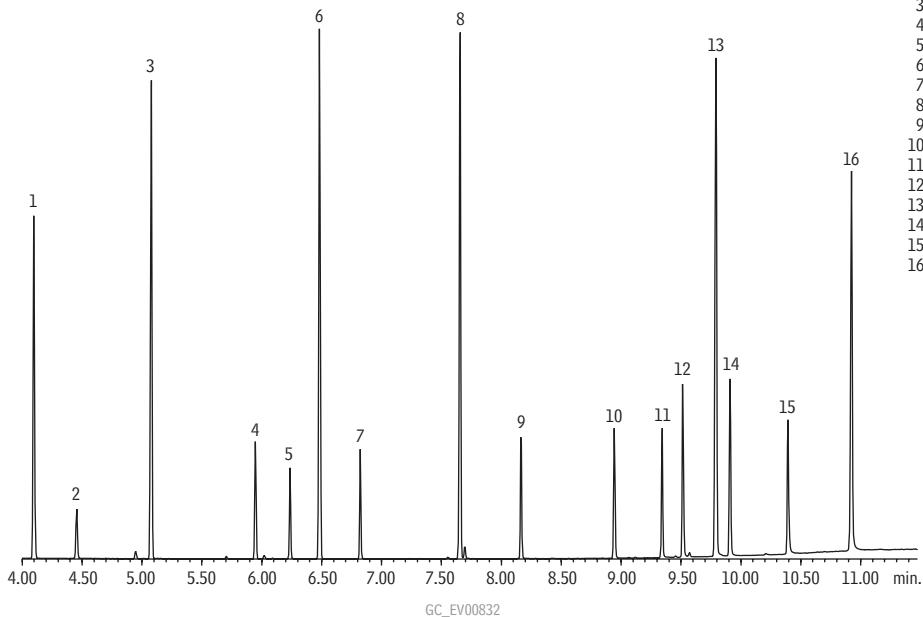
"Any time I have any type of chromatography question, I know that I can call Restek Technical Service for assistance. Every time I have spoken to them, they have been extremely helpful, and friendly!"

Carisa A. Kelley, Exygen Research

Phthalate & Adipate Esters
US EPA Method 506
Rxi®-1ms

Rxi® Technology!

Exceptionally inert,
ultra low- bleed
capillary columns.



1. 1,4-dichlorobenzene-d4 (IS)
2. nitrobenzene-d5 (SS)
3. naphthalene-d8 (IS)
4. 2-fluorobiphenyl (IS)
5. dimethylphthalate
6. acenaphthene-d10 (IS)
7. diethylphthalate
8. phenanthrene-d10 (IS)
9. di-n-butylphthalate
10. *p*-terphenyl-d14 (SS)
11. benzyl butyl phthalate
12. bis(2-ethylhexyl)adipate
13. chrysene-d12 (IS)
14. bis(2-ethylhexyl)phthalate
15. di-*n*-octylphthalate
16. perylene-d12 (IS)

Column: Rxi®-1ms, 30m, 0.25mm ID, 0.25µm (cat.# 13323)
 Sample: US EPA Method 506 mix:
 506 Calibration Mix (cat.# 31845),
 SV Internal Standard Mix (cat.# 31206), B/N Surrogate Mix (4/89 SOW)
 (cat.# 31024)
 Inj.: 1.0µL, 5µg/mL each analyte
 (internal standards 25µg/mL), split (10:1)
 4mm Drilled Uniliner® inlet liner (hole on bottom) (cat.# 20771)
 Instrument: Agilent 6890
 Inj. temp.: 250°C
 Carrier gas: helium, constant flow
 Flow rate: 1.2mL/min.
 Oven temp.: 50°C (hold 1 min.) to 330°C @ 30°C/min. (hold 2 min.)
 Det.: Agilent 5973 MSD
 Transfer line
 temp.: 280°C
 Scan range: 35-550amu
 Solvent delay: 3.75 min.
 Tune: DFTPP
 Ionization: EI



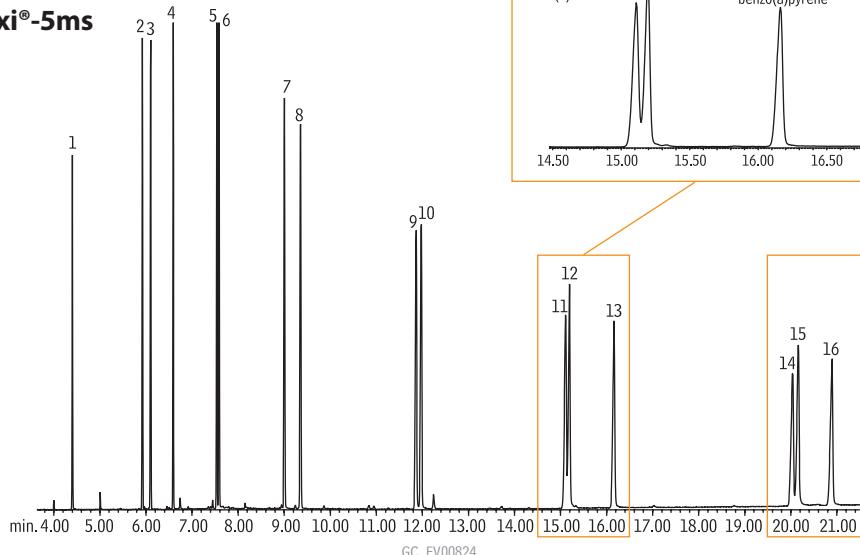
Searching for a chromatogram?

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Polycyclic Aromatic Hydrocarbons

US EPA Method 610

Rxi®-5ms



Rxi® Technology!

Exceptionally inert,
ultra low- bleed
capillary columns.

Column: Rxi®-5ms, 30m, 0.25mm ID, 0.25 μ m (cat. # 13423)
Sample: SV Calibration Mix #5/610 PAH Mix (cat. # 31011)
Inj.: 1.0 μ L, 10ppm each analyte (10ng on column), splitless (hold 0.1 min.)
4mm Drilled Uniliner® inlet liner (hole near bottom) (cat. # 20771)
Instrument: Agilent 6890
Inj. temp.: 275°C
Carrier gas: helium, constant flow

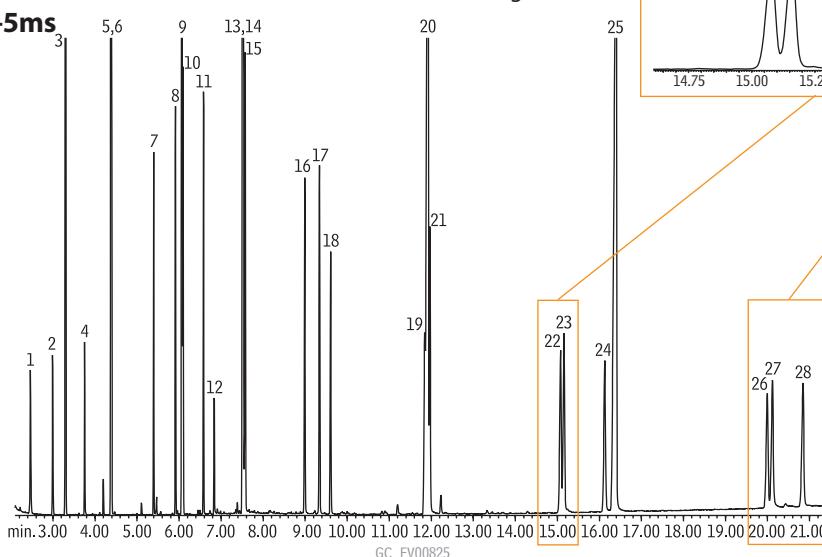
Flow rate: 1.2mL/min.
Oven temp.: 75°C (hold 0.5 min.) to 245°C @ 25°C/min., to 330°C @ 4°C/min. (hold 1 min.)
Det.: Agilent 5973 GC/MS
Transfer line temp.: 280°C
Scan range: 35-550amu
Solvent delay: 2 min.
Tune: DFTPP
Ionization: EI

1. naphthalene
2. acenaphthylene
3. acenaphthene
4. fluorene
5. phenanthrene
6. anthracene
7. fluoranthene
8. pyrene
9. benzo(a)anthracene
10. chrysene
11. benzo(b)fluoranthene
12. benzo(k)fluoranthene
13. benzo(a)pyrene
14. indeno(1,2,3-cd)pyrene
15. dibenzo(a,h)anthracene
16. benzo(ghi)perylene

Polycyclic Aromatic Hydrocarbons

US EPA Method 610 (with Internal Standards & Surrogates)

Rxi®-5ms



Rxi® Technology!

Exceptionally inert,
ultra low- bleed
capillary columns.

Column: Rxi®-5ms, 30m, 0.25mm ID, 0.25 μ m (cat. # 13423)
Sample: SV Calibration Mix #5/610 PAH Mix (cat. # 31011), Acid Surrogate Mix (4/89 SOW) (cat. # 31025), B/N Surrogate Mix (4/89 SOW) (cat. # 31024), SV Internal Standard Mix (cat. # 31206)
Inj.: 1.0 μ L, 10ppm each analyte (10ng on column, 40ng each internal standard), splitless (hold 0.1 min.)
4mm Drilled Uniliner® inlet liner (hole near bottom) (cat. # 20771)
Instrument: Agilent 6890

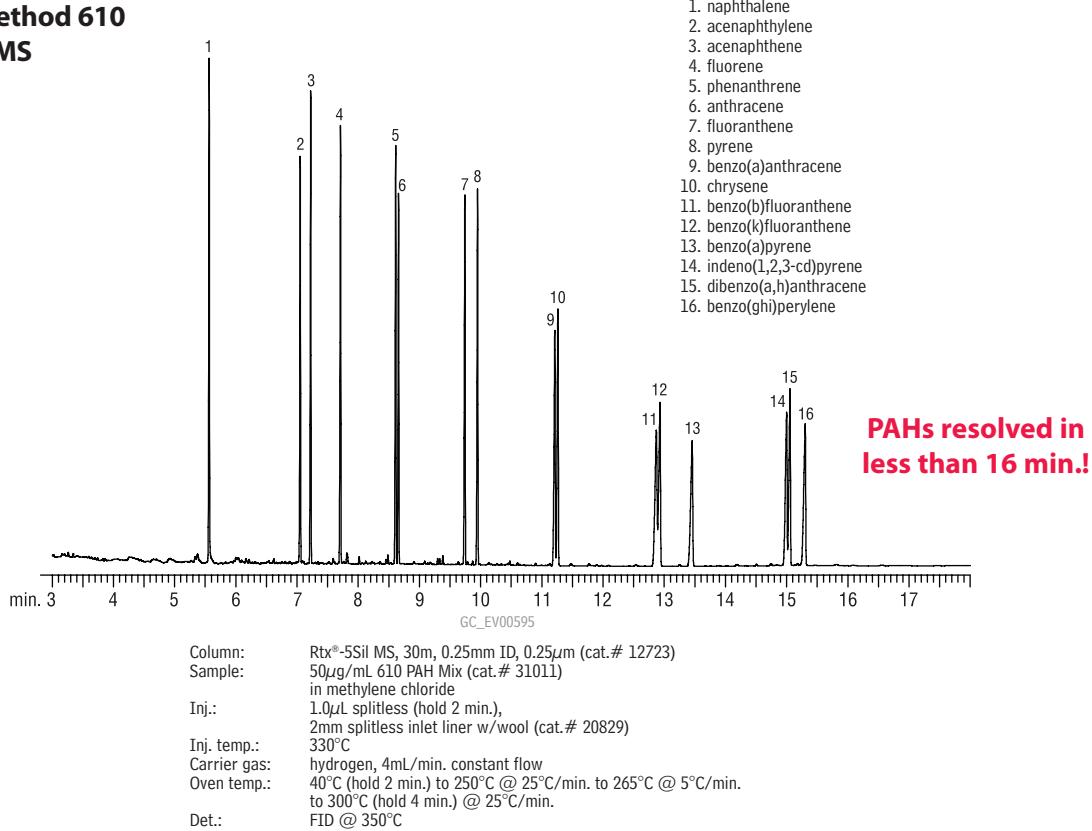
Inj. temp.: 275°C
Carrier gas: helium, constant flow
Flow rate: 1.2mL/min.
Oven temp.: 75°C (hold 0.5 min.) to 245°C @ 25°C/min., to 330°C @ 4°C/min. (hold 1 min.)
Det.: Agilent 5973 GC/MS
Transfer line temp.: 280°C
Scan range: 35-550amu
Solvent delay: 2 min.
Tune: DFTPP
Ionization: EI

1. 2-fluorophenol
2. phenol-d6
3. 1,4-dichlorobenzene-d4
4. nitrobenzene-d5
5. naphthalene-d8
6. naphthalene
7. 2-fluorobiphenyl
8. acenaphthylene
9. acenaphthene-d10
10. acenaphthene
11. fluorene
12. 2,4,6-tribromophenol
13. phénanthrene-d10
14. phenanthrene
15. anthracene
16. fluoranthene
17. pyrene
18. p-terphenyl-d14
19. benzo(a)anthracene
20. chrysene-d12
21. chrysene
22. benzo(b)fluoranthene
23. benzo(k)fluoranthene
24. benzo(a)pyrene
25. perylene-d12
26. indeno(1,2,3-cd)pyrene
27. dibenzo(a,h)anthracene
28. benzo(ghi)perylene

Polycyclic Aromatic Hydrocarbons

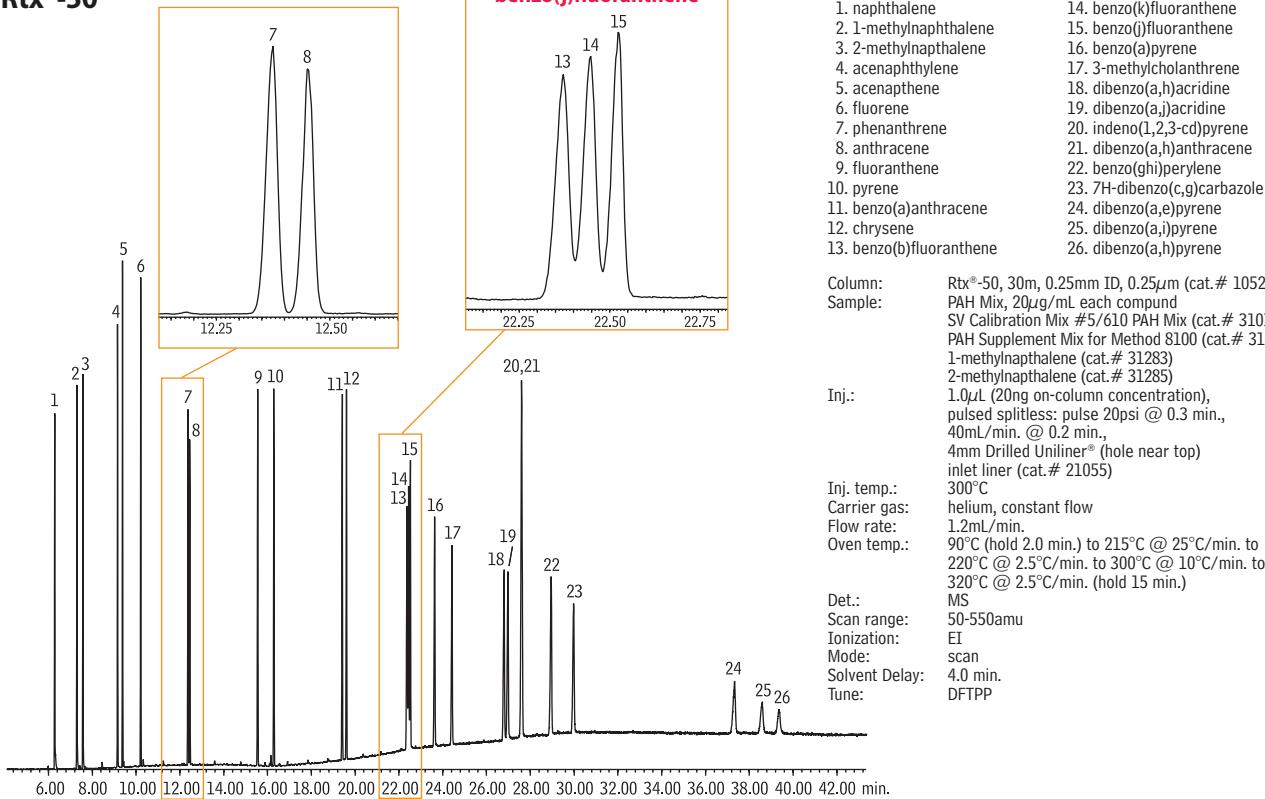
US EPA Method 610

Rtx®-5Sil MS

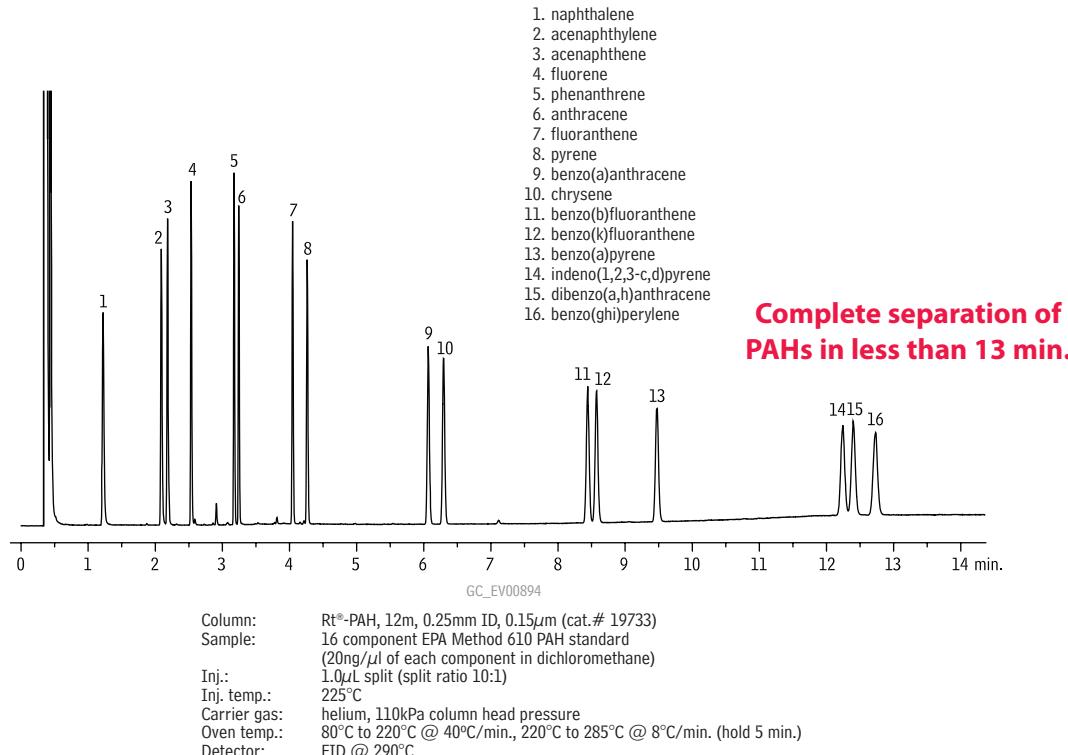


Polycyclic Aromatic Hydrocarbons

Rtx®-50



Polycyclic Aromatic Hydrocarbons
Rt[®]-PAH



Chromatogram courtesy of J&K Scientific.

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Mike Shuey, Customer Service

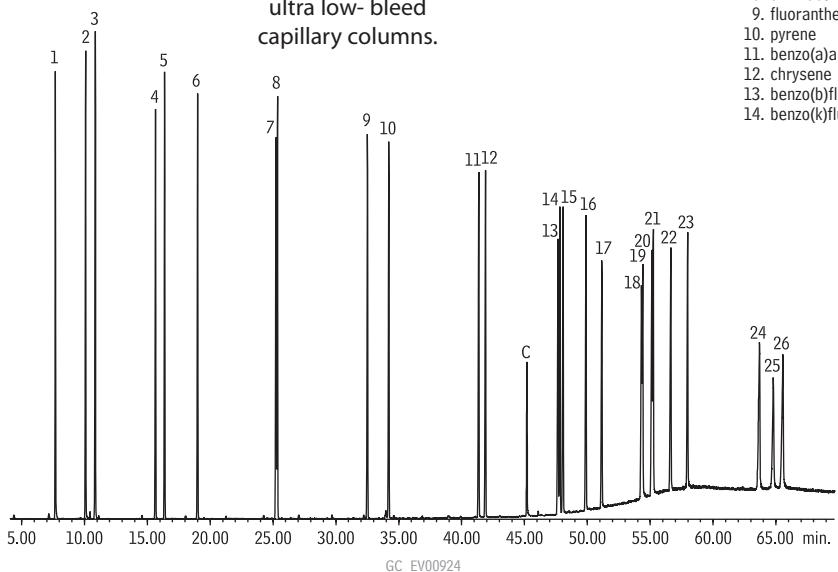
Polycyclic Aromatic Hydrocarbons

Rxi®-17

- maximum resolution
- benzo(j)fluoranthene resolved

Rxi® Technology!

Exceptionally inert,
ultra low- bleed
capillary columns.



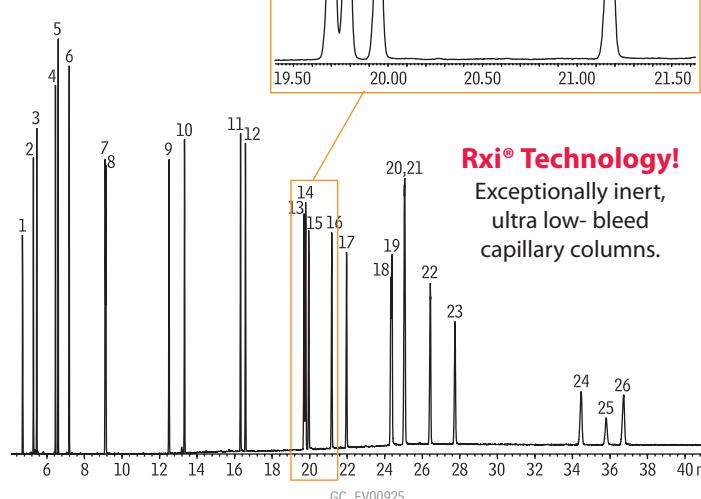
Peak List	Ret. Time (min.)
1. naphthalene	7.70
2. 1-methylnaphthalene	10.08
3. 2-methylnaphthalene	10.85
4. acenaphthylene	15.64
5. acenaphthene	16.36
6. fluorene	19.00
7. phenanthrene	25.24
8. anthracene	25.36
9. fluoranthene	32.50
10. pyrene	34.21
11. benzo(a)anthracene	41.37
12. chrysene	41.91
13. benzo(b)fluoranthene	47.67
14. benzo(k)fluoranthene	47.82
c=contaminant	

Column:
Rxi®-17, 30m, 0.25mm ID, 0.25μm (cat.# 13523)
Sample:
PAH mix, 50μg/mL each component:
EPA Method 610 Mix (cat.# 31011)
PAH Supplement Mix (cat.# 31857)
1-methylnaphthalene (cat.# 31283)
2-methylnaphthalene (cat.# 31285)
Instrument:
Agilent 6890
Inj.:
1.0μL pulsed splitless injection (50ng each component on column), 4mm Drilled Uniliner® inlet liner with hole near top (cat.# 21055); pulse: 20psi @ 0.3 min., 40mL/min. @ 0.2 min.
300°C
Carrier gas:
helium, constant flow
Flow rate:
1.2mL/min.
Oven temp.:
100°C (hold 0.5 min.) to 320°C @ 4°C/min. (hold 20 min.)
Det.:
Agilent 5973 GC/MS
Scan range:
50-550amu
Solvent delay:
4.0 min.
Tune:
DFTPP
Ionization:
EI

Polycyclic Aromatic Hydrocarbons

Rxi®-17

Benzo(j)fluoranthene
completely resolved from
benzo(b)fluoranthene and
benzo(k)fluoranthene!



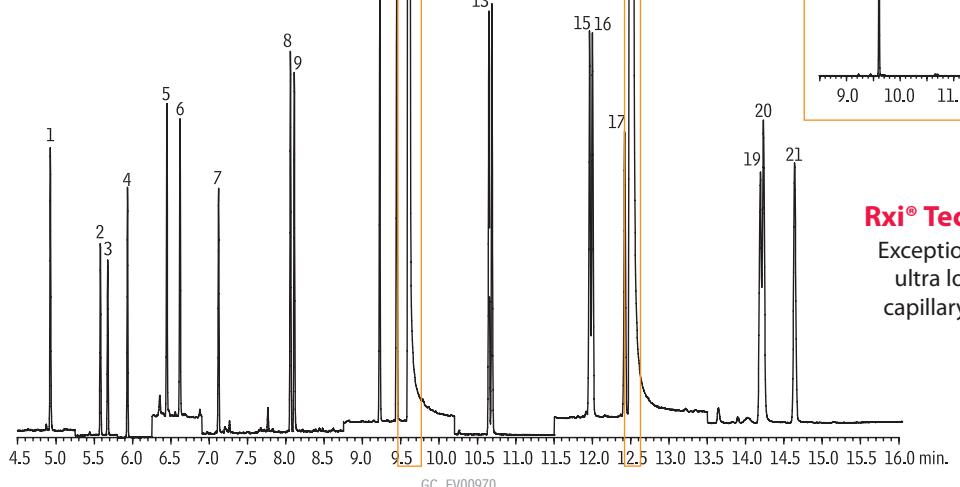
Peak List	Ret. Time (min.)	Ret. Time (min.)	
1. naphthalene	4.70	14. benzo(k)fluoranthene	19.78
2. 1-methylnaphthalene	5.28	15. benzo(j)fluoranthene	19.95
3. 2-methylnaphthalene	5.46	16. benzo(a)pyrene	21.17
4. acenaphthylene	6.45	17. 3-methylnaphthalene	21.97
5. acenaphthene	6.60	18. dibenz(a,h)acridine	24.33
6. fluorene	7.18	19. dibenz(a,j)acridine	24.39
7. phenanthrene	9.10	20. indeno(1,2,3-cd)pyrene	25.04
8. anthracene	9.14	21. dibenz(a,h)anthracene	25.07
9. fluoranthene	12.50	22. benzo(g,h)perylene	26.43
10. pyrene	13.33	23. 7H-dibenzo(c,g)carbazole	27.75
11. benzo(a)anthracene	16.32	24. dibenz(a,e)pyrene	34.46
12. chrysene	16.58	25. dibenz(a,i)pyrene	35.80
13. benzo(b)fluoranthene	19.70	26. dibenz(a,h)pyrene	36.73

Column:
Rxi®-17, 30m, 0.25mm ID, 0.25μm (cat.# 13523)
Sample:
PAH mix, 20μg/mL each component:
EPA Method 610 Mix (cat.# 31011)
PAH Supplement Mix (cat.# 31857)
1-methylnaphthalene (cat.# 31283)
2-methylnaphthalene (cat.# 31285)
Inj.:
1.0μL pulsed splitless injection (20ng each component on column), 4mm Drilled Uniliner® inlet liner with hole near top (cat.# 21055); pulse: 20psi @ 0.3 min., 40mL/min. @ 0.2 min.
300°C
Carrier gas:
helium, constant flow
Flow rate:
1.2mL/min.
Oven temp.:
90°C (hold 1.0 min.) to 215°C @ 25°C/min. (hold 0.5 min.) to 235°C @ 4°C/min., to 280°C @ 15°C/min., to 320°C @ 4°C/min. (hold 20 min.)
Det.:
Agilent 5973 GC/MS
Scan range:
50-550amu
Solvent delay:
4.0 min.
Tune:
DFTPP
Ionization:
EI

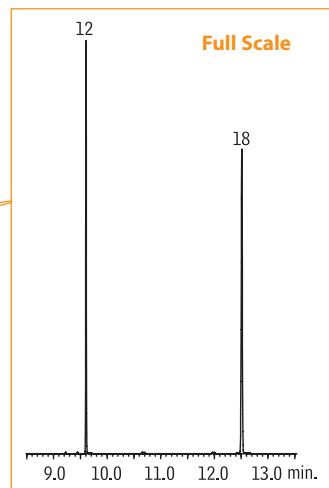
Polycyclic Aromatic Hydrocarbons
Rxi®-5Sil MS

NEW!

Peak List	Retention Time
1. naphthalene	4.93
2. 2-methylnaphthalene	5.58
3. 1-methylnaphthalene	5.68
4. 2-fluorobiphenyl (SS)	5.93
5. acenaphthylene	6.45
6. acenaphthene	6.62
7. fluorene	7.12
8. phenanthrene	8.06
9. anthracene	8.11
10. fluoranthene	9.23
11. pyrene	9.45
12. <i>p</i> -terphenyl-d14 (IS)	9.61
13. benzo(a)anthracene	10.65
14. chrysene	10.69
15. benzo(b)fluoranthene	11.96
16. benzo(k)fluoranthene	12.00
17. benzo(a)pyrene	12.42
18. perylene-d12 (IS)	12.51
19. indeno(1,2,3-cd)pyrene	14.19
20. dibenz(a,h)anthracene	14.23
21. benzo(ghi)perylene	14.65



**Outstanding
response at 5pg
on-column!**



Rxi® Technology!

Exceptionally inert,
ultra low- bleed
capillary columns.

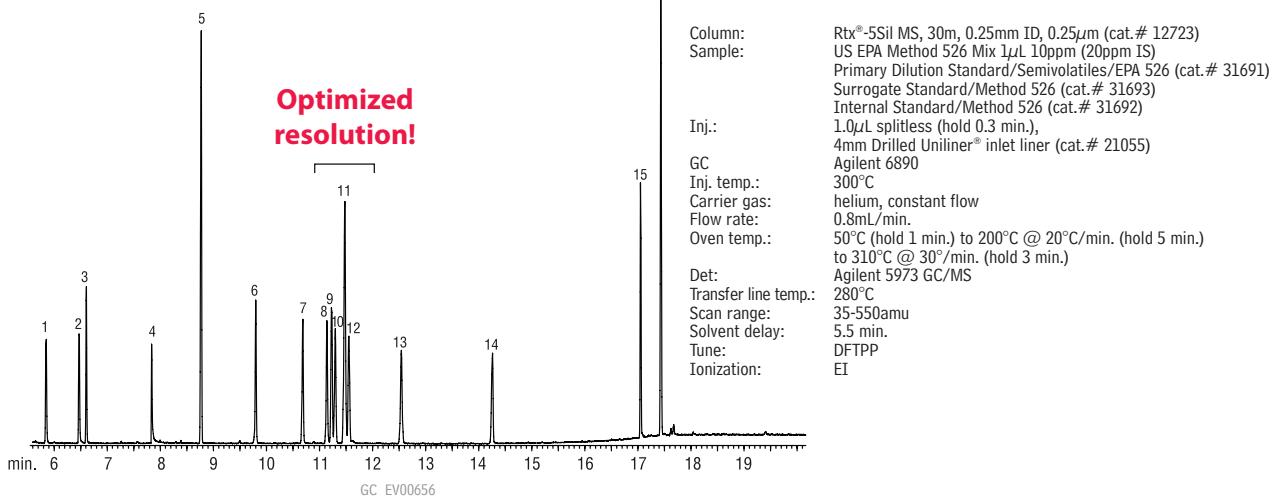
Column:	Rxi®-5Sil MS, 30m, 0.25mm ID, 0.25μm (cat.# 13623)
Sample:	PAH mix, 1μL of 0.005μg/mL (IS 2μg/mL) SV Calibration Mix #5 (cat.# 31011) 1-methylnaphthalene (cat.# 31283) 2-methylnaphthalene (cat.# 31285) 2-fluorobiphenyl (cat.# 31091)
Inj.:	1.0μL (5pg on-column concentration), 4mm Drilled Uniliner® (hole near top) inlet liner w/wool (cat.# 21055-200.5), pulsed splitless: pulse 20psi @ 0.2 min., 60mL/min. @ 0.15 min.
Inj. temp.:	300°C
Carrier gas:	helium, constant flow
Flow rate:	1.4mL/min.
Oven temp.:	50°C (hold 0.5 min.) to 290°C @ 25°C/min. to 320°C @ 5°C/min.
Det.:	MS
Transfer line temp.:	290°C
Ionization:	EI
Mode:	SIM

Single Ion Monitoring Program			
Group	Time	Ion(s)	Dwell (ms)
1	4.00	128	100
2	5.25	142	100
3	5.80	172	100
4	6.25	152	100
5	6.90	166	100
6	7.60	178	100
7	8.75	202, 244	100
8	10.2	228	100
9	11.5	252, 264	100
10	13.5	276, 278	100

Semivolatile Organics
US EPA Method 526 (Screening)
Rtx®-5Sil MS

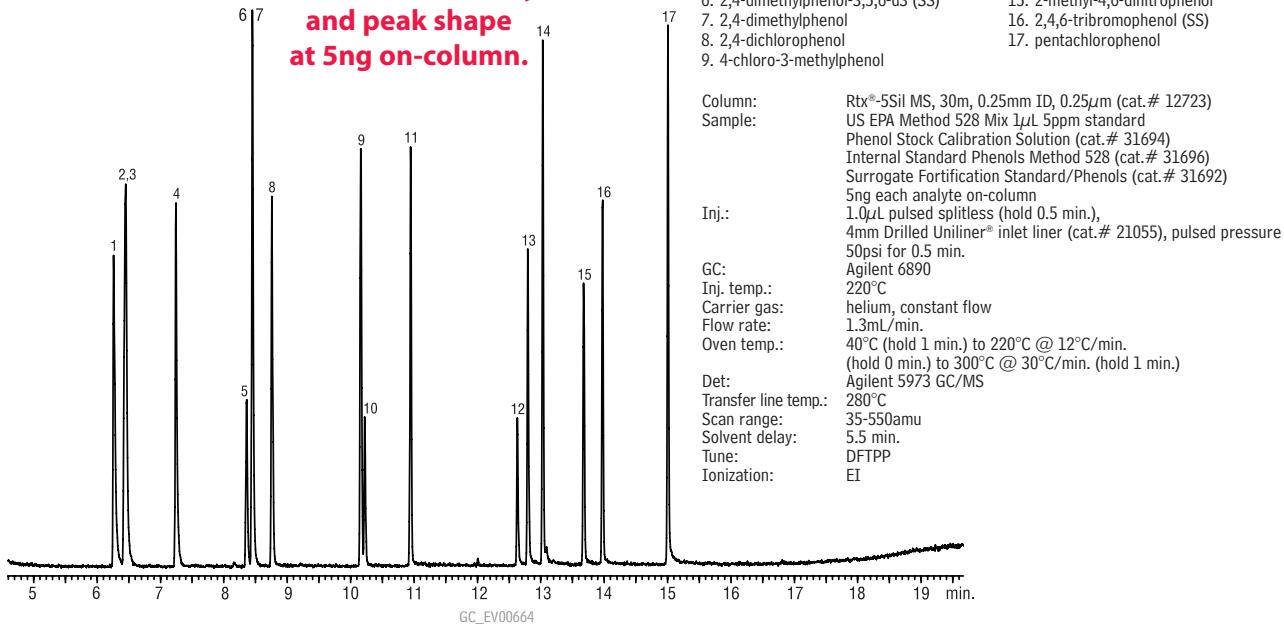
Rxi® Technology!

Exceptionally inert,
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capillary columns.



Phenols
US EPA Method 528
Rtx®-5Sil MS

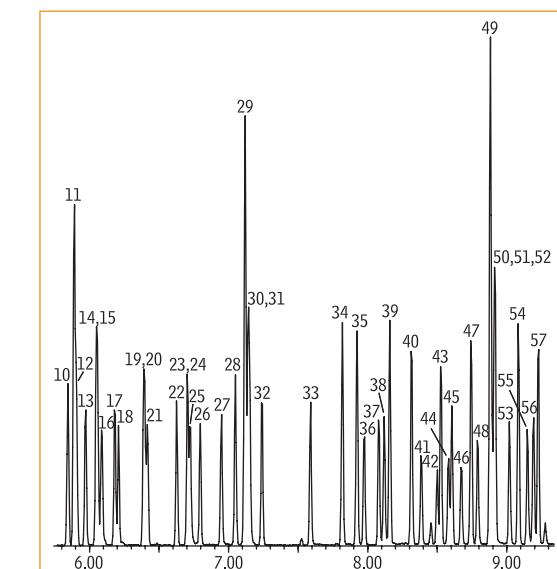
**Excellent sensitivity
and peak shape
at 5ng on-column.**



GC APPLICATIONS | ENVIRONMENTAL

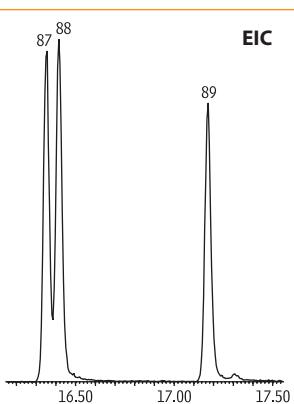
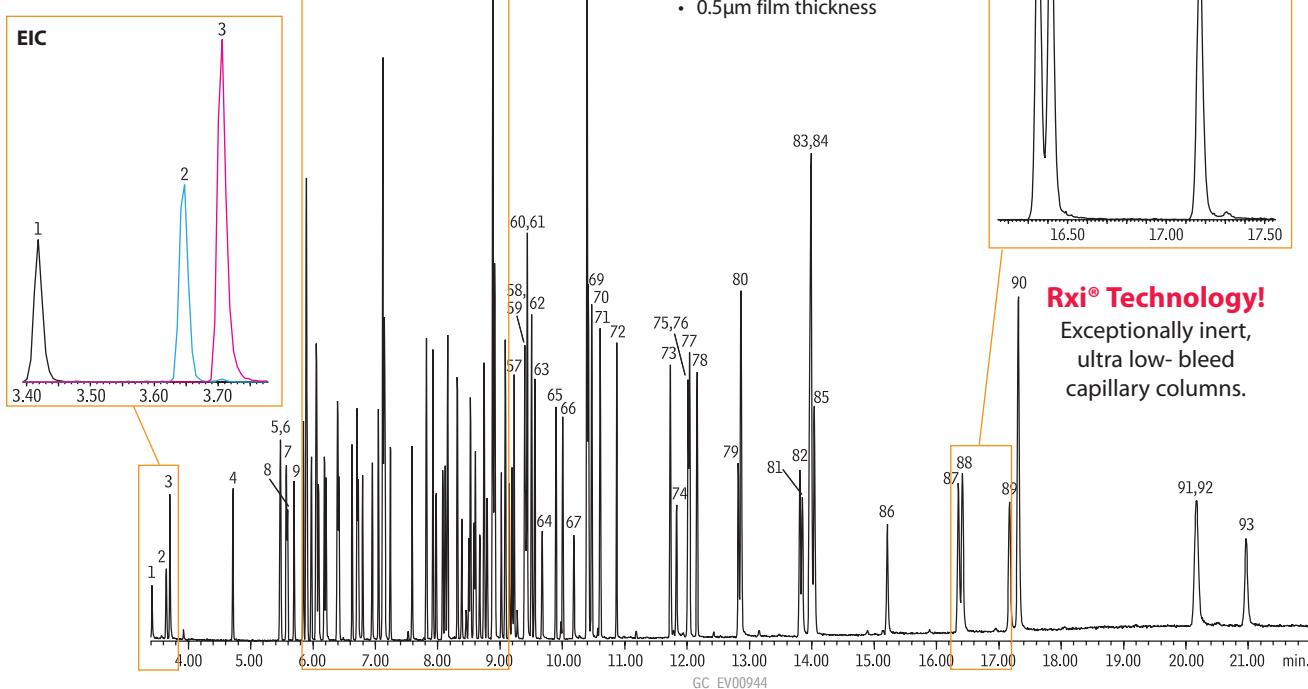
Semivolatiles

Semivolatile Organics US EPA Method 8270 Rxⁱ-5Sil MS



Column: Rxⁱ-5Sil MS, 30m, 0.25mm ID, 0.5μm (cat.# 13638)
 Sample: US EPA Method 8270D Mix, 1μL of 10μg/mL (IS 40μg/mL)
 8270 MegaMix® (cat.# 31850)
 Benzoic Acid (cat.# 31879)
 8270 Benzidines Mix (cat.# 31852)
 Acid Surrogate Mix (4/89 SOW) (cat.# 31025)
 Revised B/N Surrogate Mix (cat.# 31887)
 1,4-Dioxane (cat.# 31853)
 SV Internal Standard Mix (cat.# 31206)
 1.0μL (10ng on-column concentration),
 4mm Drilled Uniliner® (hole near bottom) inlet liner (cat.# 20756),
 pulsed splitless: pulse 30psi @ 0.3 min., 40mL/min. @ 0.25 min.
 250°C
 Inj.: helium, constant flow
 Flow rate: 1.2mL/min.
 Oven temp.: 40°C (hold 1.0 min.) to 280°C @ 25°C/min. to 320°C @ 5°C/min. (hold 3.5 min.)
 Det.: MS
 Transfer line temp: 280°C
 Scan range: 35-550amu
 Ionization: EI
 Mode: scan

- Drilled Uniliner® liner
- 10ng each compound
- Silarylene phase
- 0.5μm film thickness



Rxⁱ Technology!

Exceptionally inert,
ultra low-bleed
capillary columns.

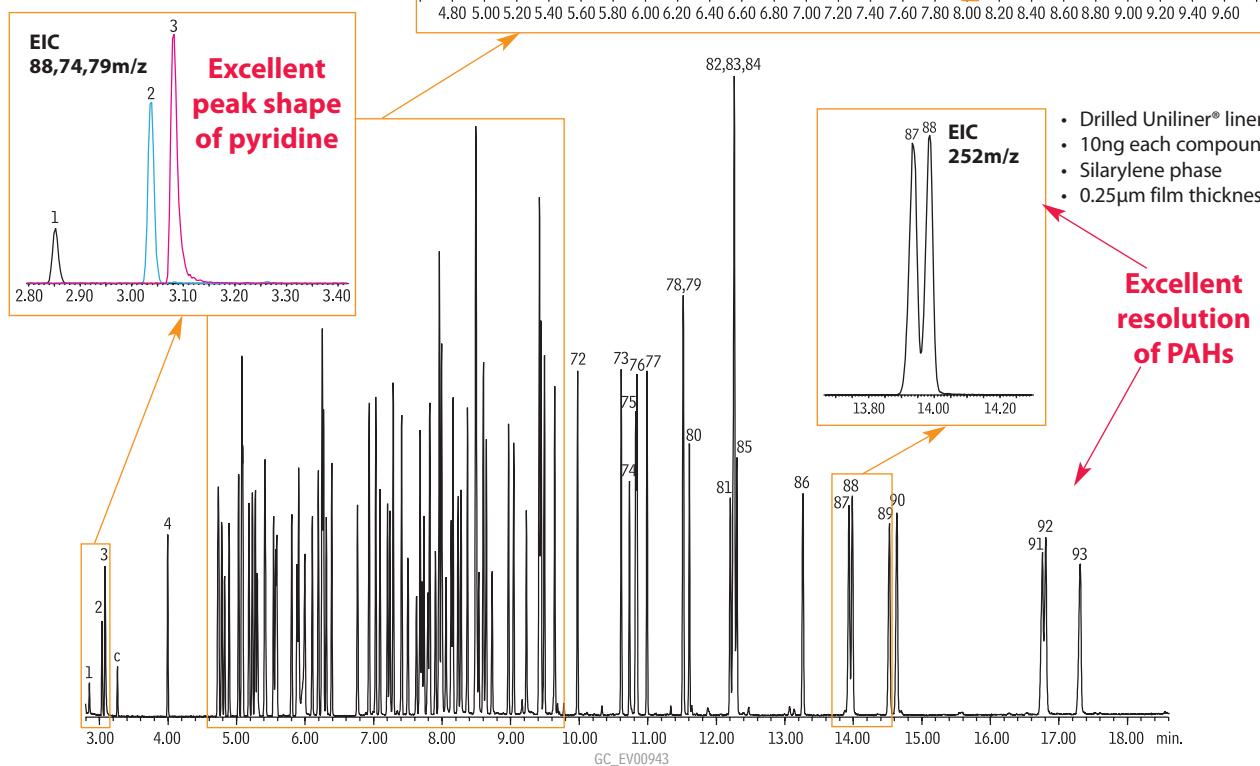
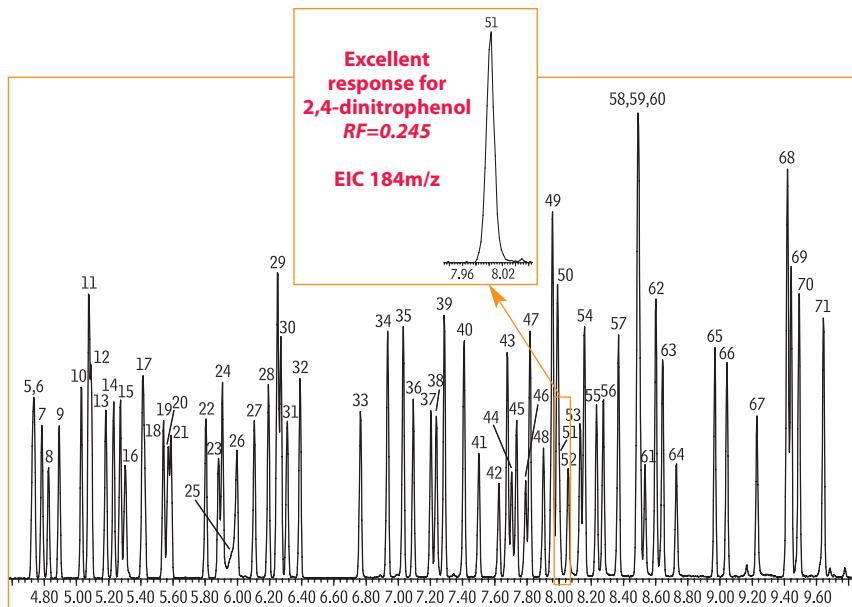
1. 1,4-dioxane	18. n-nitroso-di-n-propylamine	36. hexachlorocyclopentadiene	54. dibenzofuran	70. anthracene	88. benzo(k)fluoranthene
2. n-nitrosodimethylamine	19. hexachloroethane	37. 2,4,6-trichlorophenol	55. 2,3,5,6-tetrachlorophenol	71. carbazole	89. benzo(a)pyrene
3. pyridine	20. nitrobenzene-d5 (SS)	38. 2,4,5-trichlorophenol	56. 2,3,4,6-tetrachlorophenol	72. di-n-butyl phthalate	90. perylene-d12 (IS)
4. 2-fluorophenol (SS)	21. nitrobenzene	39. 2-fluorobiphenyl (SS)	57. diethyl phthalate	73. fluoranthene	91. indeno(1,2,3-cd)pyrene
5. phenol-d6 (SS)	22. isopropone	40. 2-chloronaphthalene	58. 4-chlorophenyl phenyl ether	74. benzidine	92. dibenz(a,h)anthracene
6. phenol	23. 2,4-dimethylphenol	41. 2-nitroaniline	59. 4-nitroaniline	75. pyrene-d10 (SS)	93. benzo(ghi)perylene
7. aniline	24. benzoic acid	42. 1,4-dinitrobenzene	60. fluorene	76. 3,3'-dimethylbenzidine	
8. bis(2-chloroethyl) ether	25. 2-nitrophenol	43. dimethyl phthalate	61. 4,6-dinitro-2-methylphenol	77. pyrene	
9. 2-chlorophenol	26. bis(2-chloroethoxy)methane	44. 1,3-dinitrobenzene	62. n-nitrosodiphenylamine (diphenylamine)	78. p-terphenyl-d14 (SS)	
10. 1,3-dichlorobenzene	27. 2,4-dichlorophenol	45. 2,6-dinitrotoluene	63. 1,2-diphenylhydrazine (as azobenzene)	79. butyl benzyl phthalate	
11. 1,4-dichlorobenzene-d4 (IS)	28. 1,2,4-trichlorobenzene	46. 1,2-dinitrobenzene	64. 2,4,6-tribromophenol (SS)	80. bis(2-ethylhexyl) adipate	
12. 1,4-dichlorobenzene	29. naphthalene-d8 (IS)	47. acenaphthylene	65. 4-bromophenyl phenyl ether	81. bis(2-ethylhexyl) phthalate	
13. benzyl alcohol	30. naphthalene	48. 3-nitroaniline	66. hexachlorobenzene	82. 3,3'-dichlorobenzidine	
14. 2-methylphenol	31. 4-chloroaniline	49. acenaphthene-d10 (IS)	67. pentachlorophenol	83. benzo(a)anthracene	
15. 1,2-dichlorobenzene	32. hexachlorobutadiene	50. 2,4-dinitrophenol	68. phenanthrene-d10 (IS)	84. chrysene-d12 (IS)	
16. bis(2-chloroisopropyl) ether	33. 4-chloro-3-methylphenol	51. acenaphthene	69. phenanthrene	85. chrysene	
17. 4-methylphenol/3-methylphenol	34. 2-methylnaphthalene	52. 4-nitrophenol		86. di-n-octyl phthalate	
	35. 1-methylnaphthalene	53. 2,4-dinitrotoluene		87. benzo(b)fluoranthene	

Semivolatile Organics

US EPA Method 8270

Rxi®-5Sil MS

Column: Rxi®-5Sil MS, 30m, 0.25mm ID, 0.25 μ m (cat.# 13623)
Sample: US EPA Method 8270D Mix, 1 μ L of 10 μ g/mL (IS 40 μ g/mL) 8270 MegaMix® (cat.# 31850) Benzoic Acid (cat.# 31879) 8270 Benzidines Mix (cat.# 31852) Acid Surrogate Mix (4/89 SOW) (cat.# 31025) Revised B/N Surrogate Mix (cat.# 31887) 1,4-Dioxane (cat.# 31853)
Inj.: 1.0 μ L (10ng on-column concentration), 4mm Drilled Uniliner® (hole near bottom) inlet liner (cat.# 20756), pulsed splitless: pulse 25psi @ 0.2 min., 60mL/min. @ 0.15 min.
Inj. temp.: 250°C
Carrier gas: helium, constant flow
Flow rate: 1.2mL/min.
Oven temp.: 40°C (hold 1.0 min.) to 280°C @ 25°C/min. to 320°C @ 5°C/min. (hold 1 min.)
Det.:
Transfer line temp.: 280°C
Scan range: 35-550amu
Ionization: EI
Mode: scan



- | | | | | | |
|----------------------------------|-----------------------------------|-------------------------------|---------------------------------|-------------------------------|---------------------------------|
| 1. 1,4-dioxane | 17. 4-methylphenol/3-methylphenol | 34. 2-methylnaphthalene | 51. 2,4-dinitrophenol | 66. hexachlorobenzene | 83. bis(2-ethylhexyl) phthalate |
| 2. n-nitrosodimethylamine | 18. n-nitroso-di-n-propylamine | 35. 1-methylnaphthalene | 52. 4-nitrophenol | 67. pentachlorophenol | 84. chrysene-d12 (IS) |
| 3. pyridine | 19. hexachloroethane | 36. hexachlorocyclopentadiene | 53. 2,4-dinitrotoluene | 68. phenanthrene-d10 (IS) | 85. chrysene |
| c. toluene | 20. nitrobenzene-d5 (SS) | 37. 2,4,6-trichlorophenol | 54. dibenzofuran | 69. phenanthrene | 86. di-n-octyl phthalate |
| 4. 2-fluorophenol (SS) | 21. nitrobenzene | 38. 2,4,5-trichlorophenol | 55. 2,3,5,6-tetrachlorophenol | 70. anthracene | 87. benzo(b)fluoranthene |
| 5. phenol-d6 (SS) | 22. isophorone | 39. 2-fluorobiphenyl (SS) | 56. 2,3,4,6-tetrachlorophenol | 71. carbazole | 88. benzo(k)fluoranthene |
| 6. phenol | 23. 2-nitrophenol | 40. 2-chloronaphthalene | 57. diethyl phthalate | 72. di-n-butyl phthalate | 89. benzo(a)pyrene |
| 7. aniline | 24. 2,4-dimethylphenol | 41. 2-nitroaniline | 58. 4-chlorophenyl phenyl ether | 73. fluoranthene | 90. perylene-d12 (IS) |
| 8. bis(2-chloroethyl) ether | 25. benzoic acid | 42. 1,4-dinitrobenzene | 59. fluorene | 74. benzidine | 91. indeno(1,2,3-cd)pyrene |
| 9. 2-chlorophenol | 26. bis(2-chloroethoxy)methane | 43. dimethyl phthalate | 60. 4-nitroaniline | 75. pyrene-d10 (SS) | 92. dibenzo(a,h)anthracene |
| 10. 1,3-dichlorobenzene | 27. 2,4-dichlorophenol | 44. 1,3-dinitrobenzene | 61. 4,6-dinitro-2-methylphenol | 76. pyrene | 93. benzo(ghi)perylene |
| 11. 1,4-dichlorobenzene-d4 (IS) | 28. 1,2,4-trichlorobenzene | 45. 2,6-dinitrotoluene | 62. n-nitrosodiphenylamine | | |
| 12. 1,4-dichlorobenzene | 29. naphthalene-d8 (IS) | 46. 1,2-dinitrobenzene | (diphenylamine) | 77. p-terphenyl-d14 (SS) | |
| 13. benzyl alcohol | 30. naphthalene | 47. acenaphthylene | 63. 1,2-diphenylhydrazine (as | 78. 3,3'-dimethylbenzidine | |
| 14. 1,2-dichlorobenzene | 31. 4-chloroaniline | 48. 3-nitroaniline | azobenzene) | 79. butyl benzyl phthalate | |
| 15. 2-methylphenol | 32. hexachlorobutadiene | 49. acenaphthene-d10 (IS) | 64. 2,4,6-tribromophenol (SS) | 80. bis(2-ethylhexyl) adipate | |
| 16. bis(2-chloroisopropyl) ether | 33. 4-chloro-3-methylphenol | 50. acenaphthene | 65. 4-bromophenyl phenyl ether | 81. 3,3'-dichlorobenzidine | |
- c = contaminant

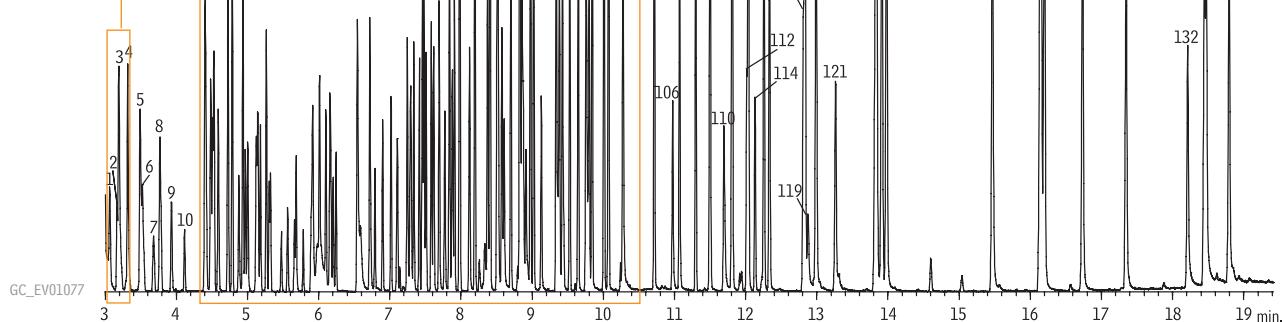
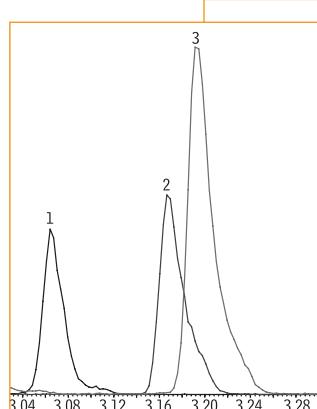
GC APPLICATIONS | ENVIRONMENTAL

Semivolatiles

Semivolatile Organics US EPA Method 8270 w/Appendix IX Rxⁱ-5Sil MS

NEW!

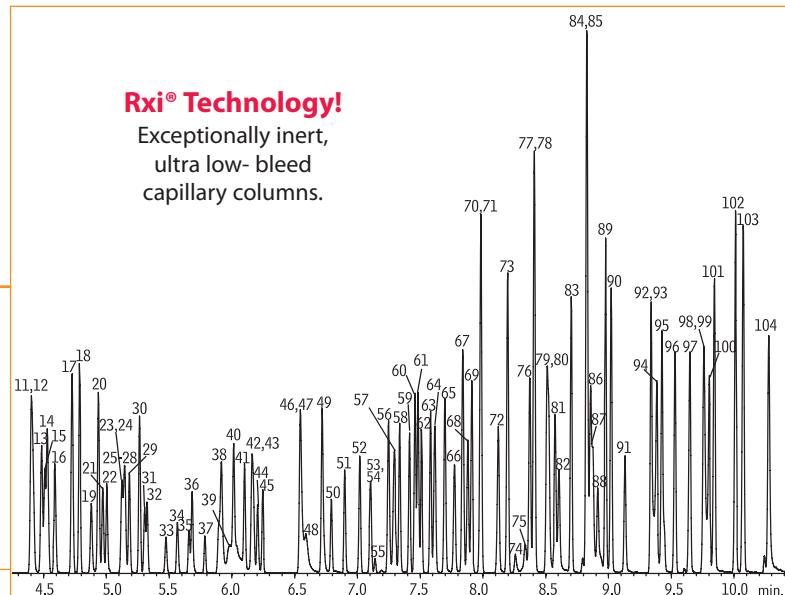
Column: Rxⁱ-5Sil MS, 30m, 0.25mm ID,
0.25 μ m, w/10m Integra-Guard™
(cat.# 13623-127)
Sample: 8270 MegaMix® (cat.# 31850),
Appendix IX Mix #1 (cat.# 31625),
Appendix IX Mix #2 (cat.# 31806)
Revised B/N Surrogate Mix (cat.# 31887),
Acid Surrogate Mix (4/89 SOW) (cat.# 31025),
8270 Benzidines Mix (cat.# 31852)
in methylene chloride, 10ng on-column
Inj.: 1.0 μ L pulsed splitless, pulse 20psi @ 0.3 min.,
60mL/min. @ 0.25 min, 4mm single gooseneck
inlet liner w/wool (cat.# 22405)
Inj. temp.: 275°C
Carrier gas: helium, constant flow
Flow rate: 1.2mL/min.
Oven temp.: 50°C (hold 0.5 min.) to 260°C @ 20°C/min. to
280°C @ 5°C/min. to 340°C (hold 2 min.) @
18°C/min.
Det: MS
Transfer line temp.: 280°C
Scan range: 35-550
Ionization: EI
Mode: scan



1. 1,4-dioxane	24. 3-methylphenol	47. caprolactam	70. acenaphthylene	93. 1,3,5-trinitrobenzene	116. dichlorobenzilate
2. N-nitrosodimethylamine	25. acetophenone	48. 1,4-phenylenediamine	71. 1,2-dinitrobenzene	94. phenacetin	117. 3,3-dimethylbenzidine
3. pyridine	26. N-nitroso-di- <i>n</i> -propylamine	49. 4-chloro-3-methylphenol	72. 3-nitroaniline	95. 4-bromophenyl phenyl ether	118. benzyl butyl phthalate
4. ethyl methacrylate	27. nitrosopyrrolidine	50. isosafole	73. acenaphthene	96. hexachlorobenzene	119. Kepone
5. 2-picoline	28. 4-nitrosophorpholine	51. 2-methylnaphthalene	74. 2,4-dinitrophenol	97. atrazine	120. bis(2-ethylhexyl)adipate
6. N-nitrosomethylalkylamine	29. <i>o</i> -toluidine	52. 1-methylnaphthalene	75. 4-nitrophenol	98. 4-aminobiphenyl	121. 2-acetylaminofluorene
7. methyl methanesulfonate	30. hexachloroethane	53. hexachlorocyclopentadiene	76. pentachlorobenzene	99. pentachlorophenol	122. 3,3'-dichlorobenzidine
8. 2-fluorophenol	31. nitrobenzene-d5 (SS)	54. 1,2,4,5-tetrachlorobenzene	77. dibenzofuran	100. pentachloronitrobenzene	123. chrysene
9. N-nitrosodiethylamine	32. nitrobenzene	55. isosafole	78. 2,4-dinitrotoluene	101. propyzamide	124. benzo(a)anthracene
10. ethyl methanesulfonate	33. N-nitrosopiperidine	56. 2,4,6-trichlorophenol	79. 1-naphthalamine	102. phenanthrene	125. bis(2-ethylhexyl)phthalate
11. benzaldehyde	34. isophorone	57. 2,4,5-trichlorophenol	80. 2,3,4,6-tetrachlorophenol	103. anthracene	126. di- <i>n</i> -octyl phthalate
12. phenol	35. 2-nitrophenol	58. 2-fluorobiphenyl (SS)	81. 2,3,5,6-tetrachlorophenol	104. carbazole	127. benzo(b)fluoranthene
13. aniline	36. 2,4-dimethylphenol	59. safrole	82. 2-naphthylamine	105. di- <i>n</i> -butylphthalate	128. 7,12-dimethylbenzo(a)anthracene
14. bis(2-chloroethyl)ether	37. bis(2-chloroethoxy)methane	60. biphenyl	83. diethyl phthalate	106. 4-nitroquinoline-1-oxide	129. benzo(g)fluoranthene
15. pentachloroethane	38. 2,4-dichlorophenol	61. 2-chloronaphthalene	84. fluorene	107. methapyrilene	130. benzo(a)pyrene
16. 2-chlorophenol	39. α,α -dimethylphenylamine	62. 1-chloronaphthalene	85. 4-chlorophenyl phenyl ether	108. isodrin	131. 3-methylcholanthrene
17. 1,3-dichlorobenzene	40. 1,2,4-trichlorobenzene	63. diphenyl ether	86. 2-methyl-5-nitroaniline	109. fluoranthene	132. dibenzo(a,j)acridine
18. 1,4-dichlorobenzene	41. naphthalene	64. 2-nitroaniline	87. 4-nitroaniline	110. benzidine	133. indeno(1,2,3-cd)pyrene
19. benzyl alcohol	42. 2,6-dichlorophenol	65. 1,4-naphthoquinone	88. 4,6-dinitro-2-methylphenol	111. pyrene	134. dibenzo(a,h)anthracene
20. 1,2-dichlorobenzene	43. 4-chloroaniline	66. 1,4-dinitrobenzene	89. diphenylamine	112. Aramite (isomer)	135. benzo(ghi)perylene
21. 2-methylphenol	44. hexachloropropene	67. dimethylphthalate	90. azobenzene	113. <i>p</i> -terphenyl-d14 (SS)	
22. bis(2-chloroisopropyl)ether	45. hexachlorobutadiene	68. 1,3-dinitrobenzene	91. 2,4,6-tribromophenol (SS)	114. Aramite (isomer)	
23. 4-methylphenol	46. N-nitroso- <i>n</i> -butylamine	69. 2,6-dinitrotoluene	92. diallate	115. dimethylaminoazobenzene	

Rxi® Technology!

Exceptionally inert,
ultra low- bleed
capillary columns.





Rxi®-5Sil MS

Exceptionally Inert Columns for GC/MS and Trace Level Analyses

- **Low bleed** at high temperatures, for higher sensitivity and lower detection limits.
- **Excellent inertness** for acidic and basic compounds.
- Engineered to assure **column-to-column reproducibility**.

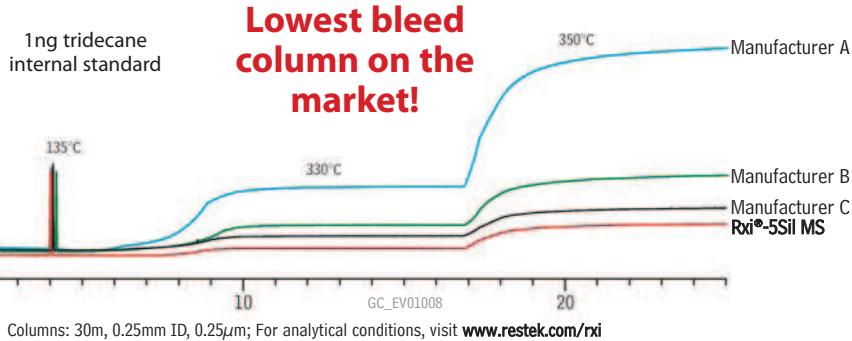
ID	df (μm)	temp. limits	length	cat. #	price
0.18mm	0.18	-60 to 330/350°C	20-Meter	43602	\$455
0.18mm	0.36	-60 to 330/350°C	20-Meter	43604	\$455
0.25mm	0.25	-60 to 330/350°C	15-Meter	13620	\$330
0.25mm	0.25	-60 to 330/350°C	30-Meter	13623	\$530
0.25mm	0.25	-60 to 330/350°C	60-Meter	13626	\$905
0.25mm	0.50	-60 to 330/350°C	30-Meter	13638	\$530
0.32mm	0.25	-60 to 330/350°C	30-Meter	13624	\$570
0.32mm	0.50	-60 to 330/350°C	30-Meter	13639	\$570

Rxi®-5Sil MS with Integra-Guard™

Description	qty.	cat.#	price
15m, 0.25mm ID, 0.25 μm Rxi-5Sil MS w/10m Integra-Guard Column	ea.	13620-127	\$410
30m, 0.25mm ID, 0.25 μm Rxi-5Sil MS w/5m Integra-Guard Column	ea.	13623-124	\$610
30m, 0.25mm ID, 0.25 μm Rxi-5Sil MS w/10m Integra-Guard Column	ea.	13623-127	\$630
30m, 0.25mm ID, 0.50 μm Rxi-5Sil MS w/5m Integra-Guard Column	ea.	13638-124	\$610
30m, 0.25mm ID, 0.50 μm Rxi-5Sil MS w/10m Integra-Guard Column	ea.	13638-127	\$630
30m, 0.32mm ID, 0.50 μm Rxi-5Sil MS w/5m Integra-Guard Column	ea.	13639-125	\$655

Visit www.restek.com/rxi for a complete listing of Restek's Rxi®-5Sil MS Columns!

New Rxi®-5Sil MS columns outperform competitors, producing lower bleed at 300°C and 350°C than any other column on the market.



GC APPLICATIONS | ENVIRONMENTAL

Semivolatiles

Semivolatile Organics

US EPA Method 8270

Rxi®-5Sil MS

Column: Rxi®-5Sil MS, 20m, 0.18mm ID, 0.18 μ m (cat.# 43602)
 Sample: US EPA Method 8270D Mix, 1 μ L of 10 μ g/mL (IS 40 μ g/mL) 8270 MegaMix® (cat.# 31850)
 Benzoic Acid (cat.# 31879)
 8270 Benzidines Mix (cat.# 31852)
 Acid Surrogate Mix (4/89 SOW) (cat.# 31025)
 Revised B/N Surrogate Mix (cat.# 31887)
 1,4-Dioxane (cat.# 31853)
 SV Internal Standard Mix (cat.# 31206)

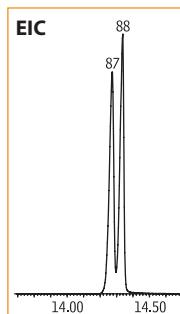
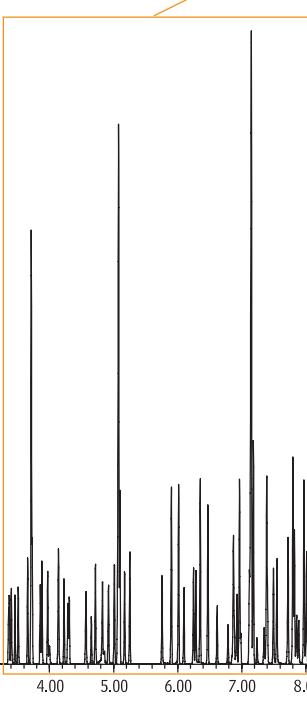
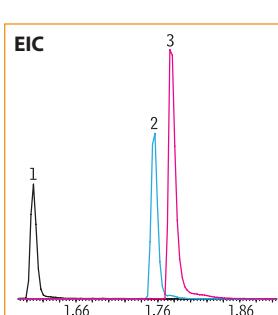
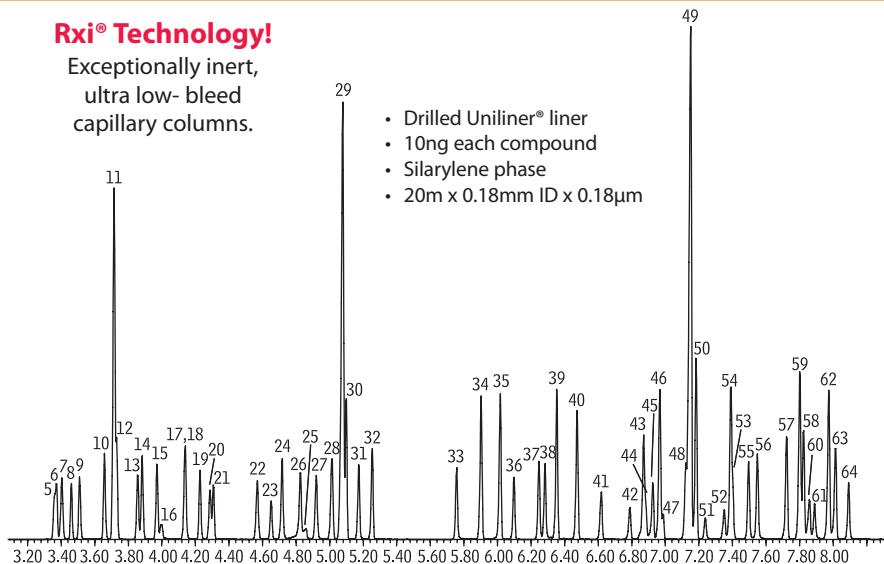
Inj.: 1.0 μ L (10ng on-column concentration), 4mm Drilled Uniliner® (hole near bottom) inlet liner (cat.# 20756), pulsed splitless: pulse 30psi @ 0.2 min., 60mL/min. @ 0.15 min.

Inj. temp.: 250°C
 Carrier gas: helium, constant flow
 Flow rate: 1.0mL/min.
 Oven temp.: 50°C (hold 0.5 min.) to 260°C @ 20°C/min. to 280°C @ 5°C/min. to 330°C @ 20°C/min. (hold 1.0 min.)

Det.: MS
 Transfer line temp.: 280°C
 Scan range: 35-550amu
 Ionization: EI
 Mode: scan

Rxi® Technology!

Exceptionally inert,
 ultra low- bleed
 capillary columns.

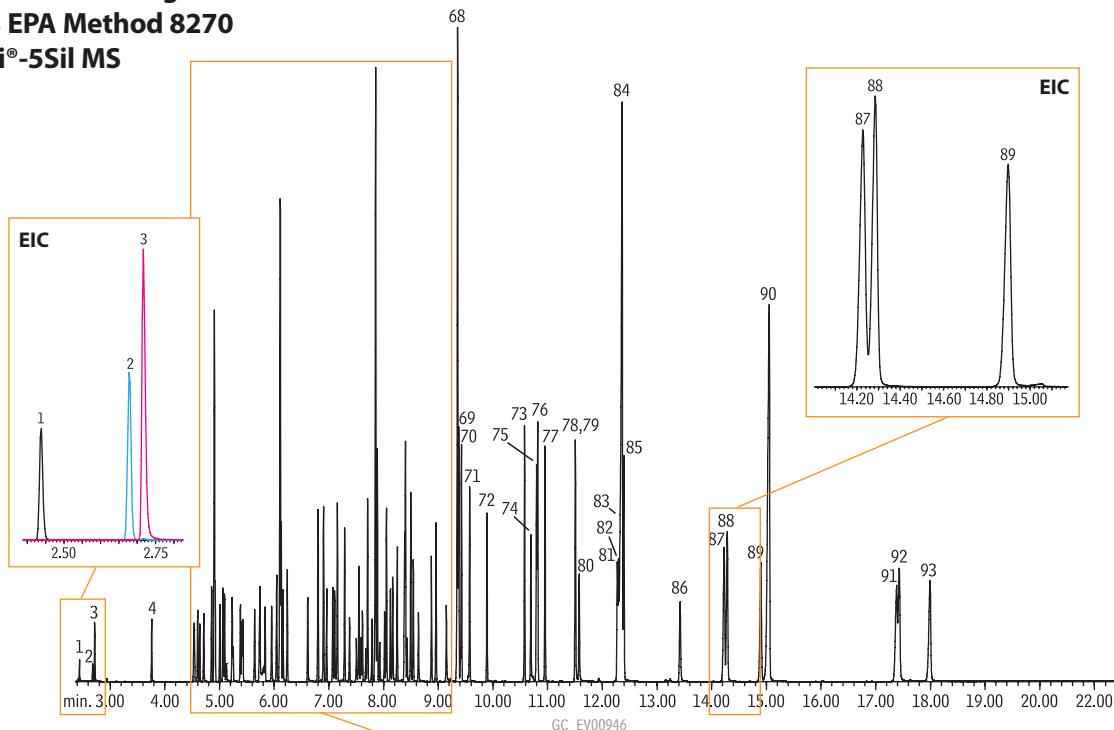


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|-----------------------------------|---|-------------------------------|--|-----------------------------------|----------------------------|
| 1. 1,4-dioxane | 18. <i>n</i> -nitroso-di- <i>n</i> -propylamine | 36. hexachlorocyclopentadiene | 54. 2,4-dinitrotoluene | 70. anthracene | 88. benzo(k)fluoranthene |
| 2. <i>n</i> -nitrosodimethylamine | 19. hexachloroethane | 37. 2,4,6-trichlorophenol | 55. 2,3,5,6-tetrachlorophenol | 71. carbazole | 89. benzo(a)pyrene |
| 3. pyridine | 20. nitrobenzene-d5 (SS) | 38. 2,4,5-trichlorophenol | 56. 2,3,4,6-tetrachlorophenol | 72. di- <i>n</i> -butyl phthalate | 90. perylene-d12 (IS) |
| 4. 2-fluorophenol (SS) | 21. nitrobenzene | 39. 2-fluorobiphenyl (SS) | 57. diethyl phthalate | 73. fluoranthene | 91. indeno(1,2,3-cd)pyrene |
| 5. phenol-d6 (SS) | 22. isophorone | 40. 2-chloronaphthalene | 58. fluorene | 74. benzidine | 92. dibenzo(a,h)anthracene |
| 6. phenol | 23. 2-nitrophenol | 41. 2-nitroaniline | 59. 4-chlorophenyl phenyl ether | 75. pyrene-d10 (SS) | 93. benzo(ghi)perylene |
| 7. aniline | 24. 2,4-dimethylphenol | 42. 1,4-dinitrobenzene | 60. 4-nitroaniline | 76. pyrene | |
| 8. bis(2-chloroethyl) ether | 25. bis(2-chloroethoxy)methane | 43. dimethyl phthalate | 61. 4,6-dinitro-2-methylphenol | 77. <i>p</i> -terphenyl-d14 (SS) | |
| 9. 2-chlorophenol | 26. benzoic acid | 44. 1,3-dinitrobenzene | 62. <i>n</i> -nitrosodiphenylamine (diphenylamine) | 78. 3,3'-dimethylbenzidine | |
| 10. 1,3-dichlorobenzene | 27. 2,4-dichlorophenol | 45. 2,6-dinitrotoluene | 63. 1,2-diphenylhydrazine (as azobenzene) | 79. butyl benzyl phthalate | |
| 11. 1,4-dichlorobenzene-d4 (IS) | 28. 1,2,4-trichlorobenzene | 46. 1,2-dinitrobenzene | 64. 2,4,6-tribromophenol (SS) | 80. bis(2-ethylhexyl) adipate | |
| 12. 1,4-dichlorobenzene | 29. naphthalene-d8 (IS) | 47. acenaphthylene | 65. 4-bromophenyl phenyl ether | 81. benzo(a)anthracene | |
| 13. benzyl alcohol | 30. naphthalene | 48. 3-nitroaniline | 66. hexachlorobenzene | 82. 3,3'-dichlorobenzidine | |
| 14. 1,2-dichlorobenzene | 31. 4-chloroaniline | 49. acenaphthene-d10 (IS) | 67. pentachlorophenol | 83. chrysene-d12 (IS) | |
| 15. 2-methylphenol | 32. hexachlorobutadiene | 50. acenaphthene | 68. phenanthrene-d10 (IS) | 84. chrysene | |
| 16. bis(2-chloroisopropyl) ether | 33. 4-chloro-3-methylphenol | 51. 2,4-dinitrophenol | 69. phenanthrene | 85. bis(2-ethylhexyl) phthalate | |
| 17. 4-methylphenol/3-methylphenol | 34. 2-methylnaphthalene | 52. 4-nitrophenol | 70. anthracene | 86. di- <i>n</i> -octyl phthalate | |
| | 35. 1-methylnaphthalene | 53. dibenzofuran | 71. carbazole | 87. benzo(b)fluoranthene | |

Semivolatile Organics

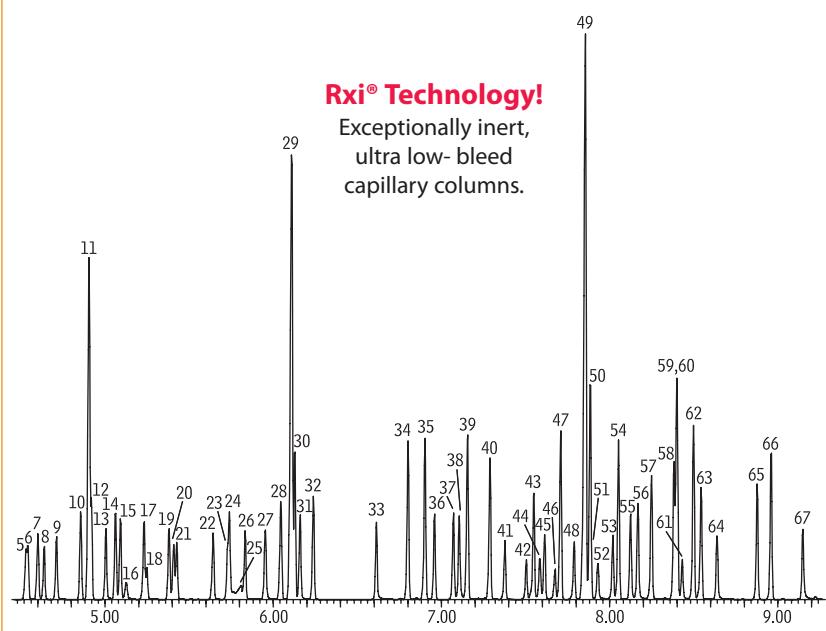
US EPA Method 8270

Rxi®-5Sil MS



Rxi® Technology!

Exceptionally inert,
ultra low- bleed
capillary columns.



Column: Rxi®-5Sil MS, 20m, 0.18mm ID, 0.36 μ m (cat.# 43604)
 Sample: US EPA Method 8270D Mix, 1 μ L of 10 μ g/mL (IS 40 μ g/mL)
 8270 MegaMix® (cat.# 31850)
 Benzoic Acid (cat.# 31879)
 8270 Benzidines Mix (cat.# 31852)
 Acid Surrogate Mix (4/89 SOW) (cat.# 31025)
 Revised B/N Surrogate Mix (cat.# 31887)
 1,4-Dioxane (cat.# 31853)
 SV Internal Standard Mix (cat.# 31206)
 1.0 μ L (1.0ng on-column concentration),
 4mm Drilled Uniliner® (hole near bottom)
 inlet liner (cat.# 20756),
 pulsed splitless: pulse 30psi @ 0.2 min.,
 60mL/min. @ 0.15 min.
 Inj. temp.: 250°C
 Carrier gas: helium, constant flow
 Flow rate: 1.2mL/min.
 Oven temp.: 40°C (hold 1.0 min.) to 280°C @ 25°C/min.
 to 330°C @ 5°C/min.
 Det.: MS
 Transfer line temp.: 280°C
 Scan range: 35-550amu
 Ionization: EI
 Mode: scan

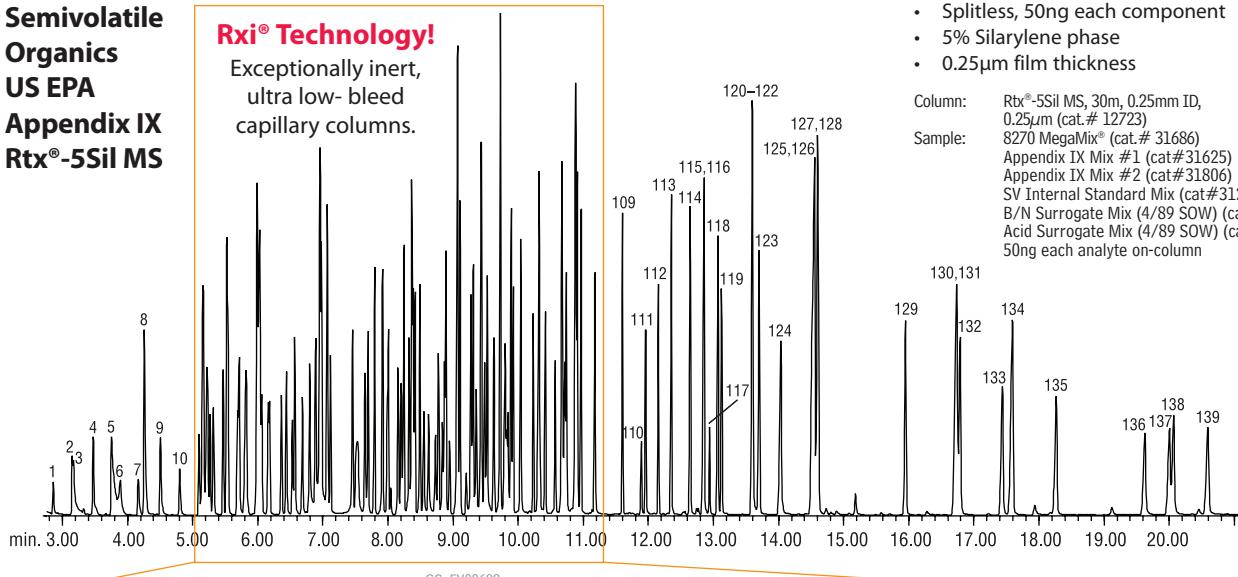
- | | | | | | |
|-----------------------------------|---|-------------------------------|---|--|----------------------------|
| 1. 1,4-dioxane | 17. 4-methylphenol/
3-methylphenol | 32. hexachlorobutadiene | 48. 3-nitroaniline | 63. 1,2-diphenylhydrazine
(as azobenzene) | 78. butyl benzyl phthalate |
| 2. <i>n</i> -nitrosodimethylamine | 18. <i>n</i> -nitroso-di- <i>n</i> -propylamine | 33. 4-chloro-3-methylphenol | 49. acenaphthene-d10 (IS) | 79. 3,3'-dimethylbenzidine | |
| 3. pyridine | 19. hexachloroethane | 34. 2-methylnaphthalene | 50. acenaphthene | 80. bis(2-ethylhexyl) adipate | |
| 4. 2-fluorophenol (SS) | 20. nitrobenzene-d5 (SS) | 35. 1-methylnaphthalene | 51. 2,4-dinitrophenol | 81. 3,3'-dichlorobenzidine | |
| 5. phenol-d6 (SS) | 21. nitrobenzene | 36. hexachlorocyclopentadiene | 52. 4-nitrophenol | 82. bis(2-ethylhexyl) phthalate | |
| 6. phenol | 22. isophorone | 37. 2,4,6-trichlorophenol | 53. 2,4-dinitrotoluene | 83. benzo(a)anthracene | |
| 7. aniline | 23. 2-nitrophenol | 38. 2,4,5-trichlorophenol | 54. dibenzofuran | 84. chrysene-d12 (IS) | |
| 8. bis(2-chloroethyl) ether | 24. 2,4-dimethylphenol | 39. 2-fluorobiphenyl (SS) | 55. 2,3,5,6-tetrachlorophenol | 85. chrysene | |
| 9. 2-chlorophenol | 25. benzoic acid | 40. 2-chloronaphthalene | 56. 2,3,4,6-tetrachlorophenol | 86. di- <i>n</i> -octyl phthalate | |
| 10. 1,3-dichlorobenzene | 26. bis(2-chloroethoxy)methane | 41. 2-nitroaniline | 57. diethyl phthalate | 87. benzo(b)fluoranthene | |
| 11. 1,4-dichlorobenzene-d4 (IS) | 27. 2,4-dichlorophenol | 42. 1,4-dinitrobenzene | 58. fluorene | 88. benzo(k)fluoranthene | |
| 12. 1,4-dichlorobenzene | 28. 1,2,4-trichlorobenzene | 43. dimethyl phthalate | 59. 4-chlorophenyl phenyl ether | 89. benzo(a)pyrene | |
| 13. benzyl alcohol | 29. naphthalene-d8 (IS) | 44. 1,3-dinitrobenzene | 60. 4-nitroaniline | 90. perylene-d12 (IS) | |
| 14. 2-methylphenol | 30. naphthalene | 45. 2,6-dinitrotoluene | 61. 4,6-dinitro-2-methylphenol | 91. indeno(1,2,3- <i>c</i> <i>d</i>)pyrene | |
| 15. 1,2-dichlorobenzene | 31. 4-chloroaniline | 46. 1,2-dinitrobenzene | 62. <i>n</i> -nitrosodiphenylamine
(diphenylamine) | 92. dibenzo(a,h)anthracene | |
| 16. bis(2-chloroisopropyl) ether | | 47. acenaphthylene | 63. benzidine | 93. benzo(ghi)perylene | |

GC APPLICATIONS | ENVIRONMENTAL Semivolatiles

Semivolatile Organics US EPA Appendix IX Rtx[®]-5Sil MS

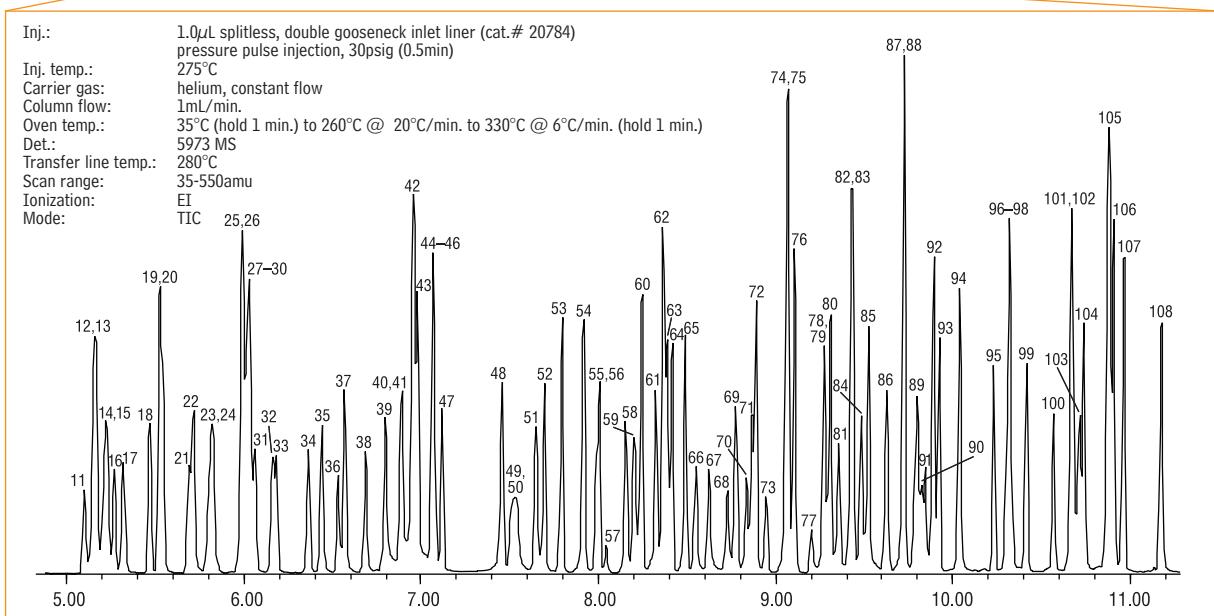
Rxi[®] Technology!

Exceptionally inert,
ultra low- bleed
capillary columns.



- Splitless, 50ng each component
- 5% Silarylene phase
- 0.25µm film thickness

Column: Rtx[®]-5Sil MS, 30m, 0.25mm ID, 0.25µm (cat.# 12723)
Sample: 8270 MegaMix[®] (cat.# 31686)
Appendix IX Mix #1 (cat.# 31625)
Appendix IX Mix #2 (cat.# 31806)
SV Internal Standard Mix (cat.# 31206)
B/N Surrogate Mix (4/89 SOW) (cat.# 31062)
Acid Surrogate Mix (4/89 SOW) (cat.# 31063)
50ng each analyte on-column



1. 1,4-dioxane	26a. 4-methylphenol	51. 4-chloro-3-methylphenol	77. 2,4-dinitrophenol	103. pentachloronitrobenzene	129. di-n-octyl phthalate
2. pyridine	26b. 3-methylphenol	52. isosafrole	78. pentachlorobenzene	104. propyzamide	130. benzo(b)fluoranthene
3. N-nitrosodimethylamine	27. N-nitroso-di-n-propylamine	53. 2-methylnaphthalene	79. 4-nitrophenol	105. phenanthrene-d10 (IS)	131. 7,12-dimethylbenzo(a)anthracene
4. ethyl methacrylate	28. nitrosopyrrolidine	54. 1-methylnaphthalene	80. dibenzofuran	106. phenanthrene	132. benzo(k)fluoranthene
5. 2-picoline	29. o-toluidine	55. hexachlorocyclopentadiene	81. 2,4-dinitrotoluene	107. anthracene	133. benzo(a)pyrene
6. N-nitrosomethylamine	30. 4-nitrosomorpholine	56. 1,2,4,5-tetrachlorobenzene	82. 1-naphthalamine	108. carbazole	134. perylene-d12 (IS)
7. methyl methanesulfonate	31. hexachloroethane	57. isosafrole	83. 2,3,4-tetrachlorophenol	109. di-n-butylphthalate	135. 3-methylcholanthrene
8. 2-fluorophenol	32. nitrobenzene-d5 (SS)	58. 2,4,6-trichlorophenol	84. 2,3,5,6-tetrachlorophenol	110. 4-nitroquinoline-1-oxide	136. dibenz(a,j)acridine
9. N-nitrosodiethylamine	33. nitrobenzene	59. 2,4,5-trichlorophenol	85. 2-naphthylamine	111. methapyriline	137. indeno(1,2,3-cd)pyrene
10. ethyl methanesulfonate	34. N-nitrosopiperidine	60. 2-fluorobiphenyl (SS)	86. diethyl phthalate	112. isodrin	138. dibenz(a,h)anthracene
11. benzaldehyde	35. isophorone	61. safrole	87. fluorene	113. fluoranthene	139. benzo(ghi)perylene
12. phenol-d6 (SS)	36. 2-nitrophenol	62. biphenyl	88. 4-chlorophenyl phenyl ether	114. pyrene	
13. phenol	37. 2,4-dimethylphenol	63. 2-chloronaphthalene	89. 2-methyl-5-nitroaniline	115. Aramite (isomer)	
14. aniline	38. bis(2-chloroethoxy)methane	64. 1-chloronaphthalene	90. 4-nitroaniline	116. <i>p</i> -terphenyl-d14 (SS)	
15. pentachloroethane	39. 2,4-dichlorophenol	65. diphenyl ether	91. 4,6-dinitro-2-methylphenol	117. Aramite (isomer)	
16. bis(2-chloroethyl)ether	40. 1,2,4-trichlorobenzene	66. 2-nitroaniline	92. diphenylamine	118. dimethylaminoazobenzene	
17. 2-chlorophenol	41. α,α' -dimethylphenylamine	67. 1,4-naphthoquinone	93. azobenzene	119. dichlorobenzilate	
18. 1,3-dichlorobenzene	42. naphthalene-d8 (IS)	68. 1,4-dinitrobenzene	94. 2,4,6-tribromophenol (SS)	120. 3,3-dimethylbenzidine	
19. 1,4-dichlorobenzene-d4 (IS)	43. naphthalene	69. dimethylphthalate	95. diallate	121. benzyl butyl phthalate	
20. 1,4-dichlorobenzene	44. 2,6-dichlorophenol	70. 1,3-dinitrobenzene	96. 1,3,5-trinitrobenzene	122. Kepone	
21. benzyl alcohol	45. 4-chloroaniline	71. 2,6-dinitrotoluene	97. phenacetin	123. bis(2-ethylhexyl)adipate	
22. 1,2-dichlorobenzene	46. hexachloropropene	72. acenaphthylene	98. 4-bromophenyl phenyl ether	124. 2-acetylaminofluorene	
23. 2-methylphenol	47. hexachlorobutadiene	73. 1,2-dinitrobenzene	99. hexachlorobenzene	125. benz(a)anthracene	
24. bis(2-chloroisopropyl)ether	48. N-nitroso- <i>n</i> -butylamine	74. 3-nitroaniline	100. atrazine	126. chrysene-d12 (IS)	
25. acetophenone	49. 1,4-phenylenediamine	75. acenaphthene-d10 (IS)	101. 4-aminobiphenyl	127. chrysene	
	50. caprolactam	76. acenaphthene	102. pentachlorophenol	128. bis(2-ethylhexyl)phthalate	

Semivolatile Organics

US EPA Method 8270D by GC/MS

Rtx®-XLB

Column: Rtx®-XLB, 20m, 0.18mm ID, 0.18 μ m (cat. # 42802)

Sample: US EPA Method 8270D mix:

8270 MegaMix® (cat.# 31850),

benzoic acid (cat.# 31415),

benzidine (cat.# 31441),

2,4-dinitrophenol (cat.# 31291),

Acid Surrogate Mix (4/89 SOW) (cat.# 31063),

B/N Surrogate Mix (4/89 SOW) (cat.# 31062)

Inj.: 0.5 μ L, 5ppm each analyte (2.5ng on column) (2.5ppm/1.25ng on column for 3-methylphenol and 4-methylphenol)

2mm splitless cyclo double

gooseneck inlet liner

(cat.# 20907);

splitless hold time 0.15 min.;

pressure pulse: 0.20 min. @ 30psi

GC: Agilent 6890

Inj. temp.: 270°C

Carrier gas: helium

Flow rate: 1.2mL/min., constant flow

Oven temp.: 40°C (hold 0.5 min.) to 90°C @

14°C/min. (no hold) to 330°C @

22°C/min. (hold 1 min.)

Det.: Agilent 5973 GC/MS

Transfer line temp.: 280°C

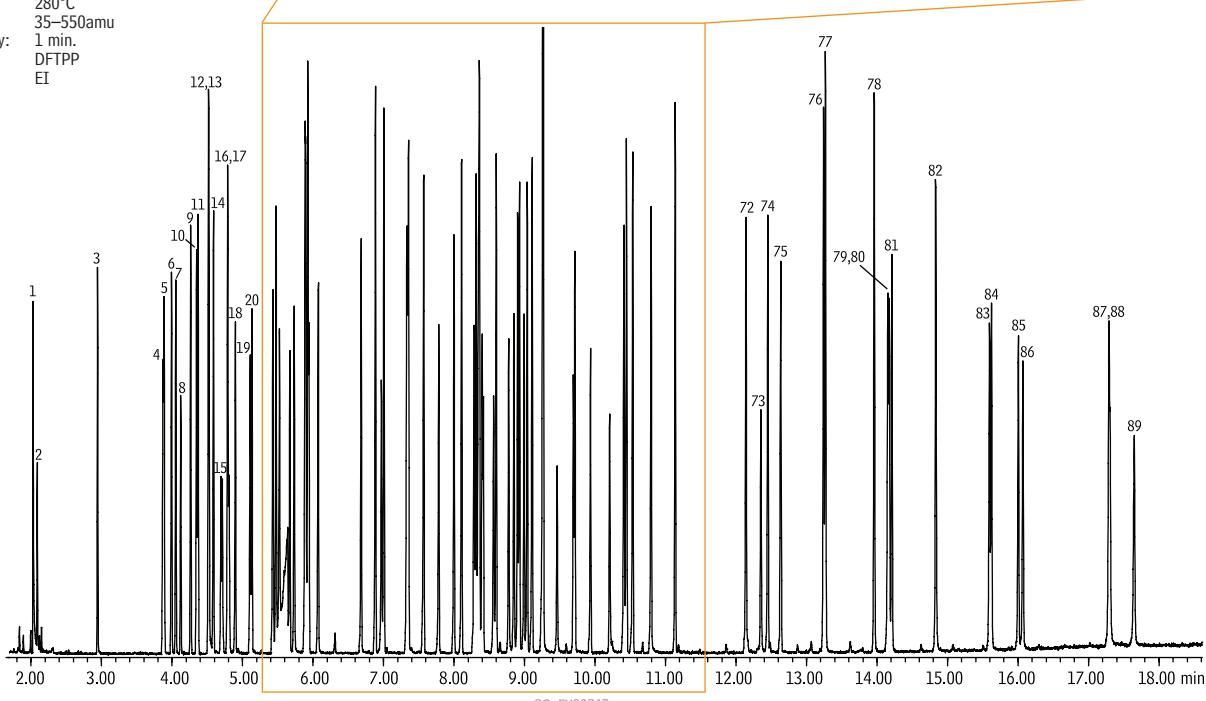
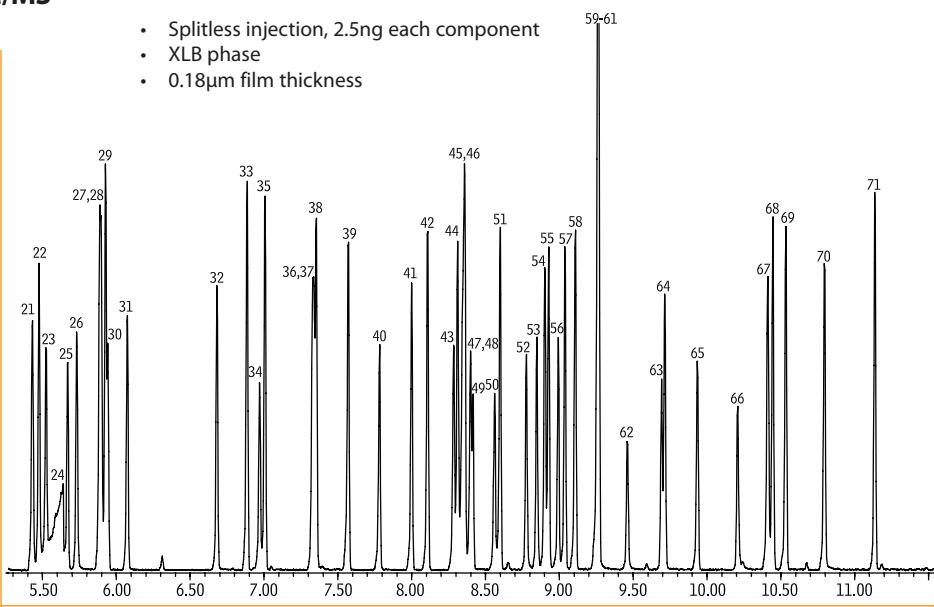
Scan range: 35–550amu

1 min.

Tune: DFTPP

Ionization: EI

- Splitless injection, 2.5ng each component
- XLB phase
- 0.18 μ m film thickness



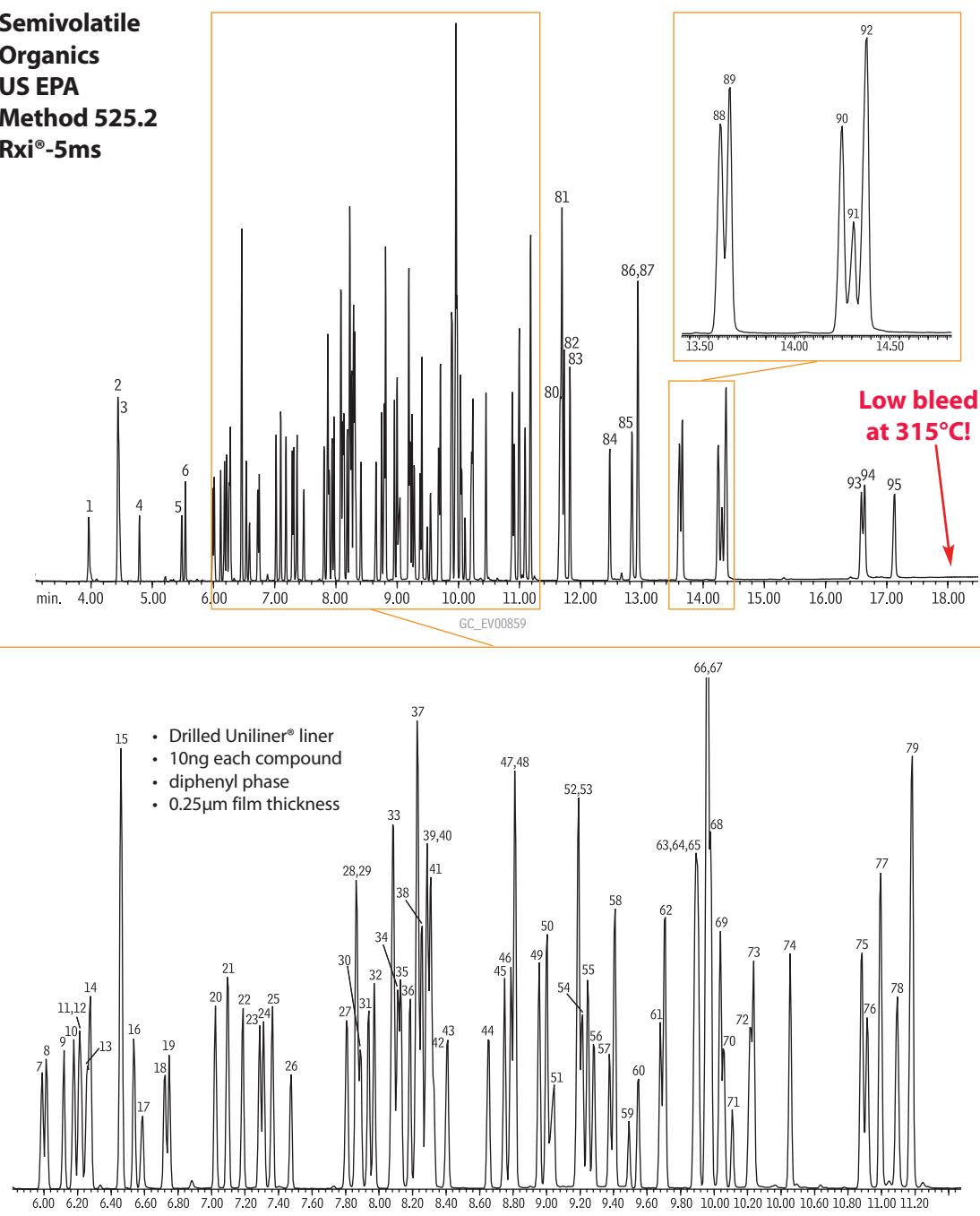
GC_EV00747

1. pyridine	19. nitrobenzene-d5	38. 2-fluorophenyl	57. 4-chlorophenyl phenyl ether	76. benzyl butyl phthalate
2. N-nitrosodimethylamine	20. nitrobenzene	39. 2-chloronaphthalene	58. fluorene	77. bis(2-ethylhexyl)adipate
3. 2-fluorophenol	21. isophorone	40. 2-nitroaniline	59. diphenylamine	78. bis(2-ethylhexyl)phthalate
4. phenol-d6	22. 2,4-dimethylphenol	41. dimethylphthalate	60. 4-nitroaniline	79. benzo(a)anthracene
5. phenol	23. 2-nitrophenol	42. acenaphthylene	61. azobenzene	80. chrysene-d12
6. aniline	24. benzoic acid	43. 2,6-dinitrotoluene	62. 2,4,6-tribromophenol	81. chrysene
7. 2-chlorophenol	25. bis(2-chloroethoxy)methane	44. acenaphthene-d10	63. 4,6-dinitro-2-methylphenol	82. di-n-octyl phthalate
8. bis(2-chloroethyl)ether	26. 2,4-dichlorophenol	45. 1,4-dinitrobenzene	64. 4-bromophenyl phenyl ether	83. benzo(b)fluoranthene
9. 1,3-dichlorobenzene	27. 1,2,4-trichlorobenzene	46. acenaphthene	65. hexachlorobenzene	84. benzo(k)fluoranthene
10. 1,4-dichlorobenzene-d4	28. naphthalene-d8	47. 1,3-dinitrobenzene	66. pentachlorophenol	85. benzo(a)pyrene
11. 1,4-dichlorobenzene	29. naphthalene	48. 3-nitroaniline	67. phenanthrene-d10	86. perylene-d12
12. 1,2-dichlorobenzene	30. hexachlororobutadiene	49. 1,2-dinitrobenzene	68. phenanthrene	87. indeno(1,2,3-cd)pyrene
13. benzyl alcohol	31. 4-chloroaniline	50. 4-nitrophenol	69. anthracene	88. dibenzo(a,h)anthracene
14. 2-methylphenol	32. 4-chloro-3-methylphenol	51. dibenzofuran	70. carbazole	89. benzo(ghi)perylene
15. bis(2-chloroisopropyl)ether	33. 2-methylnaphthalene	52. 2,3,4,6-tetrachlorophenol	71. di-n-butylphthalate	
16. hexachloroethane	34. hexachlorocyclopentadiene	53. 2,3,5,6-tetrachlorophenol	72. fluoranthene	
17a. 4-methylphenol	35. 1-methylnaphthalene	54. 2,4-dinitrophenol	73. benzidine	
17b. 3-methylphenol	36. 2,4,6-trichlorophenol	55. diethyl phthalate	74. pyrene	
18. N-nitroso-di-n-propylamine	37. 2,4,5-trichlorophenol	56. 2,4-dinitrotoluene	75. p-terphenyl-d14	

GC APPLICATIONS | ENVIRONMENTAL

Semivolatiles

**Semivolatile
Organics
US EPA
Method 525.2
Rxi®-5ms**



Column: Rxi®-5ms, 30m, 0.25mm ID, 0.25µm (cat.# 13423)
 Sample: US EPA Method 525.2 mix, 10µg/ml each analyte,
 25µg/ml each internal standard and surrogate:
 Method 525.2 Semivolatile Mix (cat.# 31899), Organonitrogen Pesticide Mix #1 (cat.# 33012),
 Organonitrogen Pesticide Mix #2 (cat.# 33011), Organophosphate Pesticide Mix #1 (cat.# 33013),
 Nitrogen/Phosphorous Pesticide Mix #2 (cat.# 32423), Method 525.2 Internal Standard Mix (cat.# 31825),
 Method 525.2 Surrogate Standard Mix (cat.# 31826)

Instrument: Agilent 6890
 Inj.: 1.0µL, pulsed splitless injection: 50psi (0.3 min.), 80mL/min. (0.15 min.), gas saver 15mL/min. (1 min.),
 4mm Drilled Uniliner® inlet liner, hole near bottom (cat.# 20771)

Inj. temp.: 250°C
 Carrier gas: helium, constant flow
 Flow rate: 1.2mL/min.
 Oven temp.: 90°C (1 min.) to 270°C @ 20°C/min., to 315°C @ 6°C/min.
 Det.: Agilent 5973 MSD
 Interface line temp.: 280°C
 Scan range: 35-550amu
 Solvent delay: 3.00 min.
 Tune: DFTPP
 Ionization: EI

Rxi® Technology!

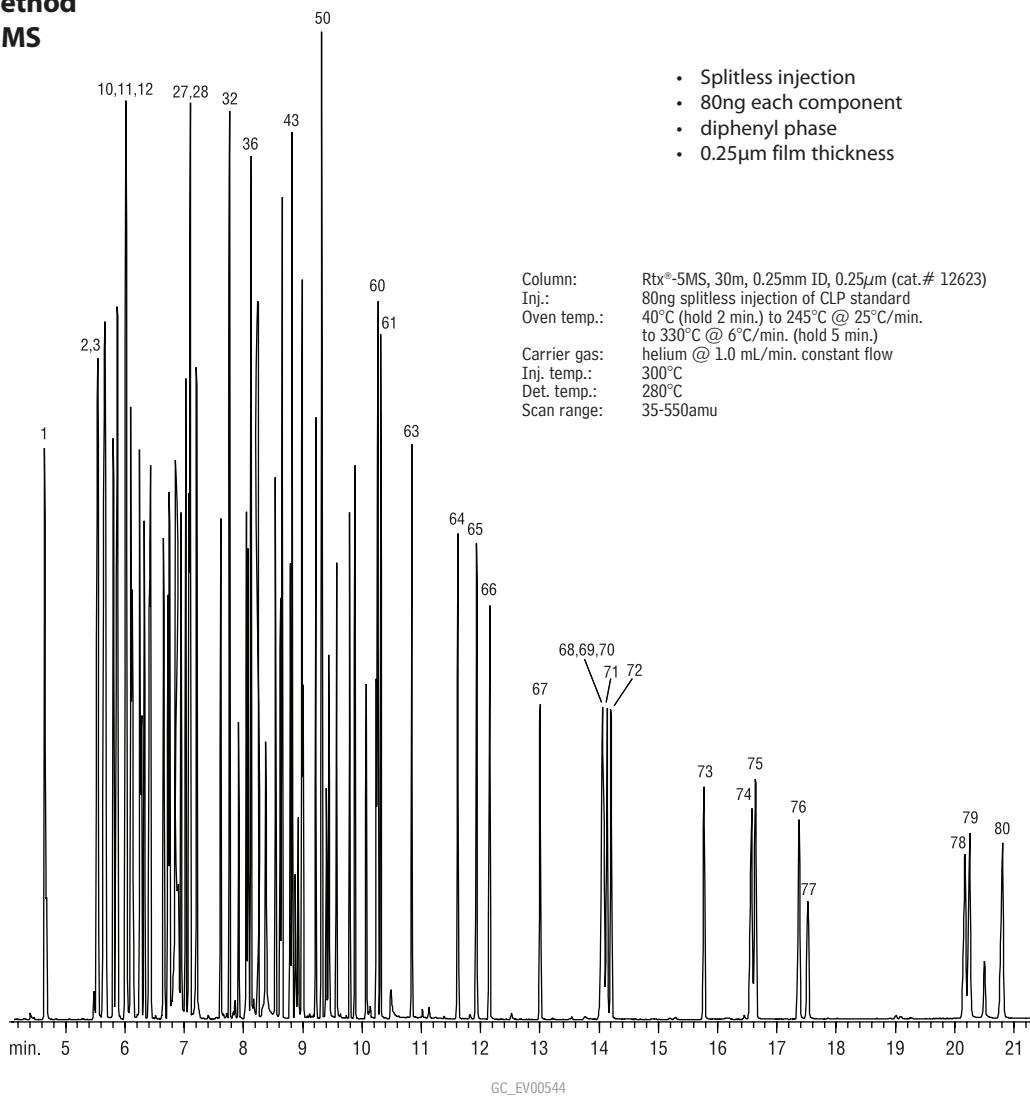
Exceptionally inert,
 ultra low- bleed
 capillary columns.

1. isophorone
2. 2-nitro-*m*-xylene (SS)
3. naphthalene
4. dichlorofene (DDVP)
5. hexachlorocyclopentadiene
6. EPTC
7. mevinphos
8. butylate
9. vernalate
10. dimethyl phthalate
11. pebutate
12. etridiazole (Terrazole®)
13. 2,6-dinitrotoluene
14. acenaphthylene
15. acenaphthene-d10 (IS)
16. chlorneb
17. tebuuthuron
18. 2,4-dinitrotoluene
19. molinate
20. diethyl phthalate
21. fluorene
22. propachlor
23. ethoprop (ethoprophos)
24. cycloate
25. chlorpropham
26. trifluralin
27. atraton
28. hexachlorobenzene
29. prometon
30. simazine
31. atrazine
32. propazine
33. pentachlorophenol
34. terbufos
35. pronamide (propyzamide)
36. diazinon
37. phenanthrene-d10 (IS)
38. phenanthrene
39. disulfoton
40. methyl paraoxon
41. anthracene
42. terbacil
43. chlorothalonil
44. metribuzin
45. simetryn
46. ametryn
47. alachlor
48. prometryn
49. terbutryn
50. di-*n*-butyl phthalate
51. bromacil
52. cyanazine (Bladex)
53. metolochlor
54. chloryrifos (Durban®)
55. triadimenol
56. Dacthal® (DCPA)
57. MGK-264 (isomer A)
58. diphenamid
59. MGK-264 (isomer B)
60. morphos
61. heptachlor epoxide
62. fluoranthene
63. stirofos
64. disulfoton sulfone
65. butachlor
66. pyrene-d10 (SS)
67. fenamiphos
68. pyrene
69. napropamide (Devrinol®)
70. trans-nonachlor
71. morphos oxide
72. tricyclazole (Beam)
73. carboxin
74. chlorobenzilate
75. benzyl butyl phthalate
76. norfuralon
77. bis(2-ethylhexyl) adipate
78. hexazinone (Velpar®)
79. triphenylphosphate (SS)
80. benzo(a)anthracene
81. chrysene-d12 (IS)
82. chrysene
83. bis(2-ethylhexyl) phthalate
84. fenamol
85. *cis*-permethrin
86. *trans*-permethrin
87. di-*n*-octyl phthalate
88. benzo(*o*)fluoranthene
89. benzo(*k*)fluoranthene
90. benzo(*a*)pyrene
91. fluridone (Sonar®)
92. perylene-d12 (SS)
93. indeno(1,2,3-*cd*)pyrene
94. dibenz(a,h)anthracene
95. benzo(ghi)perylene

Semivolatile Organics

CLP Method

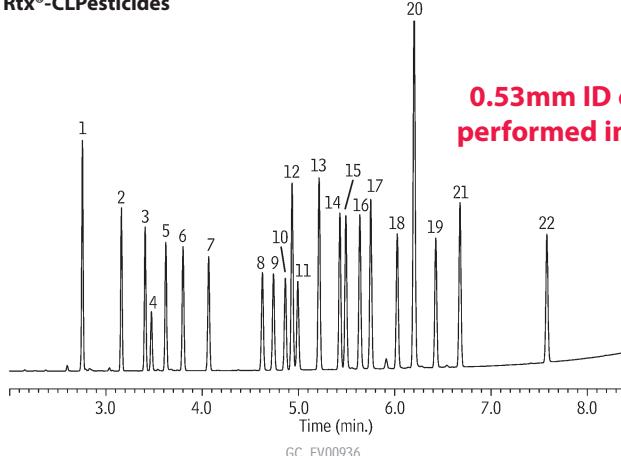
Rtx®-5MS



1. 2-fluorophenol (SS)	RT	28. naphthalene	7.10	56. 4-bromophenyl phenyl ether	9.80
2. phenol-d6 (SS)	4.65	29. 4-chloroaniline	7.20	57. hexachlorobenzene	9.88
3. phenol	5.53	30. hexachlorobutadiene	7.21	58. pentachlorophenol	10.07
4. bis(2-chloroethyl)ether	5.55	31. 4-chloro-3-methylphenol	7.62	59. phenanthrene-d10 (IS)	10.24
5. 2-chlorophenol-d4 (SS)	5.64	32. 2-methylnaphthalene	7.77	60. phenanthrene	10.27
6. 2-chlorophenol	5.66	33. hexachlorocyclopentadiene	7.92	61. anthracene	10.32
7. 1,3-dichlorobenzene	5.67	34. 2,4,6-trichlorophenol	8.05	62. carbazole	10.49
8. 1,4-dichlorobenzene-d4 (IS)	5.81	35. 2,4,5-trichlorophenol	8.08	63. di-n-butylphthalate	10.84
9. 1,4-dichlorobenzene	5.86	36. 2-fluorobiphenyl (SS)	8.13	64. fluoranthene	11.62
10. 1,2-dichlorobenzene-d4 (IS)	5.87	37. 2-chloronaphthalene	8.25	65. pyrene	11.94
11. benzyl alcohol	6.01	38. 2-nitroaniline	8.38	66. p-terphenyl-d14 (SS)	12.16
12. 1,2-dichlorobenzene	6.01	39. dimethylphthalate	8.54	67. benzyl butyl phthalate	13.01
13. 2-methylphenol	6.03	40. 2,6-dinitrotoluene	8.62	68. benzo(a)anthracene	14.05
14. bis(2-chloroisopropyl)ether	6.10	41. acenaphthylene	8.66	69. 3,3'-dichlorobenzidine	14.06
15. 4-methylphenol/3-methylphenol	6.13	42. acenaphthene-d10 (IS)	8.79	70. chrysene-d12 (IS)	14.08
16. N-nitroso-di-n-propylamine	6.25	43. acenaphthene	8.83	71. chrysene	14.14
17. hexachloroethane	6.28	44. 3-nitroaniline	8.88	72. bis(2-ethylhexyl)phthalate	14.2
18. nitrobenzene-d5 (SS)	6.33	45. 2,4-dinitrophenol	8.88	73. di-n-octyl phthalate	15.77
19. nitrobenzene	6.41	46. 4-nitrophenol	8.92	74. benzo(b)fluoranthene	16.57
20. isophorone	6.43	47. dibenzofuran	8.99	75. benzo(k)fluoranthene	16.64
21. 2-nitrophenol	6.66	48. 2,4-dinitrotoluene	9.01	76. benzo(a)pyrene	17.38
22. 2,4-dimethylphenol	6.73	49. diethyl phthalate	9.22	77. perylene-d12 (IS)	17.52
23. bis(2-chlorooxy)methane	6.75	50. 4-chlorophenyl phenyl ether	9.32	78. indeno(1,2,3-cd)pyrene	20.18
24. benzoic acid	6.85	51. fluorene	9.33	79. dibenzo(a,h)anthracene	20.26
25. 2,4-dichlorophenol	6.91	52. 4-nitroaniline	9.39	80. benzo(ghi)perylene	20.81
26. 1,2,4-trichlorobenzene	6.95	53. 2-methyl-4,6-dinitrophenol	9.40		
27. naphthalene-d8 (IS)	7.03	54. diphenylamine	9.44		
	7.08	55. 2,4,6-tribromophenol (SS)	9.57		

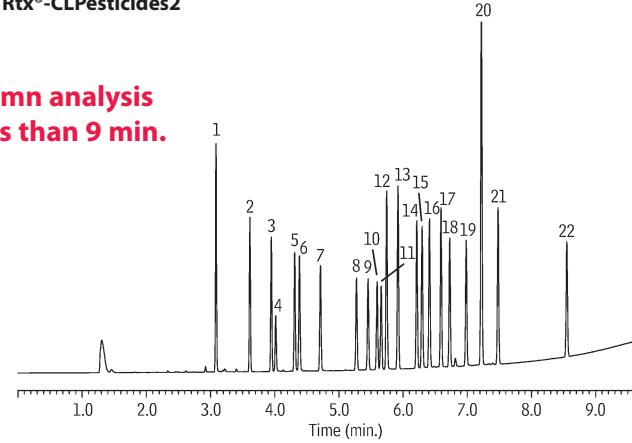
**Organochlorine Pesticide Mix AB #2
Rtx®-CLPesticides and Rtx®-CLPesticides2**

Rtx®-CLPesticides



Columns: Rtx®-CLPesticides, 30m, 0.53mm ID, 0.50 μ m (cat.# 11140) and Rtx®-CLPesticides2, 30m, 0.53mm ID, 0.42 μ m (cat.# 11340) with 5m x 0.53mm ID Rx[®] deactivated guard tubing (cat.# 10054), connected using Siltek® Treated Universal "Y" Press-Tight® connector (cat.# 20486)
Sample: Organochlorine Pesticide Mix AB #2, 8-80 μ g/mL each component in hexane/toluene (cat.# 32292), Pesticide Surrogate Mix, 200 μ g/mL each component in acetone (cat.# 32000)
Inj.: 1.0 μ L splitless (hold 0.3 min.), 4mm single gooseneck inlet liner (cat.# 20799)
Inj. temp.: 250°C
Carrier gas: helium, constant flow
Linear velocity: 45cm/sec. @ 120°C
Oven temp.: 120°C to 200°C @ 45°C/min. to 230°C @ 12.5°C/min. to 320°C (hold 2 min.) @ 20°C/min.
Det.: ECD @ 330°C

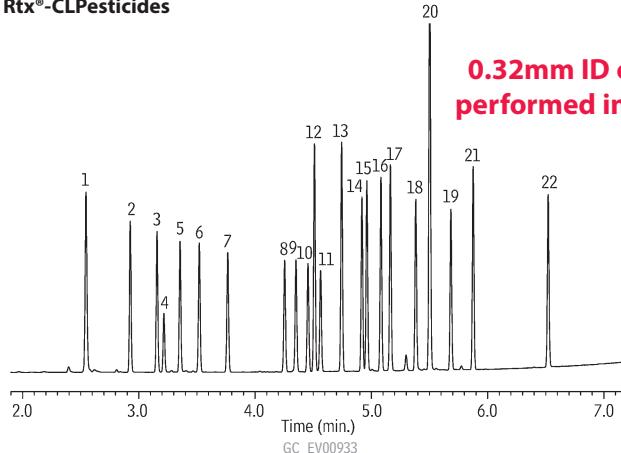
Rtx®-CLPesticides2



- | | |
|---|-----------------------------|
| 1. 2,4,5,6-tetrachloro- <i>m</i> -xylene (SS) | 12. 4,4'-DDE |
| 2. α -BHC | 13. dieldrin |
| 3. γ -BHC | 14. endrin |
| 4. β -BHC | 15. 4,4'-DDD |
| 5. δ -BHC | 16. endosulfan II |
| 6. heptachlor | 17. 4,4'-DDT |
| 7. aldrin | 18. endrin aldehyde |
| 8. heptachlor epoxide (isomer B) | 19. endosulfan sulfate |
| 9. γ -chlordane | 20. methoxychlor |
| 10. α -chlordane | 21. endrin ketone |
| 11. endosulfan I | 22. decachlorobiphenyl (SS) |

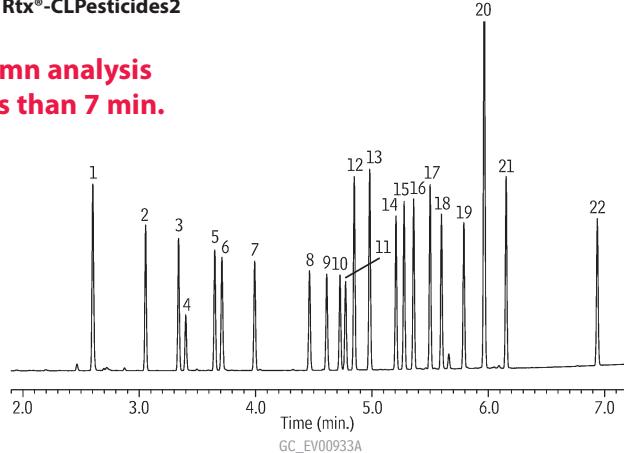
**Organochlorine Pesticide Mix AB #2
Rtx®-CLPesticides and Rtx®-CLPesticides2**

Rtx®-CLPesticides



Columns: Rtx®-CLPesticides, 30m, 0.32mm ID, 0.32 μ m (cat.# 11141) and Rtx®-CLPesticides2, 30m, 0.32mm ID, 0.25 μ m (cat.# 11324) with 5m x 0.32mm ID Rx[®] deactivated guard tubing (cat.# 10039), connected using Deactivated Universal "Y" Press-Tight® connector (cat.# 20405-261)
Sample: Organochlorine Pesticide Mix AB #2, 8-80 μ g/mL each component in hexane/toluene (cat.# 32292), Pesticide Surrogate Mix, 200 μ g/mL each component in acetone (cat.# 32000)
Inj.: 1.0 μ L splitless (hold 0.3 min.), 4mm single gooseneck inlet liner (cat.# 20799)
Inj. temp.: 250°C
Carrier gas: helium, constant flow
Linear velocity: 60cm/sec. @ 120°C
Oven temp.: 120°C to 200°C @ 45°C/min. to 230°C @ 15°C/min. to 330°C (hold 2 min.) @ 30°C/min.
Det.: ECD @ 330°C

Rtx®-CLPesticides2

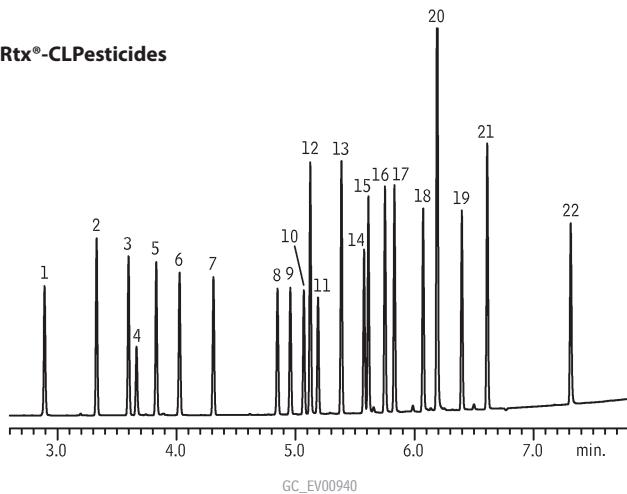


- | | |
|---|-----------------------------|
| 1. 2,4,5,6-tetrachloro- <i>m</i> -xylene (SS) | 12. 4,4'-DDE |
| 2. α -BHC | 13. dieldrin |
| 3. γ -BHC | 14. endrin |
| 4. β -BHC | 15. 4,4'-DDD |
| 5. δ -BHC | 16. endosulfan II |
| 6. heptachlor | 17. 4,4'-DDT |
| 7. aldrin | 18. endrin aldehyde |
| 8. heptachlor epoxide (isomer B) | 19. endosulfan sulfate |
| 9. γ -chlordane | 20. methoxychlor |
| 10. α -chlordane | 21. endrin ketone |
| 11. endosulfan I | 22. decachlorobiphenyl (SS) |

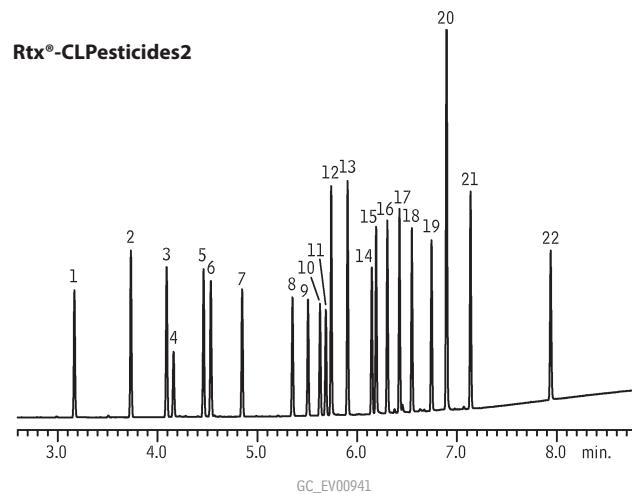
Organochlorine Pesticide Mix AB #2

Rtx®-CLPesticides and Rtx®-CLPesticides2 (0.25mm ID column set)

Rtx®-CLPesticides



Rtx®-CLPesticides2



Columns: Rtx®-CLPesticides, 30m, 0.25mm ID, 0.25 μ m (cat.# 11123) and Rtx®-CLPesticides2, 30m, 0.25mm ID, 0.20 μ m (cat.# 11323) with 5m x 0.25mm ID Rx® deactivated guard tubing (cat.# 10029), connected using Siltek® treated Universal "Y" Press-Tight® Connector (cat.# 20486)

Sample: Organochlorine Pesticide Mix AB #2, 8–80 μ g/mL each component in hexane/toluene (cat.# 32292), Pesticide Surrogate Mix, 200 μ g/mL each component in acetone (cat.# 32000)

Inj.: 0.5 μ L splitless (hold 0.5 min.), 2mm Cyclo Double Gooseneck inlet liner (cat.# 20908)

Inj. temp.: 250°C

Carrier gas: helium, constant flow

Linear velocity: 41cm/sec. @ 125°C

Oven temp.: 125°C to 200°C @ 45°C/min. to 230°C @ 12.5°C/min. to 330°C (hold 2 min.) @ 30°C/min.

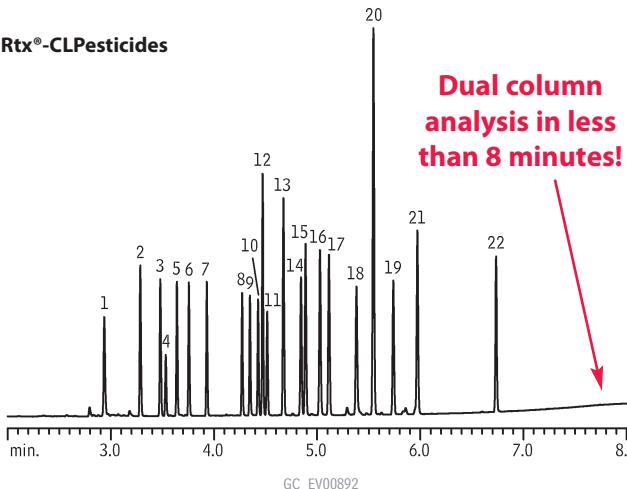
Det.: ECD @ 330°C

1. 2,4,5,6-tetrachloro-*m*-xylene (SS)
2. α -BHC
3. γ -BHC
4. β -BHC
5. δ -BHC
6. heptachlor
7. aldrin
8. heptachlor epoxide (isomer B)
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 (SS)

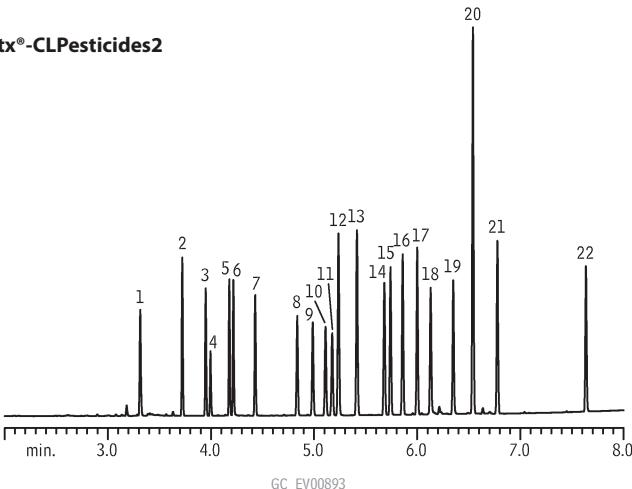
Organochlorine Pesticides

Rtx®-CLPesticides and Rtx®-CLPesticides2 (0.18mm ID column set)

Rtx®-CLPesticides



Rtx®-CLPesticides2



Columns: Rtx®-CLPesticides, 20m, 0.18mm ID, 0.18 μ m (cat.# 42102) and 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

Sample: Organochlorine Pesticide Mix AB #2 (cat.# 32292), 8–80 μ g/mL each component in hexane/toluene, Pesticide Surrogate Mix (cat.# 32000), 200 μ g/mL each component in acetone

Inj.: 0.5 μ L splitless (hold 0.75 min.), 2mm single gooseneck inlet liner (cat.# 20796)

Inj. temp.: 250°C

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

1. 2,4,5,6-tetrachloro-*m*-xylene (SS)
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 (SS)

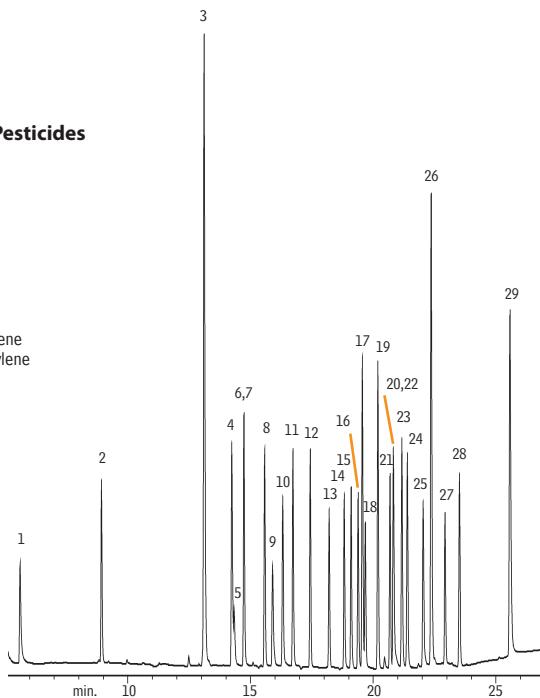
Organochlorine Pesticides

US EPA Method 8081A

Rtx®-CLPesticides & Rtx®-CLPesticides2

1. dibromochloropropane
2. hexachlorocyclopentadiene
3. 2,4,5,6-tetrachloro-*m*-xylene
4. hexachlorobenzene
5. *cis*-diallate
6. α -BHC
7. *trans*-diallate
8. γ -BHC
9. β -BHC
10. δ -BHC
11. heptachlor
12. aldrin
13. isodrin
14. heptachlor epoxide
15. γ -chlordane
16. α -chlordane
17. 4,4'-DDE
18. endosulfan I
19. dieldrin
20. chlorobenzilate
21. endrin
22. 4,4'-DDD
23. endosulfan II
24. 4,4'-DDT
25. endrin aldehyde
26. methoxychlor
27. endosulfan sulfate
28. endrin ketone
29. decachlorobiphenyl

Rtx®-CLPesticides



free literature



GC Analysis of US EPA Method 504.1 Organochlorine Pesticides, Using the Rtx®-CLPesticides and Rtx®-CLPesticides2 Columns

A versatile column pair for analyzing organochlorine pesticides, herbicides, or PCBs

Analysts following Method 504.1 in monitoring 1,2-dibromoethane (EDB), 1,2-dibromo-3-chloropropane (DBCP), and 1,2,3-trichloropropane (TCP) in drinking water will value Rtx®-CLPesticides and Rtx®-CLPesticides2 columns because this same primary column/confirmation column pair can be used to perform numerous related analyses: organochlorine pesticides (e.g., by EPA Method 608 or 8081), herbicides, or polychlorinated biphenyls (PCBs). Details in this 2-page note show EDB, DBCP, and TCP are fully resolved from common interference compounds, per requirements of Method 504.1.

Applications Note
lit. cat.# 59539

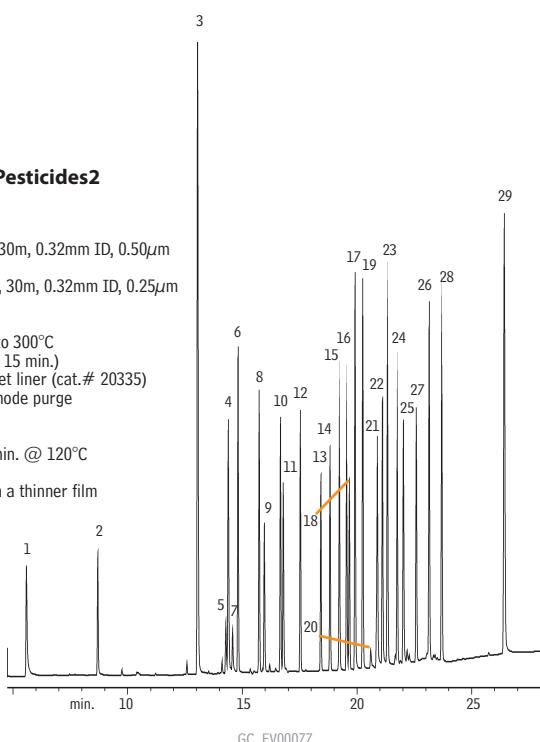
Rtx®-CLPesticides and Rtx®-CLPesticides2 columns also are ideal for:

- Triazine herbicides (lit. cat.# 59101)
- PCBs (lit. cat.# 59120)
- Haloacetic acids (lit. cat.# 59175)
- Polynuclear aromatic hydrocarbons (lit. cat.# 59196A)

Download your free copy of the literature listed here from www.restek.com.

Columns: Rtx®-CLPesticides, 30m, 0.32mm ID, 0.50 μ m (cat.# 11139)*
Rtx®-CLPesticides2, 30m, 0.32mm ID, 0.25 μ m (cat.# 11324)
On-column conc.: 16–160pg
Oven temp.: 80°C (hold 1 min.) to 300°C (@ 10°C/min. hold 15 min.)
Inj.: direct, Uniliner® inlet liner (cat.# 20335)
Det.: ECD, 300°C, with anode purge
Dead time: 1.9 min.
Head pressure: 8.7psi (constant)
Flow rate: helium @ 1.3mL/min. @ 120°C

*Rtx®-CLPesticides is also offered with a thinner film thickness (cat. # 11141).

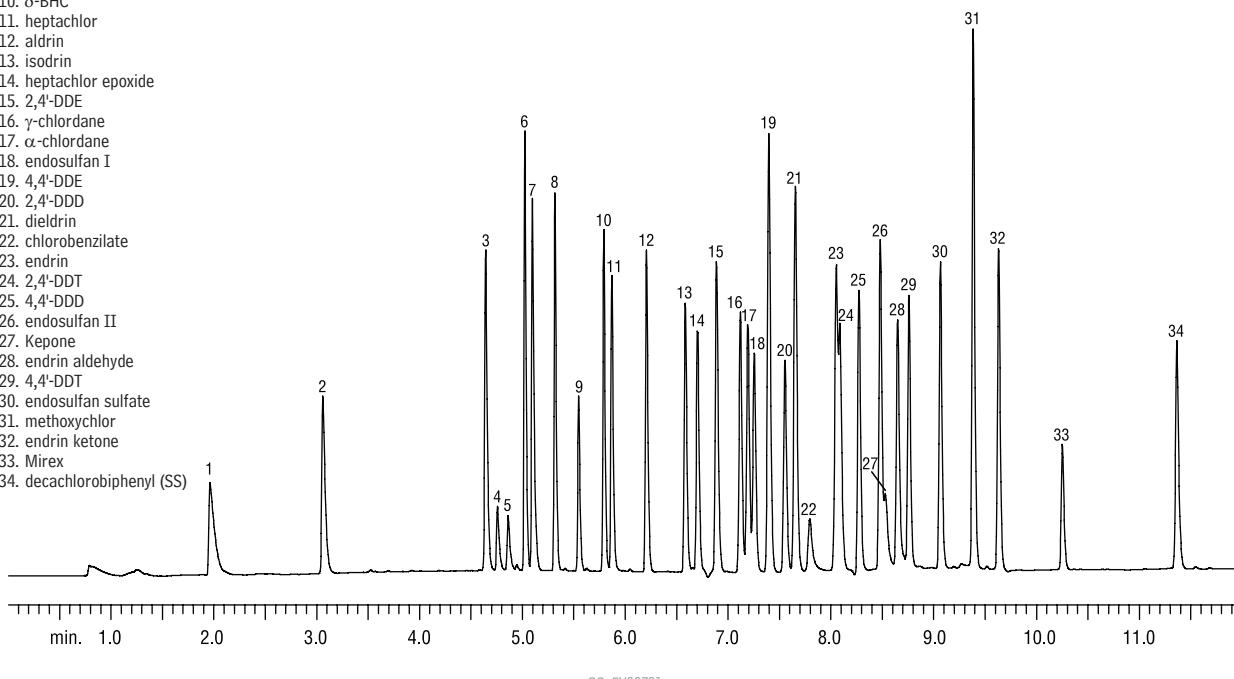


Organochlorine Pesticides

US EPA Method 8081A

Rtx®-XLB

1. 1,2-dibromo-3-chloropropane
2. hexachlorocyclopentadiene
3. 2,4,5,6-tetrachloro-*m*-xylene (SS)
4. *cis*-diallate
5. *trans*-diallate
6. α -BHC
7. hexachlorobenzene
8. γ -BHC
9. β -BHC
10. δ -BHC
11. heptachlor
12. aldrin
13. isodrin
14. heptachlor epoxide
15. 2,4'-DDE
16. γ -chlordane
17. α -chlordane
18. endosulfan I
19. 4,4'-DDE
20. 2,4'-DDD
21. dieldrin
22. chlorobenzilate
23. endrin
24. 2,4'-DDT
25. 4,4'-DDD
26. endosulfan II
27. Kepone
28. endrin aldehyde
29. 4,4'-DDT
30. endosulfan sulfate
31. methoxychlor
32. endrin ketone
33. Mirex
34. decachlorobiphenyl (SS)



Column: Rtx®-XLB, 30m, 0.32mm ID, 0.5 μ m (cat.# 12839)
 Sample: 8081A pesticides, 80-160ppb in hexane
 8081A Pesticides/Surrogates
 8080 Organochlorine Pesticide Mix AB #2 (20 components) (cat.# 32292)
 8081a Organochlorine Pesticide Mix C #2 (7 components) (cat.# 32295)
 2,4'-DDT (cat.# 32200)
 2,4'-DDD (cat.# 32098)
 2,4'-DDE (cat.# 32099)
 Kepone (custom)
 Mirex (custom)
 2,4,5,6-tetrachloro-*m*-xylene (ss, 20ppb) (cat.# 32027)
 decachlorobiphenyl (ss, 40ppb) (cat.# 32029)
 Inj.: 1.0 μ L splitless (hold 0.75 min.), 4mm Drilled Uniliner® inlet liner (cat.# 21055)
 Inj. temp.: 220°C
 Carrier gas: hydrogen, constant pressure
 Linear velocity: 60cm/sec. @ 120°C
 Oven temp.: 120°C (hold 0.5 min.) to 260°C @ 29°C/min. (hold 2.5 min.), to 330°C @ 28°C/min. (hold 3 min.)
 Det.: ECD @ 320°C

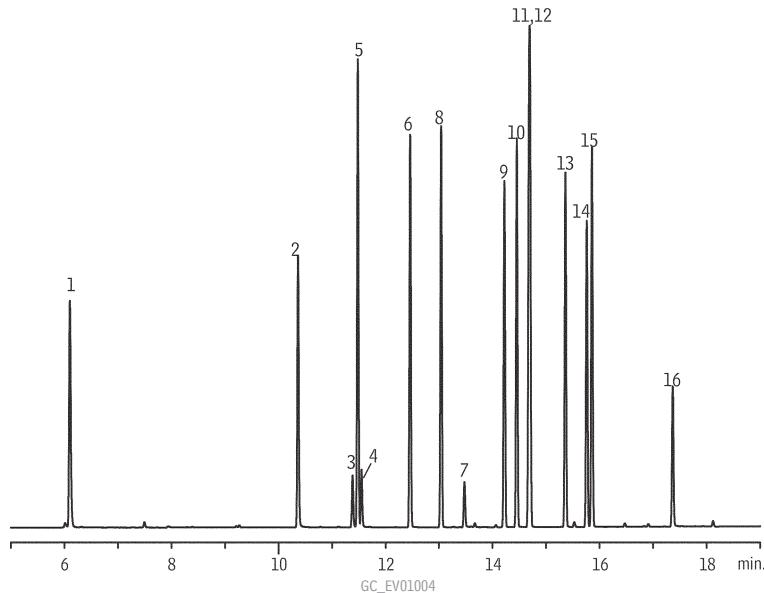


Searching for a chromatogram?
www.restek.com

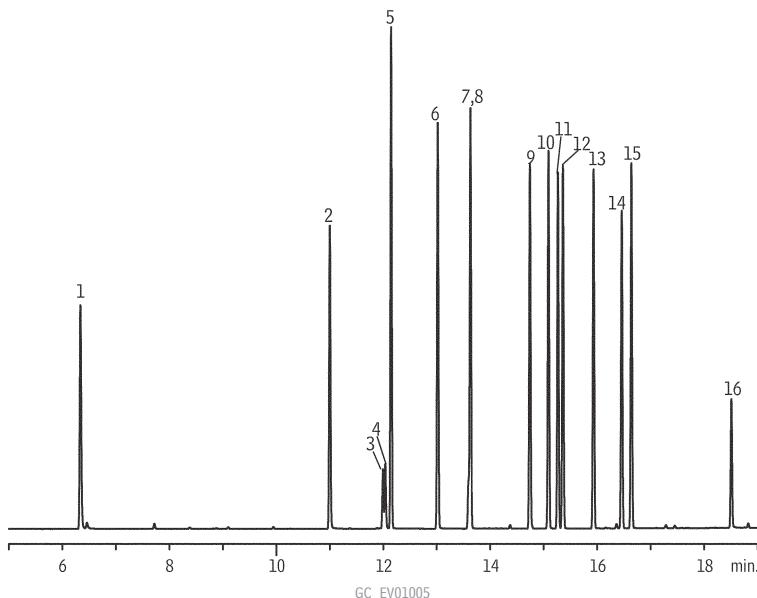
Pesticides & Herbicides
US EPA Method 505
Rtx®-CLPesticides & Rtx®-CLPesticides2



Rtx®-CLPesticides



Rtx®-CLPesticides2



- 1. hexachlorocyclopentadiene
- 2. hexachlorobenzene
- 3. simazine
- 4. atrazine
- 5. γ -BHC
- 6. heptachlor
- 7. alachlor
- 8. aldrin
- 9. heptachlor epoxide
- 10. γ -chlordane
- 11. *trans*-nonachlor
- 12. α -chlordane
- 13. dieldrin
- 14. endrin
- 15. *cis*-nonachlor
- 16. methoxychlor

Column: Rtx®-CLPesticides2, 30m, 0.32mm ID, 0.25 μ m (cat.# 11324) and Rtx®-CLPesticides, 30m, 0.32mm ID, 0.32 μ m (cat.# 11141) with 5m x 0.32mm ID RxI® deactivated guard tubing (cat.# 10039), connected using Universal "Y" Press-Tight® Connector (cat.# 20405-261)
 Sample: 200ng/mL 505 Organohalide Pesticide Mix (cat.# 32204), 4.2 μ g/mL Simazine (cat.# 32236), 4.2 μ g/ml Atrazine (cat.# 32208) in methanol
 Inj.: 2 μ L splitless (hold 0.75 min.), 4mm cyclo double gooseneck liner (cat.# 20896)
 Inj. temp.: 250°C
 Carrier gas: helium, constant flow
 Linear velocity: 40cm/sec. @ 90°C
 Oven temp.: 90°C (hold 1 min.) to 310°C (hold 5 min.) @ 10°C/min.
 Det. temp.: ECD @ 325°C

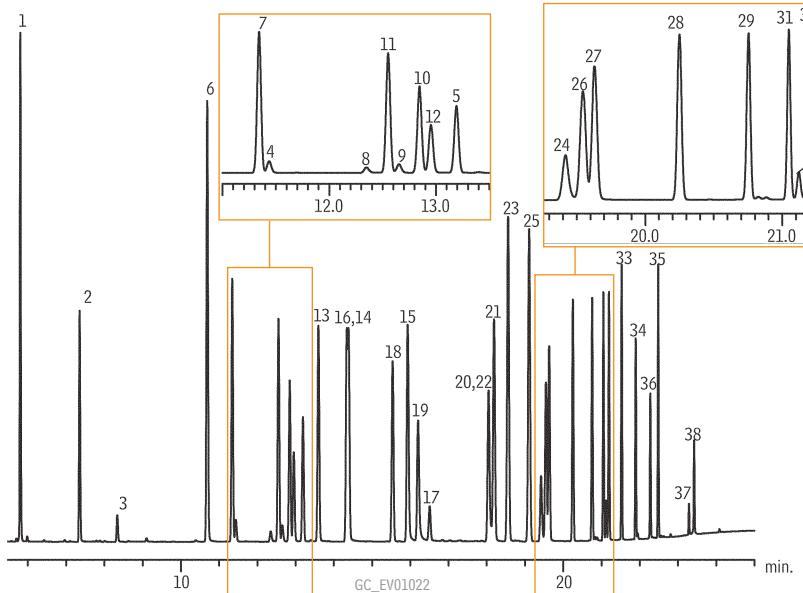


Pesticides & Herbicides

US EPA Method 508.1

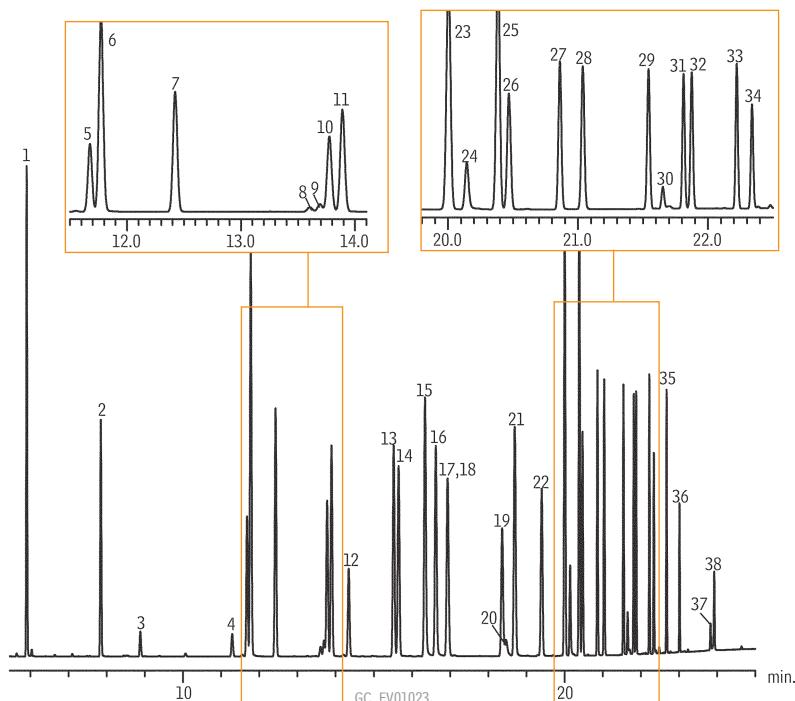
Rtx®-CLPesticides & Rtx®-CLPesticides2

Rtx®-CLPesticides



1. hexachlorocyclopentadiene
2. etridiazole
3. chloroneb
4. propachlor
5. trifluralin
6. hexachlorobenzene
7. α -BHC
8. simazine
9. atrazine
10. pentachloronitrobenzene (IS)
11. γ -BHC
12. β -BHC
13. δ -BHC
14. heptachlor
15. chlorothalonil
16. metribuzin
17. alachlor
18. aldrin
19. 4,4'-dibromobiphenyl (SS)
20. metachlor
21. DCPA
22. heptachlor epoxide
23. γ -chlordane
24. cyanazine
25. α -chlordane
26. endosulfan I
27. 4,4'-DDE
28. dieldrin
29. endrin
30. chlorobenzilate
31. 4,4'-DDD
32. endosulfan II
33. 4,4'-DDT
34. endrin aldehyde
35. endosulfan sulfate
36. methoxychlor
37. *cis*-permethrin
38. *trans*-permethrin

Rtx®-CLPesticides2



Column:

Rtx®-CLPesticides2,
30m, 0.32mm ID, 0.25 μ m (cat.# 11324) and
Rtx®-CLPesticides,
30m, 0.32mm ID, 0.32 μ m (cat.# 11141) with
5m x 0.32mm ID Rtx® deactivated guard tubing
(cat.# 10039), connected using Universal "Y"
Press-Tight® Connector (cat.# 20405-261)

Sample:

50ng/mL 508.1 Calibration Mix #1 (cat.# 32094),
100ng/mL 508.1 Calibration Mix #2 (cat.# 32095),
100ng/mL 508.1 Calibration Mix #3 (cat.# 32096),
50ng/mL 508.1 Internal Standard (cat.# 32091),
250ng/mL 508.1 Surrogate (cat.# 32092),
500ng/mL Atrazine (cat.# 32209),
500ng/mL Simazine (cat.# 32236) in ethyl acetate

Inj.:

2 μ L splitless (hold 0.75 min.), 4mm cyclo double
gooseneck liner (cat.# 20896)

Inj. temp.:

250°C

Carrier gas:

helium, constant flow

Linear velocity:

26cm/sec. @ 80°C

Oven temp.:

80°C (hold 0.5 min.) to 155°C (hold 1 min.) @

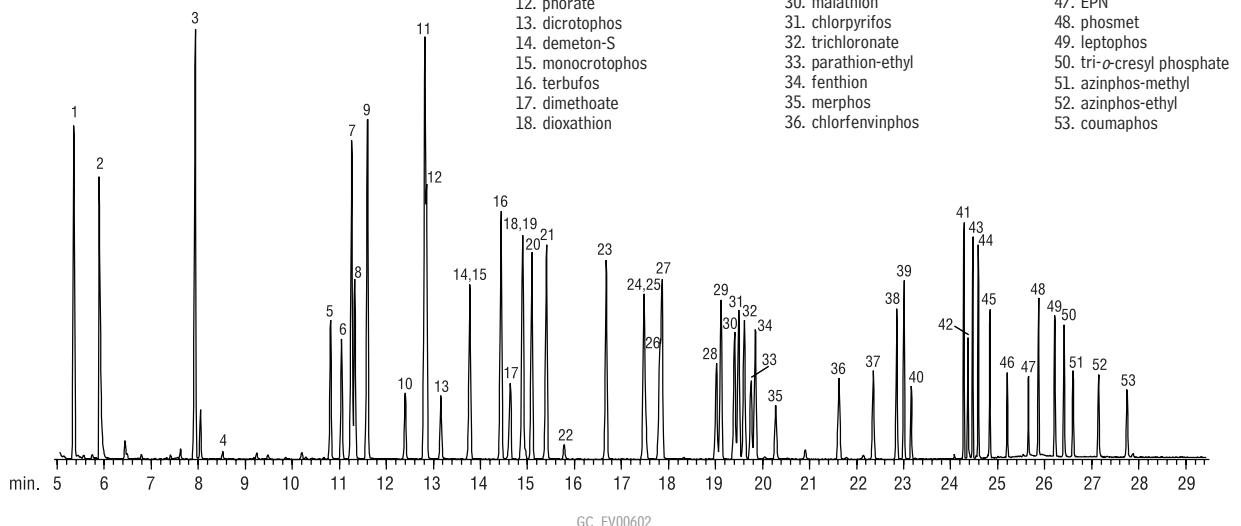
19°C/min. to 210°C @ 4°C/min. to 310°C

(hold 0.5 min.) @ 25°C/min.

Detector temp.: ECD @ 325°C

Organophosphorus Pesticides
US EPA Method 8141A
Rtx®-OPPesticides2

Best column for most resolved compounds for Method 8141A.



Column: Rtx®-OPPesticides2, 30m, 0.25mm ID, 0.25 μ m (cat.# 11243)
Sample: US EPA Method 8141A Custom Standard Mix 1 μ L 100ppm (100ng on column)
Triphenylphosphate Standard (cat.# 32281)
Tributylphosphate Standard (cat.# 32280)
8140/8141 OP Pesticides Calibration Mix A (cat.# 32277)
8141 OP Pesticides Calibration Mix B (cat.# 32278)
Custom Mixes: Call Restek for Information
Inj.: 1.0 μ L splitless (hold 0.4 min.), 4mm double gooseneck inlet liner (cat.# 20785)

Inj. temp.: 250°C
Carrier gas: helium, constant flow
Flow rate: 1.0mL/min.
Oven temp.: 80°C (hold 0.5 min.) to 140°C @ 20°C/min.
to 210°C @ 4°C/min. (hold 1 min.) to 280°C @ 30°C (hold 5 min.)
Det: MS
Transfer line temp.: 280°C
Scan range: 35-400amu
Ionization: EI

for more info

GC Columns for Pesticide Analyses

Choose from 9 capillary GC phases for pesticide analyses and more than 50 combinations of column ID and phase film thickness. For descriptions of special purpose columns, see pages 26-27. To locate a column type in this catalog, see pages 18-19.

Partners in Pesticide Analysis



Please visit www.restek.com/pesticides for information about the ChemService product line.

Organophosphorus Pesticides

US EPA Method 8141A

Rtx[®]-OPPesticides &

Rtx[®]-OPPesticides2

Dual-column injector

GC: splitless, purge on 1.0 min. constant pressure
Oven temp.: 80°C (hold 0.5 min.) to 280°C
(@ 12°C/min. hold 10 min.)

Injector: 200°C

Inlet liner: 4mm Siltek[®] single gooseneck inlet liner

Detector: FPD @ 250°C

Dead time: 1.03 min. @ 80°C

Injection: 1μL US EPA Method 8141A Custom Standard Mixes (100ng/mL)

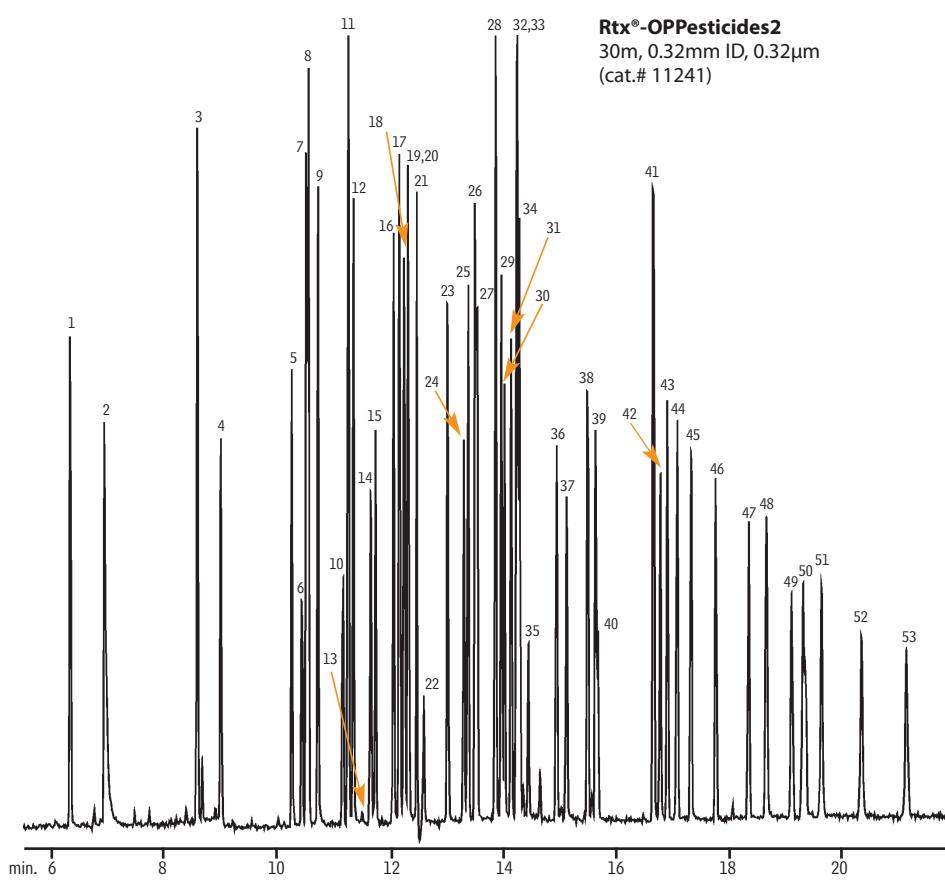
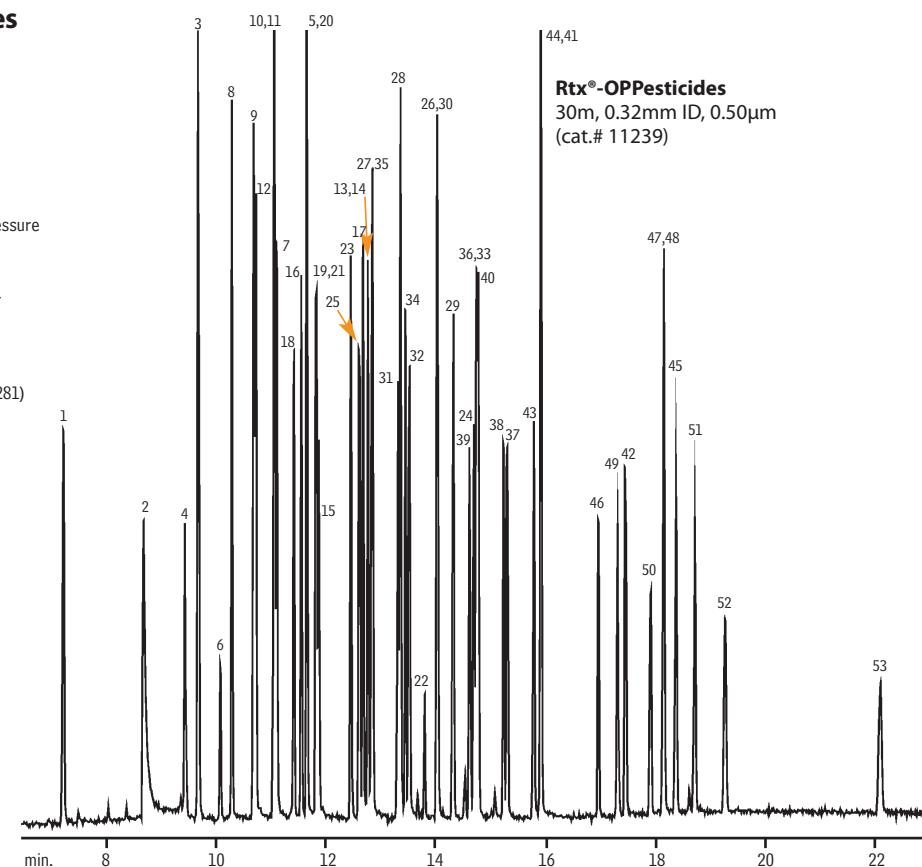
Triphenylphosphate Standard (cat.# 32281)

Tributylphosphate Standard (cat.# 32280)

8140/8141 OP Pesticides Calibration Mix A (cat.# 32277)

8141 OP Pesticides Calibration Mix B (cat.# 32278)

1. dichlorvos
2. hexamethylphosphoramide
3. mevinphos
4. trichlorfon
5. TEPP
6. demeton-O
7. tributyl phosphate (SS)
8. thionazin
9. ethoprop
10. naled
11. sulfotep
12. phorate
13. dicrotophos
14. monocrotophos
15. demeton-S
16. terbufos
17. dimethoate
18. diazinon
19. dioxathion
20. fonophos
21. disulfoton
22. phosphamidon isomer (breakdown product)
23. dichlorofenthion
24. phosphamidon
25. chlorpyrifos methyl
26. parathion-methyl
27. ronnel
28. aspron
29. fenitrothion
30. malathion
31. chlorpyrifos
32. trichloronate
33. parathion-ethyl
34. fenthion
35. merphos
36. chlorenvinphos
37. crotoxyphos
38. stirofos
39. tokuthion
40. merphos oxone (breakdown product)
41. ethion
42. fensulfofenthion
43. bolstar
44. carbophenothion
45. famphur
46. triphenyl phosphate (SS)
47. EPN
48. phosmet
49. leptophos
50. tri-o-cresyl phosphate
51. azinphos-methyl
52. azinphos-ethyl
53. coumaphos



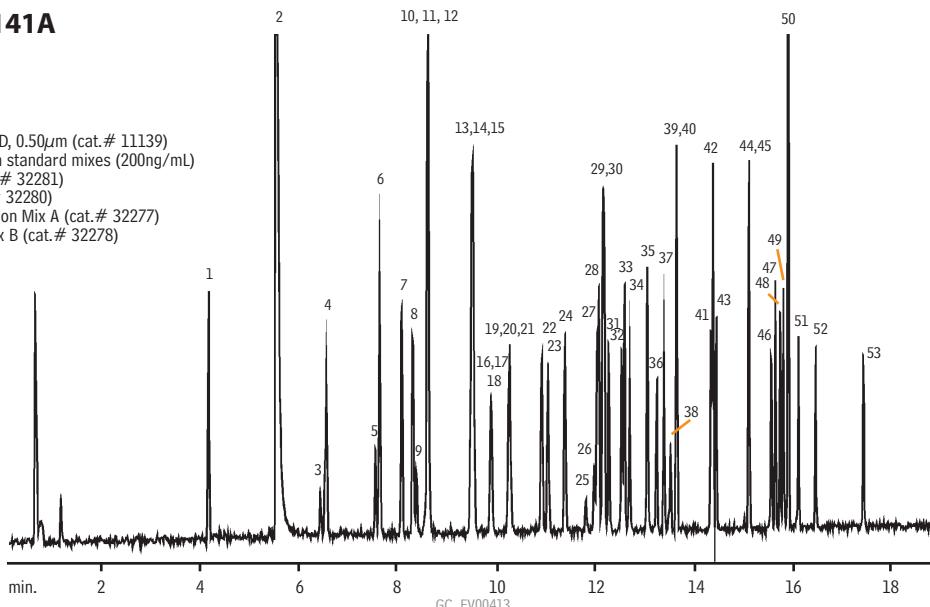
Organophosphorus Pesticides

US EPA Method 8140/8141/8141A

Rtx®-CLPesticides

Column: Rtx®-CLPesticides, 30m, 0.32mm ID, 0.50 μ m (cat.# 11139)
 Sample: 1 μ L US EPA Method 8141A custom standard mixes (200ng/mL)
 Triphenylphosphate Standard (cat.# 32281)
 Tributylphosphate Standard (cat.# 32280)
 8140/8141 OP Pesticides Calibration Mix A (cat.# 32277)
 8141 OP Pesticides Calibration Mix B (cat.# 32278)

Splitless hold time: 1 min.
 Oven temp.: 100°C to 180°C @ 10°C/min.
 (hold 2 min.), to 300°C @ 18°C/min. (hold 3 min.)
 Inj./det. temp.: 250°C/280°C FPD



- | | | | | |
|-----------------------------|----------------------|-------------------------|---------------------|------------------------------|
| 1. dichlorvos | 12. sulfotep | 23. chlorpyrifos methyl | 34. phosphamidon | 45. triphenyl phosphate (SS) |
| 2. hexamethylphosphoramide | 13. demeton-S | 24. ronnel | 35. parathion-ethyl | 46. leptophos |
| 3. trichlorfon | 14. terbufos | 25. phosphamidon isomer | 36. chlорfenvinphos | 47. ethion |
| 4. mevinphos | 15. fonophos | 26. merphos | 37. tokuthion | 48. phosmet |
| 5. demeton-O | 16. dicrotophos | 27. chlorpyrifos | 38. merphos oxone | 49. EPN |
| 6. thionazin | 17. diazinon | 28. fenthion | 39. crotoxyphos | 50. tri-o-cresyl phosphate |
| 7. ethoprop | 18. disulfoton | 29. aspon | 40. stirofos | 51. azinphos-methyl |
| 8. phorate | 19. dioxathion | 30. parathion-methyl | 41. bolstar | 52. azinphos-ethyl |
| 9. naled | 20. monocrotophos | 31. trichloronate | 42. famphur | 53. coumaphos |
| 10. tributyl phosphate (SS) | 21. dimethoate | 32. malathion | 43. carbophenothion | |
| 11. TEPP | 22. dichlorofenthion | 33. fenitrothion | 44. fensulfothion | |

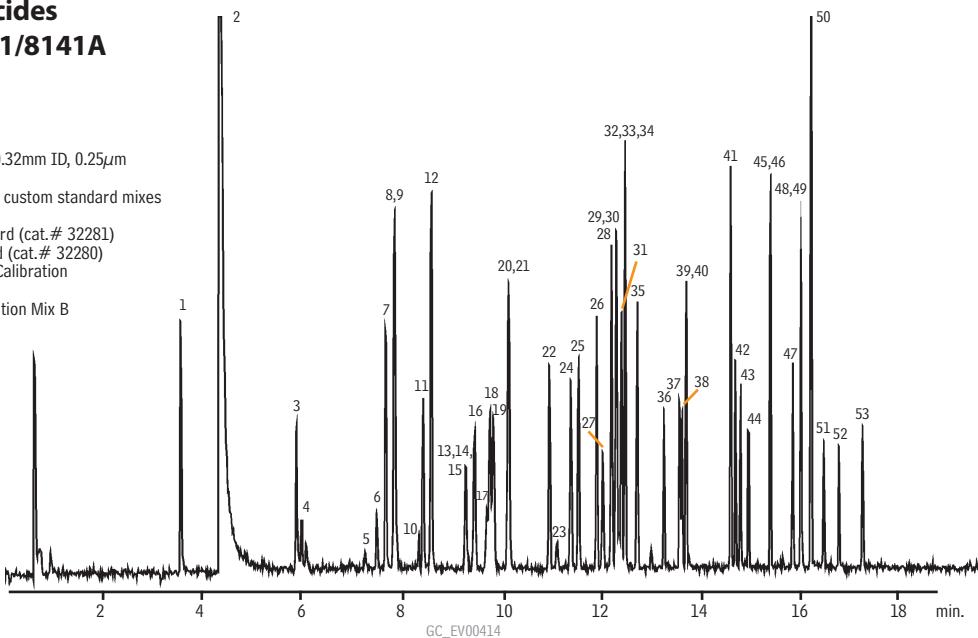
Organophosphorus Pesticides

US EPA Method 8140/8141/8141A

Rtx®-CLPesticides2

Column: Rtx®-CLPesticides2, 30m, 0.32mm ID, 0.25 μ m (cat.# 11324)
 Sample: 1 μ L US EPA Method 8141A custom standard mixes (200ng/mL)
 Triphenylphosphate Standard (cat.# 32281)
 Tributylphosphate Standard (cat.# 32280)
 8140/8141 OP Pesticides Calibration Mix A (cat.# 32277)
 8141 OP Pesticides Calibration Mix B (cat.# 32278)

Splitless hold time: 1 min.
 Oven temp.: 100°C to 180°C @ 10°C/min. (hold 2 min.), to 300°C @ 18°C/min. (hold 3 min.)
 Inj./det. temp.: 250°C/280°C FPD



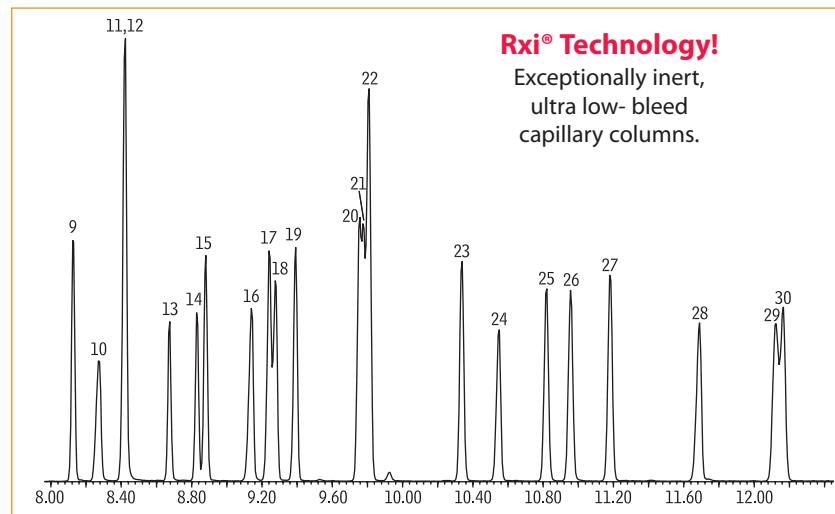
- | | | | | |
|----------------------------|----------------------|-------------------------|---------------------|------------------------------|
| 1. dichlorvos | 12. sulfotep | 23. phosphamidon isomer | 34. malathion | 45. triphenyl phosphate (SS) |
| 2. hexamethylphosphoramide | 13. demeton-S | 24. chlorpyrifos methyl | 35. parathion-ethyl | 46. ethion |
| 3. mevinphos | 14. dicrotophos | 25. ronnel | 36. chlорfenvinphos | 47. EPN |
| 4. trichlorfon | 15. dioxathion | 26. parathion-methyl | 37. crotoxyphos | 48. phosmet |
| 5. demeton-O | 16. terbufos | 27. phosphamidon | 38. tokuthion | 49. leptophos |
| 6. thionazin | 17. monocrotophos | 28. aspon | 39. merphos oxone | 50. tri-o-cresyl phosphate |
| 7. tributyl phosphate (SS) | 18. fonophos | 29. chlorpyrifos | 40. stirofos | 51. azinphos-methyl |
| 8. ethoprop | 19. diazinon | 30. trichloronate | 41. famphur | 52. azinphos-ethyl |
| 9. TEPP | 20. disulfoton | 31. merphos | 42. bolstar | |
| 10. naled | 21. dimethoate | 32. fenitrothion | 43. carbophenothion | |
| 11. phorate | 22. dichlorofenthion | 33. fenthion | 44. fensulfothion | |

Pesticides

Minnesota Ag List 1

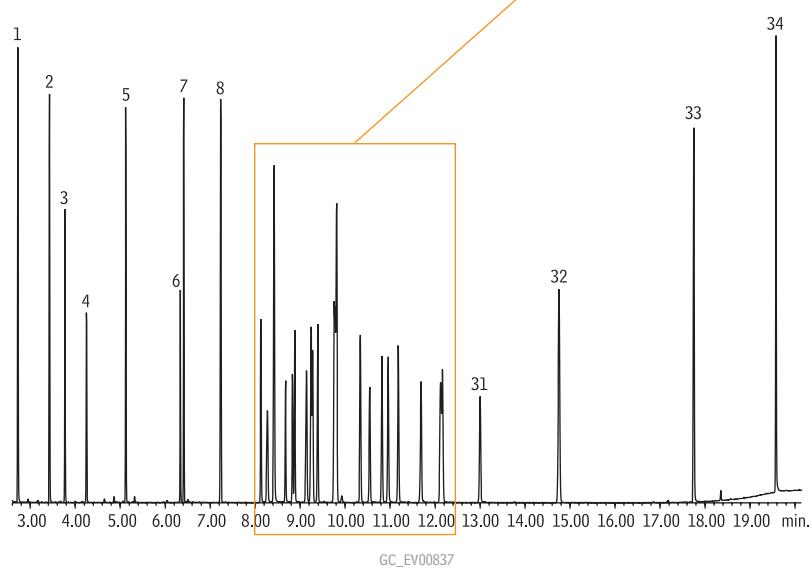
Rxi®-1ms

1. 2-fluorophenol (SS)
2. phenol-d6 (SS)
3. 1,4-dichlorobenzene-d4 (IS)
4. nitrobenzene-d5 (SS)
5. naphthalene-d8 (IS)
6. EPTC
7. 2-fluorobiphenyl (SS)
8. acenaphthene-d10 (IS)
9. propachlor
10. desisopropyl atrazine
11. desethyl atrazine
12. 2,4,6-tribromophenol (SS)
13. ethalfluralin
14. trifluralin
15. phorate
16. simazine
17. prometon
18. atrazine
19. propazine
20. terbufos
21. fonofos
22. phenanthrene-d10 (IS)
23. triallate
24. metribuzin
25. dimethenamid
26. acetochlor
27. alachlor
28. cyanazine
29. metolachlor
30. chlorpyrifos
31. pendimethalin
32. *p*-terphenyl-d14 (SS)
33. chrysene-d12 (IS)
34. perylene-d12 (IS)



Rxi® Technology!

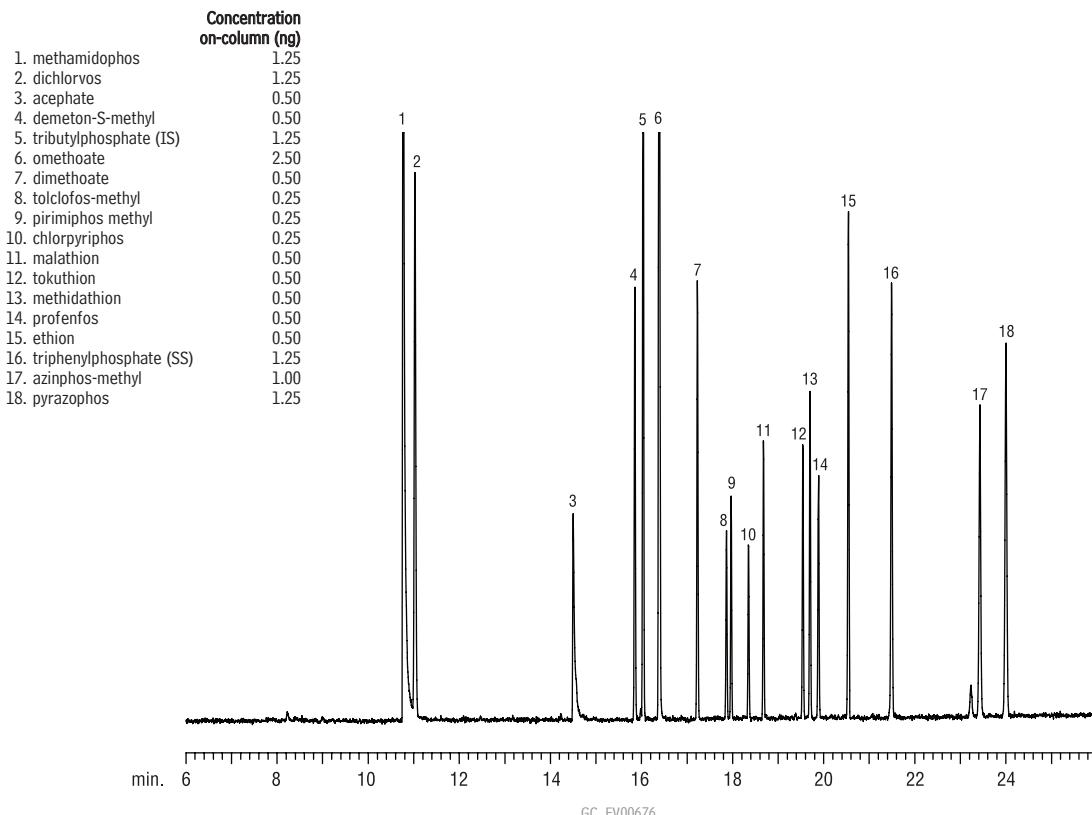
Exceptionally inert,
ultra low- bleed
capillary columns.



GC_EV00837

Column:	Rxi®-1ms, 30m, 0.25mm ID, 0.25μm (cat.# 13323)
Sample:	Minnesota Ag List 1 Pesticides Mix A (cat.# 32406), Minnesota Ag List 1 Pesticides Mix B (cat.# 32407), SV Internal Standard Mix (cat.# 31206), B/N Surrogate Mix (4/89 SOW) (cat.# 31024), Acid Surrogate Mix (4/89 SOW) (cat.# 31025)
Inj.:	1.0μL, 10μg/mL each analyte (internal standards 25μg/mL), split (10:1)
Instrument:	4mm Drilled Uniliner® inlet liner (hole near bottom) (cat.# 20771)
Inj. temp.:	Agilent 6890
Carrier gas:	250°C
Flow rate:	helium, constant flow
Oven temp.:	1.2mL/min.
Det.:	70°C (hold 1 min.) to 180°C @ 20°C/min., to 230°C @ 5°C/min., to 325°C @ 40°C/min. (hold 3.5 min.)
Transfer line temp.:	Agilent 5973 MSD
Scan range:	280°C
Solvent delay:	35-550amu
Tune:	2.50 min.
Ionization:	DFTPP

Organophosphorus Pesticides (European)
Rtx®-CLPesticides



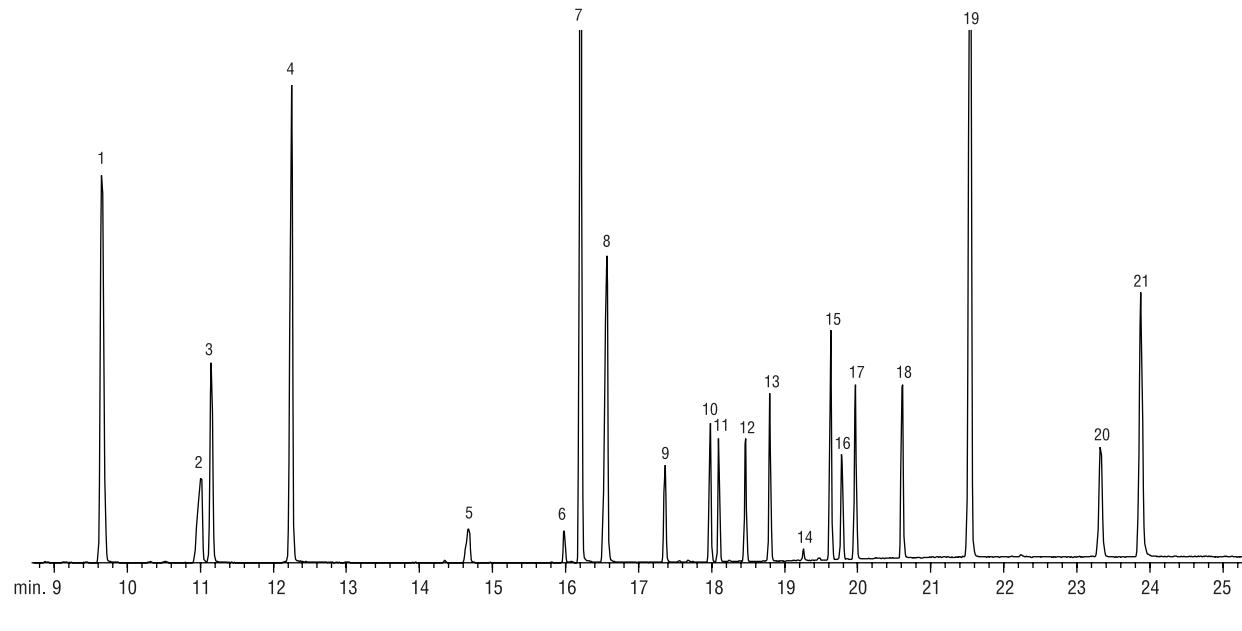
Column: Rtx®-CLPesticides, 30m, 0.32mm ID, 0.50 μ m (cat.# 11139)
 Sample: European OPP Mix (cat.# 32418)
 100–1000 μ g/mL in acetone
 Inj.: 0.5 μ L direct, open-top Siltex® Drilled Uniliner®
 inlet liner (cat.# 21055-214.5)
 Inj. temp.: 250°C
 Carrier gas: helium, constant pressure
 Linear velocity: 35cm/sec. @ 80°C
 Oven temp.: 80°C (hold 1 min.) to 150°C @ 7°C/min.
 to 280°C @ 15°C/min. (hold 10 min.)
 Det.: FPD @ 280°C

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**Organophosphorus Pesticides (European)
Rtx®-CLPesticides**



Column: Rtx®-CLPesticides, 30m, 0.25mm ID, 0.25 μ m (cat.# 11123)
 Sample: Custom European Mix
 1-bromo-2-nitrobenzene (cat.# 32279)
 4-chloro-3-nitrobenzotrifluoride (cat.# 32282)
 tributylphosphate (cat.# 32280)
 triphenylphosphate (cat.# 32281)

Inj.: 1.0 μ L splitless (hold 0.4 min.)
 4mm double gooseneck inlet liner (cat.# 20785)
 Inj. temp.: 250°C
 Carrier gas: helium, constant flow, 6psi head pressure
 Flow rate: 0.75mL/min.
 Linear velocity: 28cm/sec.*
 Dead time: 1.82 min. @ 80°C
 Oven temp.: 80°C (hold 1.0 min.) to 150°C @ 7°C/min. (no hold)
 to 280°C @ 15°C/min. (hold 7 min.)
 Det.: Agilent 5971A GC/MS
 Transfer line temp.: 280°C
 Scan range: 35–400amu
 Solvent Delay 5 min.
 Tune PFTBA
 Ionization: EI

Compound	Conc. on-column (ng)
1. 4-chloro-3-nitro-trifluoride	100
2. methamidophos	50
3. dichlorvos	50
4. 1-bromo-2-nitrobenzene	100
5. acephate	20
6. demeton-S-methyl	20
7. TBP (IS)	100
8. omethoate	100
9. dimethoate	20
10. tolclofos-methyl	10
11. pirimiphos methyl	10
12. chlorpyrifos	10
13. malathion	20
14. quinalphos	10
15. tokuthion (prothiofos)	20
16. methidathion	20
17. profenfos	20
18. ethion	20
19. TPP (SS)	100
20. azinphos-methyl	40
21. pyrazophos	50

a plus 1 story

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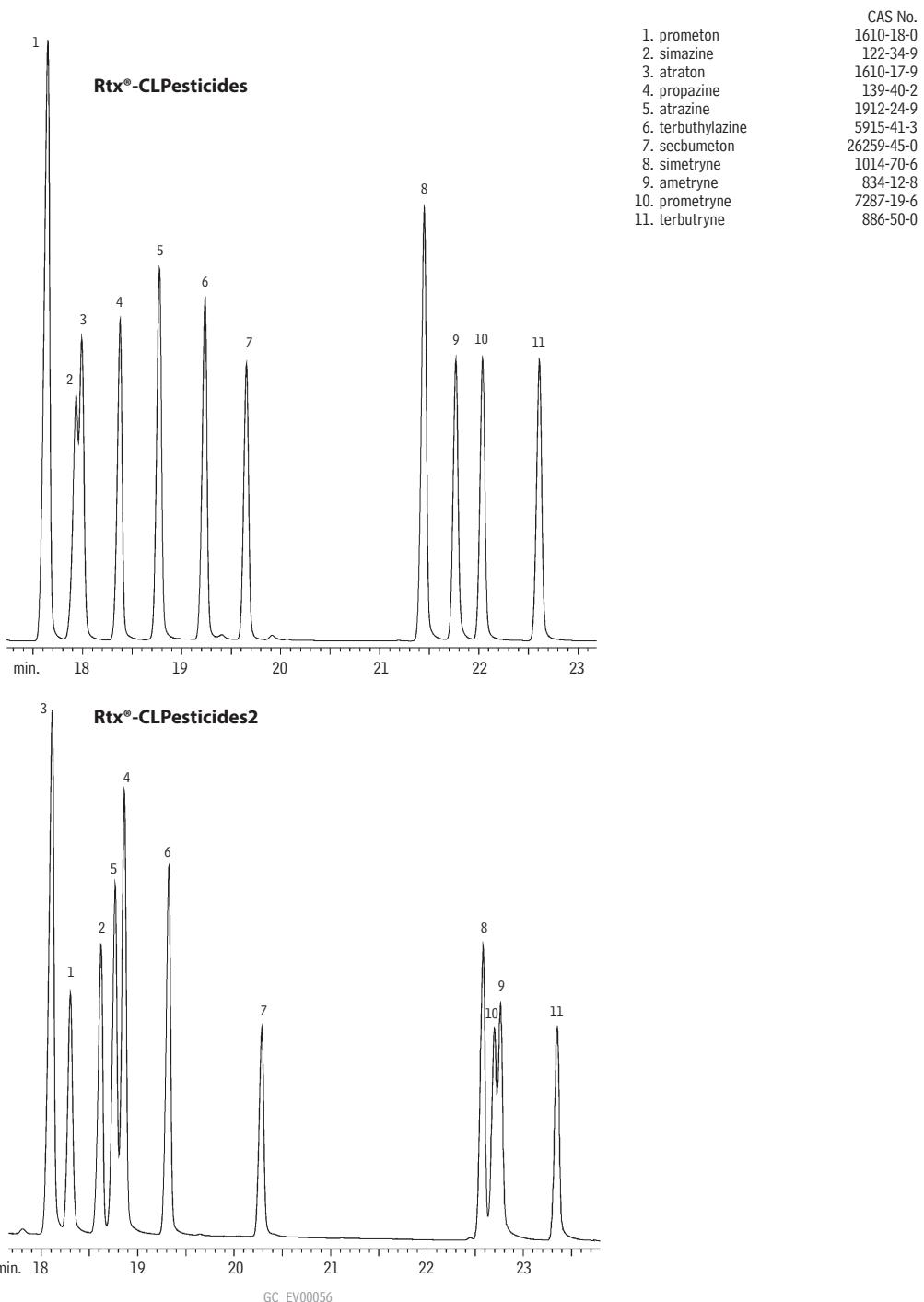
John T. Brunette, Chemist, Bausch & Lomb

GC APPLICATIONS | ENVIRONMENTAL
Pesticides/Herbicides

Nitrogen/Phosphorus Pesticides & Herbicides

US EPA Method 619

Rtx®-CLPesticides & Rtx®-CLPesticides2 (dual column analysis)



Columns: Rtx®-CLPesticides, 30m, 0.32mm ID, 0.50 μ m (cat.# 11139) and Rtx®-CLPesticides2, 30m, 0.32mm ID, 0.25 μ m (cat.# 11324)
 with a 5m, 0.32mm ID guard column (cat.# 10044) and a "Y" Press-Tight® connector (cat.# 20403)
 Inj.: Direct injection using a Uniliner® inlet liner (cat.# 21303) and adaptor for an Agilent 5890 (cat.# 20964)
 Conc.: On-column, 50pg each compound
 Oven temp.: 100°C (hold 0 min.) to 250°C @ 4°C/min. (hold 5 min.)
 Inj./det. temp.: 250°C/275°C
 Carrier gas: hydrogen, 9.65psi constant pressure
 GC: Agilent 6890 with purged packed injection port

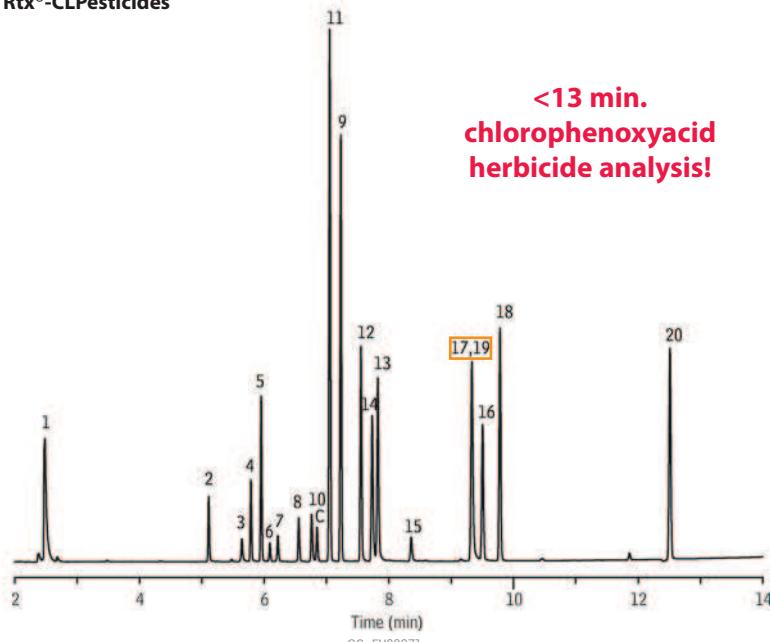


Herbicides

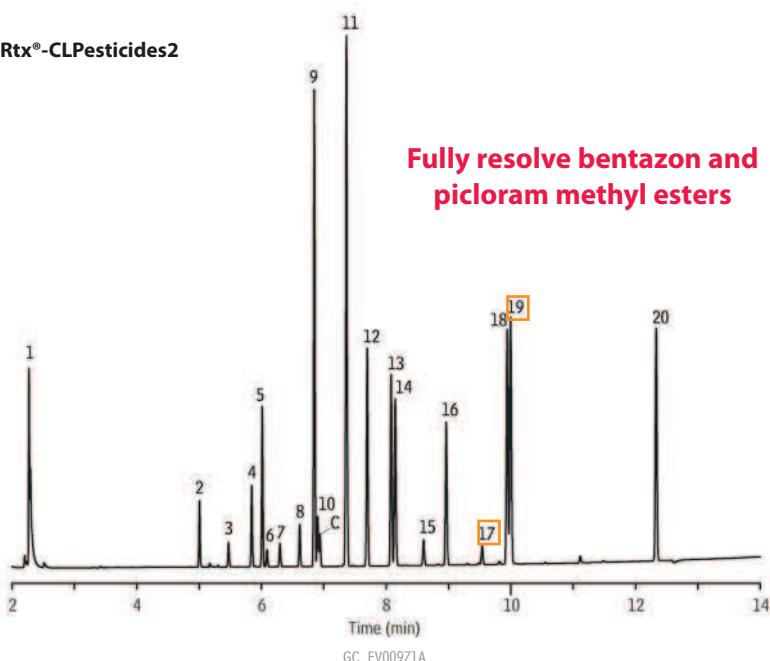
US EPA Method 8151A

Rtx®-CLPesticides & Rtx®-CLPesticides2

Rtx®-CLPesticides



Rtx®-CLPesticides2



1. dalapon methyl ester
2. 3,5-dichlorobenzoic acid methyl ester (SS)
3. 4-nitroanisole
4. DCAA methyl ester (SS)
5. dicamba methyl ester
6. MCPP methyl ester
7. MCPA methyl ester
8. dichlorprop methyl ester
9. 4,4'-DBOB (IS)
10. 2,4-D methyl ester
11. pentachloroanisole
12. 2,4,5-TP methyl ester
13. 2,4,5-T methyl ester
14. chloramben methyl ester
15. 2,4-DB methyl ester
16. dinoseb methyl ester
17. bentazon methyl ester
18. DCPA
19. picloram methyl ester
20. acifluorfen methyl ester
- C. contaminant

Column: Rtx®-CLPesticides2, 30m, 0.32mm ID, 0.25 μ m (cat.# 11324) and Rtx®-CLPesticides, 30m, 0.32mm ID, 0.32 μ m (cat.# 11141), with 5m x 0.32mm ID Rtx® deactivated guard tubing (cat.# 10039), connected using Deactivated Universal "Y" Press-Tight® Connector (cat.# 20405-261)

Sample: 200ng/mL Herbicide Mix #1 (cat.# 32055) in hexane 1,000ng/mL Herbicide Mix #2 (cat.# 32057) in hexane

20,000ng/mL Herbicide Mix #3 (cat.# 32059) in hexane 200ng/mL Herbicide Mix #4 (cat.# 32062) in hexane

250ng/mL Herbicide Internal Standard (cat.# 32053) in hexane

400ng/mL Herbicide Surrogate (cat.# 32050) in hexane

Inj.: 1.0 μ L splitless (hold 0.75 min.), 4mm Cyclo Double Gooseneck inlet liner (cat.# 20895)

Inj. temp.: 250°C

Carrier gas: helium, constant pressure

Flow rate: 36cm/sec. @ 70°C

Oven temp.: 70°C (hold 0.5 min.) to 190°C @ 25°C/min. (hold 1 min.) to 300°C @ 11°C/min. (hold 5 min.)

Det.: ECD @ 325°C

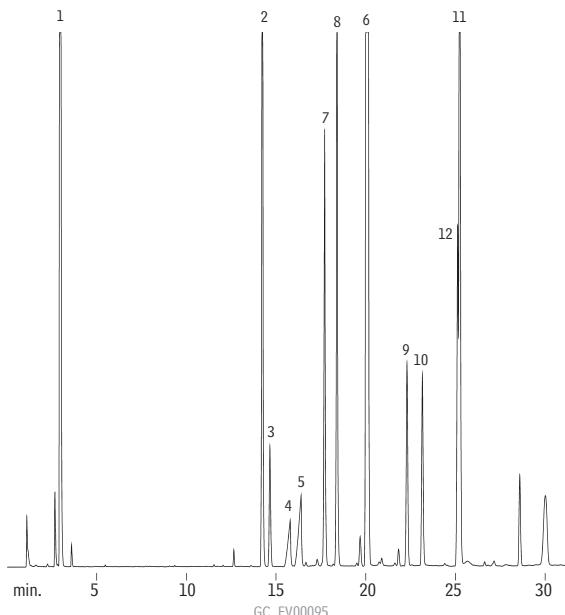
Chlorophenoxyacid Herbicides

US EPA Method 615

Rtx®-5

**Analysis optimized
using Pro ezGC
software!**

1. dalapon
2. DCAA (SS)
3. dicamba
4. MCPP
5. MCPA
6. DBOB (IS)
7. dichlorprop
8. 2,4-D
9. 2,4,5-TP
10. 2,4,5-T
11. dinoseb
12. 2,4-DB



Column: Rtx®-5, 30m, 0.53mm ID, 0.50μm (cat.# 10240)
 Sample: 0.5μL direct injection of chlorophenoxy herbicides,
 on-column concentration 10–10,000μg/mL
 Oven temp.: 60°C to 150°C @ 8°C/min. (hold 5 min.),
 to 210°C @ 4°C/min.
 Inj./det. temp.: 250°C/275°C
 Carrier gas: helium
 Linear velocity: 35cm/sec. set @ 60°C
 Det.: ECD w/anode purge

Pro ezGC Methods Development Software

- Optimize temperature and flow programs with a single analysis.
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- Model retention gap and guard column applications, including Restek Integrator Guard™ columns.
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Take the guesswork out of selecting the best column and conditions for your GC analysis. Pro ezGC software accurately predicts separations on any capillary column, and is useful for selecting a column and conditions from a single GC run. Using your retention data, or the extensive library, you can automatically evaluate thousands of combinations of column dimensions, oven temperature programs, and carrier gas pressure programs to determine the best separation with the fastest analysis time.

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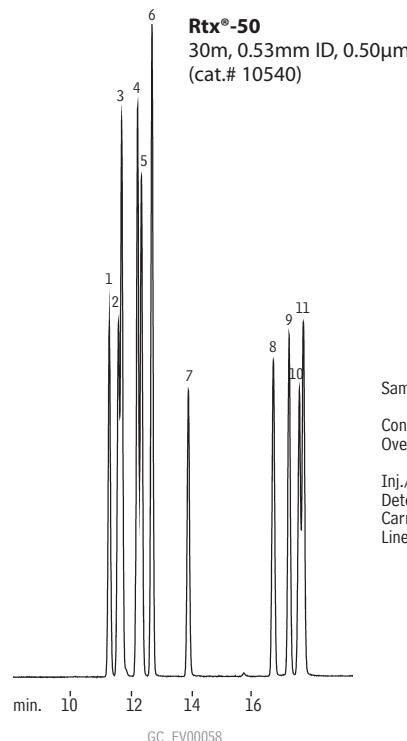
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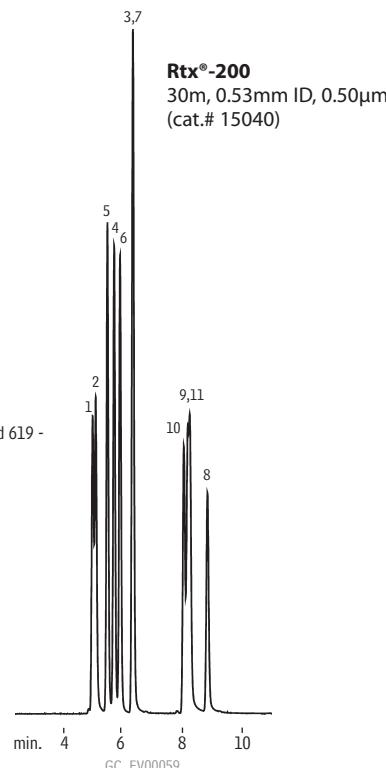
Triazine Herbicides

US EPA Method 619

Rtx®-50, Rtx®-200



- 1. atraton
- 2. prometon
- 3. terbutylazine
- 4. atrazine
- 5. simazine
- 6. propazine
- 7. secbumeton
- 8. terbutryne
- 9. ametryne
- 10. simetryne
- 11. prometryne



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Hanna Rutter, Customer Service

Nitrogen-Containing Herbicides

Rtx®-35



Column: Rtx®-35, 30m, 0.53mm ID, 0.50 μ m (cat.# 10440)
Inj.: 0.2 μ L direct injection, Uniliner® inlet liner,
approximately 10ng per component.
Oven temp.: 60°C (hold 1 min.) to 290°C
@ 15°C/min. (hold 5 min.)
Inj./det. temp.: 290°C
Carrier gas: helium
Linear velocity: 40cm/sec. (flow rate: 5.2cc/min.)
FID sensitivity: 16 x 10⁻¹¹ AFS

18,19

- | | |
|---------------|----------------|
| 1. Eptam® | 12. atrazine |
| 2. Sutan® | 13. simazine |
| 3. Vernam | 14. terbacil |
| 4. Tillam | 15. Sencor® |
| 5. Ordram® | 16. Dual® |
| 6. Treflan® | 17. Paarlan |
| 7. Balan® | 18. Prowl |
| 8. Ro-Neet | 19. bromacil |
| 9. propachlor | 20. oxadiazon |
| 10. Tolban | 21. GOAL® |
| 11. propazine | 22. hexazinone |

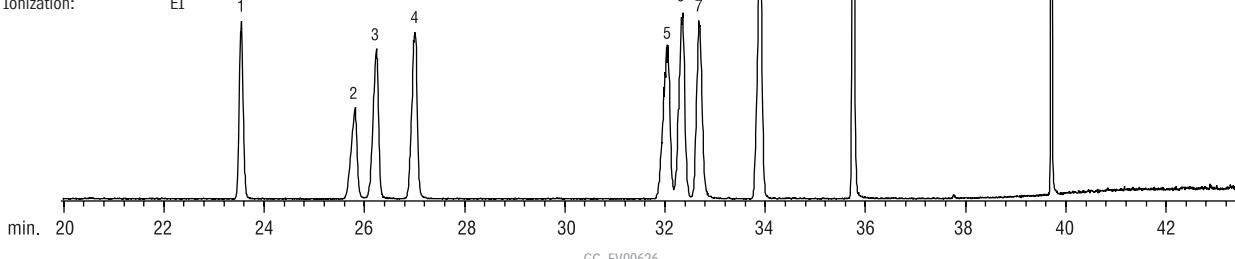
GC_EV00088

Triazine Herbicides (French) & Degradation Products

Rtx®-OPPesticides2

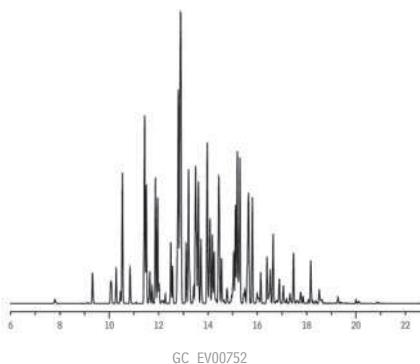
Peak List:	CAS#
1. trifluralin	1582-09-8
2. desisopropylatrazine	1007-28-9
3. desethyl-atrazine	6190-65-4
4. desethyl-terbutylazine	—
5. simazine	122-34-9
6. atrazine	1912-24-9
7. terbumeton	33693-04-8
8. terbutylazine	5915-41-3
9. secbumeton	26259-45-0
10. cyanazine	21725-46-2

Column: Rtx®-OPPesticides2, 30m, 0.25mm ID, 0.25 μ m (cat.# 11243)
Sample: custom standard, 100ng/ μ L each component
Inj.: 1.0 μ L splitless (hold 0.5 min.), 4mm single gooseneck inlet liner (cat.# 20904)
Inj. temp.: 300°C
Carrier gas: helium, constant pressure
Flow rate: 1.0mL/min. @ 80°C (27.22cm/sec.)
Oven temp.: 80°C (hold 1 min.) to 140°C @ 25°C/min. (hold 5 min.) to 165°C @ 1°C/min. to 300°C @ 15°C (hold 1 min.)
Det: Agilent 5971A GC/MS
Transfer line temp.: 280°C
Scan range: 35-360amu
Ionization: EI



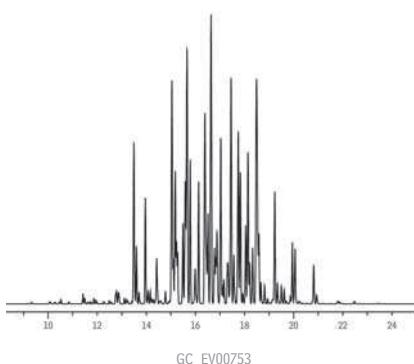
GC_EV00626

Aroclor 1242 PCBs
Rtx®-PCB



Sample: 200ng/mL Aroclor 1242 (cat.# 32009)

Aroclor 1254 PCBs
Rtx®-PCB



Sample: 200ng/mL Aroclor 1254 (cat.# 32011)

Column: Rtx®-PCB, 30m, 0.25mm ID, 0.25 μ m (cat.# 13223)

Inj.: 1.0 μ L splitless (hold 0.75 min.), 3.5mm ID single gooseneck inlet liner (cat.# 20962)

Inj. temp.: 250°C

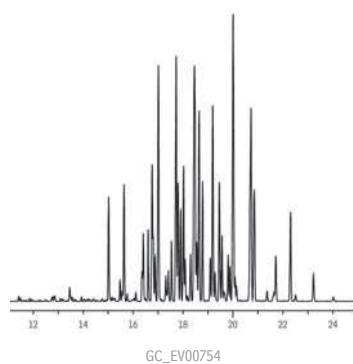
Carrier gas: hydrogen, constant pressure

Linear velocity: 71cm/sec. @ 110°C

Oven temp.: 100°C (hold 1.0 min.) to 300°C @ 10°C/min. (hold 4 min.)

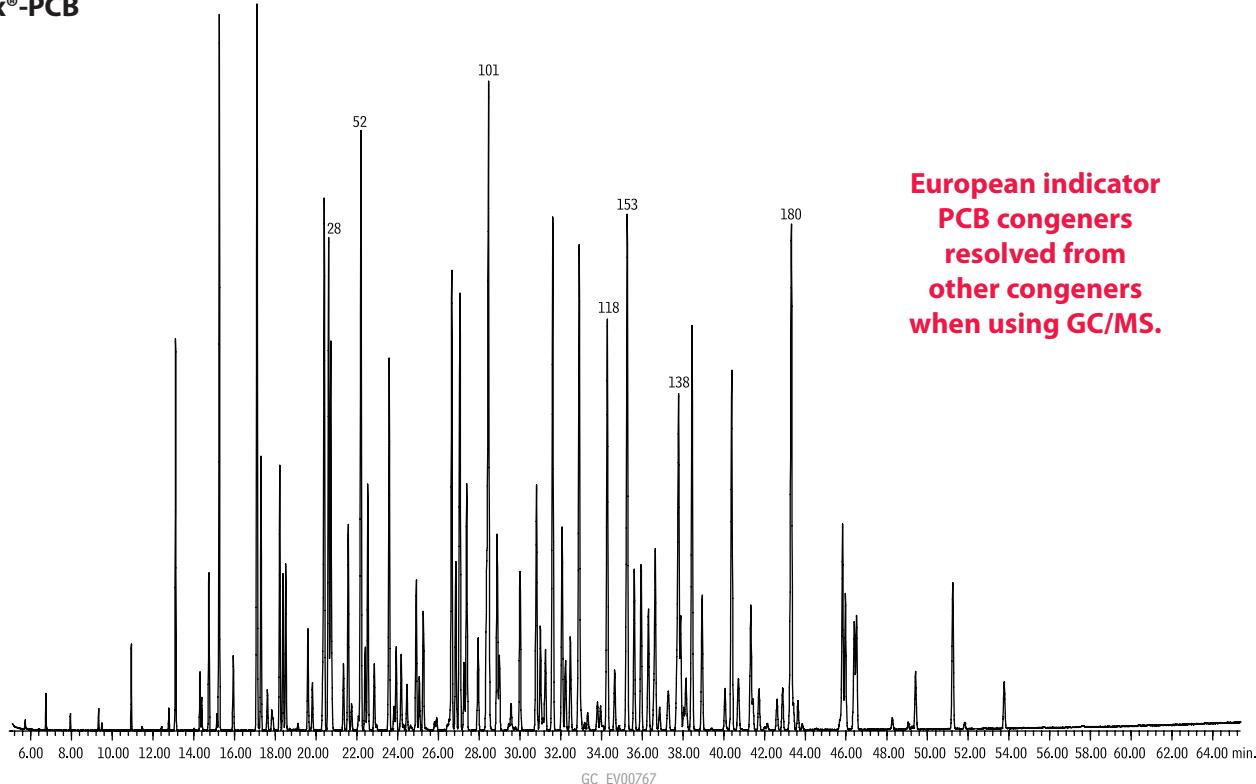
Det.: ECD @ 310°C

Aroclor 1260 PCBs
Rtx®-PCB



Sample: 200ng/mL Aroclor 1260 (cat.# 32012)

Aroclor 1242/1254/1262 PCBs
Rtx®-PCB



Column: Rtx®-PCB, 60m, 0.25mm ID, 0.25 μ m (cat.# 13226)

Sample: Aroclor 1242 (cat.# 32009), 1254 (cat.# 32011), 1262 (cat.# 32409), 333ppm each

Inj.: 1.0 μ L splitless (hold 0.75 min.), 4mm single gooseneck inlet liner w/wool (cat.# 22405)

Inj. temp.: 280°C

Carrier gas: helium, constant flow

Flow rate: 1.1ml/min.

Oven temp.: 100°C (hold 1 min.) to 200°C @ 30°C/min., to 320°C @ 2°C/min. (hold 1 min.)

Det.: MS

Transfer line temp.: 280°C

Scan range: 50 to 550amu

Ionization: EI

Mode: scan

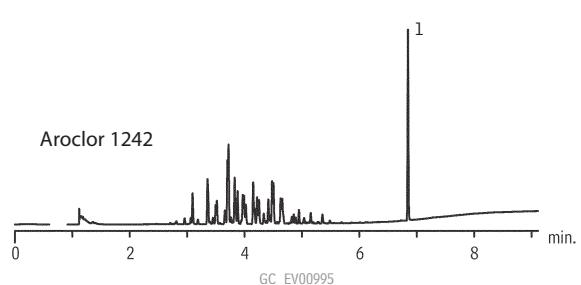
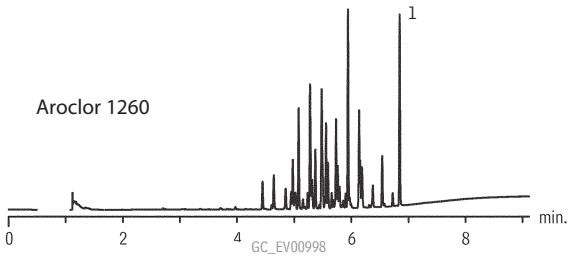
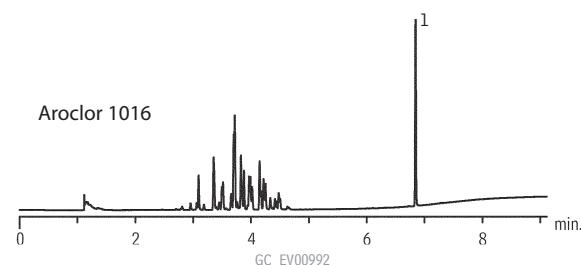
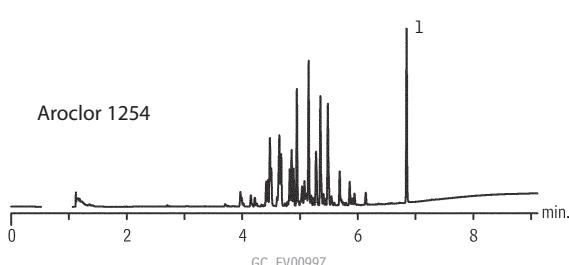
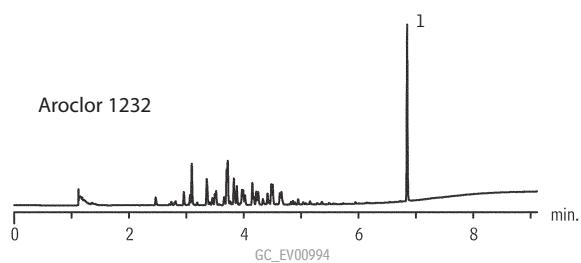
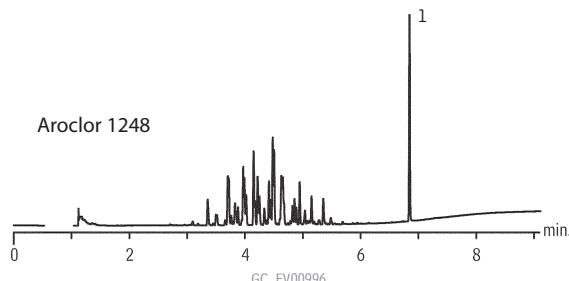
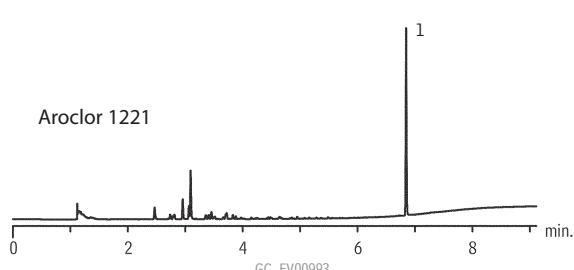
Aroclor PCBs
Rtx-CLPesticides



Rtx®-CLPesticides

30m, 0.32mm ID, 0.32µm (cat.# 11141)

1. decachlorobiphenyl (DCB)



Column: Rtx®-CLPesticides, 30m, 0.32mm ID, 0.32µm (cat.# 11141)
 Sample: 1,000µg/mL each Aroclor compound in hexane diluted to 1,000ppb,
 decachlorobiphenyl (BZ #209) 200µg/mL in acetone (cat.# 32029)
 diluted to 100ppb
 Inj.: 1.0µL pulsed splitless @ 30psi (hold 0.3 min.),
 4mm cyclo double gooseneck inlet liner (cat.# 20895)
 Inj. temp.: 250°C
 Carrier gas: helium, constant flow
 Linear velocity: 60cm/sec. @ 120°C
 Oven temp.: 120°C to 200°C @ 45°C/min. to 230°C @ 15°C/min.
 to 330°C (hold 2 min.) @ 30°C/min.
 Det.: ECD @ 330°C

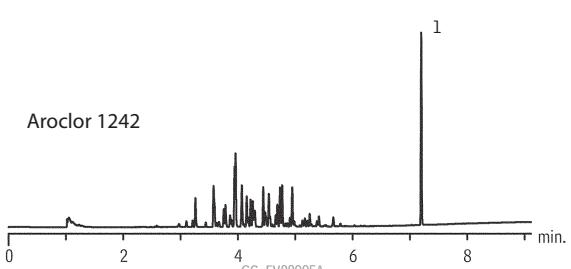
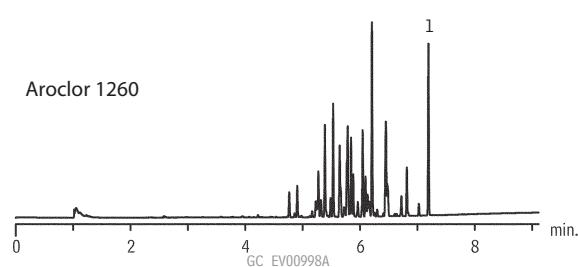
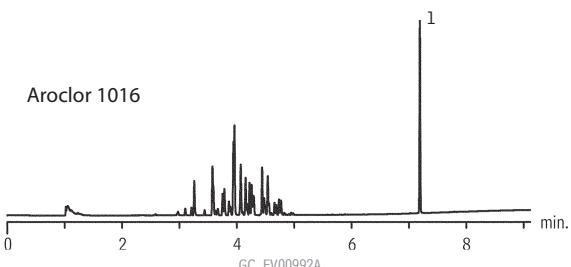
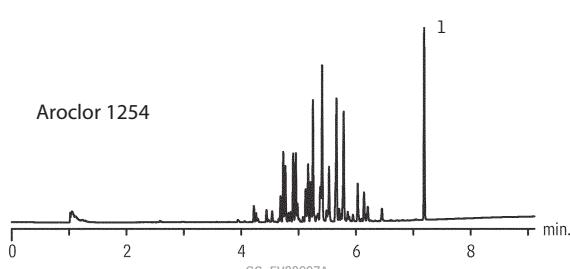
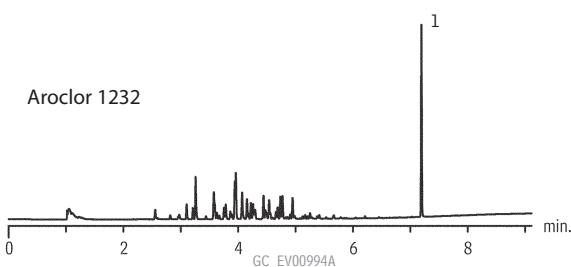
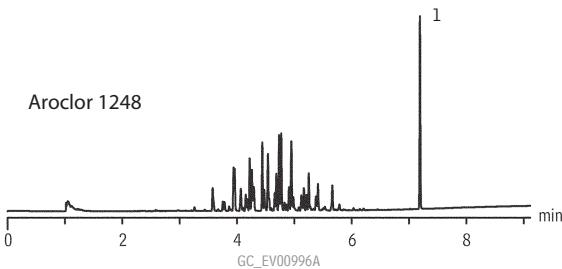
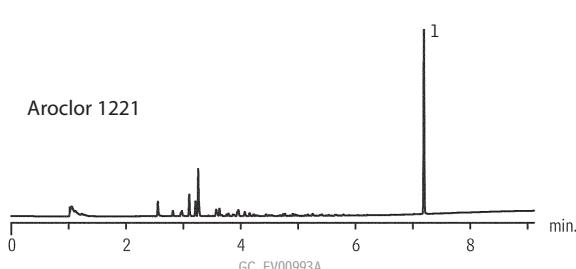


Aroclor PCBs
Rtx-CLPesticides2

Rtx®-CLPesticides2

30m, 0.32mm ID, 0.25µm (cat.# 11324)

1. decachlorobiphenyl (DCB)



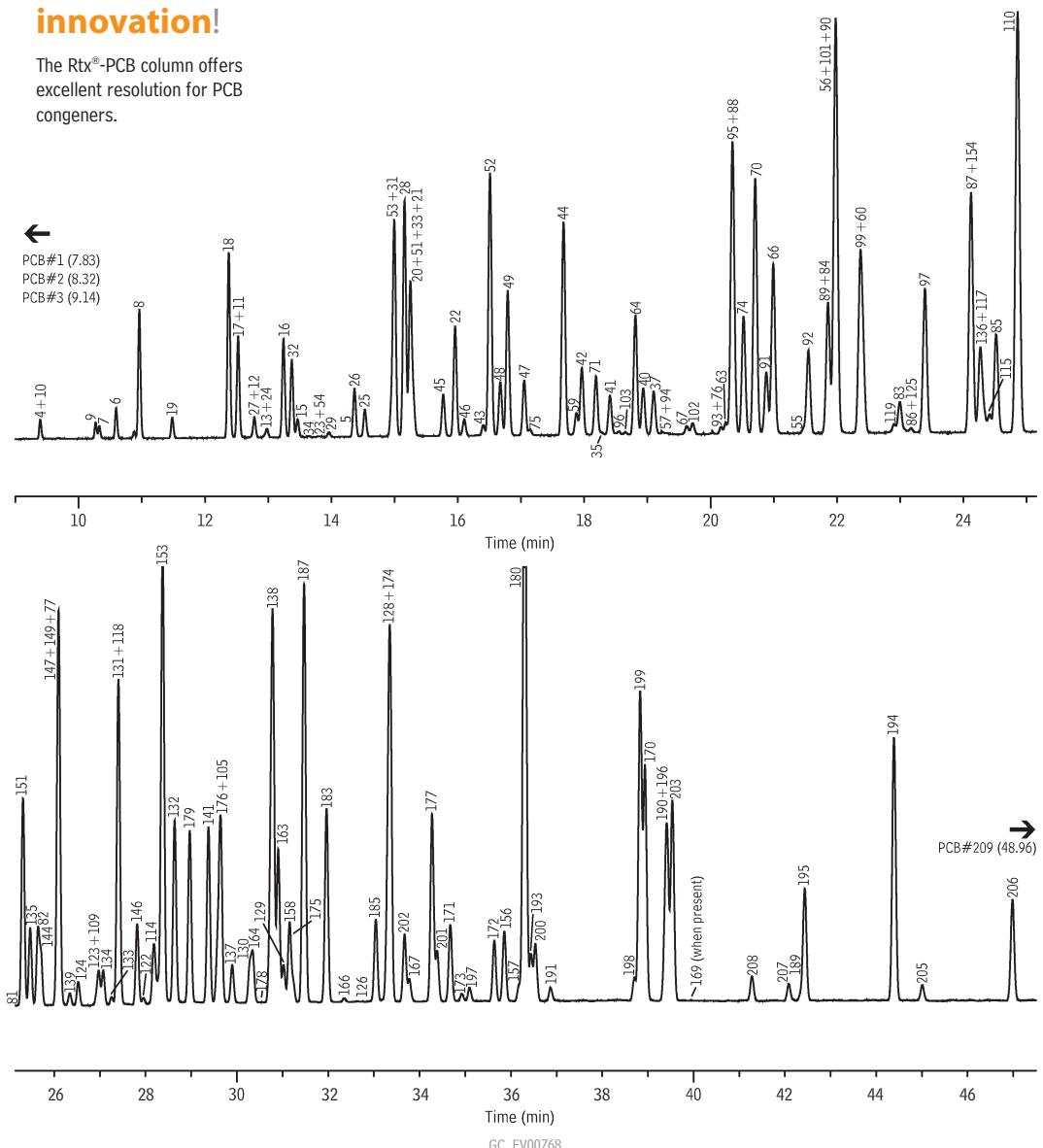
Column: Rtx®-CLPesticides2, 30m, 0.32mm ID, 0.25µm (cat.# 11324)
 Sample: 1,000µg/mL each Aroclor compound in hexane diluted to 1,000ppb,
 decachlorobiphenyl (BZ #209) 200µg/mL in acetone (cat.# 32029)
 diluted to 100ppb
 Inj.: 1.0µL pulsed splitless @ 30psi (hold 0.3 min.),
 4mm cyclo double gooseneck inlet liner (cat.# 20895)
 Inj. temp.: 250°C
 Carrier gas: helium, constant flow
 Linear velocity: 60cm/sec. @ 120°C
 Oven temp.: 120°C to 200°C @ 45°C/min. to 230°C @ 15°C/min.
 to 330°C (hold 2 min.) @ 30°C/min.
 Det.: ECD @ 330°C

GC APPLICATIONS | ENVIRONMENTAL
PCB Mixtures

Aroclor 1242/1254/1262 PCBs
Rtx®-PCB

restek
innovation!

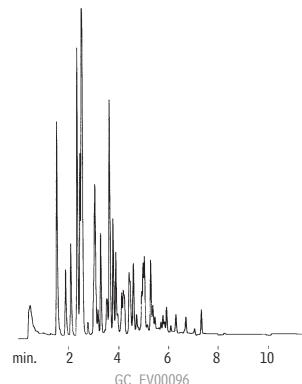
The Rtx®-PCB column offers excellent resolution for PCB congeners.



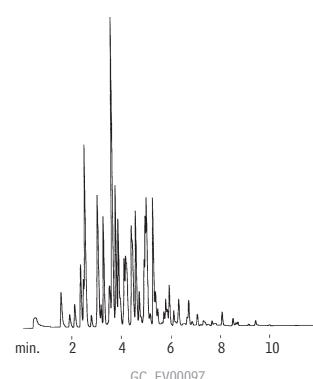
Column: Rtx®-PCB, 40m, 0.18mm ID, 0.18 μ m (cat.# 41303)
 Sample: 300ng/mL Aroclor 1242/1254/1262 in hexane: Aroclor 1242 (cat.# 32009),
 Aroclor 1254 (cat.# 32011), Aroclor 1262 (cat.# 32409)
 Inj.: 1.0 μ L splitless (hold 0.75 min.), 4mm single gooseneck inlet liner (cat.# 20983)
 Inj. temp.: 230°C
 Carrier gas: hydrogen, constant pressure
 Linear velocity: 40cm/sec. @ 100°C
 Oven temp.: 100°C (hold 1 min.) to 200°C @ 30°C/min., to 320°C @ 2°C/min. (hold 1 min.)
 Det.: ECD @ 330°C

Aroclor PCBs (Quick Screening)
Rtx®-5

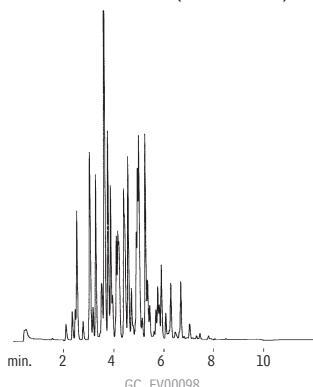
Aroclor 1221 Mix (cat.# 32007)



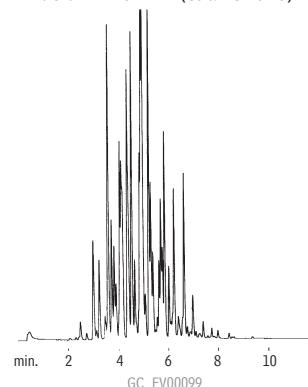
Aroclor 1232 Mix (cat.# 32008)



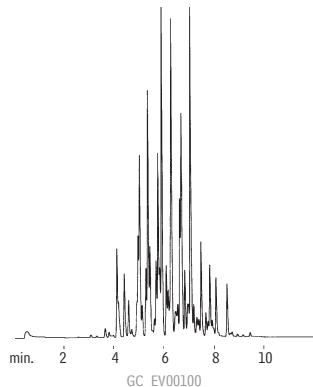
Aroclor 1242 Mix (cat.# 32009)



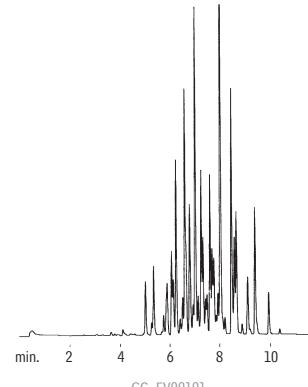
Aroclor 1248 Mix (cat.# 32010)



Aroclor 1254 Mix (cat.# 32011)



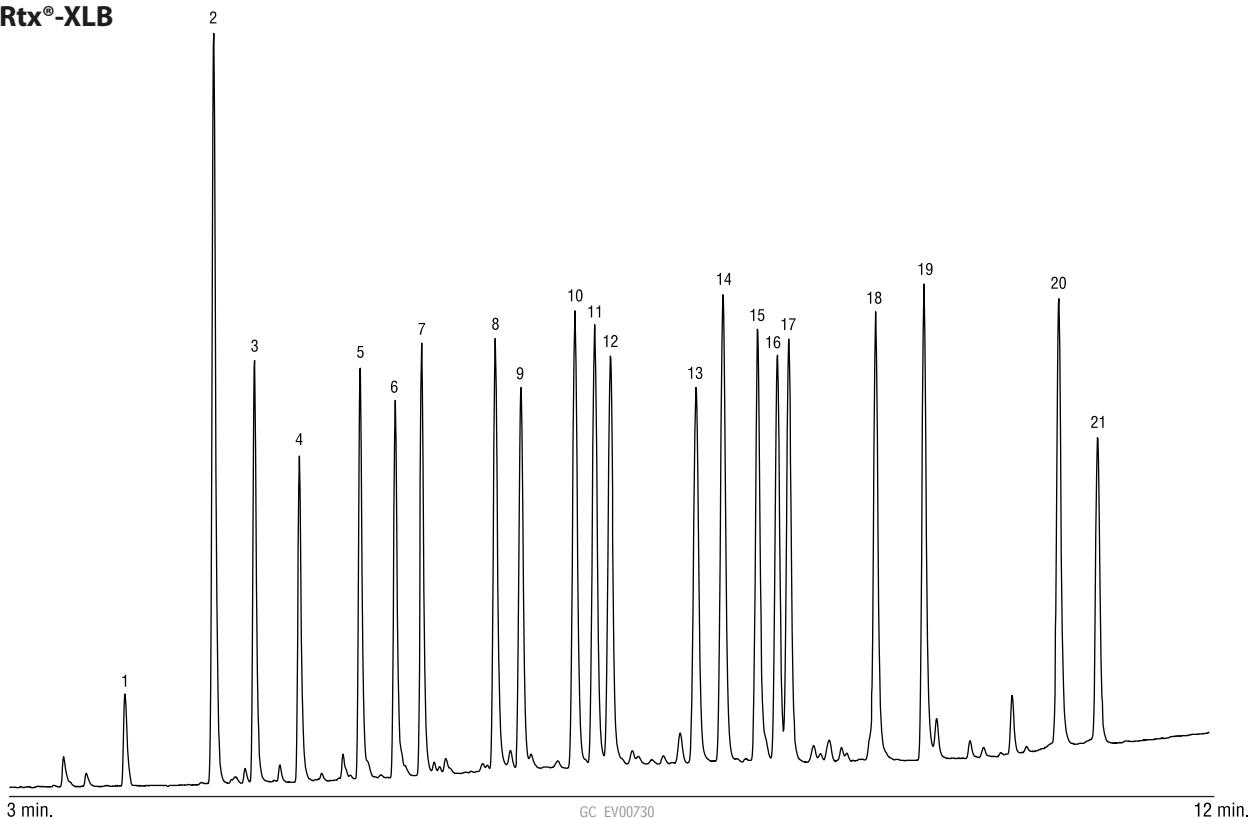
Aroclor 1260 Mix (cat.# 32012)



Column: Rtx®-5, 15m, 0.53mm ID, 0.50µm (cat.# 10237)
Inj.: 1.0µL direct injection
Conc.: 50ppm
Oven temp.: 150°C to 300°C @ 12°C/min. (hold 5 min.)
Inj./det. temp.: 250°C/310°C
Carrier gas: helium
Linear velocity: 30cm/sec. set @ 150°C
ECD sensitivity: 16kHz full scale

PCB Congeners

Rtx®-XLB



Column: Rtx®-XLB, 30m, 0.32mm ID, 0.50 μ m (cat.# 12839)
 Sample: 200ppb each PCB congener in hexane (cat.# 32416), 200ppb 2,4,5,6-tetrachloro-*m*-xylene (SS) (cat.# 32027), 100ppb decachlorobiphenyl (IS) (cat.# 32289)
 Inj.: 1.0 μ L splitless (hold 0.75 min.), 4mm Drilled Uniliner® inlet liner (cat.# 21055)
 Inj. temp.: 220°C
 Carrier gas: hydrogen, constant pressure
 Linear velocity: 66cm/sec. @ 120°C
 Oven temp.: 120°C (hold 0.5 min.) to 260°C @ 29°C/min. (hold 2.5 min.), to 330°C @ 28°C/min. (hold 5 min.)
 Det.: ECD @ 320°C

Compound	RT (min.)
1. 2-chlorobiphenyl	3.86
2. 2,4,5,6-tetrachloro- <i>m</i> -xylene (SS)	4.53
3. 2,3-dichlorobiphenyl	4.83
4. 2,2',5-trichlorobiphenyl	5.17
5. 2,4',5-trichlorobiphenyl	5.63
6. 2,2',5,5'-tetrachlorobiphenyl	5.89
7. 2,2',3,5'-tetrachlorobiphenyl	6.09
8. 2,3',4,4'-tetrachlorobiphenyl	6.64
9. 2,2',4,5,5'-pentachlorobiphenyl	6.84
10. 2,2',3,4,5-pentachlorobiphenyl	7.24
11. 2,3,3',4,6-pentachlorobiphenyl	7.39
12. 2,2',3,5,5',6-hexachlorobiphenyl	7.51
13. 2,2',4,4',5,5'-hexachlorobiphenyl	8.15
14. 2,2',3,4,4',5-hexachlorobiphenyl	8.35
15. 2,2',3,4,4',5-hexachlorobiphenyl	8.61
16. 2,2',3,4',5,5'-heptachlorobiphenyl	8.76
17. 2,2',3,4,4',5,6-heptachlorobiphenyl	8.84
18. 2,2',3,4,4',5,5'-heptachlorobiphenyl	9.50
19. 2,2',3,3',4,4',5-heptachlorobiphenyl	9.86
20. 2,2',3,3',4,4',5,5,6-nonachlorobiphenyl	10.87
21. decachlorobiphenyl (SS)	11.17



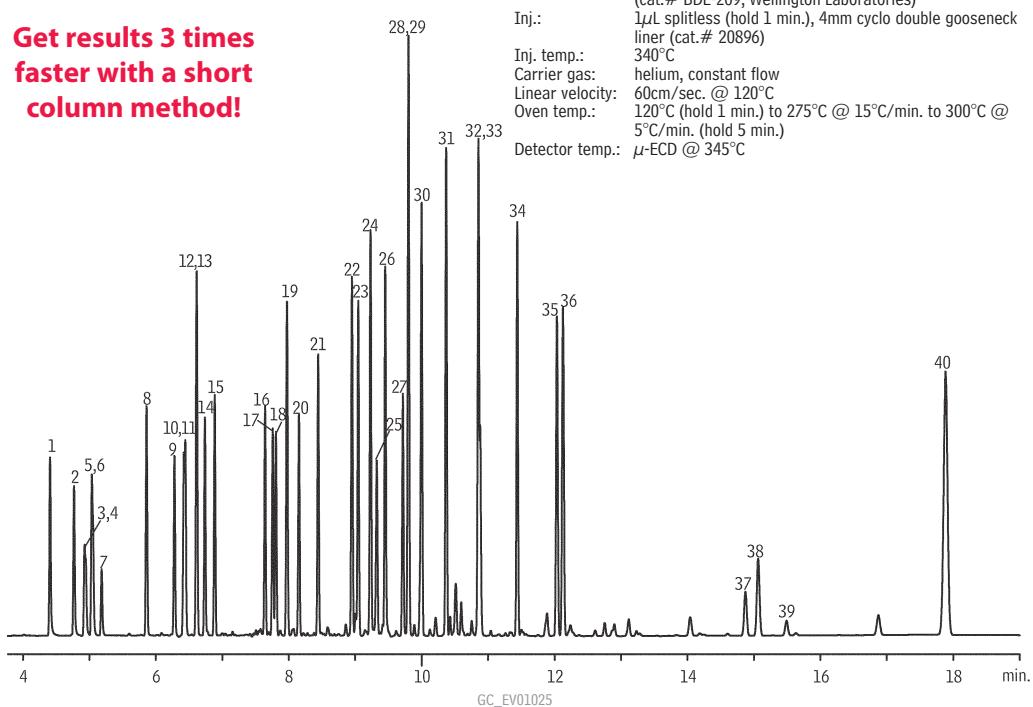
Restek training seminars are full-day courses presented in an engaging multimedia format. They are equally valuable to beginning chromatographers, those who have moderate experience and want a better understanding of the subject matter, and those interested in the "best practices" and latest technologies. **No sales pitch is presented**, just the facts on how to make your chromatography results better. Visit www.restek.com/seminars for more information.



Brominated Flame Retardants

Rtx®-1614

Get results 3 times faster with a short column method!



1. BDE-10
 2. BDE-7
 3. BDE-8
 4. BDE-11
 5. BDE-12
 6. BDE-13
 7. BDE-15
 8. BDE-30
 9. BDE-32
 10. BDE-17
 11. BDE-25
 12. BDE-28
 13. BDE-33
 14. BDE-35
 15. BDE-37
 16. BDE-75
 17. BDE-49
 18. BDE-71
 19. BDE-47
 20. BDE-66
 21. BDE-77
 22. BDE-100
 23. BDE-119
 24. BDE-99
 25. BDE-116
 26. BDE-118
 27. BDE-85
 28. BDE-155
 29. BDE-126
 30. BDE-154
 31. BDE-153
 32. BDE-138
 33. BDE-166
 34. BDE-183
 35. BDE-181
 36. BDE-190
 37. BDE-208
 38. BDE-207
 39. BDE-206
 40. BDE-209

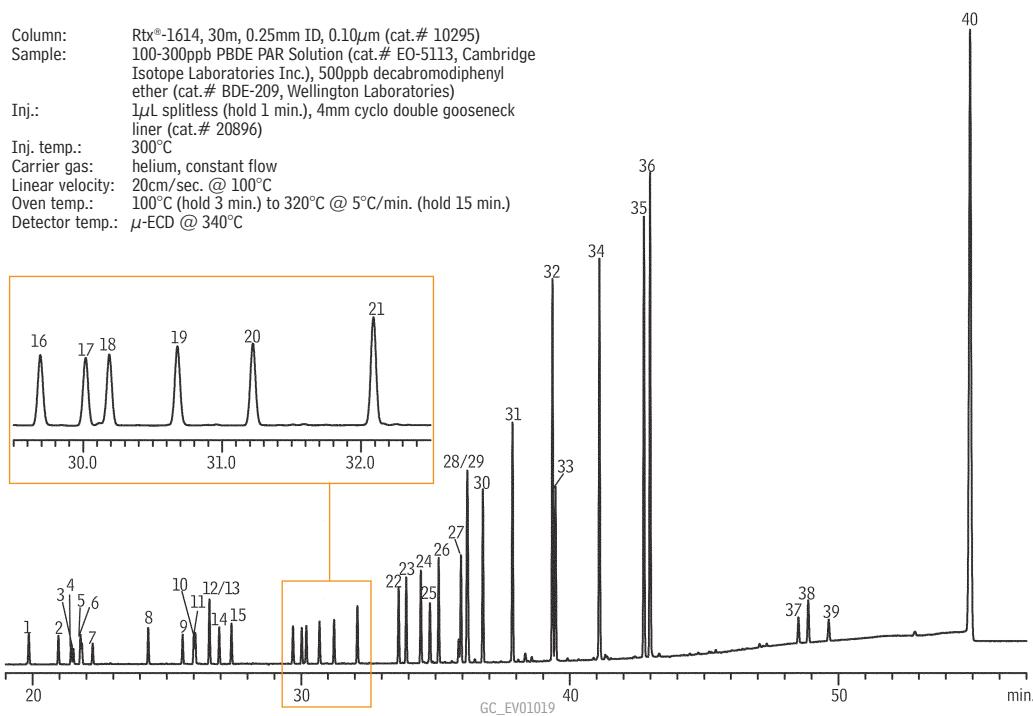


Brominated Flame Retardants

Rtx®-1614



Column: Rtx®-1614, 30m, 0.25mm ID, 0.10 μ m (cat.# 10295)
 Sample: 100-300ppb PBDE PAR Solution (cat.# EO-5113, Cambridge Isotope Laboratories Inc.), 500ppb decabromodiphenyl ether (cat.# BDE-209, Wellington Laboratories)
 Inj.: 1 μ L splitless (hold 1 min.), 4mm cyclo double gooseneck liner (cat.# 20896)
 Inj. temp.: 300°C
 Carrier gas: helium, constant flow
 Linear velocity: 20cm/sec. @ 100°C
 Oven temp.: 100°C (hold 3 min.) to 320°C @ 5°C/min. (hold 15 min.)
 Detector temp.: μ -ECD @ 340°C



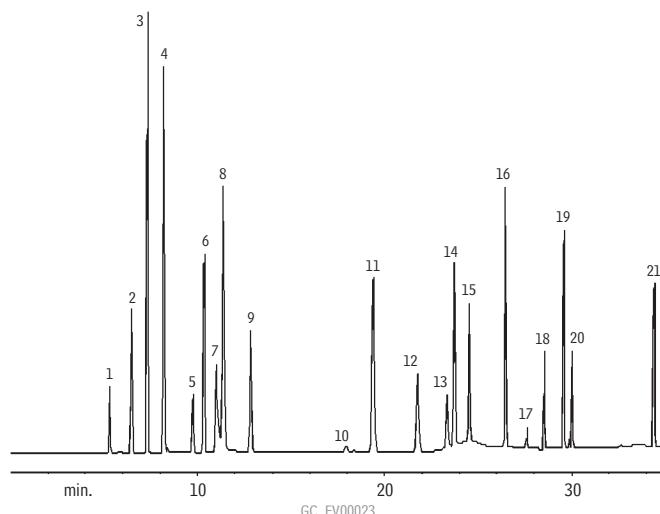
1. BDE-10
 2. BDE-7
 3. BDE-8
 4. BDE-11
 5. BDE-12
 6. BDE-13
 7. BDE-15
 8. BDE-30
 9. BDE-32
 10. BDE-17
 11. BDE-25
 12. BDE-28
 13. BDE-33
 14. BDE-35
 15. BDE-37
 16. BDE-75
 17. BDE-49
 18. BDE-71
 19. BDE-47
 20. BDE-66
 21. BDE-77
 22. BDE-100
 23. BDE-119
 24. BDE-99
 25. BDE-116
 26. BDE-118
 27. BDE-85
 28. BDE-155
 29. BDE-126
 30. BDE-154
 31. BDE-153
 32. BDE-138
 33. BDE-166
 34. BDE-183
 35. BDE-181
 36. BDE-190
 37. BDE-208
 38. BDE-207
 39. BDE-206
 40. BDE-209

GC APPLICATIONS | ENVIRONMENTAL
Chlorinated Disinfection Byproducts

Chlorinated Disinfection Byproducts

US EPA Method 551.1

Rtx®-5



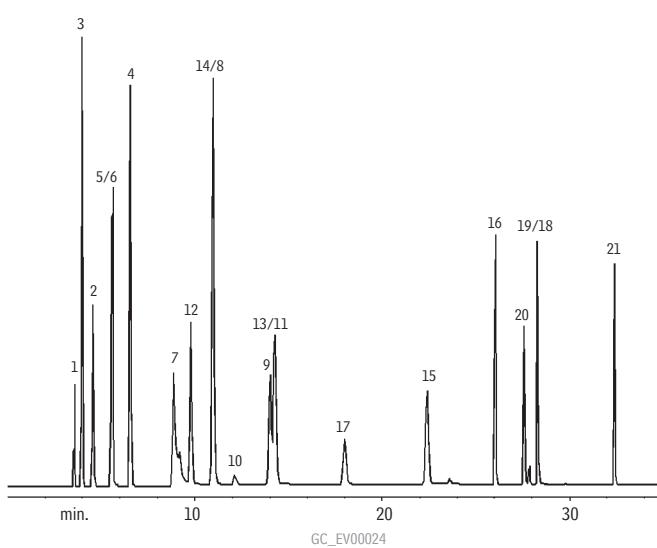
Column: Rtx®-5, 30m, 0.25mm ID, 1.0 μ m (cat.# 10253)
 Inj.: 1.0 μ L split injection, 1ng on-column concentration
 Oven temp.: 35°C (hold 22 min.) to 200°C @ 10°C/min.
 Inj./det. temp.: 200°C/290°C
 Carrier gas: helium
 Linear velocity: 30cm/sec. @ 50°C
 ECD sensitivity: 20kHz full scale
 Split ratio: 10:1

1. chloroform
2. 1,1,1-trichloroethane
3. carbon tetrachloride
4. trichloroacetonitrile
5. trichloroethylene
6. bromodichloromethane
7. chloral hydrate
8. dichloroacetonitrile
9. 1,1-dichloro-2-propanone
10. 1,1,2-trichloroethane
11. chloropicrin
12. dibromochloromethane
13. 1,2-dibromoethane (EDB)
14. tetrachloroethylene
15. bromochloroacetonitrile
16. 1,1,1-trichloro-2-propanone
17. bromoform
18. dibromoacetonitrile
19. 1,2,3-trichloropropane
20. 4-bromofluorobenzene (IS)
21. 1,2-dibromo-3-chloropropane (DBCP)

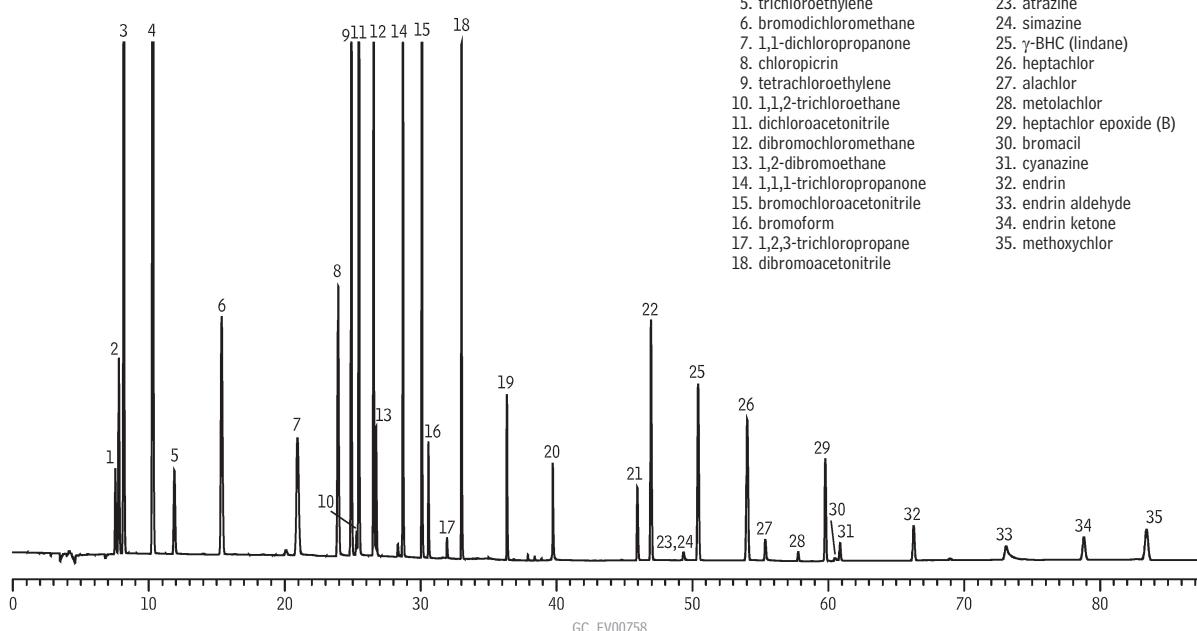
Chlorinated Disinfection Byproducts

US EPA Method 551.1

Rtx®-200



Column: Rtx®-200, 30m, 0.25mm ID, 1.0 μ m (cat.# 15053)
 Inj.: 1.0 μ L split injection, 1ng on-column concentration
 Oven temp.: 35°C (hold 22 min.) to 200°C @ 10°C/min.
 Inj./det. temp.: 200°C/290°C
 Carrier gas: helium
 Linear velocity: 30cm/sec. @ 50°C
 ECD sensitivity: 20kHz full scale
 Split ratio: 10:1

Chlorinated Disinfection Byproducts, Chlorinated Solvents, and Halogenated Pesticides**US EPA Method 551.1****Rtx®-1301**

1. chloroform
2. 1,1,1-trichloroethane
3. carbon tetrachloride
4. trichloroacetonitrile
5. trichloroethylene
6. bromodichloromethane
7. 1,1-dichloropropane
8. chloropicrin
9. tetrachloroethylene
10. 1,1,2-trichloroethane
11. dichloroacetonitrile
12. dibromochloromethane
13. 1,2-dibromoethane
14. 1,1,1-trichloropropane
15. bromochloroacetonitrile
16. bromoform
17. 1,2,3-trichloropropane
18. dibromoacetonitrile
19. 1,2-dibromo-3-chloropropane
20. hexachlorocyclopentadiene
21. trifluralin
22. hexachlorobenzene
23. atrazine
24. simazine
25. γ -BHC (lindane)
26. heptachlor
27. alachlor
28. metolachlor
29. heptachlor epoxide (B)
30. bromacil
31. cyanazine
32. endrin
33. endrin aldehyde
34. endrin ketone
35. methoxychlor

Column: Rtx®-1301, 30m, 0.25mm ID, 1.0 μ m (cat.# 16053)
 Sample: 5-10 μ g/mL each analyte (Method 551.1 Pesticide/Herbicide Mix (cat.# 32438) and Disinfection Byproducts & Chlorinated Solvents Mix (cat.# 30615))
 Inj.: 1.0 μ L splitless (hold 0.5 min.), 4mm split injection liner w/wool (cat.# 20781)
 Inj. temp.: 200°C
 Carrier gas: helium, constant pressure
 Linear velocity: 30cm/sec. @ 35°C
 Oven temp.: 35°C (hold 22 min.) to 145°C @ 10°C/min. (hold 2 min.)
 to 225° @ 20°C/min. (hold 15 min.) to 260° @ 10°C/min. (hold 30 min.)
 Det.: ECD @ 290°C

Restek Customer Service**In the U.S.**

Call: 800-356-1688 (ext. 3) or 814-353-1300 (ext. 3)
 Monday–Friday 8:00 a.m.–6:00 p.m. ET
 Fax: 814-353-1309—24-hours a day
 Online: www.restek.com—24-hours a day

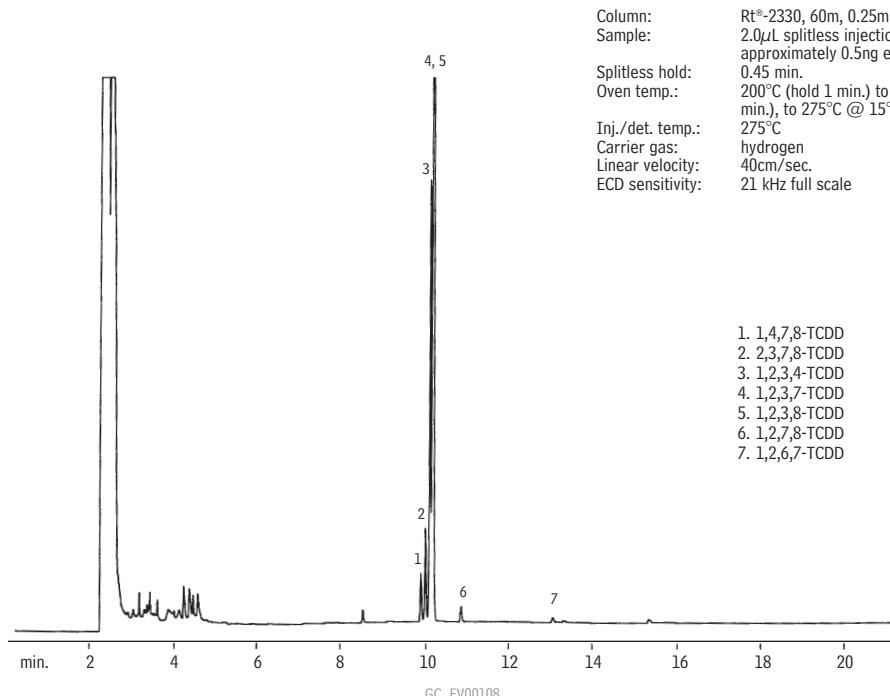
Outside the U.S.

Contact your Restek representative:
 Refer to our list on pages 4-5 or visit our website at www.restek.com



Dave Facey, Customer Service

TCDD Isomers
Rt®-2330



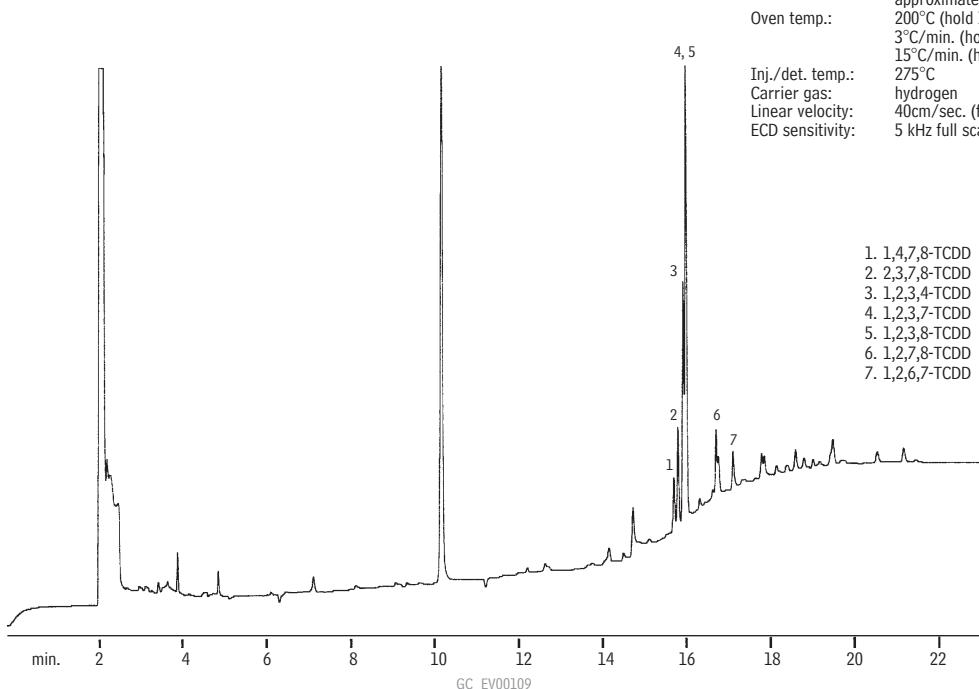
Column: Rt®-2330, 60m, 0.25mm ID, 0.20 μ m (cat.# 10726)
Sample: 2.0 μ L splitless injection of TCDD isomers, approximately 0.5ng each isomer
Splitless hold: 0.45 min.
Oven temp.: 200°C (hold 1 min.) to 250°C @ 8°C/min. (hold 15 min.), to 275°C @ 15°C/min. (hold 5 min.)
Inj./det. temp.: 275°C
Carrier gas: hydrogen
Linear velocity: 40cm/sec.
ECD sensitivity: 21 kHz full scale

- 1. 1,4,7,8-TCDD
- 2. 2,3,7,8-TCDD
- 3. 1,2,3,4-TCDD
- 4. 1,2,3,7-TCDD
- 5. 1,2,3,8-TCDD
- 6. 1,2,7,8-TCDD
- 7. 1,2,6,7-TCDD

also available

For Rtx®-Dioxin2 columns, designed specifically for dioxin/furan analysis, see page 87.

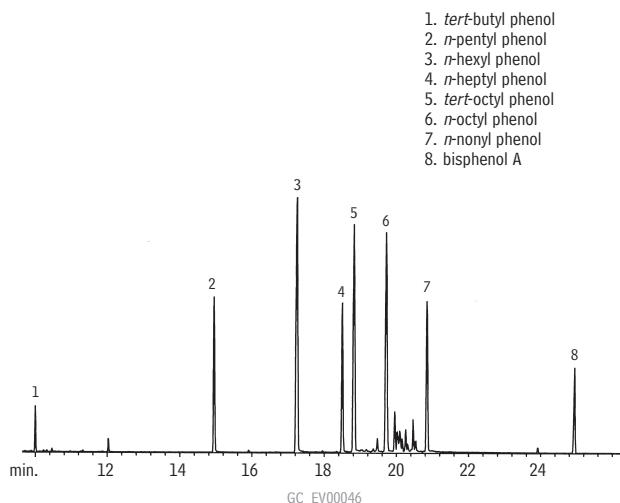
TCDD Isomers
Rt®-2330



Column: Rt®-2330, 60m, 0.32mm ID, 0.20 μ m (cat.# 10727)
Sample: 1.5 μ L cold on-column injection of TCDD isomers, approximately 0.5ng each isomer
Oven temp.: 200°C (hold 1 min.) to 240°C @ 3°C/min. (hold 6 min.), to 275°C @ 15°C/min. (hold 30 min.)
Inj./det. temp.: 275°C
Carrier gas: hydrogen
Linear velocity: 40cm/sec. (flow rate: 3.2cc/min.)
ECD sensitivity: 5 kHz full scale

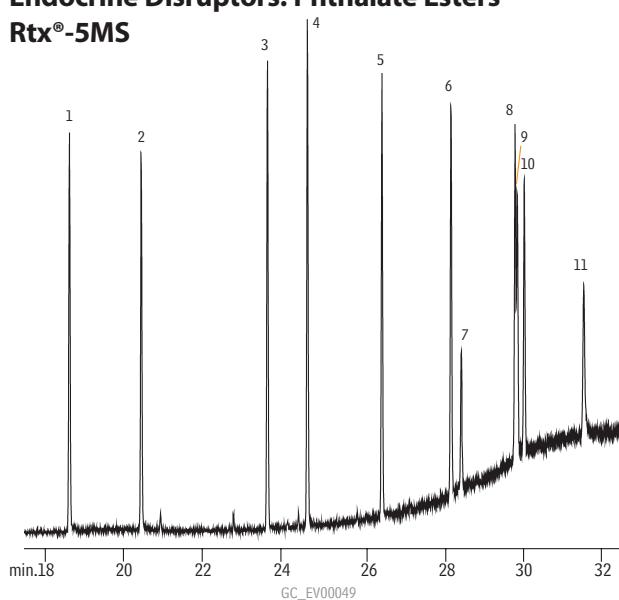
- 1. 1,4,7,8-TCDD
- 2. 2,3,7,8-TCDD
- 3. 1,2,3,4-TCDD
- 4. 1,2,3,7-TCDD
- 5. 1,2,3,8-TCDD
- 6. 1,2,7,8-TCDD
- 7. 1,2,6,7-TCDD

**Endocrine Disruptors: Alkyl Phenols
Rtx®-5MS**



Column: Rtx®-5MS, 30m, 0.25mm ID, 0.25 μ m (cat.# 12623)
Conc.: 5–10ng on-column
Inj.: splitless, purge on @ 1 min.
Oven temp.: 35°C (hold 1 min.) to 300°C @ 10°C/min. (hold 15 min.)
Inj./det. temp.: 275°C/310°C
Carrier gas: helium

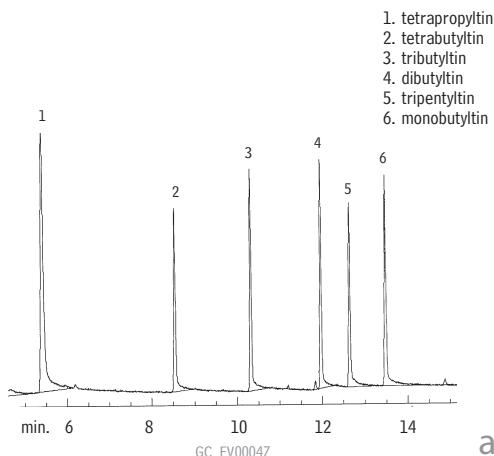
**Endocrine Disruptors: Phthalate Esters
Rtx®-5MS**



1. dimethyl phthalate
2. diethyl phthalate
3. isobutyl phthalate
4. dibutyl phthalate
5. dipentyl phthalate
6. dihexyl phthalate
7. benzylethyl phthalate
8. diheptyl phthalate
9. 2-ethylhexyl phthalate
10. cyclohexyl phthalate
11. dioctyl phthalate

Column: Rtx®-5MS, 30m, 0.25mm ID, 0.50 μ m (cat #12638)
Conc.: 100pg on-column injection MS-SIM
Oven temp.: 35°C (hold 1 min.) to 285°C @ 10°C/min.
Pressure: 7.5psi constant pressure

**Endocrine Disruptors:
Butyl Tins (hexyl derivatives)
Rtx®-5**

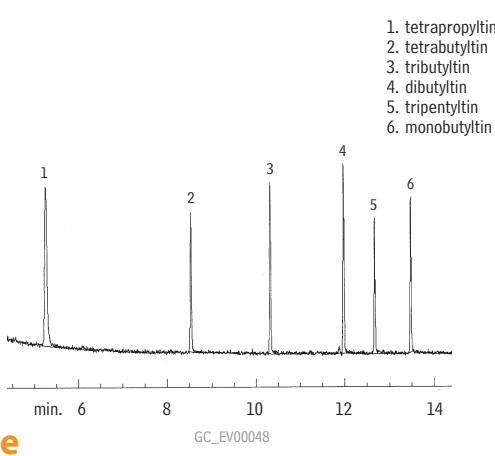


also available

Butyl tin reference
materials—see page 452.

Column: Rtx®-5, 30m, 0.32mm ID, 0.50 μ m (cat.# 10239)
Conc.: 500pg on-column direct injection
Oven temp.: 100°C (hold 1 min.) to 285°C
@ 10°C/min.
Inj./det. temp.: 250°C
Carrier gas: helium
Linear velocity: 45cm/sec.
Detector: FPD with 610nm filter

**Endocrine Disruptors:
Butyl Tins (hexyl derivatives)
Rtx®-35**



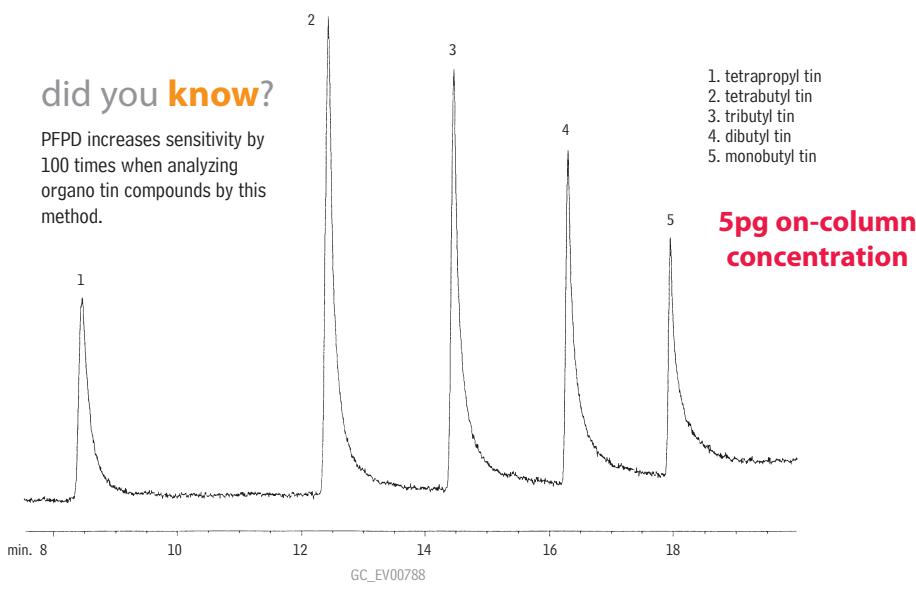
Column: Rtx®-35, 30m, 0.32mm ID, 0.50 μ m (cat.# 10439)
Conc.: 500pg on-column direct injection
Oven temp.: 100°C (hold 1 min.) to 285°C
@ 10°C/min.
Inj./det. temp.: 250°C
Carrier gas: helium
Linear velocity: 45cm/sec.
Detector: FPD with 610nm filter

GC APPLICATIONS | ENVIRONMENTAL Organo Tins, Explosives

Organo Tins Rtx[®]-35

did you know?

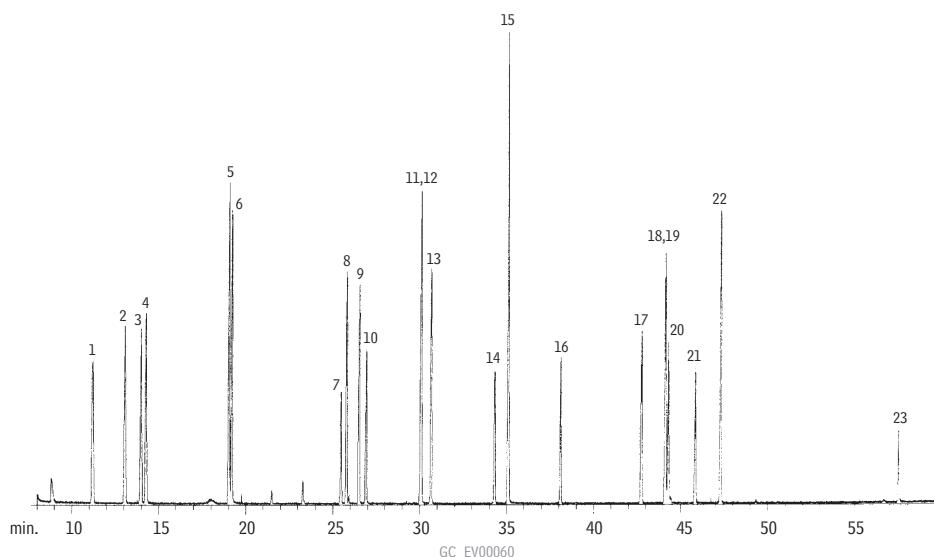
PFPD increases sensitivity by 100 times when analyzing organo tin compounds by this method.



Column: Rtx[®]-35, 30m, 0.32mm ID, 1.0 μ m (cat.# 10454)
Inj.: direct injection using a Uniliner[®] inlet liner (cat.# 20335)
Conc.: 5pg on-column
Head pressure: 15psi, constant
Oven temp.: 100°C (hold 1 min.) to 285°C @ 10°C/min. (hold 10 min.)
Detector: PFPD* Model 5380 courtesy of O.I. Analytical Corp., College Station, TX

*Peak tailing is a function of this detector.

Explosives Rtx[®]-200



Column:	Rtx [®] -200, 30m, 0.25mm ID, 0.25 μ m (cat.# 15023)	1. 2-nitrotoluene	13. 2,3-dinitrotoluene
Inj.:	1.0 μ L splitless injection	2. 3-nitrotoluene	14. 3,4-dinitrotoluene
Conc.:	20ng/ μ L	3. 4-nitrotoluene	15. 3-nitrobiphenyl
Oven temp.:	80°C (hold 2 min.) to 260°C @ 3°C/min. (hold 2 min.)	4. 2,3-diaminotoluene	16. 2,4,6-trinitrotoluene
Inj. temp.:	280°C	5. 2,6-diaminotoluene	17. 2,4,5-trinitrotoluene
Det.:	MS, 300°C	6. 2,4-diaminotoluene	18. 4-amino-2,6-dinitrotoluene
Carrier gas:	helium	7. 1,4-dinitrobenzene	19. 2,3,4-trinitrotoluene
Linear velocity:	20cm/sec. set @ 80°C	8. 2,6-dinitrotoluene	20. 1,3-dinitronaphthalene
Splitless hold time:	0.6 min.	9. 2-amino-6-nitrotoluene	21. 2,6-diamino-4-nitrotoluene
		10. 1,3-dinitrobenzene	22. 2-amino-4,6-dinitrotoluene
		11. 2,4-dinitrotoluene	23. 2,2-dinitrobiphenyl
		12. 2-amino-4-nitrotoluene	

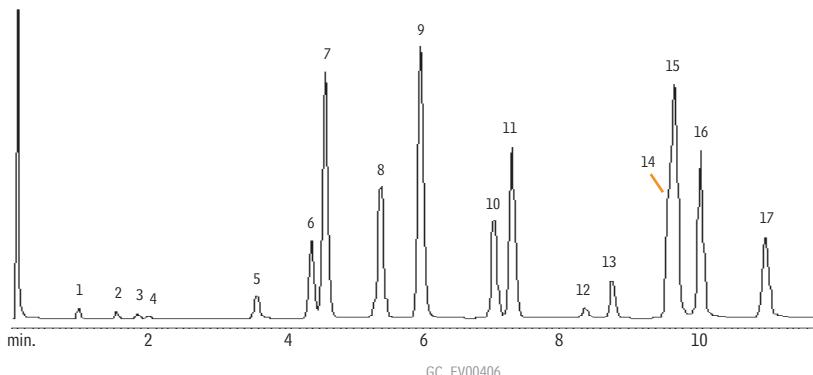
Explosives

US EPA Method 8095 Rtx®-TNT & Rtx®-TNT2

Rtx®-TNT

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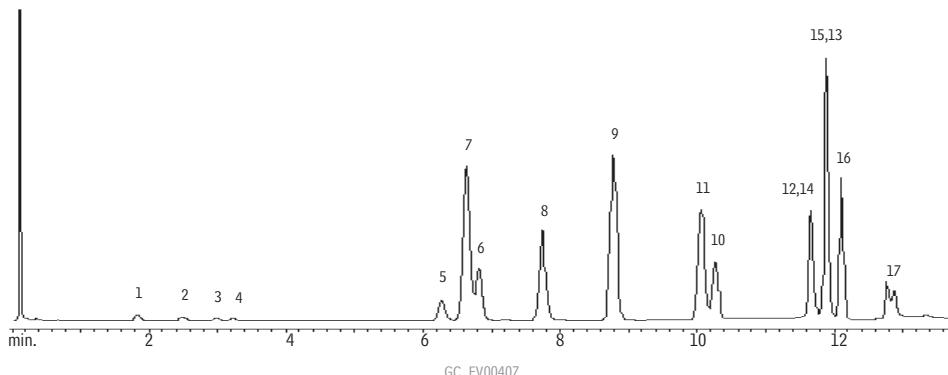
Improved resolution of
nitroaromatic compounds such
as those listed in US EPA
Method 8095.



Column: Rtx®-TNT, 6m, 0.53mm ID, 1.50 μ m (cat.# 12998)
Inj.: direct injection using a 1mm Siltek® Uniliner® inlet liner (cat.# 21052-214.1)
On-column conc.: est. 200-1,000pg/compound, 8095 Calibration Mix A (cat.# 31607),
8095 Calibration Mix B (cat.# 31608), and 3,4-dinitrotoluene (cat.# 31452)
Oven temp.: 80°C (hold 1 min.) to 180°C @ 10°C/min. to 300°C @
30°C/min. (hold 3 min.)
Inj. temp.: 250°C
Det.: ECD @ 330°C with anode purge
Dead time: 4.4 sec.
Head pressure: helium @ 3psi (20.7 KPa)
Flow rate: helium @ 17mL/min. @ 80°C

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

Rtx®-TNT2



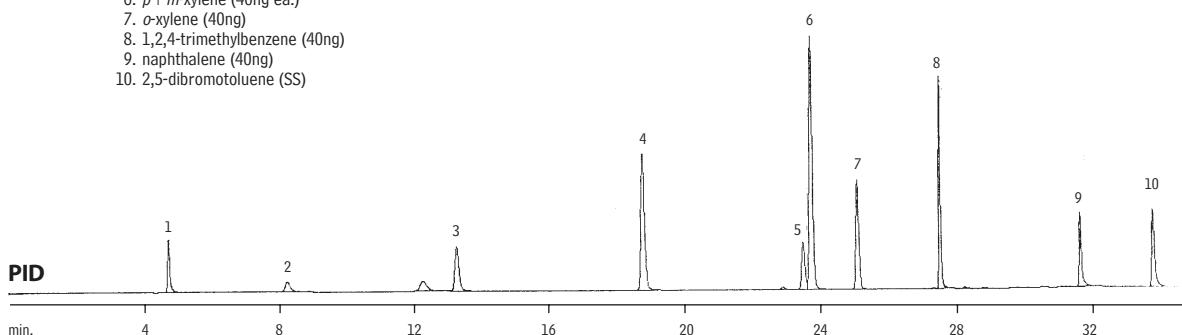
Column: Rtx®-TNT2, 6m, 0.53mm ID, 1.50 μ m (cat.# 12999)
Inj.: direct injection using a 1mm Siltek® Uniliner® (cat.# 21052-214.1)
On-column conc.: est. 200-1,000pg/compound, 8095 Calibration Mix A (cat.# 31607),
8095 Calibration Mix B (cat.# 31608), and 3,4-dinitrotoluene (cat.# 31452)
Oven temp.: 80°C (hold 1 min.) to 180°C @ 10°C/min. to 300°C @
30°C/min. (hold 3 min.)
Inj. temp.: 250°C
Det.: ECD @ 330°C with anode purge
Dead time: 4.4 sec.
Head pressure: helium @ 3psi (20.7 KPa)
Flow rate: helium @ 17mL/min. @ 80°C

GC APPLICATIONS | ENVIRONMENTAL
Gasoline Range Organics (GRO)

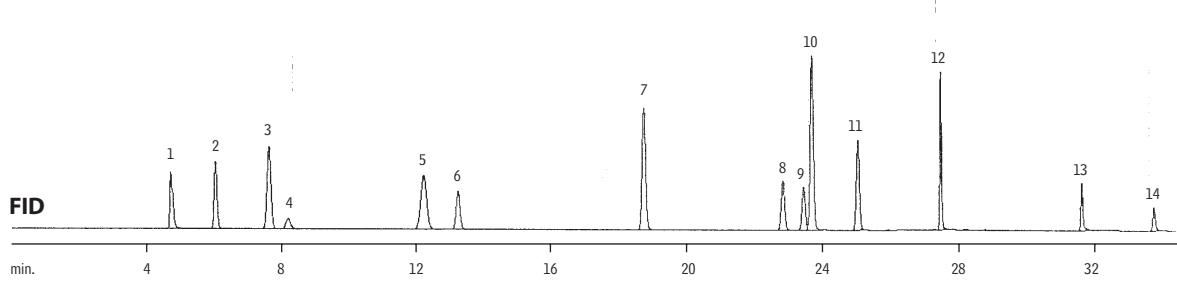
Volatile Petroleum Hydrocarbons (VPH)
Massachusetts Department of Environmental Protection
Rtx®-502.2

For VPH analysis on an Rtx®-502.2 column, use PID for aromatic compounds and FID for aliphatic compounds.

1. methanol
2. methyl *tert*-butyl ether (60ng)
3. benzene (20ng)
4. toluene
5. ethylbenzene (20ng)
6. *p*+*m*-xylene (40ng ea.)
7. *o*-xylene (40ng)
8. 1,2,4-trimethylbenzene (40ng)
9. naphthalene (40ng)
10. 2,5-dibromotoluene (SS)



1. methanol (40ng)
2. *n*-pentane (60ng)
3. 2-methylpentane (60ng)
4. methyl *tert*-butyl ether (60ng)
5. 2,2,4-trimethylpentane (60ng)
6. benzene (20ng)
7. toluene (60ng)
8. *n*-nonane (40ng)
9. ethylbenzene (20ng)
10. *p*+*m*-xylene (40ng ea.)
11. *o*-xylene (40ng)
12. 1,2,4-trimethylbenzene (40ng)
13. naphthalene (40ng)
14. 2,5-dibromotoluene (SS)



Column: Rtx®-502.2, 105m, 0.53mm ID, 3.0 μ m (cat.# 10910)
Conc.: on-column at levels listed
Oven temp: 45°C to 90°C @ 3°C/min., to 140° @ 5°C/min.,
to 230°C @ 45°C/min. (hold 8 min.)
Carrier gas: helium @ 15mL/min. Tekmar Model LSC 2000
Trap: BTEX
Purge: helium @ 40mL/min. for 11 min.
Dry purge: 2 min.
Desorb preheat: 245°C
Desorb: 2 min. @ 250°C
Bake: 6 min. @ 260°C

Chromatograms courtesy of Severn Trent Laboratories, Burlington, VT.

free literature

Optimizing Massachusetts Volatile Petroleum Hydrocarbon GC Analysis

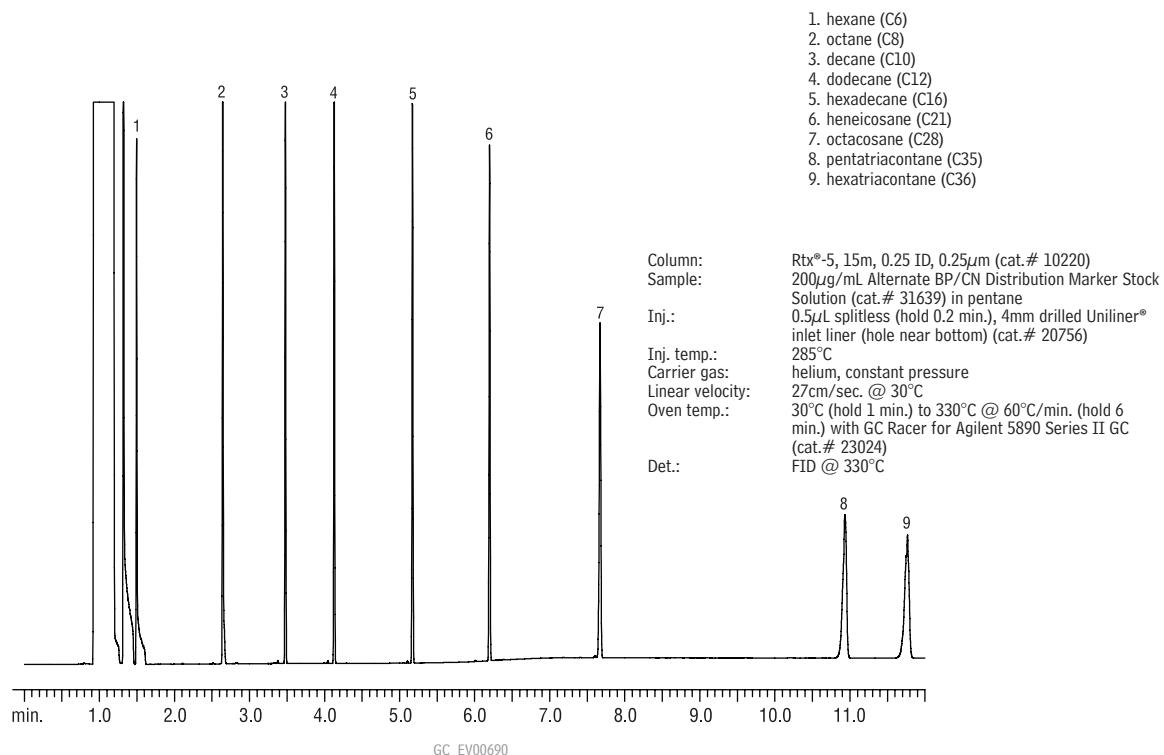
Massachusetts VPH affords more reliable quantification of volatile petroleum hydrocarbons, relative to older "analytical window" methods, and has been adopted by other states and in Canada. This 2-page note offers valuable tips for selecting a trap and a capillary GC column compatible with the methodology. Reference mixes specifically designed for MA VPH are described.

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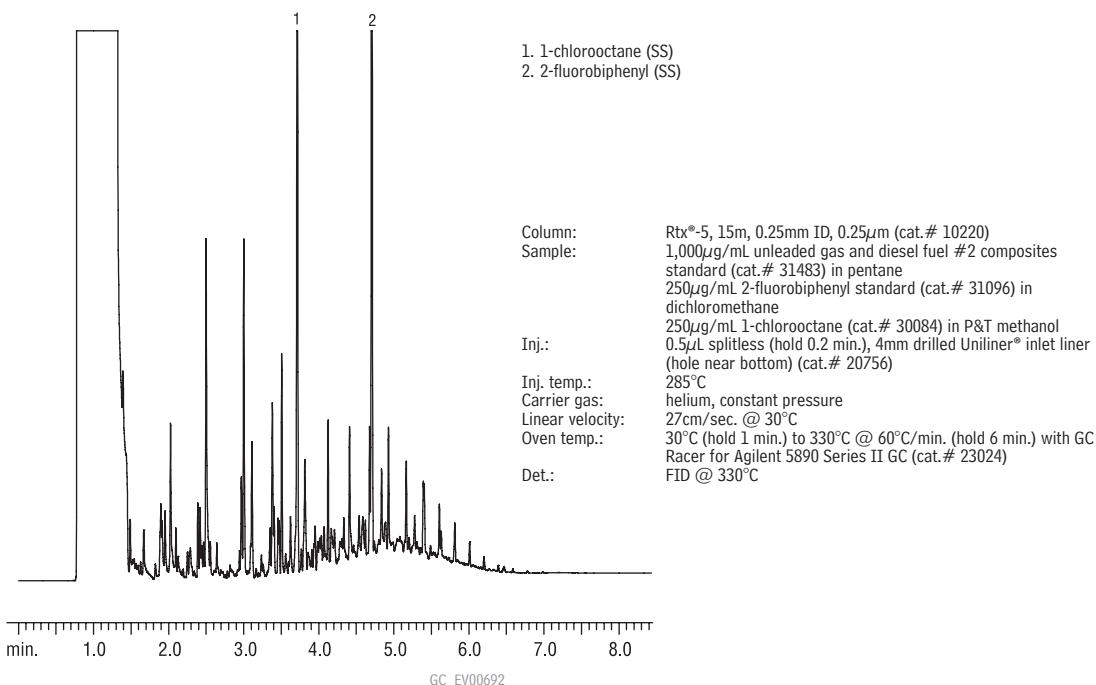
Applications Note
lit. cat.# 59150



Texas UST: Alternate Boiling Point/Carbon Number Distribution Marker Rtx®-5

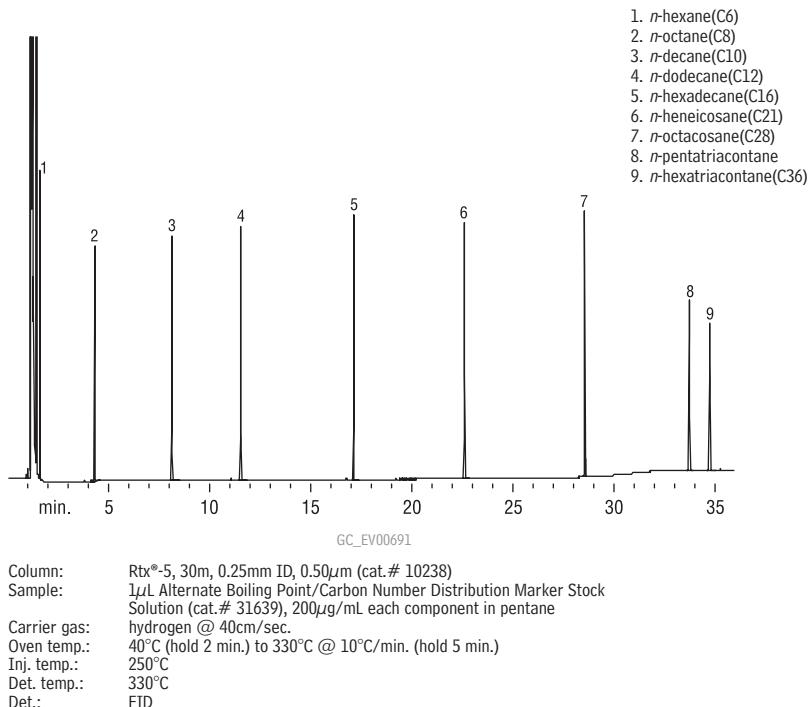


Texas UST: diesel/gas composites Rtx®-5



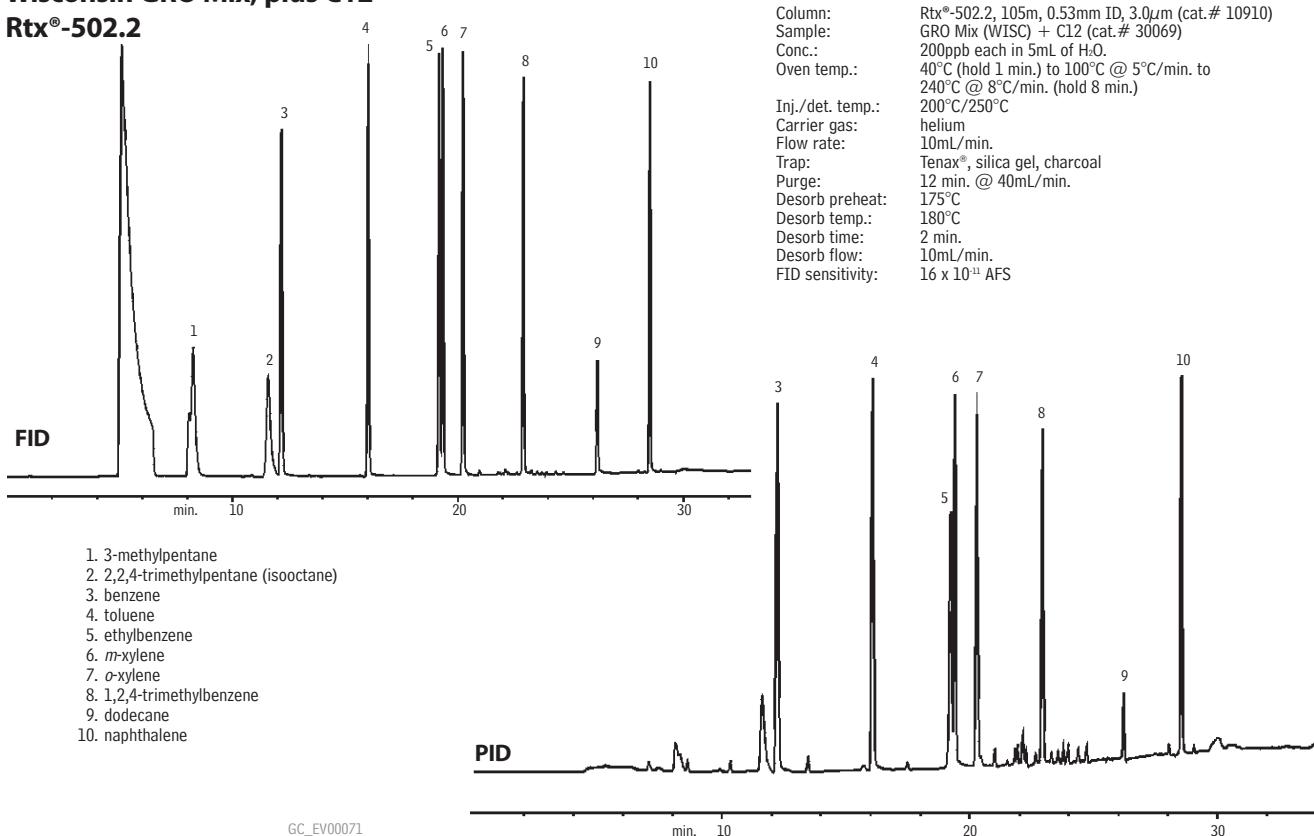
GC APPLICATIONS | ENVIRONMENTAL
Gasoline Range Organics (GRO)

Texas UST: Alternate Boiling Point/Carbon Number Distribution Marker
Rtx®-5

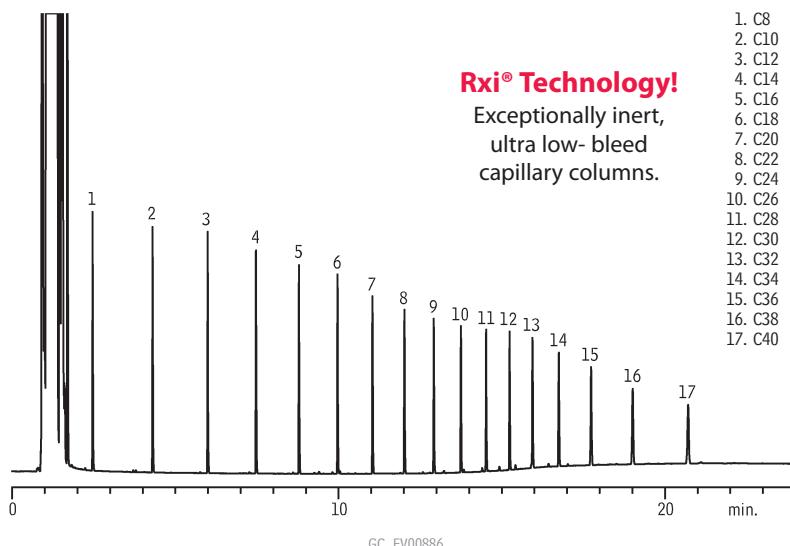


Wisconsin GRO Mix, plus C12

Rtx®-502.2



**Petroleum Hydrocarbons (TPH)
 Rxⁱ-1ms**

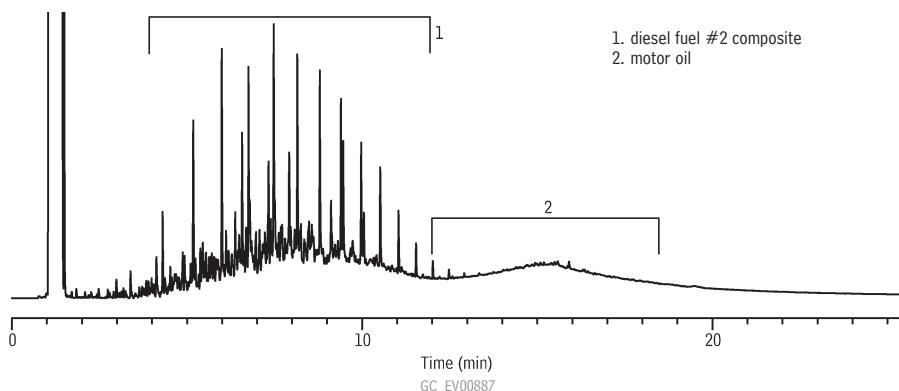


Column: Rxⁱ-1ms, 20m, 0.18mm ID, 0.18 μ m (cat.# 13302)
 Sample: Florida TRPH Standard (cat.# 31266), 500 μ g/mL each component in hexane
 Inj.: 0.5 μ L, split, split ratio 20:1, 3.5mm PrecisionTM inlet liner (cat.# 21021)
 Instrument: Shimadzu GC-2010*
 Inj. temp.: 275°C
 Carrier gas: hydrogen, constant pressure
 Linear velocity: 55cm/sec. @ 40°C
 Oven temp.: 40°C (hold 1 min.) to 330°C @ 20°C/min. (hold 10 min.)
 Det.: FID @ 350°C

*GC courtesy of Shimadzu Scientific.

**Lubrication Range Organics
 Diesel Fuel #2/Motor Oil
 Rxⁱ-1ms**

Rxⁱ Technology!
 Exceptionally inert,
 ultra low- bleed
 capillary columns.

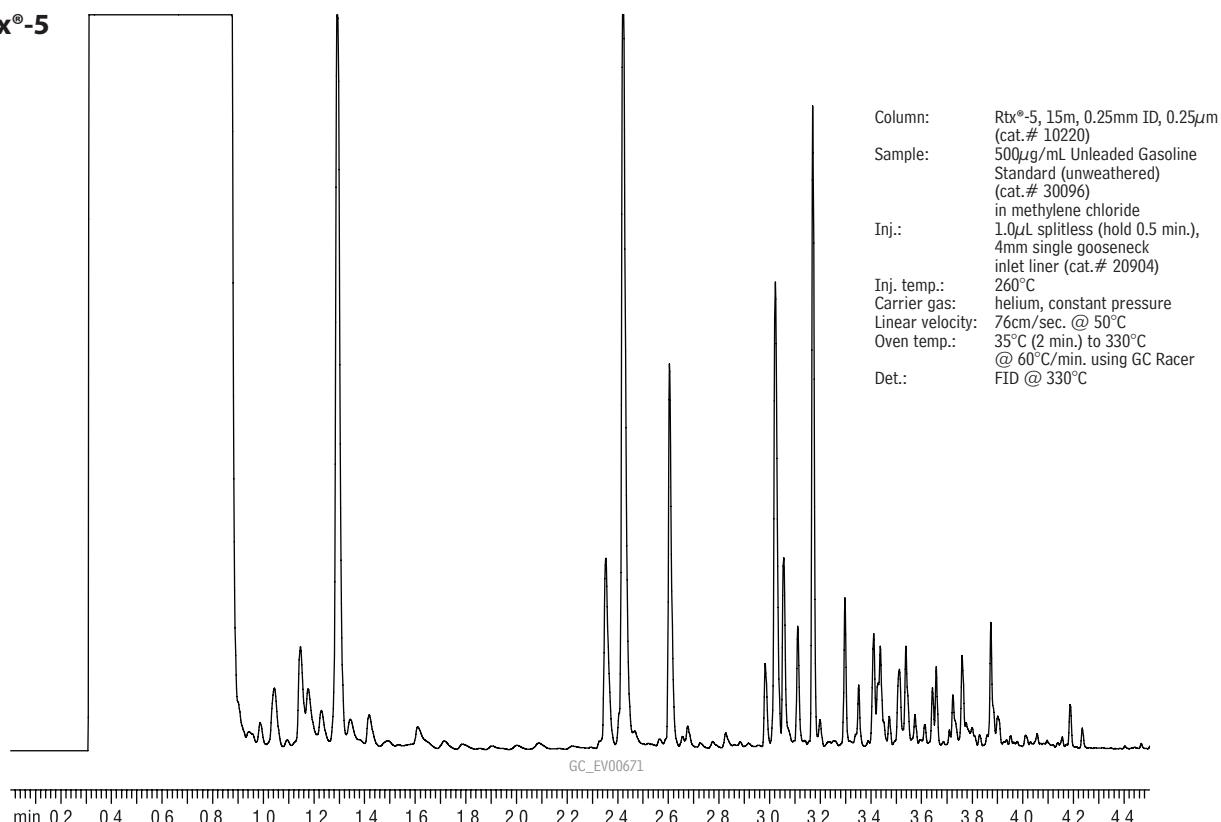


Column: Rxⁱ-1ms, 20m, 0.18mm ID, 0.18 μ m (cat.# 13302)
 Sample: Diesel #2/Motor Oil (cat.# 31682) 5,000 μ g/mL each component in hexane
 Inj.: 0.5 μ L, split, split ratio 20:1, 3.5mm PrecisionTM inlet liner (cat.# 21021)
 Instrument: Shimadzu GC-2010
 Inj. temp.: 275°C
 Carrier gas: hydrogen, constant pressure
 Linear velocity: 55cm/sec. @ 40°C
 Oven temp.: 40°C (hold 1 min.) to 330°C @ 20°C/min. (hold 10 min.)
 Det.: FID @ 350°C

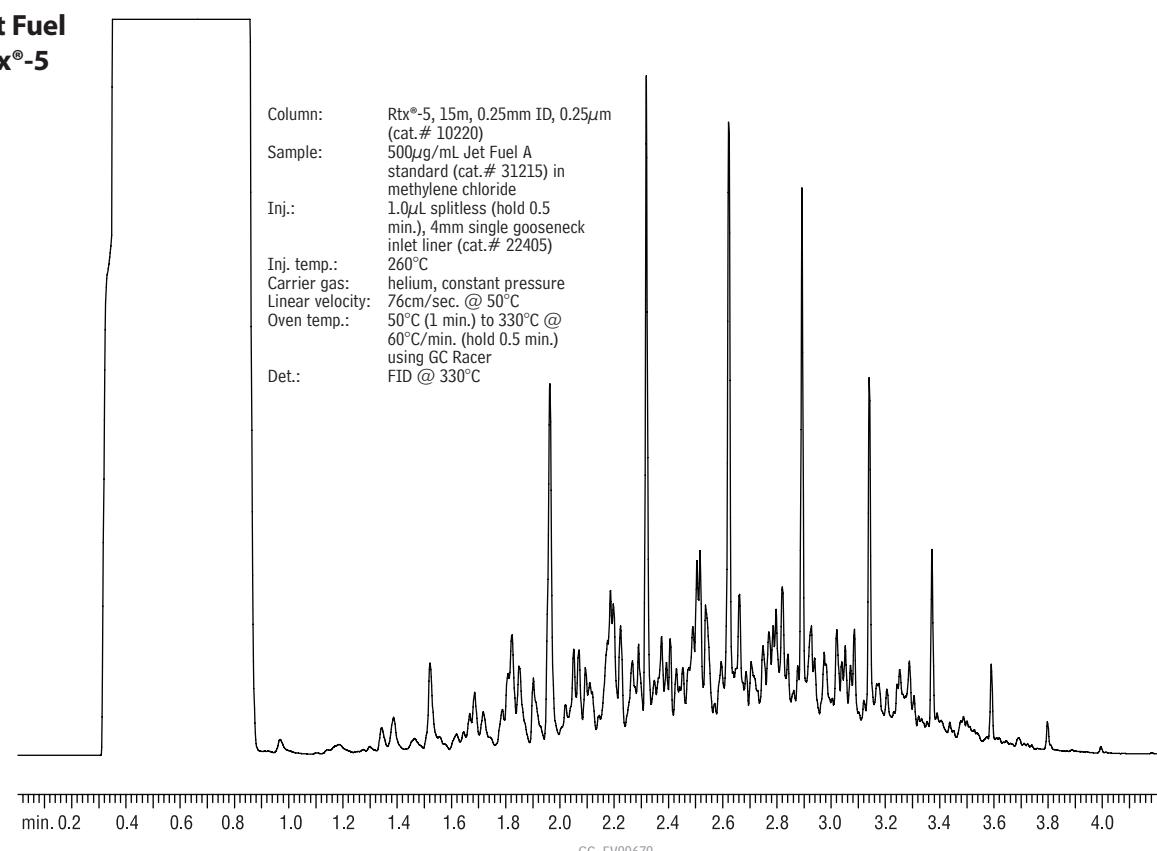
GC APPLICATIONS | ENVIRONMENTAL
Gasoline Range Organics (GRO)

Unleaded Gasoline

Rtx®-5



Jet Fuel
Rtx®-5



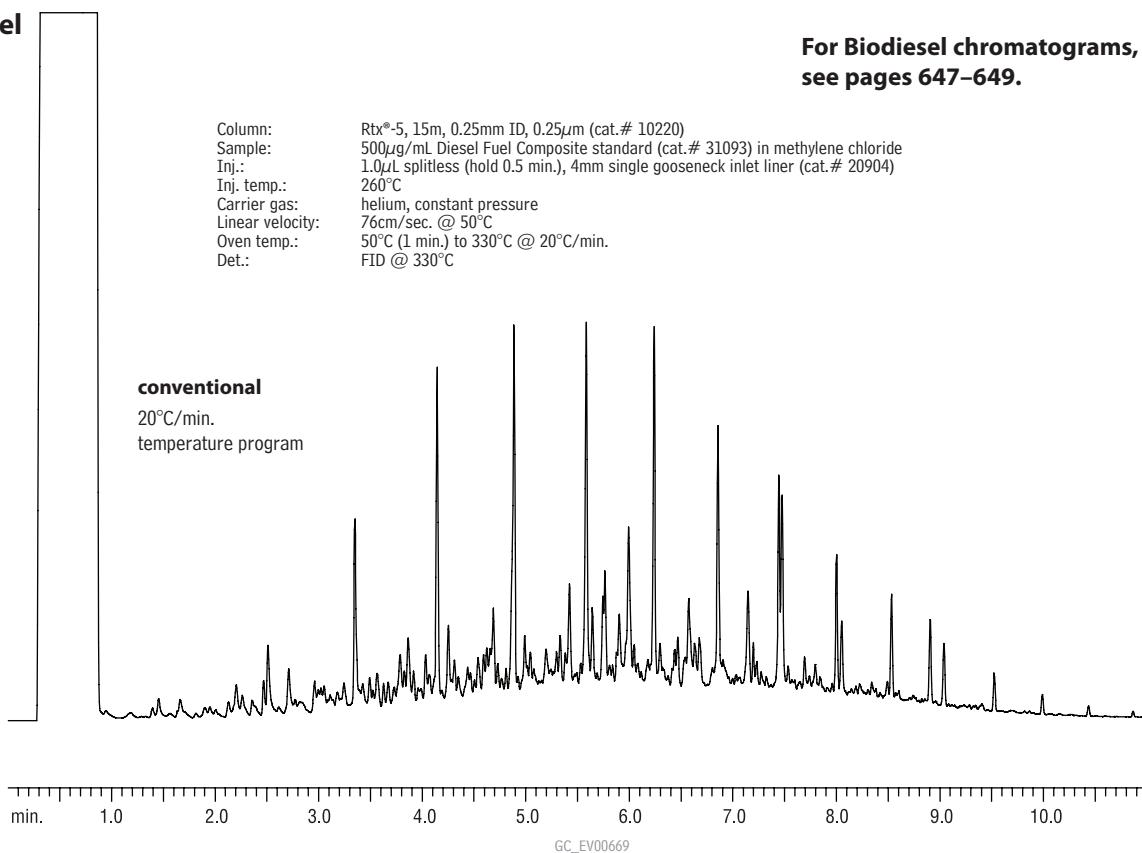


Diesel Fuel Rtx®-5

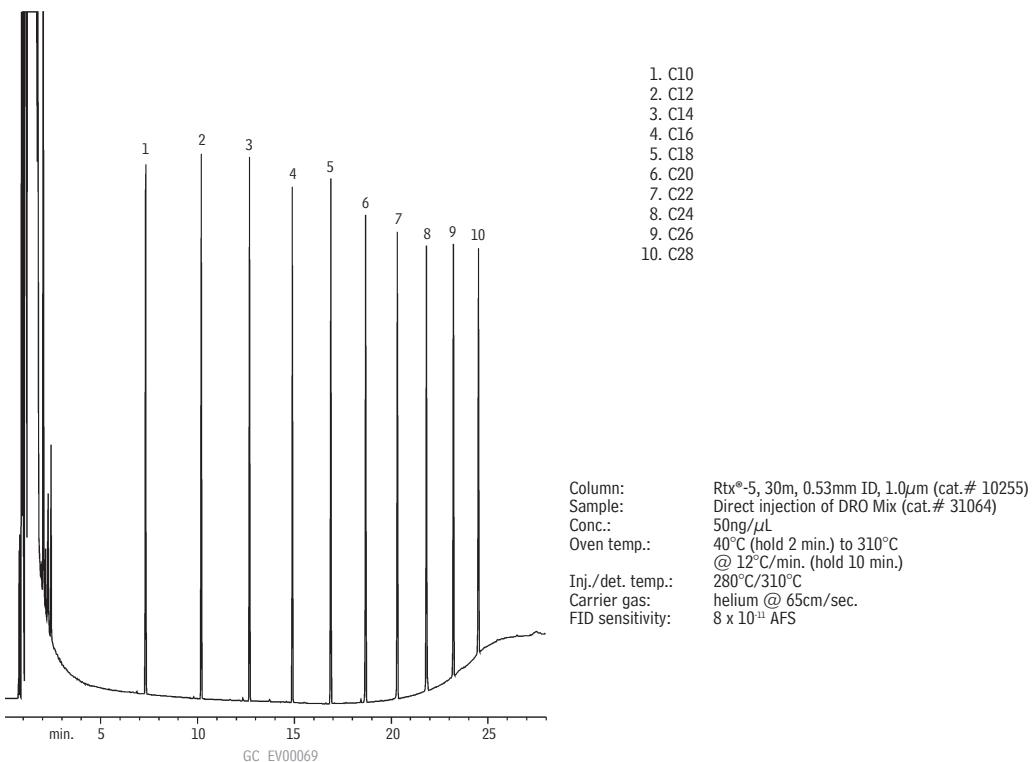
GC APPLICATIONS | ENVIRONMENTAL Diesel Range Organics (DRO)

For Biobiodiesel chromatograms,
see pages 647–649.

Column: Rtx®-5, 15m, 0.25mm ID, 0.25 μ m (cat.# 10220)
Sample: 500 μ g/ml Diesel Fuel Composite standard (cat.# 31093) in methylene chloride
Inj.: 1.0 μ L splitless (hold 0.5 min.), 4mm single gooseneck inlet liner (cat.# 20904)
Inj. temp.: 260°C
Carrier gas: helium, constant pressure
Linear velocity: 76cm/sec. @ 50°C
Oven temp.: 50°C (1 min.) to 330°C @ 20°C/min.
Det.: FID @ 330°C

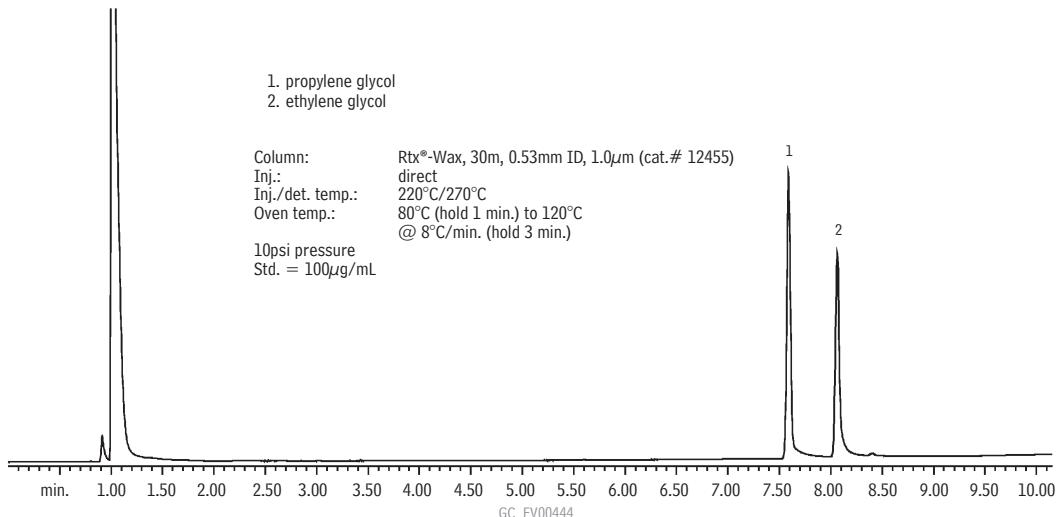


DRO Mix Rtx®-5



GC APPLICATIONS | ENVIRONMENTAL Glycols

Glycols Rtx®-Wax



free literature

Techniques to Optimizing GC Analysis of Ethylene Glycol in Water

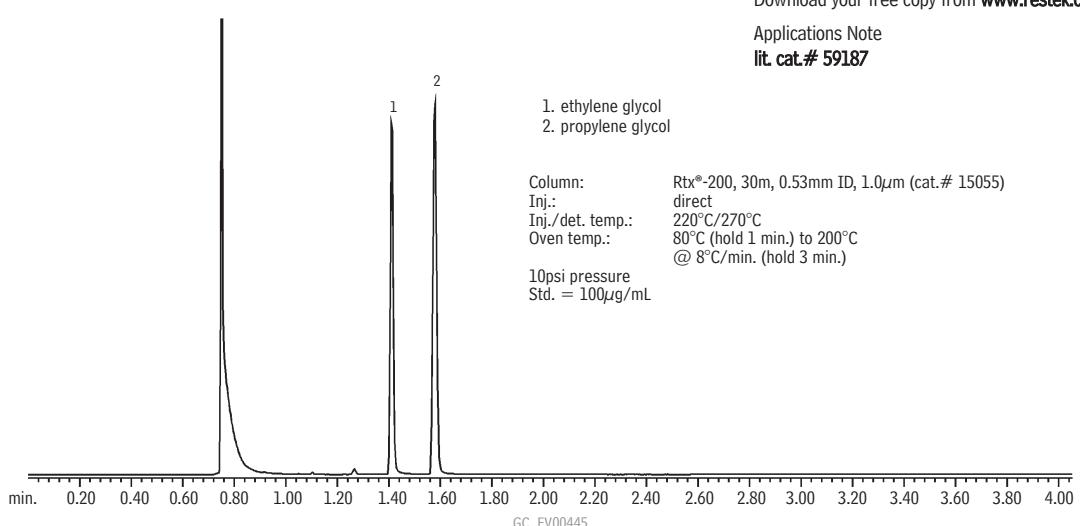
Avoid the problems that aqueous samples can create

Direct injections of water-based samples, such as samples containing ethylene glycol, can cause problems for chromatographers. This 4-page note alerts analysts to the potential for poor peak shape, sample carryover, and FID flameout, and describes approaches to follow to avoid these problems. With care, detection limits of 1-10ppm ethylene glycol can be attained.

Download your free copy from www.restek.com.

Applications Note
lit. cat.# 59187

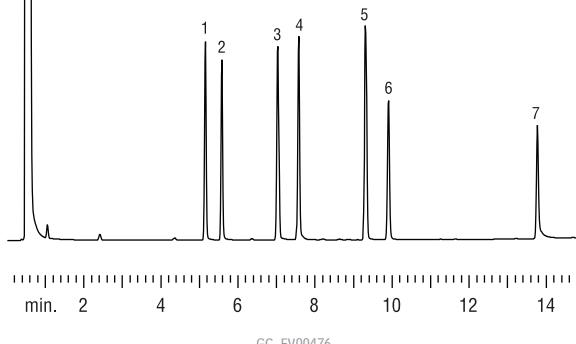
Glycols Rtx®-200



Glycols
Stabilwax®

1. 1,2-propylene glycol
2. ethylene glycol
3. 1,3-butylene glycol
4. 1,3-propylene glycol
5. 1,4-butylene glycol
6. diethylene glycol
7. glycerol

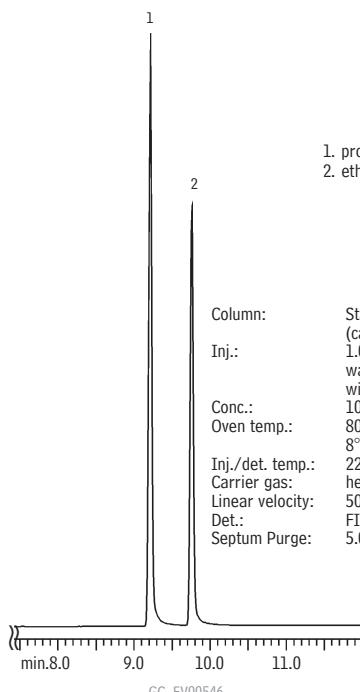
Column: Stabilwax®, 30m, 0.53mmID, 1.0 μ m (cat.# 10655)
 Inj.: 1.0 μ L direct injection, open-top Uniliner® inlet liner without wool (cat.# 20843-205)
 Conc.: 150ppm
 Solvent: water/methanol (50:50)
 Oven temp.: 80°C to 200°C @ 8°C/min. (hold 10 min.)
 Septa purge: 5.0cc/min.
 Carrier gas: helium
 Linear velocity: 50cm/sec.
 Column flow rate: 6.9mL/min.
 Det.: FID @ 270°C
 Make up gas flow: 45cc/min.



Glycols
Stabilwax®

1. propylene glycol
2. ethylene glycol

Column: Stabilwax®, 30m, 0.53mm ID, 1.0 μ m (cat.# 10655)
 Inj.: 1.0 μ L of direct injection of glycols in water. Open-top Uniliner® inlet liner without wool (cat.# 20843-205)
 Conc.: 100ppm
 Oven temp.: 80°C (hold 1 min.) to 200°C @ 8°C/min. (hold 5 min.)
 Inj./det. temp.: 225°C/250°C
 Carrier gas: helium
 Linear velocity: 50cm/sec.
 Det.: FID
 Septum Purge: 5.0cc/min.



Glycols
Rtx®-BAC1 & Rtx®-BAC2

Rtx®-BAC1

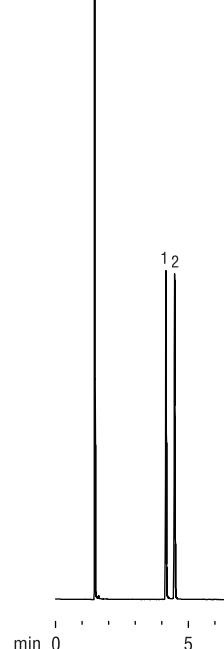
1. ethylene glycol
2. propylene glycol

Columns: Rtx®-BAC1, 30m, 0.32mm ID, 1.8 μ m (cat.# 18003)
 Rtx®-BAC2, 30m, 0.32mm ID, 1.2 μ m (cat.# 18002)
 Inj.: 0.5 μ L split injection
 Conc.: 1%
 Solvent: methanol
 Oven temp.: 100°C to 240°C @ 5°C/min. (hold 5 min.)
 Inj. temp.: 240°C
 Inj. mode: 100:1 split
 Inlet liner: 4mm single gooseneck (cat.# 20798)
 Septa purge: 5.0cc/min.
 Carrier gas: helium, constant pressure
 Pressure: 12psi
 Linear velocity: 37cm/sec.
 Column flow rate: 2.1mL/min.
 Det.: FID @ 240°C
 Make-up gas flow: 40cc/min.

Rtx®-BAC2

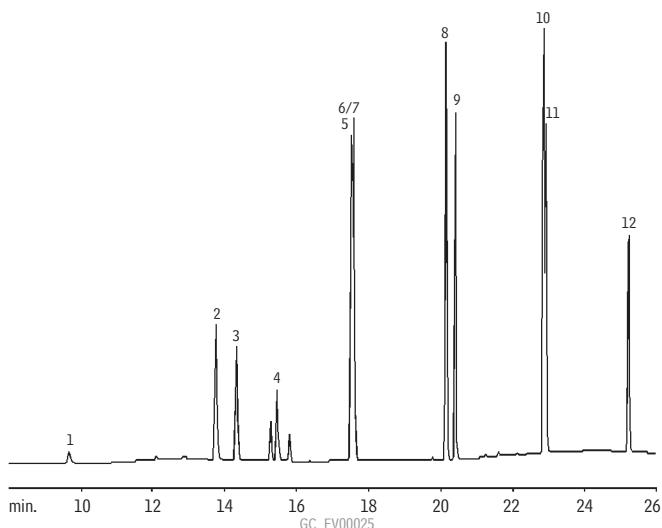
- 1
- 2

GC_EV00474



GC APPLICATIONS | ENVIRONMENTAL
Haloacetic Acids

Haloacetic Acids
US EPA Method 552.2
Rtx®-5

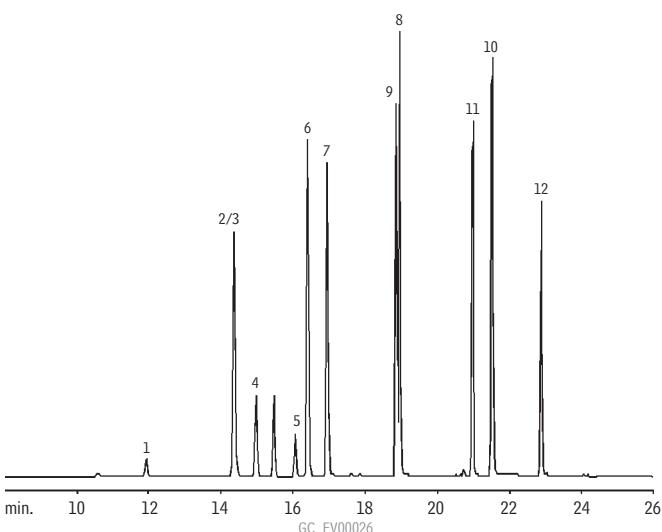


Column: Rtx®-5, 30m, 0.25mm ID, 1.0 μ m (cat.# 10253)
 Inj.: 1.0 μ L split injection, 1ng on-column concentration
 Oven temp.: 50°C (hold 10 min.) to 225°C @ 8°C/min.
 Inj./det. temp.: 200°C/290°C
 Carrier gas: helium
 Linear velocity: 30cm/sec. @ 50°C
 ECD sensitivity: 20kHz full scale
 Split ratio: 10:1

1. monochloroacetic acid (MCAA)
2. monobromoacetic acid (MBAA)
3. dichloroacetic acid (DCAA)
4. dalapon
5. 1,2,3-trichloropropane (I.S.)
6. bromochloroacetic acid (BCAA)
7. trichloroacetic acid (TCAA)
8. dibromoacetic acid (DBAA)
9. bromodichloroacetic acid (BDCAA)
10. 2,3-dibromopropionic acid (Surr.)
11. chlorodibromoacetic acid (CDBAA)
12. tribromoacetic acid (TBAA)

(All compounds derivatized)

Haloacetic Acids
US EPA Method 552.2
Rtx®-200



Column: Rtx®-200, 30m, 0.25mm ID, 1.0 μ m (cat.# 15053)
 Inj.: 1.0 μ L split injection, 1ng on-column concentration
 Oven temp.: 50°C (hold 10 min.) to 225°C @ 8°C/min.
 Inj./det. temp.: 200°C/290°C
 Carrier gas: helium
 Linear velocity: 30cm/sec. @ 50°C
 ECD sensitivity: 20kHz full scale
 Split ratio: 10:1

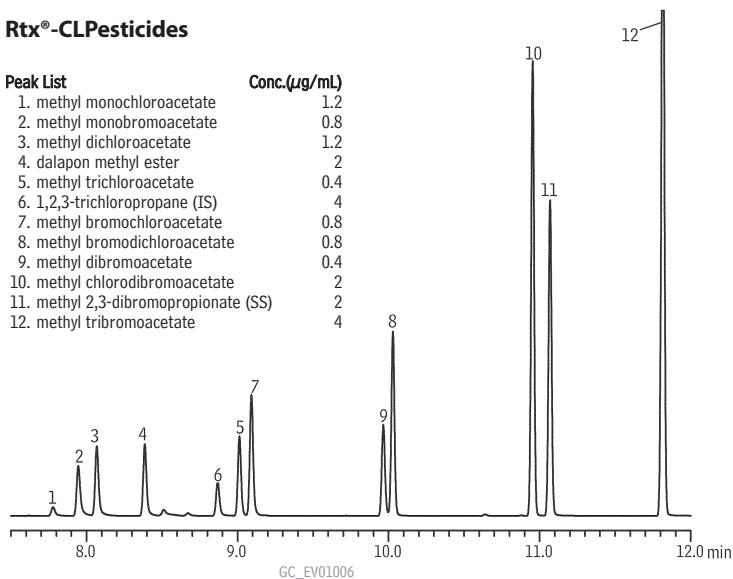


Haloacetic Acids & Dalapon
US EPA Method 552.2
Rtx®-CLPesticides & Rtx®-CLPesticides2

Rtx®-CLPesticides

Peak List

	Conc. ($\mu\text{g/mL}$)
1. methyl monochloroacetate	1.2
2. methyl monobromacetate	0.8
3. methyl dichloroacetate	1.2
4. dalapon methyl ester	2
5. methyl trichloroacetate	0.4
6. 1,2,3-trichloropropane (IS)	4
7. methyl bromochloroacetate	0.8
8. methyl bromodichloroacetate	0.8
9. methyl dibromoacetate	0.4
10. methyl chlorodibromoacetate	2
11. methyl 2,3-dibromopropionate (SS)	2
12. methyl tribromoacetate	4



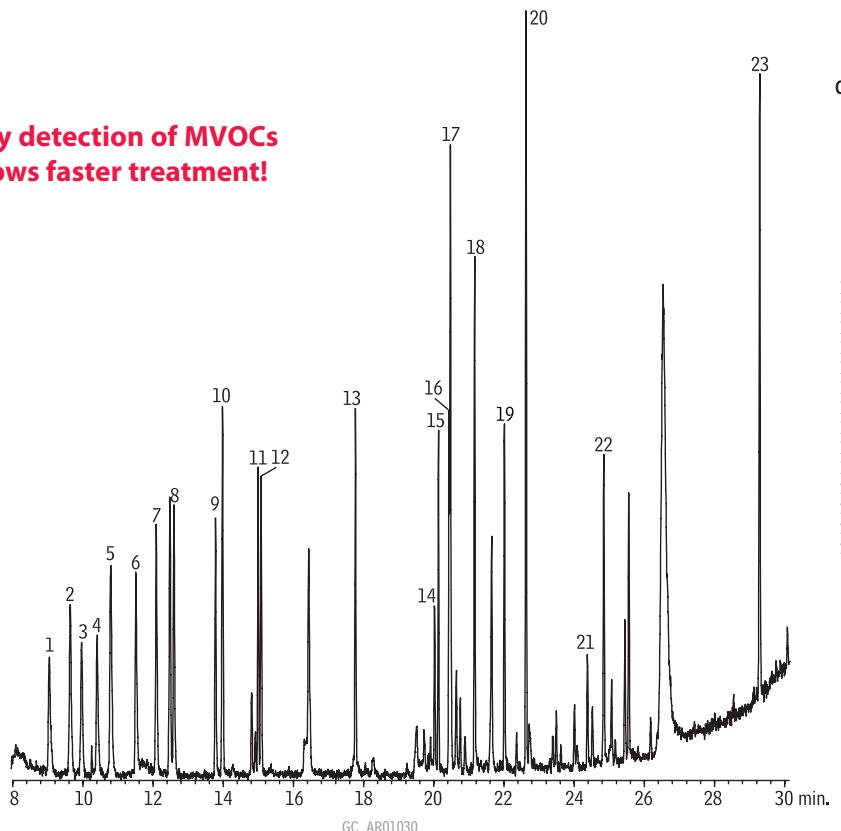
Rtx®-CLPesticides2

Column: Rtx®-CLPesticides2, 30m, 0.32mm ID, 0.25 μm (cat.# 11324) and Rtx®-CLPesticides, 30m, 0.32mm ID, 0.32 μm (cat.# 11141) with 5m x 0.32mm ID Rtx® deactivated guard tubing (cat.# 10039), connected using Universal "Y" Press-Tight® Connector (cat.# 20405-261)
 Sample: Haloacetic Acid Methyl Ester Mix #2 (cat.# 31647), Dalapon Methyl Ester (cat.# 32057), Methyl-2,3-dibromopropionate (cat.# 31656), 552.2 Internal Standard (cat.# 31648), diluted in methyl *tert*-butyl ether (MTBE)
 Inj.: 1 μL splitless (hold 0.75 min.), 4mm cyclo double gooseneck liner (cat.# 20896)
 Inj. temp.: 250°C
 Carrier gas: helium, constant flow
 Linear velocity: 25cm/sec. @ 35°C
 Oven temp.: 35°C (hold 4 min.) to 250°C (hold 5 min.) @ 15°C/min.
 Detector temp.: ECD @ 300°C

Microbial VOCs

Rxⁱ-1ms

**Early detection of MVOCs
allows faster treatment!**



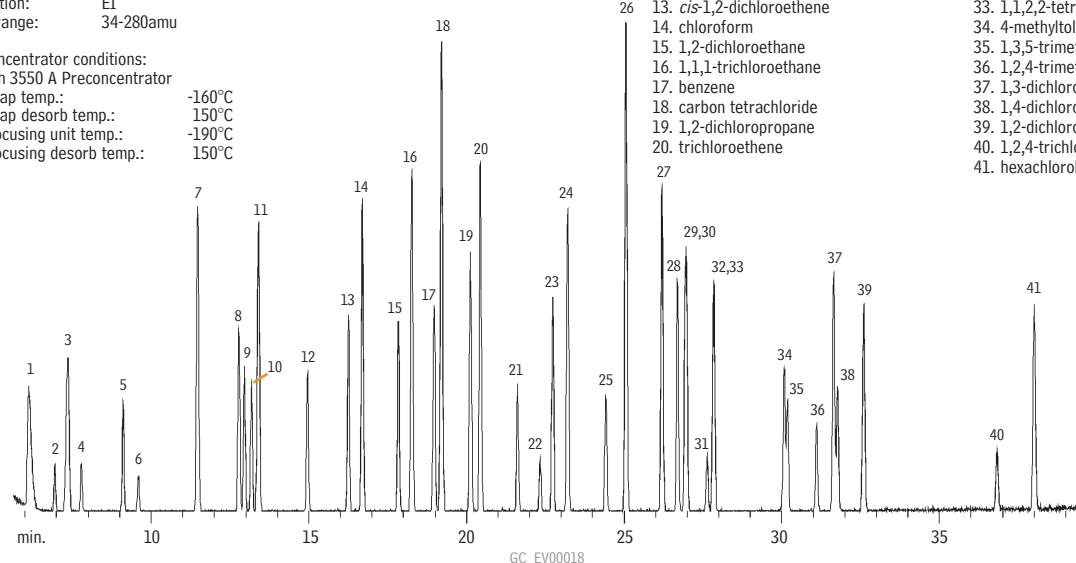
Compound	Rt (min.)
1. 2-butanone	9.047
2. 2-methyl-furan	9.640
3. 3-methyl-furan	9.962
4. 2-methyl-1-propanol	10.405
5. 2-methyl-2-butanol	10.791
6. 1-butanol	11.506
7. 3-methyl-2-butanol	12.092
8. 2-pentanol	12.592
9. 2-methyl-1-butanol	13.779
10. dimethyl-disulfide	13.979
11. 3-hexanone	14.994
12. 2-hexanone	15.080
13. 2-heptanone	17.767
14. 1-octen-3-ol	20.019
15. 3-octanone	20.133
16. 3-octanol	20.433
17. 2-pentyl-furan	20.476
18. 2-ethyl-1-hexanol	21.163
19. 1-octanol	22.013
20. 2-isopropyl-3-methoxypyrazine	22.628
21. isoborneol	24.379
22. α -terpineol	24.844
23. geosmin	28.347

Column: Rxⁱ-1ms, 60m, 0.25mm ID, 1.00 μ m (cat.# 13356)
 Sample: microbial volatile organic compounds, 2ppbv, 60% RH
 Inj.: 1.0 μ L split (split ratio 1:1),
 1mm split inlet liner (cat.# 20972)
 Inj. temp.: 200°C
 Carrier gas: helium, constant flow
 Flow rate: 1.5mL/min.
 Oven temp.: 10°C (hold 1 min.) to 235°C @ 8°C/min.
 Det: Agilent 6890/5973 GC/MS
 5 min. solvent delay
 Transfer line temp.: 260°C
 Scan range: 35 to 350amu
 Ionization: EI
 Mode: scan
 Other: Nutech 8900DS Preconcentrator
 Conditions:
 Sample = 200mL from canister
 Cryotrap1 = -160°C
 Desorb = 20°C
 Cryotrap2 = 20°C
 Desorb = 200°C
 Cryofocuser = 200°C
 Desorb = 200°C

US EPA TO-14 Compounds**Rtx®-1**

Column: Rtx®-1, 60m, 0.32mm ID, 3.0 μ m (cat.# 10187)
 Sample: 5ml of 2ppmv TO-14 standard.
 Oven temp.: 30°C (hold 4 min.) to 250°C @ 7°C/min. (hold 15 min.)
 Detector: MS
 Det. temp.: 250°C
 Carrier gas: helium
 Linear velocity: 21cm/sec. set @ 30°C
 Ionization: EI
 Scan range: 34-280amu

Preconcentrator conditions:
 Nutech 3550 A Preconcentrator
 Cryotrap temp.: -160°C
 Cryotrap desorb temp.: 150°C
 Cryofocusing unit temp.: -190°C
 Cryofocusing desorb temp.: 150°C

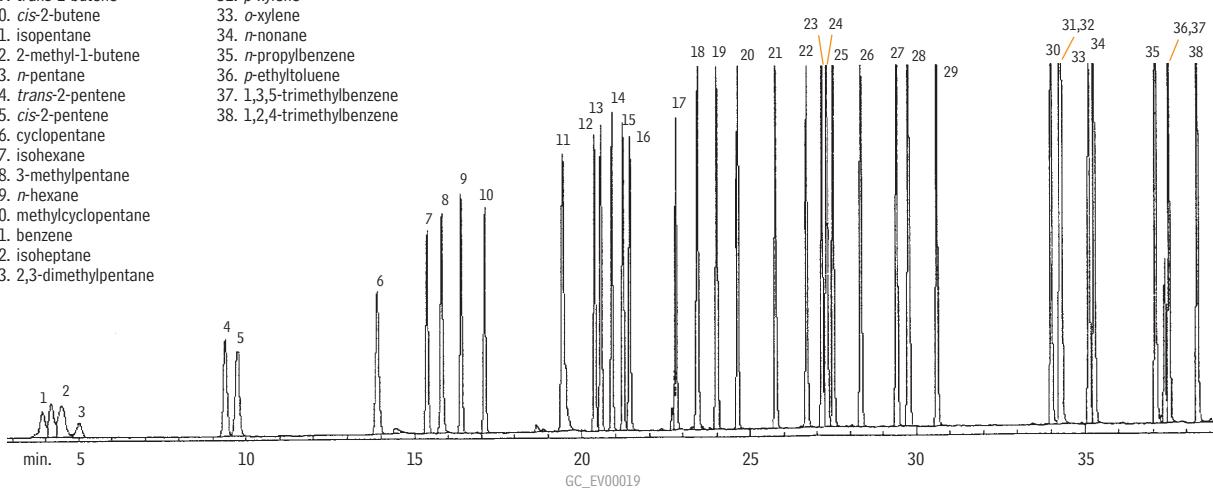


1. dichlorodifluoromethane
2. chloromethane
3. 1,2-dichlorotetrafluoroethane
4. vinyl chloride
5. bromomethane
6. chloroethane
7. trichlorofluoromethane
8. 1,1-dichloroethene
9. methylene chloride
10. 3-chloropropene
11. 1,1,2-trichloro-1,2,2-trifluoroethane
12. 1,1-dichloroethane
13. *cis*-1,2-dichloroethene
14. chloroform
15. 1,2-dichloroethane
16. 1,1,1-trichloroethane
17. benzene
18. carbon tetrachloride
19. 1,2-dichloropropane
20. trichloroethylene
21. *cis*-1,3-dichloropropene
22. *trans*-1,3-dichloropropene
23. 1,1,2-trichloroethane
24. toluene
25. 1,2-dibromoethane
26. tetrachloroethene
27. chlorobenzene
28. ethylbenzene
29. *m*-xylene
30. *p*-xylene
31. styrene
32. *o*-xylene
33. 1,1,2,2-tetrachloroethane
34. 4-methyltoluene
35. 1,3,5-trimethylbenzene
36. 1,2,4-trimethylbenzene
37. 1,3-dichlorobenzene
38. 1,4-dichlorobenzene
39. 1,2-dichlorobenzene
40. 1,2,4-trichlorobenzene
41. hexachlorobutadiene

Ozone Precursors**Rtx®-1**

1. ethylene
2. acetylene
3. ethane
4. propylene
5. propane
6. isobutane
7. 1-butene
8. *n*-butane
9. *trans*-2-butene
10. *cis*-2-butene
11. isopentane
12. 2-methyl-1-butene
13. *n*-pentane
14. *trans*-2-pentene
15. *cis*-2-pentene
16. cyclopentane
17. isohexane
18. 3-methylpentane
19. *n*-hexane
20. methylcyclopentane
21. benzene
22. isoheptane
23. 2,3-dimethylpentane
24. 3-methylhexane
25. 2,2,4-trimethylpentane
26. *n*-heptane
27. methylcyclohexane
28. 2,2,3-trimethylpentane
29. toluene
30. ethylbenzene
31. *m*-xylene
32. *p*-xylene
33. *o*-xylene
34. *n*-nonane
35. *n*-propylbenzene
36. *p*-ethyltoluene
37. 1,3,5-trimethylbenzene
38. 1,2,4-trimethylbenzene

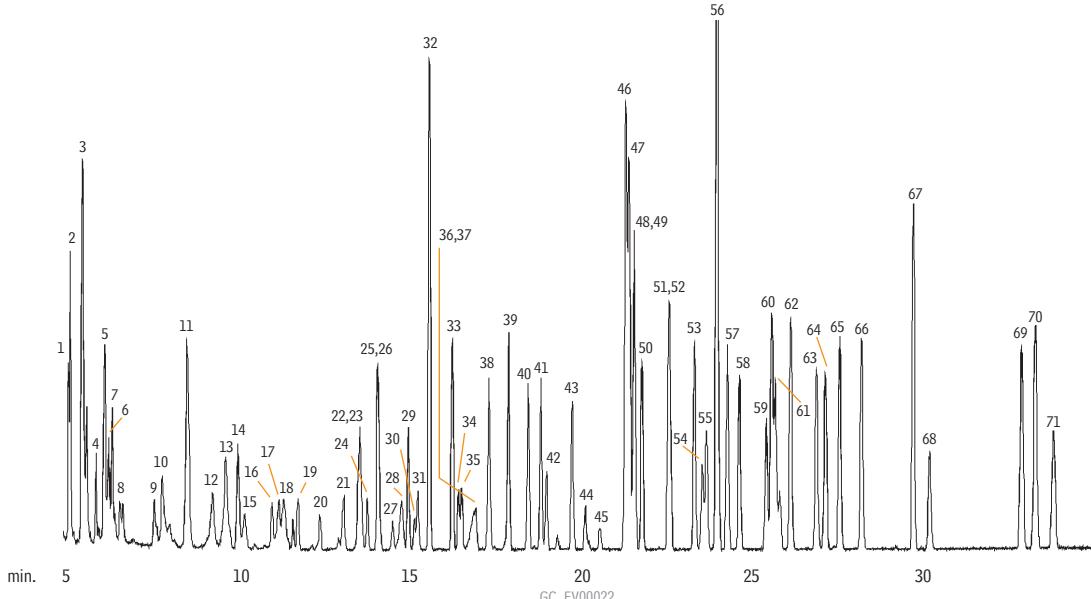
Column: Rtx®-1, 60m, 0.32mm ID, 3.0 μ m (cat.# 10187)
 Sample: 0.5L of C2-C9 gas standard cryogenically concentrated; 15nl/component desorbed onto column.
 Oven temp.: -60°C (hold 5 min.) to 100°C @ 8°C/min., to 150°C @ 6°C/min., then to 240°C @ 8°C/min.
 Carrier gas: helium
 Linear velocity: 30cm/sec. (flow rate: 1.8cc/min.)
 FID sensitivity: 64 x 10⁻¹² AFS



Permission to publish this chromatogram granted by Radian Corporation.

Air Toxins

Rtx®-502.2



1. chlorodifluoromethane
2. dichlorodifluoromethane
3. dichlorotetrafluoroethane
4. chloromethane
5. butane
6. vinyl chloride
7. 1,3-butadiene
8. acetaldehyde
9. bromomethane
10. chloroethane
11. trichlorofluoromethane
12. isopropanol
13. acetone
14. 1,1-dichloroethene
15. acetonitrile
16. dichloromethane
17. acrylonitrile
18. 1-propanol

19. *trans*-1,2-dichloroethene
20. 1,1-dichloroethane
21. methyl ethyl ketone
22. *cis*-1,2-dichloroethene
23. methacrylonitrile
24. chloroform
25. bromochloromethane
26. tetrahydrofuran
27. 1,1,1-trichloroethane
28. *n*-butanol
29. heptane
30. 1,2-dichloroethane
31. benzene
32. 1,4-difluorobenzene
33. trichloroethene
34. ethyl methacrylate
35. 1,2-dichloropropane
36. 1,4-dioxane

37. bromodichloromethane
38. 4-methyl-2-pentanone
39. octane
40. toluene
41. 2-hexanone
42. 1,1,2-trichloroethane
43. tetrachloroethene
44. dibromochloromethane
45. 1,2-dibromoethane
46. chlorobenzene-d5
47. chlorobenzene
48. *m*-xylene
49. *p*-xylene
50. 2-heptanone
51. styrene
52. *o*-xylene
53. isopropylbenzene
54. bromoform

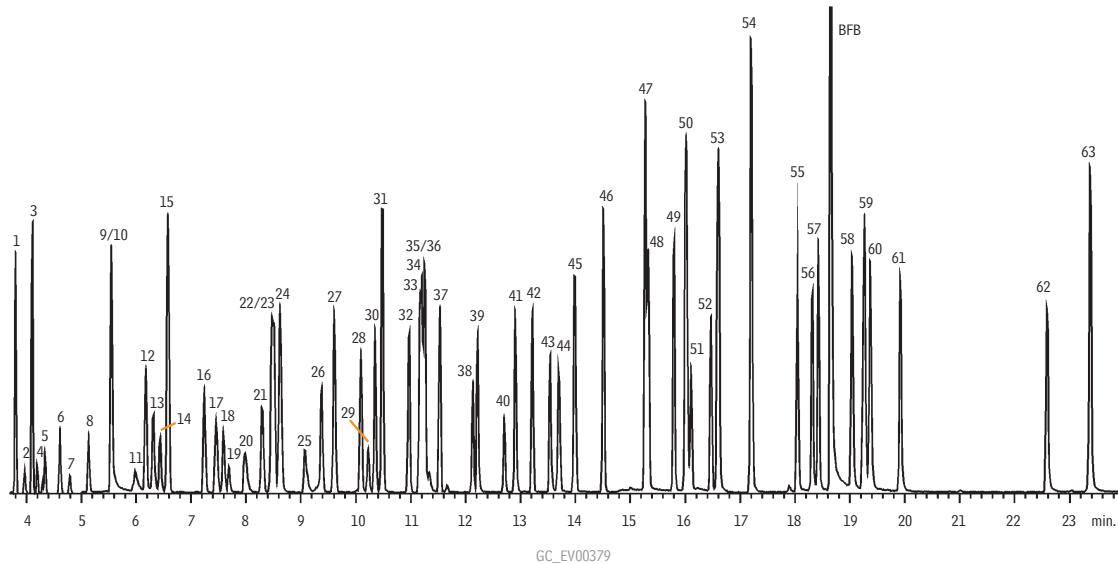
55. 1,1,1,2-tetrachloroethane
56. 4-bromofluoromethane
57. *n*-propylbenzene
58. 1,3,5-trimethylbenzene
59. α -methylstyrene
60. *tert*-butylbenzene
61. 1,2,4-trimethylbenzene
62. sec-butylbenzene
63. 1,3-dichlorobenzene
64. 1,4-dichlorobenzene
65. butylbenzene
66. 1,2-dichlorobenzene
67. dodecane
68. dibromochloropropane
69. 1,2,4-trichlorobenzene
70. hexachlorobutadiene
71. naphthalene

Column: Rtx®-502.2, 60m, 0.32mm ID, 1.8 μ m (cat.# 10920)
 Sample: 500mL of 10ppbv standard concentrated on an AEROCAN 6000 using a glass bead trap at 165°C then desorbed at 200°C for 4 min. @ 1mL/min., cryofocused @ -175°C then desorbed @ 150°C
 Oven temp.: 35°C (hold 6 min.) to 120°C @ 15°C/min., then to 200°C @ 5°C/min., then to 220°C @ 25°C/min. (hold 10 min.)
 Det. & det. temp.: Agilent-5971A GC/MS, 280°C
 Carrier gas: helium @ 1mL/min.
 Linear velocity: 20cm/sec.
 Scan range: 28-260amu
 Solvent delay: 4 min.

Permission to publish this chromatogram granted by Tekmar Company.

US EPA TO-14/TO-15 Compounds

Rtx®-1



Column: Rtx®-1, 60m, 0.32mm ID, 1.0 μ m (cat.# 10157)
 Sample: 200mL of 10ppbv TO-15 standard, injected into TO-Can® canister and humidified to 70% RH.
 Concentrator: Nutech 3550 Preconcentrator
 200mL of sample concentrated at -160°C, thermally desorbed at 150°C, and cryofocused at -185°C
 Oven temp.: 30°C (hold 4 min.) to 175°C @ 9°C/min. to 220°C @ 40°C/min.
 Carrier gas: helium @ 1.2mL/min.
 Det.: Agilent 5971 MS
 Scan range: 35-265amu

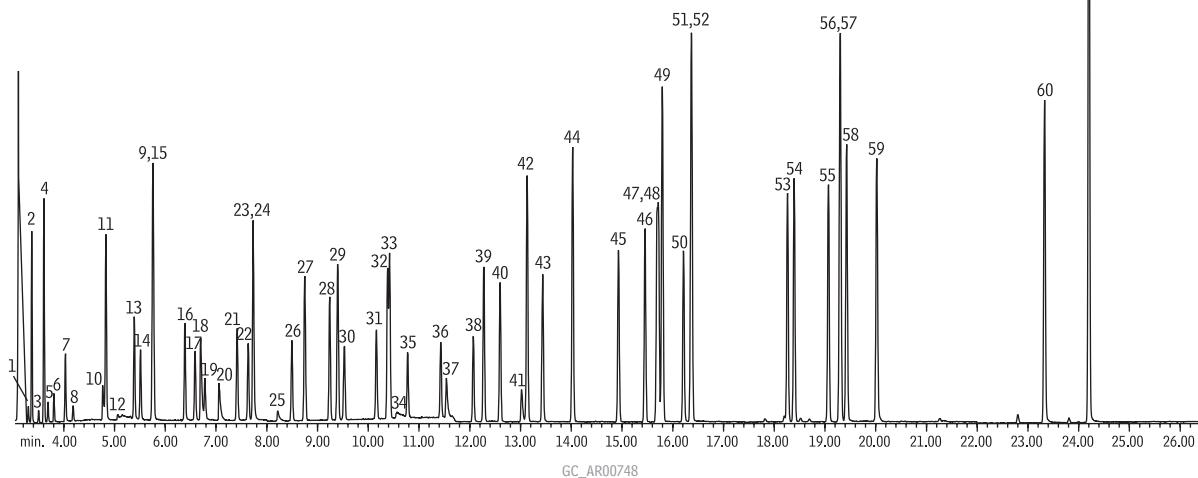
1. dichlorofluoromethane	23. <i>n</i> -hexane	45. 1,2-dibromoethane
2. chloromethane	24. chloroform	46. tetrachloroethene
3. dichlorotetrafluoroethane	25. tetrahydrofuran	47. chlorobenzene-d5 (IS)
4. vinyl chloride	26. 1,2-dichloroethane	48. chlorobenzene
5. 1,3-butadiene	27. 1,1,1-trichloroethane	49. ethylbenzene
6. bromomethane	28. benzene	50a. <i>m</i> -xylene
7. chloroethane	29. carbon tetrachloride	50b. <i>p</i> -xylene
8. bromoethene	30. cyclohexane	51. bromoform
9. acetone	31. 1,4-difluorobenzene (IS)	52. styrene
10. trichlorofluoromethane	32. 1,2-dichloropropane	53. 1,1,2,2-tetrachloroethane
11. isopropyl alcohol	33. bromodichloromethane	54. <i>o</i> -xylene
12. 1,1-dichloroethene	34. trichloroethene	55. 2-chlorotoluene
13. methylene chloride	35. 1,4-dioxane	56. 4-ethyltoluene
14. 3-chloropropene	36. 2,2,4-trimethylpentane	57. 1,3,5-trimethylbenzene
15. carbon disulfide	37. <i>n</i> -heptane	58. 1,2,4-trimethylbenzene
16. Freon® TF	38. <i>cis</i> 1,3-dichloropropene	59. 1,3-dichlorobenzene
17. <i>trans</i> 1,2-dichloroethene	39. methyl isobutyl ketone	60. 1,4-dichlorobenzene
18. 1,1-dichloroethane	40. <i>trans</i> 1,3-dichloropropene	61. 1,2-dichlorobenzene
19. methyl <i>tert</i> -butyl ether	41. 1,1,2-trichloroethane	62. 1,2,4-trichlorobenzene
20. methyl ethyl ketone	42. toluene	63. hexachlorobutadiene
21. <i>cis</i> 1,2-dichloroethene	43. methyl butyl ketone	
22. bromochloromethane (IS)	44. dibromochloromethane	

Chromatogram courtesy of Gina Maio, Severn Trent Laboratories, Inc., Burlington, VT.

US EPA TO-15 Compounds

Rtx®-1

Column: Rtx®-1, 60m, 0.32mm ID, 1.0 μ m (cat.# 10157)
 Sample: TO-15 standard (cat.# 34436) humidified to 33% RH in a 6L SilcoCan™ canister (cat.# 24182)
 Concentrator: Nutech 3550A Preconcentrator; 300mL sample concentrated at -160°C, thermally desorbed at 150°C, cryofocused at -185°C, thermally desorbed to column at 150°C
 Carrier gas: helium, constant flow
 Flow rate: 1.2mL/min.
 Oven temp.: 30°C (hold 4 min.) to 175°C @ 8°C/min., to 220°C @ 20°C/min. (hold 2 min.)
 Det.: MS
 Transfer line temp.: 150°C
 Scan range: 35–280amu
 Ionization: EI
 Mode: scan



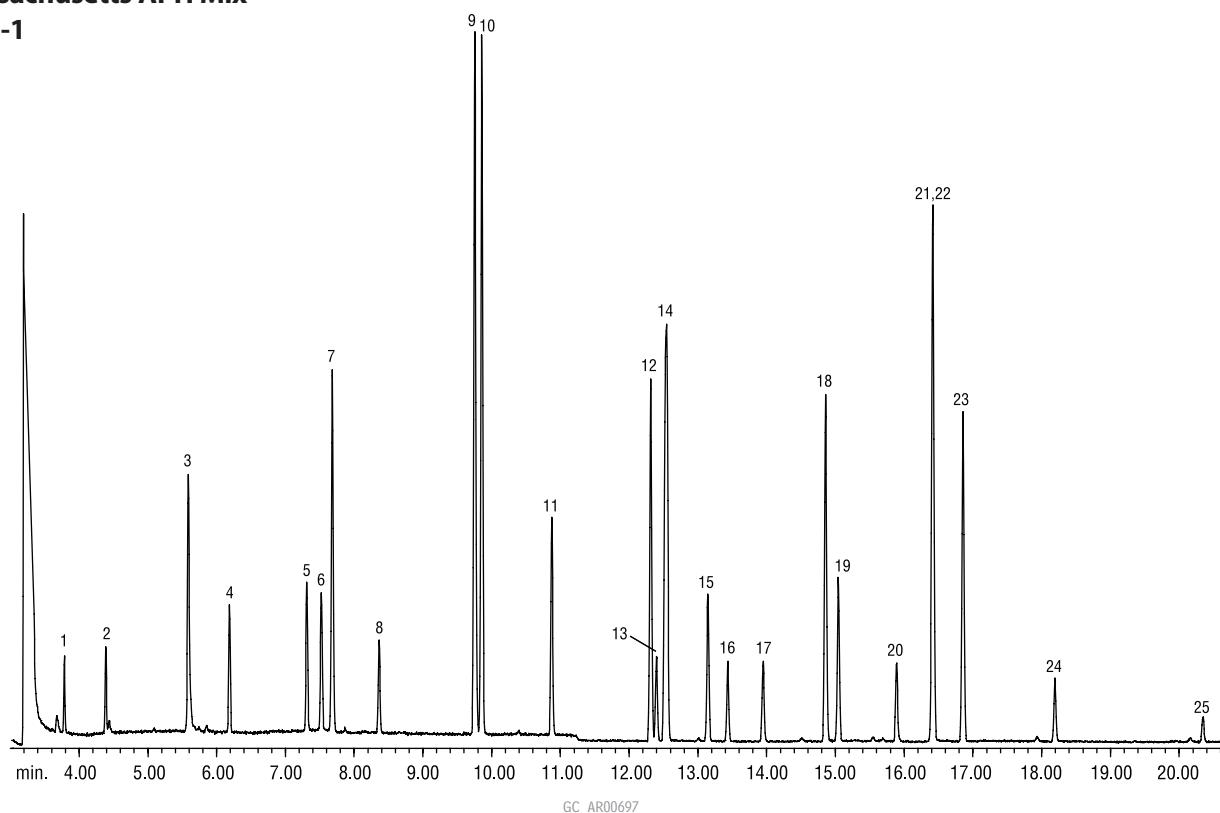
1. propylene
2. Freon®-12 (dichlorodifluoromethane)
3. chloromethane
4. Freon®-114 (dichlorotetrafluoroethane)
5. vinyl chloride
6. 1,3-butadiene
7. bromomethane
8. chloroethane
9. carbon disulfide
10. acetone
11. Freon®-11 (trichlorofluoromethane)
12. isopropyl alcohol
13. 1,1-dichloroethene
14. methylene chloride
15. Freon®-113 (1,1,2-trichloro-1,2,2-trifluoroethane)
16. *trans*-1,2-dichloroethene
17. 1,1-dichloroethane
18. methyl *tert*-butyl ether
19. vinyl acetate
20. methyl ethyl ketone
21. *cis*-1,2-dichloroethene

22. hexane
23. chloroform
24. ethyl acetate
25. tetrahydrofuran
26. 1,2-dichloroethane
27. 1,1,1-trichloroethane
28. benzene
29. carbon tetrachloride
30. cyclohexane
31. 1,2-dichloropropane
32. trichloroethylene
33. bromodichloromethane
34. 1,4-dioxane
35. heptane
36. *cis*-1,3-dichloropropene
37. methyl isobutyl ketone
38. *trans*-1,3-dichloropropene
39. 1,1,2-trichloroethane
40. toluene
41. methyl butyl ketone
42. dibromochloromethane

43. 1,2-dibromoethane
44. tetrachloroethylene
45. chlorobenzene
46. ethylbenzene
47. *p*-xylene
48. *m*-xylene
49. bromoform
50. styrene
51. *o*-xylene
52. 1,1,2,2-tetrachloroethane
53. 4-ethyltoluene
54. 1,3,5-trimethylbenzene
55. 1,2,4-trimethylbenzene
56. 1,3-dichlorobenzene
57. benzyl chloride
58. 1,4-dichlorobenzene
59. 1,2-dichlorobenzene
60. 1,2,4-trichlorobenzene
61. hexachloro-1,3-butadiene



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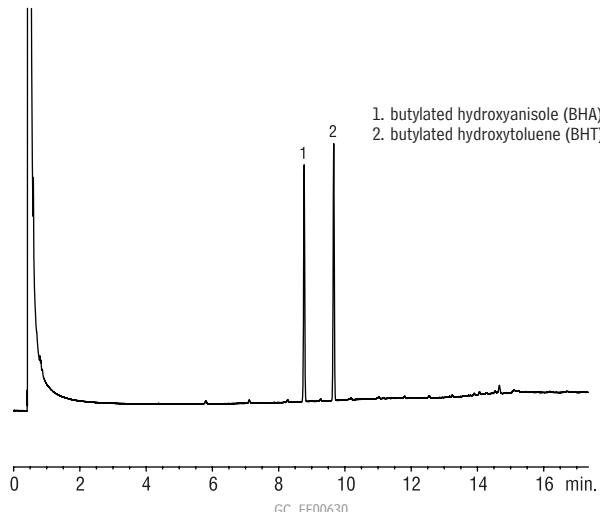
Massachusetts APH Mix**Rtx®-1**

Column: Rtx®-1, 60m, 0.32mm ID, 1.0 μ m (cat.# 10157)
 Sample: Massachusetts APH Mix, (cat.# 34446)
 Concentrator: Nutech 3550A Air Preconcentrator, 100mL of a 40ppbv standard concentrated at -160°C, thermally desorbed at 150°C and cryofocused at -185°C
 Carrier gas: helium
 Flow rate: 1mL/min.
 Oven temp.: 35°C (hold 1 min.) to 220°C @ 8°C/min.
 Det: MS, Agilent 5971
 Transfer line temp.: 250°C
 Scan range: 35-280amu
 Ionization: EI
 Mode: scan

1. 1,3-butadiene
 2. isopentane
 3. methyl *tert*-butyl ether
 4. hexane
 5. benzene
 6. cyclohexane
 7. 2,3-dimethylpentane
 8. heptane
 9. toluene-D8
 10. toluene
 11. octane
 12. ethylbenzene
 13. 2,3-dimethylheptane
 14. *m*-xylene
 14a. *p*-xylene
 14b. *o*-xylene
 15. nonane
 16. isopropylbenzene
 17. 1-methyl-3-ethylbenzene
 18. 1,3,5-trimethylbenzene
 19. 1,3,5-trimethylbenzene
 20. decane
 21. 1,2,3-trimethylbenzene
 22. *p*-isopropyltoluene
 23. butylcyclohexane
 24. undecane
 25. dodecane



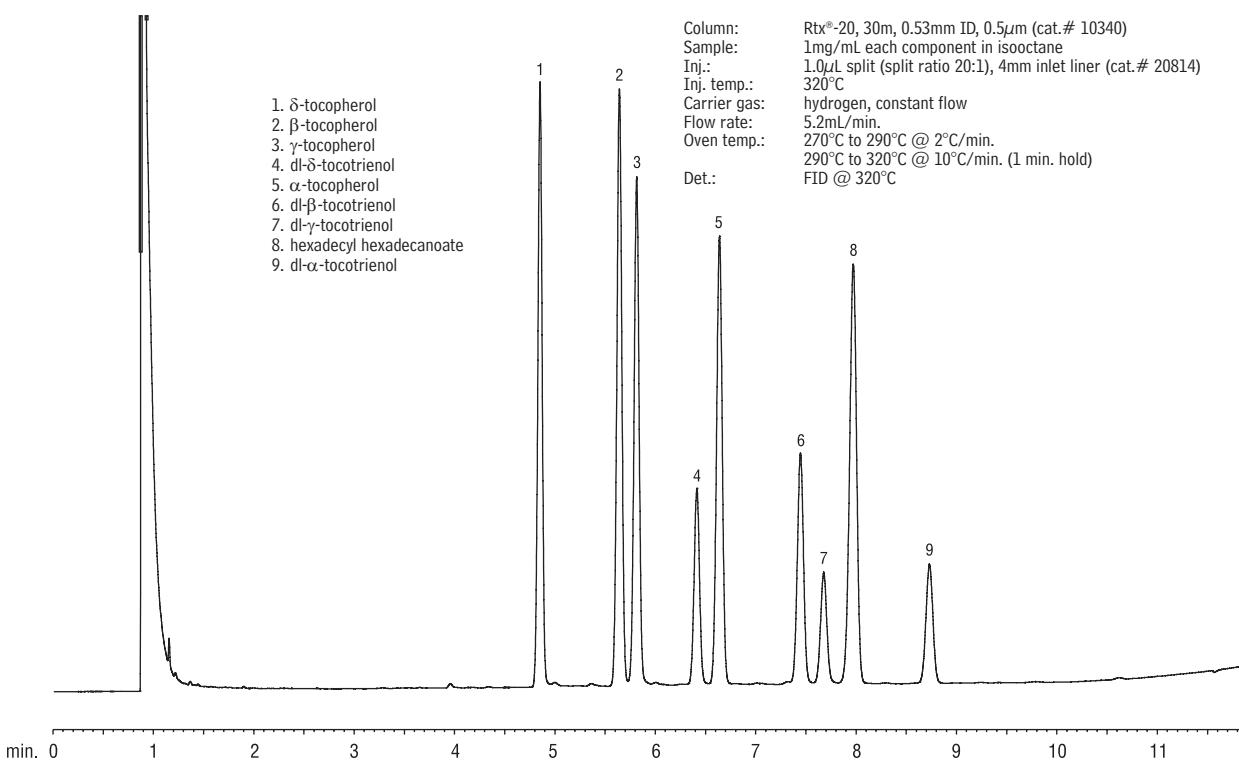
BHA and BHT
Rtx[®]-50



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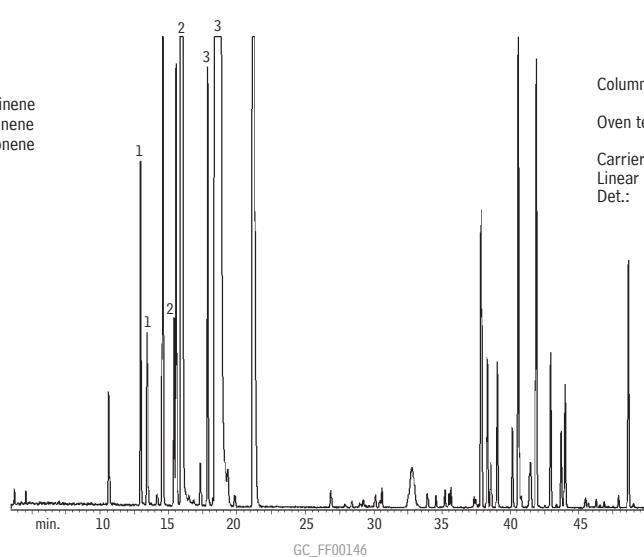
Column: Rtx[®]-50, 30m, 0.53mm ID, 0.50 μ m (cat.# 10540)
 Sample: 50ppm each in methanol
 Inj.: 1.0 μ L direct, gooseneck splitless inlet liner, 4mm (cat.# 20798)
 Inj. temp.: 280°C
 Carrier gas: helium, constant pressure
 Linear velocity: 60cm/sec. @ 50°C
 Oven temp.: 50°C to 240°C @ 15°C/min. (hold 3 min.)
 Det.: FID @ 280°C

Tocopherols and Tocotrienols
Rtx[®]-20



Lemon Oil
Rt®- β DEXsm

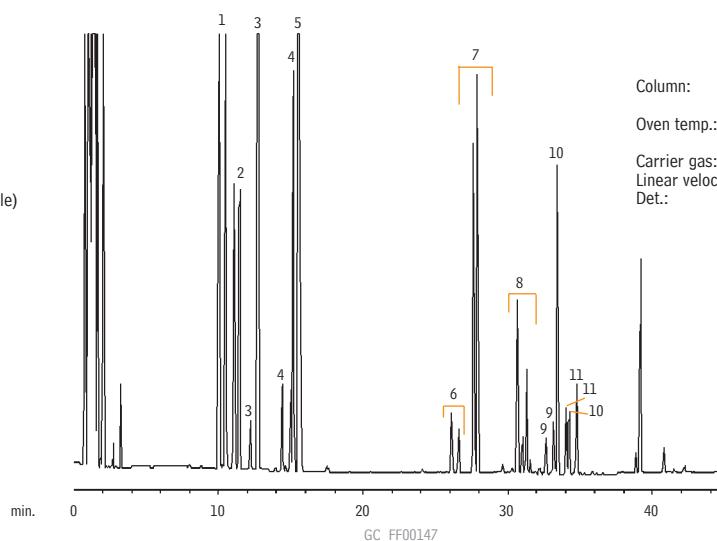
- 1. (-/+) α -pinene
- 2. (+/-) β -pinene
- 3. (-/+)limonene



Column: Rt®- β DEXsm, 30m, 0.32mm ID, 0.25 μ m
 (cat.# 13104)
 Oven temp.: 40°C (hold 1 min.) to 200°C @ 2°C/min. (hold 3 min.)
 Carrier gas: hydrogen
 Linear velocity: 80cm/sec.
 Det.: FID @ 220°C

Rosemary Oil
Rt®- β DEXsm

- 1. (-/+) α -pinene
- 2. (+/-)camphephene
- 3. (+/-) β -pinene
- 4. (-/+)limonene
- 5. eucalyptol (1,8-cineole)
- 6. (-/+)linalool
- 7. (+/-)campphor
- 8. (-/+)terpinen-4-ol
- 9. (+/-)isoborneol
- 10. (+/-)borneol
- 11. (+/-) α -terpineol

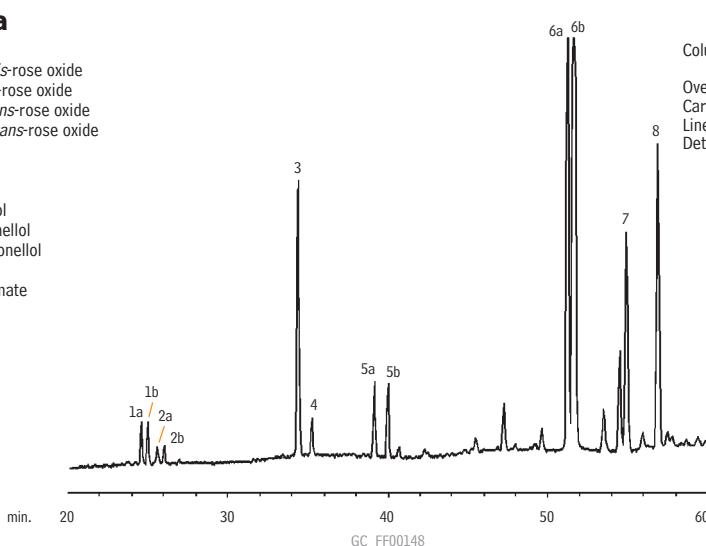


Column: Rt®- β DEXsm, 30m, 0.32mm ID, 0.25 μ m
 (cat.# 13104)
 Oven temp.: 40°C (hold 1 min.) to 200°C
 @ 2°C/min. (hold 3 min.)
 Carrier gas: hydrogen
 Linear velocity: 80cm/sec.
 Det.: FID @ 220°C

Geranium Oil (Commercial)

Rt®- β DEXsa

- 1a. (+)-(2R,4S)-*cis*-rose oxide
- 1b. (-)(2S,4R)-*cis*-rose oxide
- 2a. (-)(2R,4R)-*trans*-rose oxide
- 2b. (+)-(2S,4S)-*trans*-rose oxide
- 3. isomenthone
- 4. menthone
- 5a. (-)(R)-linalool
- 5b. (+)(S)-linalool
- 6a. (-)(S)- β -citronellol
- 6b. (+)(R)- β -citronellol
- 7. geraniol
- 8. citronellyl formate

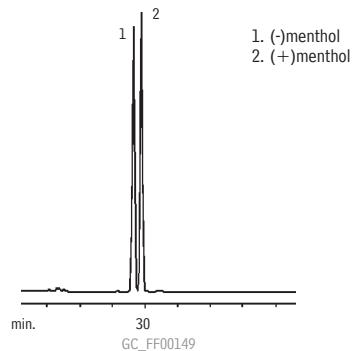


Column: Rt®- β DEXsa, 30m, 0.25mm ID, 0.25 μ m
 (cat.# 13109)
 Oven temp.: 60°C to 110°C @ 1°C/min. (hold 30 min.)
 Carrier gas: hydrogen
 Linear velocity: 40cm/sec. set @ 60°C
 Det.: FID @ 220°C

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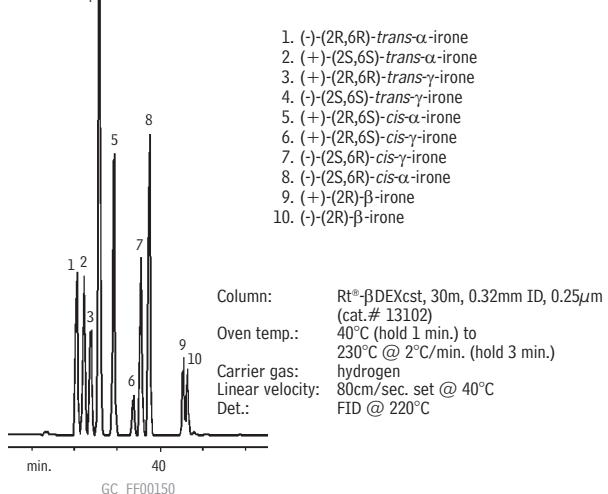
Chiral Separations

Menthol - Rt®- β DEXsp

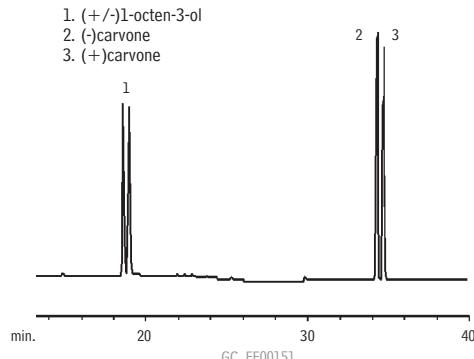


Column: Rt®- β DEXsp, 30m, 0.32mm ID, 0.25 μ m (cat.# 13110)
Oven temp.: 60°C (hold 1 min.) to 200°C @ 2°C/min.
Carrier gas: hydrogen
Linear velocity: 80cm/sec. set @ 40°C
Det.: FID @ 220°C

Irone Isomers - Rt®- β DEXcst

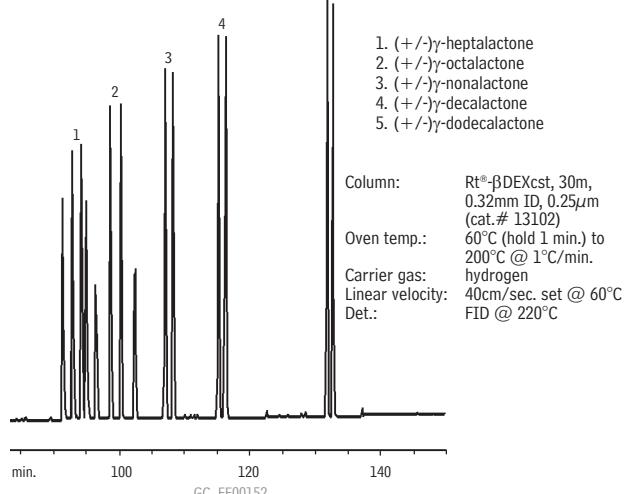


1-octen-3-ol and carvone - Rt®- β DEXsa

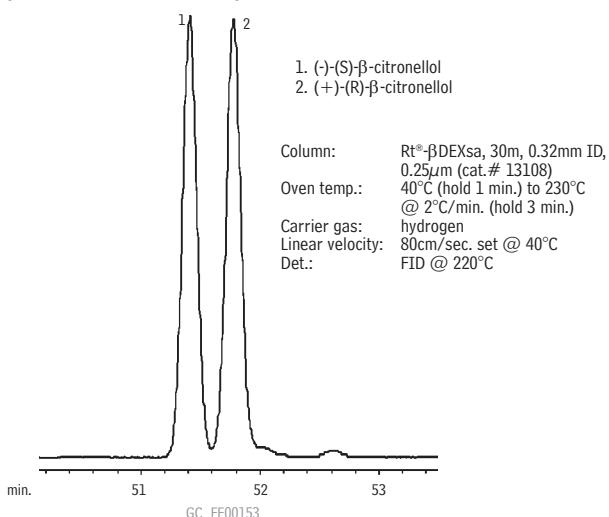


Column: Rt®- β DEXsa, 30m, 0.32mm ID, 0.25 μ m (cat.# 13108)
Oven temp.: 40°C (hold 1 min.) to 230°C @ 2°C/min. (hold 3 min.)
Carrier gas: hydrogen
Linear velocity: 80cm/sec. set @ 40°C
Det.: FID @ 220°C

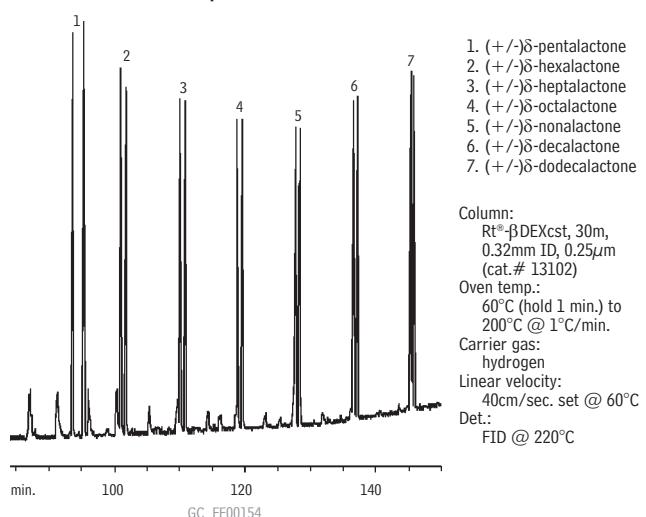
γ -lactones - Rt®- β DEXcst



β -citronellol - Rt®- β DEXsa



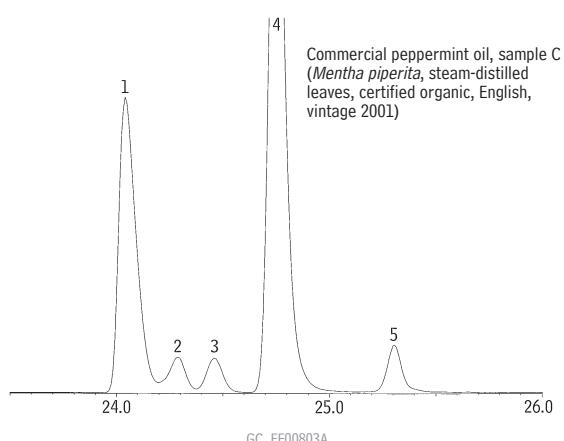
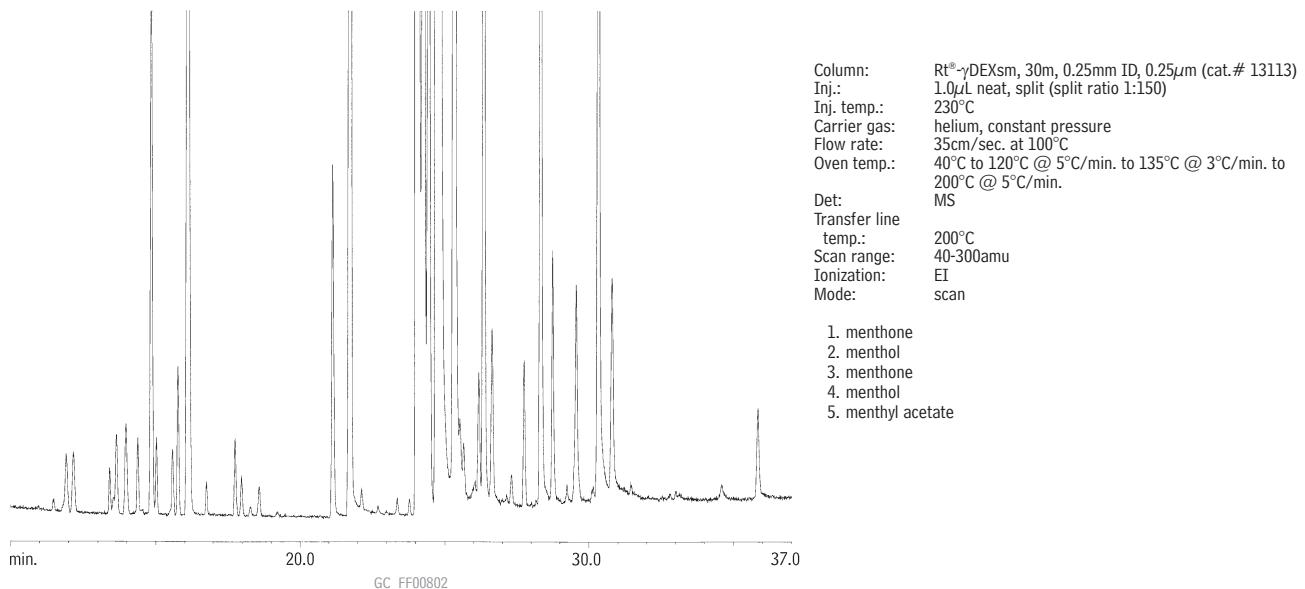
δ -lactones - Rt®- β DEXcst



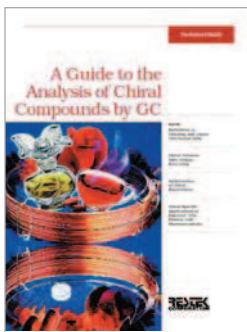


Commercial Peppermint Oil Rt[®]- γ DEXsm

Commercial peppermint oil, sample B



free literature



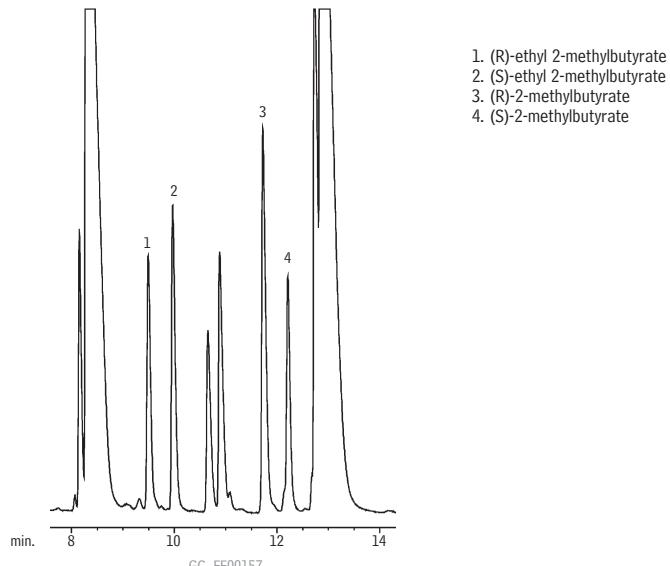
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Many example chromatograms in our 24-page chiral analysis guide will help you find the best chiral column, or columns, for your application.

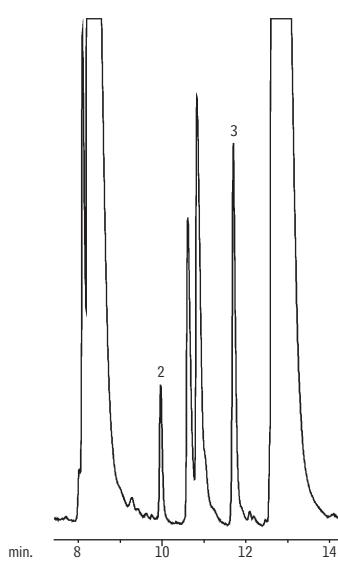
Call Restek at **800-356-1688 or 814-353-1300, ext. 5**, or contact your Restek representative, to request your free copy!

Technical Guide
lit. cat.# 59889

**Apple Juice with Standards
 Rt[®]- β DEXse**

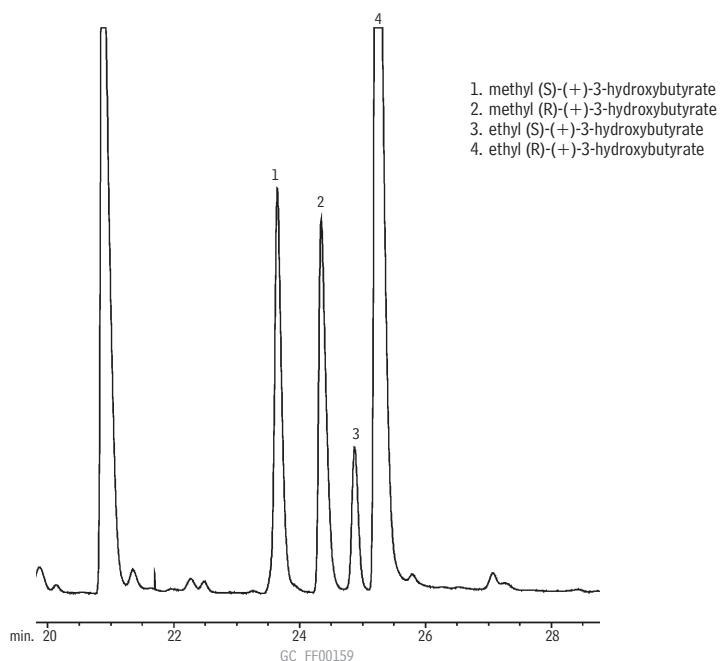


**Apple Juice
 Rt[®]- β DEXse**



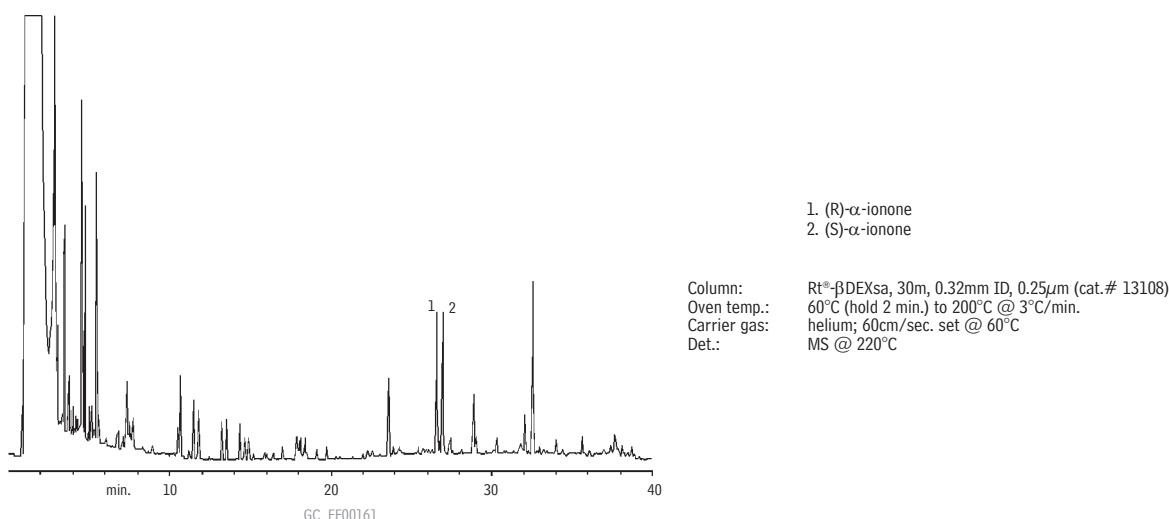
Column: Rt[®]- β DEXse, 30m, 0.32mm ID, 0.25 μ m (cat.# 13106)
 Inj.: 1.0 μ L split injection
 On-column conc.
 (standards): ~50ng
 Oven temp.: 40°C (hold 1 min.) to 220°C @ 2°C/min.
 Inj./det. temp.: 220°C
 Carrier gas: hydrogen
 Linear velocity: 80cm/sec.

**Grape Juice Extract
 Rt[®]- γ DEXsa**

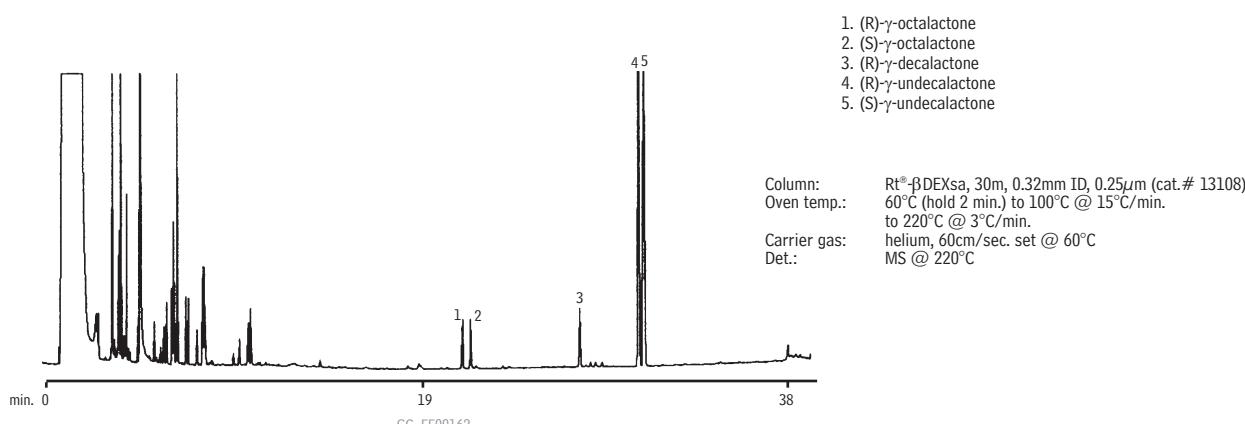


Column: Rt[®]- γ DEXsa, 30m, 0.32mm ID, 0.25 μ m (cat.# 13112)
 Inj.: 1.0 μ L split injection
 On-column conc.: ~150ng/enantiomer
 Oven temp.: 40°C (hold 1 min.) to 200°C @ 2°C/min.
 Inj./det. temp.: 220°C/230°C
 Carrier gas: hydrogen
 Linear velocity: 80cm/sec. set @ 40°C
 Split ratio: 25:1

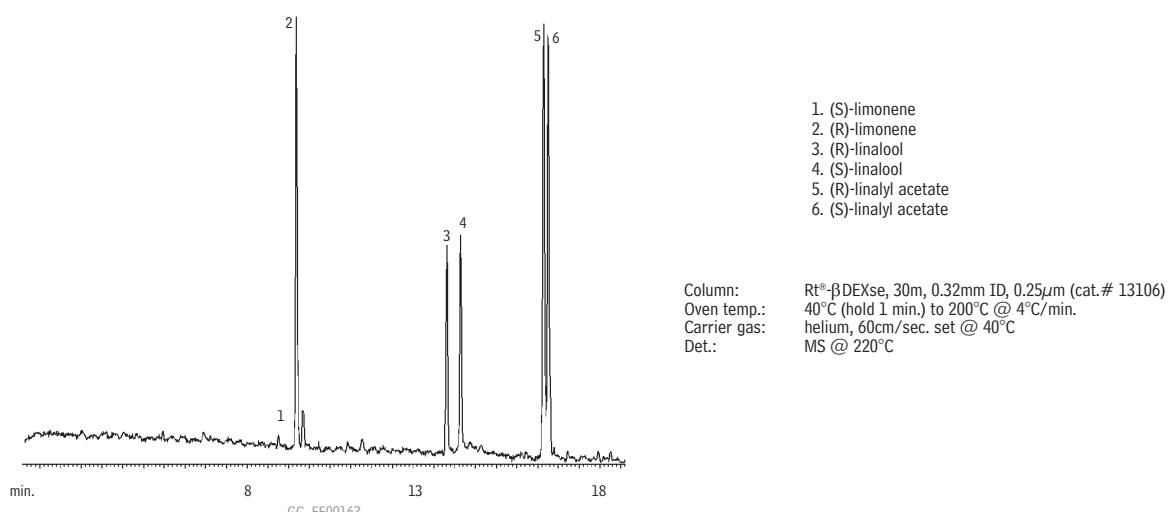
Raspberry Flavor - Rt®- β DEXsa



Peach/Vanilla Flavor - Rt®- β DEXsa

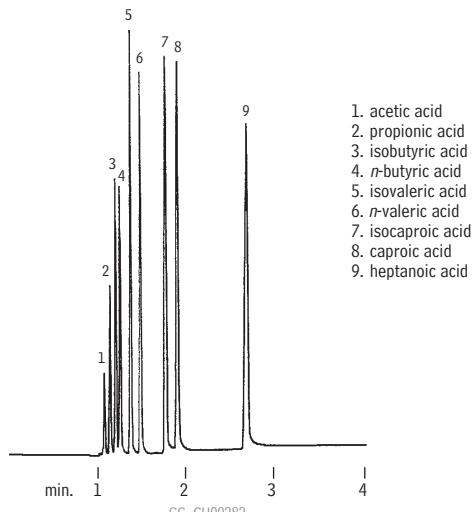


Bergamot Flavor - Rt®- β DEXse



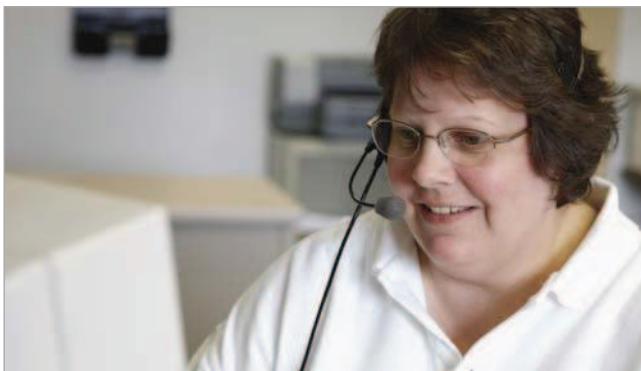
Fatty Acids

Fatty Acids (Free)

Rtx[®]-200**No derivatization
needed!**

1. acetic acid
2. propionic acid
3. isobutyric acid
4. n-butyric acid
5. isovaleric acid
6. n-valeric acid
7. isocaproic acid
8. caproic acid
9. heptanoic acid

Column: Rtx[®]-200, 30m, 0.25mm ID, 0.25 μ m (cat.# 15023)
 Sample: 0.8 μ L split injection of a free fatty acid standard
 Conc.: approximately 10 to 20ng/ μ L
 Oven temp.: 90°C
 Inj./det. temp.: 250°C
 Carrier gas: hydrogen
 Linear velocity: 40cm/sec. (flow rate: 1.4cc/min.)
 FID sensitivity: 4 x 10¹¹ AFS
 Split vent: 40cc/min.



Paula Zuchowski, Customer Service

Restek Customer Service

In the U.S.

Call: 800-356-1688 (ext. 3) or 814-353-1300 (ext. 3)

Monday–Friday 8:00 a.m.–6:00 p.m. ET

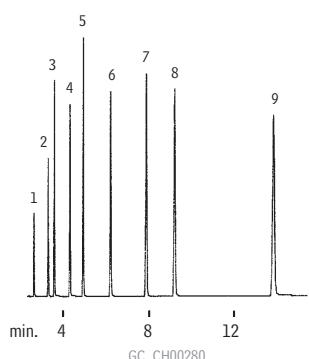
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Contact your Restek representative:

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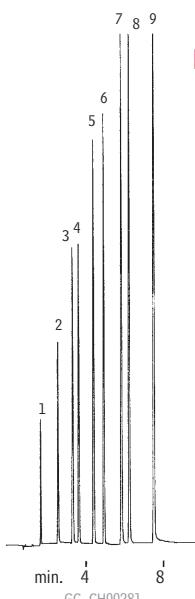
Fatty Acids (Free)

Stabilwax[®]-DA**No derivatization
needed!**

1. acetic acid
2. propionic acid
3. isobutyric acid
4. n-butyric acid
5. isovaleric acid
6. n-valeric acid
7. isocaproic acid
8. caproic acid
9. heptanoic acid

Column: Stabilwax[®]-DA, 30m, 0.25mm ID, 0.25 μ m (cat.# 11023)
 Sample: 1.0 μ L split injection of a free acid standard
 Conc.: approximately 10 to 20ng/ μ L
 Oven temp.: 145°C
 Inj./det. temp.: 250°C
 Carrier gas: hydrogen
 Linear velocity: 40cm/sec.
 FID sensitivity: 2 x 10¹¹ AFS
 Split ratio: 50:1

Fatty Acids (Free)

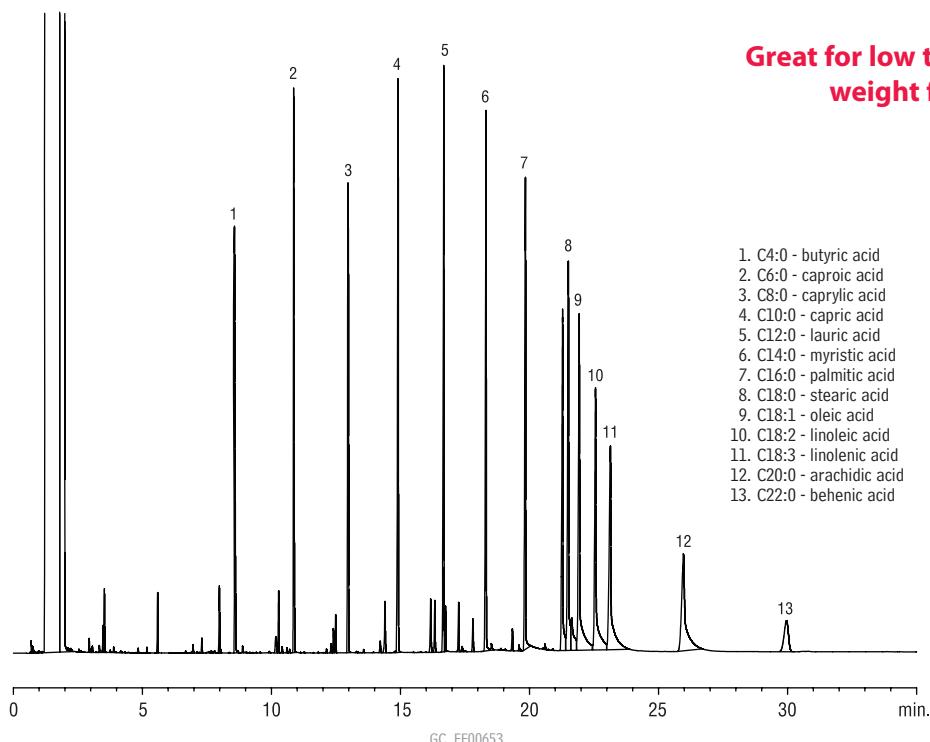
Rtx[®]-1**No derivatization
needed!**

1. acetic acid
2. propionic acid
3. isobutyric acid
4. n-butyric acid
5. isovaleric acid
6. n-valeric acid
7. isocaproic acid
8. caproic acid
9. heptanoic acid

Column: Rtx[®]-1, 30m, 0.53mm ID, 5.0 μ m (cat.# 10179)
 Sample: 0.2 μ L injection of a 10–20ng/ μ L free fatty acid standard in water.
 Inj.: direct injection using a Uniliner[®] inlet liner
 Oven temp.: 60°C to 180°C @ 15°C/min.
 Inj./det. temp.: 250°C
 Carrier gas: hydrogen
 Linear velocity: 50cm/sec. (flow rate: 6cc/min.)
 FID sensitivity: 4 x 10¹¹ AFS



**Fatty Acids (Free)
Stabilwax®-DA**



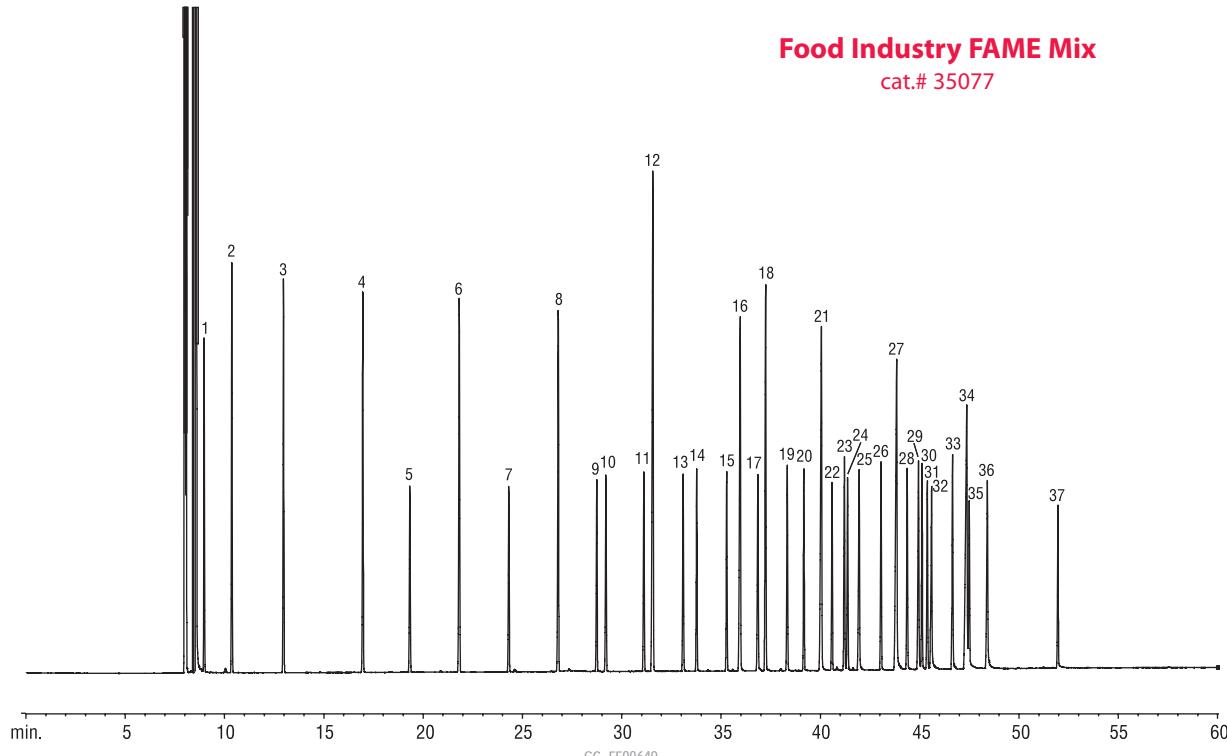
Column: Stabilwax®-DA, 30m, 0.32mm ID, 0.25 μ m (cat.# 11024)
Sample: 1.0 μ L free fatty acid mix
Solvent: methanol
Conc.: 100ppm in methanol
Inj.: splitless/250°C
Splitless hold time: 0.25min.
Carrier gas: hydrogen (constant flow)
Flow rate: 6.0mL/min.
Split flow: 75mL/min.
Det.: FID @ 250°C
Inlet liner: laminar cup splitter
Oven temp.: 40°C to 250°C @ 10°C/min. (hold 15 min.)

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FAMEs (AOAC 996.06 Standard)
Rt®-2560



Food Industry FAME Mix
 cat.# 35077

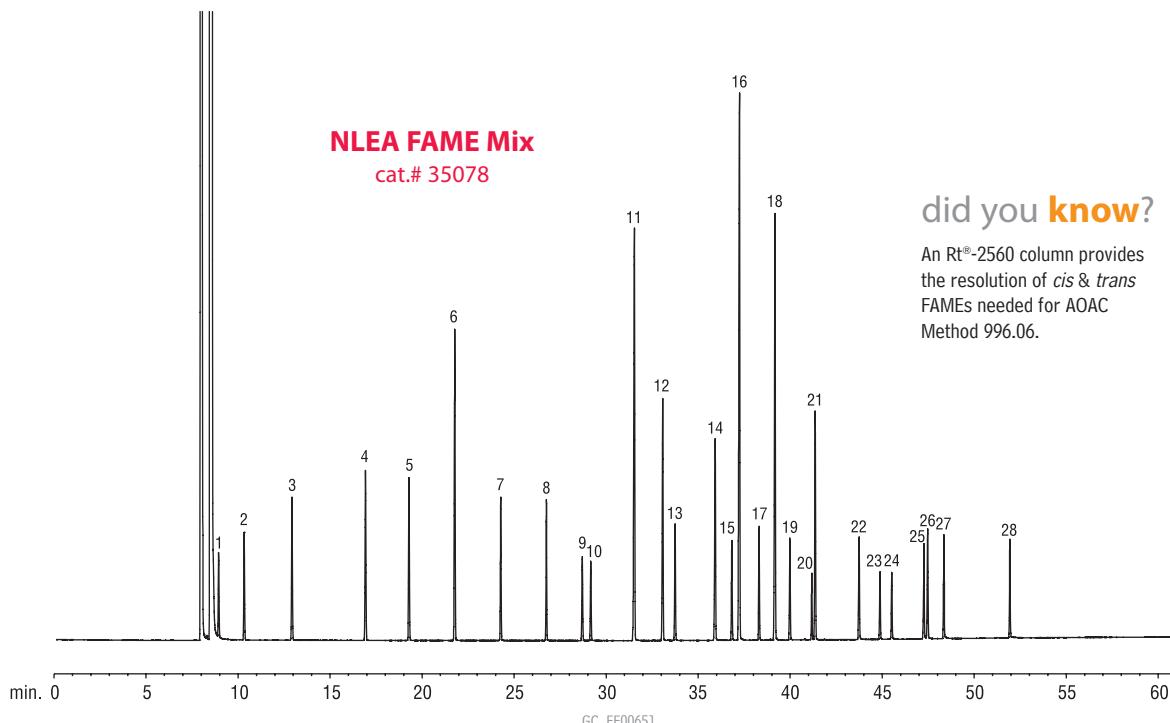
Compound	% in Mix
1. C4:0 methyl butyrate	4.0
2. C6:0 methyl hexanoate	4.0
3. C8:0 methyl octanoate	4.0
4. C10:0 methyl decanoate	4.0
5. C11:0 methyl undecanoate	2.0
6. C12:0 methyl laurate	4.0
7. C13:0 methyl tridecanoate	2.0
8. C14:0 methyl myristate	4.0
9. C14:1 methyl myristoleate (<i>cis</i> -9)	2.0
10. C15:0 methyl pentadecanoate	2.0
11. C15:1 methyl pentadecenoate (<i>cis</i> -10)	2.0
12. C16:0 methyl palmitate	6.0
13. C16:1 methyl palmitoleate (<i>cis</i> -9)	2.0
14. C17:0 methyl heptadecanoate	2.0
15. C17:1 methyl heptadecenoate (<i>cis</i> -10)	2.0
16. C18:0 methyl stearate	4.0
17. C18:1 methyl elaidate (<i>trans</i> -9)	2.0
18. C18:1 methyl oleate (<i>cis</i> -9)	4.0
19. C18:2 methyl linoleaidate (<i>trans</i> -9,12)	2.0
20. C18:2 methyl linoleate (<i>cis</i> -9,12)	2.0
21. C20:0 methyl arachidate	4.0
22. C18:3 methyl γ -linolenate (<i>cis</i> -6,9,12)	2.0
23. C20:1 methyl eicosenoate (<i>cis</i> -11)	2.0
24. C18:3 methyl linolenate (<i>cis</i> -9,12,15)	2.0
25. C21:0 methyl heneicosanoate	2.0
26. C20:2 methyl eicosadienoate (<i>cis</i> -11,14)	2.0
27. C22:0 methyl behenate	4.0
28. C20:3 methyl eicosatrienoate (<i>cis</i> -8,11,14)	2.0
29. C22:1 methyl erucate (<i>cis</i> -13)	2.0
30. C20:3 methyl eicosatrienoate (<i>cis</i> -11,14,17)	2.0
31. C20:4 methyl arachidonate (<i>cis</i> -5,8,11,14)	2.0
32. C23:0 methyl tricosanoate	2.0
33. C22:2 methyl docosadienoate (<i>cis</i> -13,16)	2.0
34. C24:0 methyl lignocerate	4.0
35. C20:5 methyl eicosapentaenoate (<i>cis</i> -5,8,11,14,17)	2.0
36. C24:1 methyl nervonate (<i>cis</i> -15)	2.0
37. C22:6 methyl docosahexaenoate (<i>cis</i> -4,7,10,13,16,19)	2.0



Searching for a chromatogram?
www.restek.com

FAMEs (NLEA Mix)

Rt[®]-2560

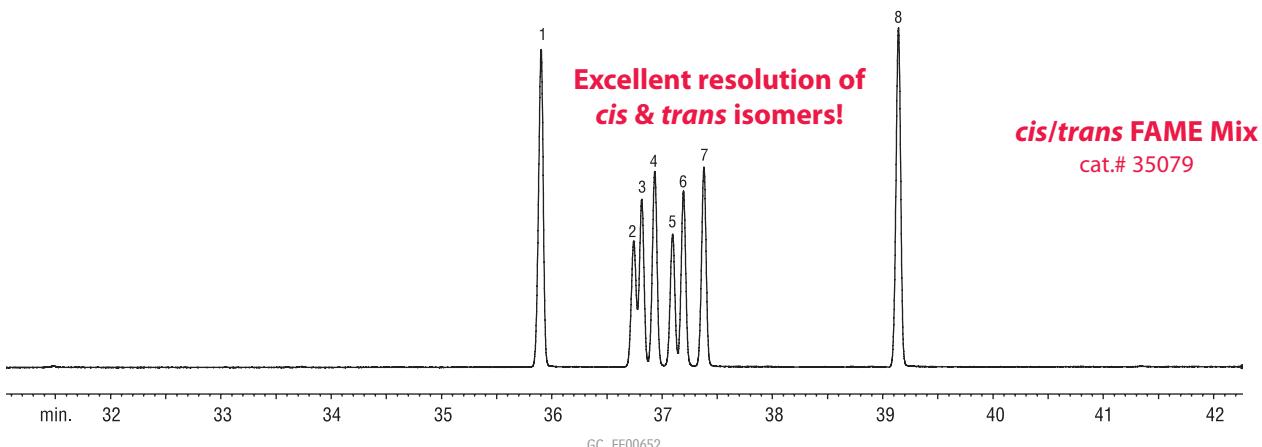


did you know?

An Rt[®]-2560 column provides the resolution of *cis* & *trans* FAMEs needed for AOAC Method 996.06.

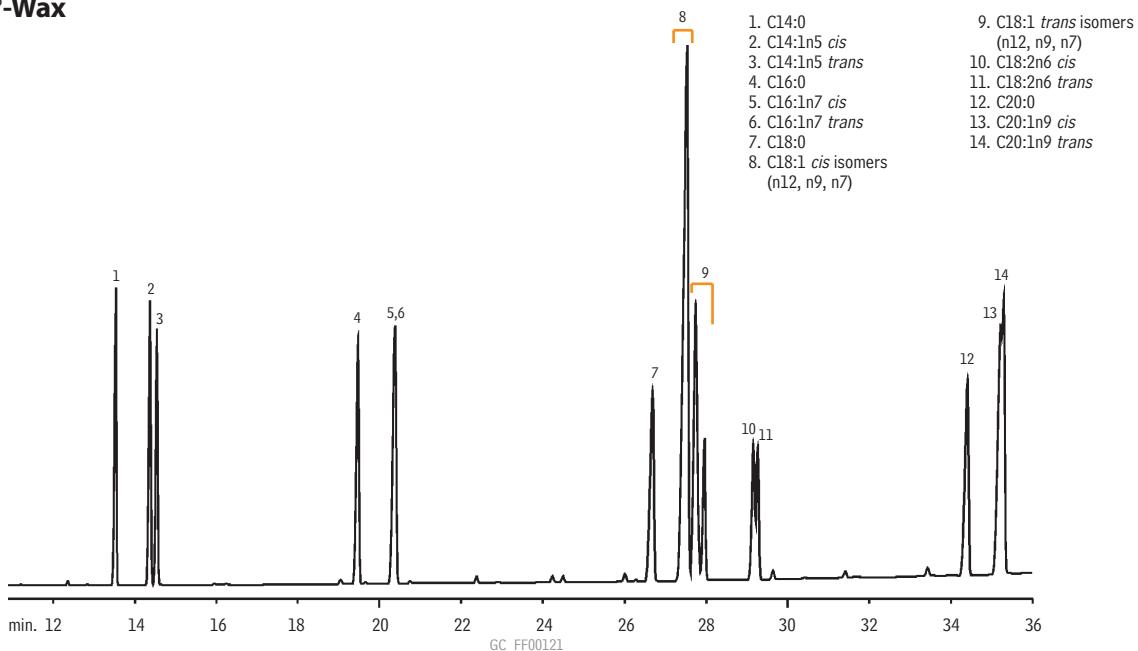
Column: Rt[®]-2560, 100m, 0.25mm ID, 0.20 μ m (cat.# 13199)
 Sample: NLEA FAME Mix (cat.# 35078), 30mg/mL total FAMEs in methylene chloride
 Inj.: 1.0 μ L split (split ratio 100:1), 4mm inlet liner (cat.# 20814)
 Inj. temp.: 225°C
 Carrier gas: hydrogen, constant flow
 Flow rate: 1.2mL/min.
 Oven temp.: 100°C (4 min. hold) to 240°C @ 3°C/min. (10 min. hold)
 Det.: FID @ 250°C

- | | | |
|---|--|--|
| 1. C4:0 methyl butyrate | 11. C16:0 methyl palmitate | 21. C18:3 methyl linolenate (<i>cis</i> -9,12,15) |
| 2. C6:0 methyl hexanoate | 12. C16:1 methyl palmitoleate (<i>cis</i> -9) | 22. C22:0 methyl behenate |
| 3. C8:0 methyl octanoate | 13. C17:0 methyl heptadecanoate | 23. C22:1 methyl erucate (<i>cis</i> -13) |
| 4. C10:0 methyl decanoate | 14. C18:0 methyl stearate | 24. C23:0 methyl tricosanoate |
| 5. C11:0 methyl undecanoate | 15. C18:1 methyl elaidate (<i>trans</i> -9) | 25. C24:0 methyl lignocerate |
| 6. C12:0 methyl laurate | 16. C18:1 methyl oleate (<i>cis</i> -9) | 26. C20:5 methyl eicosapentaenoate (<i>cis</i> -5,8,11,14,17) |
| 7. C13:0 methyl tridecanoate | 17. C18:2 methyl linolealidate (<i>trans</i> -9,12) | 27. C24:1 methyl nervonate (<i>cis</i> -15) |
| 8. C14:0 methyl myristate | 18. C18:2 methyl linoleate (<i>cis</i> -9,12) | 28. C22:6 methyl docosahexaenoate (<i>cis</i> -4,7,10,13,16,19) |
| 9. C14:1 methyl myristoleate (<i>cis</i> -9) | 19. C20:0 methyl arachidate | |
| 10. C15:0 methyl pentadecanoate | 20. C20:1 methyl eicosenoate (<i>cis</i> -11) | |

FAMEs (*cis/trans* isomers)Rt[®]-2560

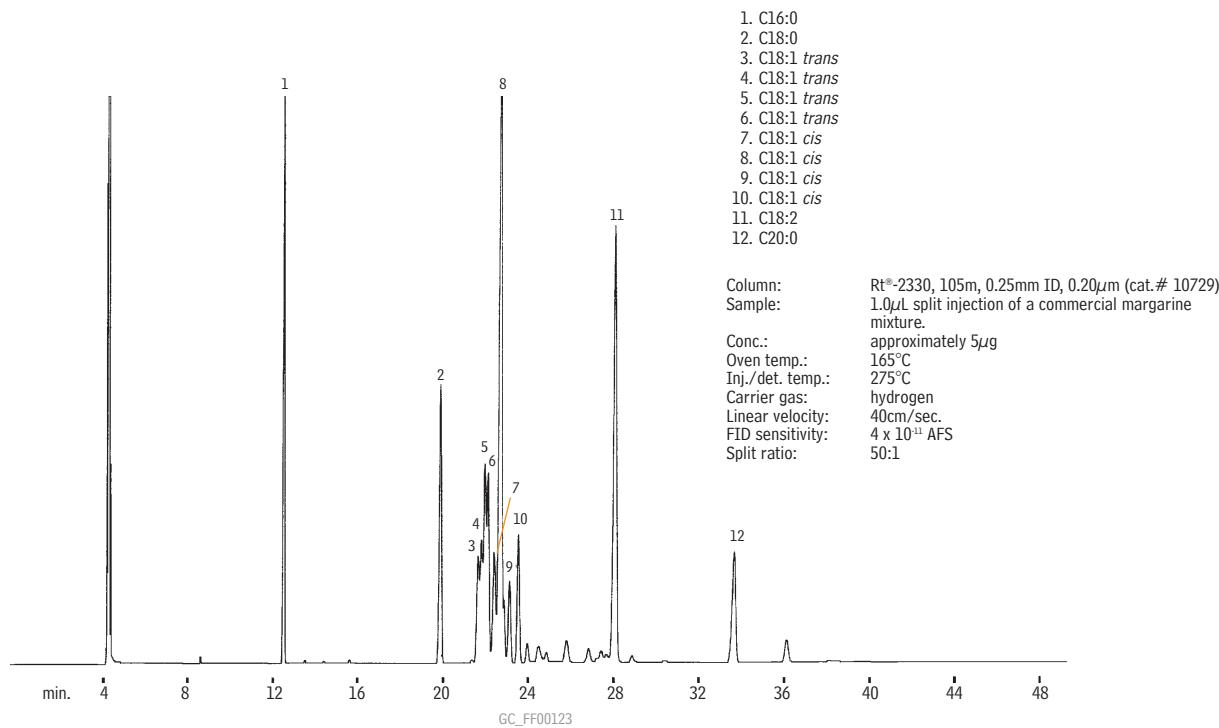
Column: Rt[®]-2560, 1.00m, 0.25mm ID, 0.2 μ m (cat.# 13199)
 Sample: *cis/trans* FAME Mix (cat.# 35079), 10mg/mL total FAMEs in methylene chloride
 Inj.: 1.0 μ L split (split ratio 20:1), 4mm inlet liner (cat.# 20814)
 Inj. temp.: 225°C
 Carrier gas: hydrogen, constant flow
 Flow rate: 1.2mL/min.
 Oven temp.: 100°C (4 min. hold) to 240°C @ 3°C/min. (10 min. hold)
 Det.: FID @ 250°C

Compound	% in Mix
1. C18:0 methyl stearate	20.0
2. C18:1 methyl petroselaidate (<i>trans</i> -6)	8.0
3. C18:1 methyl elaidate (<i>trans</i> -9)	10.0
4. C18:1 methyl trans vaccenate (<i>trans</i> -11)	12.0
5. C18:1 methyl petroselinate (<i>cis</i> -6)	8.0
6. C18:1 methyl oleate (<i>cis</i> -9)	10.0
7. C18:1 methyl vaccenate (<i>cis</i> -11)	12.0
8. C18:2 methyl linoleate (<i>cis</i> -9,12)	20.0

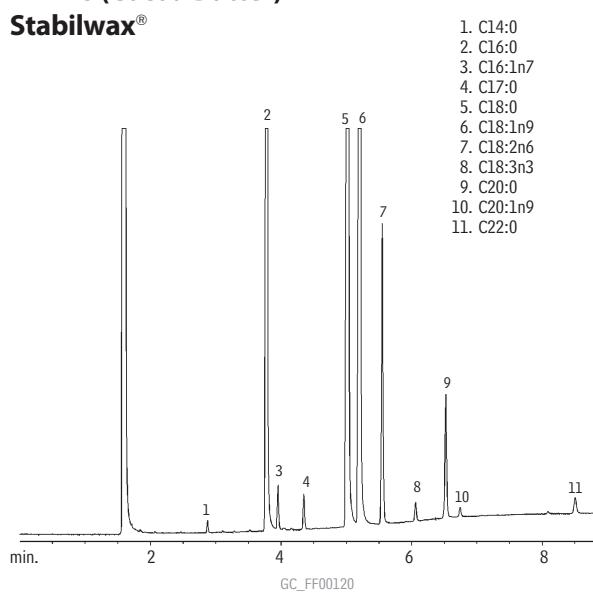
FAMEs (*cis/trans* isomers)Rtx[®]-Wax

Column: Rtx[®]-Wax, 60m, 0.25mm ID, 0.25 μ m (cat.#12426)
 On-column conc.: 40–75ng
 Oven temp.: 165°C to 250°C @ 2°C/min.
 Inj./det. temp.: 220°C/250°C
 Carrier gas: helium
 Linear velocity: 20cm/sec. set @ 165°C
 Split ratio: 50:1

**FAMEs (Commercial Margarine)
Rt[®]-2330**

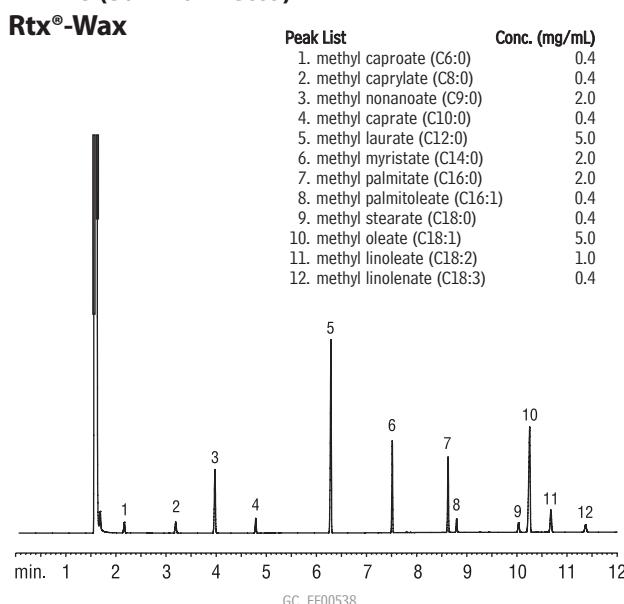


**FAMEs (Cocoa Butter)
Stabilwax[®]**



Column: Stabilwax[®], 30m, 0.25mm ID, 0.25 μ m (cat.# 10623)
 Sample: 1.0 μ L split injection of a FAME reference standard for cocoa butter.
 Oven temp.: 200°C to 250°C @ 8°C/min. (hold 3 min.)
 Inj./det. temp.: 250°C
 Carrier gas: hydrogen
 Linear velocity: 31.4cm/sec. set @ 200°C
 FID sensitivity: 8 x 10¹¹ AFS
 Split ratio: 45:1

**FAMEs (Saw Palmetto)
Rtx[®]-Wax**

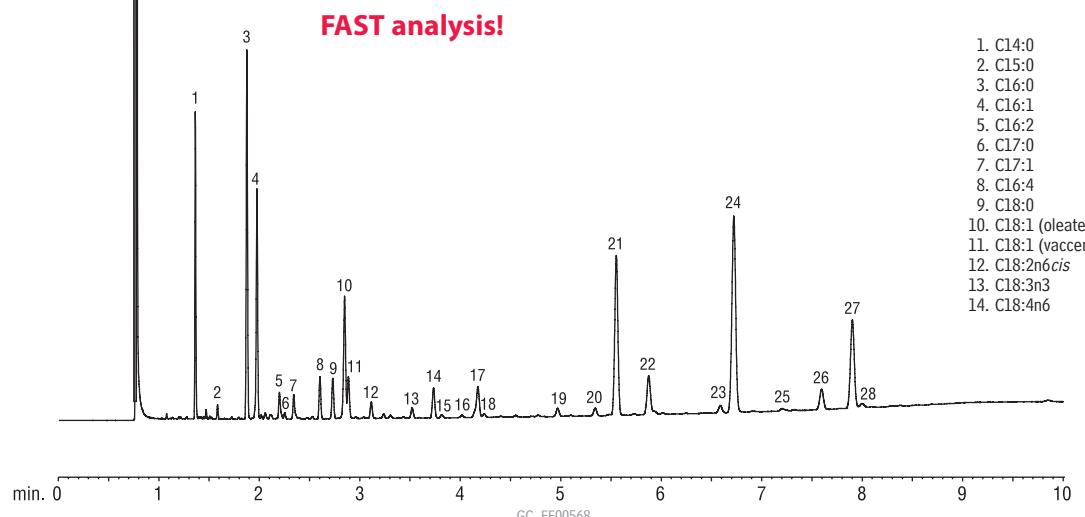


Column: Rtx[®]-Wax, 30m, 0.25mm, 0.25 μ m (cat.# 12423)
 Sample: 1 μ L split injection of saw palmetto standard
 Conc.: see peak list
 Oven temp.: 120°C (hold 3 min.) to 220°C
 at 20°C/min. (hold 12 min.)
 Inj./det. temp.: 250°C/300°C
 Carrier gas: helium
 Linear velocity: 1ml/min. (34 cm/sec.)
 Split ratio: 100:1

FAMEs (Marine Oil Standard)

FAMEWAX

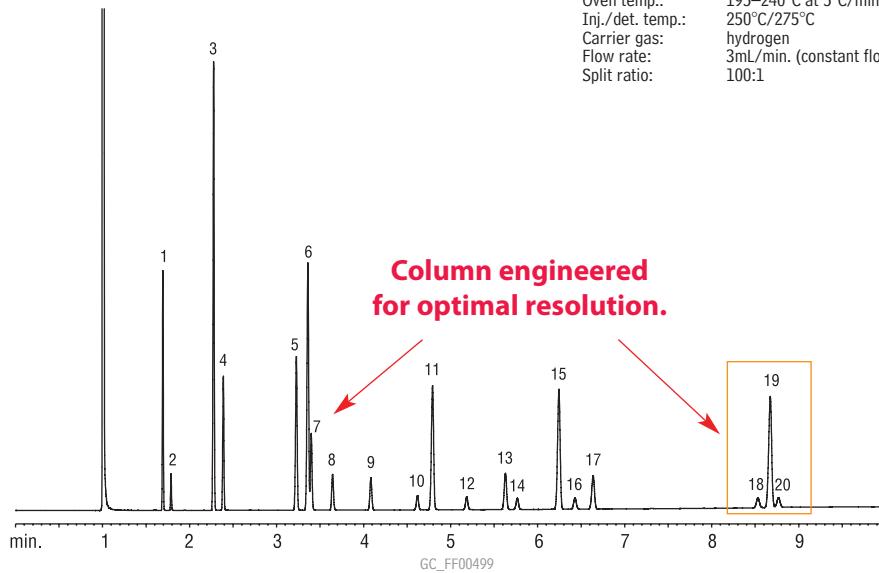
Column: FAMEWAX, 30m, 0.32mm ID, 0.25 μ m (cat.# 12498)
 Sample: 12mg/mL total FAMES
 Inj.: 0.5 μ L, split (150:1), 3mm ID split liner for TRACE Series GCs, packed
 with glass wool (cat.# 20936-202.1)
 Inj. temp.: 250°C
 Carrier gas: hydrogen, constant flow
 Linear velocity: 62cm/sec.
 Oven temp.: 195°C to 240°C @ 5°C/min. (hold 1 min.)
 Det.: FID @ 250°C



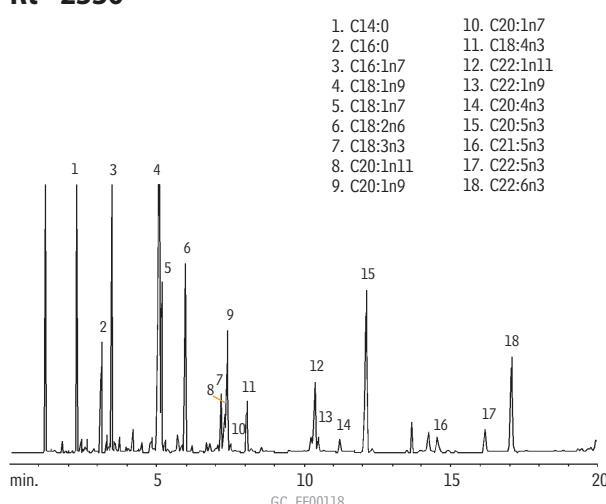
FAMEs (Marine Oil Standard)

FAMEWAX

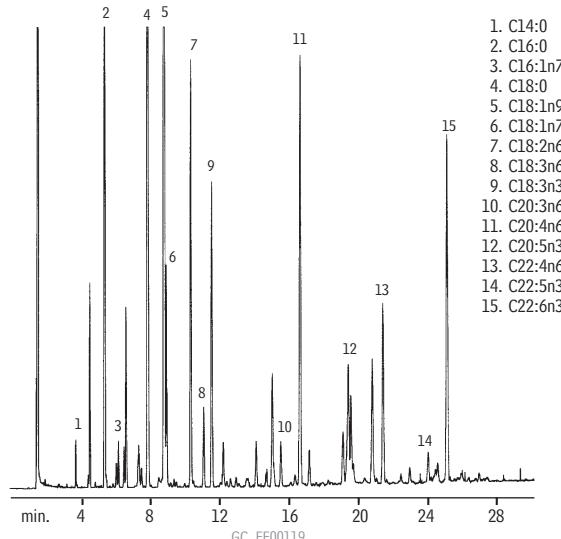
Column: FAMEWAX, 30m, 0.32mm ID, 0.25 μ m (cat.# 12498)
 Inj.: 1 μ L
 Conc.: 10,000 μ g/mL in isoctane (total FAMES; see breakdown in peak list)
 Oven temp.: 195–240°C at 5°C/min., 1 min. hold
 Inj./det. temp.: 250°C/275°C
 Carrier gas: hydrogen
 Flow rate: 3mL/min. (constant flow)
 Split ratio: 100:1



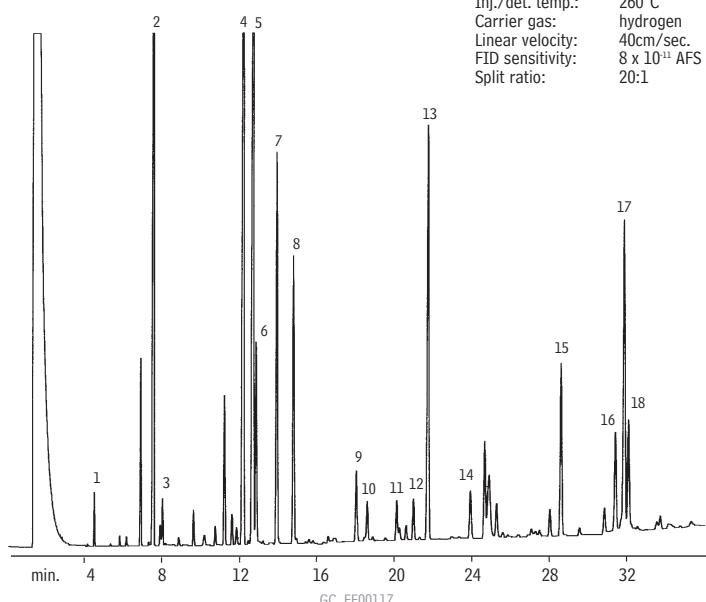
Peak List	Conc. (μ g/mL)
1. C14:0	600
2. C14:1	100
3. C16:0	1,600
4. C16:1	500
5. C18:0	800
6. C18:1 (oleate)	1,300
7. C18:1 (vaccenate)	400
8. C18:2	200
9. C18:3	200
10. C20:0	100
11. C20:1	900
12. C20:2	100
13. C20:4	300
14. C20:3	100
15. C20:5	1,000
16. C22:0	100
17. C22:1	300
18. C24:0	100
19. C22:6	1,200
20. C24:1	100

FAMEs (PUFA, marine source)**Rt[®]-2330**

Column: Rt[®]-2330, 30m, 0.25mm ID, 0.20μm (cat.# 10723)
 Sample: 0.5μL split injection of a PUFA mix
 Oven temp.: 160°C to 225°C @ 2°C/min.
 Inj./det. temp.: 225°C/250°C
 Carrier gas: hydrogen
 Linear velocity: 45cm/sec. set @ 160°C
 FID sensitivity: 8 x 10⁻¹¹ AFS
 Split ratio: 35:1

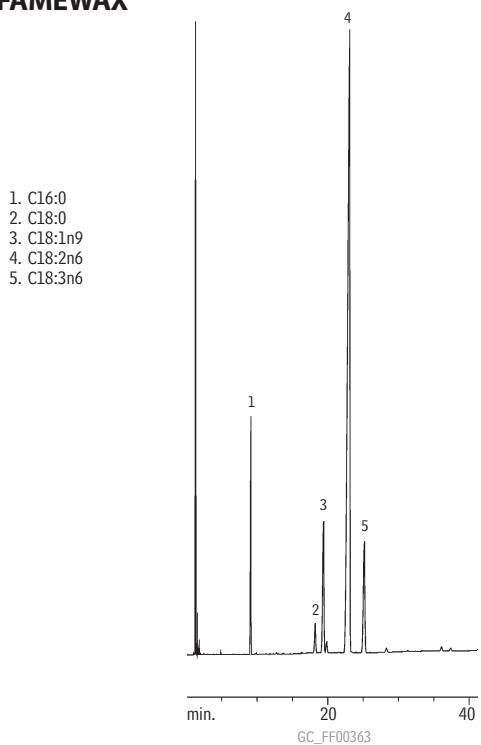
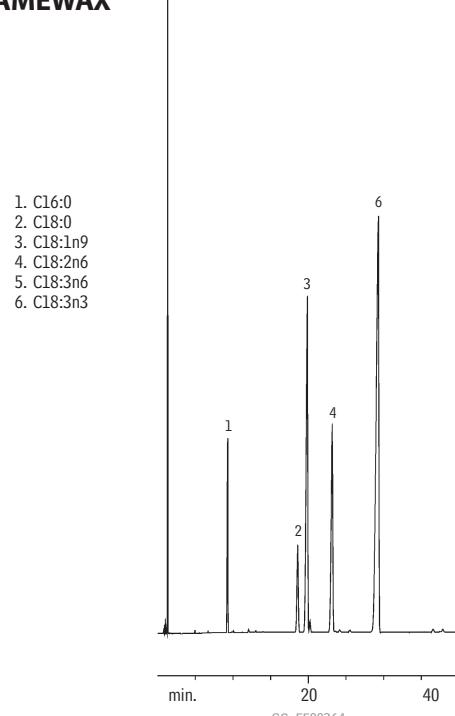
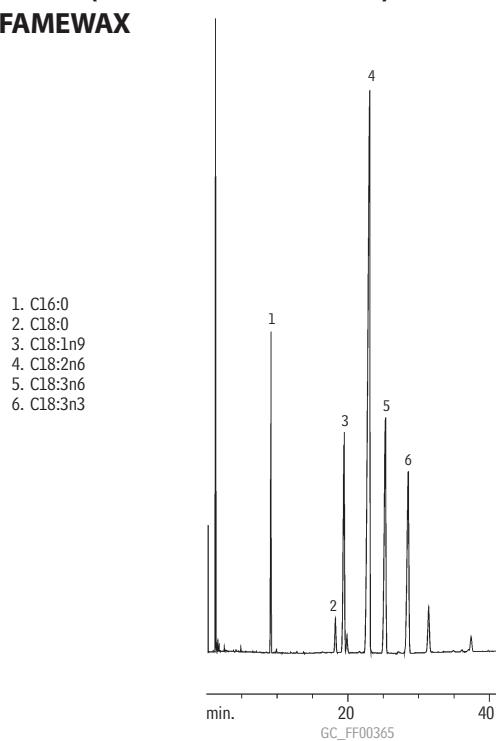
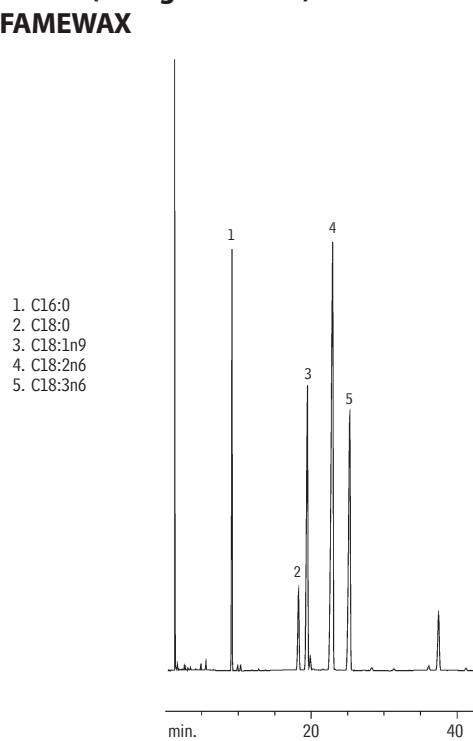
FAMEs (PUFA, animal source)**Rt[®]-2330**

Column: Rt[®]-2330, 30m, 0.32mm ID, 0.20μm (cat.# 10724)
 Sample: 0.1μL split injection of PUFA 2 mix
 Oven temp.: 160°C to 250°C @ 2°C/min. (hold 10 min.)
 Inj./det. temp.: 260°C
 Carrier gas: hydrogen
 Linear velocity: 40cm/sec.
 FID sensitivity: 8 x 10⁻¹¹ AFS
 Split ratio: 20:1

FAMEs (Polyunsaturated Fatty Acids, animal source)**MXT[®]-WAX**

Column: MXT[®]-WAX, 30m, 0.28mm ID, 0.25μm (cat.# 70624)
 Sample: 0.1μL split injection of PUFA 2 mix
 Oven temp.: 160°C to 250°C @ 2°C/min. (hold 10 min.)
 Inj./det. temp.: 260°C
 Carrier gas: hydrogen
 Linear velocity: 40cm/sec.
 FID sensitivity: 8 x 10⁻¹¹ AFS
 Split ratio: 20:1

- 1. C14:0
- 2. C16:0
- 3. C16:ln7
- 4. C18:0
- 5. C18:ln9
- 6. C18:ln7
- 7. C18:2n6
- 8. C18:3n3
- 9. C18:4n3
- 10. C20:1n9
- 11. C20:2n6
- 12. C20:3n6
- 13. C20:4n6
- 14. C20:5n3
- 15. C22:4n6
- 16. C22:5n3
- 17. C22:6n3
- 18. C24:1n9

FAMEs (Evening Primrose Oil)**FAMEWAX****FAMEs (Flax Seed Oil)****FAMEWAX****FAMEs (Black Currant Seed Oil)****FAMEWAX****FAMEs (Borage Seed Oil)****FAMEWAX****Column and conditions for all four oils analyses:**

Column: FAMEWAX, 30m, 0.25mm ID, 0.25µm (cat. # 12497)

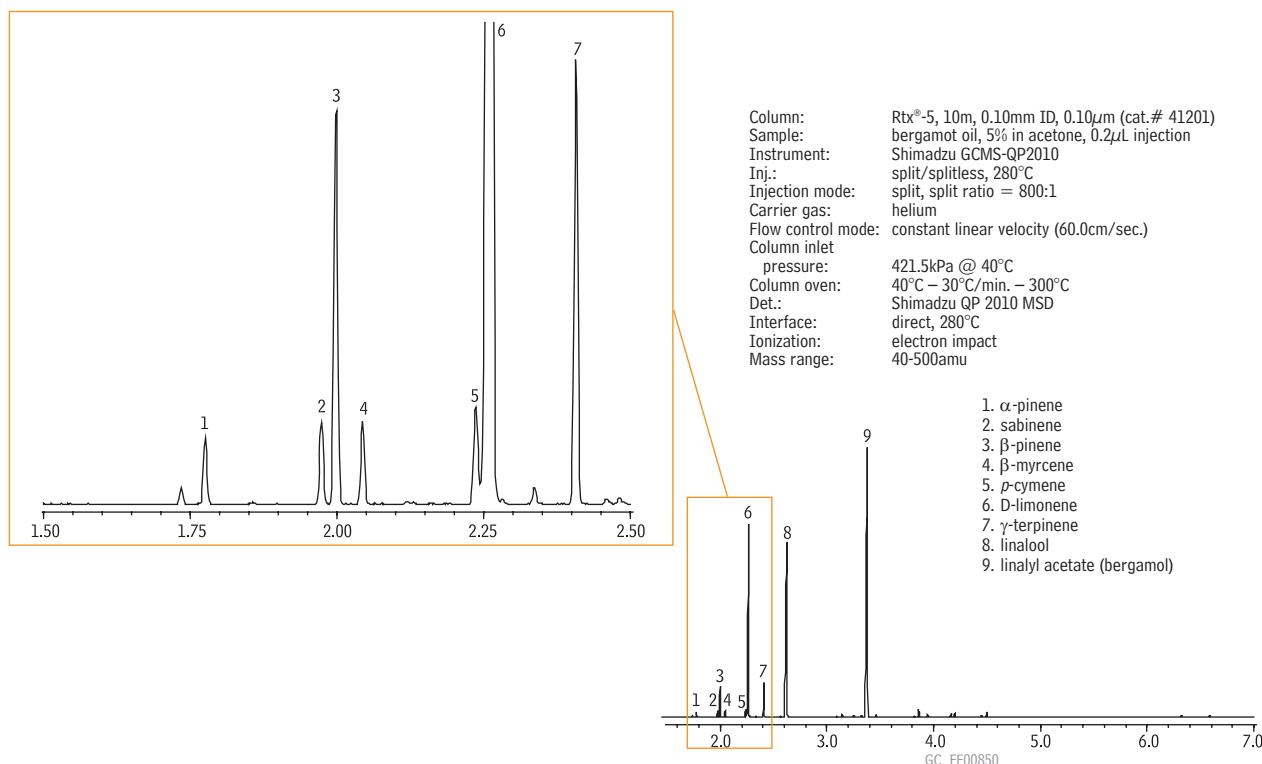
Oven temp.: 165°C (hold 30 min.) to 220°C @ 1.5°C/min. (hold 15 min.)

Inj. temp.: 225°C

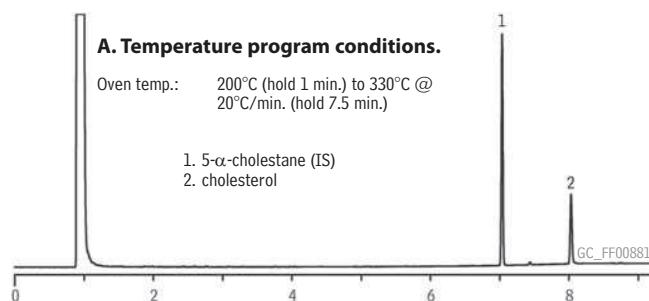
Det. temp.: 230°C

Carrier gas: helium @ 40cm/sec.

Bergamot Oil
Fast GC/MS
Rtx®-5



Underivatized Cholesterol
Rxi®-5ms

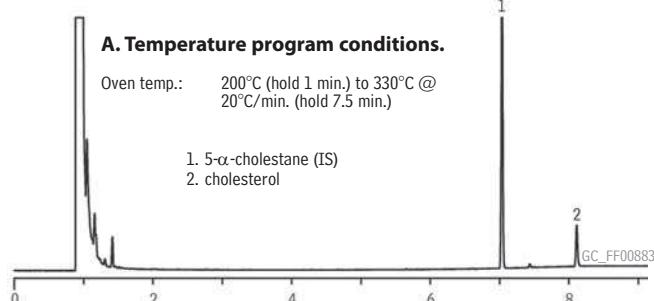


B. Isothermal conditions will maximize sample throughput.

Oven temp.: 300°C (hold 10 min.)

Column: Rxi®-5ms, 15m, 0.25mm ID, 0.25 μ m (cat.# 13420)
Sample: 1,000 μ g/mL cholesterol in DMF; 1000 μ g/mL 5- α -cholestane in hexane;
25ng cholesterol, 150ng 5- α -cholestane on column
Inj.: 1.0 μ L, split (20:1), single gooseneck inlet liner w/wool (cat.# 22405)
Inj. temp.: 250°C
Carrier gas: helium, constant pressure (9.7psi @ 200°C)
Linear velocity: 24cm/sec.
Oven temp.: see above
Det.: FID @ 340°C

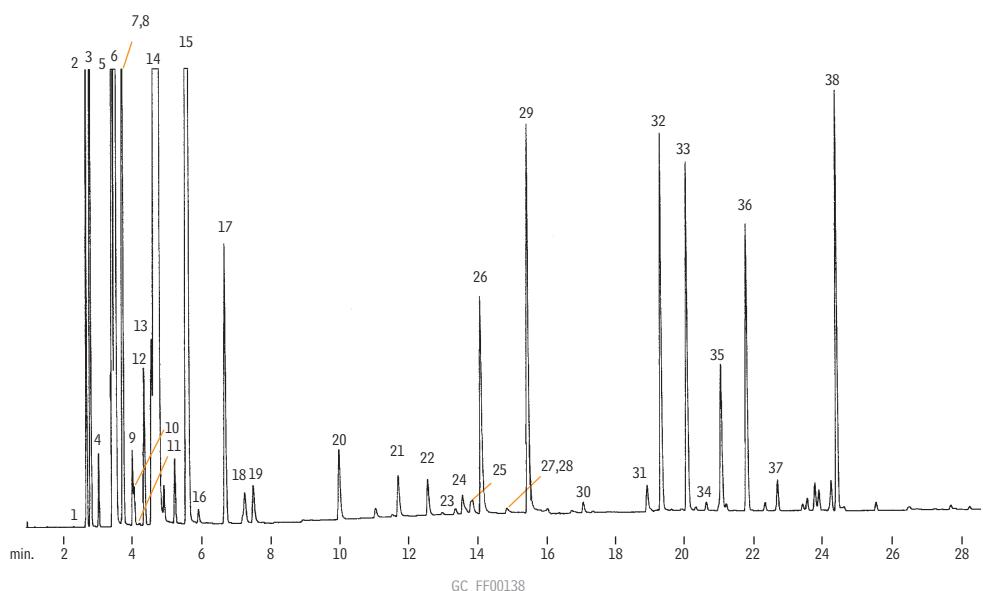
Derivatized Cholesterol
Rxi®-5ms



B. Isothermal conditions will maximize sample throughput.

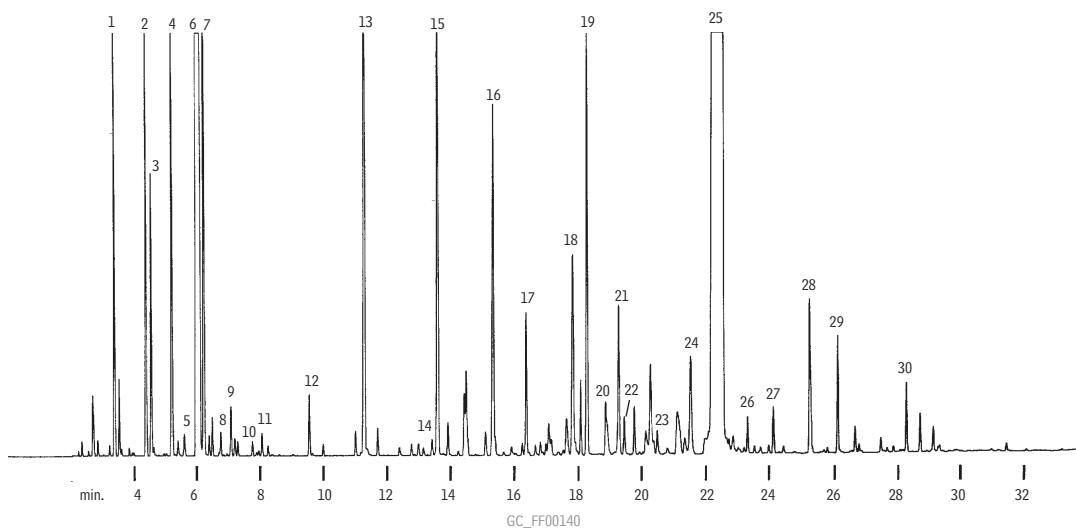
Oven temp.: 300°C (hold 10 min.)

Column: Rxi®-5ms, 15m, 0.25mm ID, 0.25 μ m (cat.# 13420)
Sample: 1,000 μ g/mL cholesterol in hexane, 1000 μ g/mL 5- α -cholestane in hexane;
50ng derivatized cholesterol, 150ng 5- α -cholestane on column
Inj.: 1.0 μ L, split (20:1), single gooseneck inlet liner w/wool (cat.# 22405)
Inj. temp.: 250°C
Carrier gas: helium, constant pressure (9.7psi @ 200°C)
Linear velocity: 24cm/sec.
Oven temp.: see above
Det.: FID @ 340°C

Lemon Oil**Rtx®-5**

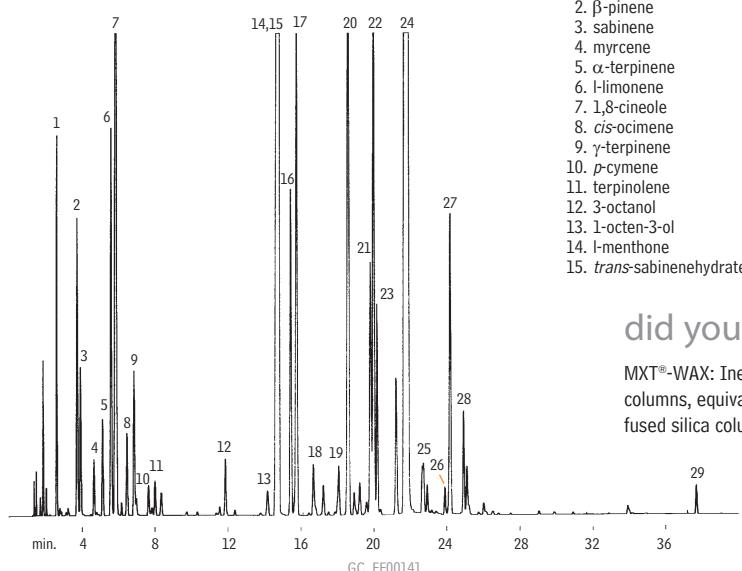
1. heptanol
2. α -thujene
3. α -pinene
4. camphene
5. sabinene
6. β -pinene
7. 6-methyl-5-hepten-2-one
8. myrcene
9. octanal
10. α -phellandrene
11. 3-carene
12. α -terpinene
13. ρ -cymene
14. limonene
15. γ -terpinene
16. octanol
17. terpinolene
18. linalool
19. nonanal
20. citronellal
21. terpinene-4-ol
22. α -terpineol
23. decanol
24. octyl acetate
25. nerol
26. neral
27. carvone
28. geraniol
29. geranial
30. nonyl acetate
31. citronellyl acetate
32. neryl acetate
33. geranyl acetate
34. dodecanal
35. β -caryophyllene
36. trans- α -bergamotene
37. α -humulene
38. β -bisabolene

Column: Rtx®-5, 30m, 0.32mm ID, 0.25 μ m (cat.# 10224)
 Sample: Wet needle split injection of a neat lemon oil
 Oven temp.: 75°C (hold 8 min.) to 250°C @ 4°C/min.
 Inj./det. temp.: 250°C
 Carrier gas: hydrogen
 Linear velocity: 40cm/sec. (flow rate: 3.2cc/min.)
 FID sensitivity: 2 x 10¹¹ AFS
 Split ratio: 100:1

Spearmint Oil (Native)**Stabilwax®**

- | | | | | |
|------------------|--|----------------------------|---------------------------|----------------------------------|
| Column: | Stabilwax®, 60m, 0.25mm ID, 0.25 μ m (cat.# 10626) | 1. α -pinene | 11. terpinolene | 21. trans-dihydrocaranyl acetate |
| Sample: | 0.2 μ L split injection of a neat spearmint oil | 2. β -pinene | 12. 3-octyl acetate | 22. β -farnesene |
| Oven temp.: | 75°C (hold 4 min.) to 200°C @ 4°C/min. (hold 10 min.) | 3. sabinene | 13. 3-octanol | 23. α -terpineol |
| Inj./det. temp.: | 250°C | 4. myrcene | 14. l-menthone | 24. germacrene- Δ |
| Carrier gas: | hydrogen | 5. α -terpinene | 15. trans-sabinenehydrate | 25. carvone |
| Linear velocity: | 40cm/sec. set @ 160°C | 6. l-limonene | 16. β -bourbonene | 26. cis-carvyl acetate |
| FID sensitivity: | 4 x 10 ¹¹ AFS | 7. 1,8-cineole | 17. linalool | 27. trans-carveol |
| Split ratio: | 100:1 | 8. cis-ocimene | 18. terpinene-4-ol | 28. cis-carveol |
| | 9. γ -terpinene | 19. β -caryophyllene | 29. cis-jasmone | |
| | 10. ρ -cymene | 20. dihydrocarvone | 30. viridiflorol | |

Peppermint Oil MXT®-WAX



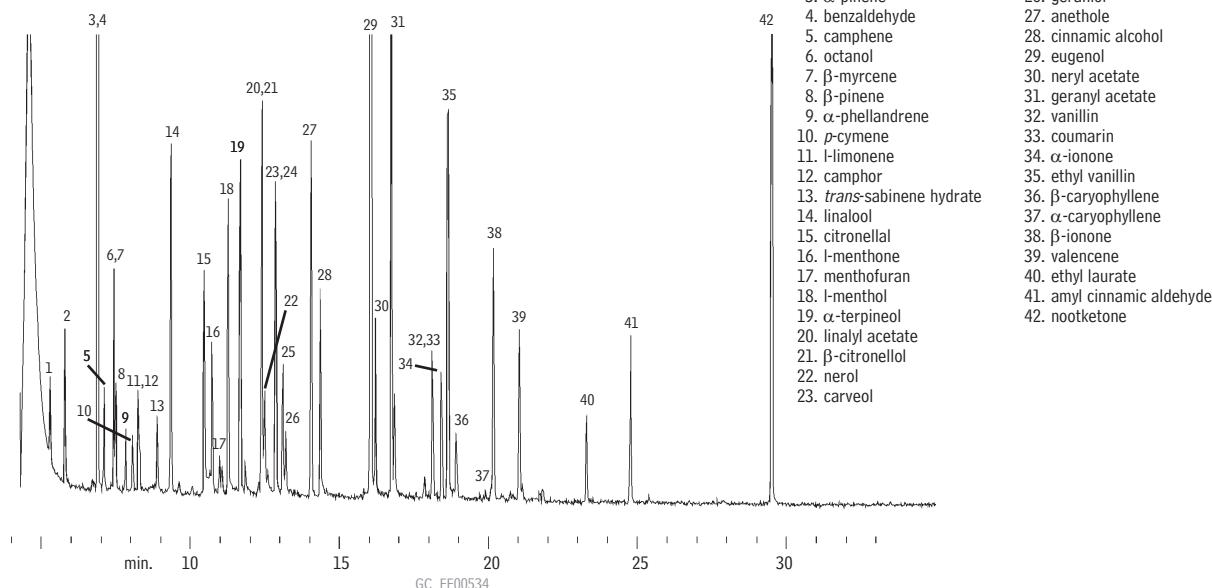
1. α -pinene
2. β -pinene
3. sabine
4. myrcene
5. α -terpinene
6. l-limonene
7. 1,8-cineole
8. *cis*-ocimene
9. γ -terpinene
10. *p*-cymene
11. terpinolene
12. 3-octanol
13. 1-octen-3-ol
14. l-menthone
15. *trans*-sabinenehydrate
16. menthofuran
17. d-isomenthone
18. β -bourbonene
19. linalool
20. methyl acetate
21. neo-menthol
22. β -caryophyllene
23. terpinene-4-ol
24. l-menthol
25. pulegone
26. α -terpineol
27. germacrene- Δ
28. piperitone
29. viridiflorol

did you know?

MXT®-WAX: Inert stainless steel columns, equivalent to Stabilwax® fused silica columns!

Column: MXT®-WAX, 30m, 0.28mm ID, 0.50 μ m (cat.# 70639)
Sample: 1.0 μ L split injection of peppermint oil
Oven temp.: 75°C (hold 4 min.) to 240°C @ 4°C/min.
Inj./det. temp.: 250°C
Carrier gas: hydrogen
Linear velocity: 40cm/sec. set @ 75°C
FID sensitivity: 16 x 10¹¹ AFS
Split ratio: 50:1

Synthetic Essential Oil Mixture Rtx®-1

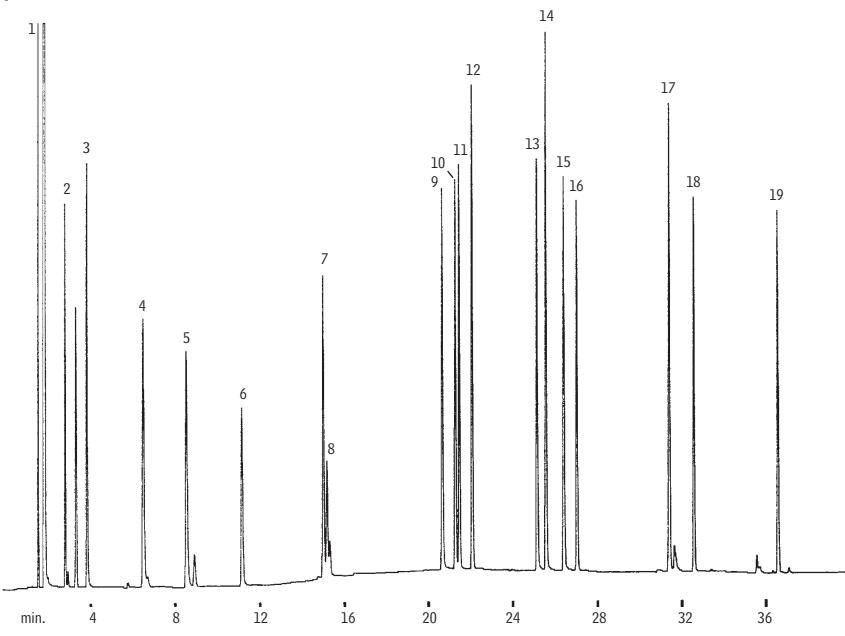


1. ethyl butyrate
2. *trans*-2-hexenol
3. α -pinene
4. benzaldehyde
5. camphene
6. octanol
7. β -myrcene
8. β -pinene
9. α -phellandrene
10. *p*-cymene
11. l-limonene
12. camphor
13. *trans*-sabinene hydrate
14. linalool
15. citronellal
16. l-menthone
17. menthofuran
18. l-menthol
19. α -terpineol
20. linalyl acetate
21. β -citronellol
22. nerol
23. carveol
24. anisaldehyde
25. carvone
26. geraniol
27. anethole
28. cinnamic alcohol
29. eugenol
30. neryl acetate
31. geranyl acetate
32. vanillin
33. coumarin
34. α -ionone
35. ethyl vanillin
36. β -caryophyllene
37. α -caryophyllene
38. β -ionone
39. valencene
40. ethyl laurate
41. amyl cinnamic aldehyde
42. nootketone

Column: Rtx®-1, 60m, 0.25mm ID, 0.25 μ m (cat.# 10126)
Sample: 1.0 μ L split injection of 42 flavor components
Oven temp.: 100°C to 260°C @ 4°C/min. (hold 1 min.)
Inj./det. temp.: 250°C/280°C
Det. type: MSD
Carrier gas: helium
Linear velocity: 30cm/sec. set @ 50°C
FID sensitivity: 2 x 10¹¹ AFS
Split vent: 100cc/min.

Mushroom Aroma (Synthetic)**Rtx[®]-20**

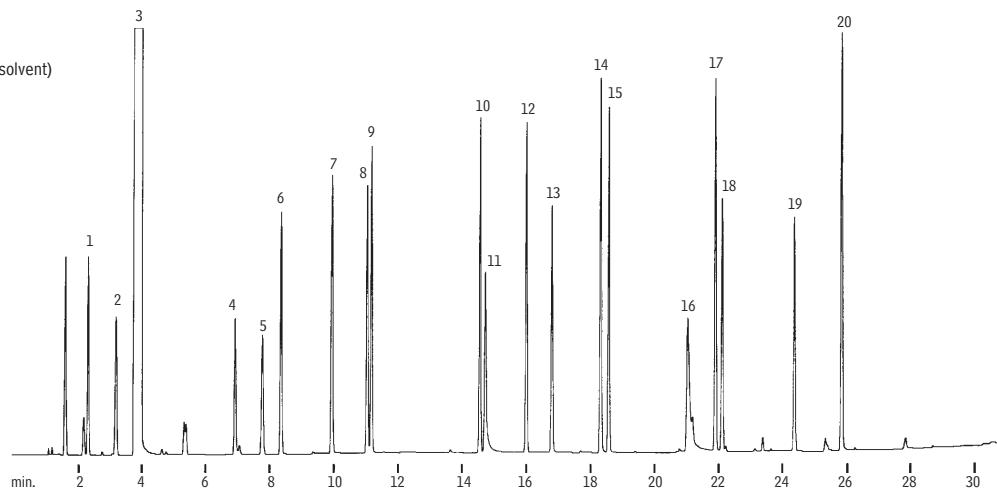
1. acetone
2. ethyl acetate
3. 1-butanol
4. 3-methyl-1-butanol
5. 1-pentanol
6. hexanal
7. furfural
8. amyl acetate
9. 1-octen-3-ol
10. 3-octanol
11. 3-octanone
12. benzaldehyde
13. octyl alcohol
14. benzyl alcohol
15. phenylacetaldehyde
16. nonanal
17. α -terpineol
18. 2,4-nonadienal
19. 2,4-decadienal



Column: Rtx[®]-20, 30m, 0.32mm ID, 1.0 μ m (cat.# 10354)
 Sample: 1.0 μ L split injection of a synthetic mushroom aroma
 Conc.: 10ng per component
 Oven temp.: 45°C (hold 8 min.) to 250°C @ 4°C/min.
 Inj./det. temp.: 260°C
 Carrier gas: hydrogen
 Linear velocity: 40cm/sec.
 FID sensitivity: 4 \times 10¹¹ AFS
 Split ratio: 100:1

Mushroom Aroma (Synthetic)**Stabilwax[®]**

1. acetone
2. ethyl acetate
3. methylene chloride (solvent)
4. hexanal
5. amyl acetate
6. 1-butanol
7. 3-methyl-1-butanol
8. 1-pentanol
9. 3-octanone
10. 3-octanol
11. nonanal
12. 1-octen-3-ol
13. furfural
14. benzaldehyde
15. octyl alcohol
16. phenylacetaldehyde
17. α -terpineol
18. 2,4-nonadienal
19. 2,4-decadienal
20. benzyl alcohol

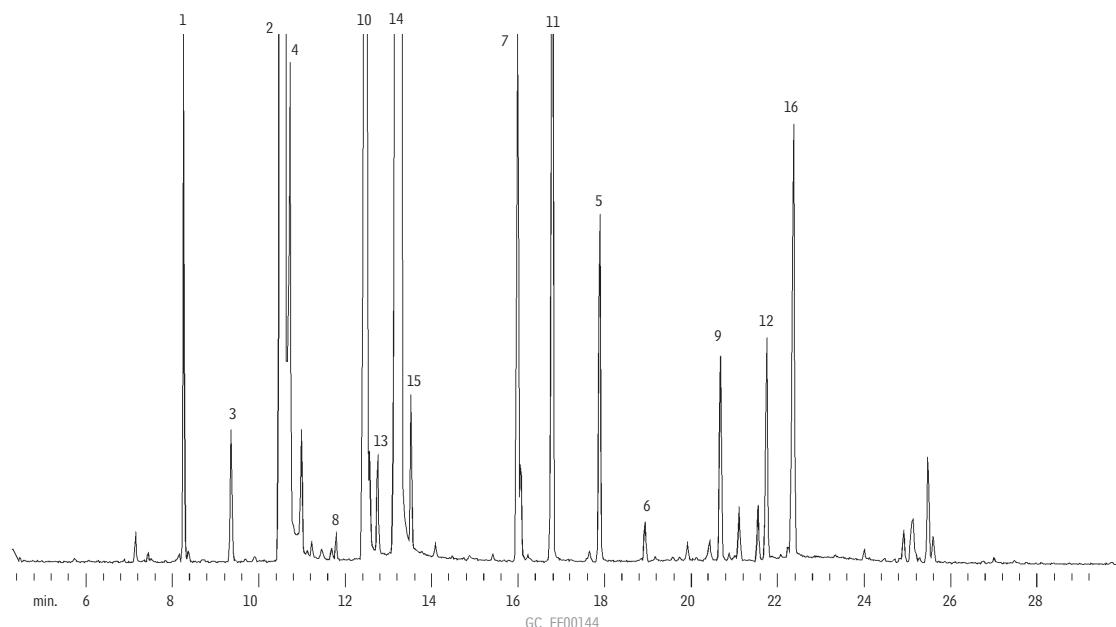


Column: Stabilwax[®], 30m, 0.32mm ID, 1.0 μ m (cat.# 10654)
 Sample: 1.0 μ L split injection of a synthetic mushroom aroma
 Conc.: 10ng per component
 Oven temp.: 40°C to 220°C @ 6°C/min.
 Inj./det. temp.: 260°C
 Carrier gas: hydrogen
 Linear velocity: 40cm/sec.
 FID sensitivity: 4 \times 10¹¹ AFS
 Split ratio: 100:1



Citronella Java Oil

Rtx®-1

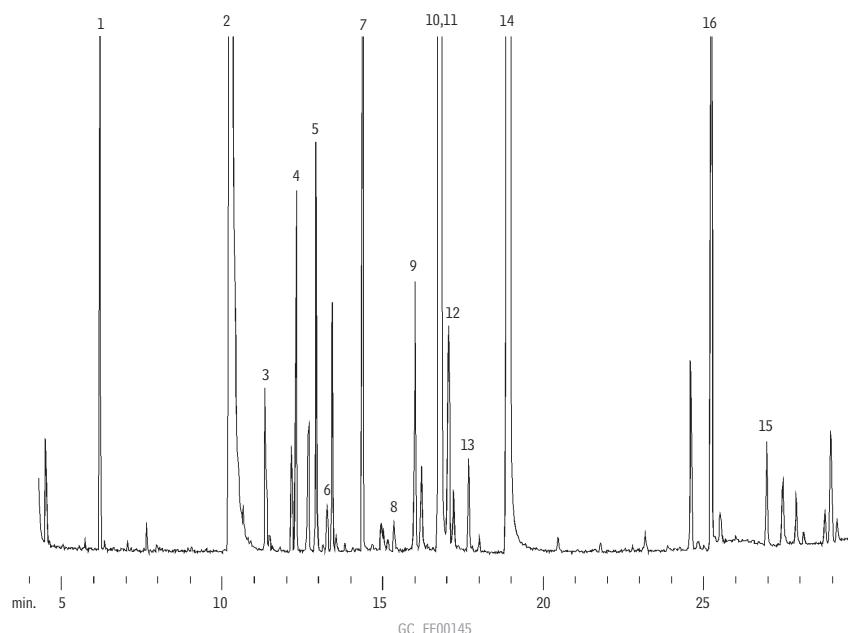


Column: Rtx®-1, 60m, 0.25mm ID, 0.25 μ m (cat.# 10126)
Sample: 1.0 μ L split injection of citronella Java oil
Oven temp.: 100°C to 260°C @ 4°C/min. (hold 1 min.)
Inj./det. temp.: 250°C/280°C
Det. type: MSD
Carrier gas: helium
Linear velocity: 30cm/sec. set @ 50°C
Split vent: 100cc/min.

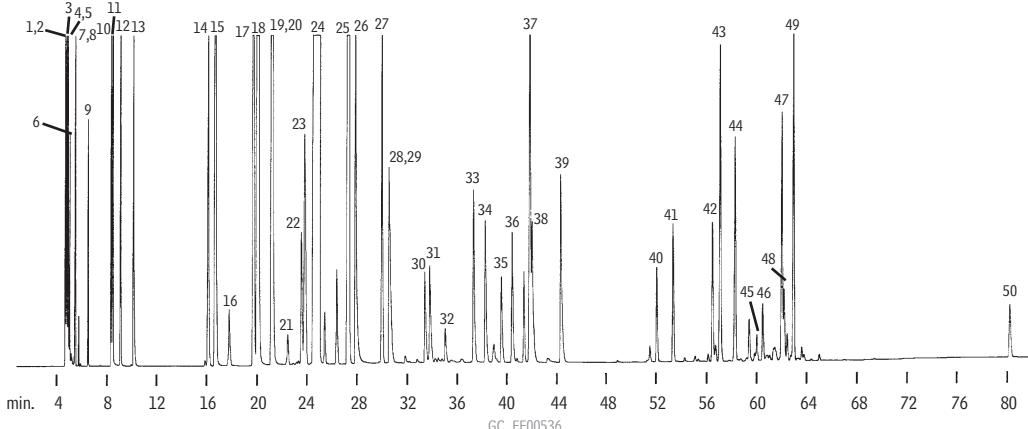
1. limonene
2. citronellal
3. linalool
4. borneol
5. γ -elemene
6. β -caryophyllene
7. neryl acetate
8. α -terpineol
9. germacrene- Δ
10. β -citronellol
11. geranyl acetate
12. δ -cadinenone
13. nerol
14. geraniol
15. eugenol
16. α -bergamotene

Citronella Java Oil

Stabilwax®

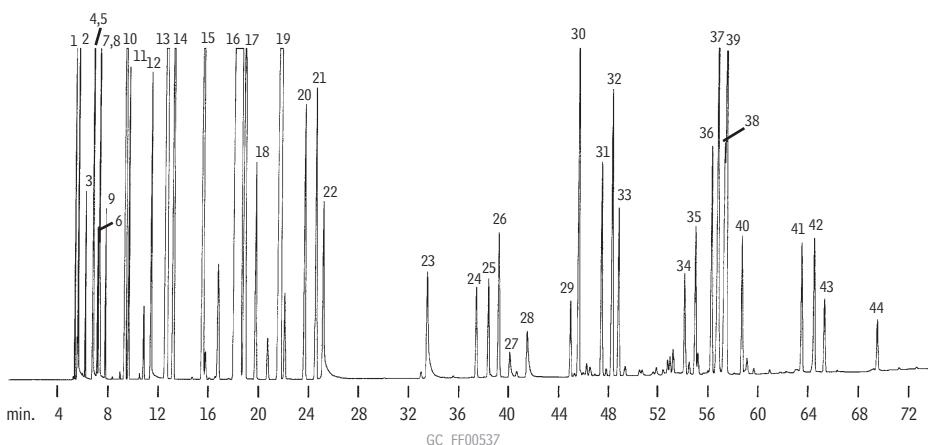


Column: Stabilwax®, 60m, 0.25mm ID, 0.25 μ m (cat.# 10626)
Sample: 1.0 μ L split injection of citronella Java oil
Oven temp.: 100°C to 260°C @ 4°C/min. (hold 1 min.)
Inj./det. temp.: 250°C/280°C
Det. type: MSD
Carrier gas: helium
Linear velocity: 30cm/sec. set @ 50°C
Split vent: 100cc/min.

Flavor Volatiles**Rtx®-1**

1. methanol	11. ethyl butyrate	21. α -phellandrene	31. <i>trans</i> -limonene monoxide	41. geranyl acetate
2. acetaldehyde	12. furfural	22. α -terpinene	32. citronellal	42. α -ionone
3. ethanol	13. <i>trans</i> -2-hexenal	23. <i>p</i> -cymene	33. terpinene-4-ol	43. β -caryophyllene
4. acetone	14. α -thujene	24. δ -limonene	34. α -terpineol	44. <i>trans</i> - α -bergamotene
5. isopropyl alcohol	15. α -pinene	25. γ -terpinene	35. decanal	45. BHA
6. methylene chloride	16. camphene	26. octanol	36. d & l carveol	46. β -ionone
7. hexane	17. sabine	27. terpinolene	37. nerol	47. valencene
8. ethyl acetate	18. β -pinene	28. nonanal	38. carvone	48. γ -elemene
9. ethyl propionate	19. octanal	29. linalool	39. geranial	49. β -bisabolene
10. <i>n</i> -hexanal	20. myrcene	30. <i>cis</i> -limonene monoxide	40. neryl acetate	50. nootketone

Column: Rtx®-1, 60m, 0.53mm ID, 0.50 μ m (cat.# 10143)
 Sample: 0.8 μ L split injection of a flavor volatiles test mix
 Oven temp.: 70° (hold 15 min.) to 190°C @ 2°C/min. (hold 5 min.)
 Inj./det. temp.: 220°C/260°C
 Carrier gas: helium
 Linear velocity: 20cm/sec. set @ 70°C
 FID sensitivity: 64 x 10¹¹ AFS
 Split ratio: 20:1

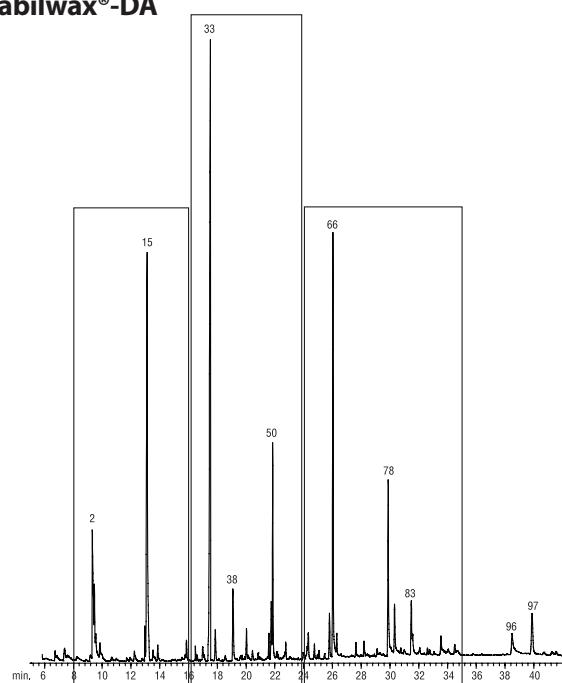
Flavor Volatiles**Stabilwax®**

1. hexane	10. α -pinene	19. γ -terpinene	28. decanal	37. valencene
2. acetaldehyde	11. ethylbutyrate	20. <i>p</i> -cymene	29. linalool	38. geranial
3. acetone	12. <i>n</i> -hexanal	21. terpinolene	30. octanol	39. carvone
4. methanol	13. β -pinene	22. octanal	31. <i>trans</i> - α -bergamotene	40. geranyl acetate
5. ethyl acetate	14. sabine	23. nonanal	32. β -caryophyllene	41. d/l carveol
6. isopropyl alcohol	15. myrcene	24. <i>cis</i> -limonene monoxide	33. terpinene-4-ol	42. α -ionone
7. ethanol	16. δ -limonene	25. <i>trans</i> -limonene	34. nerol	43. d/l carveol
8. methylene chloride	17. 1,8-cineole	26. furfural	35. α -terpineol	44. β -ionone
9. ethyl propionate	18. <i>trans</i> -2-hexenal	27. citronellal	36. neryl acetate	

Column: Stabilwax®, 60m, 053mm ID, 0.50 μ m (cat.# 10643)
 Sample: 0.8 μ L split injection of a flavor volatiles test mix
 Oven temp.: 70°C (hold 15 min.) to 190°C @ 2°C/min. (hold 5 min.)
 Inj./det. temp.: 220°C/260°C
 Carrier gas: helium
 Linear velocity: 20cm/sec. set @ 70°C
 FID sensitivity: 64 x 10¹¹ AFS
 Split ratio: 20:1

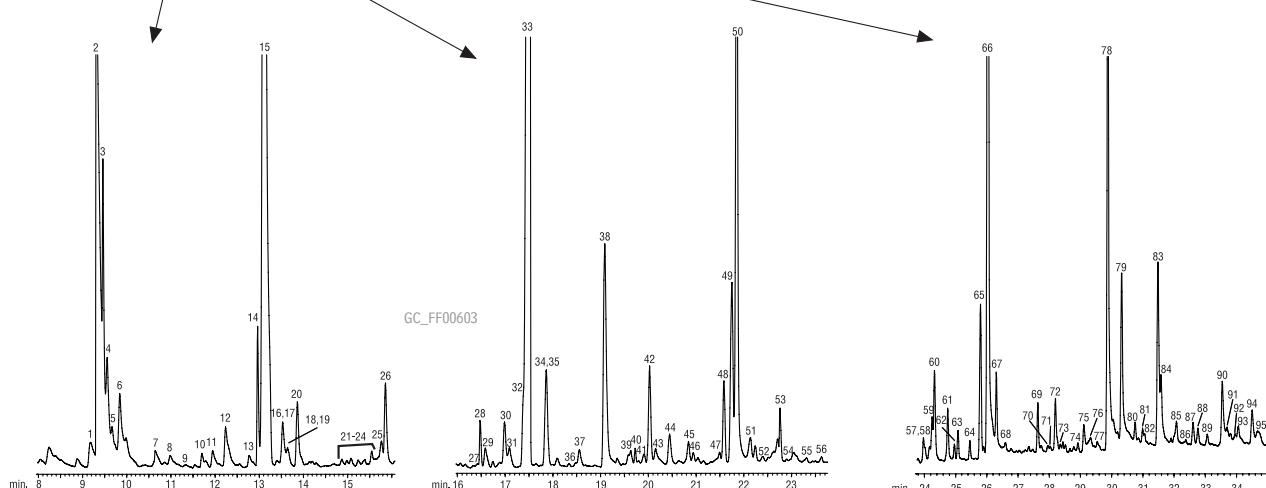


Malt Whiskey Stabilwax®-DA



Column: Stabilwax®-DA, 30m, 0.18mm ID, 0.18 μ m (cat.# 550752)
Inj.: 10 μ L large volume injection (splitless),
at 10 μ L/min.
Std. conc.: neat
Gerstel CIS Injector: 35°C (hold 2 min.), to 300°C @
10°C/sec. (hold 5 min.)
Helium vent flow: 600mL/min. with 1.8 min. vent end time
Carrier gas: helium
Linear velocity: 45cm/sec.
Oven temp.: 60°C (hold 2 min.) to 100°C @
20°C/min., to 240°C @ 5°C/min.
(hold 10 min.)
Det.: MSD
Transfer line temp.: 240°C
Quadrupole temp.: 150°C
MS source temp.: 230°C
Scan range: 30–400amu
Ionization: 70eV
Mode: EI

Chromatogram courtesy of Kevin MacNamara, Ph.D., Irish Distilleries, Ltd.

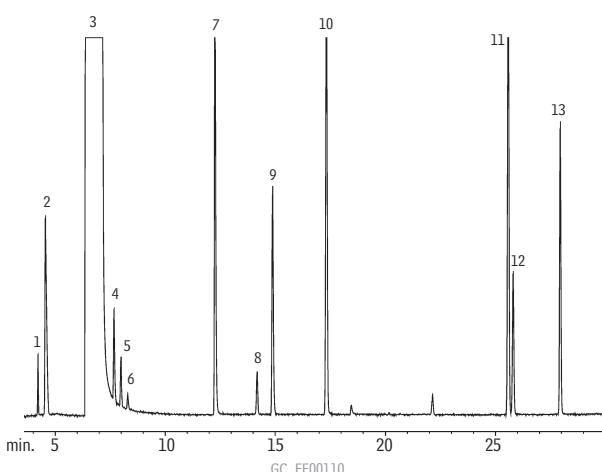


- | | | | | |
|--|--|--|--------------------------------------|--|
| 1. ethyl octanoate | 23. ethyl undecanoate | 44. unknown | 66. decanoic acid | 87. ethyl vanillate |
| 2. acetic acid | 24. isobutyl decanoate | 45. phenol | 67. ethyl 9-hexadecanoate | 88. acetovanillone |
| 3. siloxane | 25. 2(5H)-furanone | 46. methyl tetradecanoate | 68. triacosan | 89. vanillin methyl ketone |
| 4. 1-hydroxy-2,3-butadione | 26. unknown | 47. nerolidol | 69. unknown | 90. tetradecanoic acid |
| 5. 1-hydroxy-2-propanone acetate | 27. di(ethyleneglycol) butyl ether | 48. diethyl malate | 70. phthalide | 91. ethyl homovanillate |
| 6. furfural | 28. siloxane | 49. ethyl tetradecanoate | 71. diethyl phthalate | 92. propiovanillone |
| 7. formic acid | 29. methyl dodecanoate | 50. octanoic acid | 72. hexadecanol | 93. fatty acid ester |
| 8. propionic acid | 30. 2-phenylethyl acetate | 51. unknown | 73. 4-hydroxycinnamic acid (decomp.) | 94. (similar to 4-allyl-2,6-dimethoxyphenol) |
| 9. isobutyric acid | 31. methylcyclopentenolone | 52. p-cresol | 74. methyl stearate | 95. unknown |
| 10. dimethyl sulfoxide | 32. hexanoic acid | 53. siloxane | 75. benzoic acid | 96. hexadecanoic acid |
| 11. 5-methyl furfural | 33. ethyl dodecanoate | 54. diethyl octanedioate | 76. methyl 8-octadecenoate | 97. syringaldehyde |
| 12. methyl decanoate + unknown | 34. isoamyl decanoate | 55. monomethyl succinate (possible) | 77. ethyl stearate | |
| 13. butyric acid | 35. guaiacol | 56. 3,5-dimethyl-2,4(5H)furanidine | 78. dodecanoic acid | |
| 14. siloxane | 36. dodecyl acetate (possible) | 57. nonanoic acid | 79. hydroxymethylfurfural | |
| 15. ethyl decanoate | 37. whiskey lactone (1) | 58. diethyl 2-hydroxyglutarate | 80. ethyl linoleate | |
| 16. furfuryl alcohol | 38. 2-phenoylethanol | 59. unknown | 81. 4-allyl-2,6-dimethoxyphenol | |
| 17. isoamyl octanoate | 39. heptanoic acid | 60. tetradecanol | 82. diisobutyl phthalate | |
| 18. isovaleric acid | 40. siloxane | 61. 4-vinylguaiacol | 83. vanillin | |
| 19. 2-methylbutyric acid | 41. dimethoxybenzene or 4-methylguaiacol | 62. diethyl nonanedioate | 84. sinapic acid (decomp.) | |
| 20. diethyl succinate | 42. whiskey lactone (2) | 63. methyl hexadecanoate | 85. 2-phenylethyl decanoate | |
| 21. 3-methyl-2(5H)-furanone (possible) | 43. dodecanol | 64. ethyl γ -lactone 2-hydroxyglutarate | + 2 unknowns | |
| 22. valeric acid | | 65. ethyl hexadecanoate | 86. 4-propenyl-2,6-dimethoxyphenol | |

Flavors

Rum**Rtx®-1301**

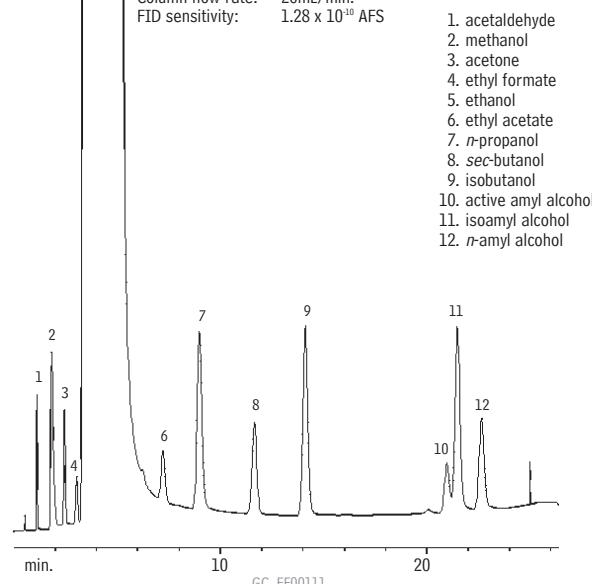
- | | |
|------------------|-------------------------|
| 1. acetaldehyde | 9. sec-butanol |
| 2. methanol | 10. isobutanol |
| 3. ethanol | 11. isoamyl alcohol |
| 4. acetone | 12. active amyl alcohol |
| 5. ethyl formate | 13. n-amyl alcohol |
| 6. isopropanol | |
| 7. n-propanol | |
| 8. ethyl acetate | |



Column: Rtx®-1301, 60m, 0.25mm ID, 1.4 μ m (cat.# 16016)
Inj.: 1.0 μ L split injection using a Cyclosplitter® inlet liner (cat.# 20706)
Conc.: neat
Oven temp.: 35°C (hold 5 min.) to 100°C @ 1°C/min.
Inj./det. temp.: 150°C/200°C
Carrier gas: hydrogen @ 40cm/sec.
Split ratio: 100:1

Rum**CarboBlack B**

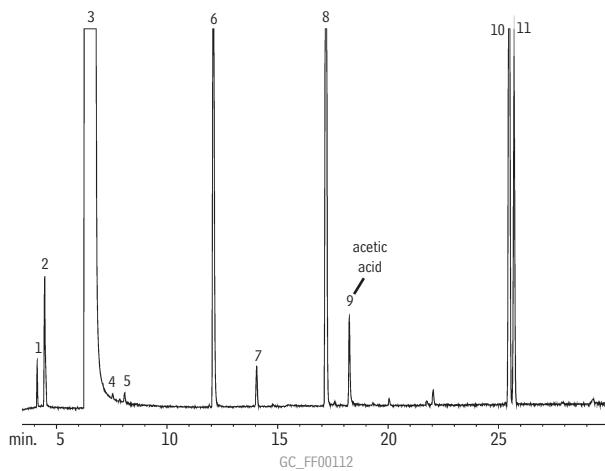
Column: 5% Carbowax® 20M 80/120 CarboBlack B, 2m, 1/8" OD, 2mm ID SilcoSmooth™ tubing (cat.# 80105)
Inj.: 0.5 μ L on-column injection, neat
Oven temp.: 65°C (hold 5 min.) to 150°C @ 4°C/min.
Inj./det. temp.: 200°C/250°C
Det.: FID
Carrier gas: nitrogen
Column flow rate: 20mL/min.
FID sensitivity: 1.28 x 10⁻¹⁰ AFS



- | | |
|-------------------------|-------------------------|
| 1. acetaldehyde | 1. acetaldehyde |
| 2. methanol | 2. methanol |
| 3. acetone | 3. acetone |
| 4. ethyl formate | 4. ethyl formate |
| 5. ethanol | 5. ethanol |
| 6. ethyl acetate | 6. ethyl acetate |
| 7. n-propanol | 7. n-propanol |
| 8. sec-butanol | 8. sec-butanol |
| 9. isobutanol | 9. isobutanol |
| 10. active amyl alcohol | 10. active amyl alcohol |
| 11. isoamyl alcohol | 11. isoamyl alcohol |
| 12. n-amyl alcohol | 12. n-amyl alcohol |

Scotch**Rtx®-1301**

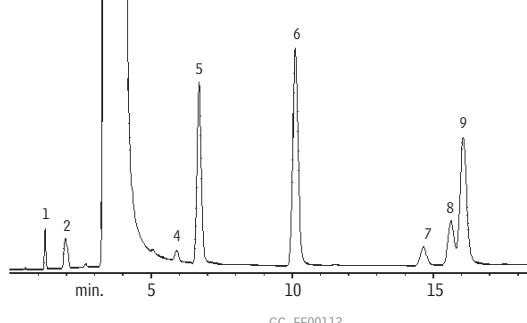
- | | |
|-----------------|-------------------------|
| 1. acetaldehyde | 7. ethyl acetate |
| 2. methanol | 8. isobutanol |
| 3. ethanol | 9. acetic acid |
| 4. acetone | 10. isoamyl alcohol |
| 5. isopropanol | 11. active amyl alcohol |
| 6. n-propanol | |



Column: Rtx®-1301, 60m, 0.25mm ID, 1.4 μ m (cat.# 16016)
Inj.: 1.0 μ L split injection using a Cyclosplitter® inlet liner (cat.# 20706)
Conc.: neat
Oven temp.: 35°C (hold 5 min.) to 100°C @ 1°C/min.
Inj./det. temp.: 150°C/200°C
Carrier gas: hydrogen @ 40cm/sec.
Split ratio: 100:1

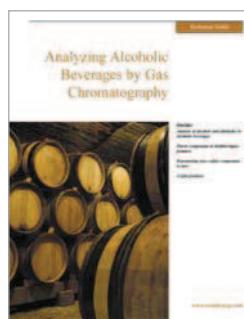
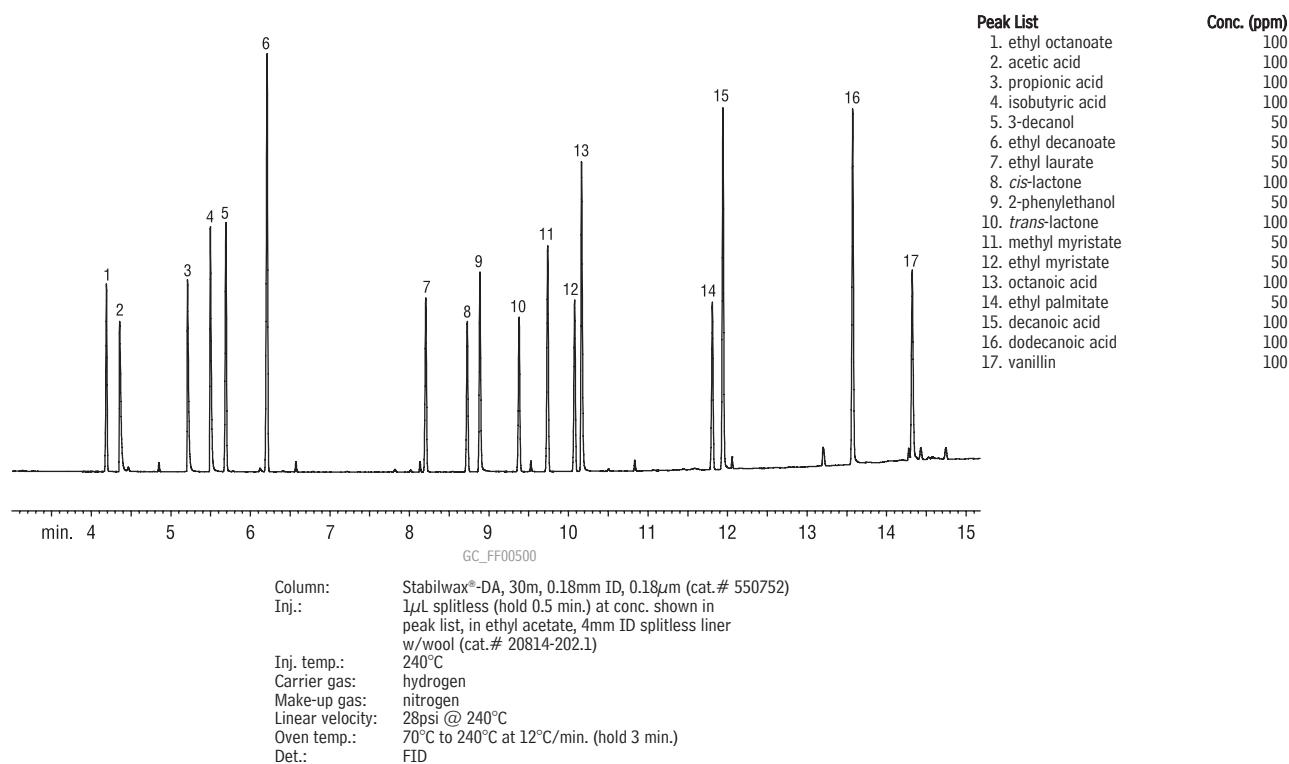
Scotch**CarboBlack B**

Column: 5% Carbowax® 20M 80/120 CarboBlack B, 2m, 1/8" OD, 2mm ID SilcoSmooth™ tubing (cat.# 80105)
Inj.: 0.5 μ L on-column injection, neat
Oven temp.: 70°C to 150°C @ 4°C/min.
Inj./det. temp.: 200°C/250°C
Det.: FID
Carrier gas: nitrogen
Column flow rate: 20mL/min.
FID sensitivity: 1.28 x 10⁻¹⁰ AFS



- | | |
|------------------------|------------------------|
| 1. acetaldehyde | 1. acetaldehyde |
| 2. methanol | 2. methanol |
| 3. ethanol | 3. ethanol |
| 4. ethyl acetate | 4. ethyl acetate |
| 5. n-propanol | 5. n-propanol |
| 6. isobutanol | 6. isobutanol |
| 7. acetic acid | 7. acetic acid |
| 8. active amyl alcohol | 8. active amyl alcohol |
| 9. isoamyl alcohol | 9. isoamyl alcohol |

**Alcoholic Beverage Standard: Acids and Esters
Stabilwax®-DA**



free literature

Analyzing Alcoholic Beverages by Gas Chromatography

Selectivity, sensitivity, and minimal sample preparation make GC a powerful tool for monitoring alcoholic beverage composition

Volatile component profiles of alcoholic beverages reveal a wide range of compounds: acids, alcohols, aldehydes, and others. This 16-page guide describes packed column GC and capillary GC approaches to monitoring these complex mixtures of analytes. A separate section is devoted to detailed information about quantifying trace sulfur compounds in beer.

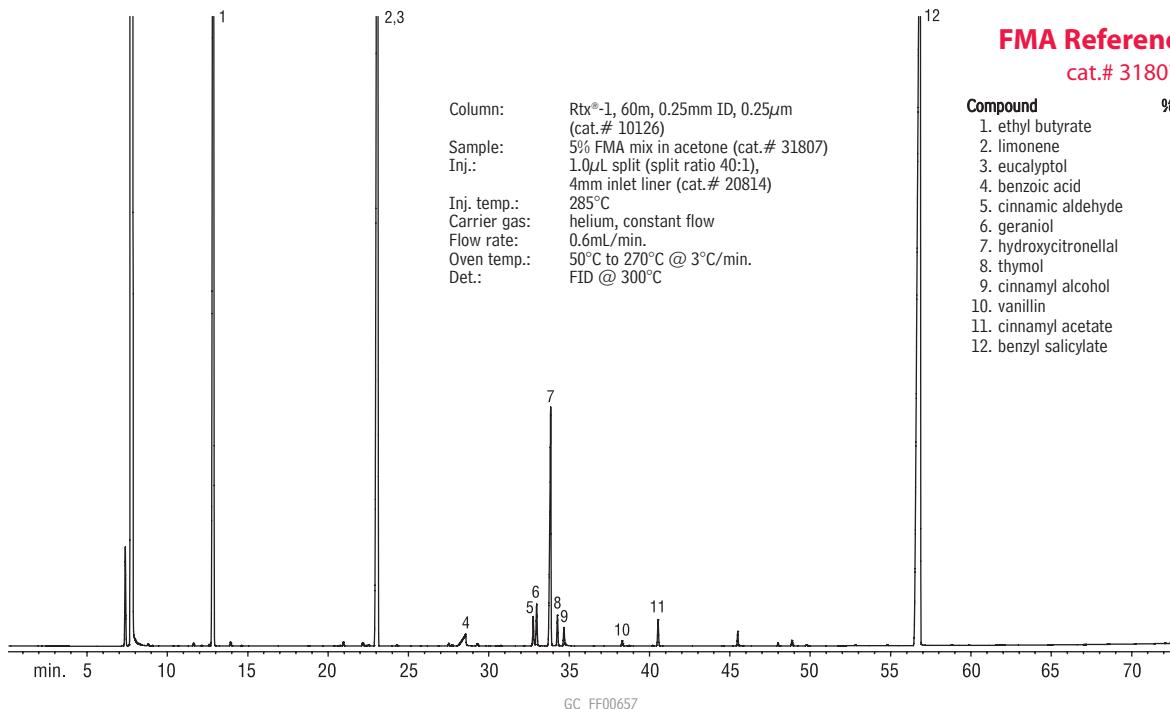
Technical Guide
lit. cat.# 59462

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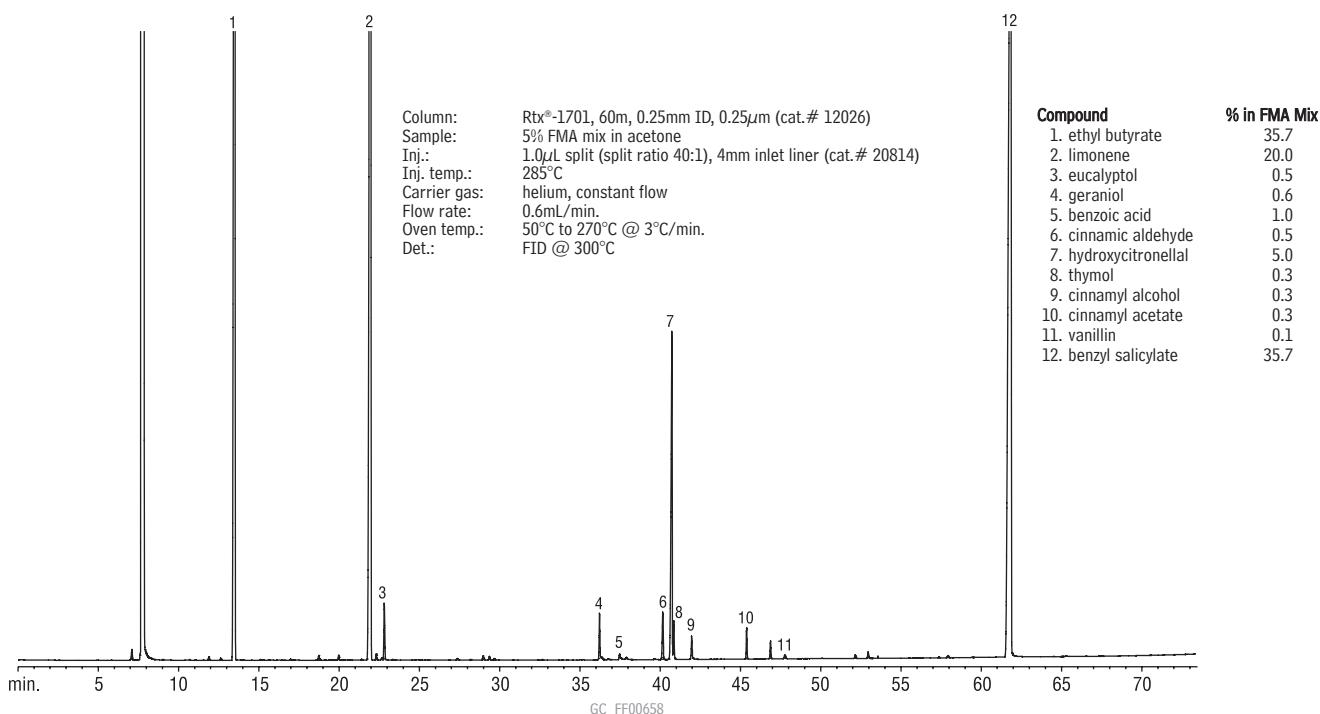
5% Fragrance Materials Association Mix

Rtx®-1



5% Fragrance Materials Association Mix

Rtx®-1701

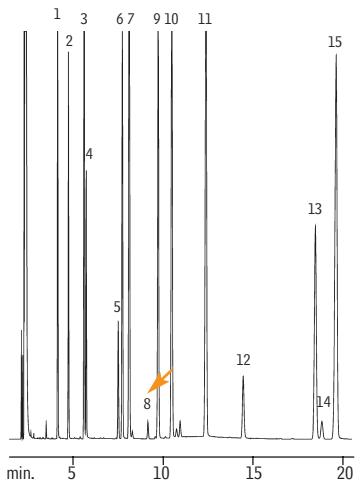




Flavor & Fragrance Compounds

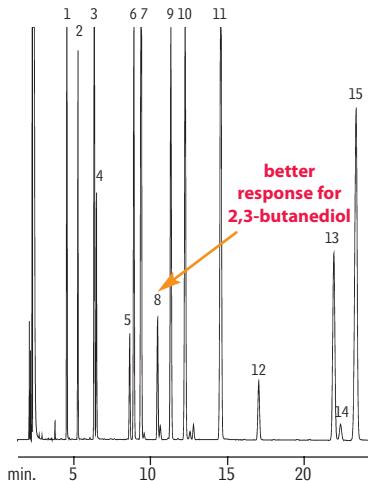
Rt[®]-CW20M F&F

Carbowax[®]



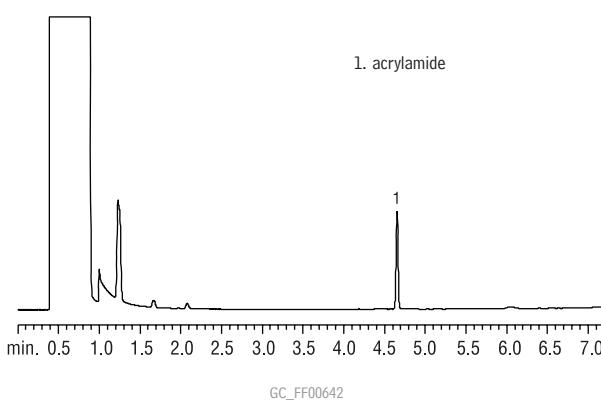
Rt[®]-CW20M F&F

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



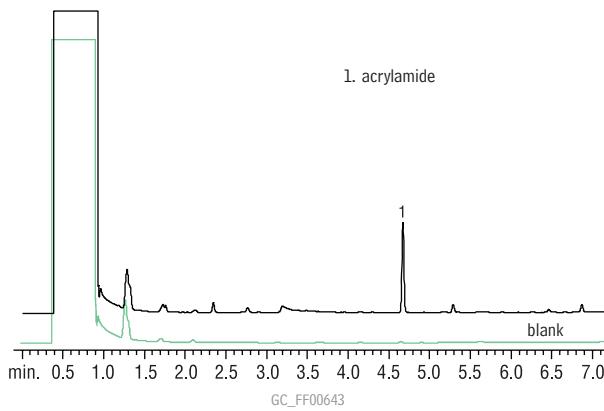
Columns: traditional Carbowax[®] 20M or Rt[®]-CW20M F&F, 50m, 0.32mm ID, 0.33μm, (cat.# 12539)
 Inj.: on-column injection of 5ng to 150ng each compound in methylene chloride, split 10:1
 Carrier gas: hydrogen, 40cm/sec.
 Inj./det. temp.: 220°C
 Oven temp.: 110°C

Acrylamide (Reference Standard) Stabilwax[®]



Column: Stabilwax[®], 15m, 0.53mm ID, 0.50μm (cat.# 10637)
 Sample: 25μg/mL acrylamide standard in water
 Inj.: 1.0μL, 0.5 min hold
 Liner: 2mm splitless with wool (cat.# 20830)
 Inj. temp.: 260°C
 Carrier gas: helium, constant pressure
 Linear velocity: 62cm/sec. @ 100°C
 Oven temp.: 100°C (hold 0.5 min.) to 200°C @ 15°C/min.
 Det.: FID @ 260°C

Acrylamide (Potato Chip Extract) Stabilwax[®]

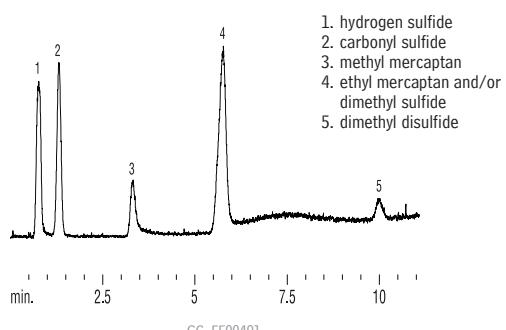


Column: Stabilwax[®], 15m, 0.53mm ID, 0.50μm (cat.# 10637)
 Sample: 1g of potato chips spiked with 100μg acrylamide
 Inj.: 1.0μL, 0.5 min. hold
 Liner: 2mm splitless with wool (cat.# 20830)
 Inj. temp.: 260°C
 Carrier gas: helium, constant pressure
 Linear velocity: 62cm/sec. @ 100°C
 Oven temp.: 100°C (hold 0.5 min.) to 200°C @ 15°C/min.
 Det.: FID @ 260°C

Food Contaminants

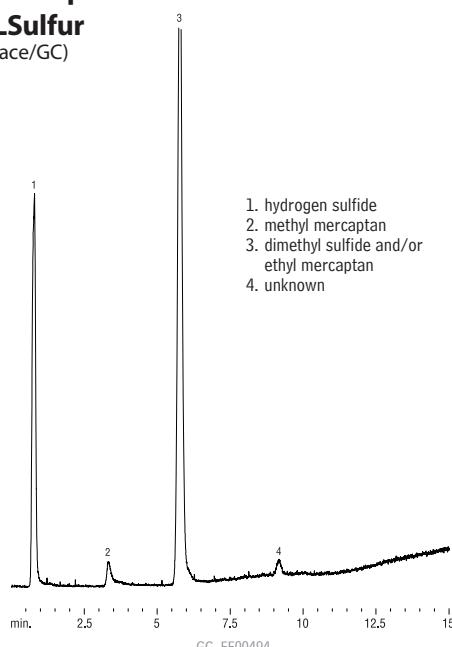
Sulfur Compounds in Beverage Grade CO₂

Rt®-XLSulfur



Column: Rt®-XLSulfur, 100/120 mesh, 1m, 0.75mm ID
Sulfinert® tubing (cat.# 19806)
Conc.: sulfur standard @ 20ppb each in CO₂
Inj.: 1cc sample loop, 6-port Valco® valve
Carrier gas: helium
Flow rate: 10mL/min. @ ambient temp.
Oven temp.: 60°C to 260°C @ 15°C/min. (hold 5 min.)
Det. sensitivity: SCD, attn. x 1
Det. temp.: 800°C

Sulfur Compounds in Beer

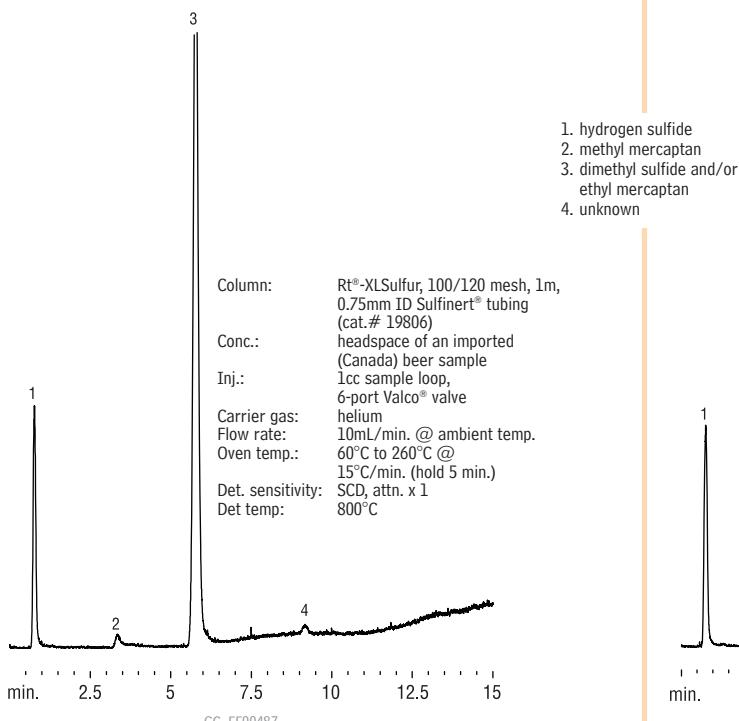
Rt®-XLSulfur
(Headspace/GC)

Column: Rt®-XLSulfur, 100/120 mesh, 1m, 0.75mm ID
Sulfinert® tubing (cat.# 19806)
Conc.: headspace of a domestic (US) beer sample
Inj.: 1cc sample loop, 6-port Valco® valve
Carrier gas: helium
Flow rate: 10mL/min. @ ambient temp.
Oven temp.: 60°C to 260°C @ 15°C/min. (hold 5 min.)
Det. sensitivity: SCD, attn. x 1
Det. temp.: 800°C

Sulfur Compounds in Beer

Rt®-XLSulfur

(Headspace/GC)

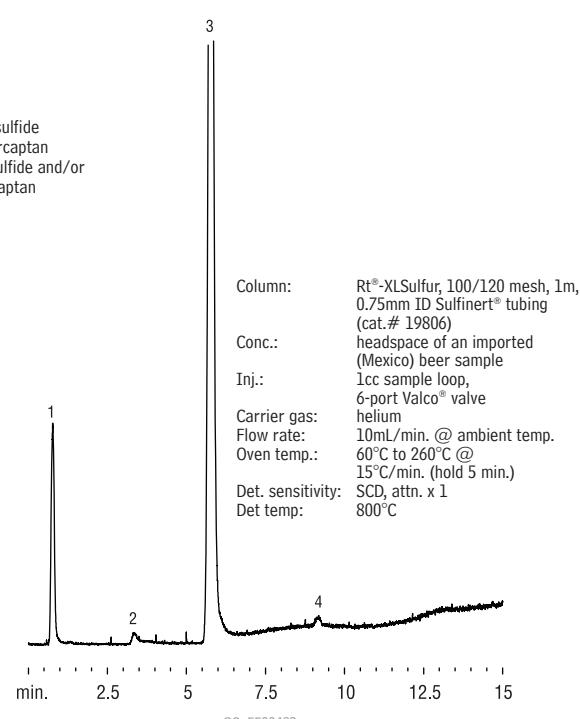


Column: Rt®-XLSulfur, 100/120 mesh, 1m, 0.75mm ID Sulfinert® tubing (cat.# 19806)
Conc.: headspace of an imported (Canada) beer sample
Inj.: 1cc sample loop, 6-port Valco® valve
Carrier gas: helium
Flow rate: 10mL/min. @ ambient temp.
Oven temp.: 60°C to 260°C @ 15°C/min. (hold 5 min.)
Det. sensitivity: SCD, attn. x 1
Det. temp.: 800°C

Sulfur Compounds in Beer

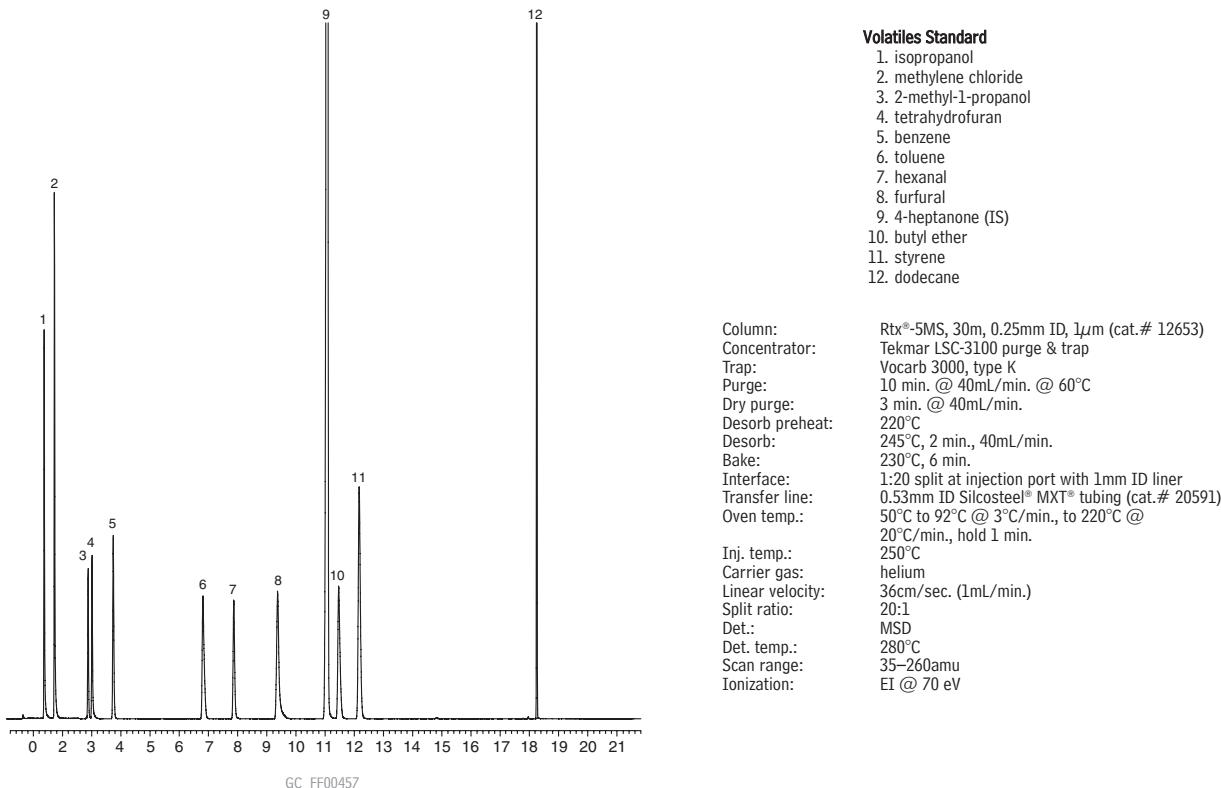
Rt®-XLSulfur

(Headspace/GC)

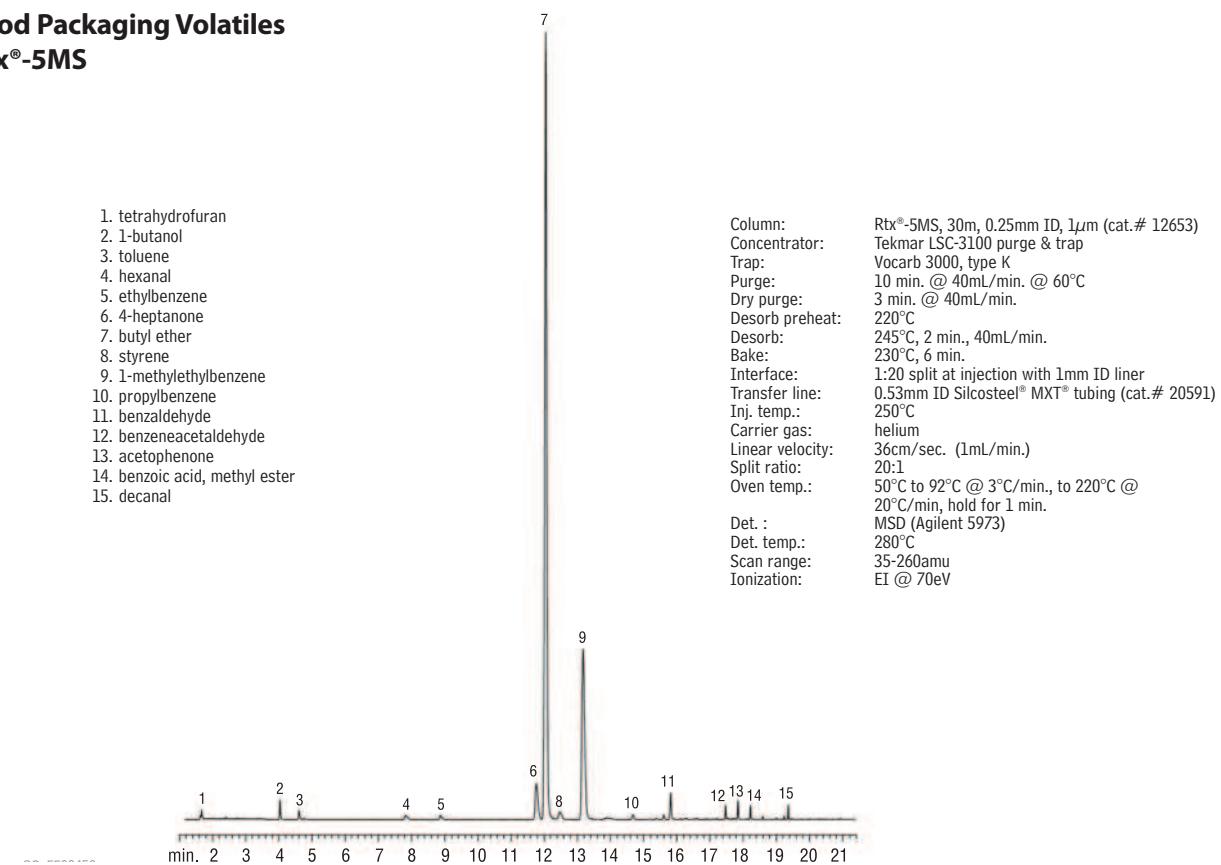


Column: Rt®-XLSulfur, 100/120 mesh, 1m, 0.75mm ID Sulfinert® tubing (cat.# 19806)
Conc.: headspace of an imported (Mexico) beer sample
Inj.: 1cc sample loop, 6-port Valco® valve
Carrier gas: helium
Flow rate: 10mL/min. @ ambient temp.
Oven temp.: 60°C to 260°C @ 15°C/min. (hold 5 min.)
Det. sensitivity: SCD, attn. x 1
Det. temp.: 800°C

Food Packaging Volatiles
Rtx®-5MS



Food Packaging Volatiles
Rtx®-5MS



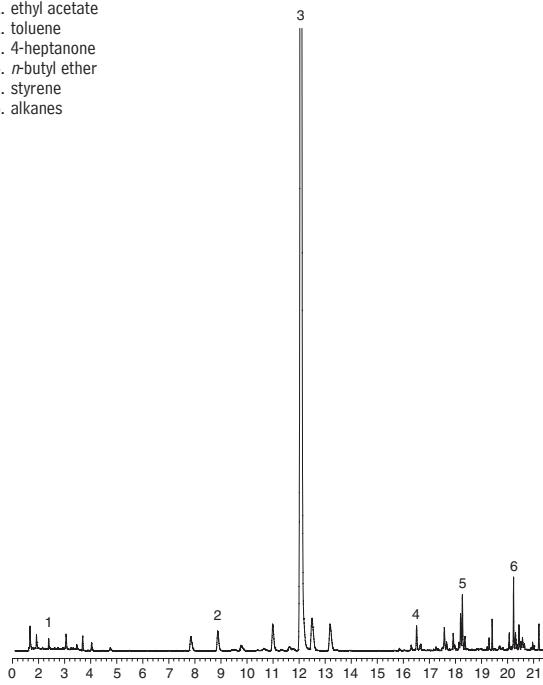
Food Contaminants

Food Packaging Volatiles by Purge & Trap GC/MS

Rtx®-5MS

(Purge & Trap GC/MS)

1. ethyl acetate
2. toluene
3. 4-heptanone
4. *n*-butyl ether
5. styrene
6. alkanes



Column: Rtx®-5MS, 30m, 0.25mm ID, 1μm (cat.# 12653)
 GC: Agilent 6890
 Oven temp.: 50°C to 92°C @ 3°C/min., to 220°C @ 20°C/min. (hold 1 min.)
 Injector temp.: 250°C
 Carrier gas: helium
 Linear velocity: 36cm/sec. (1mL/min.)
 Det. sensitivity: NA
 Split ratio: 20:1
 Det.: MSD (Agilent 5973)
 Det. temp.: 280°C
 Scan range: 35-260amu
 Ionization: EI @ 70eV
 Mode:

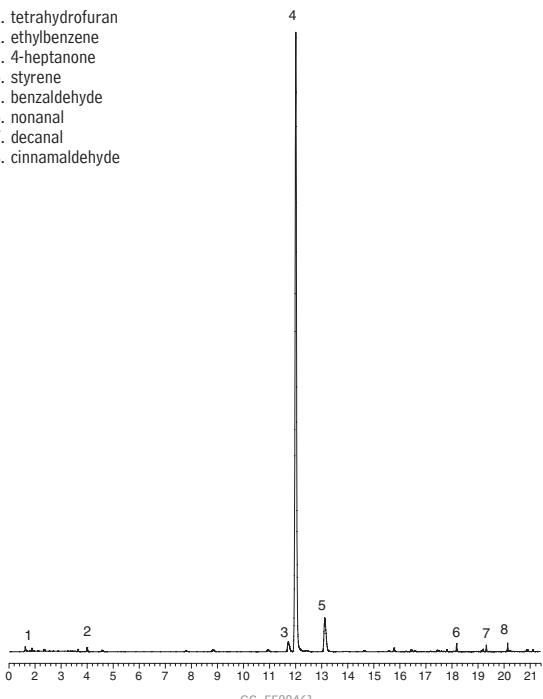
Sample Conditions:
 Sample: Overwrap, inner bowl
 Concentrator: Tekmar LSC-3100 purge & trap
 Trap: Vocarb 3000, type K
 Purge: 10 min. @ 40mL/min., at 60°C
 Dry purge: 3 min. @ 40mL/min.
 Desorb preheat: 220°C
 Desorb: 245°C, 2 min., 40mL/min.
 Bake: 230°C, 6 min.
 Interface: 1:20 split at injection port with 1mm ID inlet liner
 Transfer line: 0.53mm ID Silcosteel® MXT® tubing (cat.# 20591)

Food Packaging Volatiles by Purge & Trap GC/MS

Rtx®-5MS

(Purge & Trap GC/MS)

1. tetrahydrofuran
2. ethylbenzene
3. 4-heptanone
4. styrene
5. benzaldehyde
6. nonanal
7. decanal
8. cinnamaldehyde



Column: Rtx®-5MS, 30m, 0.25mm ID, 1μm (cat.# 12653)
 GC: Agilent 6890
 Oven temp.: 50°C to 92°C @ 3°C/min., to 220°C @ 20°C/min. (hold 1 min.)
 Inj. temp.: 250°C
 Carrier gas: helium
 Linear velocity: 36cm/sec. (1mL/min.)
 Det. sensitivity: NA
 Split ratio: 20:1
 Det.: MSD (Agilent 5973)
 Det. temp.: 280°C
 Scan range: 35-260amu
 Ionization: EI @ 70eV
 Mode:

Sample Conditions:
 Sample: Overwrap, lid of bowl
 Concentrator: Tekmar LSC-3100 purge & trap
 Trap: Vocarb 3000, type K
 Purge: 10 min. @ 40mL/min., at 60°C
 Dry purge: 3 min. @ 40mL/min.
 Desorb preheat: 220°C
 Desorb: 245°C, 2 min., 40mL/min.
 Bake: 230°C, 6 min.
 Interface: 1:20 split at injection port with 1mm ID inlet liner
 Transfer line: 0.53mm ID Silcosteel® MXT® tubing (cat.# 20591)

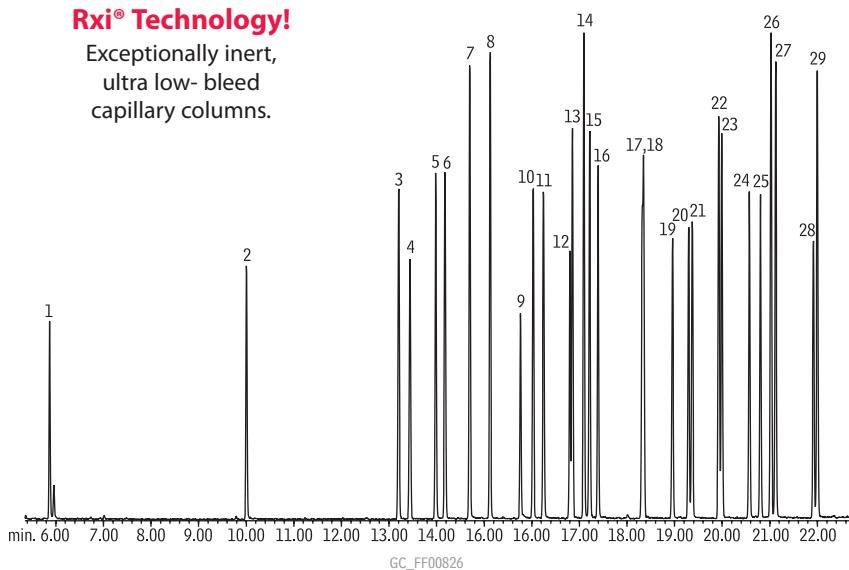
Organochlorine and Organophosphorus Pesticides

FAPAS® Proficiency Testing

Rxi®-5ms

Rxi® Technology!

Exceptionally inert,
ultra low- bleed
capillary columns.



1. dichlorvos
2. methacrifos
3. α -BHC
4. hexachlorobenzene
5. δ -BHC (lindane)
6. β -BHC
7. diazinon
8. etrimphos
9. phosphamidon
10. chlorpyrifos-methyl
11. heptachlor
12. fenitrothion
13. pirimiphos methyl
14. malathion
15. aldrin
16. chlorpyrifos
17. heptachlor epoxide
18. oxychlordane
19. *trans*-chlordane
20. endosulfan I
21. *cis*-chlordane
22. 2,4'-DDT
23. dieldrin
24. endrin
25. endosulfan II
26. 4,4'-DDE
27. 4,4'-DDD
28. endosulfan sulfate
29. 4,4'-DDT

Column: Rxi®-5ms, 30m, 0.25mm ID, 0.25 μ m (cat.# 13423)
 Sample: FAPAS Series 5 OC Pesticide Mix 1 (cat.# 32412), FAPAS Series 9 OP Pesticide Mix 1 (cat.# 32413)
 Inj.: 1.0 μ L, 10ppm each analyte, split (10:1) 4mm Drilled Uniliner® inlet liner (hole near bottom) (cat.# 20771)
 Instrument: Agilent 6890
 Inj. temp.: 290°C
 Carrier gas: helium, constant flow
 Flow rate: 1.2mL/min.
 Oven temp.: 100°C (hold 0.5 min.) to 300°C @ 7°C/min. (hold 1 min.)
 Det.: Agilent 5973 GC/MS
 Transfer line temp.: 280°C
 Scan range: 35-550amu
 Solvent delay: 4 min.
 Tune: DFTPP
 Ionization: EI

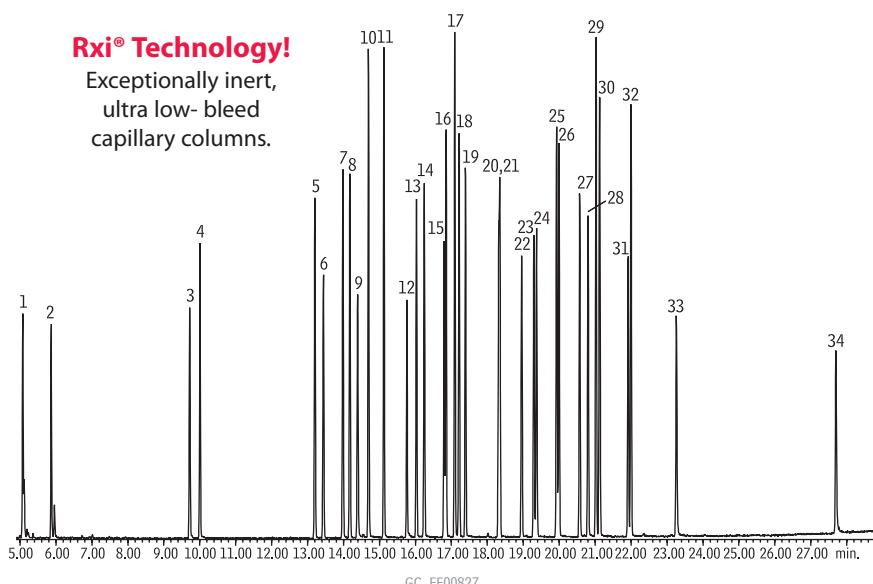
Organochlorine and Organophosphorus Pesticides

FAPAS® Proficiency Testing

Rxi®-5ms

Rxi® Technology!

Exceptionally inert,
ultra low- bleed
capillary columns.



1. naphthalene-d8
2. dichlorvos
3. acenaphthene-d10
4. methacrifos
5. α -BHC
6. hexachlorobenzene
7. δ -BHC (lindane)
8. β -BHC
9. phenanthrene-d10
10. diazinon
11. etrimphos
12. phosphamidon
13. chlorpyrifos-methyl
14. heptachlor
15. fenitrothion
16. pirimiphos methyl
17. malathion
18. aldrin
19. chlorpyrifos
20. heptachlor epoxide
21. oxychlordane
22. *trans*-chlordane
23. endosulfan I
24. *cis*-chlordane
25. 2,4'-DDT
26. dieldrin
27. endrin
28. endosulfan II
29. 4,4'-DDE
30. 4,4'-DDD
31. endosulfan sulfate
32. 4,4'-DDT
33. chrysene-d12
34. perylene-d12

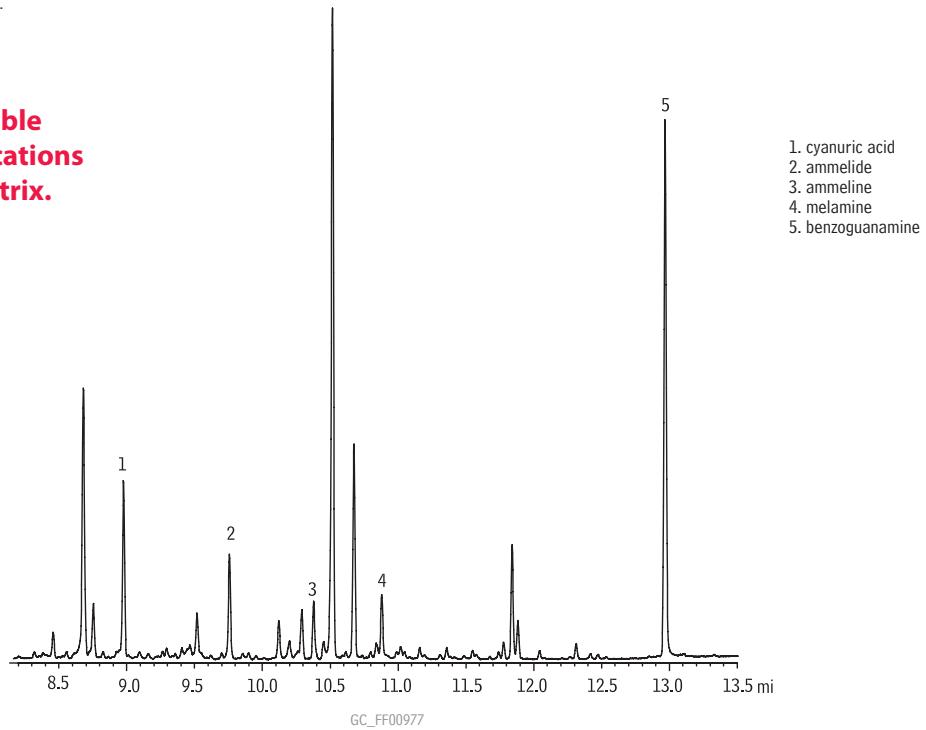
Column: Rxi®-5ms, 30m, 0.25mm ID, 0.25 μ m (cat.# 13423)
 Sample: FAPAS Series 5 OC Pesticide Mix 1 (cat.# 32412), FAPAS Series 9 OP Pesticide Mix 1 (cat.# 32413), SV Internal Standard Mix (cat.# 31206)
 Inj.: 1.0 μ L, 10ppm each analyte, split (10:1) 4mm Drilled Uniliner® inlet liner (hole near bottom) (cat.# 20771)
 Instrument: Agilent 6890
 Inj. temp.: 290°C
 Carrier gas: helium, constant flow
 Flow rate: 1.2mL/min.
 Oven temp.: 100°C (hold 0.5 min.) to 300°C @ 7°C/min. (hold 1 min.)
 Det.: Agilent 5973 GC/MS
 Transfer line temp.: 280°C
 Scan range: 35-550amu
 Solvent delay: 4 min.
 Tune: DFTPP
 Ionization: EI

Melamine Spike in Cat Food

Rtx®-5MS

NEW!

**Reliable
identifications
in matrix.**



Column: Rtx®-5MS, 30m, 0.25mm ID, 0.25 μ m (cat.# 12623)
 Sample: melamine, cyanuric acid, ammelide, ammeline, benzoguanamine in dry cat food (10 μ g/mL prederivatized)
 Inj.: 1 μ L, splitless (hold 1 min.), 3.5mm splitless inlet liner (cat.# 22286)
 Inj. temp.: 280°C
 Carrier gas: helium, constant flow
 Flow rate: 1mL/min.
 Oven temp.: 75°C to 320°C @ 15°C/min. (hold 4 min.)
 Det: MS
 Transfer line temp.: 290°C
 Ionization: EI
 Mode: SIM

Get More!

**High Sensitivity
Melamine GC/MS
Analysis of Cat Food**

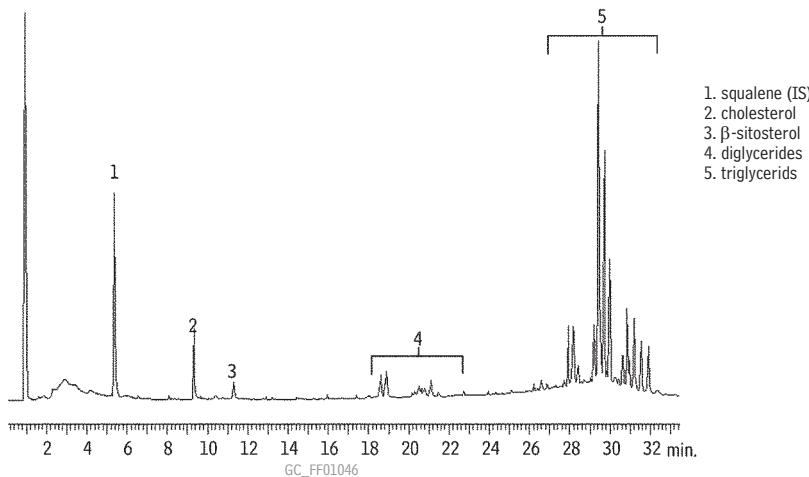
Modified Conditions Save Costs
and Reduce Maintenance

read the full article
at www.restek.com/FFF



Egg Pasta: Sterols & Glycerides

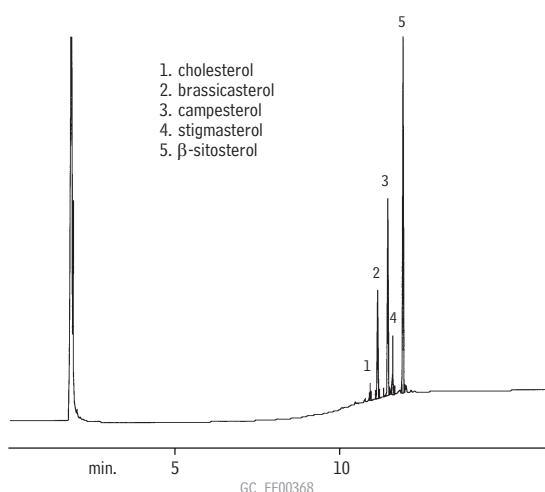
Rtx®-65TG



Column: Rtx®-65TG, 30m, 0.25mm ID, 0.10 μ m (cat.# 17008)
 Sample: 50 μ g/mL fat extract from egg pasta in diethyl ether solution with 3,000ppm squalene (IS)
 Inj.: 0.5 μ L, split (1:80), 70°C (hold 12 sec.) at 99°C up to 370°C (hold 5 min.)
 Carrier gas: hydrogen
 Flow rate: 1.5mL/min.
 Oven temp.: 220°C (hold 2.0 min.) to 360°C @ 5°C/min. (hold 5 min.)
 Det: FID @ 370°C

Phytosterols (Saw Palmetto)

Rtx®-5



Column: Rtx®-5, 60m, 0.25mm ID, 0.25 μ m (cat.# 10226)
 Inj.: 1 μ L splitless injection*
 Oven temp.: 200°C (hold 1 min.) to 340°C @ 15°C/min. (hold 10 min.)
 Inj./FID temp.: 345°C/355°C

*Split injection may be used, but results can have greater variability. A split flow of 112mL/min. is suggested.

Chromatogram provided by the Institute for Nutraceutical Advancement (INA)



free literature

Foods, Flavors, and Fragrances Catalog!

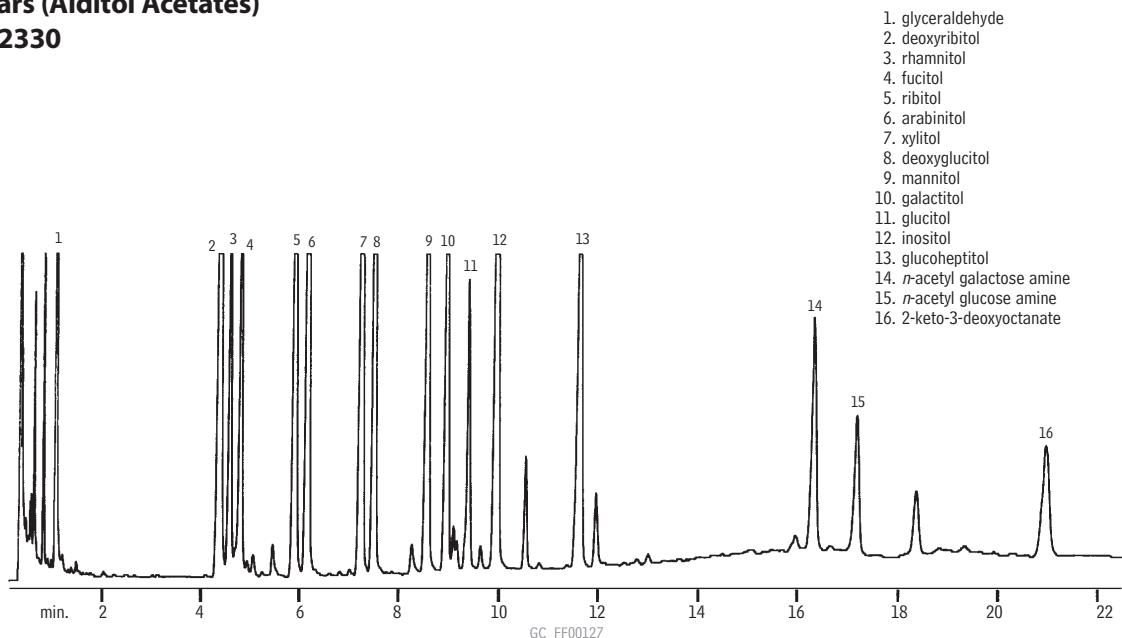
Includes important analysis tips, and chromatograms for analysis of fats and oils, carbohydrates, vitamins, amino acids, organic acids, preservatives, flavors and fragrances, essential oils, and chiral separations. Retention time indices and complete product listings for all relevant GC and HPLC products also are included.

lit. cat.# 59260A

Also available—Monitoring Volatile Compounds in Food Contact Packaging, Using Purge and Trap GC/MS and an Rtx®-5MS Capillary Column

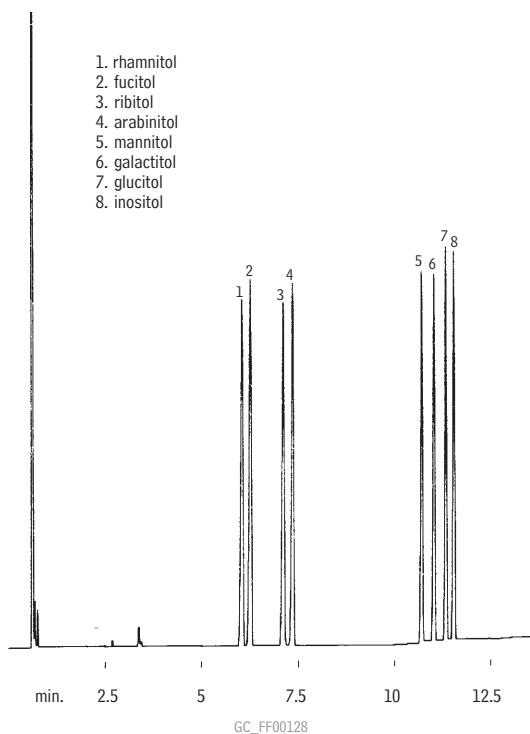
Applications Note
 lit. cat.# 59348

Sugars (Alditol Acetates)

Rt[®]-2330

Column: Rt[®]-2330, 15m, 0.32mm ID, 0.20 μ m (cat.# 10721)
 Inj.: 0.6 μ L split injection
 Oven temp.: 175°C (hold 2 min.) to 240°C @ 8°C/min. (hold 1 min.) to 265°C @ 8°C/min. (hold 12 min.)
 Inj./det. temp.: 275°C
 Carrier gas: helium
 Linear velocity: 80cm/sec. (flow rate: 10cc/min.)
 FID sensitivity: 2 x 10¹¹ AFS
 Split ratio: 20:1

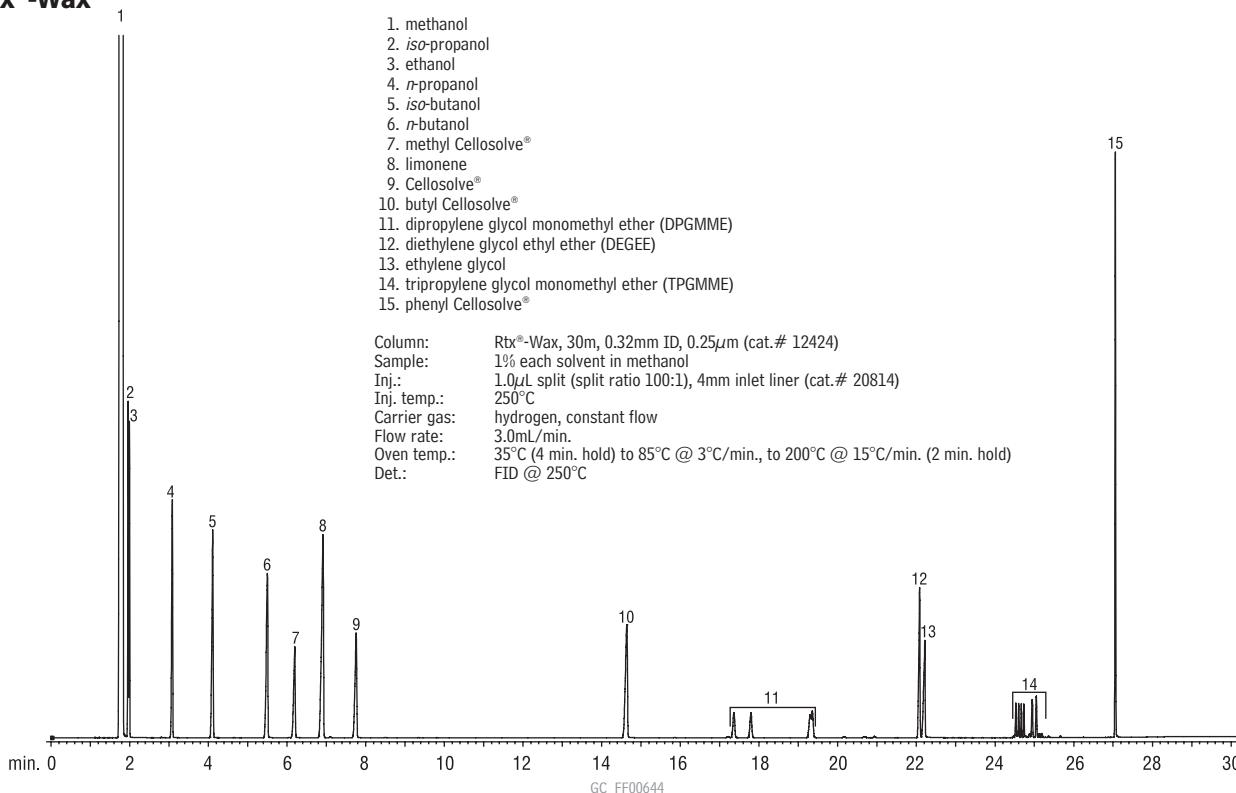
Sugars (Alditol Acetates)

Rtx[®]-225

Column: Rtx[®]-225, 15m, 0.25mm ID, 0.25 μ m (cat.# 14020)
 Inj.: 0.5 μ L split injection
 Oven temp.: 190°C (hold 5 min.) to 250°C @ 8°C/min. (hold 5 min.)
 Inj./det. temp.: 260°C
 Carrier gas: hydrogen
 Linear velocity: 42cm/sec. set @ 40°C
 FID sensitivity: 16 x 10¹¹ AFS
 Split ratio: 50:1

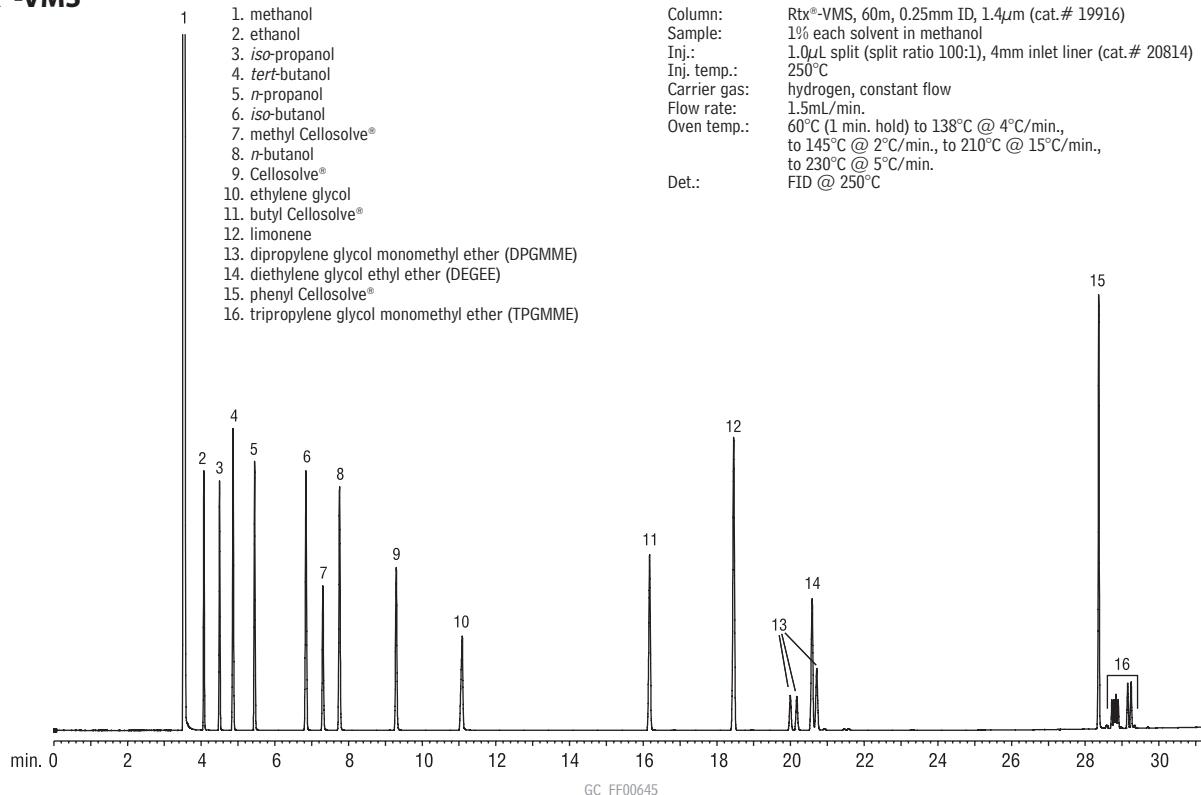
Cleaning Solvents

Rtx[®]-Wax



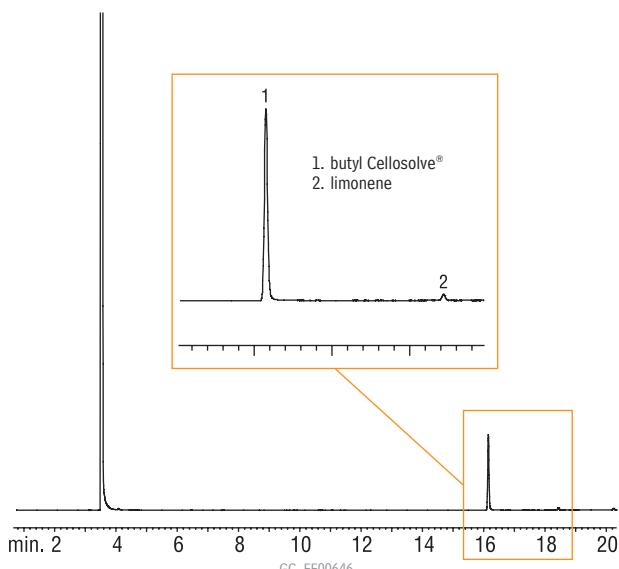
Cleaning Solvents

Rtx[®]-VMS



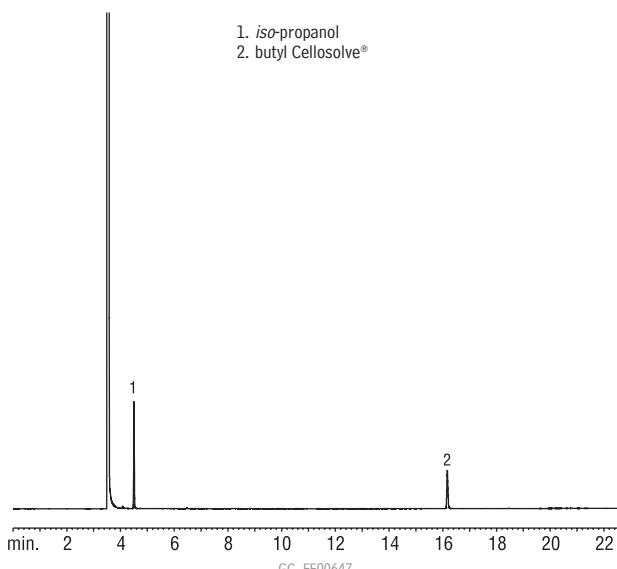
GC APPLICATIONS | PERSONAL CARE & CLEANING PRODUCTS
Cleaning Solvents, Fragrances

**Cleaning Solvents (All-Purpose Cleaner)
Rtx®-VMS**



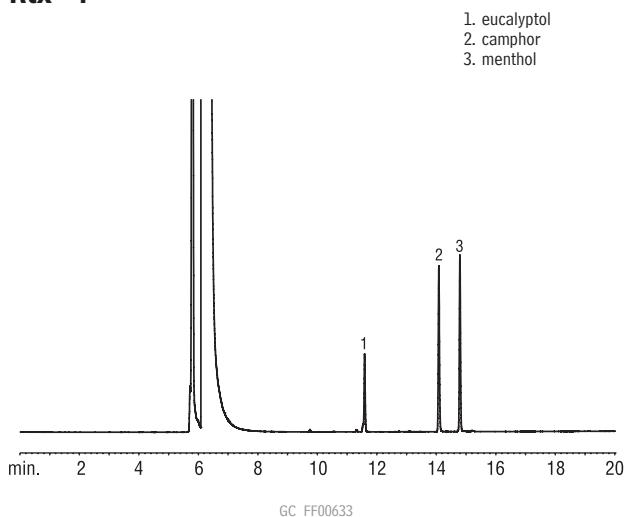
Column: Rtx®-VMS, 60m, 0.25mm ID, 1.4 μ m (cat.# 19916)
Sample: approx. 5% cleaner in methanol
Inj.: 1.0 μ L split (split ratio 100:1), 4mm inlet liner (cat.# 20814)
Inj. temp.: 250°C
Carrier gas: hydrogen, constant flow
Flow rate: 1.5mL/min.
Oven temp.: 60°C (1 min. hold) to 138°C @ 4°C/min. to 145°C @ 2°C/min. to 210°C @ 15°C/min. to 230°C @ 5°C/min.
Det.: FID @ 250°C

**Cleaning Solvents (Glass Cleaner)
Rtx®-VMS**



Column: Rtx®-VMS, 60m, 0.25mm ID, 1.4 μ m (cat.# 19916)
Sample: approx. 5% cleaner in methanol
Inj.: 1.0 μ L split (split ratio 100:1), 4mm inlet liner (cat.# 20814)
Inj. temp.: 250°C
Carrier gas: hydrogen, constant flow
Flow rate: 1.5mL/min.
Oven temp.: 60°C (1 min. hold) to 138°C @ 4°C/min. to 145°C @ 2°C/min. to 210°C @ 15°C/min. to 230°C @ 5°C/min.
Det.: FID @ 250°C

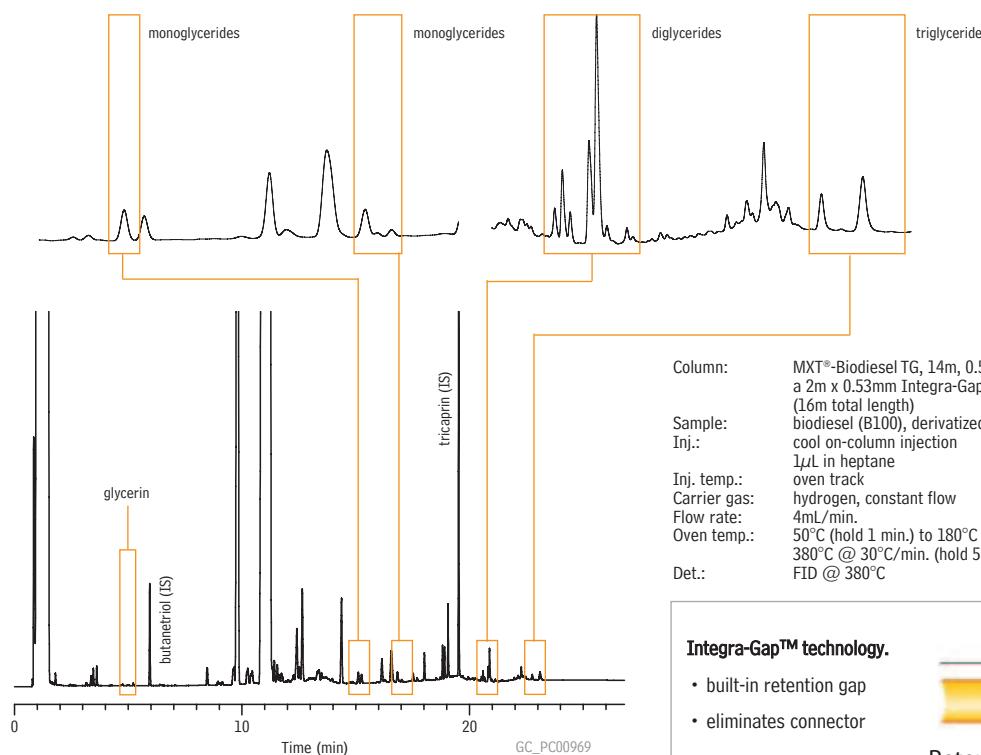
**Personal Care Product Fragrances
Rtx®-1**



Column: Rtx®-1, 60m, 0.25mm ID, 0.25 μ m (cat.# 10126)
Sample: 130ppm eucalyptus oil, 250ppm camphor,
260ppm menthol in methanol
Inj.: 1.0 μ L split (split ratio 20:1), 4mm inlet liner (cat.# 20814)
Inj. temp.: 275°C
Carrier gas: helium, constant flow
Flow rate: 0.6mL/min.
Oven temp.: 80°C to 180°C @ 5°C/min.
Det.: FID @ 300°C

Searching for a chromatogram?
www.restek.com

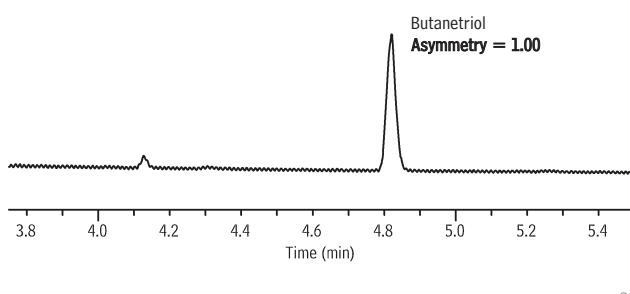
**Total Glycerin in Biodiesel
MXT®-Biodiesel TG**



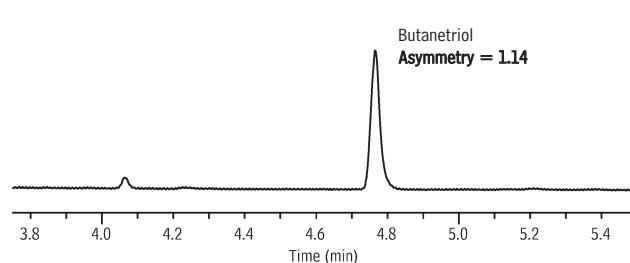
The best solution
for analyzing total
glycerin in biodiesel!

**Biodiesel Oil (B100)
Rtx®-Biodiesel TG**

**A. Rtx®-Biodiesel TG
with Alumaseal™ connector and
2 meters of 0.53mm ID Hydroguard™ tubing**

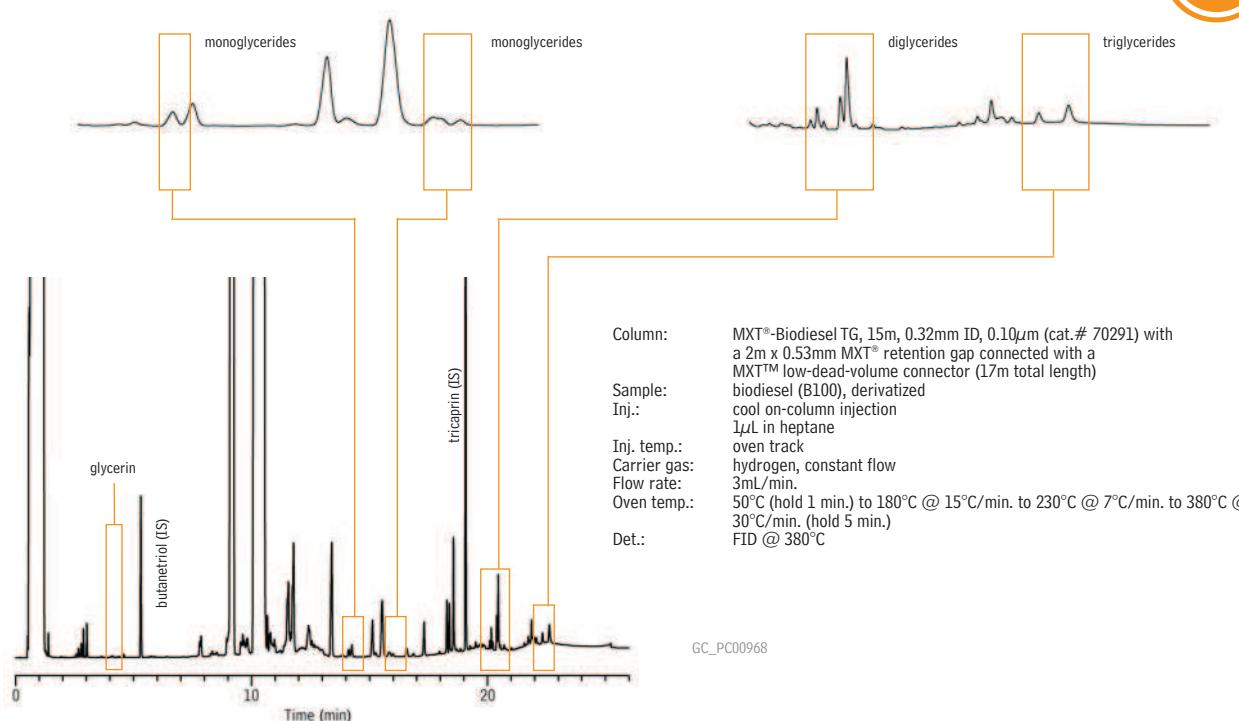


**B. Rtx®-Biodiesel TG
with Universal Press-Tight® Connector and
2 meters of 0.53mm ID Hydroguard™ tubing**

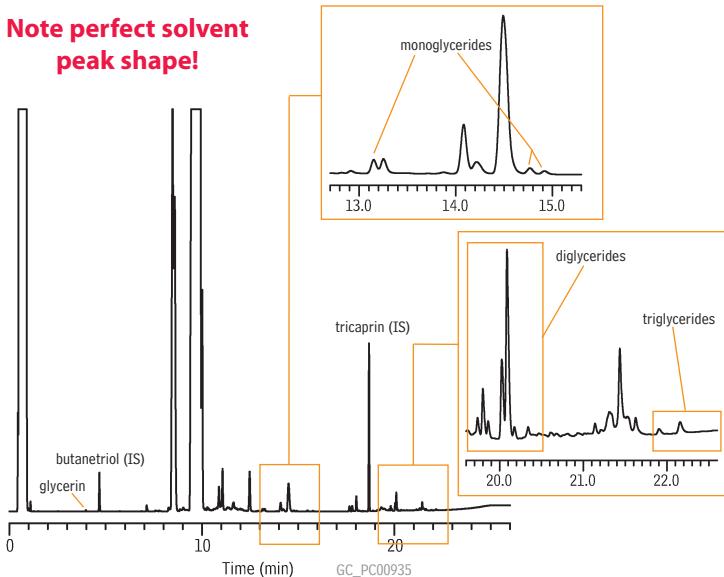


Columns: A. Rtx®-Biodiesel TG, 10m, 0.32mm ID, 0.10 μ m connected to 2m x 0.53mm Hydroguard™ tubing using Alumaseal™ connector
B. Rtx®-Biodiesel TG, 10m, 0.32mm ID, 0.10 μ m connected to 2m x 0.53mm Hydroguard™ tubing using Universal Press-Tight® connector
Sample: biodiesel (B100) with butanetriol at 12.5ppm (12.5ng on-column)
Inj.: 1 μ L, cool on-column injection
Inj. temp.: oven track mode
Carrier gas: hydrogen, constant flow 4cc/min.
Linear velocity: 79cm/sec.
Oven temp.: 50°C (hold 1min.) to 180°C @ 15°C/min. to 230°C @ 7°C/min. to 380°C @ 30°C/min. (hold 5 min.)
Det.: FID @ 380°C

B100
MXT®-Biodiesel TG



Derivatized B100 and Internal Standards
MXT®-Biodiesel TG with 2m x 0.53mm ID Retention Gap



Column: MXT®-Biodiesel TG, 10m, 0.32mm ID, 0.1 μ m with 2m x 0.53mm retention gap (cat.# 70290)
Sample: B100 + IS butanetriol & tricaprin derivatized with MSTFA as per ASTM D-6584
Inj.: 1.0 μ L 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., to 230°C @ 7°C/min., to 430°C @ 30°C/min. (hold 5 min.)
Det.: FID @ 430°C

Get More!

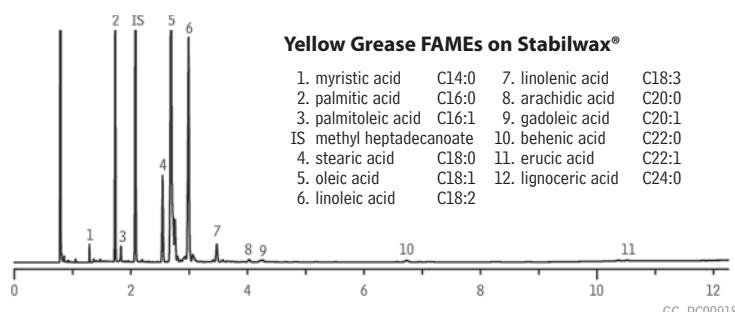
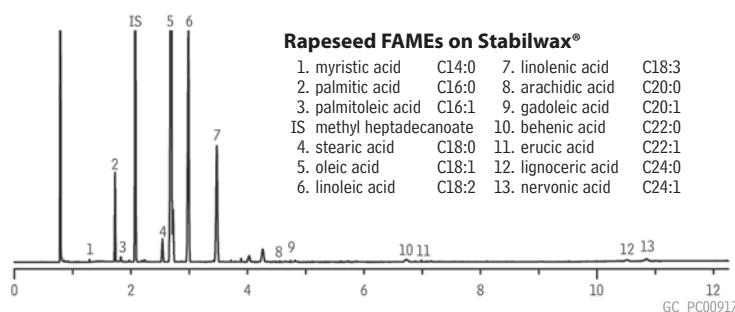
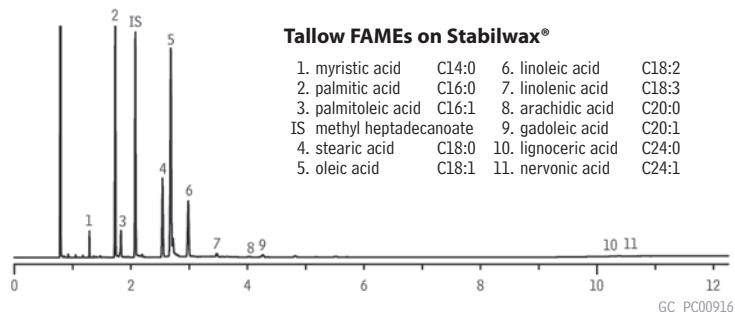
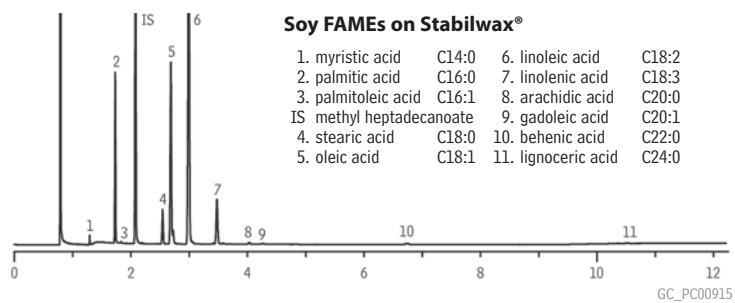
Biodiesel Related
Articles Online

www.restek.com/biodiesel



FAMEs in Biodiesel Oils

Stabilwax®



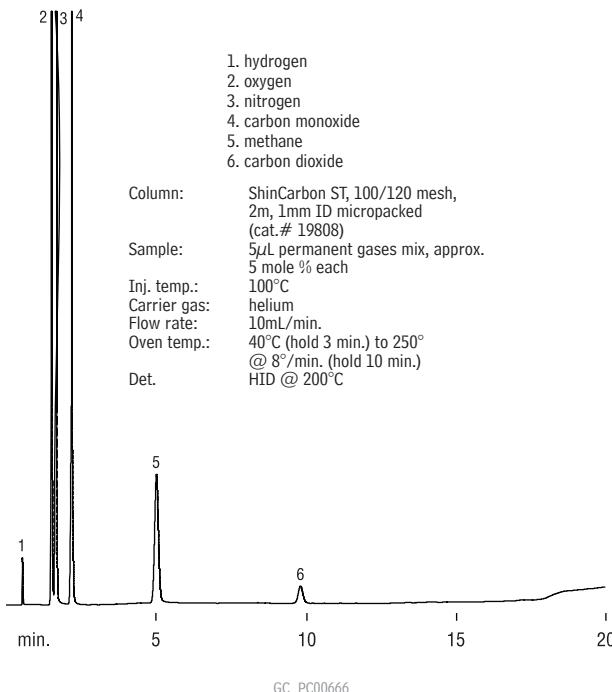
Column: Stabilwax®, 30m, 0.32mm ID, 0.25 μ m (cat.# 10624)
 Sample: various sources of biodiesel (B100), prepared according to European Method EN 14103
 Inj.: 1.0 μ L split (split ratio 100:1), Cyclosplitter® inlet liner (cat.# 20706)
 Inj. temp.: 250°C
 Carrier gas: hydrogen, constant flow, 3mL/min.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



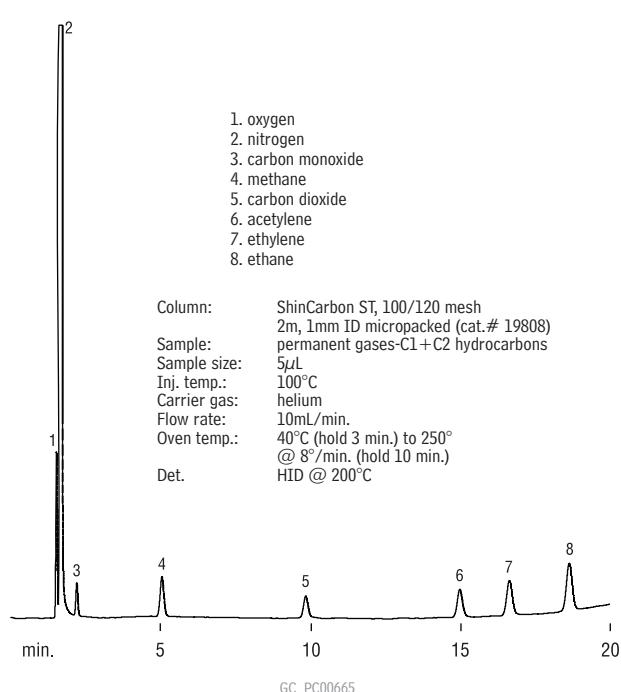
GC APPLICATIONS | PETROLEUM & PETROCHEMICAL Permanent Gases

Permanent Gases

ShinCarbon ST
(micropacked)

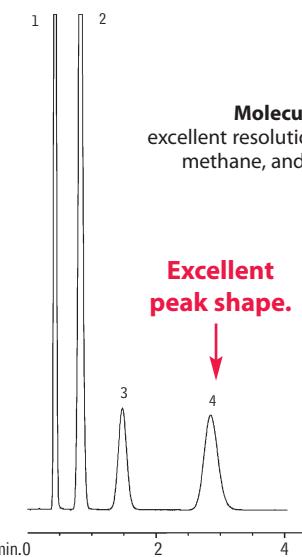


Permanent Gases, C1+C2 hydrocarbons
ShinCarbon ST
(micropacked)



Permanent Gases

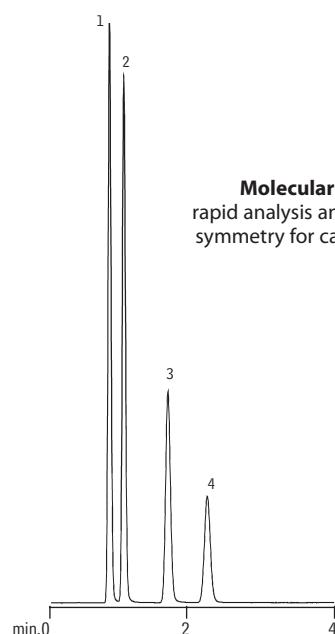
Molecular Sieve 5A and Molecular Sieve 13X
(packed)



Molecular Sieve 5A:
excellent resolution of oxygen, nitrogen, methane, and carbon monoxide.

Excellent peak shape.

10 μ L helium, 5–10% each component
Oven temp.: 50°C
Inj./det. temp.: 150°C/200°C
Carrier gas: hydrogen
Flow: 30mL/min., helium
Det.: TCD



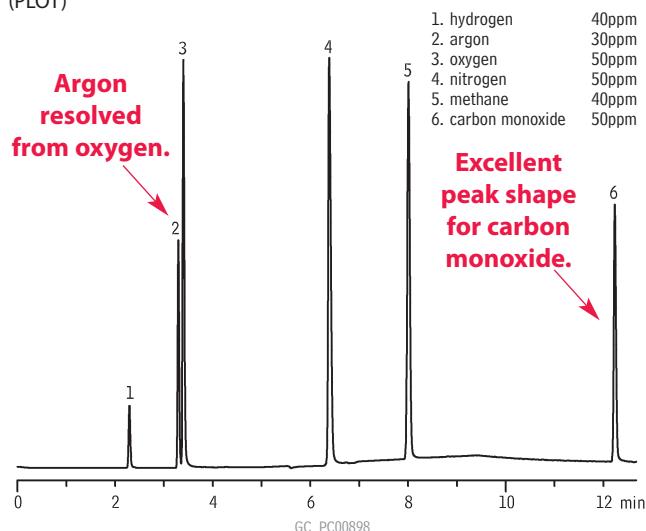
Molecular Sieve 13X:
rapid analysis and excellent peak symmetry for carbon monoxide.

Molecular Sieve 5A 80/100 mesh
1m x 1/8" x 2mm ID SilcoSmooth™ tubing (cat.# 80440-800)

Molecular Sieve 13X 80/100 mesh
2m x 1/8" x 2mm (ID) SilcoSmooth™ tubing (cat.# 80439-800)

Permanent Gases

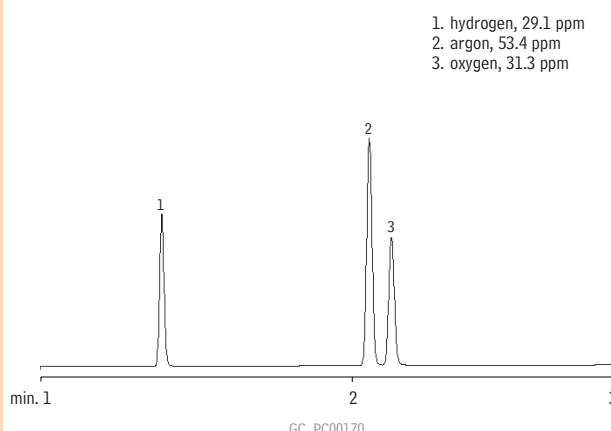
Rt®-Msieve 5A (PLOT)



Column: Rt®-Msieve 5A, 30m, 0.53mm ID, 50 μ m (cat.# 19723)
 Sample: permanent gases (ppm)
 Inj.: 5 μ L sample loop, 6-port Valco® valve, valve temp.: ambient
 Inj. temp.: 200°C
 Carrier gas: helium, constant flow
 Linear velocity: 5mL/min.
 Oven temp.: 27°C (hold 5 min.) to 100°C @ 10°C/min. (hold 5 min.)
 Det.: Valco® helium ionization detector @ 150°C

Permanent Gases

Rt®-MSieve 5A (PLOT)

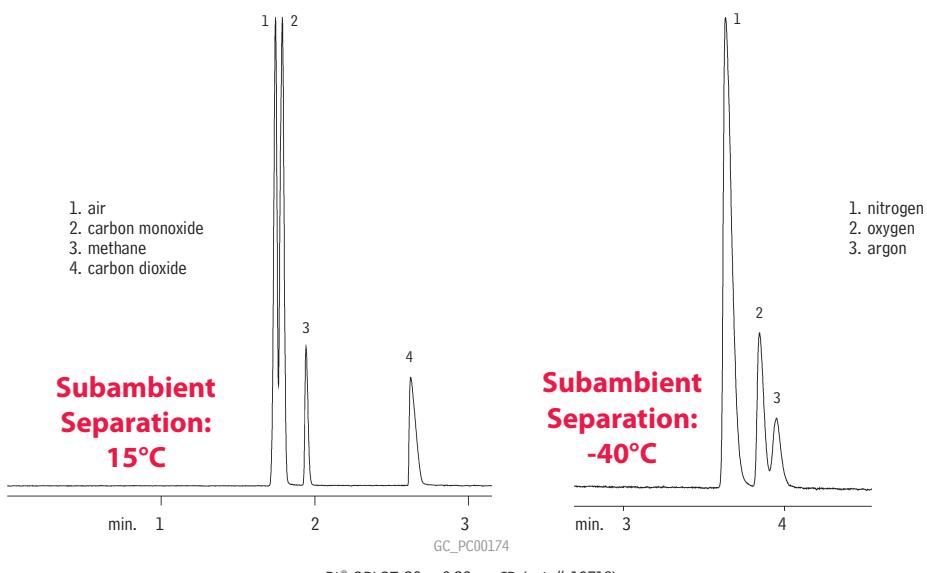


Column: Rt®-Msieve 5A, 30m, 0.53mm ID, 50 μ m (cat.# 19723)
 Sample: 0.5mL (sample loop injection)
 Column temp.: 27°C
 Carrier gas: helium
 Linear velocity: 34cm/sec.
 Det.: Valco® HID

Chromatogram courtesy of Larry McElmurry, Mobile Analytical Labs.

Permanent Gases

Rt®-QPLOT (PLOT)



Rt®-QPLOT, 30m, 0.32mm ID (cat.# 19718)

Sample conc.: 2-5 mole%
 Det.: TCD
 Inj./det. temp.: 100°C/150°C
 Carrier gas: hydrogen
 Linear velocity: 34cm/sec.
 Split flow: 40:1

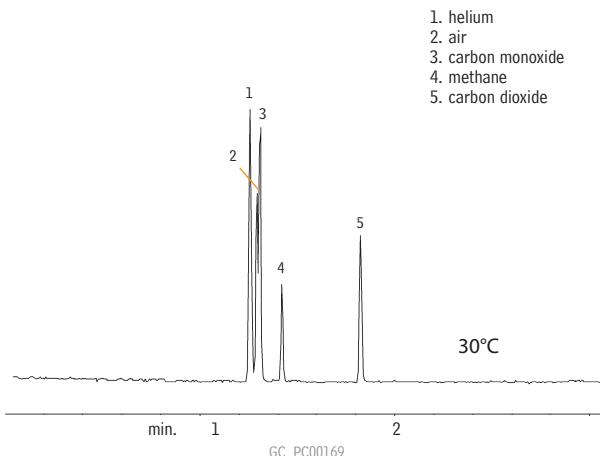
Sample conc.: 2-5 mol%
 Det.: TCD
 Inj./det. temp.: 100°C/150°C
 Carrier gas: hydrogen
 Linear velocity: 20cm/sec.
 Split flow: 40:1

GC APPLICATIONS | PETROLEUM & PETROCHEMICAL

Permanent, Chlorofluorocarbon & Hydrocarbon Gases

Permanent Gases

Rt[®]-QPLOT (PLOT)



Column: Rt[®]-QPLOT, 30m, 0.32mm ID (cat.# 19718)
Sample: 30 μ L split injection (40:1), 2-5 mole %
Column temp.: 30°C
Inj. temp.: 30°C
Det.: HP μTCD
Det. temp.: 200°C
Carrier gas: hydrogen
Linear velocity: 38cm/sec.
Split flow: 40:1

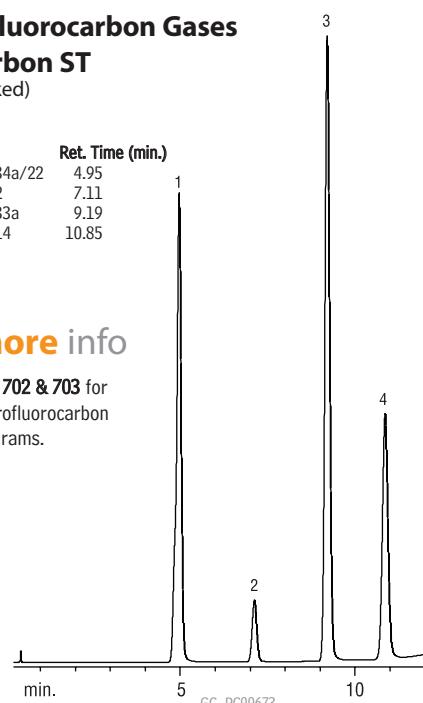
Chlorofluorocarbon Gases

ShinCarbon ST (micropacked)

Peak	Ret. Time (min.)
1. Freon [®] 134a/22	4.95
2. Freon [®] 12	7.11
3. Freon [®] 133a	9.19
4. Freon [®] 114	10.85

for more info

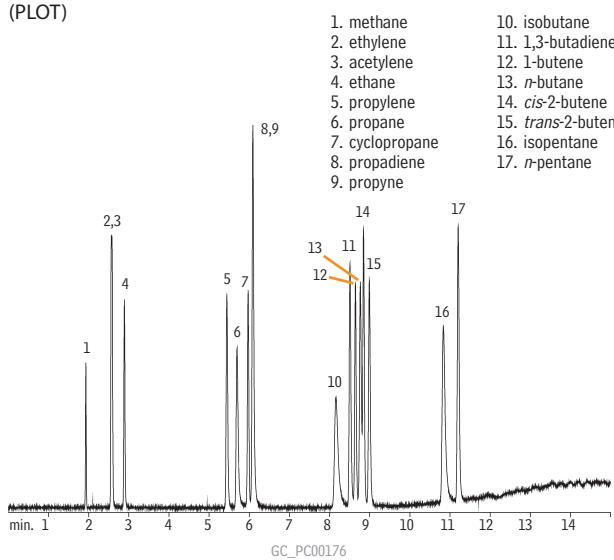
see pages 702 & 703 for
more chlorofluorocarbon
chromatograms.



Column: ShinCarbon ST, 100/120 mesh, 1m, 1mm ID
Sample: Silcosteel[®] micropacked column (cat.# 19809)
Inj. temp.: 200°C
Det.: FID @ 250°C
Carrier gas: helium
Linear velocity: 10mL/min.
Oven temp.: 125°C to 320°C @ 16°C/min.

Hydrocarbon Gases

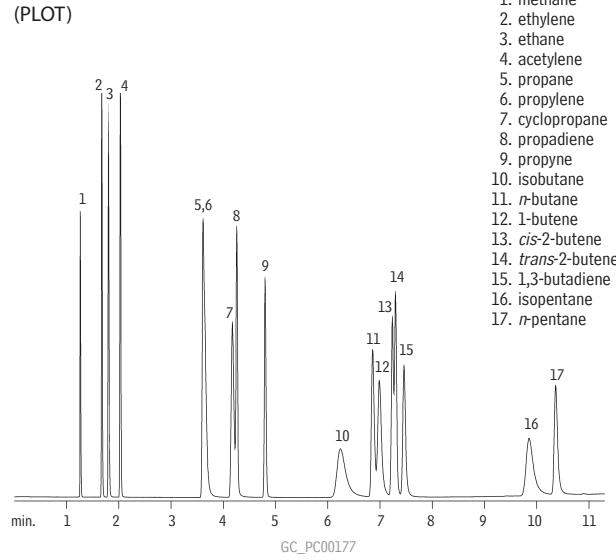
Rt[®]-QPLOT (PLOT)



Column: Rt[®]-QPLOT, 30m, 0.32mm ID (cat.# 19718)
Inj.: 300 μ L split injection (40:1), 1,000ppm
Oven temp.: 50°C (2 min.) to 220°C @ 15°C/min.
Inj./det. temp.: 250°C
Carrier gas: helium
Linear velocity: 42cm/sec. set @ 80°C (5.6mL/min.)
Split flow: 40mL/min.
FID sensitivity: 1.28 x 10⁻¹⁰ AFS

Hydrocarbon Gases

Rt[®]-UPLOT (PLOT)



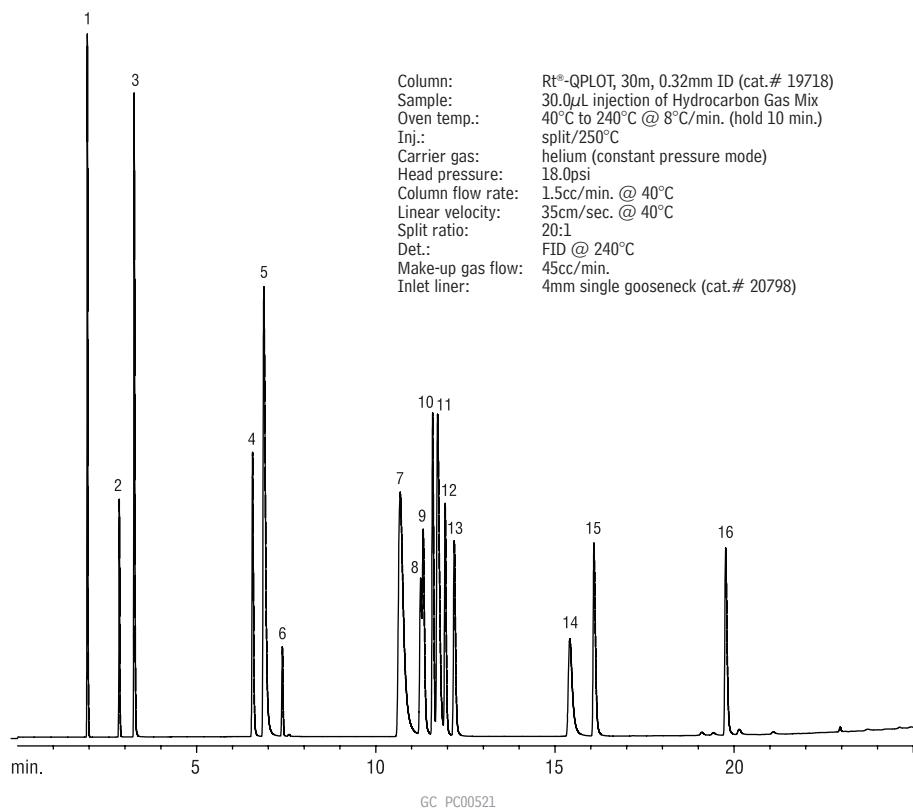
Column: Rt[®]-UPLOT, 30m, 0.32mm ID (cat.# 19724)
Inj.: 300 μ L split injection (40:1), 1,000ppm
Oven temp.: 50°C to 190°C @ 10°C/min.
Inj./det. temp.: 250°C
Carrier gas: helium
Linear velocity: 42cm/sec. set @ 80°C (5.6mL/min.)
Split flow: 40mL/min.
FID sensitivity: 1.28 x 10⁻¹⁰ AFS

Hydrocarbon Gases

Rt®-QPLOT

(PLOT)

1. methane
2. ethene
3. ethane
4. propene
5. propane
6. propadiene
7. isobutane
8. 1,3-butadiene
9. 1-butene
10. isobutene
11. n-butane
12. cis-2-butene
13. trans-2-butene
14. isopentane
15. n-pentane
16. n-hexane

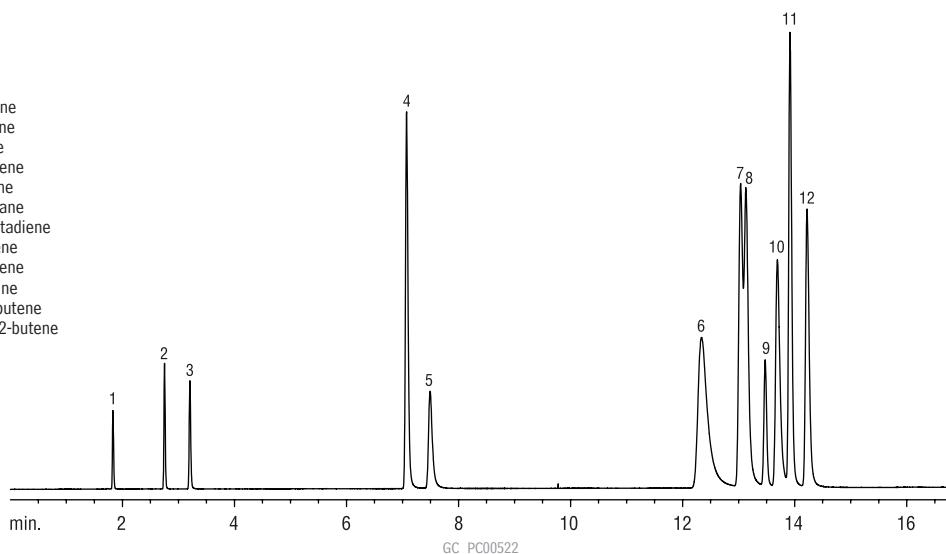


Hydrocarbon Gases

Rt®-QPLOT

(PLOT)

1. methane
2. ethylene
3. ethane
4. propylene
5. propane
6. isobutane
7. 1,3-butadiene
8. 1-butene
9. isobutene
10. n-butane
11. cis-2-butene
12. trans-2-butene



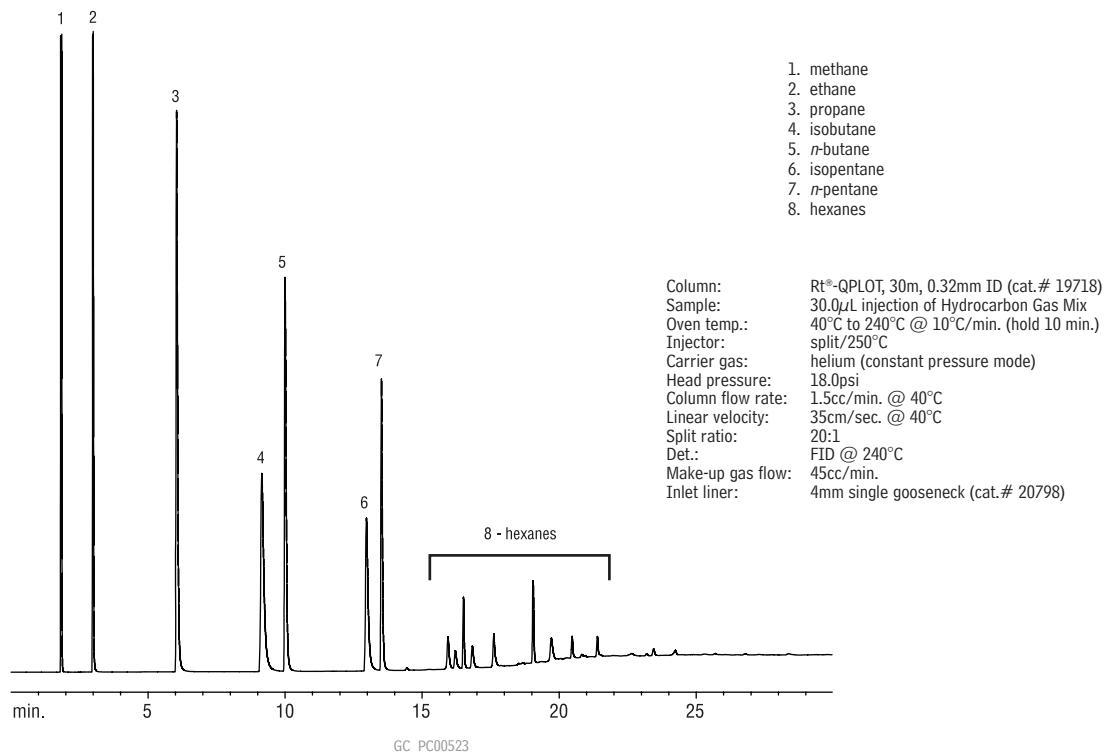
Column: Rt®-QPLOT, 30m, 0.32mm ID (cat.# 19718)
 Sample: 30.0 μ L injection of Hydrocarbon Gas Mix
 Oven temp.: 35°C to 240°C @ 10°C/min. (hold 10 min.)
 Injector: split/250°C
 Carrier gas: helium (constant pressure mode)
 Head pressure: 18.0psi
 Column flow rate: 1.5cc/min. @ 40°C
 Linear velocity: 35cm/sec. @ 40°C
 Split ratio: 20:1
 Det.: FID @ 240°C
 Make-up gas flow: 45cc/min.
 Inlet liner: 4mm single gooseneck (cat.# 20798)

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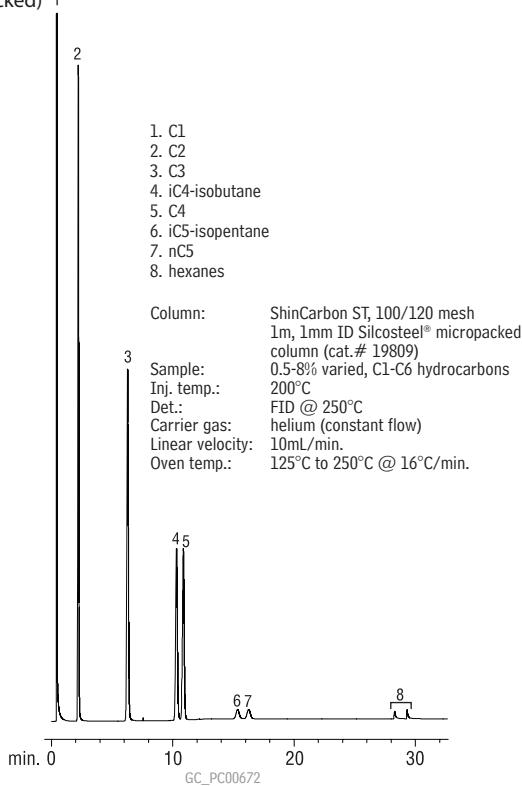
Hydrocarbon Gases

Hydrocarbon Gases

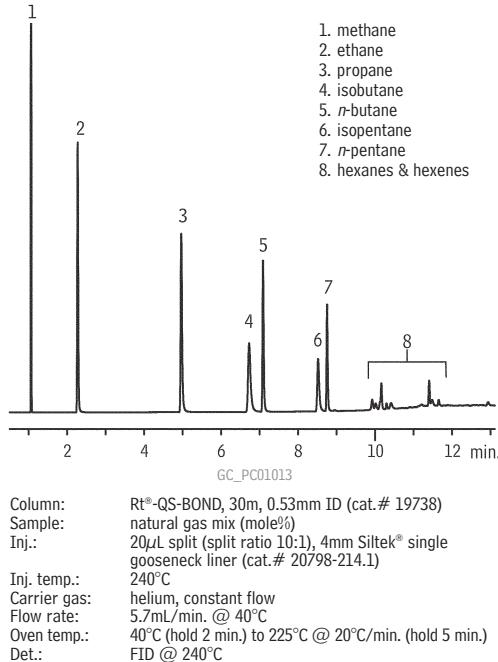
Rt[®]-QPLOT (PLOT)



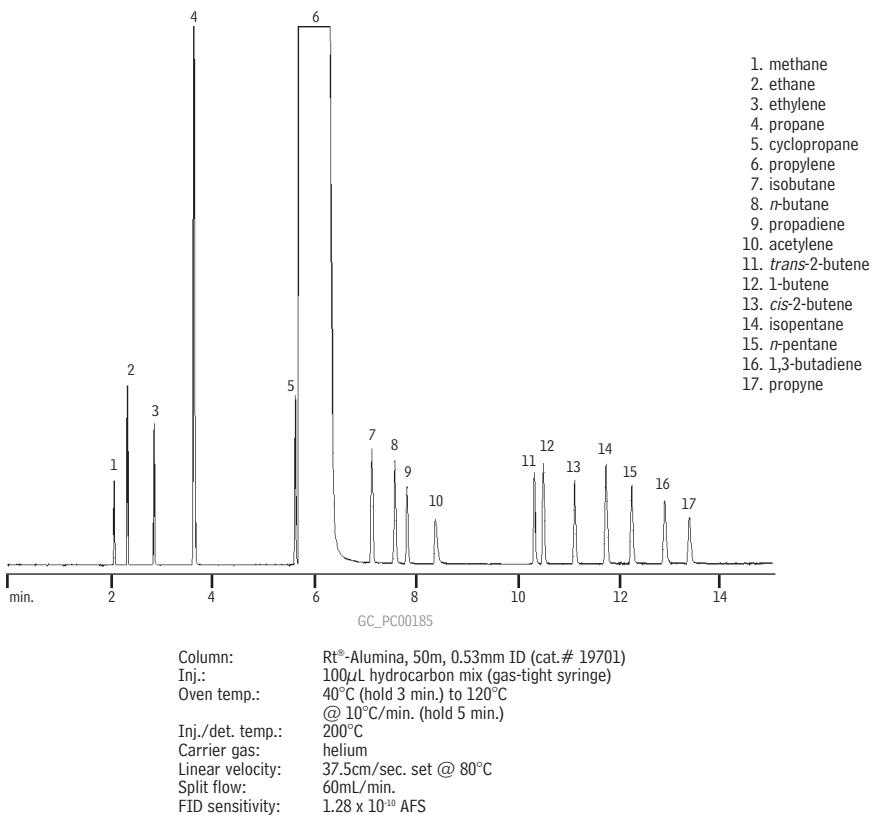
Natural Gas ShinCarbon ST (micropacked) 1



Natural Gas #2 Rt[®]-QS-BOND

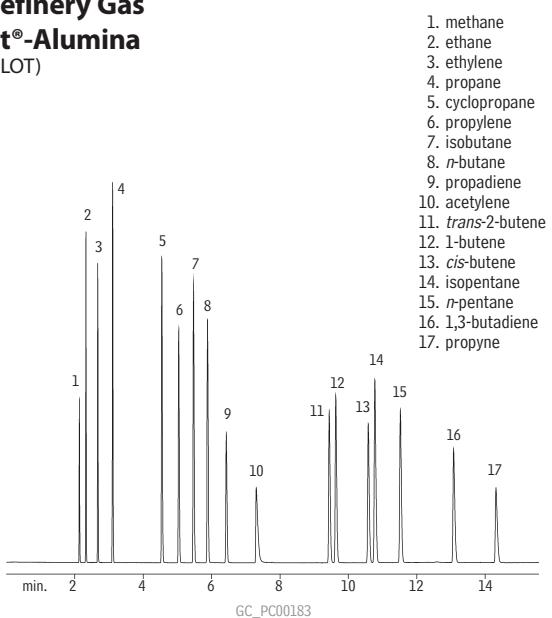


Propylene Purity
Rt[®]-Alumina
(PLOT)

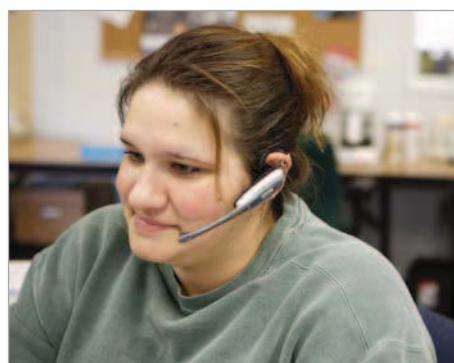


1. methane
2. ethane
3. ethylene
4. propane
5. cyclopropane
6. propylene
7. isobutane
8. n-butane
9. propadiene
10. acetylene
11. trans-2-butene
12. 1-butene
13. cis-2-butene
14. isopentane
15. n-pentane
16. 1,3-butadiene
17. propyne

Refinery Gas
Rt[®]-Alumina
(PLOT)



1. methane
2. ethane
3. ethylene
4. propane
5. cyclopropane
6. propylene
7. isobutane
8. n-butane
9. propadiene
10. acetylene
11. trans-2-butene
12. 1-butene
13. cis-butene
14. isopentane
15. n-pentane
16. 1,3-butadiene
17. propyne



Jamie Hubler, Customer Service

Restek Customer Service

In the U.S.

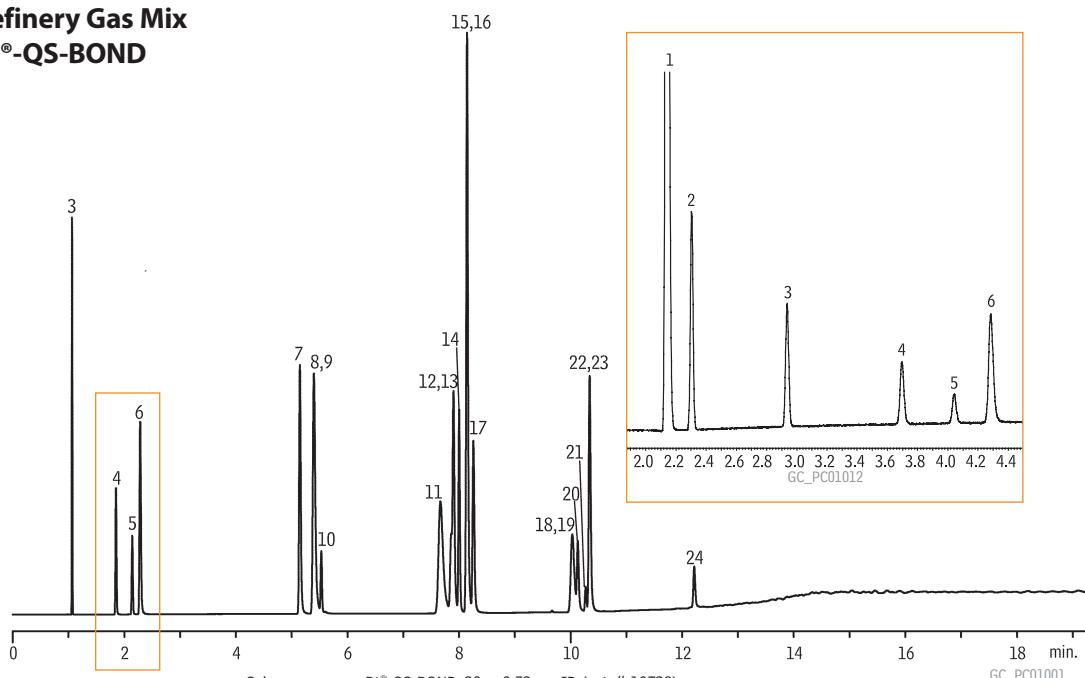
Call: 800-356-1688 (ext. 3) or 814-353-1300 (ext. 3)
Monday–Friday 8:00 a.m.–6:00 p.m. ET
Fax: 814-353-1309—24-hours a day
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Contact your Restek representative:
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Hydrocarbon Gases

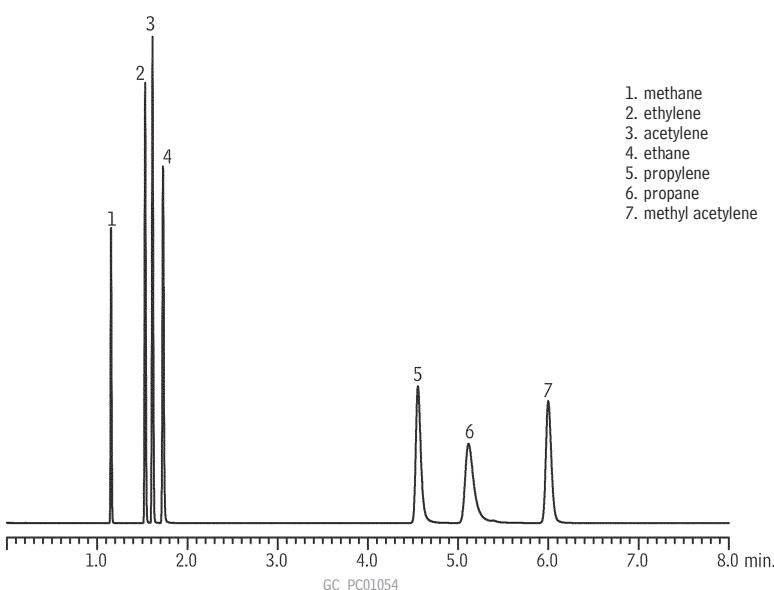
Refinery Gas Mix
Rt[®]-QS-BOND



- 1. air
- 2. CO₂
- 3. methane
- 4. ethylene
- 5. acetylene
- 6. ethane
- 7. propylene
- 8. propane
- 9. 1,2-propadiene
- 10. cyclopropane
- 11. isobutene
- 12. 1,3-butadiene
- 13. 1-butene
- 14. isobutane
- 15. n-butane
- 16. cis-2-butene
- 17. trans-2-butene
- 18. isopentene
- 19. 1-pentene
- 20. n-pentane
- 21. cis-2-pentene
- 22. trans-2-pentene
- 23. 2-methyl-2-butene
- 24. n-hexane

Column: Rt[®]-QS-BOND, 30m, 0.53mm ID (cat.# 19738)
 Sample: refinery gas mix (mole%)
 Inj.: 2 μ L split (split ratio 10:1), 4mm single gooseneck liner (cat.# 20798)
 TCD: 20 μ L split (split ratio 10:1), 4mm Siltek[®] single gooseneck liner (cat.# 20798-214.1)
 Inj. temp.: 250°C
 TCD: 240°C
 Carrier gas: FID: helium, constant flow, 5.7mL/min. @ 40°C
 TCD: helium, constant pressure, 5.5mL/min. @ 40°C
 Oven temp.: 40°C (hold 2 min.) to 225°C @ 15°C/min. (hold 5 min.)
 Det.: FID @ 250°C
 TCD @ 240°C

Refinery Gas Mix
Rt[®]-QS-BOND



- 1. methane
- 2. ethylene
- 3. acetylene
- 4. ethane
- 5. propylene
- 6. propane
- 7. methyl acetylene

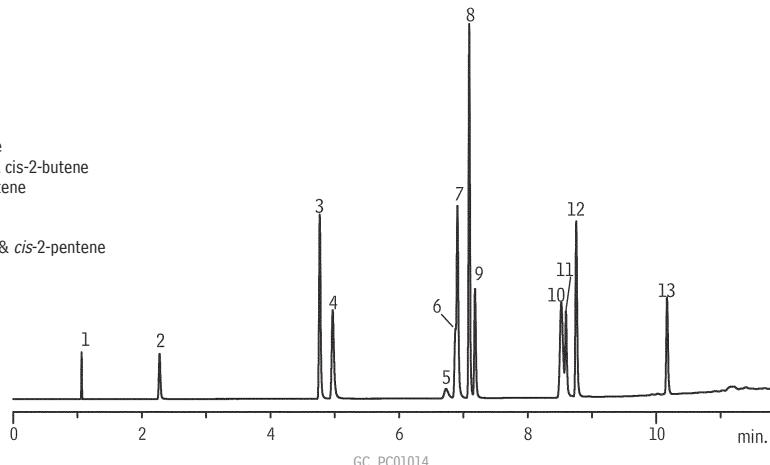
Column: Rt[®]-QS-BOND, 30m, 0.53mm ID (cat.# 19738)
 Sample: refinery gas mix (mole%)
 Inj.: 2 μ L split (split ratio 10:1), 4mm single gooseneck liner (cat.# 20798)
 Inj. temp.: 240°C
 Carrier gas: hydrogen, constant flow
 Flow rate: 3.6mL/min. @ 60°C
 Oven temp.: 60°C (hold 15 min.) to 240°C @ 25°C/min. (hold 2 min.)
 Det.: FID @ 240°C



Refinery Gas #6 Rt[®]-QS-BOND

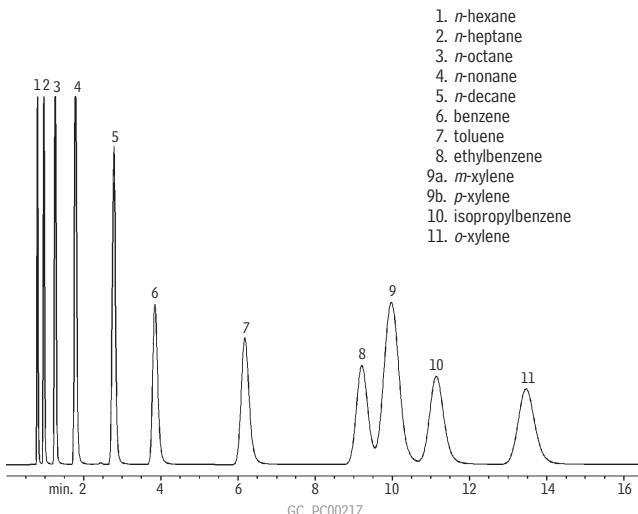


1. methane
2. ethane
3. propylene
4. propane
5. isobutane
6. 1-butene
7. isobutylene
8. n-butane & cis-2-butene
9. trans-2-butene
10. isopentene
11. 1-pentene
12. n-pentane & cis-2-pentene
13. n-hexane



Column: Rt[®]-QS-BOND, 30m, 0.53mm ID (cat.# 19738)
Sample: refinery gas mix (mole%)
Inj.: 20 μ L split (split ratio 10:1), 4mm Siltek[®] single gooseneck liner (cat.# 20798-214.1)
Inj. temp.: 240°C
Carrier gas: helium, constant flow
Flow rate: 5.7mL/min. @ 40°C
Oven temp.: 40°C (hold 2 min.) to 225°C @ 15°C/min. (hold 5 min.)
Det.: FID @ 240°C

Aromatics, Aliphatics 10% TCEP 100/120 Chromosorb[®] PAW (packed)



Column: 10% TCEP on 100/120 Chromosorb[®] PAW,
2.5m, $\frac{1}{8}$ " OD, 2mm ID SilcoSmooth[™]
tubing (cat.# 80126)
Sample size: 0.1mL neat
Oven temp.: 80°C
Inj./det. temp.: 200°C/250°C
Carrier gas: nitrogen
Flow rate: 20mL/min.
FID sensitivity: 128×10^{-10} AFS

Searching for a chromatogram?
www.restek.com

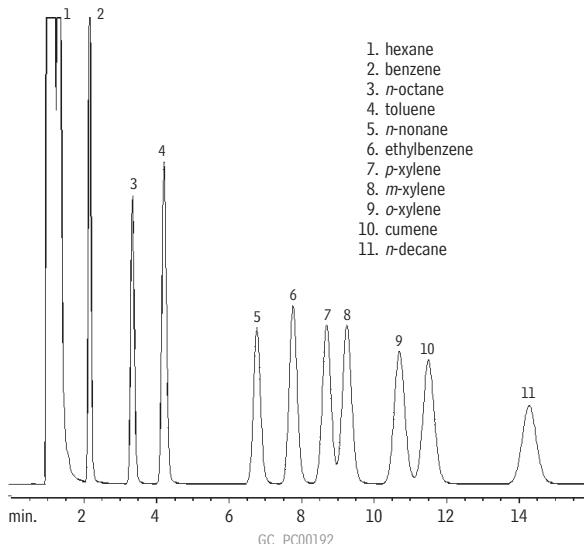


GC APPLICATIONS | PETROLEUM & PETROCHEMICAL Hydrocarbons

Aromatics (Xylene Isomers plus Cumene)

5% Rt®-1200/1.75% Bentone® 34

(packed)

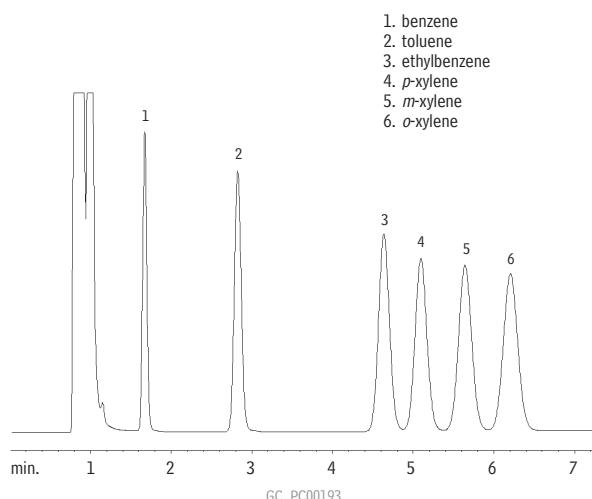


Column: 5% Rt®-1200/1.75% Bentone® 34 on 100/120 Silcoport™, 1.8m, $\frac{1}{8}$ " OD, 2mm ID SilcoSmooth™ tubing (cat.# 80125)
Sample size: 0.1 μ L
Conc.: 0.5 μ g/ μ L in hexane
Oven temp.: 75°C
Inj./det. temp.: 200°C
Carrier gas: nitrogen
Flow rate: 20mL/min.
FID sensitivity: 32×10^{-11} AFS

Aromatics (Xylene Isomers /BTEX)

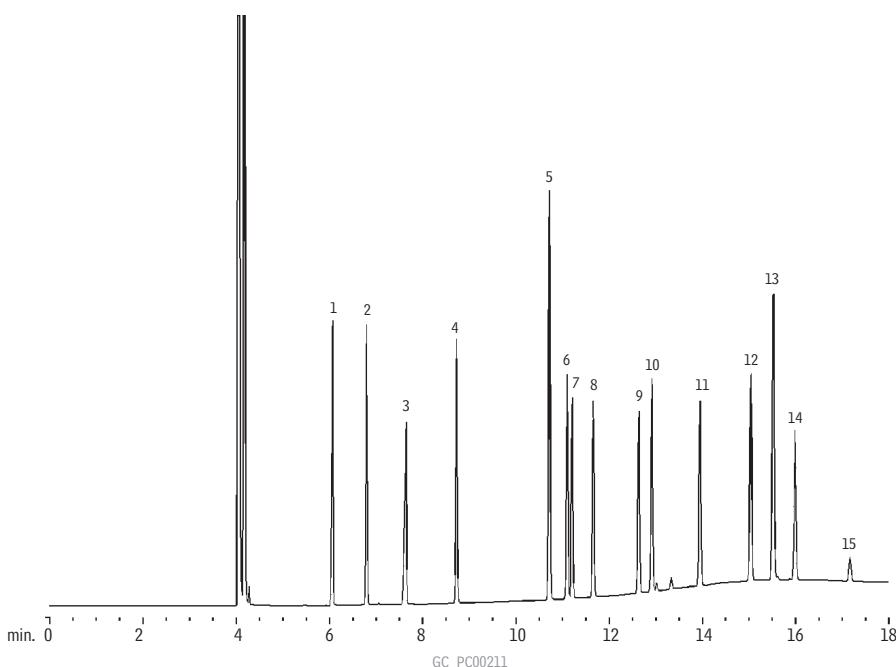
5% Rt®-1200/5% Bentone® 34

(packed)



Column: 5% Rt®-1200/5% Bentone® 34 100/120 Silcoport™, 2m, $\frac{1}{8}$ " OD, 2mm ID SilcoSmooth™ tubing (cat.# 80129)
Sample size: 0.5 μ g/ μ L in hexane
Conc.: 0.5 μ g/ μ L in hexane
Oven temp.: 100°C
Inj./det. temp.: 200°C
Carrier gas: nitrogen
Flow rate: 20mL/min.
FID sensitivity: 32×10^{-11} AFS

Aromatics Rt®-TCEP



Column: Rt®-TCEP 60m, 0.25mm ID, 0.40 μ m (cat.# 10999)
Inj.: 1.0 μ L split injection, components @ 500ppm (ethylbenzene @ 1000ppm)
Oven temp.: 60°C (hold 5 min.) to 100°C @ 5°C/min. (hold 10 min.)
Inj./det. temp.: 200°C
Carrier gas: helium
Linear velocity: 30cm/sec. set @ 80°C
FID sensitivity: 6.4×10^{-11} AFS
Split flow: 46mL/min.

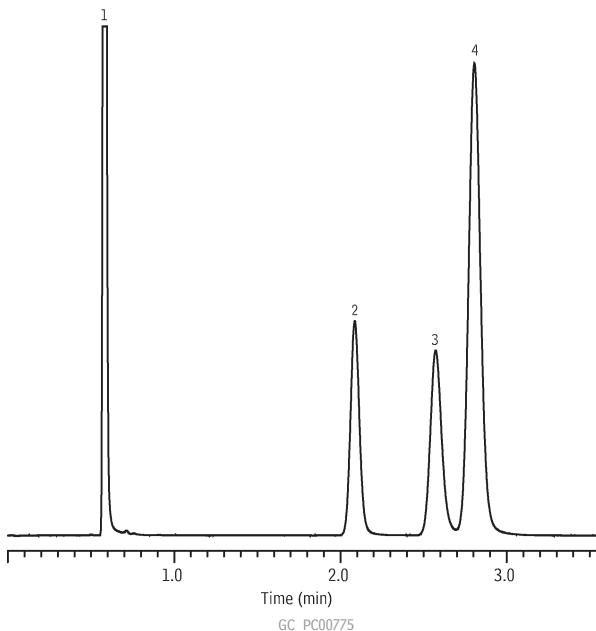


Motor Oil & Aviation Gas

ASTM Method D3606-99

10% Rtx®-1 & 20% TCEP

(micropacked)



1. nonaromatics

2. benzene

3. methyl ethyl ketone (IS)

4. toluene

Column:

A: 10% Rtx®-1 on 60/80 Chromosorb® PAW, 0.8m, $\frac{1}{16}$ inch, 1mm ID Silcosteel® tubing

B: 20% TCEP on 80/100 Chromosorb® PAW, 4.0m, $\frac{1}{16}$ inch, 1mm ID Silcosteel® tubing connected in series and using Micropacked Column On-Column Injection Kit (cat.# 22425)

Sample: benzene, toluene, methyl

ethyl ketone in pentane

Inj.: 1.0 μ L, on-column, 4mm ID splitless inlet liner (cat.# 20772)

Carrier gas: hydrogen,

constant flow

Flow rate: 9.0mL/min.

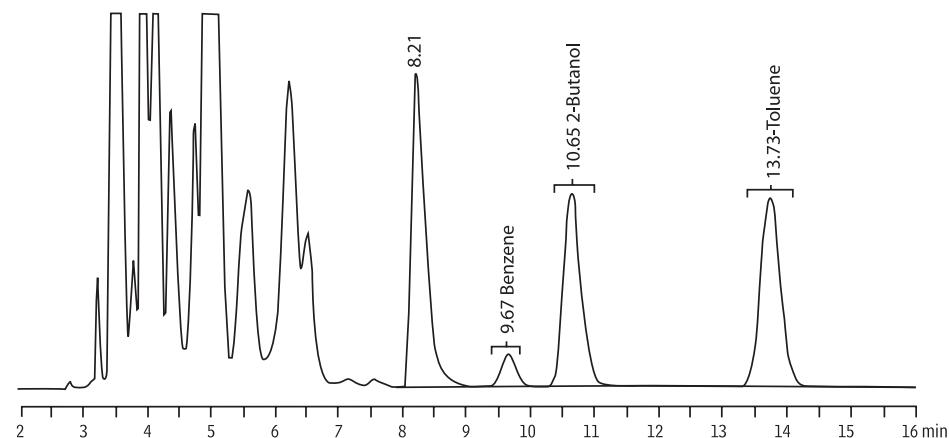
Inj. temp.: 200°C

Oven temp.: 145°C

Det.: FID @ 200°C

Gasoline

ASTM D3606-06 Modified



Column: D3606 Application Column (2 column set, cat.# 83606-800)

Column 1: nonpolar Rtx®-1, 6' (1.8m), $\frac{1}{8}$ " OD, 2.0mm ID
Column 2: proprietary packing material, 16' (4.9m), $\frac{1}{8}$ " OD, 2.0mm ID

Sample: 1.5 μ L gasoline

Inj.: 200°C

Backflush: ~1 minute

Carrier gas: helium, constant flow

Flow rate: 25mL/min.

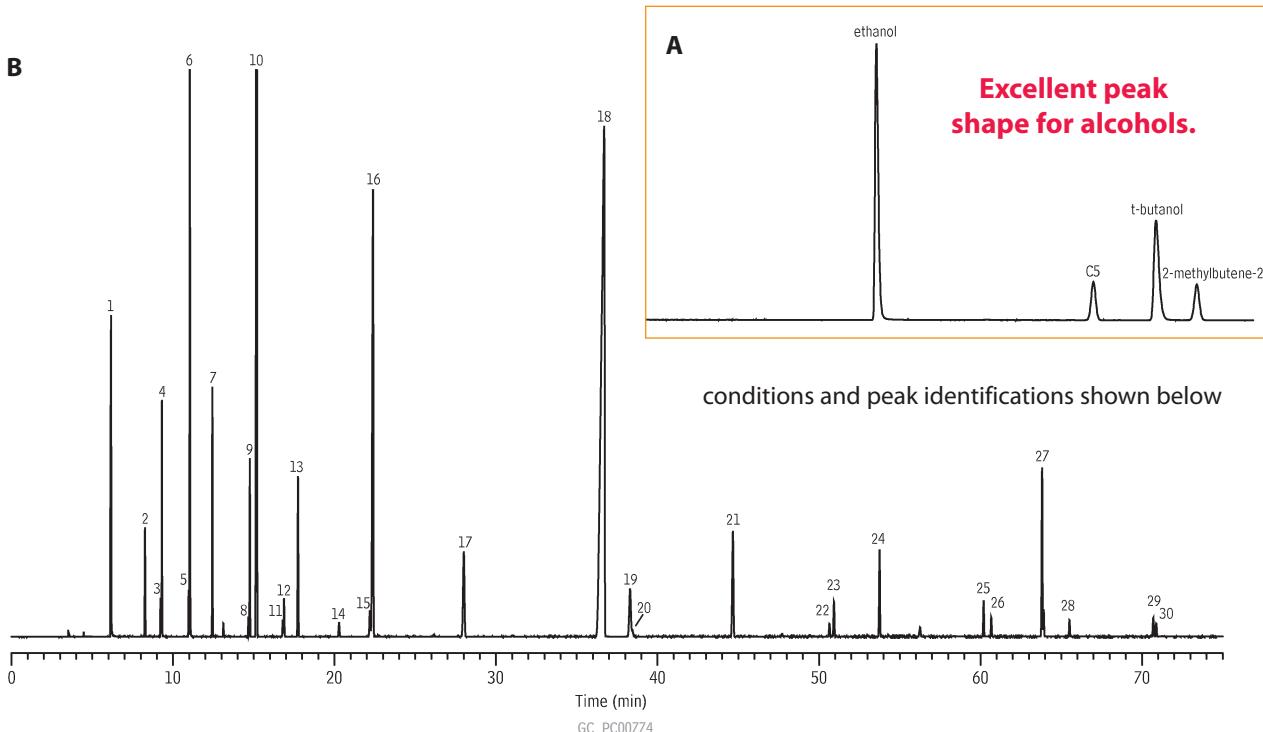
Oven temp.: 135°C, isothermal

Det.: TCD @ 200°C

Chromatogram courtesy of Boguslaw Dudek, Conoco Phillips, Linden, NJ.

GC APPLICATIONS | PETROLEUM & PETROCHEMICAL Hydrocarbons

Fast Detailed Hydrocarbons Analysis (DHA) Rtx®-1PONA/Rtx®-5PONA Tuning Column



Detailed Hydrocarbons Analysis (DHA) Rtx®-1PONA/Rtx®-5PONA Tuning Column

Column: Rtx®-1PONA, 100m, 0.25mm ID, 0.5 μ m (cat.# 10195) plus Rtx®-5PONA tuning column, 2.62m, 0.25mm ID, 1.0 μ m, connected via Press-Tight® connector (cat.# 20446)

Sample: custom detailed hydrocarbons analysis (DHA) mix, neat

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

Inj. temp.: 200°C

Carrier gas: helium, constant flow

Linear velocity: 28cm/sec. (2.3mL/min.)

Oven temp.: 35°C

Det.: FID @ 250°C

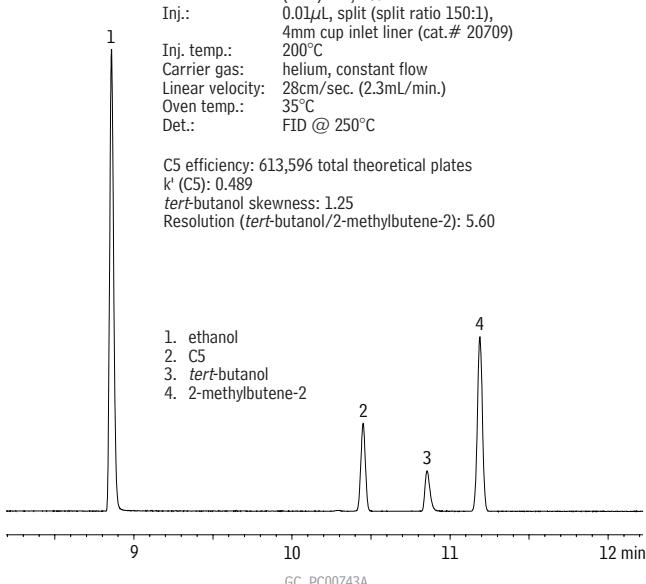
C5 efficiency: 613,596 total theoretical plates

k' (C5): 0.489

tert-butanol skewness: 1.25

Resolution (tert-butanol/2-methylbutene-2): 5.60

1. ethanol
2. C5
3. tert-butanol
4. 2-methylbutene-2



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

Sample: DHA/oxygenates setup blend
Inj.: 0.01 μ L, split (split ratio 150:1), 4mm ID cup inlet liner (cat.# 20709)

A: front slice of DHA/oxygenates setup blend
B: DHA/oxygenates setup blend

Carrier gas: hydrogen, constant flow (3.62cc/min.)
Linear velocity: 55cm/sec.

Inj. temp.: 250°C

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

Det.: FID @ 300°C

A: Front end of DHA/oxygenates setup blend

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

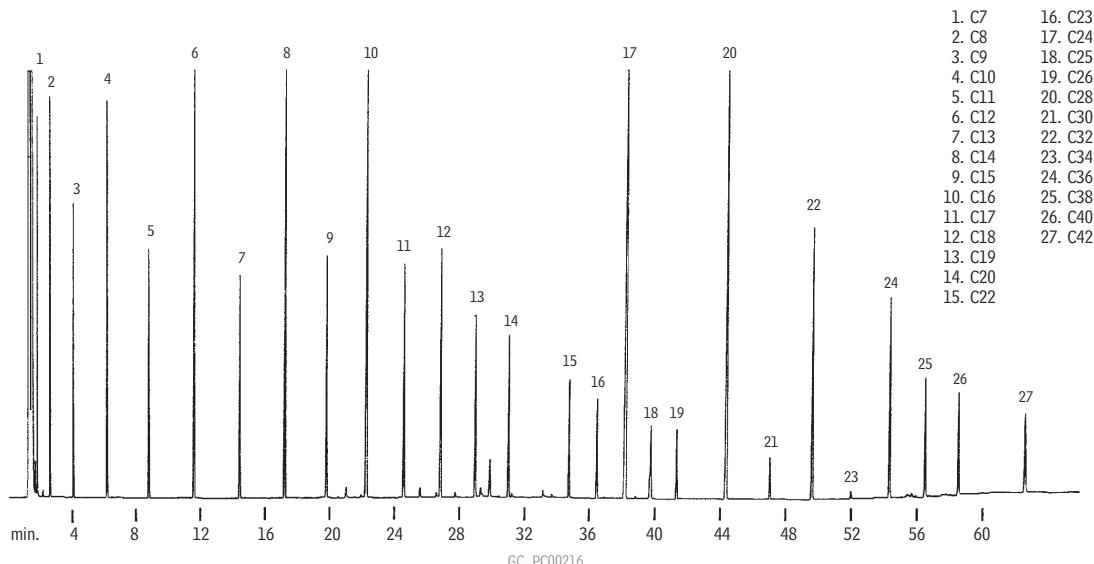
B: DHA/oxygenates setup blend

1. ethanol
2. C5
3. tert-butanol
4. 2-methylbutene-2
5. 2,3-dimethylbutane
6. methyl tert-butyl ether (MTBE)
7. C6
8. 1-methylcyclopentene
9. benzene
10. cyclohexane
11. 3-ethylpentane
12. 1,2-dimethylcyclopentane
13. C7
14. 2,2,3-trimethylpentane
15. 2,3,3-trimethylpentane
16. toluene
17. C8
18. ethylbenzene
19. p-xylene
20. 2,3-dimethylheptane
21. C9
22. 5-methylnonane
23. 1,2-methylethylbenzene
24. C10
25. C11
26. 1,2,3,5-tetramethylbenzene
27. naphthalene
28. C12
29. 1-methylnaphthalene
30. C13

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

Hydrocarbons, C7-C42

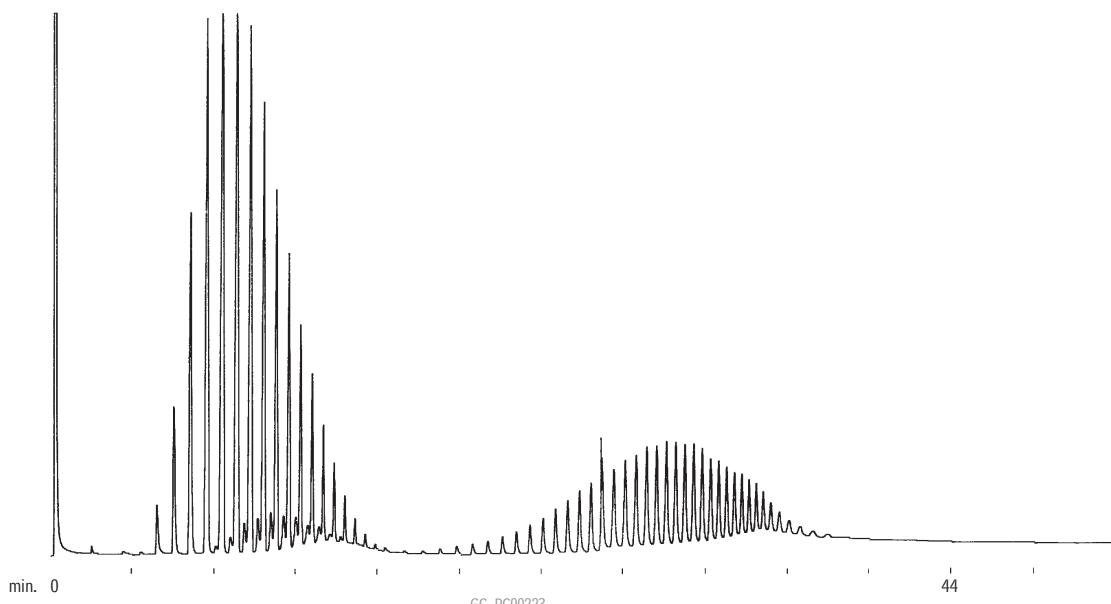
Rtx®-1



Column: Rtx®-1, 30m, 0.53mm ID, 0.25 μ m (cat.# 10125)
 Sample: 0.2 μ L injection of a synthetic hydrocarbon mix,
 ~ 0.1mg/mL per component
 Inj.: Direct injection using a Uniliner® inlet liner
 Oven temp.: 40°C to 340°C @ 5°C/min.
 Inj./det. temp.: 340°C
 Carrier gas: hydrogen
 Linear velocity: 40cm/sec. set @ 40°C
 FID sensitivity: 64 x 10⁻¹¹ AFS

Hydrocarbons (High Temperature Petroleum Wax)

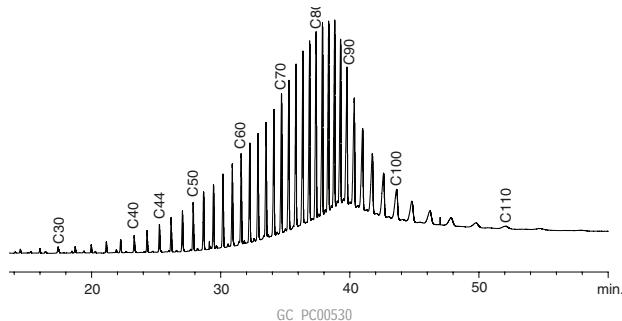
MXT®-1



Column: MXT®-1, 15m, 0.53mm ID, 0.20 μ m (cat.# 70108)
 Sample: 1.0 μ L on-column injection of paraffin wax in methylene chloride
 Oven temp.: 100°C to 400°C @ 10°C/min. (hold 20 min.)
 Inj./det. temp.: 103°C/430°C
 Injector type: HP cool on-column pressure programmable
 Carrier gas: hydrogen
 Linear velocity: 30cm/sec.
 FID sensitivity: 2.56 x 10⁻¹¹ AFS

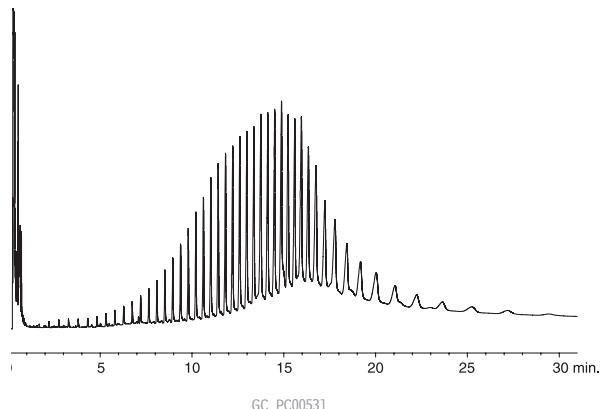
GC APPLICATIONS | PETROLEUM & PETROCHEMICAL Hydrocarbons

Hydrocarbons (C30-C110) MXT®-1HT Sim Dist



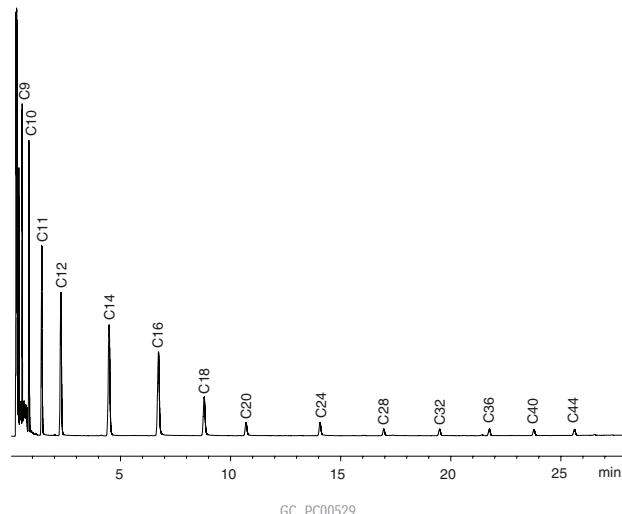
Column: MXT®-1HT Sim Dist, 5m, 0.53mm ID, 0.10 μ m (cat.# 70100)
Sample: 0.2 μ L Polywax® 1000 standard (cat.# 36227)
Solvent: carbon disulfide
Oven temp.: 40°C to 430°C @ 10°C/min. (hold 30 min.)
Injector: on-column (track oven)
Carrier gas: helium (constant pressure)
Head pressure: 1.0psi
Linear velocity: 60cm/sec.
Flow rate: 7.8mL/min.
Det.: FID @ 430°C
Make-up gas flow: 40cc/min.

Hydrocarbons (C44-C100) MXT®-1HT Sim Dist (fast GC)



Column: MXT®-1HT Sim Dist, 5m, 0.53mm ID, 0.10 μ m (cat.# 70100)
Sample: 0.2 μ L injection of Polywax® 1000
Solvent: carbon disulfide
Oven temp.: 40°C to 430°C @ 60°C/min. (hold 25 min.)
Injector: on-column (track oven)
Carrier gas: helium (constant pressure)
Head pressure: 1.0psi
Linear velocity: 60cm/sec.
Flow rate: 7.8mL/min.
Det.: FID @ 430°C
Make up gas flow: 40cc/min.

Hydrocarbons (C10-C44) MXT®-1HT Sim Dist



Column: MXT®-1HT Sim Dist, 5m, 0.53mm ID, 0.10 μ m (cat.# 70100)
Sample: 0.2 μ L hydrocarbon standard (cat.# 31222)
Solvent: carbon disulfide
Oven temp.: 40°C to 430°C @ 10°C/min. (hold 30 min.)
Injector: on-column (track oven)
Carrier gas: helium (constant pressure)
Head pressure: 1.0psi
Linear velocity: 60cm/sec.
Flow rate: 7.8mL/min.
Det.: FID @ 430°C
Make-up gas flow: 40cc/min.



Diane Thompson, Customer Service

Restek Customer Service

In the U.S.

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Online: www.restek.com—24-hours a day

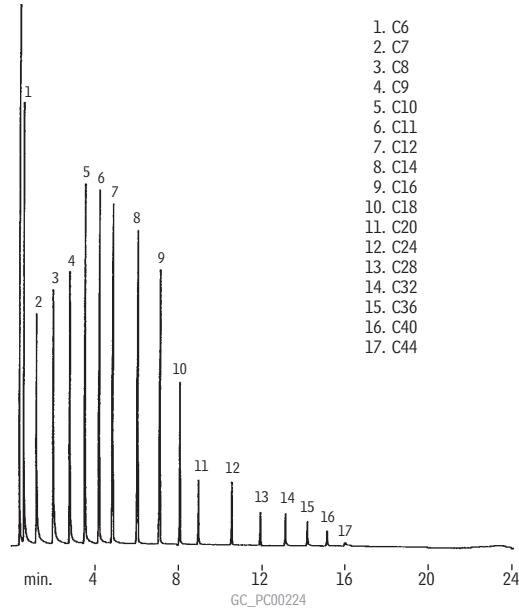
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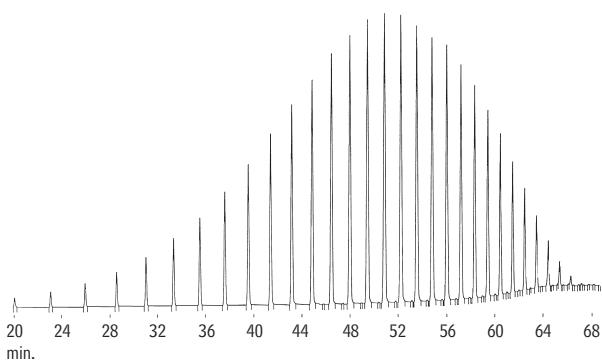


Simulated Distillation (Standard Calibration) MXT®-1 Sim Dist



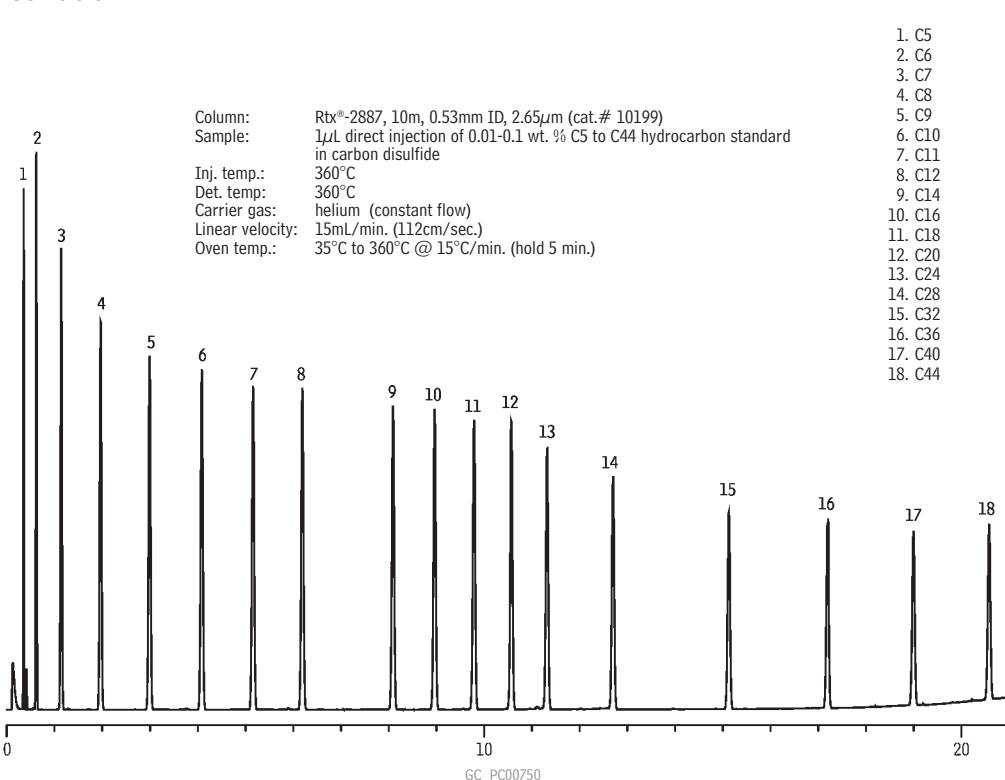
Column: MXT®-1 Sim Dist, 6m, 0.53mm ID, 0.15 μ m (cat.# 70101)
Sample: wet needle on-column injection of ASTM D2887 standard
Oven temp.: -12°C to 430°C @ 20°C/min.
Inj./det. temp.: -17°C to 433°C/430°C
Carrier gas: hydrogen
Linear velocity: 40cm/sec.
FID sensitivity: 128×10^{-11} AFS

Simulated Distillation (High-Temperature) MXT®-500 Sim Dist



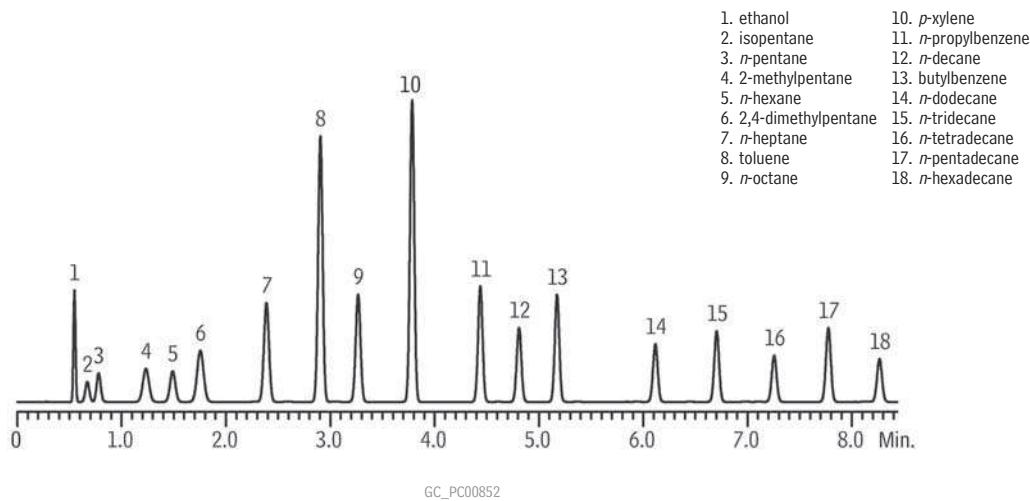
Column: MXT®-500 Sim Dist, 6m, 0.53mm ID, 0.15 μ m (cat.# 70104)
Sample: cold on-column injection of Polywax® 655 in CS₂
Oven temp.: 40°C to 430°C @ 6°C/min.
Carrier gas: helium
Linear velocity: 40cm/sec.
FID sensitivity: 2×10^{-11} AFS

Simulated Distillation Rtx®-2887



GC APPLICATIONS | PETROLEUM & PETROCHEMICAL
Hydrocarbons (Simulated Distillation)

Simulated Distillation
Rtx®-1 (Hydrogen Carrier Gas)

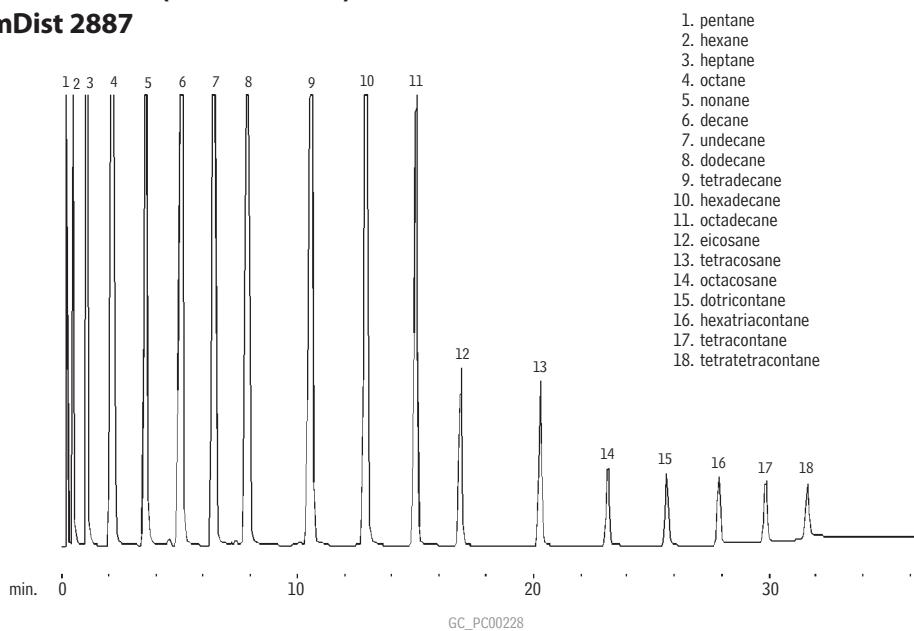


Column: Rtx®-1, 30m, 0.53mm ID, 5.0μm (cat.# 10179)
 Sample: custom paraffin mix, neat, 2.7-12.9% each component
 Inj.: 0.1μL splitless (hold 1 min.), 4mm single gooseneck inlet liner (cat.# 20904)
 Inj. temp.: 250°C
 Carrier gas: hydrogen, constant flow (Parker ChromGas® hydrogen generator)
 Linear velocity: 184cm/sec. @ 40°C
 Oven temp.: 40°C (1 min.) to 265°C @ 25°C/min. (hold 4 min.)
 Det.: FID @ 280°C

Simulated Distillation (ASTM D-2887)

Rtx®-1 SimDist 2887

(packed)



Column: Rtx®-1 SimDist 2887, SilcoSmooth™ stainless steel, 25", 1/8", 2mm ID (cat.# 80000)
 Inj.: 1.0μL direct injection, 1-12% (w/w) each component
 Oven temp.: 35°C to 350°C @ 10°C/min. (hold 5 min.)
 Inj./det. temp.: 350°C
 Carrier gas: helium @ 25mL/min.
 FID sensitivity: 256 x 10¹¹ AFS

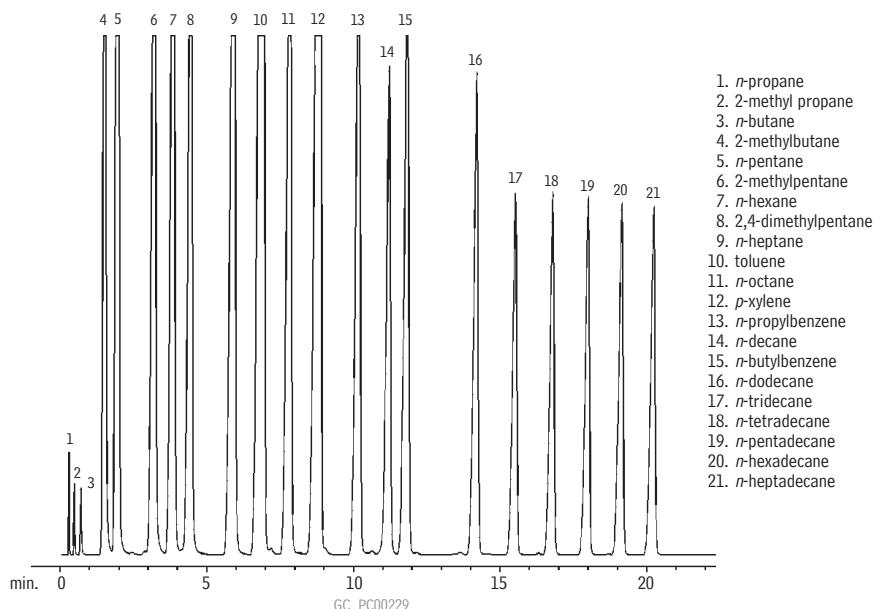
cat.# 31674 (1% each listed analyte in CS₂) and cat.# 31675 (5% each, neat)
 meet requirements of ASTM D2887-01.



Simulated Distillation (ASTM D-3710 Calibration)

Rtx®-1 SimDist 2887

(packed)

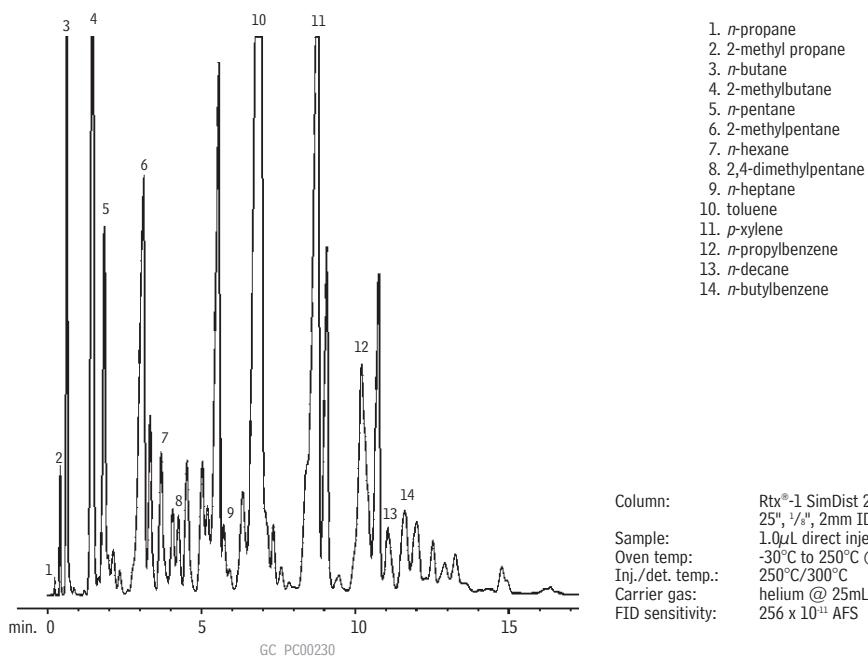


Column: Rtx®-1 SimDist 2887, SilcoSmooth™ stainless steel, 25", $\frac{1}{8}$ ", 2mm ID (cat.# 80000)
Sample: D-3710 Calibration Mix, C3, C4, C16, & C17 added
Oven temp: -30°C to 250°C @ 10°C/min.
Inj./det. temp.: 250°C/300°C
Carrier gas: helium @ 25mL/min.
FID sensitivity: 256×10^{11} AFS

Simulated Distillation (ASTM D-3710, Gasoline)

Rtx®-1 SimDist 2887

(packed)

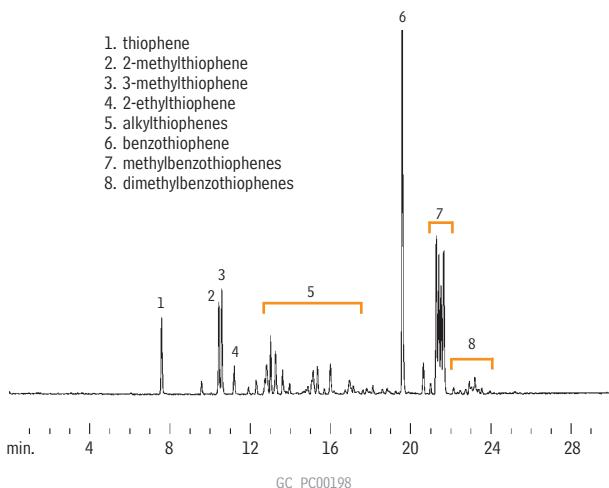


Column: Rtx®-1 SimDist 2887, SilcoSmooth™ stainless steel, 25", $\frac{1}{8}$ ", 2mm ID (cat.# 80000)
Sample: 1.0µL direct injection of unleaded gasoline (ASTM D-2887)
Oven temp: -30°C to 250°C @ 10°C/min.
Inj./det. temp.: 250°C/300°C
Carrier gas: helium @ 25mL/min.
FID sensitivity: 256×10^{11} AFS

GC APPLICATIONS | PETROLEUM & PETROCHEMICAL Sulfur Compounds

Sulfur in Gasoline

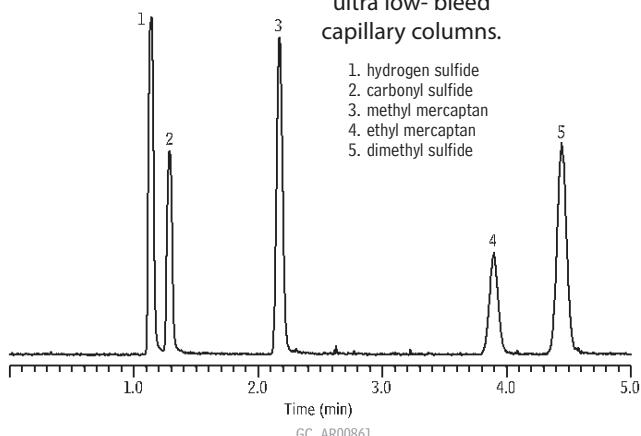
Rtx®-1



Column: Rtx®-1, 30m, 0.32mm ID, 4.0 μ m (cat.# 10198)
Sample: 1.0 μ L split injection of gasoline containing 300ppm total sulfur
Oven temp.: 40°C (hold 3 min.) to 275°C @ 10°C/min.
(hold 5 min.)
Inj./det. temp.: 275°C
Det.: SCD
Carrier gas: helium
Linear velocity: 70cm/sec. (flow rate: 2.5mL/min.)
Split ratio: 10:1

Sulfur Compounds

Rxi®-1ms



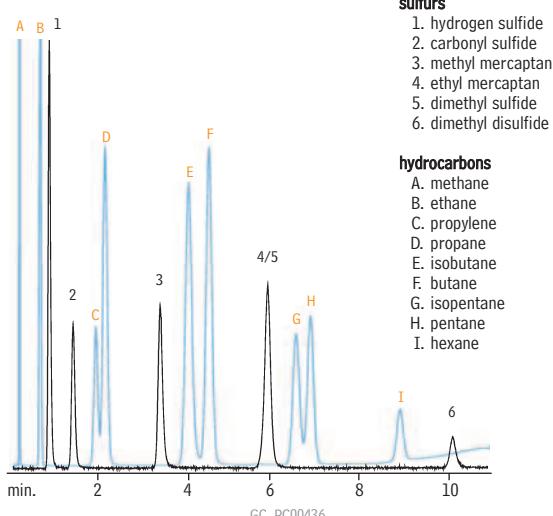
Rxi® Technology!

Exceptionally inert,
ultra low- bleed
capillary columns.

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

Sulfur Compounds

Rt®-XLSulfur
(micropacked)



Column: Rt®-XLSulfur micropacked column, 1m, 0.75mm ID (cat.# 19806)
Conc.: 50ppb each
Oven temp.: 60°C to 230°C @ 15°C/min.
Carrier gas: helium
Flow rate: 9mL/min.
Det.: SCD/FID

Sulfur standards courtesy of DCG Partnership 1 Ltd., Pearland, TX.

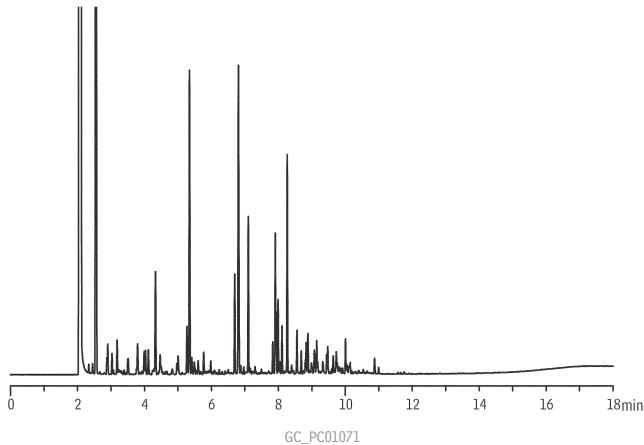
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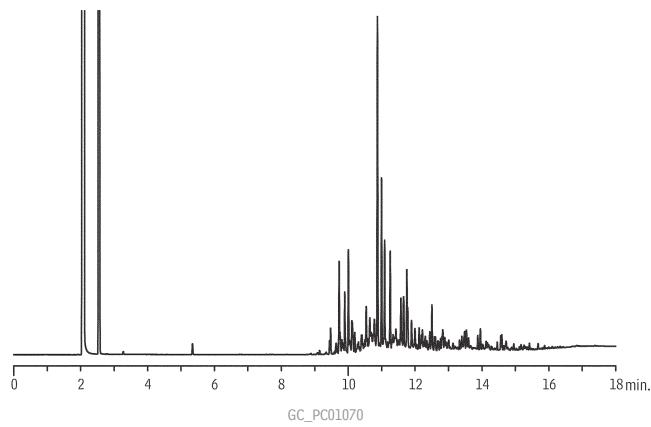


Unleaded Gasoline
Rxi®-1ms



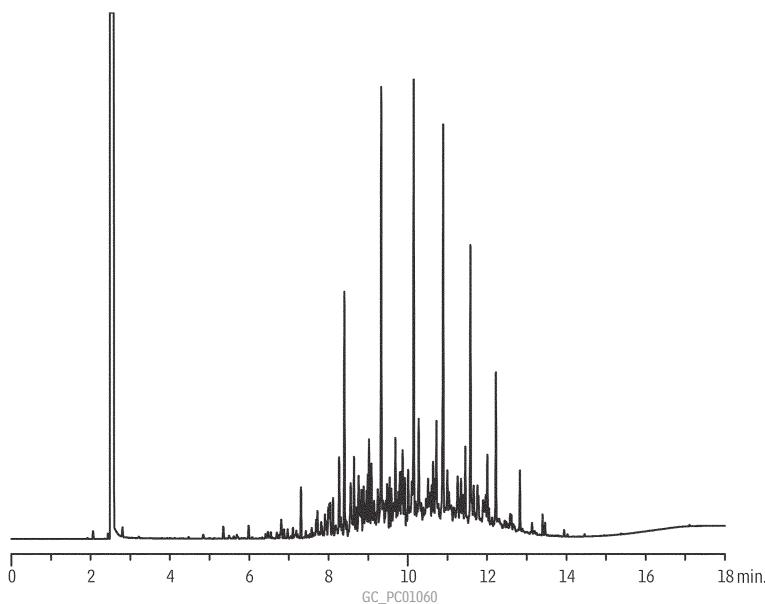
Column: Rxi®-1ms, 30m, 0.25mm ID, 0.25 μ m (cat.# 13323)
Sample: 5,000 μ g/mL unleaded gasoline, unweathered, in methanol (cat.# 30096)
Inj.: 1 μ L split (split ratio 20:1), 4mm single gooseneck liner w/ wool (cat.# 22405)
Inj. temp.: 250°C
Carrier gas: helium, constant flow
Linear velocity: 28cm/sec. @ 50°C
Oven temp.: 50°C (hold 2 min.) to 75°C @ 10°C/min. to 300°C @ 20°C/min. (hold 5 min.)
Det.: FID @ 300°C

99% Weathered Unleaded Gasoline
Rxi®-1ms



Column: Rxi®-1ms, 30m, 0.25mm ID, 0.25 μ m (cat.# 13323)
Sample: 5,000 μ g/mL unleaded gasoline, 99% weathered, in methanol (cat.# 30436)
Inj.: 1 μ L split (split ratio 20:1), 4mm single gooseneck liner w/ wool (cat.# 22405)
Inj. temp.: 250°C
Carrier gas: helium, constant flow
Linear velocity: 28cm/sec. @ 50°C
Oven temp.: 50°C (hold 2 min.) to 75°C @ 10°C/min. to 300°C @ 20°C/min. (hold 5 min.)
Det.: FID @ 300°C

Unweathered Kerosene
Rxi®-1ms

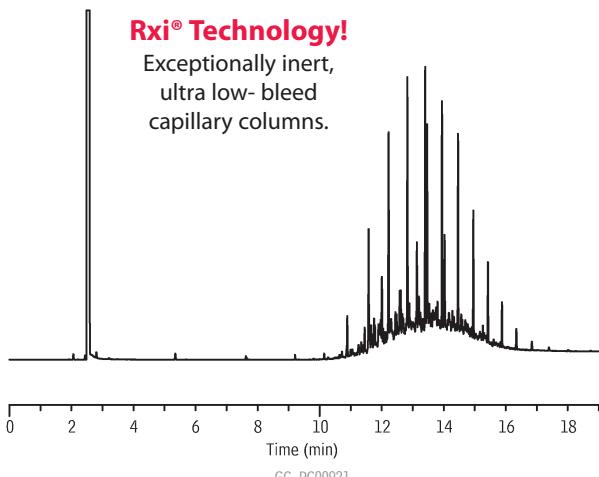


Column: Rxi®-1ms, 30m, 0.25mm ID, 0.25 μ m (cat.# 13323)
Sample: 5,000 μ g/mL kerosene, unweathered, in methylene chloride (cat.# 31229)
Inj.: 1 μ L split (split ratio 20:1), 4mm single gooseneck liner w/ wool (cat.# 22405)
Inj. temp.: 250°C
Carrier gas: helium, constant flow
Linear velocity: 28cm/sec. @ 50°C
Oven temp.: 50°C (hold 2 min.) to 75°C @ 10°C/min. to 300°C @ 20°C/min. (hold 5 min.)
Det.: FID @ 300°C



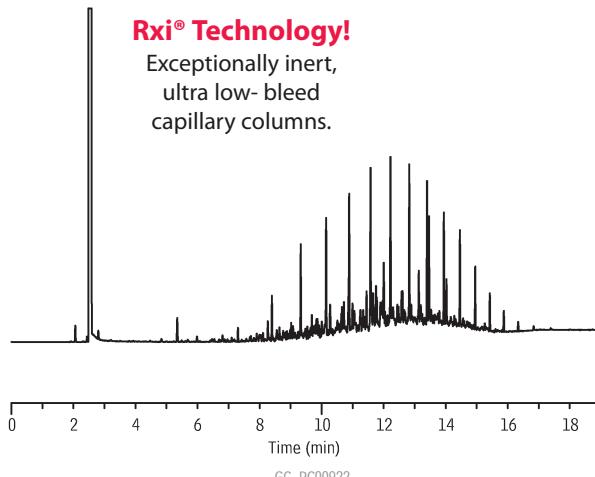
GC APPLICATIONS | FORENSIC Arson Accelerants

50% Weathered Diesel Fuel #2 Rxⁱ-1ms



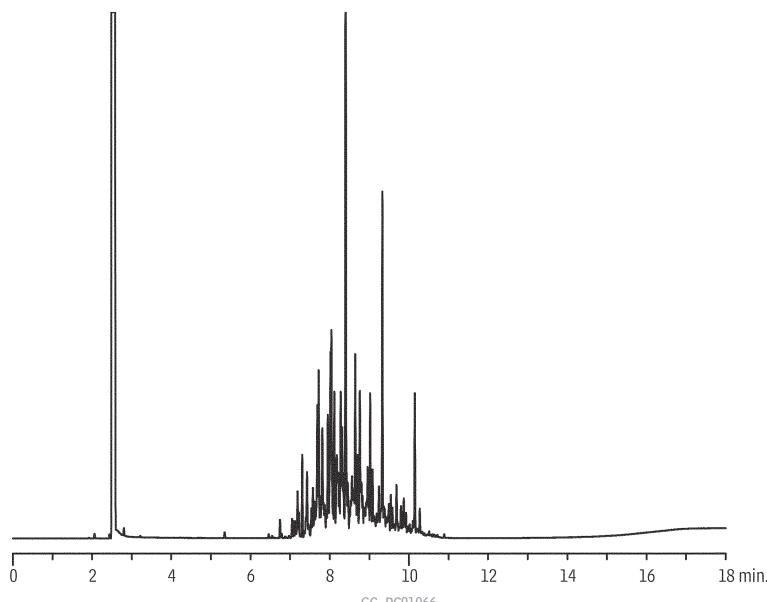
Column: Rxⁱ-1ms, 30m, 0.25mm ID, 0.50 μ m (cat.# 13338)
Sample: 5,000 μ g/mL diesel fuel #2, 50% weathered (cat.# 31235)
in methylene chloride
Inj.: 1.0 μ L split (split ratio 20:1), 4mm single gooseneck
w/wool inlet liner (cat.# 22405)
Inj. temp.: 250°C
Carrier gas: helium, constant flow
Linear velocity: 28cm/sec. @ 50°C
Oven temp.: 50°C (hold 2 min.) to 75°C @ 10°C/min.,
300°C @ 20°C/min. (hold 5 min.)
Det.: FID @ 300°C

Unweathered Diesel Fuel #2 Rxⁱ-1ms



Column: Rxⁱ-1ms, 30m, 0.25mm ID, 0.50 μ m (cat.# 13338)
Sample: 5,000 μ g/mL diesel fuel #2, unweathered (cat.# 31233) in
methylene chloride
Inj.: 1.0 μ L split (split ratio 20:1),
4mm single gooseneck w/wool inlet liner (cat.# 22405)
Inj. temp.: 250°C
Carrier gas: helium, constant flow
Linear velocity: 28cm/sec. @ 50°C
Oven temp.: 50°C (hold 2 min.) to 75°C @ 10°C/min.,
300°C @ 20°C/min. (hold 5 min.)
Det.: FID @ 300°C

Mineral Spirits Rxⁱ-1ms



Column: Rxⁱ-1ms, 30m, 0.25mm ID, 0.25 μ m (cat.# 13323)
Sample: 5,000 μ g/mL mineral spirits, unweathered, in methylene chloride (cat.# 31225)
Inj.: 1 μ L split (split ratio 20:1), 4mm single gooseneck liner w/ wool (cat.# 22405)
Inj. temp.: 250°C
Carrier gas: helium, constant flow
Linear velocity: 28cm/sec. @ 50°C
Oven temp.: 50°C (hold 2 min.) to 75°C @ 10°C/min. to 300°C @ 20°C/min. (hold 5 min.)
Det.: FID @ 300°C

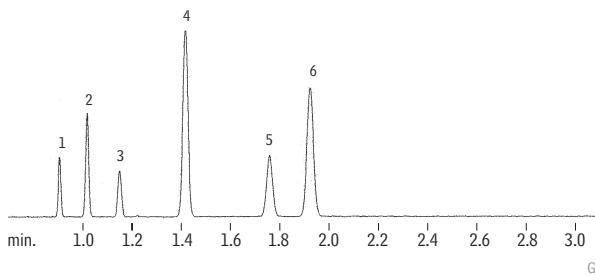
Blood Alcohol

Rtx®-BAC1 & Rtx®-BAC2 (0.32mm ID Columns)

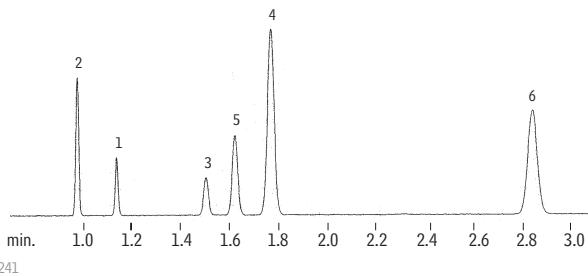
(headspace analysis)

	Conc. w/v
1. methanol	0.1%
2. acetaldehyde	0.2%
3. ethanol	0.2%
4. isopropanol	0.1%
5. acetone	0.01%
6. <i>n</i> -propanol	0.1%

Rtx®-BAC1,
30m, 0.32mm ID, 1.8µm (cat.# 18003)



Rtx®-BAC2,
30m, 0.32mm ID, 1.2µm (cat.# 18002)



Dual-column analysis using a two-hole ferrule.

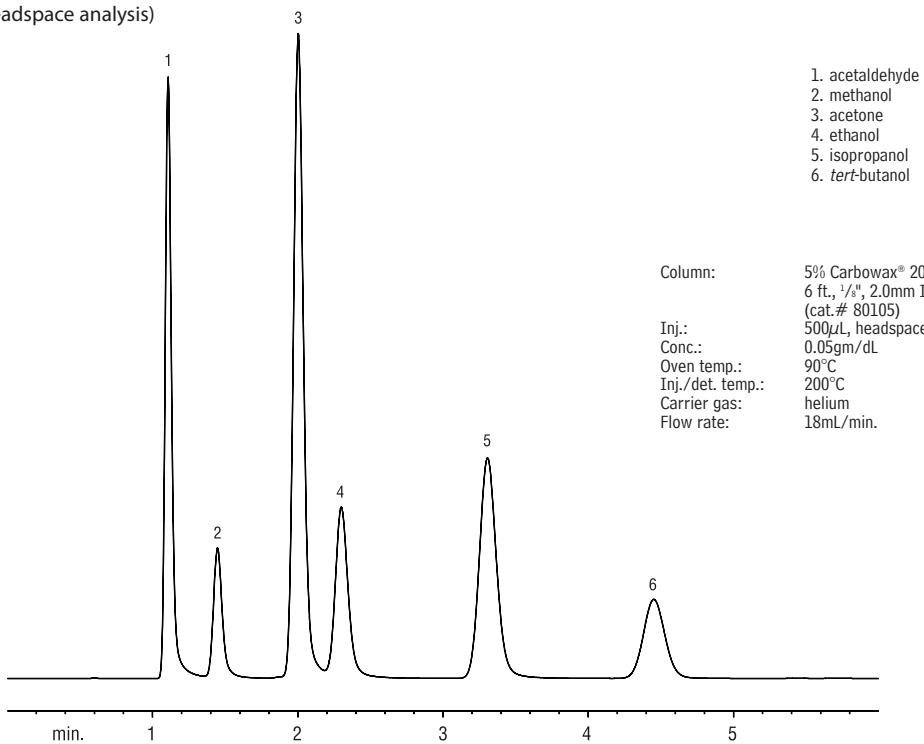
Sample: 1.0mL headspace sample of a blood alcohol mix on a PerkinElmer HS 40 headspace autosampler
Oven temp.: 40°C
Inj. temp.: 200°C
Carrier gas: helium
Sample equilibration: 70°C, 15 min.
Vial pressure: 30psi
Vial pressurization time: 0.15 min.

Vial sampling time: 0.01 min.
Transfer line: 0.32mm ID Hydroguard™ fused silica tubing
Transfer line temp.: 200°C
Injection port sleeve: 2mm ID
Split flow: 20mL/min.

Blood Alcohol

5% Carbowax® 20M on CarboBlack B

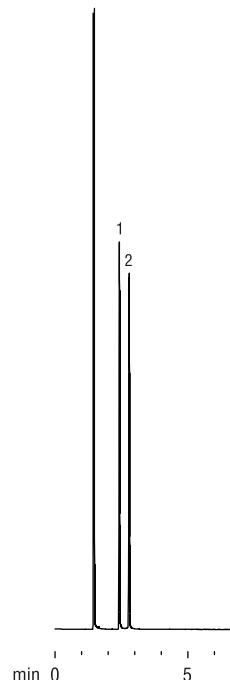
(packed; headspace analysis)



Column: 5% Carbowax® 20M on 80/120 CarboBlack B,
6 ft., $\frac{1}{8}$ " 2.0mm ID SilcoSmooth™ tubing
(cat.# 80105)
Inj.: 500µL, headspace
Conc.: 0.05gm/dL
Oven temp.: 90°C
Inj./det. temp.: 200°C
Carrier gas: helium
Flow rate: 18mL/min.

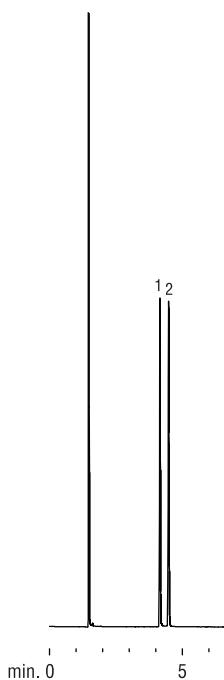
Glycols
Rtx®-BAC1 & Rtx®-BAC2

Rtx®-BAC1



GC_EV00474

Rtx®-BAC2



1. ethylene glycol
 2. propylene glycol

Columns: Rtx®-BAC1, 30m, 0.32mm ID, 1.8 μ m (cat.# 18003)
 Rtx®-BAC2, 30m, 0.32mm ID, 1.2 μ m (cat.# 18002)

Inj.: 0.5 μ L split injection
 Conc.: 1%
 Solvent: methanol
 Oven temp.: 100°C to 240°C @ 5°C/min. (hold 5 min.)
 Inj. temp.: 240°C
 Inj. mode: 100:1 split
 Inlet liner: 4mm single gooseneck (cat.# 20798)
 Septa purge: 5.0cc/min.
 Carrier gas: helium, constant pressure
 Pressure: 12psi
 Linear velocity: 37cm/sec.
 Column flow rate: 2.1mL/min.
 Det.: FID @ 240°C
 Make-up gas flow: 40cc/min.

γ -butyrolactone and γ -butyrolactone-d6
Rxi®-5ms

1. GBL-d6 (m/z 92)
 2. GBL (m/z 86)

Rxi® Technology!

Column: Rxi®-5ms, 30m, 0.25mm ID, 0.25 μ m (cat.# 13423)
 Sample: 50 μ g/mL γ -butyrolactone (GBL) and 25 μ g/mL γ -butyrolactone-d6 (GBL-d6) in methanol
 Inj.: 1 μ L split (1:10), 4mm Sittel® treated single gooseneck inlet liner (cat.# 20798-214.1)
 Inj. temp.: 250°C
 Carrier gas: helium, constant flow
 Flow rate: 1mL/min.
 Oven temp.: 40°C (3 min.) to 300°C @ 25°C/min. (hold 5 min.)
 Det: MS
 Transfer line temp.: 280°C
 Scan range: 35-200amu
 Ionization: EI
 Mode: scan

GC_PH00869

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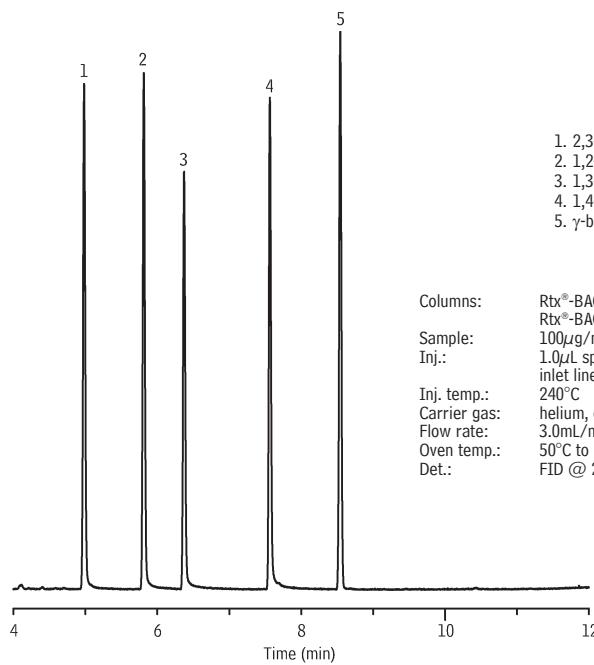
"Fast Screening and
 Confirmation for Gamma-
 Hydroxybutyrate (GHB)"

www.restek.com/CFT

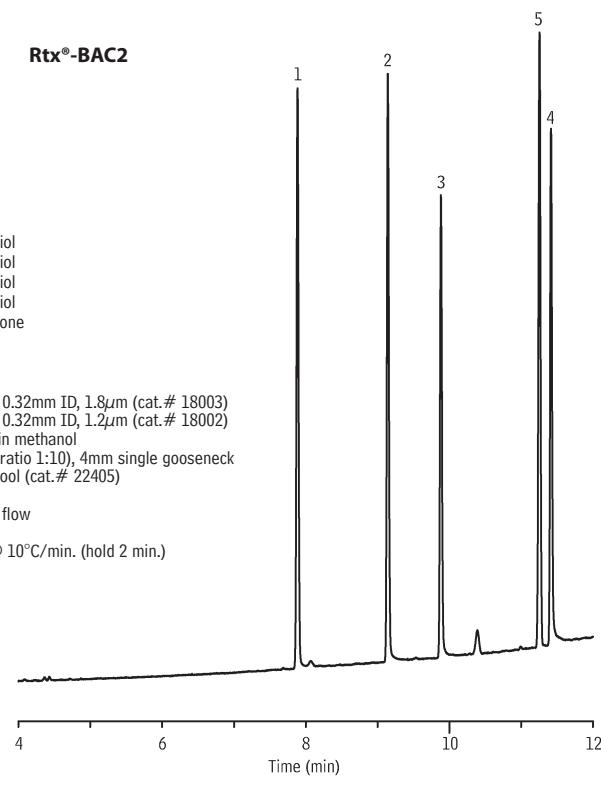


γ -butyrolactone & 1,4-butanediol

Rtx[®]-BAC1



Rtx[®]-BAC2

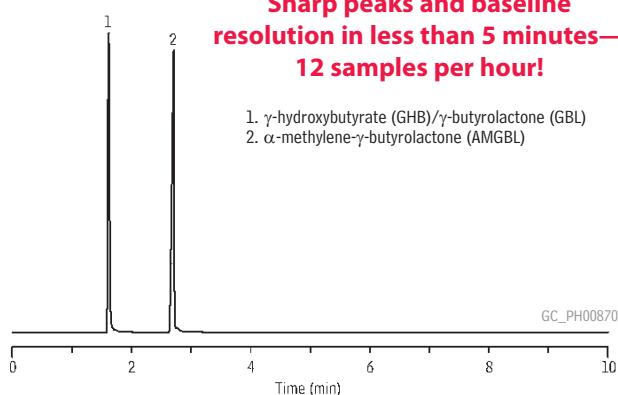


- 1. 2,3-butanediol
- 2. 1,2-butanediol
- 3. 1,3-butanediol
- 4. 1,4-butanediol
- 5. γ -butyrolactone

Columns: Rtx[®]-BAC1, 30m, 0.32mm ID, 1.8 μ m (cat.# 18003)
Rtx[®]-BAC2, 30m, 0.32mm ID, 1.2 μ m (cat.# 18002)
Sample: 100 μ g/mL each in methanol
Inj.: 1.0 μ L split (split ratio 1:10), 4mm single gooseneck inlet liner with wool (cat.# 22405)
Inj. temp.: 240°C
Carrier gas: helium, constant flow
Flow rate: 3.0mL/min.
Oven temp.: 50°C to 240°C @ 10°C/min. (hold 2 min.)
Det.: FID @ 240°C

γ -hydroxybutyrate (GHB) and γ -butyrolactone (GBL) Rtx[®]-BAC1 and Rtx[®]-BAC2 (dual column analysis)

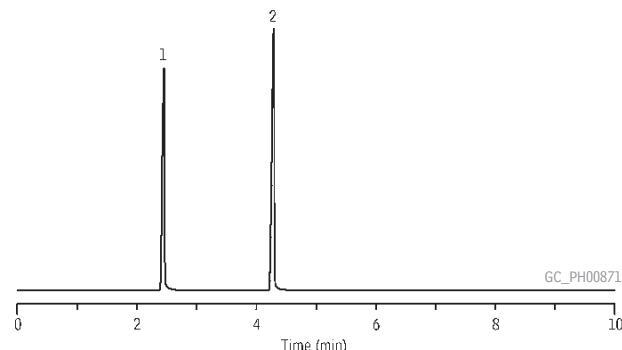
Rtx[®]-BAC1



**Sharp peaks and baseline resolution in less than 5 minutes—
12 samples per hour!**

- 1. γ -hydroxybutyrate (GHB)/ γ -butyrolactone (GBL)
- 2. α -methylene- γ -butyrolactone (AMGBL)

Rtx[®]-BAC2

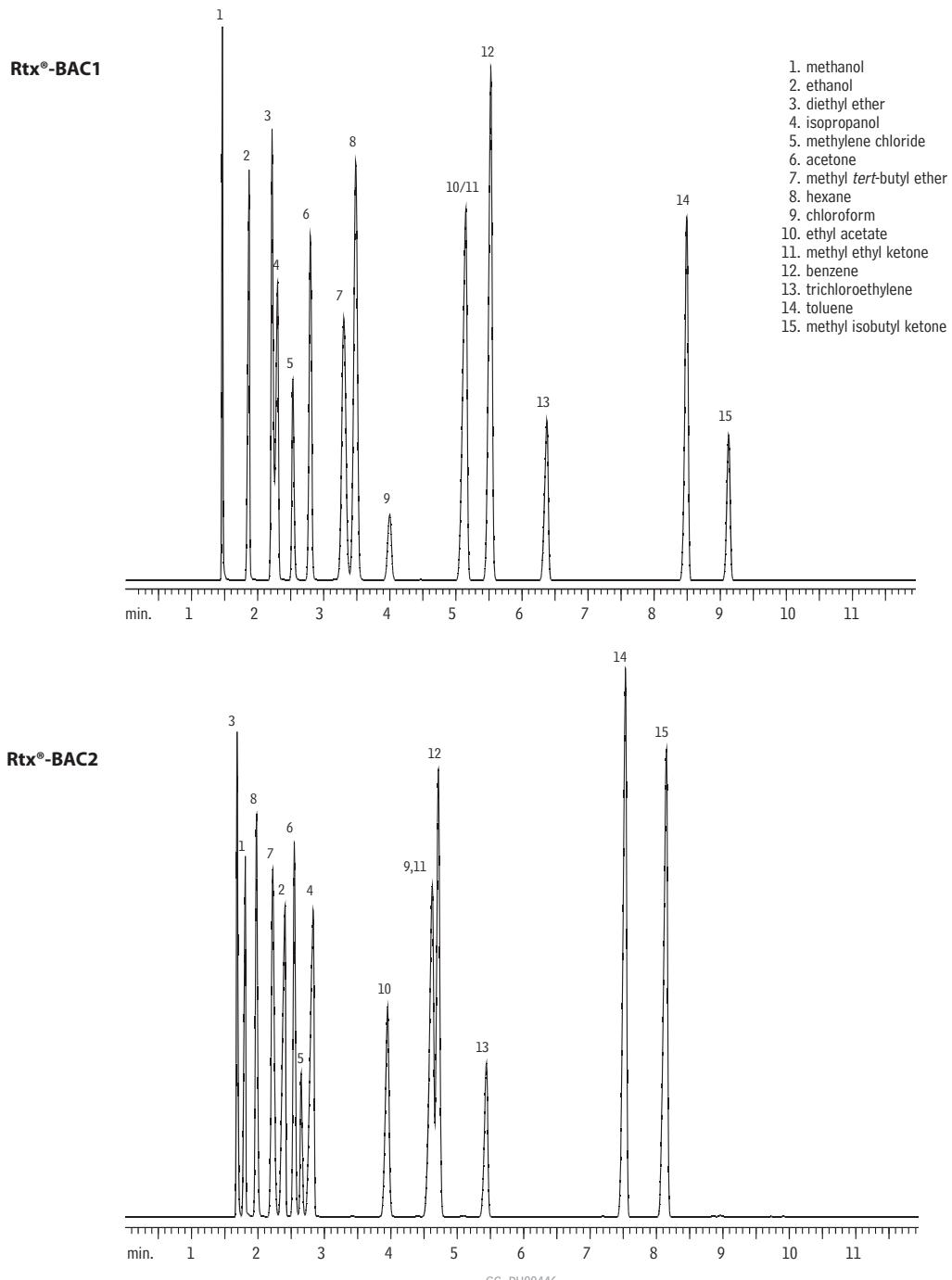


Columns: Rtx[®]-BAC1, 30m, 0.32mm ID, 1.8 μ m (cat.# 18003) and Rtx[®]-BAC2, 30m, 0.32mm ID, 1.2 μ m (cat.# 18002), connected via universal "Y" Press-Tight[®] connector (cat.# 20405)
Sample: GHB, GBL, α -methylene- γ -butyrolactone (AMGBL), 10 μ g/mL each in water
Inj.: 1.0mL headspace, split (split ratio 1:10), 1mm split inlet liner (cat.# 20972)
Inj. temp.: 200°C
Carrier gas: helium, constant pressure
Linear velocity: 44cm/sec. @ 50°C
Oven temp.: 50°C (3 min.) to 150°C @ 20°C/min. (hold 7 min.)
Det.: FID @ 240°C
Headspace autosampler: Teledyne/Tekmar HT3
Sample/platen temp.: 100°C
Sample equilibration: 15 min.
Mixing time: 5 min.
Vial pressure: 10psig
Vial pressurization time: 2 min.
Loop fill time: 2 min.
Transfer line temp.: 120°C



Abused Inhalants

Rtx®-BAC1 & Rtx®-BAC2



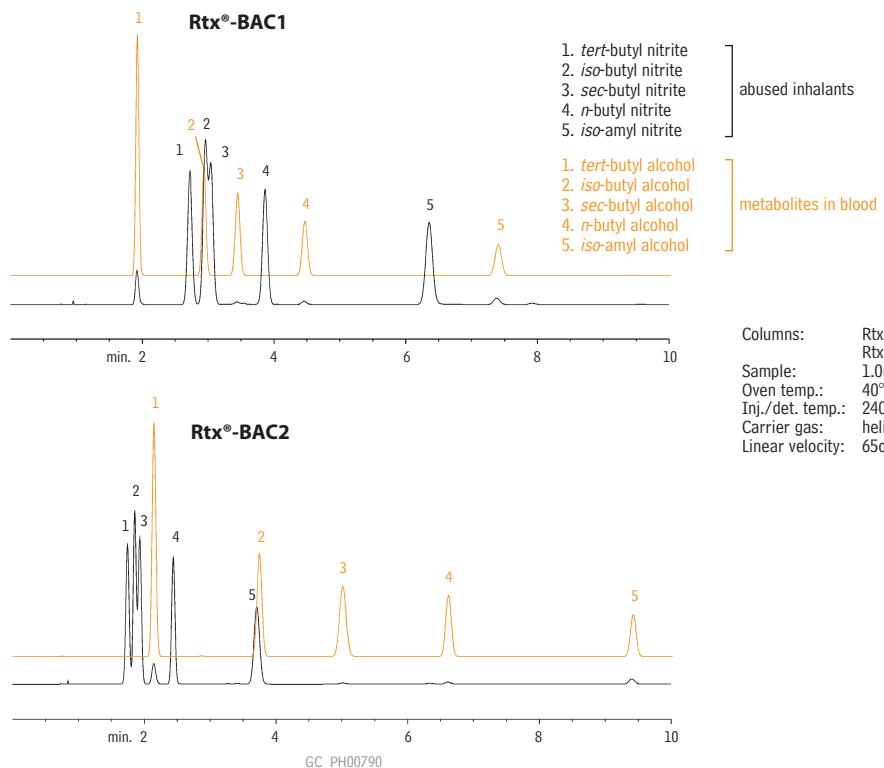
Columns: Rtx®-BAC1, 30m, 0.32mm ID, 1.80 μ m (cat.# 18003)
Rtx®-BAC2, 30m, 0.32mm ID, 1.20 μ m (cat.# 18002)
Oven temp.: 40°C (hold 4 min.) to 120°C @ 10°C/min.
Carrier gas: helium
Linear velocity: 50cm/sec.
Det.: FID
Sample: 250 μ L headspace
Transfer line temp.: 125°C
Sample loop temp.: 125°C
Vial temp.: 70°C

Acknowledgement: Analyses performed using a Tekmar 7000 Headspace Autosampler on loan courtesy of Tekmar-Dohrmann.



Alkyl Nitrites

Rtx®-BAC1 & Rtx®-BAC2



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

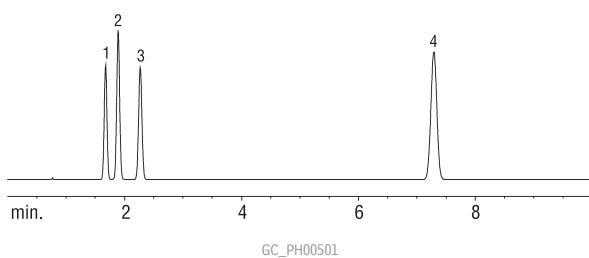
Anesthetics

Rtx®-BAC1 & Rtx®-BAC2

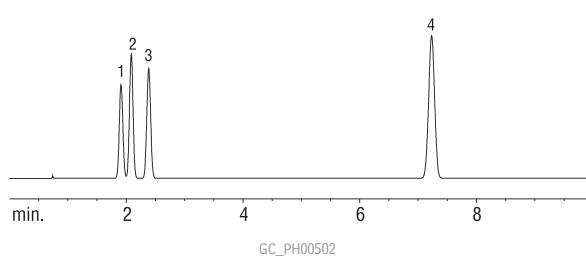
(headspace analysis)



Rtx®-BAC1,
30m, 0.53mm ID, 3.0 μ m (cat.# 18001)



Rtx®-BAC2,
30m, 0.53mm ID, 2.0 μ m (cat.# 18000)



Sample: 1.0mL headspace sample
Oven temp.: 40°C (hold 5 min.) to 240°C @ 5°C/min.
Inj./det. temp.: 240°C
Carrier gas: helium
Linear velocity: 65cm/sec.

1. isoflurane
2. enflurane
3. halothane
4. methoxyflurane

GC APPLICATIONS | FORENSIC

Solvents, Cocaine

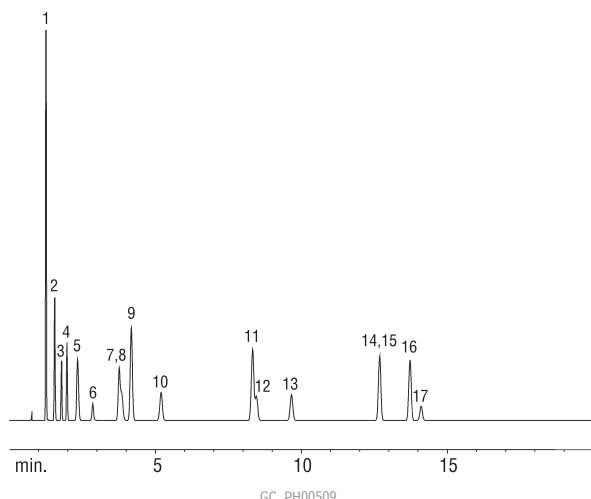
Solvents

Rtx®-BAC1 & Rtx®-BAC2

(headspace analysis)

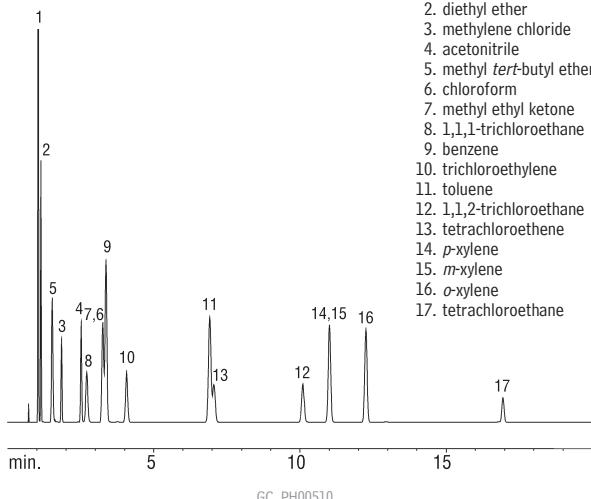
Rtx®-BAC1,

30m, 0.53mm ID, 3.0 μ m (cat.# 18001)



Rtx®-BAC2,

30m, 0.53mm ID, 2.0 μ m (cat.# 18000)

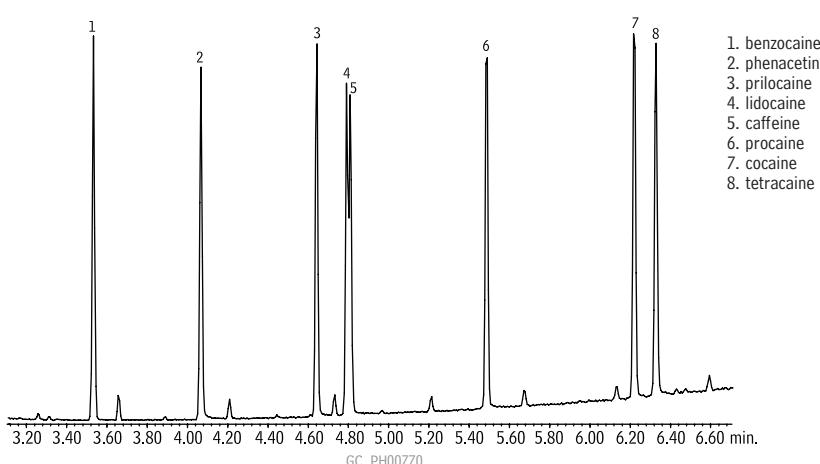


- 1. ethyl chloride
- 2. diethyl ether
- 3. methylene chloride
- 4. acetonitrile
- 5. methyl *tert*-butyl ether
- 6. chloroform
- 7. methyl ethyl ketone
- 8. 1,1,1-trichloroethane
- 9. benzene
- 10. trichloroethylene
- 11. toluene
- 12. 1,1,2-trichloroethane
- 13. tetrachloroethene
- 14. *p*-xylene
- 15. *m*-xylene
- 16. *o*-xylene
- 17. tetrachloroethane

Sample: 1.0mL headspace sample
Oven temp.: 40°C (hold 5 min.) to 240°C @ 5°C/min.
Inj./det. temp.: 240°C
Carrier gas: helium
Linear velocity: 65cm/sec.

Cocaine & Cocaine Adulterants

Rtx®-440

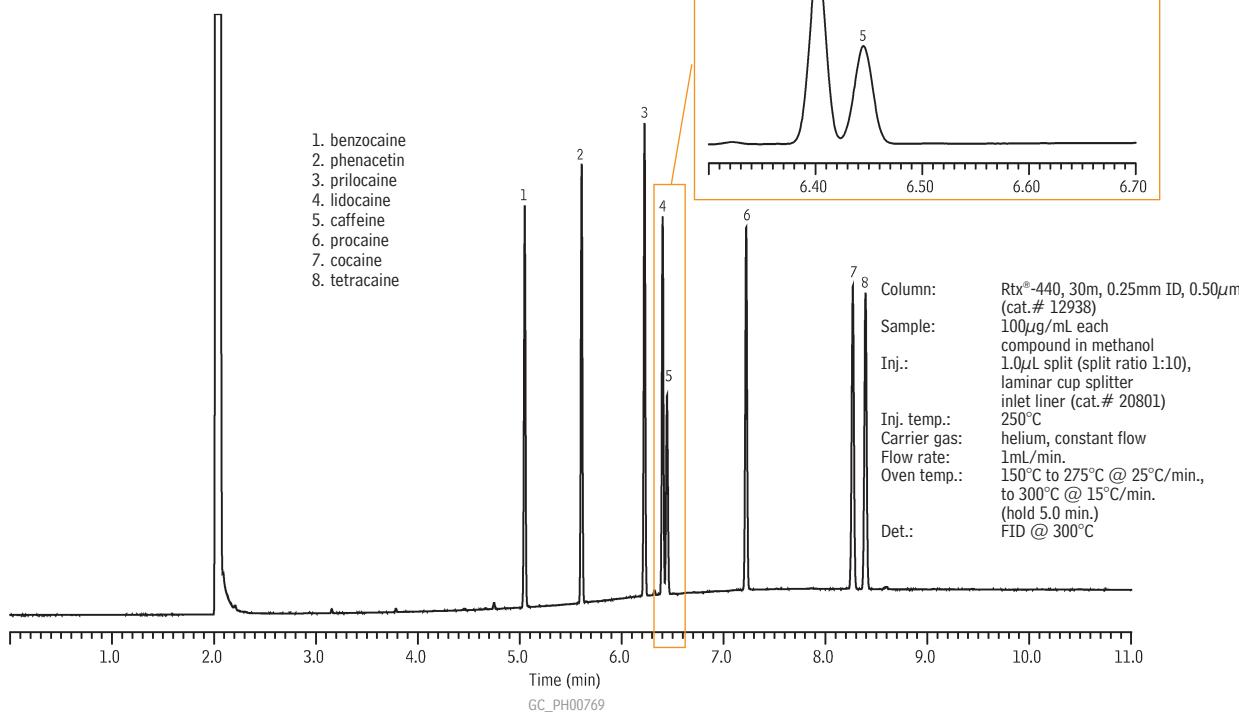


- 1. benzocaine
- 2. phenacetin
- 3. prilocaine
- 4. lidocaine
- 5. caffeine
- 6. procaine
- 7. cocaine
- 8. tetracaine

Column: Rtx®-440, 30m, 0.25mm ID, 0.50 μ m (cat.# 12938)
Sample: 100 μ g/mL each compound in methanol
Inj.: 1.0 μ L split (split ratio 1:10), laminar cup splitter inlet liner (cat.# 20801)
Inj. temp.: 250°C
Carrier gas: helium, constant flow
Flow rate: 1mL/min.
Oven temp.: 150°C to 275°C @ 25°C/min., to 300°C @ 15°C/min. (hold 5.0 min.)
Det.: MS
Transfer line temp.: 180°C
Scan range: 35-550amu
Ionization: EI
Mode: scan

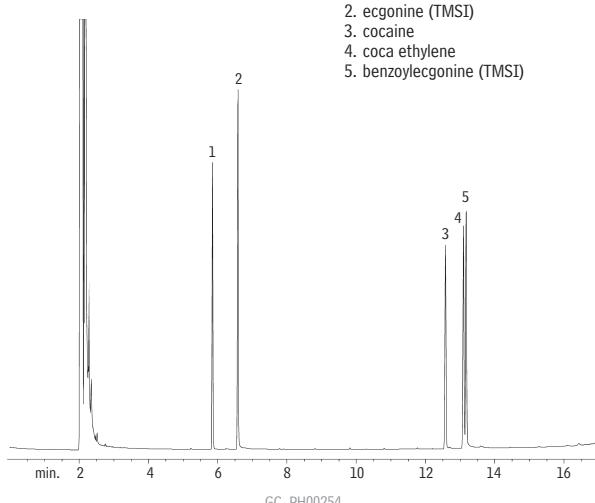
Cocaine & Cocaine Adulterants

Rtx®-440



Cocaine & Metabolites (TMS Derivatives)

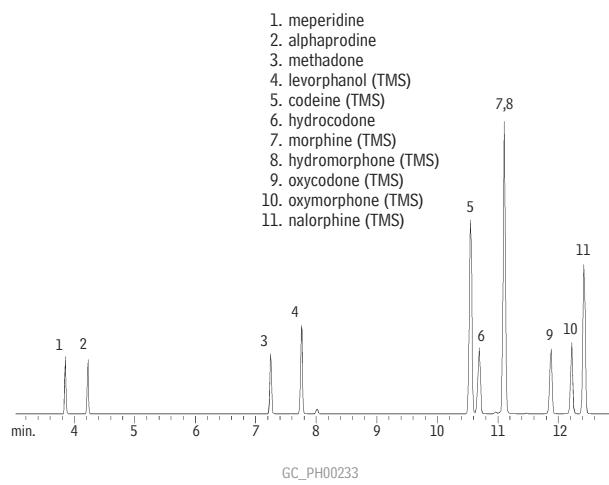
Rtx®-5



Column: Rtx®-5, 30m, 0.25mm ID, 0.25 μ m (cat.# 10223)
Sample: 1.0 μ L split injection of cocaine and cocaine metabolites
Oven temp.: 150°C to 320°C @ 10°C/min.
Inj./det. temp.: 250°C/300°C
Carrier gas: helium
Linear velocity: 30cm/sec. set @ 50°C
FID sensitivity: 2.56 x 10¹⁰ AFS
Split ratio: 30:1

Opiates (TMS Derivatives)

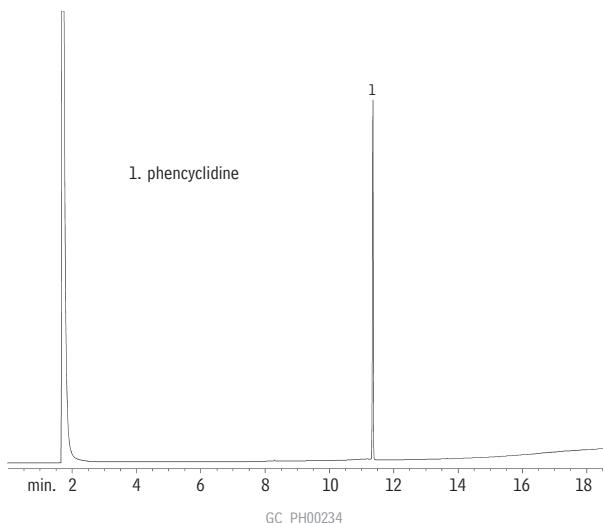
Rtx®-5



Column: Rtx®-5, 30m, 0.25mm ID, 0.25 μ m (cat.# 10223)
Sample: 2.0 μ L split injection of opiates
Conc: 2,000ng/ μ L
Oven temp.: 200°C to 325°C @ 7°C/min.
Inj./det. temp.: 250°C/300°C
Det. type: MS
Ionization: EI
Carrier gas: helium
Mode: full scan
Linear velocity: 30cm/sec. set @ 200°C
Split ratio: 50:1

GC APPLICATIONS | FORENSIC PCP, Cannabinoids

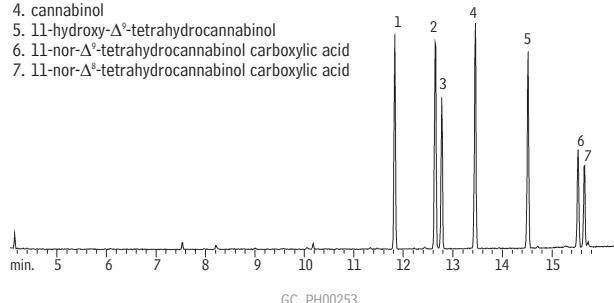
Phencyclidine (PCP) Rtx®-5



Column: Rtx®-5, 30m, 0.25mm ID, 0.25 μ m (cat.# 10223)
Sample: 1.0 μ L split injection of phencyclidine
Conc.: 1,000ng/ μ L
Oven temp.: 50°C (hold 1 min.) to 250°C @ 25°C/min.,
then to 325°C @ 10°C/min. (hold 2 min.)
Inj./det. temp.: 250°C/325°C
Carrier gas: helium
Linear velocity: 30cm/sec. set @ 50°C
FID sensitivity: 2.56 x 10¹⁰ AFS
Split ratio: 30:1

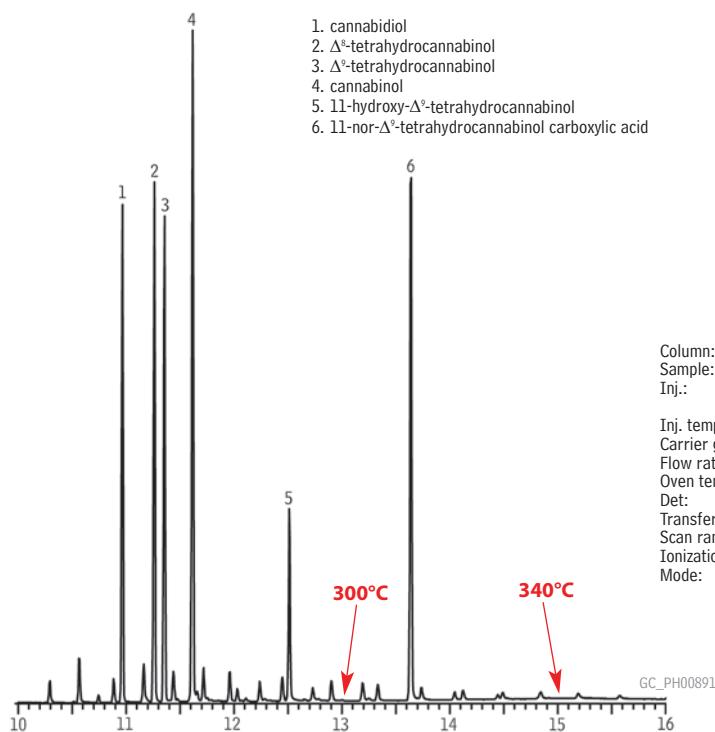
Cannabinoids (TMS Derivatives) Rtx®-5

1. cannabidiol
2. Δ^9 -tetrahydrocannabinol
3. Δ^8 -tetrahydrocannabinol
4. cannabinol
5. 11-hydroxy- Δ^9 -tetrahydrocannabinol
6. 11-nor- Δ^9 -tetrahydrocannabinol carboxylic acid
7. 11-nor- Δ^8 -tetrahydrocannabinol carboxylic acid



Column: Rtx®-5, 15m, 0.25mm ID, 0.25 μ m (cat.# 10220)
Sample: 1.0 μ L splitless injection of cannabinoids
Conc.: 100 μ g/mL
Oven temp.: 50°C (hold 0.5 min.) to 225°C @ 30°C/min.,
to 325°C @ 10°C/min.
Inj. temp.: 225°C
Interface temp.: 320°C
Det.: MSD
Ionization: EI
Carrier gas: helium
Scan range: 40-500amu
Linear velocity: 40cm/sec. set @ 50°C
Splitless hold time: 0.75 min.

Cannabinoids Rxi®-5ms

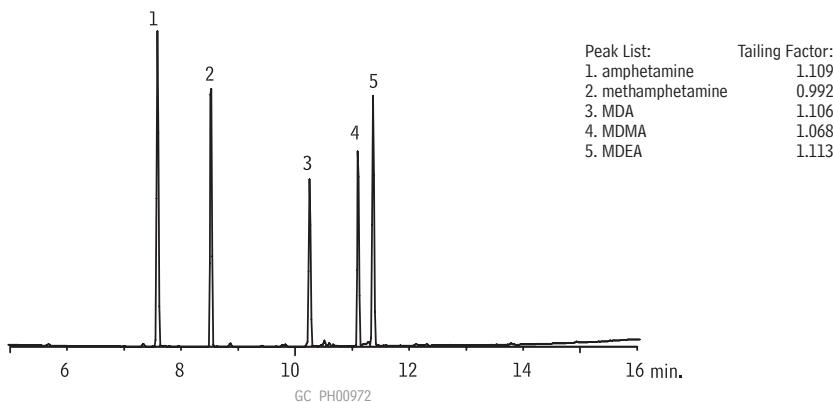


Rxi® Technology!

Exceptionally inert,
ultra low- bleed
capillary columns.

Column: Rxi®-5ms, 12m, 0.20mm ID, 0.33 μ m (cat.# 13497)
Sample: 1,000 μ g/mL each component in methanol
Inj.: 1.0 μ L, split, split ratio 25:1, 4mm ID base-deactivated
single gooseneck inlet liner w/wool (cat.# 20798-211.1)
Inj. temp.: 250°C
Carrier gas: helium, constant flow
Flow rate: 1mL/min.
Oven temp.: 40°C to 340°C @ 20°C/min. (hold 5 min.)
Det: MS
Transfer line temp.: 280°C
Scan range: 100-550amu
Ionization: EI
Mode: scan

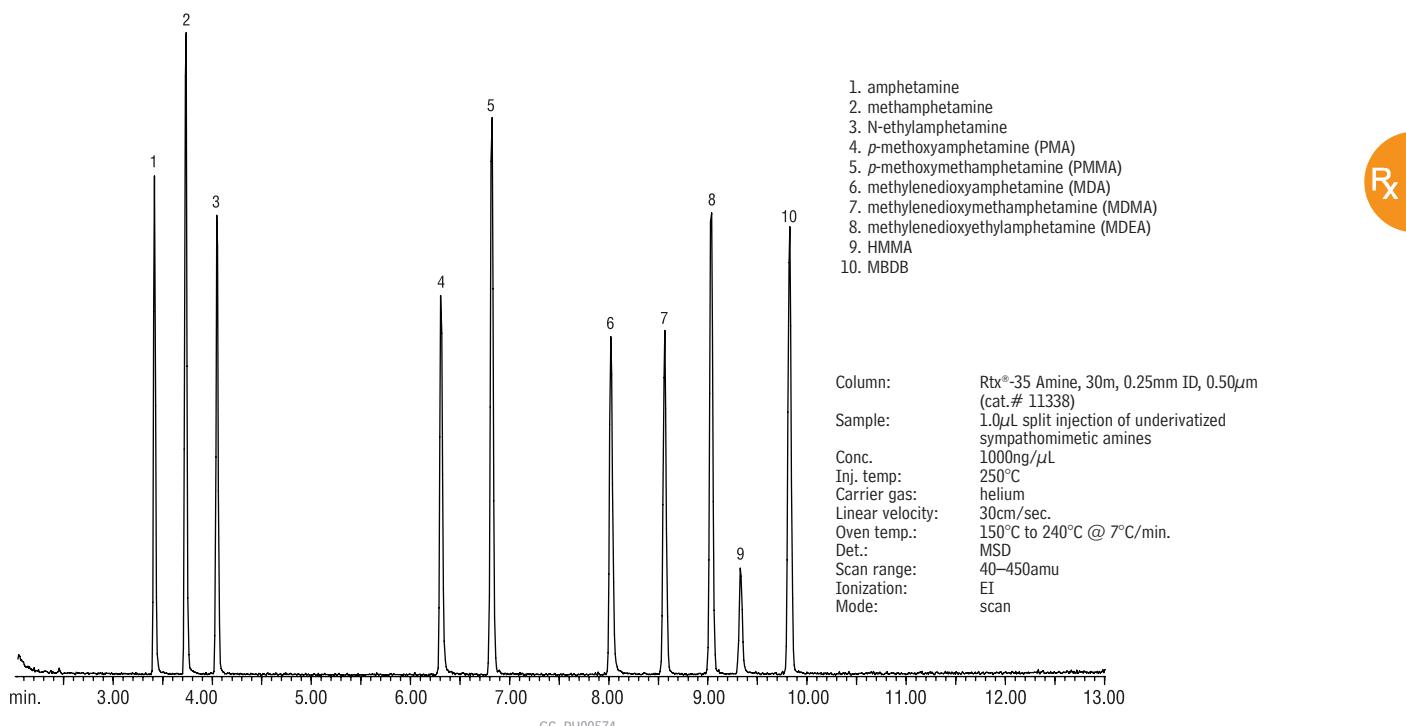
Amphetamines
Rtx®-5MS



Column: Rtx®-5MS, 30m, 0.25mm ID, 0.25 μ m (cat.# 12623)
 Sample: 100 μ g/mL each amphetamine, methamphetamine, MDA, MDMA, and MDEA extracted from methanol and HFAA derivatized
 Inj.: 1 μ L, splitless (hold 0.5 min.), 3.5mm custom splitless inlet liner w/IP deactivated wool
 Inj. temp.: 220°C
 Carrier gas: helium, constant flow
 Flow rate: 1.25mL/min.
 Oven temp.: 70°C (hold 1 min.) to 290°C @ 15°C/min. (hold 4 min.)
 Det: MS
 Transfer line temp.: 280°C
 Scan range: 43-450amu
 Ionization: EI
 Mode: scan

Sympathomimetic Amines (Basic Drugs) (Underivatized)

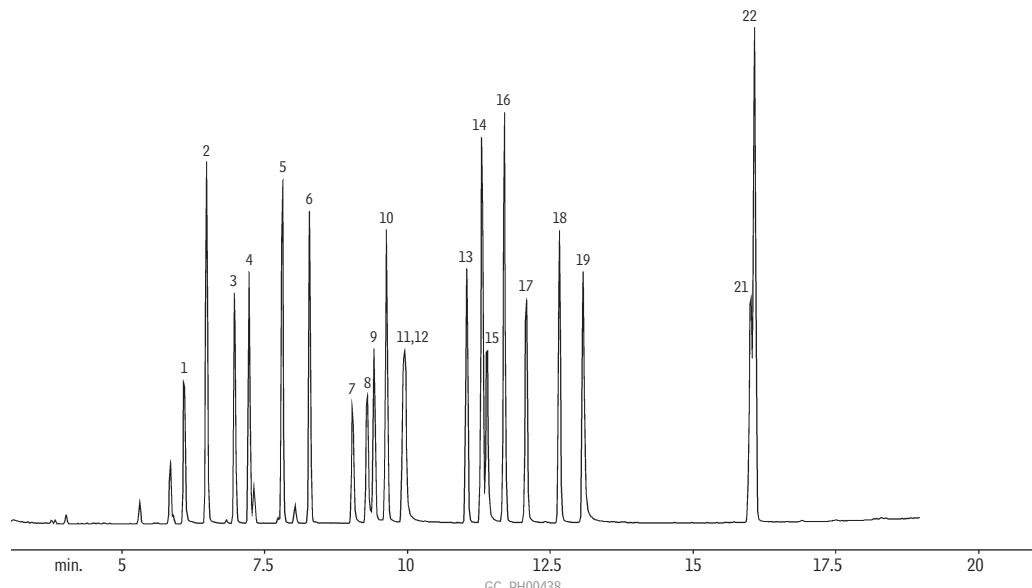
Rtx®-35 Amine



Sympathomimetic Amines

Sympathomimetic Amines (Basic Drugs) (Underivatized)

Rtx®-5 Amine



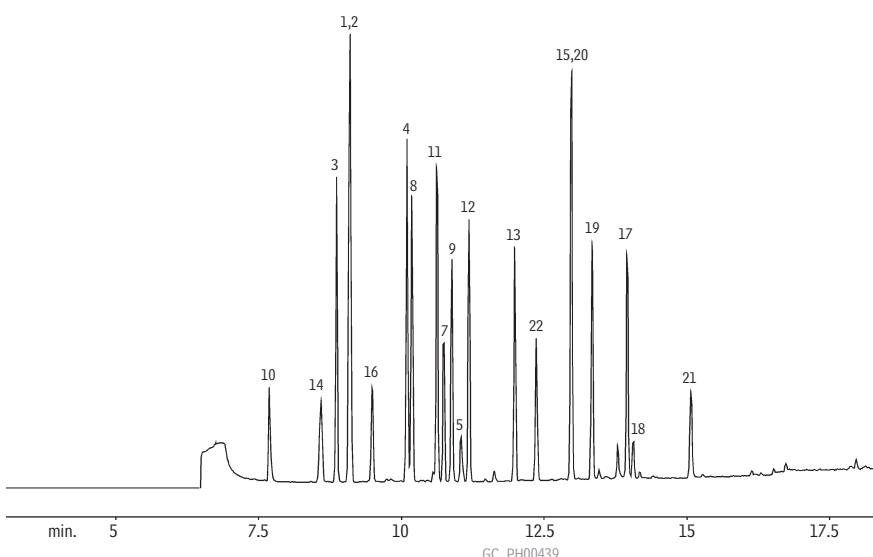
Column: Rtx®-5 Amine, 30m, 0.25mm ID, 0.50 μ m (cat.# 12338)
 Instrument: Varian 3400 GC coupled with Varian Saturn 2000 MS detector
 Inj.: 1 μ L, split, split vent flow rate 45mL/min.
 Inj. temp.: 250°C
 Carrier gas: helium
 Det.: mass spectroscopy data collected using a scan range of 40 amu through 600 amu.
 Oven temp.: 100°C to 310°C @ 10°C/min.

Ionization performed in the EI Auto mode.

1. phenylethylamine
2. amphetamine
3. phentermine
4. methamphetamine
5. fenfluramine
6. mephentermine
7. cathinone
8. phenylpropanolamine
9. methcathinone
10. nicotine
11. ephedrine
12. pseudoephedrine
13. phenmetrazine
14. phendimetrazine
15. methylenedioxymethamphetamine
16. diethylpropion
17. methylenedioxymethamphetamine
18. methylenedioxymethamphetamine
19. 4-methyl-2,5-dimethoxyamphetamine
20. phenylephrine
21. caffeine
22. benzphetamine

Sympathomimetic Amines (Basic Drugs) (Underivatized)

Rtx®-200

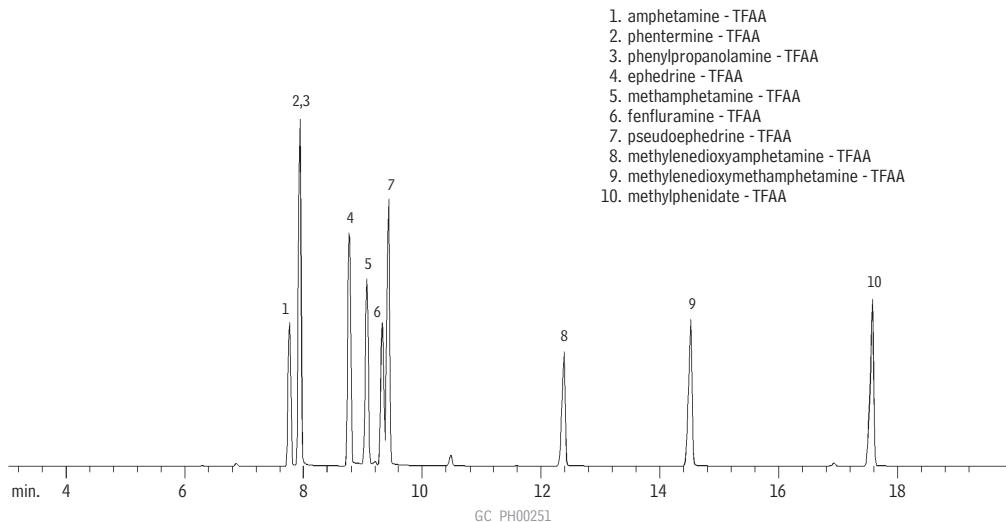


Column: Rtx®-200, 30m, 0.25mm ID, 0.50 μ m (cat.# 15038)
 Instrument: Varian 3400 GC coupled with Varian Saturn 2000 MS detector
 Inj.: 1 μ L, split, split vent flow rate 45mL/min.
 Inj. temp.: 250°C
 Carrier gas: helium
 Det.: mass spectroscopy data collected using a scan range of 40 amu through 600 amu.
 Oven temp.: 100°C to 310°C @ 10°C/min.

Ionization performed in the EI Auto mode.

Sympathomimetic Amines (Basic Drugs) (TFAA Derivatives)

Rtx®-5

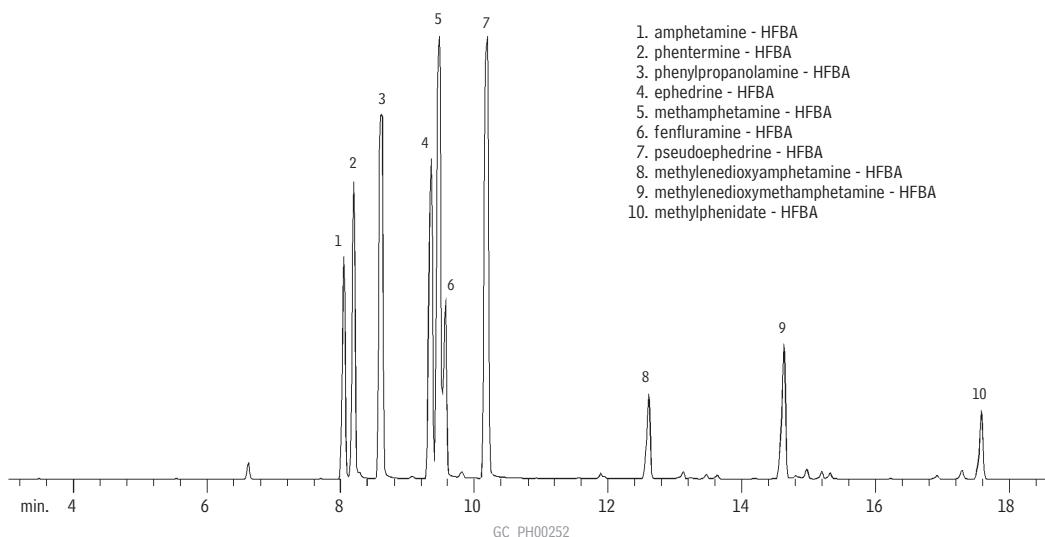


1. amphetamine - TFAA
2. phentermine - TFAA
3. phenylpropanolamine - TFAA
4. ephedrine - TFAA
5. methamphetamine - TFAA
6. fenfluramine - TFAA
7. pseudoephedrine - TFAA
8. methylenedioxymphetamine - TFAA
9. methylenedioxymethamphetamine - TFAA
10. methylphenidate - TFAA

Column: Rtx®-5, 30m, 0.25mm ID, 0.25µm (cat.# 10223)
 Sample: 1.0µL splitless injection of derivatized sympathomimetic amines
 Conc.: approximately 2.5ng/µL
 Oven temp.: 40°C (hold 1 min.) to 150°C @ 30°C/min.,
 to 300°C @ 5°C/min.
 Inj. temp.: 225°C
 Interface temp.: 275°C
 Det.: MSD
 Ionization: EI
 Carrier gas: helium
 Linear velocity: 20cm/sec. set @ 100°C
 Splitless hold time: 1 min.

Sympathomimetic Amines (Basic Drugs) (HFBA Derivatives)

Rtx®-5



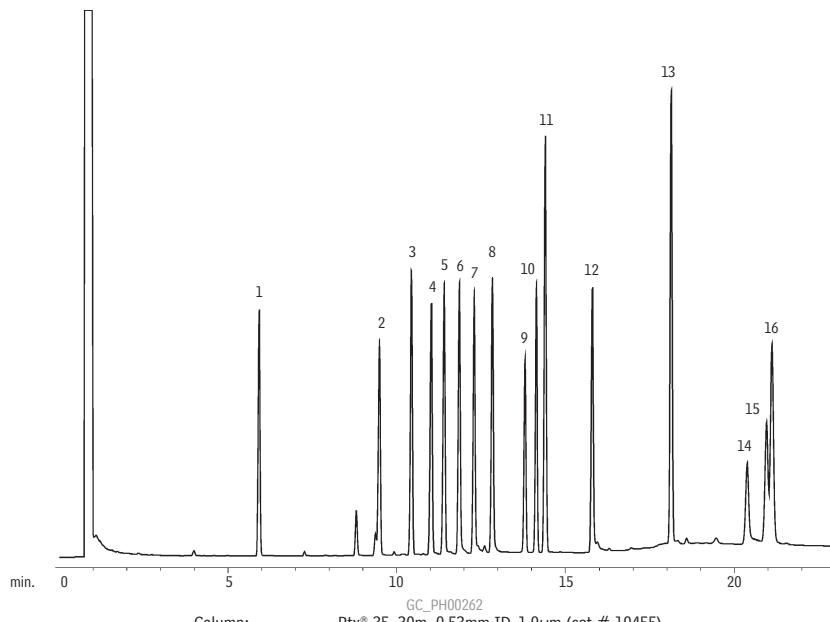
1. amphetamine - HFBA
2. phentermine - HFBA
3. phenylpropanolamine - HFBA
4. ephedrine - HFBA
5. methamphetamine - HFBA
6. fenfluramine - HFBA
7. pseudoephedrine - HFBA
8. methylenedioxymphetamine - HFBA
9. methylenedioxymethamphetamine - HFBA
10. methylphenidate - HFBA

Column: Rtx®-5, 30m, 0.25mm ID, 0.25µm (cat.# 10223)
 Sample: 1.0µL splitless injection of sympathomimetic amines
 Conc.: approximately 2.5ng/µL
 Oven temp.: 40°C (hold 1 min.) to 150°C @ 30°C/min.,
 to 300°C @ 5°C/min.
 Inj. temp.: 225°C
 Interface temp.: 275°C
 Det.: MSD
 Ionization: EI
 Carrier gas: helium
 Linear velocity: 20cm/sec. set @ 100°C
 Splitless hold time: 1 min.



GC APPLICATIONS | FORENSIC/PHARMACEUTICAL
Barbiturates

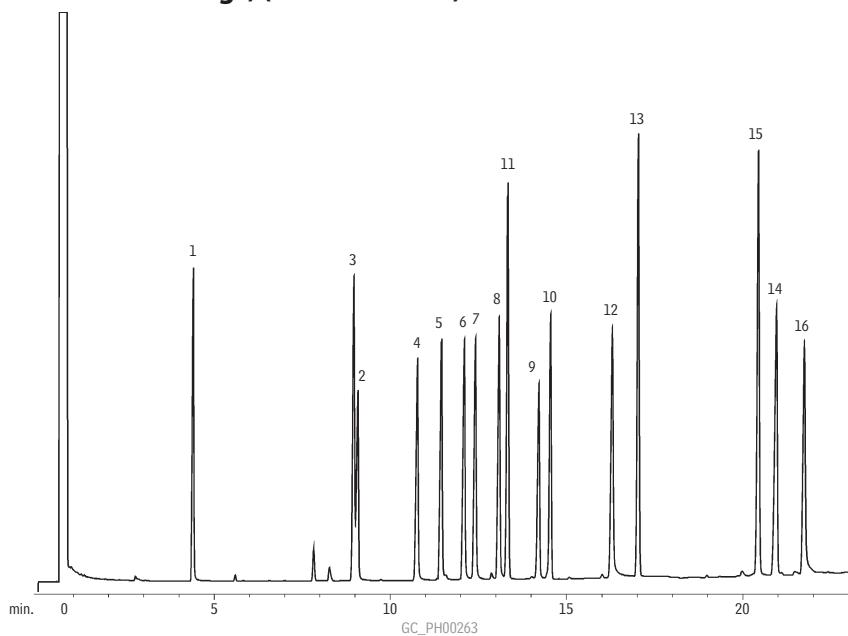
Barbiturates (Acidic/Neutral Drugs) (Underivatized)
Rtx®-35



Column: Rtx®-35, 30m, 0.53mm ID, 1.0 μ m (cat.# 10455)
 Sample: 1.0 μ L splitless injection of acidic/neutral drugs
 Conc.: 50 μ g/mL
 Oven temp.: 100°C to 280°C @ 10°C/min. (hold 5 min.)
 Inj./det. temp.: 250°C
 Carrier gas: helium
 Linear velocity: 40cm/sec. set @ 100°C
 FID sensitivity: 5.12 x 10⁻¹⁰ AFS
 Splitless hold time: 0.5 min.

1. ethosuximide
2. barbital
3. methyprylon
4. aprobarbital
5. butalbital
6. amobarbital
7. pentobarbital
8. secobarbital
9. meprobamate
10. carisoprodal
11. glutethimide
12. phenobarbital
13. methaqualone
14. primidone
15. carbamazepine
16. diphenylhydantoin

Barbiturates (Acidic/Neutral Drugs) (Underivatized)
Rtx®-1701



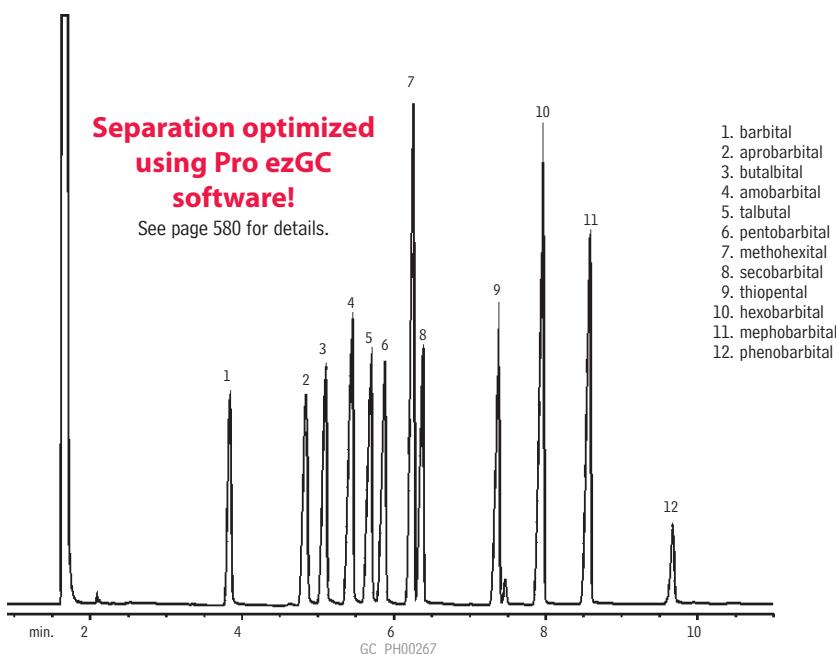
Column: Rtx®-1701, 15m, 0.53mm ID, 0.50 μ m (cat.# 12037)
 Sample: 1.0 μ L splitless injection of acidic/neutral drugs
 Conc.: 50 μ g/mL concentration
 Oven temp.: 100°C to 280°C @ 7°C/min.
 Inj./det. temp.: 250°C/275°C
 Carrier gas: helium
 Linear velocity: 40cm/sec. set @ 100°C
 FID sensitivity: 5.12 x 10⁻¹⁰ AFS
 Splitless hold time: 0.5 min.



GC APPLICATIONS | FORENSIC/PHARMACEUTICAL Barbiturates, Acidic/Neutral Drugs

Barbiturates (Acidic/Neutral Drugs) (Underivatized)

Rtx®-35



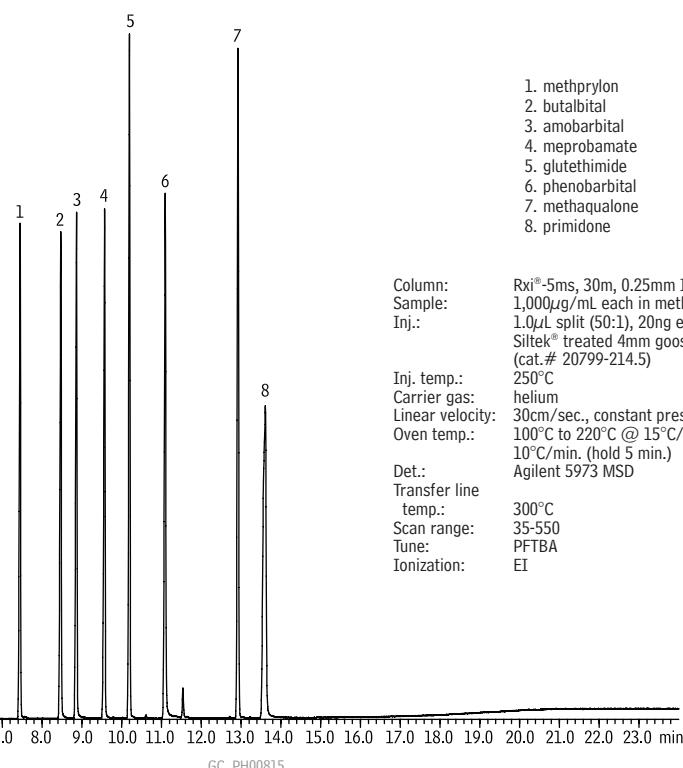
Column: Rtx®-35, 30m, 0.32mm ID, 0.50 μ m (cat.# 10439)
Sample: 1.0 μ L split injection of barbiturates
Oven temp.: 210°C (hold 2 min.) to 300°C @ 7°C/min. (hold 2 min.)
Inj./det. temp.: 300°C
Carrier gas: helium
Linear velocity: 35cm/sec. set @ 210°C
FID sensitivity: 5.12 x 10⁻¹⁰ AFS
Split vent: 30:1

Acidic/Neutral Drugs

Rxi®-5ms

Rxi® Technology!

Exceptionally inert,
ultra low- bleed
capillary columns.

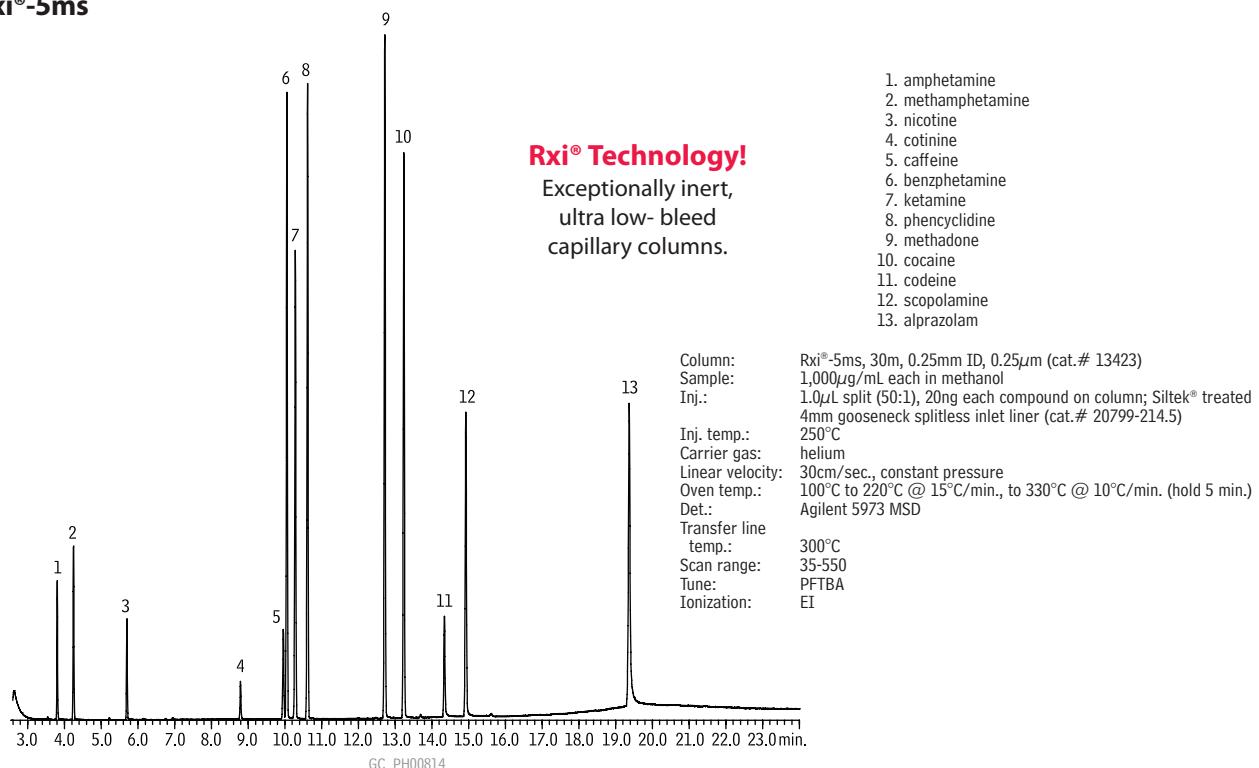


GC APPLICATIONS | FORENSIC/PHARMACEUTICAL

Basic Drugs

Basic Drugs (Underivatized)

Rxi®-5ms

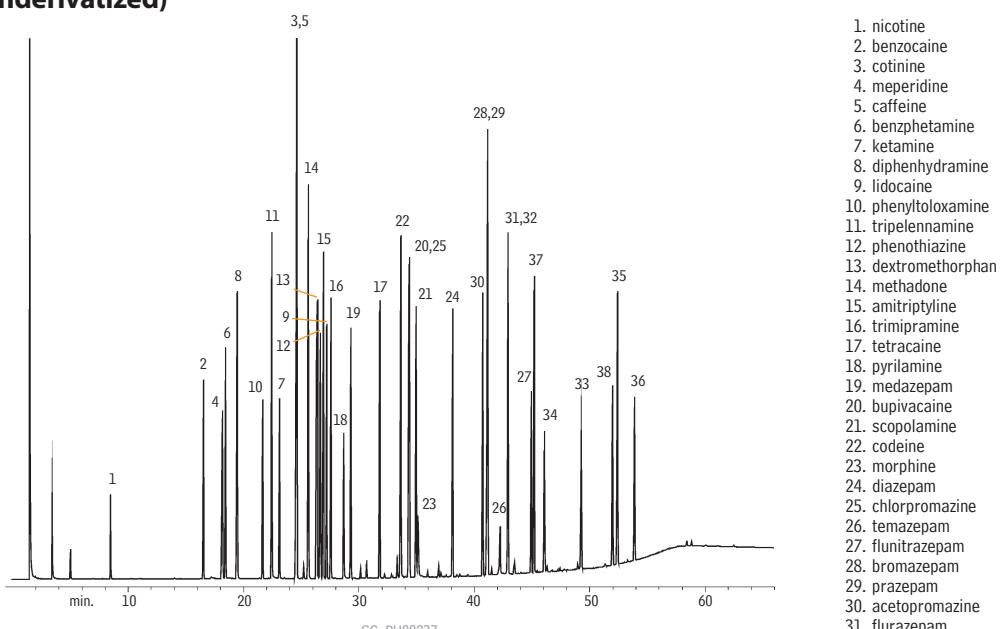


Basic Drugs (Underivatized)

Rtx®-200

Rx

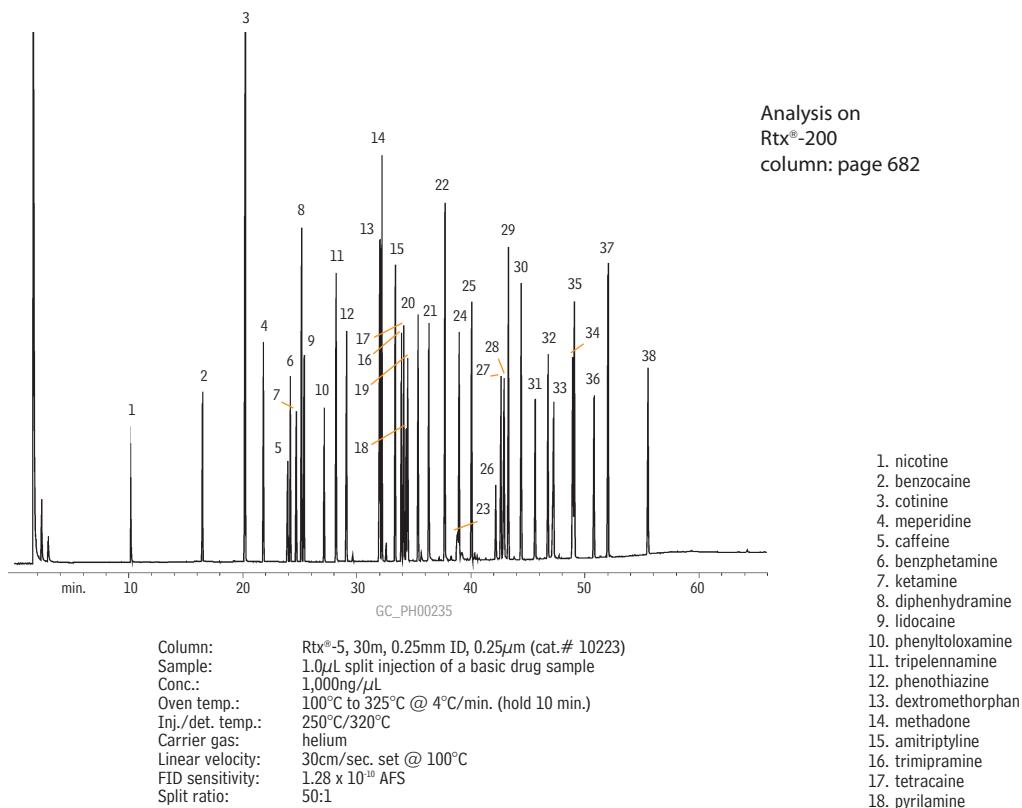
Analysis on
Rtx®-5 and Rtx®-35
columns: page 683.



Column: Rtx®-200, 30m, 0.25mm ID, 0.25 μ m (cat.# 15023)
 Sample: 1.0 μ L split injection of a basic drug sample (1mg/mL)
 Conc.: 1,000ng/ μ L
 Oven temp.: 100°C to 325°C @ 4°C/min. (hold 10 min.)
 Inj./det. temp.: 250°C/320°C
 Carrier gas: helium
 Linear velocity: 30cm/sec. set @ 100°C
 FID sensitivity: 1.28 x 10⁻¹⁰ AFS
 Split ratio: 50:1

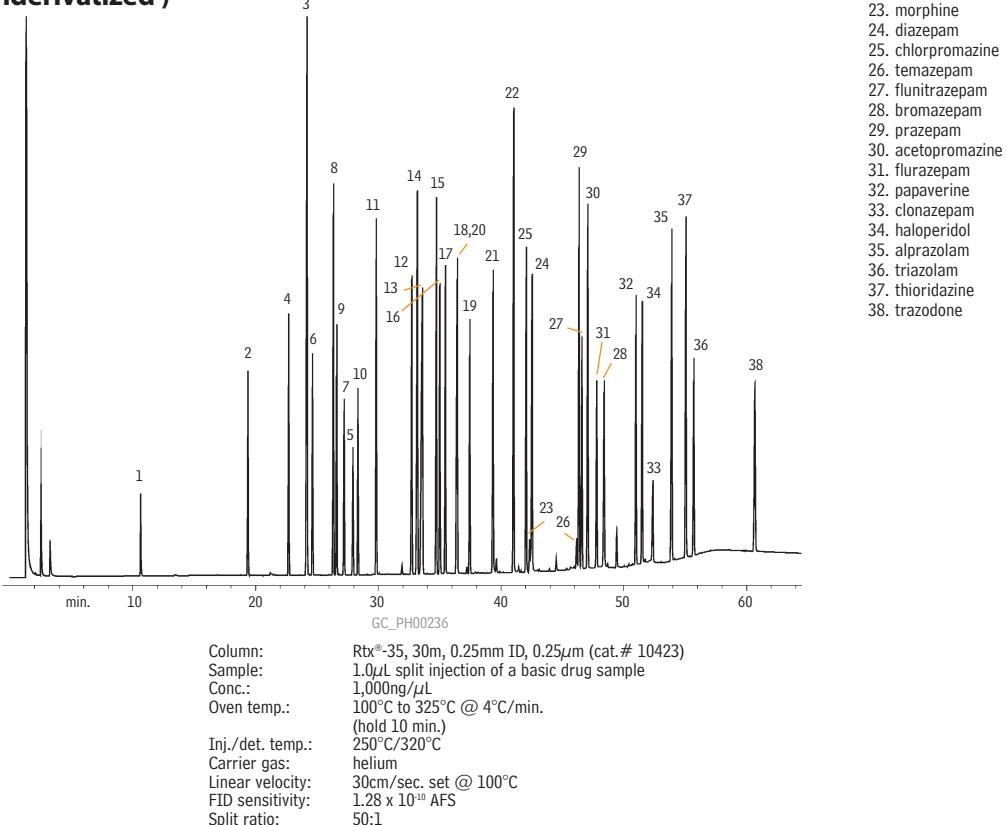
Basic Drugs (Underivatized)

Rtx®-5



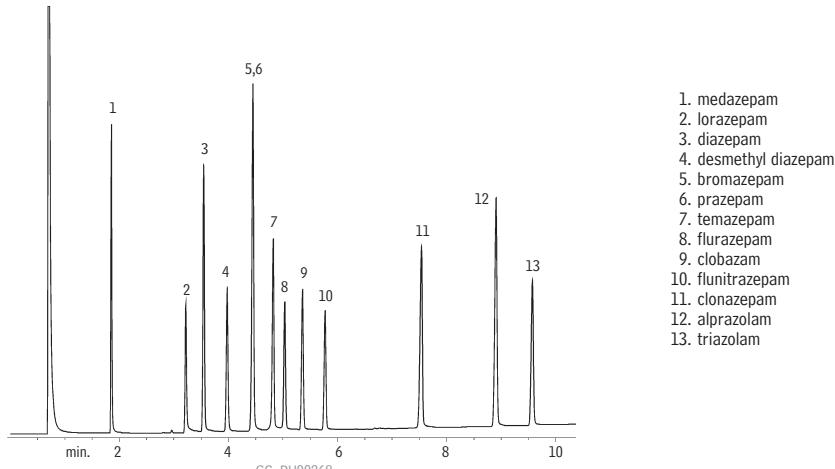
Basic Drugs (Underivatized)

Rtx®-35



GC APPLICATIONS | FORENSIC/PHARMACEUTICAL
Benzodiazepines, Phenothiazines

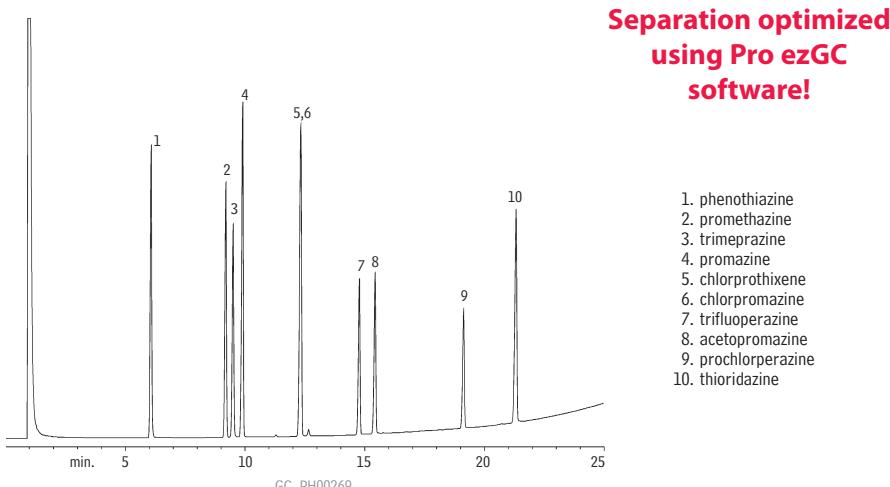
Benzodiazepines (Basic Drugs) (Underivatized)
Rtx®-200



Column: Rtx®-200, 15m, 0.32mm ID, 0.25 μ m (cat.# 15021)
 Sample: 1.0 μ L split injection of benzodiazepines
 Conc.: 15ng/component
 Oven temp.: 225°C to 325°C @ 8°C/min.
 Inj./det. temp.: 250°C/320°C
 Carrier gas: helium
 Linear velocity: 35cm/sec. set @ 225°C
 FID sensitivity: 5.12 x 10⁻¹⁰ AFS
 Split ratio: 60:1

Phenothiazines (Basic Drugs) (Underivatized)

Rtx®-5



Column: Rtx®-5, 15m, 0.32mm ID, 0.50 μ m (cat.# 10236)
 Sample: 1.0 μ L split injection of phenothiazines
 Conc.: 2,000ng/ μ L
 Oven temp.: 200°C to 325°C @ 5°C/min.
 Inj./det. temp.: 250°C/315°C
 Carrier gas: helium
 Linear velocity: 25cm/sec. set @ 200°C
 FID sensitivity: 2.56 x 10⁻¹⁰ AFS
 Split ratio: 30:1

**Separation optimized
using Pro ezGC
software!**



did you know?

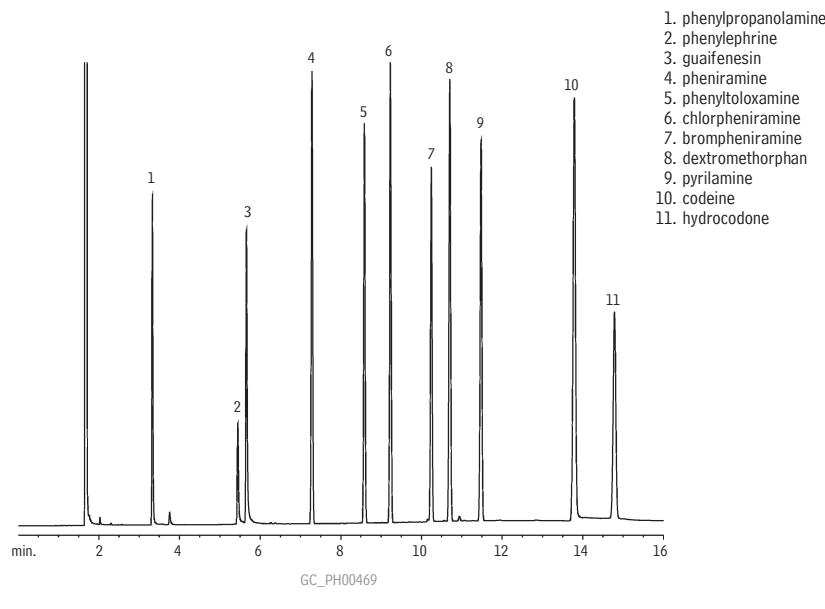
Pro ezGC software will save you time and money by greatly enhancing your productivity and increasing sample throughput.

Pro ezGC™ Method Development Software (cat.# 21487)

See page 580 for details.

Cold Medications (Basic Drugs) (Underivatized)

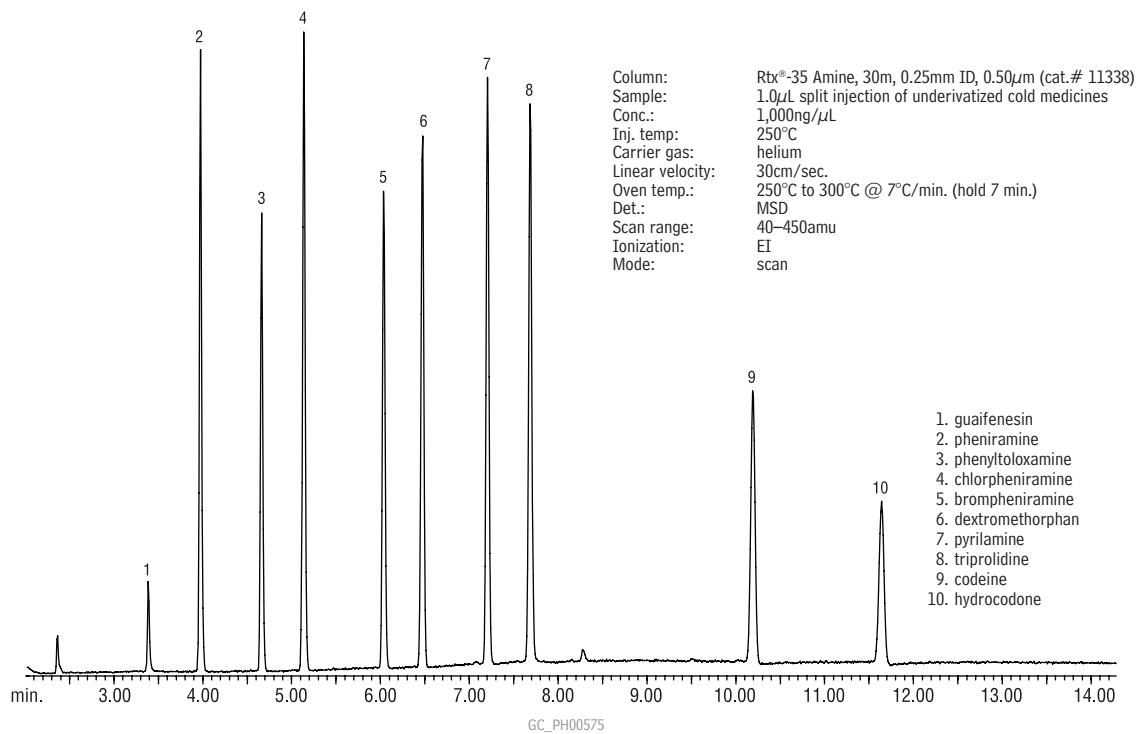
Rtx®-5 Amine



Column: Rtx®-5 Amine, 30m, 0.53mm ID, 1.0 μ m (cat.# 12355)
 Oven temp.: 175°C to 280°C @ 10°/min. (hold 5.5 min.)
 Inj./det. temp.: 250°C/280°C
 Carrier gas: helium
 Linear velocity: 40cm/sec.
 Sample size: 1 μ L
 Split vent flow: 88mL/min.
 Split ratio: 20:1

Cold Medications (Basic Drugs) (Underivatized)

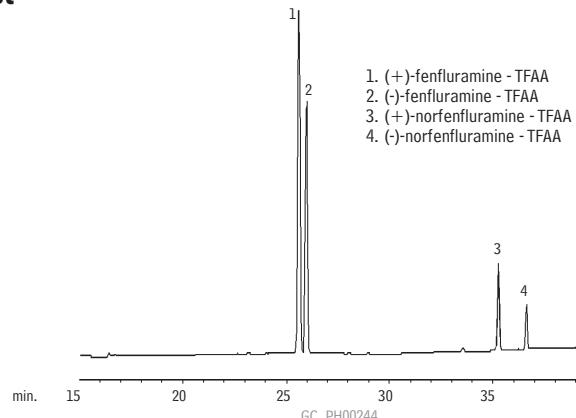
Rtx®-35 Amine



GC APPLICATIONS | PHARMACEUTICAL Chiral Analyses

Fenfluramine (TFAA Derivative)

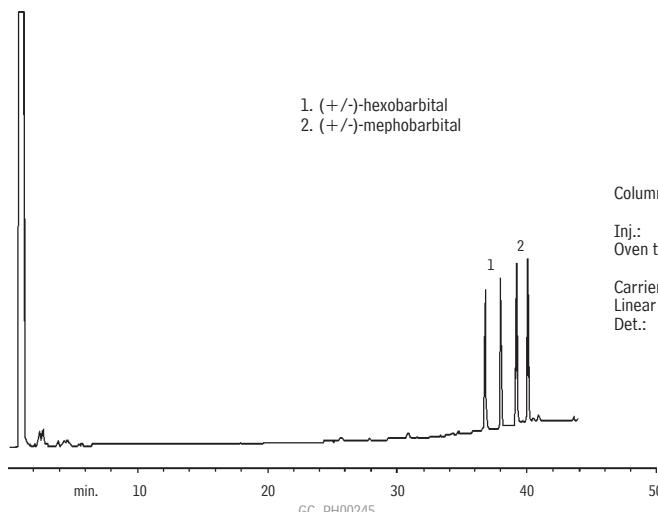
Rt[®]- β DEXcst



Column: Rt[®]- β DEXcst, 30m, 0.32mm ID, 0.25 μ m (cat.# 13102)
Inj.: on-column, 25ng/enantiomer
Oven temp.: 90°C (hold 1 min.) to 200°C @ 2°C/min. (hold 3 min.)
Carrier gas: hydrogen
Linear velocity: 80cm/sec. set @ 60°C
Det.: FID @ 220°C

Barbiturates (Underivatized)

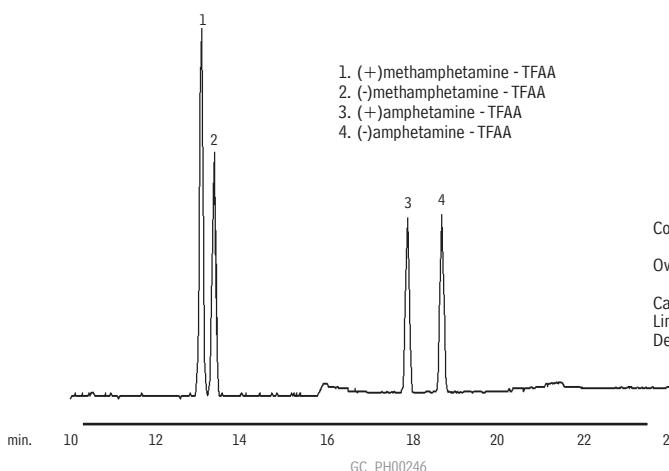
Rt[®]- β DEXcst



Column: Rt[®]- β DEXcst, 30m, 0.32mm ID, 0.25 μ m (cat.# 13102)
Inj.: on-column, 25ng/enantiomer
Oven temp.: 60°C (hold 1 min.) to 220°C @ 3°C/min.
Carrier gas: hydrogen
Linear velocity: 80cm/sec. set @ 60°C
Det.: FID @ 220°C

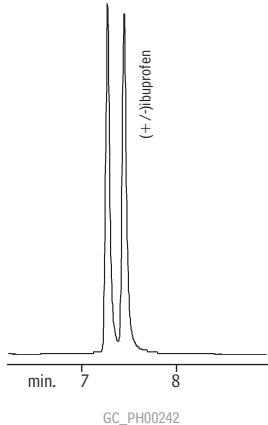
Amphetamine and Methamphetamine (TFAA Derivatives)

Rt[®]- β DEXcst



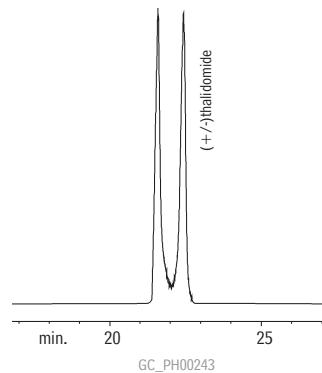
Column: Rt[®]- β DEXcst, 30m, 0.25mm ID, 0.25 μ m (cat.# 13103)
Oven temp.: 120°C (hold 1 min.) to 175°C @ 1.5°C/min.
Carrier gas: helium
Linear velocity: 25cm/sec. set @ 120°C
Det.: MSD @ 220°C

Ibuprofen (Underivatized)
Rt[®]- β DEXsm



Column: Rt[®]- β DEXsm, 30m, 0.32mm ID, 0.25 μ m
 (cat.# 13104)
 Inj.: on-column, 125ng each enantiomer
 Oven temp.: 175°C to 200°C @ 2°C/min.
 Inj./det. temp.: 200°C/230°C
 Carrier gas: helium
 Linear velocity: 60cm/sec.
 Det.: GC/FID
 Split ratio: 13:1 using cup splitter inlet liner (cat.# 20709)

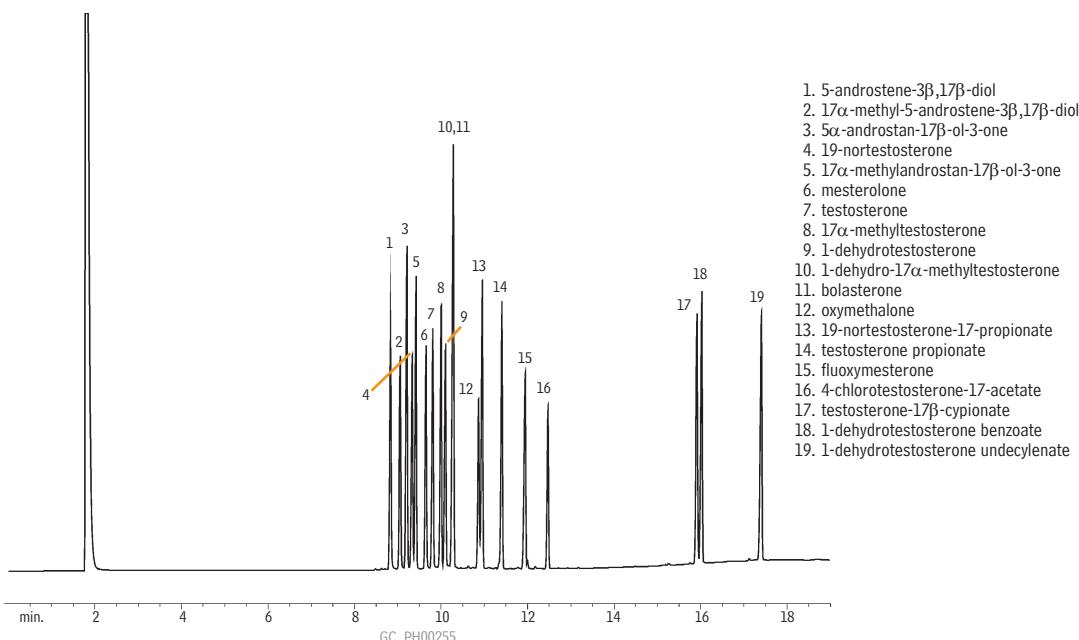
Thalidomide (Underivatized)
Rt[®]- β DEXcst



Column: Rt[®]- β DEXcst, 30m, 0.32mm ID, 0.25 μ m
 (cat.# 13102)
 Inj.: on-column, approximately 15ng each enantiomer
 Oven temp.: 200°C to 230°C @ 1°C/min.
 Inj./det. temp.: 200°C/230°C
 Carrier gas: hydrogen
 Linear velocity: 80cm/sec.
 Det.: GC/FID
 Split ratio: 13:1 using cup splitter inlet liner (cat.# 20709)

Steroids, Anabolic (Underivatized)

Rtx[®]-5



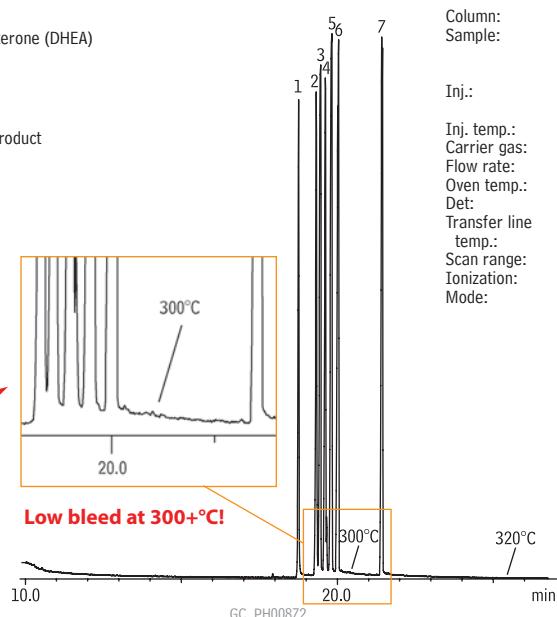
Column: Rtx[®]-5, 30m, 0.25mm ID, 0.10 μ m (cat.# 10208)
 Sample: 0.5 μ L split injection of anabolic steroids
 Conc.: 1,000ng/ μ L
 Oven temp.: 180°C to 340°C @ 10°C/min. (hold 3 min.)
 Inj./det. temp.: 280°C/340°C
 Carrier gas: helium
 Linear velocity: 35cm/sec. set @ 180°C
 FID sensitivity: 1.28 x 10⁻¹⁰ AFS
 Split ratio: 50:1

GC APPLICATIONS | PHARMACEUTICAL Steroids, PGIs

Steroids: Sex Hormones Rxi®-1ms

1. androsterone
2. dehydroepiandrosterone (DHEA)
3. 17- α -estradiol
4. estrone
5. 17- β -estradiol
6. testosterone
7. derivatization by-product

Excellent resolution of closely eluting hormones.



Column: Rxi®-1ms, 30m, 0.25mm ID, 0.25 μ m (cat.# 13323)
 Sample: 100 μ g/mL each hormone in methanol or ethanol; compounds derivatized using 2% methoxylamine HCl (CH₃ONH₂) in pyridine, then N-trimethylsilylimidazole (TMSI), then analyzed
 Inj.: 1.0 μ L splitless (hold 0.5 min.), 3.5mm single gooseneck inlet liner (cat.# 20961)
 Inj. temp.: 250°C
 Carrier gas: helium, constant flow
 Flow rate: 1mL/min.
 Oven temp.: 100°C to 320°C @ 10°C/min. (hold 10 min.)
 Det: MS: Shimadzu 17A with QP5000
 Transfer line temp.: 280°C
 Scan range: 40-700amu
 Ionization: EI
 Mode: scan

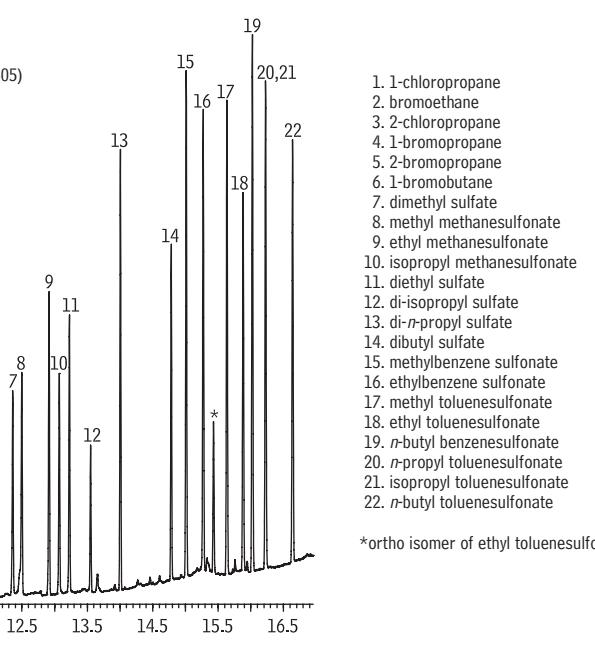
Rxi® Technology!

Exceptionally inert,
ultra low-bleed
capillary columns.

Potential Genotoxic Impurities (PGIs) Rtx®-200



Column: Rtx®-200, 30m, 0.25mm ID, 1.0 μ m (cat.# 15053)
 Sample: 100 μ g/mL each compound in 90:10 acetonitrile:water
 Inj.: 1 μ L, split (10:1), 4mm single gooseneck inlet liner w/ wool (cat.# 22405)
 Inj. temp.: 220°C
 Carrier gas: helium, constant flow
 Flow rate: 1.0mL/min.
 Oven temp.: 40°C (hold 8.3 min.) to 70°C @ 70°C/min. to 115°C @ 40°C/min. to 250°C @ 30°C/min. to 300°C @ 15°C/min. (hold 3 min.)
 Det: MS
 Transfer line temp.: 280°C
 Scan range: 20-250m/z
 Ionization: EI
 Mode: scan

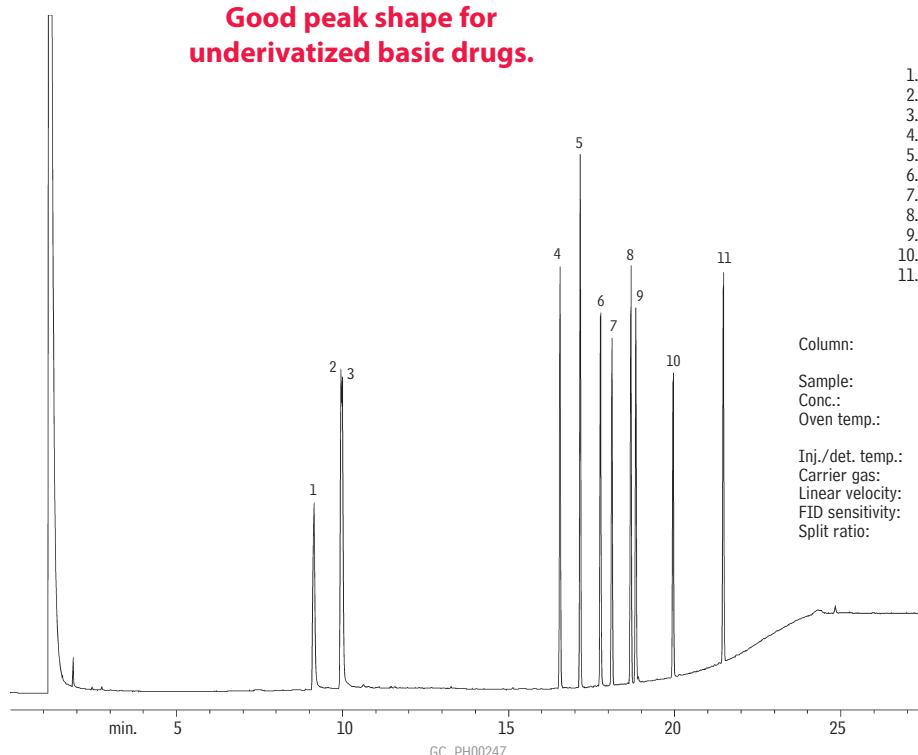


1. 1-chloropropane
2. bromoethane
3. 2-chloropropane
4. 1-bromopropane
5. 2-bromopropane
6. 1-bromobutane
7. dimethyl sulfate
8. methyl methanesulfonate
9. ethyl methanesulfonate
10. isopropyl methanesulfonate
11. diethyl sulfate
12. di-isopropyl sulfate
13. di-n-propyl sulfate
14. dibutyl sulfate
15. methylbenzene sulfonate
16. ethylbenzene sulfonate
17. methyl toluenesulfonate
18. ethyl toluenesulfonate
19. n-butyl benzenesulfonate
20. n-propyl toluenesulfonate
21. isopropyl toluenesulfonate
22. n-butyl toluenesulfonate

*ortho isomer of ethyl toluenesulfonate

Underivatized Antihistamines (Basic Drugs)
Rtx®-5 Amine

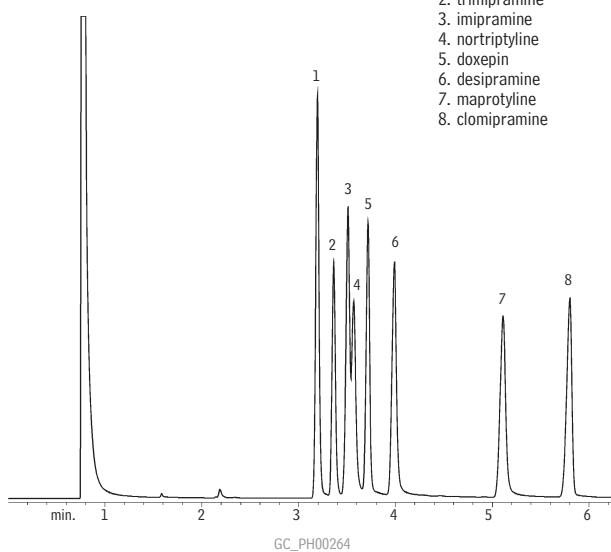
Good peak shape for underivatized basic drugs.



1. phenylpropanolamine
2. ephedrine
3. pseudoephedrine
4. pheniramine
5. diphenhydramine
6. doxylamine
7. phenyltoloxamine
8. methapyrilene
9. chlorpheniramine
10. brompheniramine
11. triprolidine

Column: Rtx®-5 Amine, 30m, 0.32mm ID, 1.0 μ m (cat.# 12354)
Sample: 1.0 μ L split injection of antihistamines
Conc.: 1,000ng/ μ L
Oven temp.: 130°C (hold 5 min.) to 305°C (@ 10°C/min. hold 5 min.)
Inj./det. temp.: 305°C
Carrier gas: hydrogen
Linear velocity: 43cm/sec. set @ 130°C
FID sensitivity: 6.4 x 10⁻¹¹ AFS
Split ratio: 50:1

Antidepressants (Basic Drugs) (Underivatized)
Rtx®-1701



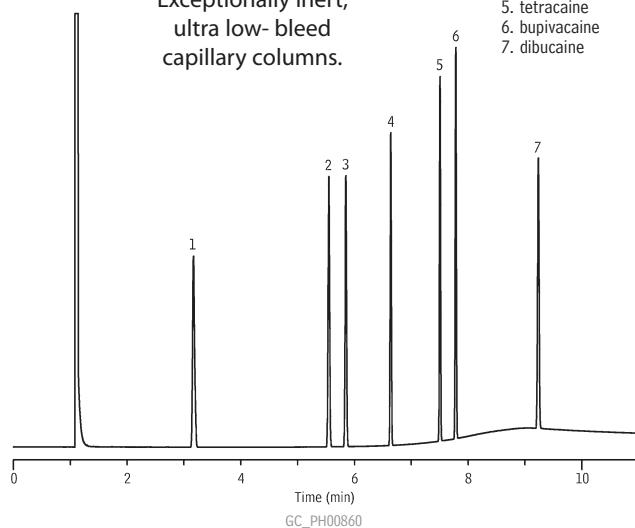
1. amitriptyline
2. trimipramine
3. imipramine
4. nortriptyline
5. doxepin
6. desipramine
7. maprotiline
8. clomipramine

Column: Rtx®-1701, 15m, 0.25mm ID, 0.25 μ m (cat.# 12020)
Sample: 1.0 μ L split injection of antidepressants
Conc.: 25ng/component
Oven temp.: 225°C
Inj./det. temp.: 250°C/260°C
Carrier gas: helium
Linear velocity: 30cm/sec. set @ 225°C
FID sensitivity: 2.56 x 10⁻¹⁰ AFS
Split ratio: 40:1

Local Anesthetics
Rxi®-5ms

Rxi® Technology!

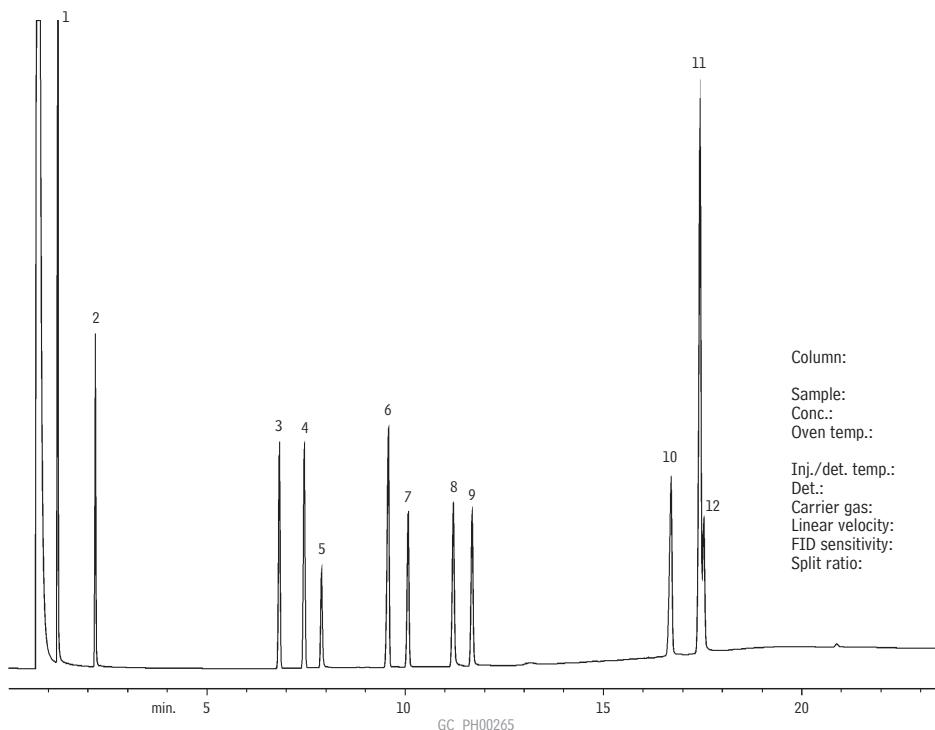
Exceptionally inert,
ultra low-bleed
capillary columns.



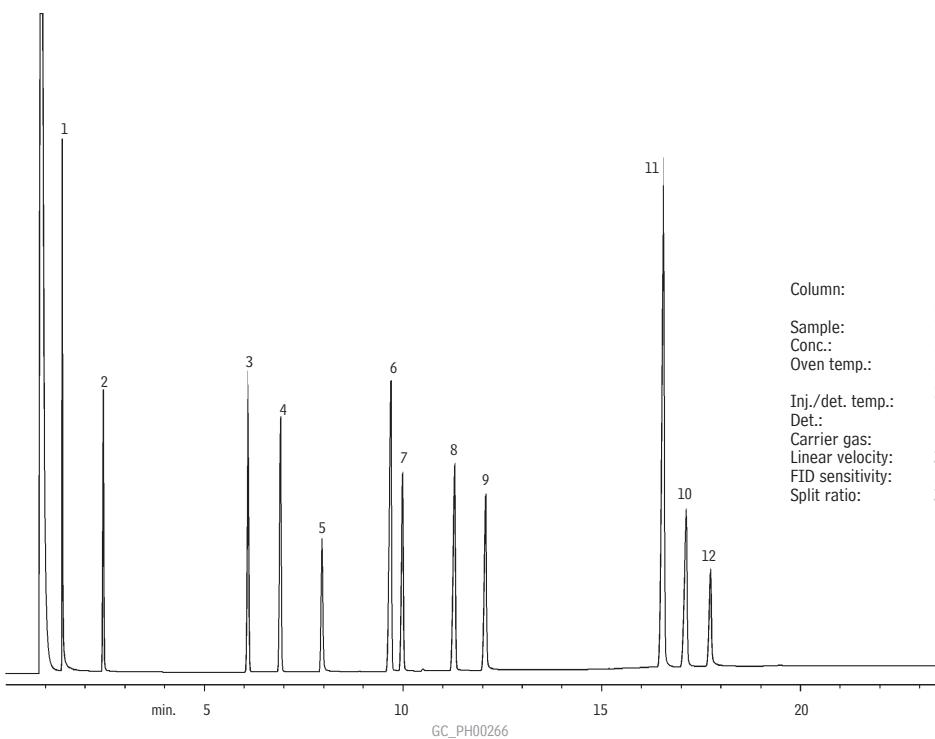
1. benzocaine
2. prilocaine
3. lidocaine
4. procaine
5. tetracaine
6. bupivacaine
7. dibucaine

Column: Rxi®-5ms, 30m, 0.53mm ID, 1.00 μ m (cat.# 13455)
Sample: 50 μ g/mL each component in methanol
Inj.: 1.0 μ L split (10:1), 4mm split inlet liner with wool (cat.# 20781)
Inj. temp.: 250°C
Carrier gas: helium, constant flow
Flow rate: 5.0mL/min.
Oven temp.: 200°C (hold 4 min.) to 320°C @ 30°C/min. (hold 3 min.)
Det.: FID @ 300°C

Antiepileptics (Underivatized)
Rtx®-20



Antiepileptics (Underivatized)
Rtx®-1701



Organic Volatile Impurities: Retention Time Index

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®-I: 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®-I 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
methyleneethyl 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	14.29	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	14.17	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-diethoxypropane	—	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
isooctane	—	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

GC APPLICATIONS | PHARMACEUTICAL

Organic Volatile Impurities/Residual Solvents

Residual Solvents Class 1

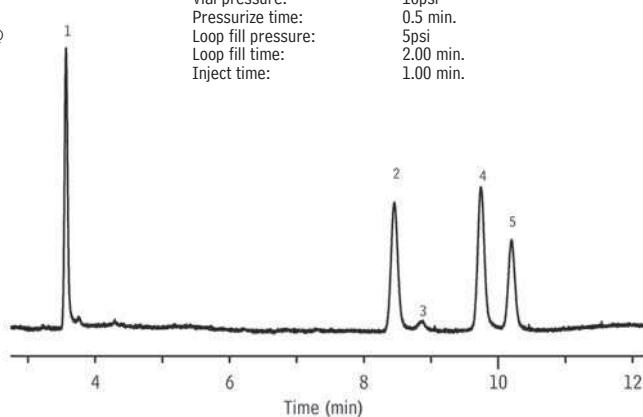
Rtx®-1301

Column: Rtx®-1301, 30m, 0.32mm ID, 1.8 μ m (cat.# 16092)
 Sample: USP <467> Class 1 standard solution (cat.# 36279) in 20mL headspace vial
 Inj.: headspace injection (split ratio 1:5), 1mm split liner, Siltek® deactivated (cat.# 20972-214.1)
 Inj. temp.: 140°C
 Carrier gas: helium, constant flow
 Flow rate: 2.16mL/min., 35.3cm/sec.
 Oven temp.: 40°C for 20 min. to 240°C @ 10°C/min. (hold for 20 min.)
 Det.: FID @ 240°C

Headspace Conditions
 Instrument: Tekmar HT3
 Transfer line temp.: 105°C
 Valve oven temp.: 105°C
 Sample temp.: 80°C
 Sample equil. time: 45 min.
 Vial pressure: 10psi
 Pressurize time: 0.5 min.
 Loop fill pressure: 5psi
 Loop fill time: 2.00 min.
 Inject time: 1.00 min.

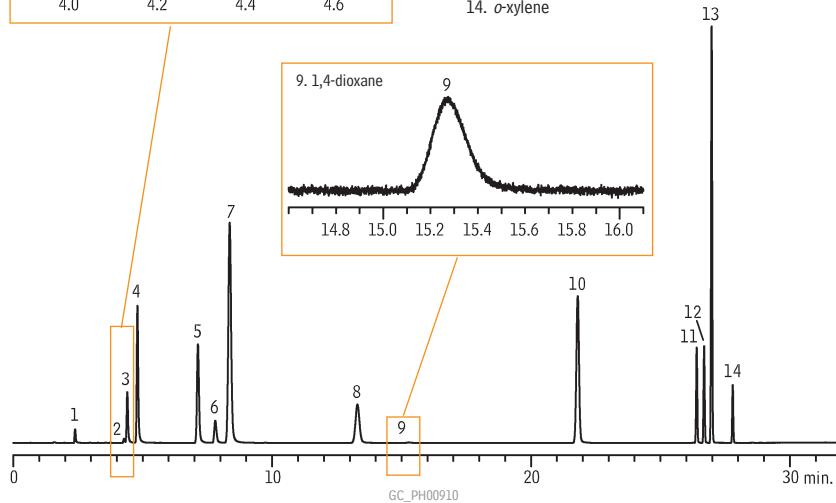
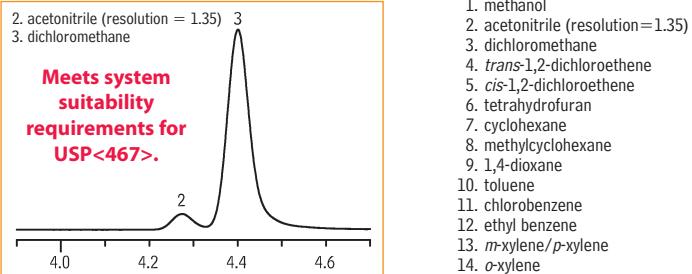
- 1. 1,1-dichloroethene
- 2. 1,1,1-trichloroethane
- 3. carbon tetrachloride
- 4. benzene
- 5. 1,2-dichloroethane

GC_PH00909



Residual Solvents Class 2 Mixture A

Rtx®-1301



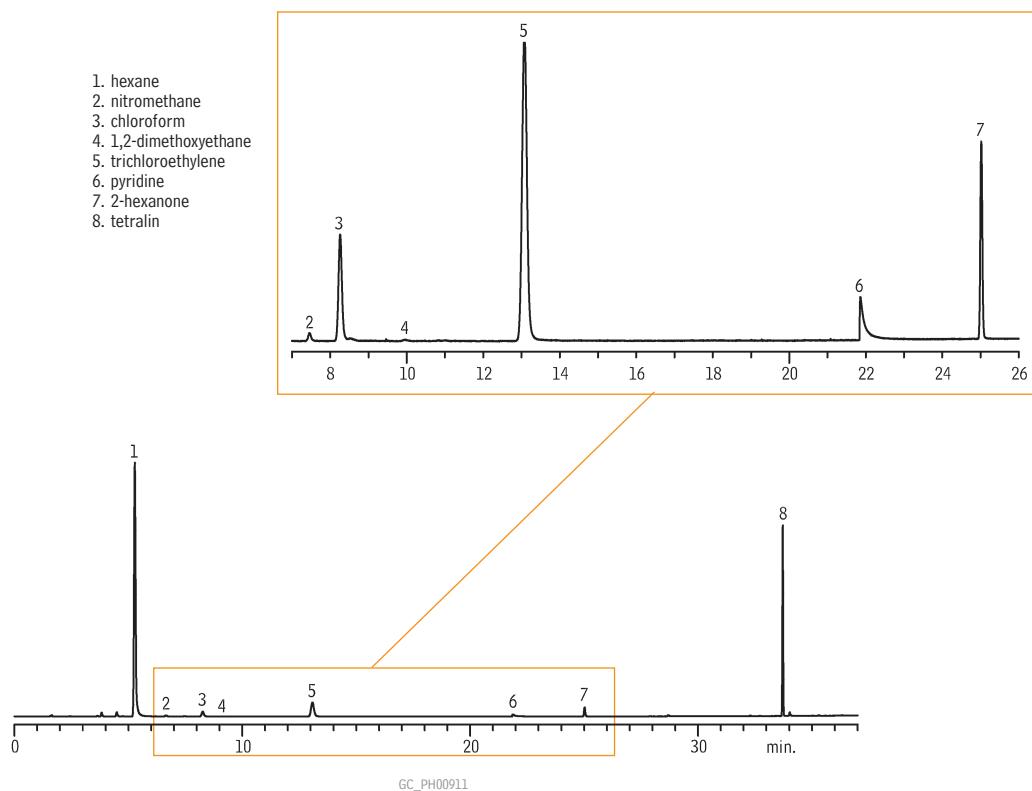
Column: Rtx®-1301, 30m, 0.32 ID, 1.8 μ m (cat.# 16092)
 Sample: USP <467> Class 2 Mixture A standard solution (cat.# 36271) in 20mL headspace vial
 Inj.: headspace injection (split ratio 1:5), 1mm split liner, Siltek® deactivated (cat.# 20972-214.1)
 Inj. temp.: 140°C
 Carrier gas: helium, constant flow
 Flow rate: 2.16mL/min., 35.3cm/sec.
 Oven temp.: 40°C for 20 min. to 240°C @ 10°C/min. (hold for 20 min.)
 Det.: FID @ 240°C

Headspace Conditions
 Instrument: Tekmar HT3
 Transfer line temp.: 105°C
 Valve oven temp.: 105°C
 Sample temp.: 80°C
 Sample equil. time: 45 min.
 Vial pressure: 10psi
 Pressurize time: 0.5 min.
 Loop fill pressure: 5psi
 Loop fill time: 2.00 min.
 Inject time: 1.00 min.



Residual Solvents Class 2 Mixture B

Rtx®-1301



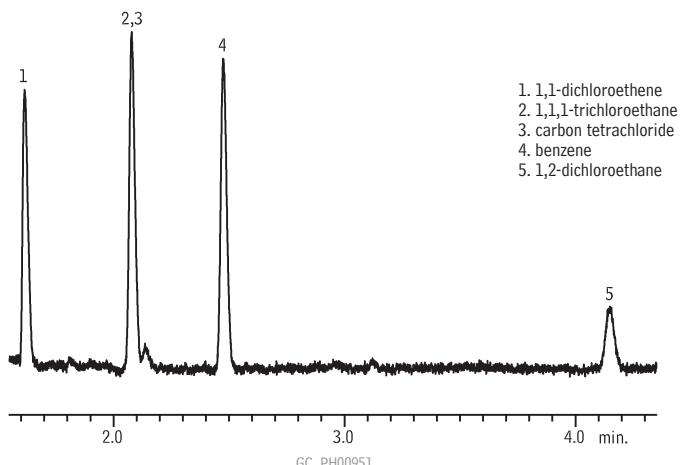
Column:	Rtx®-1301, 30m, 0.32mm ID, 1.8 μ m (cat.# 16092)	Headspace Conditions	
Sample:	USP <467> Class 2 Mixture B standard solution (cat.# 36280) in 20mL headspace vial	Instrument:	Tekmar HT3
Inj.:	headspace injection (split ratio 1:5), 1mm split liner Sritek® deactivated (cat.# 20972-214.1)	Transfer line temp.:	105°C
Inj. temp.:	140°C	Valve oven temp.:	105°C
Carrier gas:	helium, constant flow	Sample temp.:	80°C
Flow rate:	2.16mL/min., 35.3cm/sec.	Sample equil. time:	45 min.
Oven temp.:	40°C for 20 min. to 240°C @ 10°C/min. (hold for 20 min.)	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.



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GC APPLICATIONS | PHARMACEUTICAL
Organic Volatile Impurities/Residual Solvents

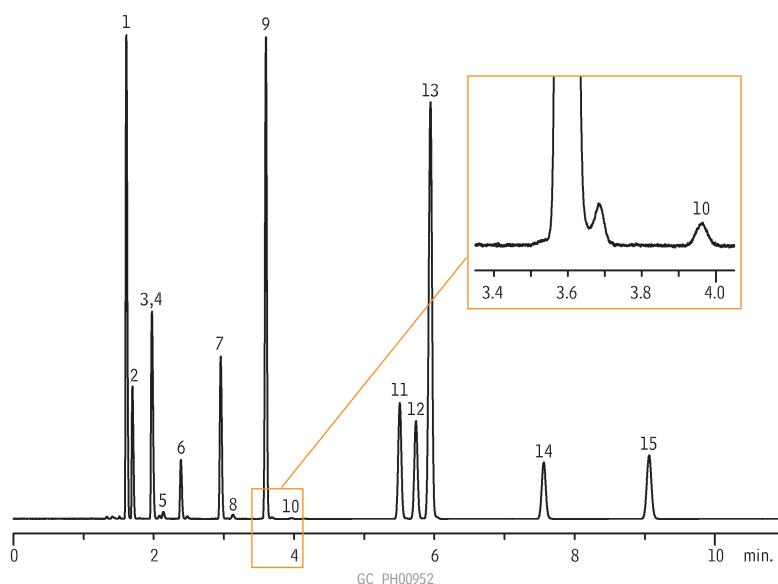
Residual Solvents Class 1
Stabilwax® (G16)



Column: Stabilwax®, 30m, 0.32mm ID, 0.25 μ m (cat.# 10624) Headspace Conditions
 Sample: USP Stock Mixture USP<467> Residual Instrument: Overbrook Scientific HT200H
 Solvents Class 1 Mix (cat.# 36279) in Syringe temp.: 100°C
 20mL headspace vial (cat.# 24685), Sample temp.: 80°C
 water diluent Sample equil. time.: 45 min.
 Inj.: headspace injection (split ratio 1:5), Injection vol.: 1.0mL
 2mm splitless liner IP deactivated Injection speed: setting 8
 (cat.# 20712) Injection dwell: 5 sec.

Inj. temp.: 140°C
 Carrier gas: helium, constant flow
 Flow rate: 2.15mL/min., 35.2cm/sec.
 Oven temp.: 50°C for 20 min. to 165°C @ 6°C/min.
 (hold for 20 min.)
 Det.: FID @ 250°C

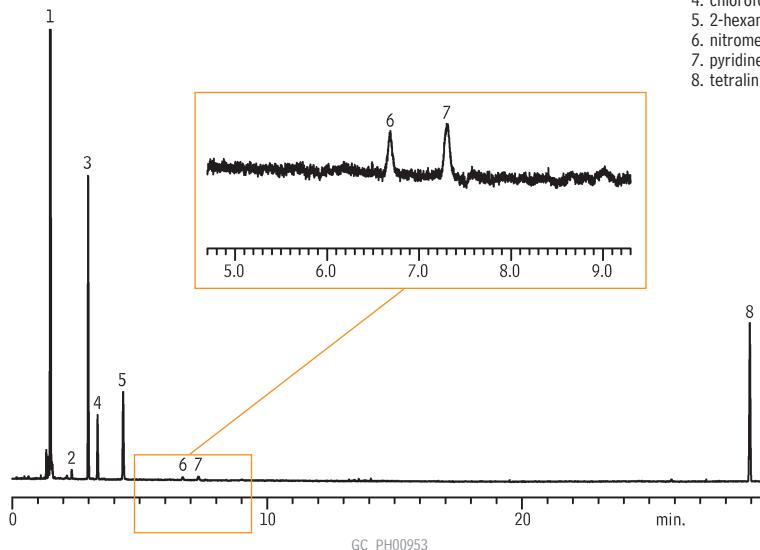
Residual Solvents Class 2
Stabilwax® (G16)



1. cyclohexane
2. methylcyclohexane
3. *trans*-1,2-dichloroethene
4. tetrahydrofuran
5. methanol
6. dichloromethane
7. *cis*-1,2-dichloroethene
8. acetonitrile
9. toluene
10. 1,4-dioxane
11. ethyl benzene
12. *p*-xylene
13. *m*-xylene
14. *o*-xylene
15. chlorobenzene

Column: Stabilwax®, 30m, 0.32mm ID, 0.25 μ m (cat.# 10624)
 Sample: USP Stock Standard Residual Solvents Headspace Conditions
 Class 2 Mix A (cat.# 36271) in 20mL headspace Instrument: Overbrook Scientific HT200H
 vial (cat.# 24685), water diluent Syringe temp.: 100°C
 Inj.: headspace injection (split ratio 1:5), 2mm Sample temp.: 80°C
 splitless liner IP deactivated (cat.# 20712) Sample equil. time.: 45 min.
 Inj. temp.: 140°C Injection vol.: 1.0mL
 Carrier gas: helium, constant flow Injection speed: setting 8
 Flow rate: 2.15mL/min., 35.2cm/sec. Injection dwell: 5 sec.
 Oven temp.: 50°C for 20 min. to 165°C @ 6°C/min.
 (hold for 20 min.)
 Det.: FID @ 250°C

Organic Volatile Impurities/Residual Solvents

**Residual Solvents Class 2
Stabilwax® (G16)**


1. hexane
2. 1,2-dimethoxyethane
3. trichloroethylene
4. chloroform
5. 2-hexanone
6. nitromethane
7. pyridine
8. tetralin

Column: Stabilwax®, 30m, 0.32mm ID, 0.25 μ m (cat.# 10624)
 Sample: USP Stock Standard Residual Solvents Class 2 Mix B (cat.# 36272) in 20mL headspace vial (cat.# 24685), water diluent
 Inj.: Inj. temp.: 140°C
 Carrier gas: helium, constant flow
 Flow rate: 2.15mL/min., 35.2cm/sec.
 Oven temp.: 50°C for 20 min. to 165°C @ 6°C/min.
 (hold for 20 min.)
 Det.: FID @ 250°C

Headspace Conditions
 Instrument: Overbrook Scientific HT200H
 Syringe temp.: 100°C
 Sample temp.: 80°C
 Sample equil. time.: 45 min.
 Injection vol.: 1.0mL
 Injection speed: setting 8
 Injection dwell: 5 sec.



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GC APPLICATIONS | PHARMACEUTICAL

Organic Volatile Impurities/Residual Solvents

Organic Volatile Impurities

Rtx®-200 & Rtx®-WAX (GCxGC)



Columns: Rtx®-200, 60m, 0.25mm ID, 1.0 μ m (cat. # 15056)
 Rtx®-Wax, 2m, 0.18mm ID, 0.3 μ m (custom)
 Sample: 0.2 μ L mix of 69 neat organic volatile impurities
 Instrument: Agilent 6890 with LECO liquid nitrogen cryojet modulator
 Inj.: split/splitless, split ratio 600:1; gas saver: 20mL/min. after 1 min.;
 4mm ID split inlet liner w/wool (cat.# 20781); injection with band formation (fast injection)
 Inj. temp.: 250°C
 Carrier gas: helium, constant flow
 Flow rate: 1.5mL/min.
 Oven temp.: Rtx®-200: 35°C (9 min.) to 220°C @ 3°C/min. (hold 1 min.);
 Rtx®-Wax: 65°C (9 min.) to 250°C @ 3°C/min. (hold 1 min.)
 Modulation: modulator offset: 30°C; 2nd dimension separation: 4 sec.; hot pulse: 0.3 sec.;
 cool between stages: 1.7 sec.
 Det.: FID @ 250°C; hydrogen: 40mL/min.; air: 450mL/min.; make-up gas: 45mL/min.; sampling rate: 200Hz

did you **know?**

GCxGC Separations

Separation of the complete list of International Conference on Harmonization Class 1, Class 2, and Class 3 organic volatiles requires at least two, and often three, separate analyses on differing capillary GC columns. While many laboratories do not monitor for the complete list, separation of OVIs still is a challenge, often characterized by long runtimes and incomplete separations.

Using comprehensive GC_xGC, it is possible to resolve all of these target compounds, in a single analysis, with less than a 1-hour run time. In this approach, results for which are shown above, two columns of differing selectivity are used to separate the compounds in a 2-dimensional plot. Various detectors also can be employed, including time-of-flight mass spectrometry, to yield reliable information for the entire target compound list in a single analysis.

For more about GCxGC, visit our website and review the article on pages 4-5 of **Restek Advantage 2005, vol. 1** ([lit. cat. # 59077](#)), or enter GCxGC in the search feature.

GC APPLICATIONS | PHARMACEUTICAL

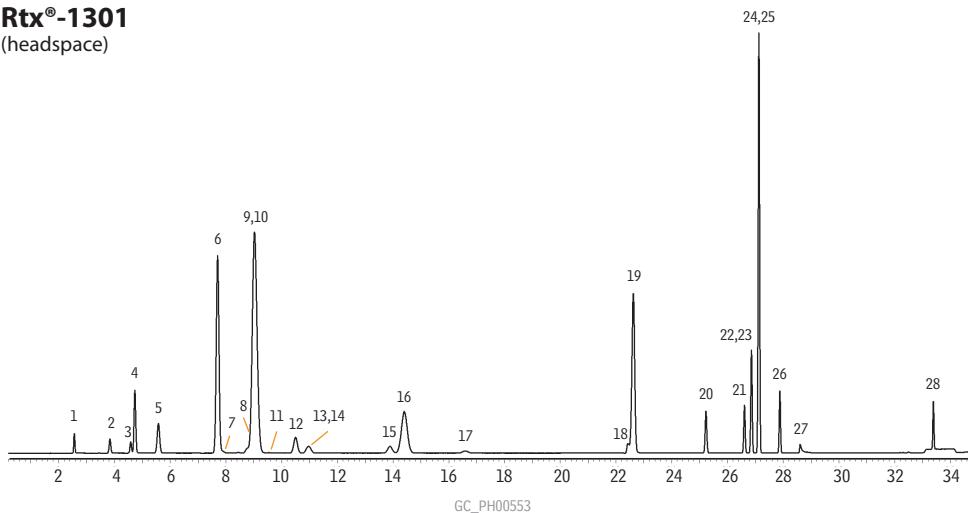
Organic Volatile Impurities/Residual Solvents

Residual Solvents

European Pharmacopoeia Class 1 and Class 2

Rtx®-1301

(headspace)



1. methanol
2. 1,1-dichloroethene
3. acetonitrile
4. methylene chloride (dichloromethane)
5. hexane (C6)
6. *cis*-1,2-dichloroethene
7. nitromethane
8. chloroform
9. cyclohexane
10. 1,1,1-trichloroethane
11. carbon tetrachloride
12. benzene
13. 1,2-dimethoxyethane
14. 1,2-dichloroethane
15. trichloroethylene (1,1,2-trichlorethane)
16. methylcyclohexane
17. 1,4-dioxane
18. pyridine
19. toluene
20. 2-hexanone
21. chlorobenzene
22. DMF
23. ethylbenzene
24. *m*-xylene
25. *p*-xylene
26. *o*-xylene
27. N,N-dimethylacetamide
28. 1,2,3,4-tetrahydronaphthalene

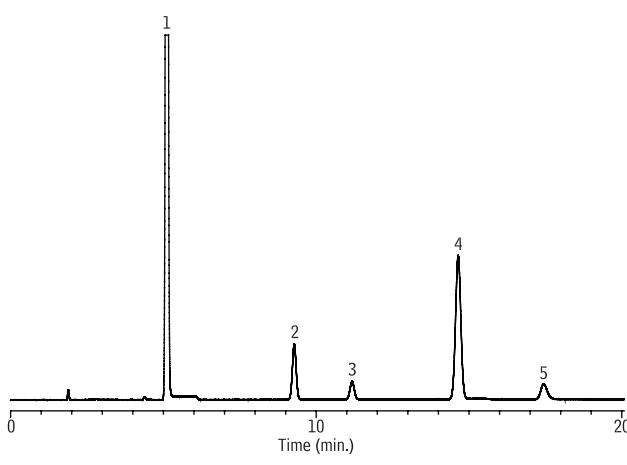
Column: Rtx®-1301, 30m, 0.53mm ID x 3.0 μ m (cat.# 16085)
 Sample: headspace injection of 28 Class 1 and 2 residual solvents for pharmaceutical processing, prepared at the regulatory limit concentration, using samples shaken and heated at 80°C for 15 min., 1mL headspace injection
 Oven temp.: 40°C (hold 20 min.) to 240°C @ 10°C/min. (hold 20 min.)
 Inj./det. temp.: 200°C/250°C
 FID sensitivity: 1.1 x 10¹¹ AFS
 Carrier gas: hydrogen @ 35cm/sec.
 Split ratio: 2:1

Organic Volatile Impurities

USP <467>

Rtx®-G43

(static headspace)



Column: Rtx®-G43, 30m, 0.53mm ID, 3.0 μ m (cat.# 16085-126)
 Sample: USP <467> Calibration Mixture #5 (cat.# 36007) in DMSO stock standard. To each 22mL headspace vial 5ml water, ~ 1.0g of sodium sulfate and 100 μ L of stock standard were added.
 The preparation yielded the following concentrations,

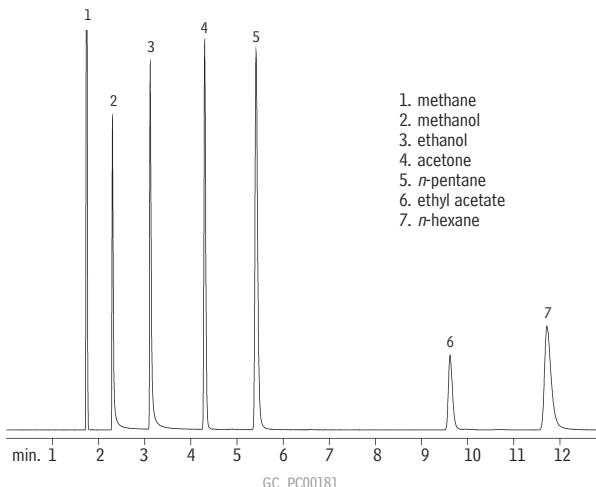
	Retention Time (min.)	Sample Concentration (μ g/mL)
1. dichloromethane	5.110	12.0
2. chloroform	9.285	1.2
3. benzene	11.173	0.04
4. trichloroethylene	14.647	1.6
5. 1,4-dioxane	17.436	7.6

Inj.: static headspace injection (see static headspace conditions)
 Inj. temp.: 180°C
 Carrier gas: helium, split 2:1
 Linear velocity: 5mL/min., constant flow
 Oven temp.: 40°C for 20 min. to 240°C at 25°C/min. (hold for 10 min.)
 Det.: FID @ 250°C
 hydrogen flow: 40mL/min.
 air flow: 450mL/min.
 make-up flow: 45mL/min.

Static Headspace (Loop) Conditions:
 Instrument: Teledyne Tekmar HT3
 Valve oven temp.: 150°C
 Transfer line temp.: 150°C
 Standby flow rate: 10mL/min.
 Platen/sample temp.: 80°C
 Platen temp equil. time: 2.00 min.
 Sample equil. time: 15.00 min.
 Mixer time: 2.00 min.
 Mixing level: 5
 Mixer stabilize time: 0.50 min.
 Pressurize: 15psi
 Pressurize time: 2.00 min.
 Pressurize equil. time: 0.50 min.
 Loop fill pressure: 5psi
 Loop fill time: 2.00 min.
 Loop fill equil. time: 0.50 min.
 Trieft time: 1.00 min.

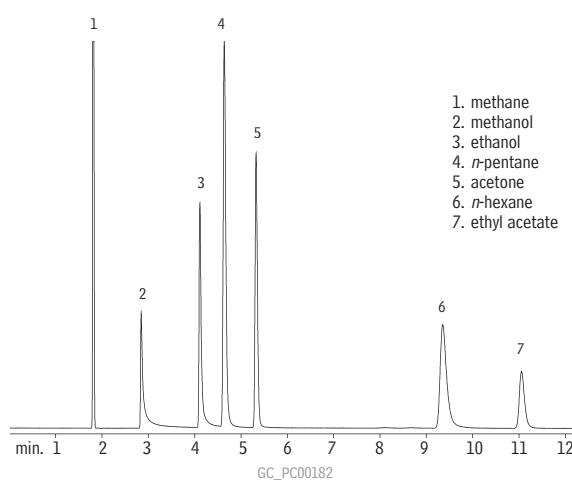
Solvents

Solvents, Polar Rt[®]-QPLOT



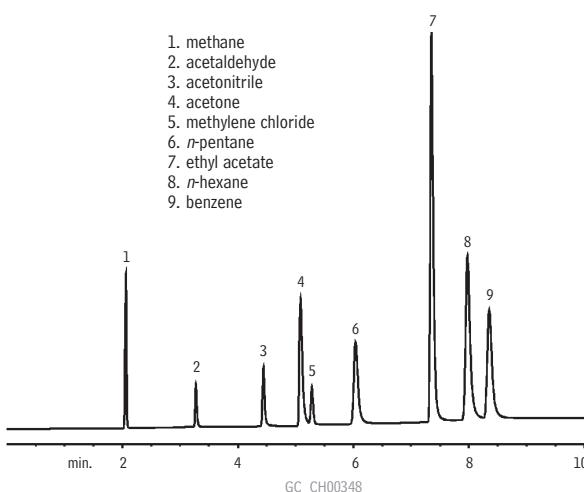
Column: Rt[®]-QPLOT, 30m, 0.32mm ID (cat.# 19718)
Sample: 20 μ L split injection. 50ppm (w/v) each in helium,
Cyclosplitter[®] inlet liner (cat.# 20755)
Oven temp.: 150°C
Inj./det. temp.: 200°C
Carrier gas: hydrogen
Det.: FID
Split ratio: 20/1

Solvents, Polar Rt[®]-UPLOT



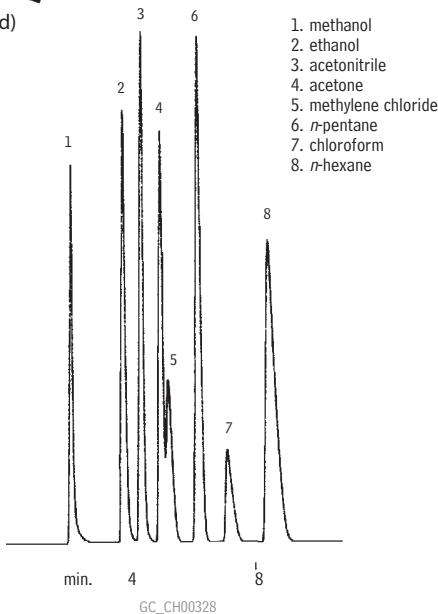
Column: Rt[®]-UPLOT, 30m, 0.32mm ID (cat.# 19724)
Sample: 20 μ L split injection. 50ppm (w/v) each in helium,
Cyclosplitter[®] inlet liner (cat.# 20755)
Oven temp.: 150°C
Inj./det. temp.: 200°C
Carrier gas: hydrogen
Detector: FID
Split ratio: 20/1

Solvents Rt[®]-QPLOT



Column: Rt[®]-QPLOT, 30m, 0.53mm ID (cat.# 19716)
Sample: 70 μ L split injection of solvent mixture
Oven temp.: 100°C to 220°C @ 15°C/min. (hold 2 min.)
Inj./det. temp.: 220°C
Carrier gas: helium
Linear velocity: 23.6cm/sec. set @ 100°C
FID sensitivity: 1.28 x 10¹⁰ AFS
Split ratio: 7.7:1
Split: 44.5cc/min.
Column flow: 6.6cc/min.

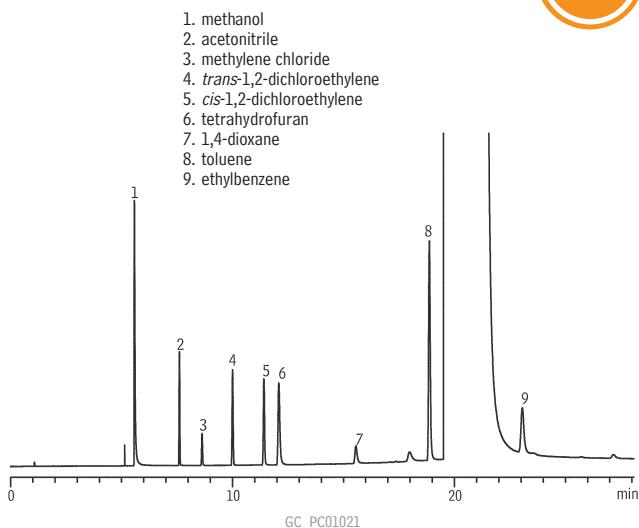
Solvents HayeSep[®] Q (micropacked)



Column: HayeSep[®] Q, 2m, 1mm ID (cat.# 19017)
Sample: 1 μ L direct injection of a neat solvent mixture
Oven temp.: 80°C to 180°C @ 16°C/min. (hold 5 min.)
Inj./det. temp.: 200°C
Carrier gas: helium
Flow: 20mL/min. set @ 40°C
FID sensitivity: 512 x 10¹¹ AFS

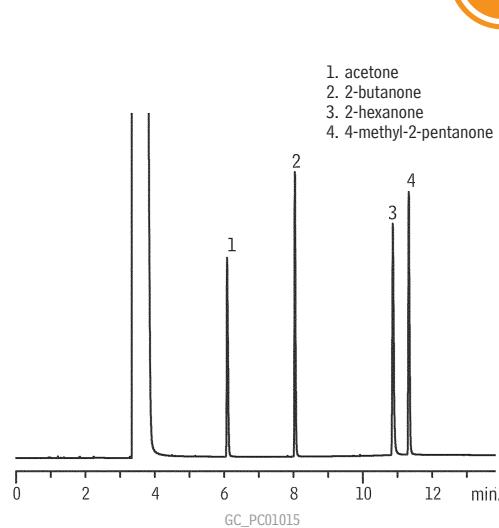


Solvents Rt[®]-QS-BOND



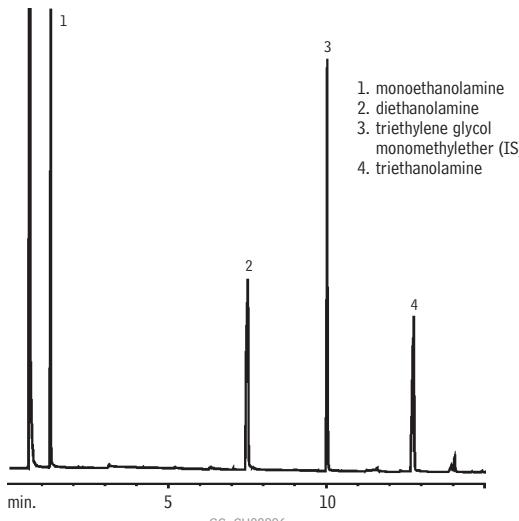
Column: Rt[®]-QS-BOND, 30m, 0.53mm ID (cat.# 19738)
Sample: 100-1,000 μ g/mL solvent mix in DMSO:water, 60:40 (v/v)
Inj.: 1 μ L split (split ratio 5:1), 4mm Siltek[®] single gooseneck liner (cat.# 20798-214.1)
Inj. temp.: 240°C
Carrier gas: helium, constant flow
Flow rate: 5.7mL/min. @ 40°C
Oven temp.: 40°C (hold 0.5min.) to 120°C @ 15°C/min. to 200°C @ 5°C/min. (hold 10 min.)
Det.: FID @ 240°C

Ketones Rt[®]-QS-BOND



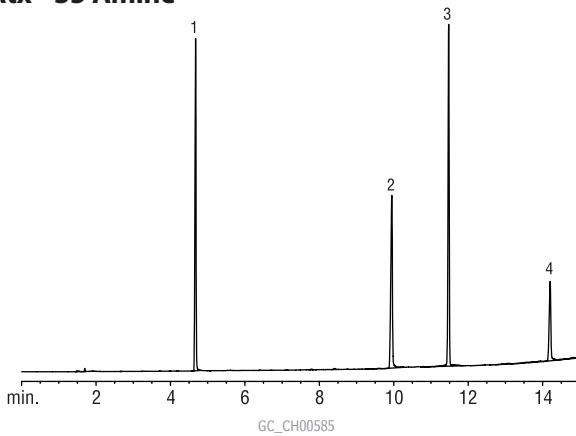
Column: Rt[®]-QS-BOND, 30m, 0.53mm ID (cat.# 19738)
Sample: 1,000 μ g/mL VOA Calibration Mix #1 (ketones) (cat.# 30006) in methanol:water, 90:10 (v/v)
Inj.: 1 μ L split (split ratio 50:1), 4mm Siltek[®] single gooseneck liner (cat.# 20798-214.1)
Inj. temp.: 240°C
Carrier gas: helium, constant flow
Flow rate: 5.7mL/min. @ 40°C
Oven temp.: 60°C to 225°C @ 15°C/min. (hold 10 min.)
Det.: FID @ 240°C

Ethanolamines Rtx[®]-5 Amine



Column: Rtx[®]-5 Amine, 15m, 0.25mm ID, 0.50 μ m (cat.# 12335)
Sample: 1.0 μ L split injection of ethanolamine mix in methanol
On-column conc.: 34ng
Oven temp.: 50°C (hold 2 min.) to 180°C @ 10°C/min. (hold 2 min.)
Inj./det. temp.: 280°C/300°C
Carrier gas: hydrogen
Linear velocity: 43cm/sec. set @ 50°C
FID sensitivity: 6.4 x 10¹¹ AFS
Split ratio: 58:1

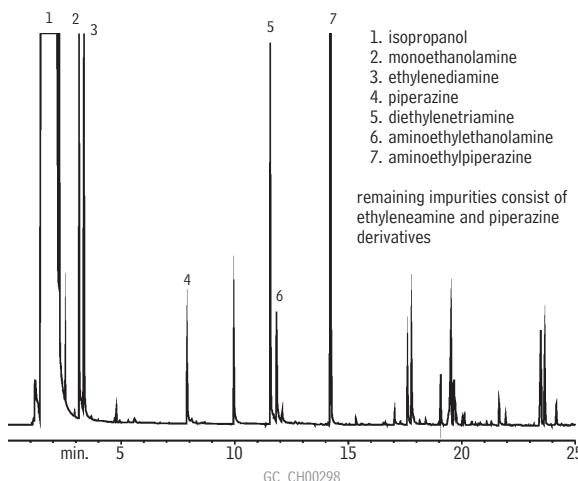
Ethanolamines Rtx[®]-35 Amine



Column: Rtx[®]-35 Amine, 30m, 0.32mm ID, 1.0 μ m (cat.# 11354)
Sample: 500 μ g/mL ethanolamine standard in water
Inj.: 1.0 μ L split (split ratio 10:1), cup splitter inlet liner (cat.# 20709)
Inj. temp.: 300°C
Carrier gas: helium, constant pressure
Linear velocity: 40cm/sec. @ 50°C
Oven temp.: 50°C (hold 0.50 min.) to 280°C @ 15°C/min.
Det.: FID @ 300°C

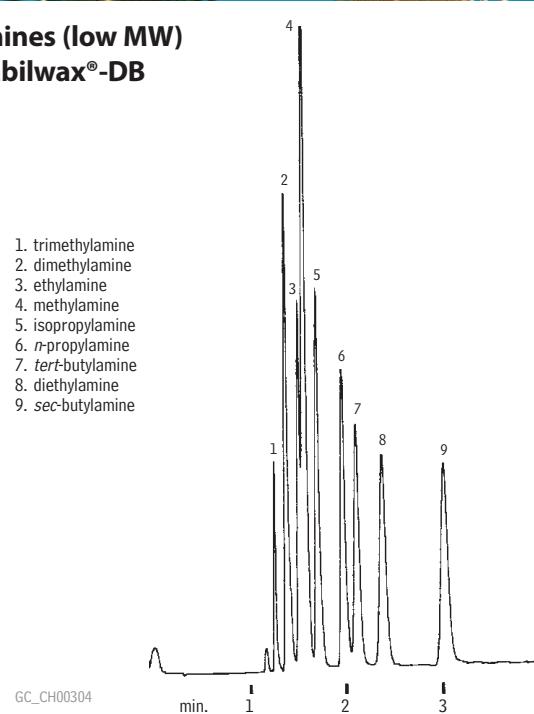
GC APPLICATIONS | SOLVENTS & CHEMICALS
Amines, Amines & Phenols

Ethyleneamines
Rtx®-5 Amine



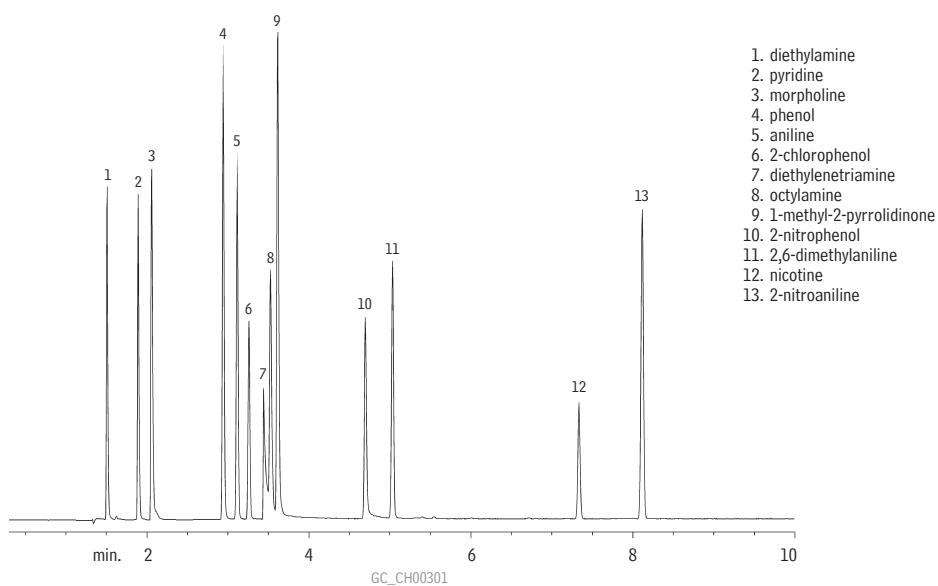
Column: Rtx®-5 Amine, 30m, 0.25mm ID, 0.50 μ m (cat.# 12338)
 Sample: 3.0 μ L split injection of ethyleneamine industrial sample
 On-column conc.: ~5-80ng
 Oven temp.: 40°C (hold 4 min.) to 315°C
 @ 10°C/min. (hold 5 min.)
 Inj./det. temp.: 315°C
 Carrier gas: hydrogen
 Linear velocity: 43cm/sec. set @ 40°C
 FID sensitivity: 6.4 x 10⁻¹¹ AFS
 Split ratio: 20:1

Amines (low MW)
Stabilwax®-DB



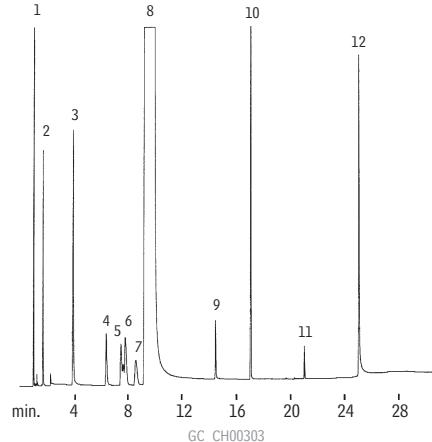
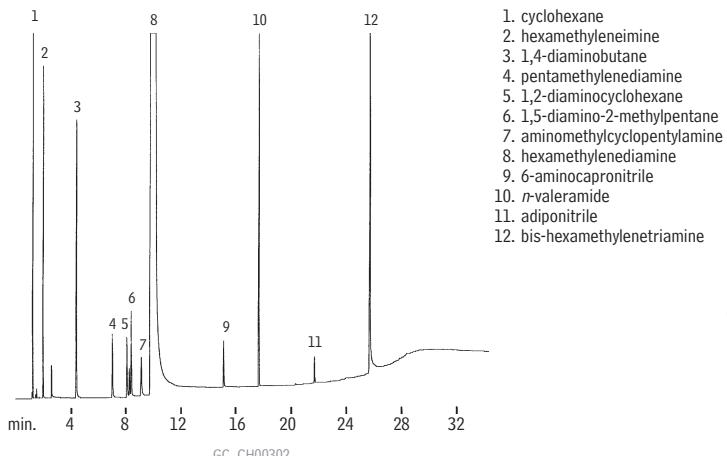
Column: Stabilwax®-DB, 30m, 0.53mm ID, 1.0 μ m (cat.# 10855)
 Sample: 1.0 μ L direct injection of amines in water
 Oven temp.: 45°C
 Inj./det. temp.: 250°C
 Carrier gas: hydrogen
 Linear velocity: 40cm/sec. (flow rate: 5cc/min.)
 FID sensitivity: 1 x 10⁻¹¹ AFS
 Recommended inlet liner: Uniliner®

Amines & Phenols
Rtx®-5 Amine



Column: Rtx®-5 Amine, 30m, 0.32mm ID, 1.0 μ m (cat.# 12354)
 Sample: 1.0 μ L split injection of amines and phenols in water
 On-column conc.: 22ng
 Oven temp.: 120°C to 220°C @ 10°C/min.
 Inj./det. temp.: 305°C
 Carrier gas: hydrogen
 Linear velocity: 38cm/sec. set @ 120°C
 FID sensitivity: 6.4 x 10⁻¹¹ AFS
 Split ratio: 25:1

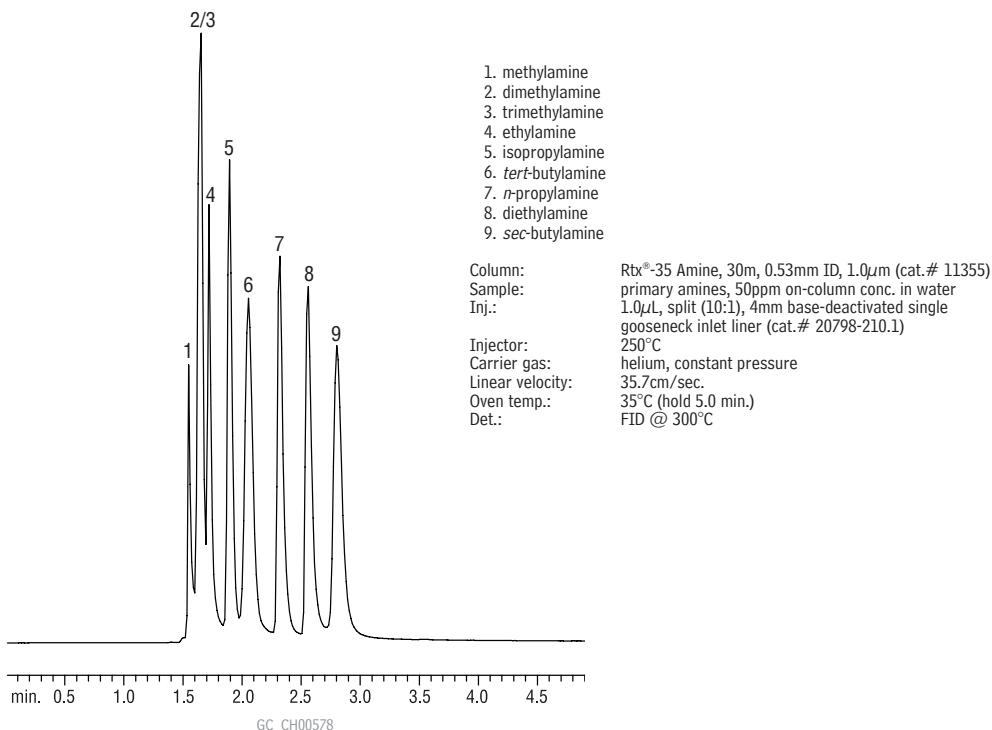
Hexamethylenediamine (HMD) Stabilwax®-DB



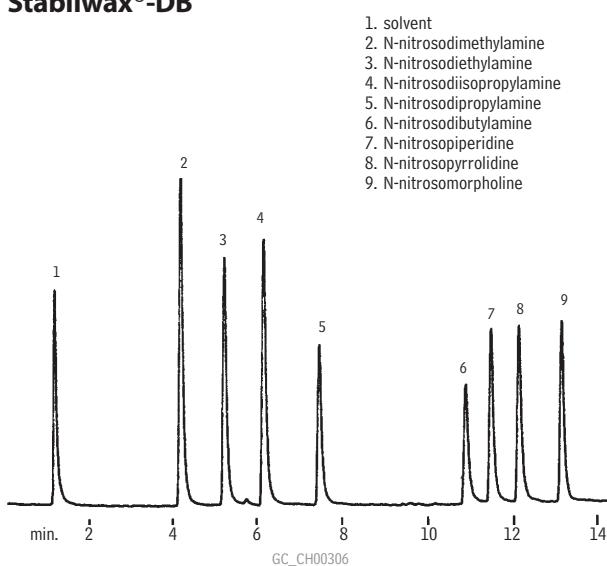
Column: Stabilwax®-DB, 30m, 0.32mm ID, 0.25 μ m (cat.# 10824)
Sample: 0.4 μ L direct injection of a neat hexamethylenediamine (HMD) sample
On-column conc.: 10 to 1,000ng/component
Oven temp.: 95°C (hold 6 min.) to 235°C @ 7°C/min. (hold 4 min.)
Inj./det. temp.: 250°C
Carrier gas: hydrogen
Linear velocity: 40cm/sec.
FID sensitivity: 2 x 10⁻¹¹ AFS

Column: Stabilwax®-DB, 30m, 0.53mm ID, 0.5 μ m (cat.# 10840)
Sample: 0.2 μ L direct injection of a neat hexamethylenediamine sample onto a Liner® inlet liner
Oven temp.: 95°C (hold 6 min.) to 235°C @ 7°C/min. (hold 2 min.)
Inj./det. temp.: 255°C
Carrier gas: hydrogen
Linear velocity: 40cm/sec. (flow rate: 5cc/min.)
FID sensitivity: 64 x 10⁻¹¹ AFS

Amines, Primary Rtx®-35 Amine



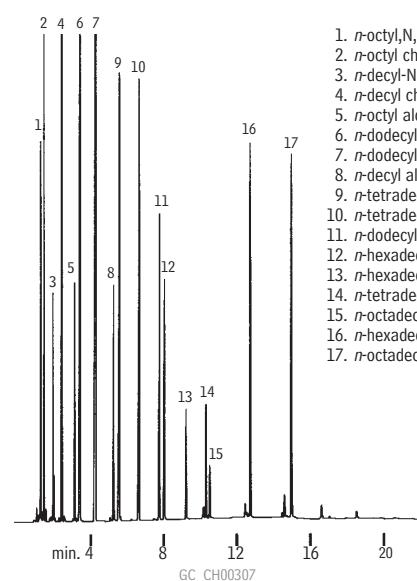
Nitrosamines Stabilwax®-DB



1. solvent
2. N-nitrosodimethylamine
3. N-nitrosodiethylamine
4. N-nitrosodisopropylamine
5. N-nitrosodipropylamine
6. N-nitrosodibutylamine
7. N-nitrosopiperidine
8. N-nitrosopyrrolidine
9. N-nitrosomorpholine

Column: Stabilwax®-DB, 60m, 0.53mm ID, 1.0 μ m (cat.# 10858)
 Sample: direct injection of nitrosamines
 Conc.: 1.0 μ g/mL
 Oven temp.: 100°C (hold 1 min.) to 170°C @ 5°C/min.
 Inj./det. temp.: 200°C
 Carrier gas: helium
 Linear velocity: 100cm/sec. (flow rate: 15cc/min.)
 Det.: TSD

Amines/Alcohols/Chlorides Stabilwax®



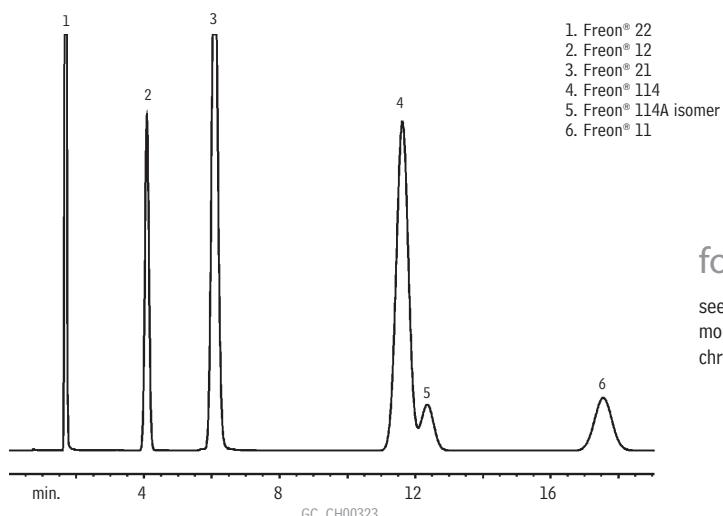
1. n-octyl,N,N-dimethylamine
2. n-octyl chloride
3. n-decyl,N,N-dimethylamine
4. n-decyl chloride
5. n-octyl alcohol
6. n-dodecyl,N,N-dimethylamine
7. n-dodecyl chloride
8. n-decyl alcohol
9. n-tetradecyl,N,N-dimethylamine
10. n-tetradecyl chloride
11. n-dodecyl alcohol
12. n-hexadecyl,N,N-dimethylamine
13. n-hexadecyl chloride
14. n-tetradecyl alcohol
15. n-octadecyl,N,N-dimethylamine
16. n-hexadecyl alcohol
17. n-octadecyl alcohol

Column: Stabilwax®, 30m, 0.53mm ID, 0.25 μ m (cat.# 10625)
 Inj.: 0.5 μ L split injection
 Oven temp.: 100°C to 250°C @ 8°C/min. (hold 5 min.)
 Inj./det. temp.: 250°C
 Carrier gas: hydrogen
 Linear velocity: 40cm/sec. (flow rate: 5.2cc/min.)
 FID sensitivity: 128 x 10⁻¹¹ AFS
 Split ratio: 40:1

Chlorofluorocarbons

5% Krytox on 60/80 CarboBlack B

(packed)



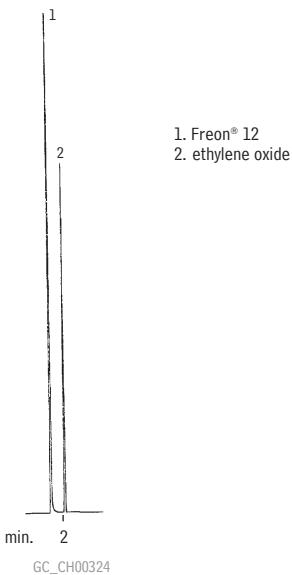
1. Freon® 22
2. Freon® 12
3. Freon® 21
4. Freon® 114
5. Freon® 114A isomer
6. Freon® 11

for **more** info

see **pages 652 & 703** for
more chlorofluorocarbon
chromatograms.

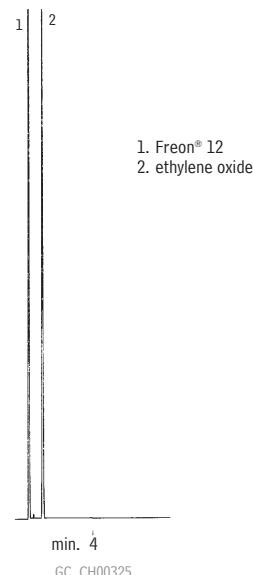


**Freon® 12 & Ethylene Oxide
Rtx®-1**



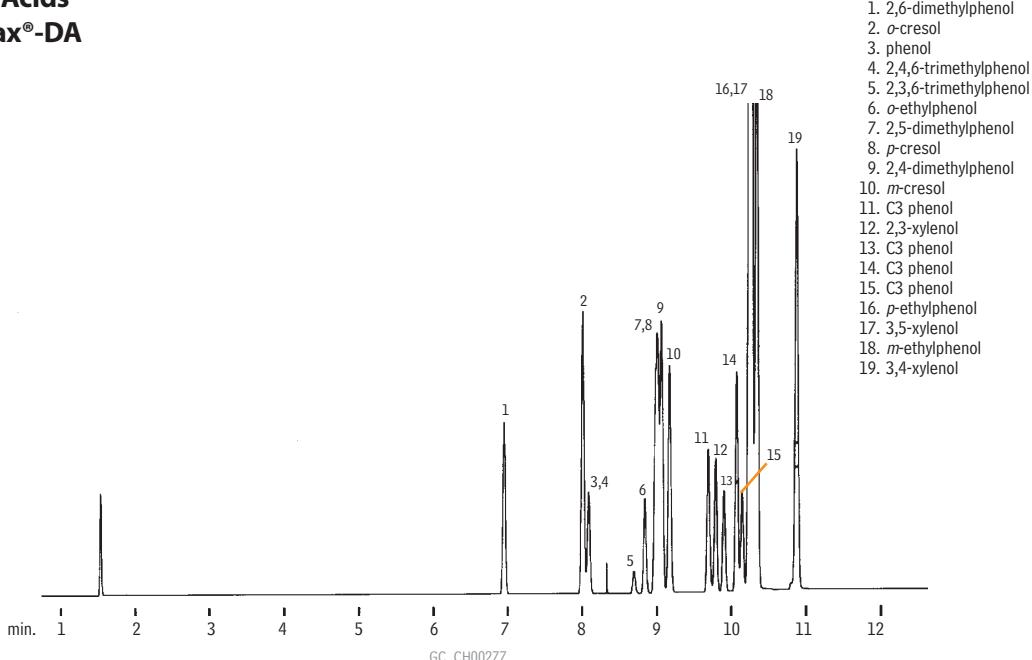
Column: Rtx®-1, 30m, 0.53mm ID, 5.0 μ m (cat.# 10179)
Sample: 50 μ L split injection of Freon® 12 and ETO
Oven temp.: 25°C
Inj./det. temp.: 290°C
Carrier gas: hydrogen
Linear velocity: 40cm/sec.
FID sensitivity: 4 x 10⁻¹¹ AFS
Split vent: 40:1

**Freon® 12 & Ethylene Oxide
Rtx®-200**



Column: Rtx®-200, 30m, 0.53mm ID, 3.0 μ m (cat.# 15085)
Sample: 50 μ L direct injection of Freon® 12 and ETO
Oven temp.: 25°C
Inj./det. temp.: 290°C
Carrier gas: hydrogen
Linear velocity: 40cm/sec. (flow rate: 5.2cc/min.)

**Cresylic Acids
Stabilwax®-DA**



Column: Stabilwax®-DA, 30m, 0.25mm ID, 0.50 μ m (cat.# 11038)
Sample: Wet needle split injection of cresylic acids
Oven temp.: 180°C (hold 2 min.) to 260°C @ 2°C/min.
Inj./det. temp.: 250°C
Carrier gas: hydrogen
Linear velocity: 40cm/sec. (flow rate: 3.2cc/min.)
FID sensitivity: 64 x 10⁻¹¹ AFS
Split ratio: 40:1