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CAPILLARY COLUMNS

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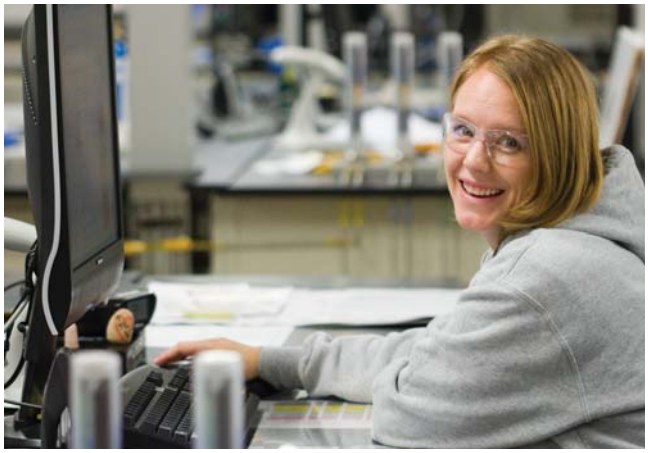

Top: Henry Knepp and Tim Wilson, Manufacturing Technicians
Bottom: Trisha Houser, Quality Assurance

What's **NEW?** look for this circle

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!"

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

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Description	qty.	cat.#	price
Pro *ez*GC 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.

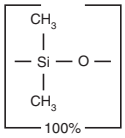
Table I lists the Kovats retention indices for the stationary phases in Table II. Assigning a retention index to each probe listed provides a basis for comparing several stationary phases and their relative retention to one another for a set of molecular probes. For example, when Kovats indices are identical 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

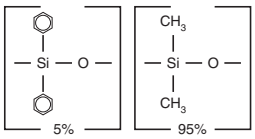
Table II Structures, polarities, properties, and uses for Restek capillary column phases, in order of increasing polarity

Rxi®-1ms, Rtx®-1
100% dimethyl polysiloxane



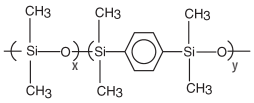
Polarity: nonpolar
Uses: solvents, petroleum products, pharmaceutical samples, waxes
[G1]

Rxi®-5ms, Rtx®-5, Rtx®-5MS
5% diphenyl
95% dimethyl polysiloxane



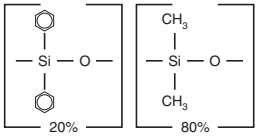
Polarity: slightly polar
Uses: flavors, environmental, aromatic hydrocarbons
[G27]

Rxi®-5Sil MS, Rtx®-5Sil MS
proprietary



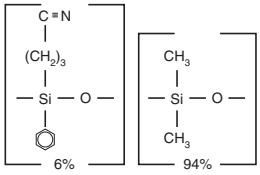
Polarity: slightly polar
Uses: flavors, environmental, pesticides, PCBs, aromatic hydrocarbons

Rtx®-20
20% diphenyl
80% dimethyl polysiloxane



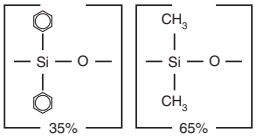
Polarity: slightly polar
Uses: volatile compounds, alcohols
[G32]

Rtx®-1301, Rtx®-624, Rtx®-G43
6% cyanopropylphenyl
94% dimethyl polysiloxane



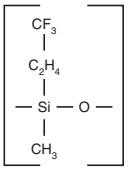
Polarity: slightly polar
Uses: volatile compounds, insecticides, residue solvents in pharmaceutical products
[G43]

Rtx®-35
35% diphenyl
65% dimethyl polysiloxane



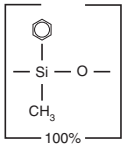
Polarity: intermediately polar
Uses: pesticides, Aroclor PCBs, amines, nitrogen-containing herbicides
[G42]

Rtx®-200
trifluoropropylmethyl polysiloxane



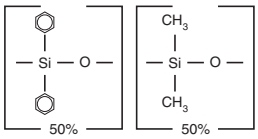
Polarity: selective for lone pair electrons
Uses: environmental, solvents, Freon® gases, drugs, ketones, alcohols
[G6]

Rtx®-50
100% methylphenyl polysiloxane



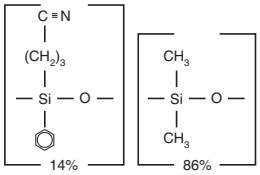
Polarity: intermediately polar
Uses: FAMEs, carbohydrates
[G3]

Rxi®-17
50% diphenyl
50% dimethyl polysiloxane



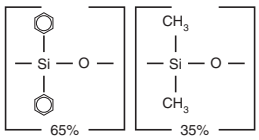
Polarity: intermediately polar
Uses: triglycerides, phthalate esters, steroids, phenols
[G3]

Rtx®-1701
14% cyanopropylphenyl
86% dimethyl polysiloxane



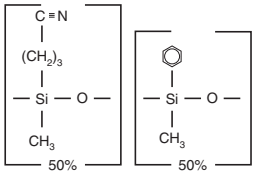
Polarity: intermediately polar
Uses: pesticides, Aroclor PCBs, alcohols, oxygenates
[G46]

Rtx®-65TG
65% diphenyl
35% dimethyl polysiloxane



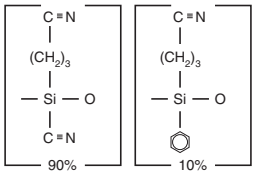
Polarity: intermediately polar
Uses: triglycerides, rosin acids, free fatty acids

Rtx®-225
50% cyanopropylmethyl
50% phenylmethyl polysiloxane



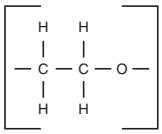
Polarity: polar
Uses: FAMEs, carbohydrates
[G7]

Rt®-2330
90% biscyanopropyl
10% cyanopropylphenyl polysiloxane



Polarity: polar
Uses: cis/trans FAMEs, dioxin isomers, rosin acids
[G48]

Stabilwax®, Rtx®-Wax
Carbowax® PEG



Polarity: polar
Uses: FAMEs, flavors, acids, amines, solvents, xylene isomers
[G16]

ordering **note**

Designations in [brackets] are USP codes. We recommend this phase when your application calls for this code.

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

	Column ID				
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.

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

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.

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.

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

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

2) Select column ID, film thickness, and length

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

3) Set optimum parameters for your analysis

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

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_2SO_4 deactivation		GS-Alumina, HP PLOT S	CP-AL2O3 / Na2SO4				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
Specially 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) MXT-Biodiesel TG (p. 72,107)	Triglycerides in biodiesel	unique **column**					
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**					

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.

Trisha Houser, Quality Assurance

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.

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

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.

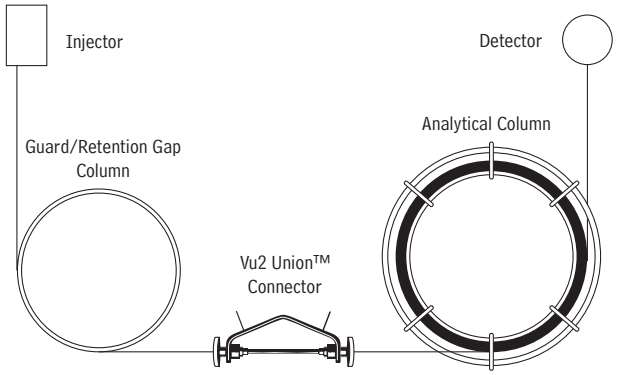
Long-Term: remove the column from the GC and seal the ends by gently and carefully pushing each end into the curved edge of a septum. Store the column in the original box away from strong lighting.

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 splitless 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.

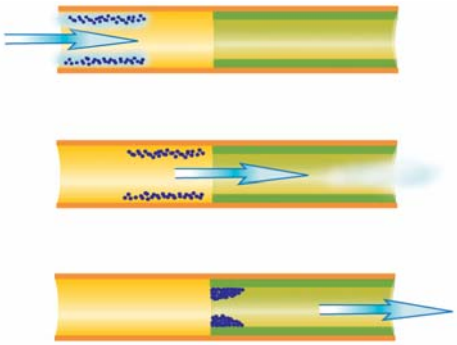
Having trouble making a leak-free connection?
Try our "built in" Integra-Guard™ columns!

See **page 33** for details.

did you **know**?

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

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.

it's a **fact**

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

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 nonvolatile 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?

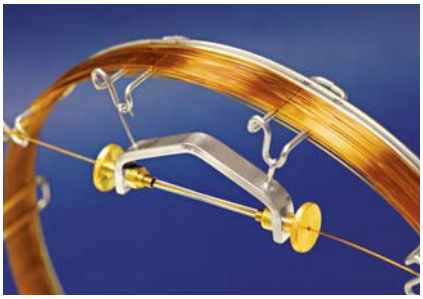
When using a guard column, it is important to match the polarity of the solvent and the polarity of the surface deactivation. Rxi® Guard tubing is good for a wide variety of applications and allows most common solvents (methylene chloride, hexane, isooctane, toluene) to easily wet and create a uniform 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**.

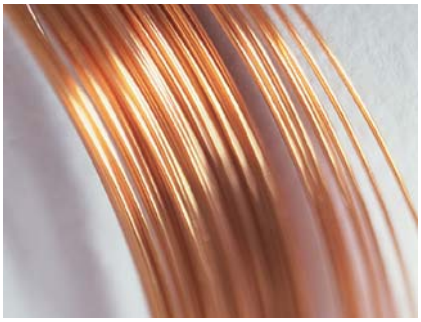
also **available**

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®-deactived 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.

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.

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.

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.

restek **innovation**!

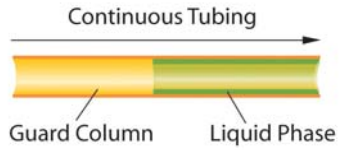
Integra-Guard™ Columns: guard columns WITHOUT connections—protecting your analytical column has never been this easy!

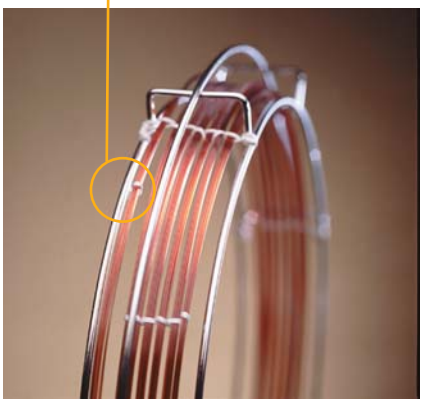
similar **products**

DuraGuard, EZ-Guard, Guardian

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	

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

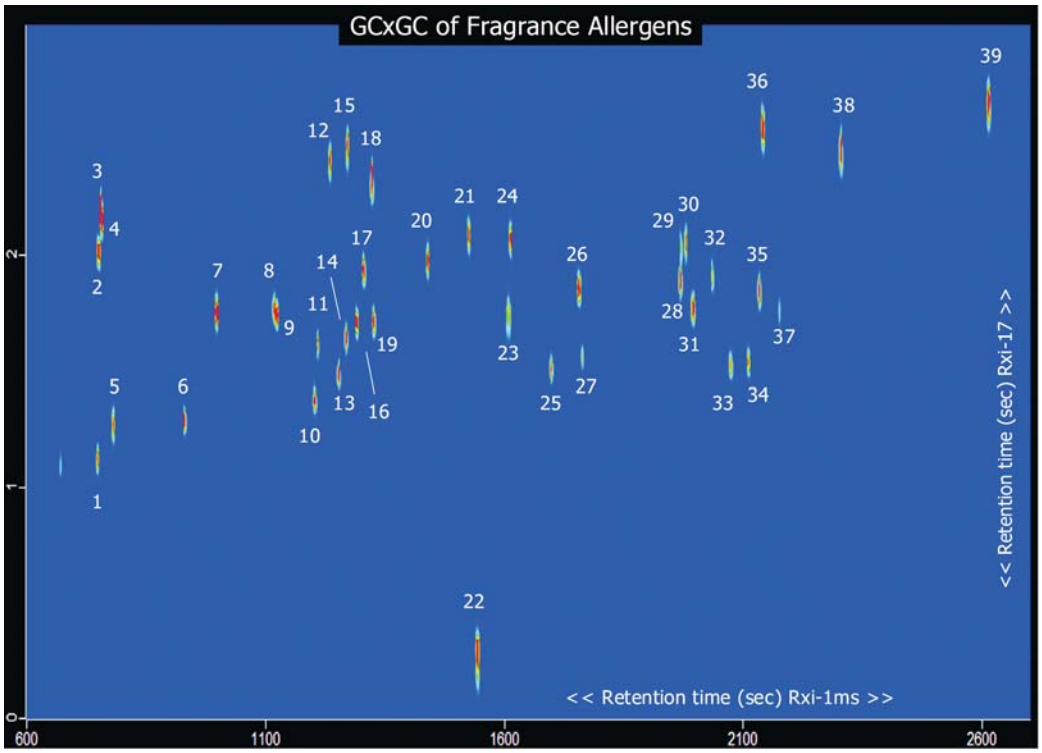
The selectivity kit contains four columns of different selectivity for method development. Includes one each of the following:

NEW!

- 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

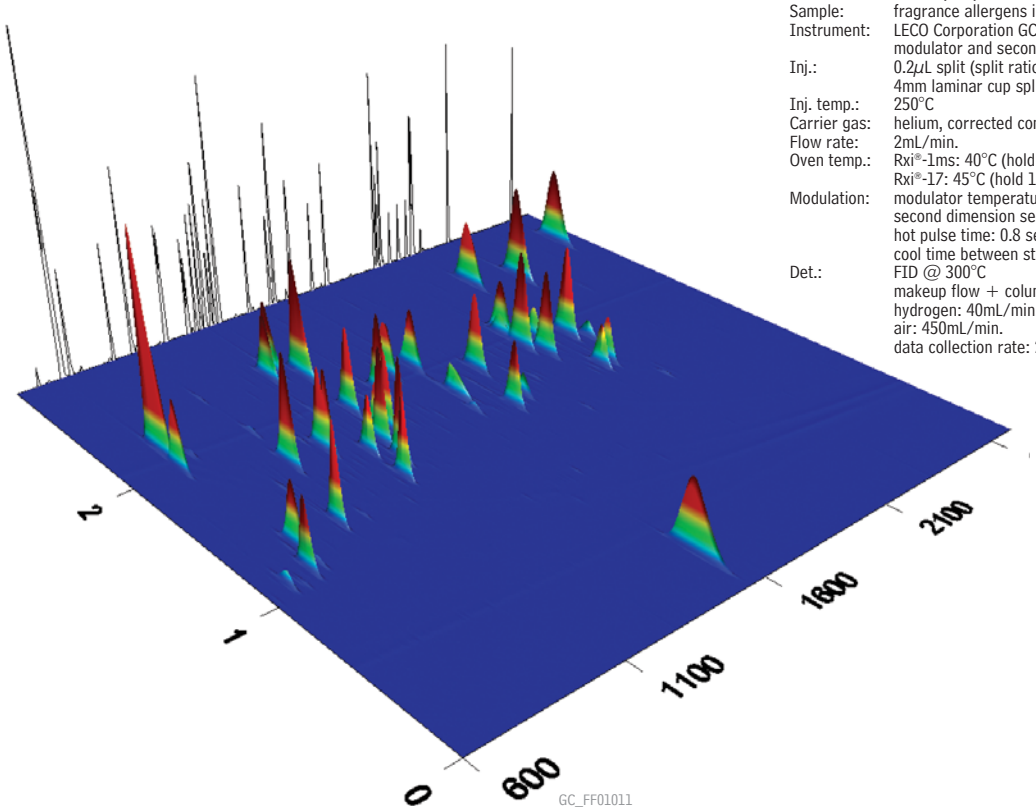
Description	qty.	cat.#	price
GCxGC Selectivity Kit A	kit	15105	
Columns can also be purchased individually.			
Rxi-17, 1.1m (±3cm), 0.10mm ID, 0.10µm	ea.	15104	
Rtx-CLPesticides, 1.1m (±3cm), 0.10mm ID, 0.10µm	ea.	15103	
Stabilwax, 1.1m (±3cm), 0.10mm ID, 0.10µm	ea.	15102	
Rt-LC350, 1.1m (±3cm), 0.15mm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

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



GC_FF01010

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 1
36. benzyl benzoate
37. hexyl cinnamal 2
38. benzyl salicylate
39. benzyl cinnamate



GC_FF01011

Columns:	Rxi®-1ms, 30m, 0.25mm ID, 0.25μm (cat.# 13323) Rxi®-17, 1m, 0.10mm ID, 0.10μm (10m, cat.# 13501)
Sample:	fragrance allergens in MTBE
Instrument:	LECO Corporation GCxGC/FID with quad-jet, dual-stage modulator and secondary oven
Inj.:	0.2μL 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.
Det.:	FID @ 300°C makeup flow + column flow: 50mL/min. hydrogen: 40mL/min. air: 450mL/min. data collection rate: 200 Hz

High-Perfomance 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

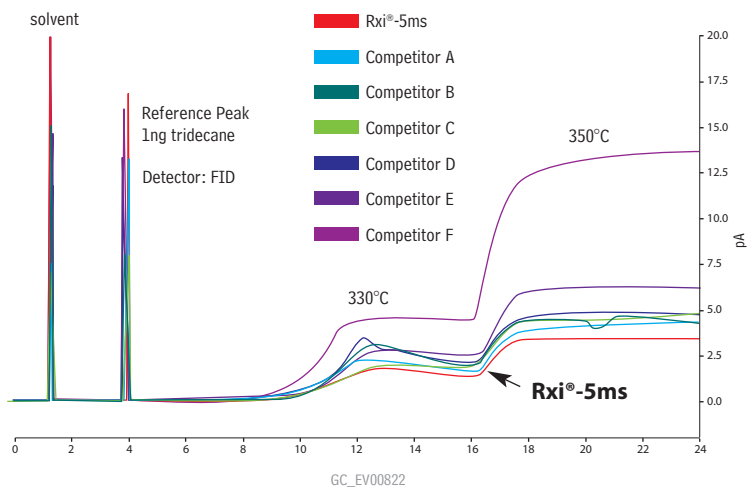
As GC detectors become more sensitive, accurately quantifying low concentrations of target compounds becomes much more challenging. We developed the Rxi® column line specifically to improve low-level quantification. Our goal was to develop a superior column that had the highest inertness, lowest bleed,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

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

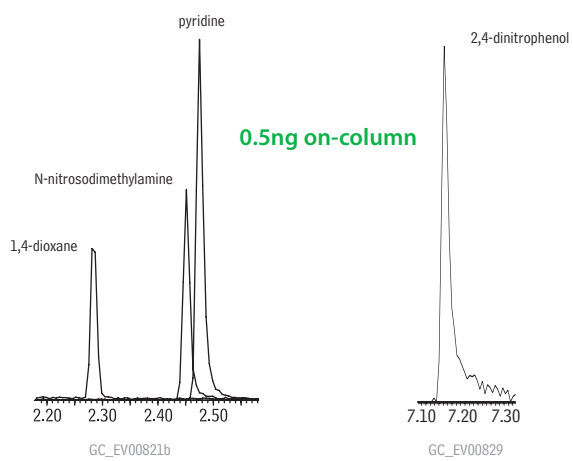
Comparison of 30m x 0.25mm ID, 0.25µm columns at 330°C through 350°C; hydrogen carrier gas; flame ionization detection.



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.

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

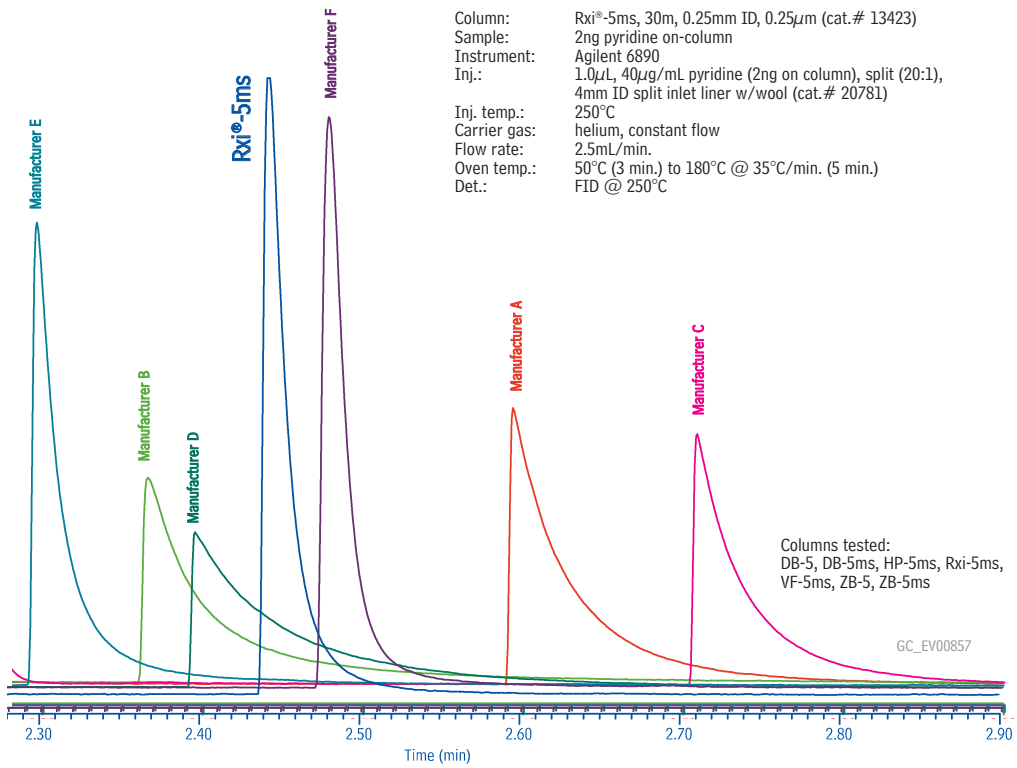


Highly Inert

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.

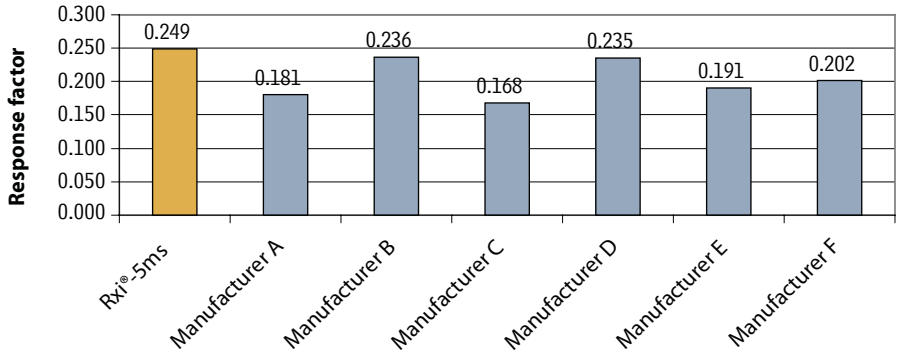
To further compare the inertness of the Rxi®-5ms column toward basic compounds to other columns on the market, 2ng of pyridine was used as a test probe. As shown in Figure 3, the tailing of pyridine is a very sensitive marker for inertness, and the excellent peak symmetry on the Rxi®-5ms column demonstrates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

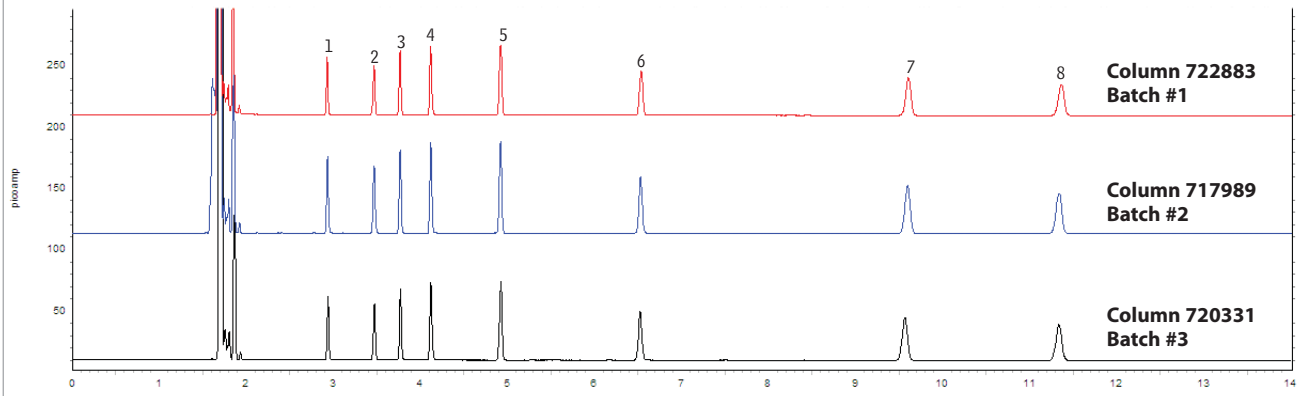
Column-to-column reproducibility is critical to obtaining consistent, reliable results for low-level analytes. We re-engineered our column manufacturing process to guarantee column-to-column reproducibility. The data in Figure 5 compare column performance from three separate production lots that were 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

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

Guard Columns, Rxi®-1ms

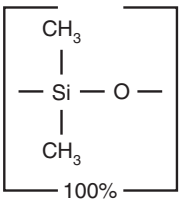
Rxi® Guard/Retention Gap Columns

- 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)

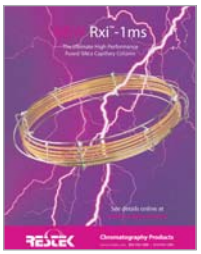
(Crossbond® 100% dimethyl polysiloxane)

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
	4.00	-60 to 330/350°C		13396	
0.53mm	0.50	-60 to 330/350°C	13337	13340	
	1.00	-60 to 330/350°C	13352	13355	
	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

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



free literature

Rxi®-1ms: The Ultimate High Performance Fused Silica Capillary Column

Download your free copy from **www.restek.com**.

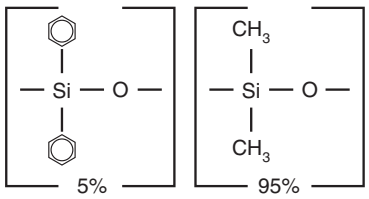
Flyer
lit. cat.# 580075B

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)

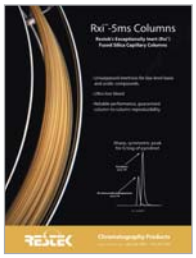
(Crossbond® 5% diphenyl/95% dimethyl polysiloxane)

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	25-Meter	50-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	13499

similar **phases**

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



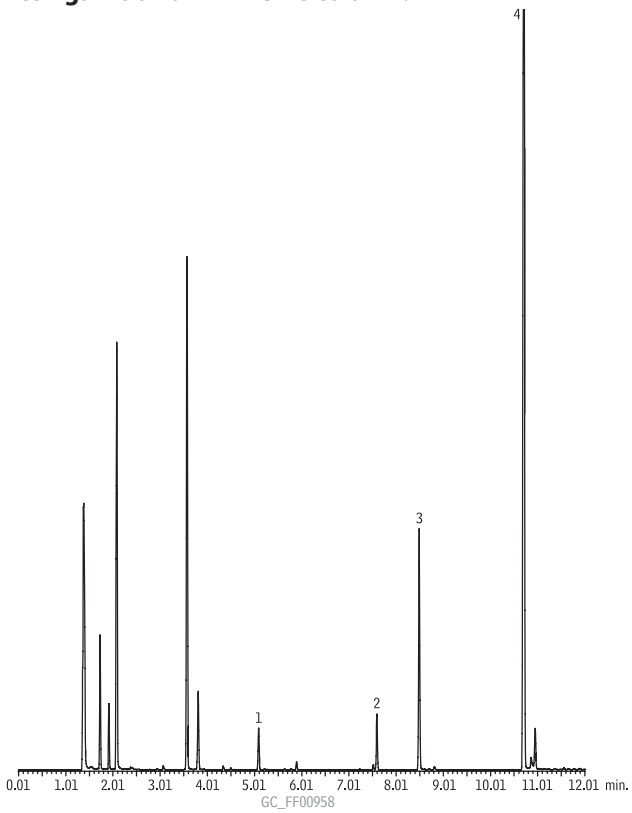
free literature

Rxi®-5ms Columns

Download your free copy from **www.restek.com**.

Flyer
lit. cat.# 580046A

Fresh garlic on an Rxi®-5ms column.



1. allyl methylsulfide
2. 3,3'-thiobis-1-propene
3. allyl mercaptan
4. diallyl disulphide

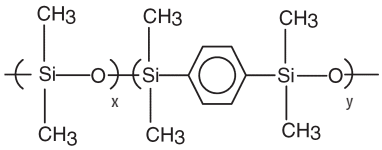
Column:	Rxi®-5ms, 30m, 0.25mm ID, 1.0µm (cat.# 13453) with a 5m, 0.32mm ID IP deactivated guard column (cat.# 10044)
Sample:	fresh garlic
Inj.:	split (10:1)
Inj. temp.:	220°C
Flow rate:	1.5mL/min.
Oven temp.:	35°C (hold 1 min.) to 220°C @ 15°C/min. to 300°C @ 45°C/min.
Det:	MS
Scan range:	35-350amu
Ionization:	EI
Mode:	scan

Headspace Conditions

Instrument:	PerkinElmer TurboMatrix 40 Trap Headspace Sampler
Column pressure:	15psi (103kPa)
Inj. pressure:	30psi (207kPa)
Thermostat time:	15 min.
Vial pressurize time:	1 min.
Withdraw time:	0.2 min.
Injection time:	0.02 min.
Oven temp.:	80°C
Needle temp.:	90°C
Transfer temp.:	110°C

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.

similar phases

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

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

free literature

Rxi®-5Sil MS: Exceptionally Inert Columns for GC/MS and Trace Level Analyses

Download your free copy from **www.restek.com**.

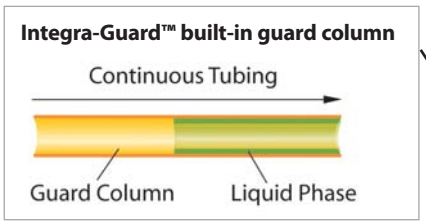
Flyer
lit. cat.# GNFL1061

Rxi®-5Sil MS with Integra-Guard™

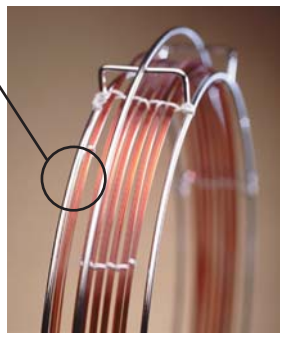
Get the protection without the connection!

- 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

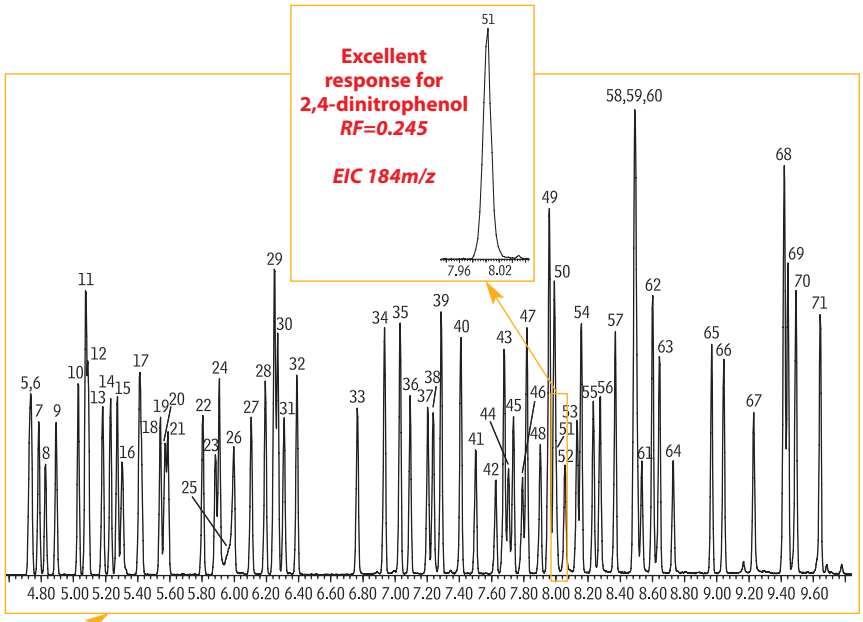


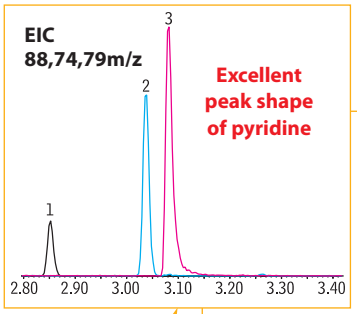
Rtx®-1
Rtx®-5
Rtx®-5MS
Rxi®-5Sil MS
Rtx®-1301
Rtx®-624
Rtx®-1701
Rtx®-Volatiles
Rtx®-20
Rtx®-35
Rtx®-BAC 1 & 2
Stabilwax®

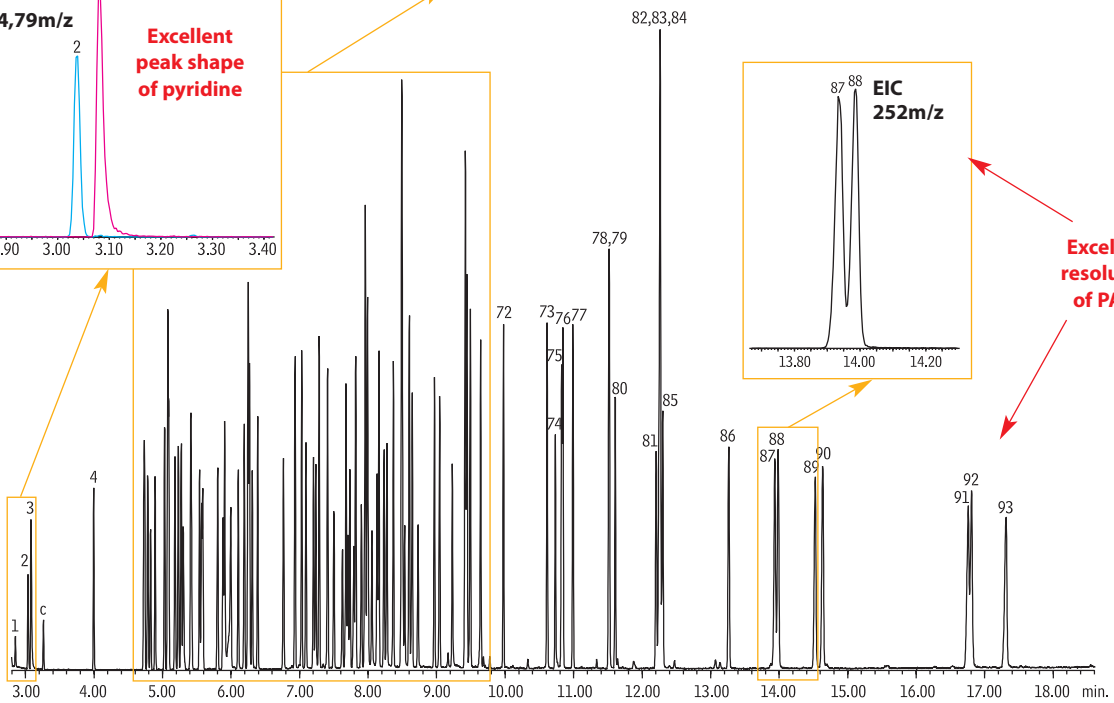
Integra-Guard™ columns are available for all phases listed, for columns with 0.25, 0.32 or 0.53mm ID and lengths to 75 meters.

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

Column:	Rxi®-5Sil MS, 30m, 0.25mm ID, 0.25µm (cat.# 13623)
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)
Inj.:	1.0µL (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







GC_EV00943

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

c = contaminant

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.

NEW!

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

similar phases

DB-35ms, MR2

NEW! Lowest bleed, most inert high-temperature column available!

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.

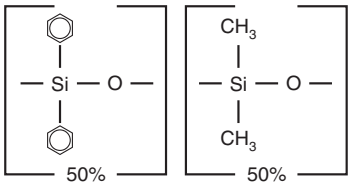
similar phases

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

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 Structure



similar **phases**

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

Rxi®-17 Columns (fused silica)

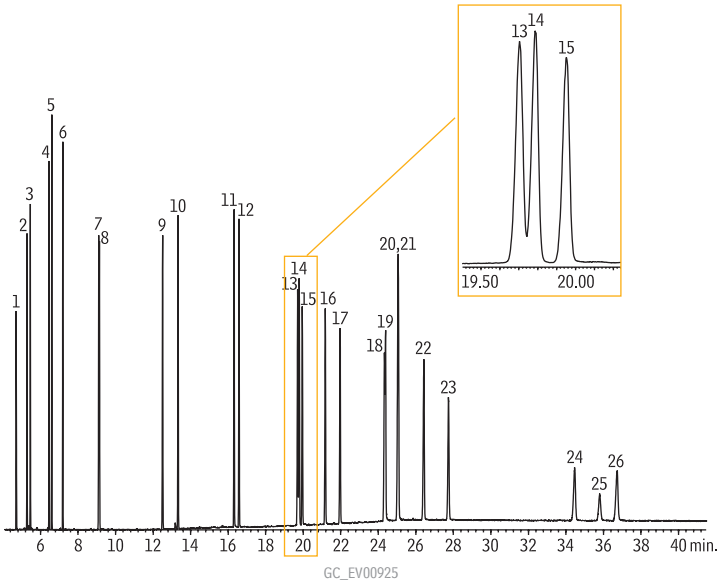
(Crossbond® 50% diphenyl/50% dimethyl polysiloxane)

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

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-methylnapthalene	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(ghi)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

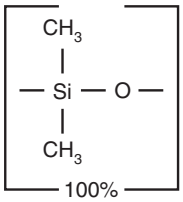
- Columns based on polysiloxane backbone; functional groups added to the polymers to vary selectivity.
- Polyethylene glycol (PEG) phases.

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	
0.45mm	2.55	-60 to 270/290°C				
0.53mm	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.

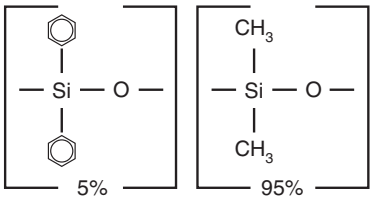
it's a fact

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.

Rtx®-5/Rtx®-5MS Structure

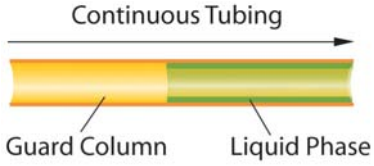


similar **phases**

DB-5, HP-5, HP-5MS, Ultra-2, SPB-5, Equity-5, MDN-5, CP-Sil 8 CB

NOTE: DB-5MS is a silarylene based polymer, similar to Rxi-5Sil MS.

Integra-Guard™ built-in guard column



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

also **available**

MXT® Columns
Rugged, flexible, Siltek® treated stainless steel tubing; inertness comparable to fused silica tubing. See **page 106** for our MXT®-5 columns.

Rtx®-5 Amine Columns
See **page 59**.

it's a **fact**

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

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
	1.50	-60 to 310/330°C	10266	10269	10272	10275
	3.00	-60 to 280/300°C	10281	10284	10287	10290
0.53mm	0.10	-60 to 320/340°C	10207	10210	10213	
	0.25	-60 to 320/340°C	10222	10225	10228	
	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	
	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.

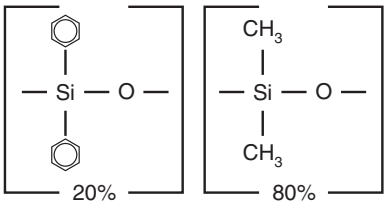
ID	df (µm)	temp. limits	15-Meter	30-Meter	60-Meter
0.25mm	0.10	-60 to 330/350°C	12605	12608	12611
	0.25	-60 to 330/350°C	12620	12623	12626
	0.50	-60 to 330/350°C	12635	12638	12641
	1.00	-60 to 325/350°C	12650	12653	
0.32mm	0.10	-60 to 330/350°C	12606	12609	12612
	0.25	-60 to 330/350°C	12621	12624	12627
	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	

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 Structure



Rtx®-20 Columns (fused silica)

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

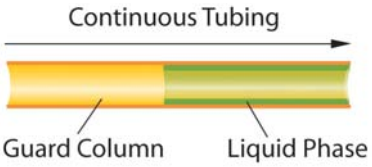
ID	df (µm)	temp. limits	15-Meter	30-Meter
0.25mm	0.25	-20 to 300/320°C	10320	10323
	0.50	-20 to 290/310°C	10335	10338
	1.00	-20 to 280/300°C	10350	10353
0.32mm	0.25	-20 to 300/320°C	10321	10324
	0.50	-20 to 290/310°C	10336	10339
	1.00	-20 to 280/300°C	10351	10354
0.53mm	0.25	-20 to 260/280°C	10322	10325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

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**.

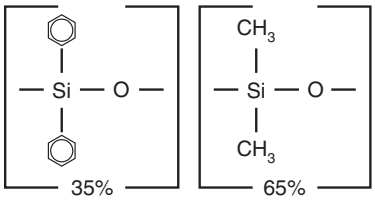


Rtx®-35 (midpolarity phase; Crossbond® 35% diphenyl/65% dimethyl polysiloxane)

- 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 Structure



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
	3.00	40 to 240/260°C	10482	10485

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

similar phases

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

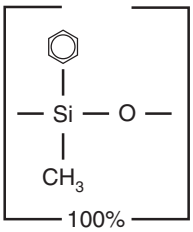
also available

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



similar **phases**

HP-50, SPB-50, SP-2250

also **available**

MXT® Columns
Rugged, flexible, Siltek® treated stainless steel tubing; inertness comparable to fused silica tubing.
See **page 108** for our MXT®-50 columns.

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.

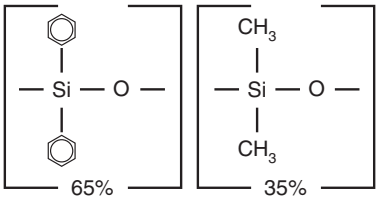
Rtx®-50 Columns (fused silica)

(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.

restek **innovation**!

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.

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

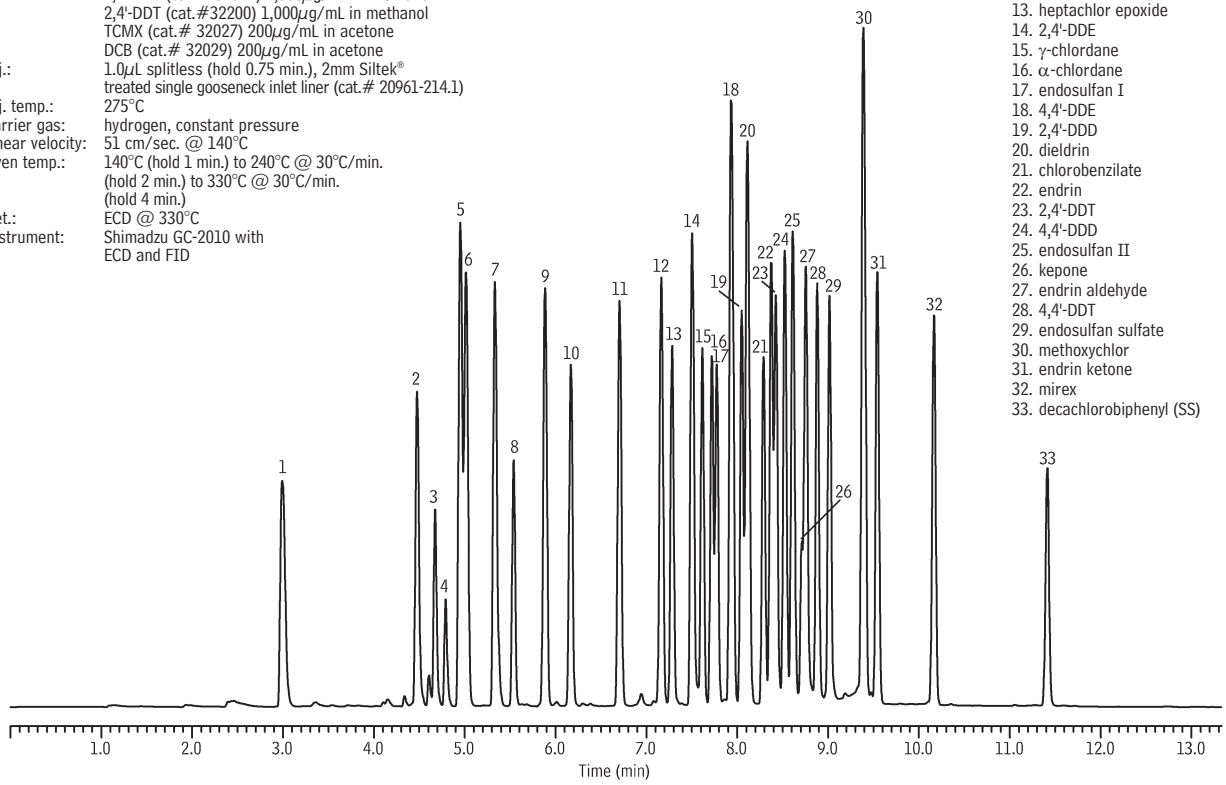
Linear velocity: 51 cm/sec. @ 140°C

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

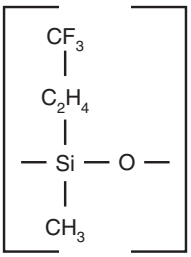
Instrument: Shimadzu GC-2010 with ECD and FID

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, Rtx®-200MS

Rtx®-200 Structure



similar **phases**

DB-200, DB-210

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®-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)

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
	1.50	-20 to 280/300°C	15066	15069	15072	15075
0.53mm	0.25	-20 to 310/330°C	15022	15025	15028	
	0.50	-20 to 300/320°C	15037	15040	15043	
	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.

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

(Crossbond® trifluoropropylmethyl polysiloxane)

Column specifically tested for low bleed performance.

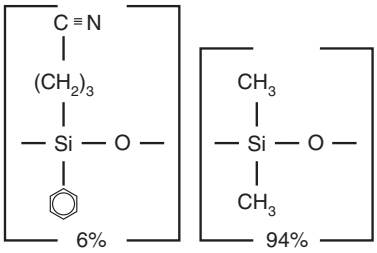
ID	df (µm)	temp. limits	30-Meter
0.25mm	0.10	-20 to 320/340°C	15608
	0.25	-20 to 320/340°C	15623
	0.50	-20 to 310/330°C	15638
	1.00	-20 to 290/310°C	15653
0.32mm	0.10	-20 to 320/340°C	15609
	0.25	-20 to 320/340°C	15624
	0.50	-20 to 310/330°C	15639
	1.00	-20 to 290/310°C	15654

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 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

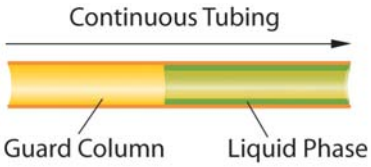
See Rtx-624, pages 74 and 93.

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

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**.

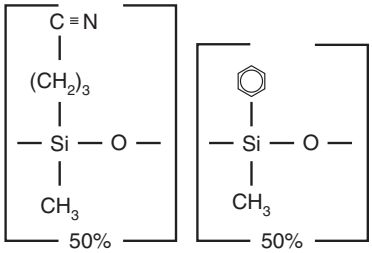
Rtx®-225 (polar phase; Crossbond® 50% cyanopropylmethyl/ 50% phenylmethyl polysiloxane)

- 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 Structure



similar phases

DB-225, HP-225, SPB-225

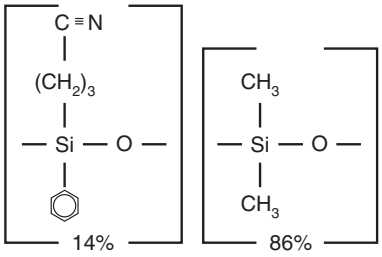
Rtx®-225 Columns (fused silica)

(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®-1701 Structure



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

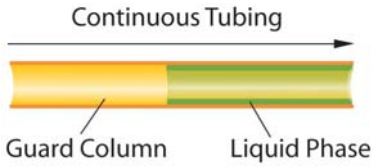
- General purpose columns for alcohols, oxygenates, PCB congeners or (e.g.) Aroclor mixes, pesticides.
- Temperature range: -20°C to 280°C.
- Equivalent to USP G46 phase.

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.

similar phases

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

Integra-Guard™ built-in guard column



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

Rtx®-1701 Columns (fused silica)

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

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

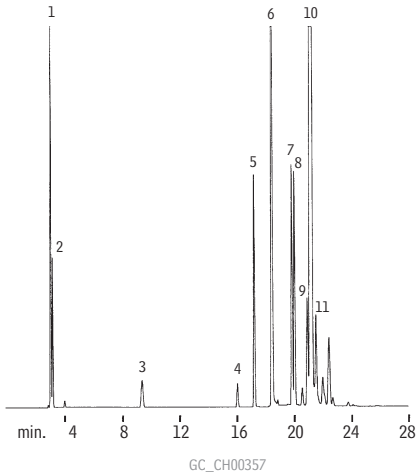
ID	df (µm)	temp. limits	10-Meter	20-Meter
0.10mm	0.10	-20 to 280°C	42201	42202
0.18mm	0.20	-20 to 280°C	42001	42002
	0.40	-20 to 270/280°C	42010	42011

*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

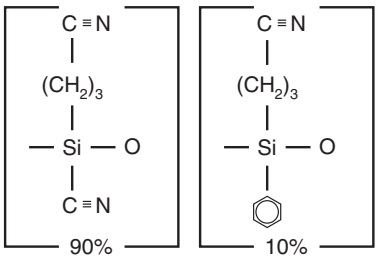
Column:	Rtx®-1701, 30m, 0.53mm ID, 3.0µm (cat.# 12085)
Inj.:	0.5mL split injection of a 95% pure styrene
Oven temp.:	40°C (hold 10 min.) to 150°C @ 12°C/min. (hold 15 min.)
Inj./det. temp.:	150°C
Carrier gas:	helium
Linear velocity:	20cm/sec. set @ 40°C
FID sensitivity:	16 x 10^{-11} AFS
Split vent: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



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.

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**.

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.

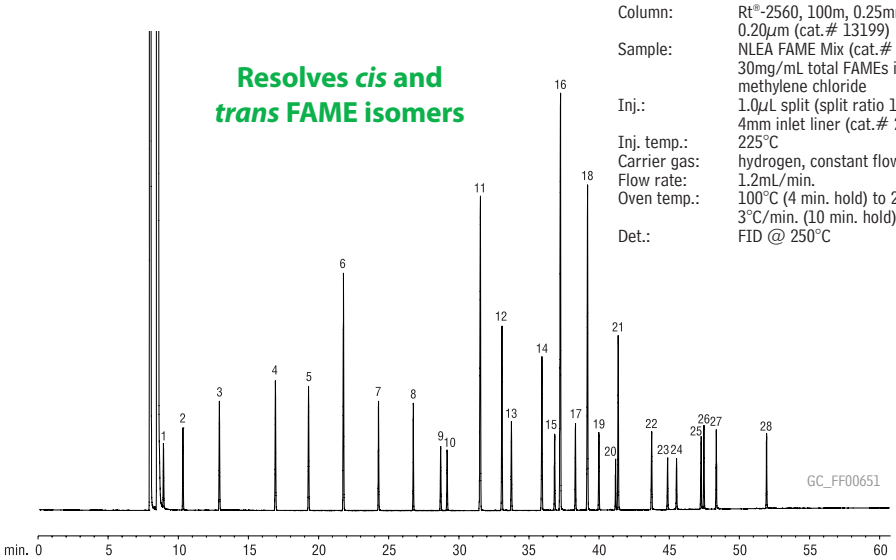
Rt®-2560 Column (fused silica)
(biscyanopropyl polysiloxane)

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

similar **phases**

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

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 linoelaidate (*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)

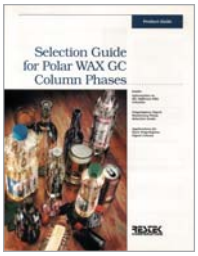
a **plus 1** story

"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)

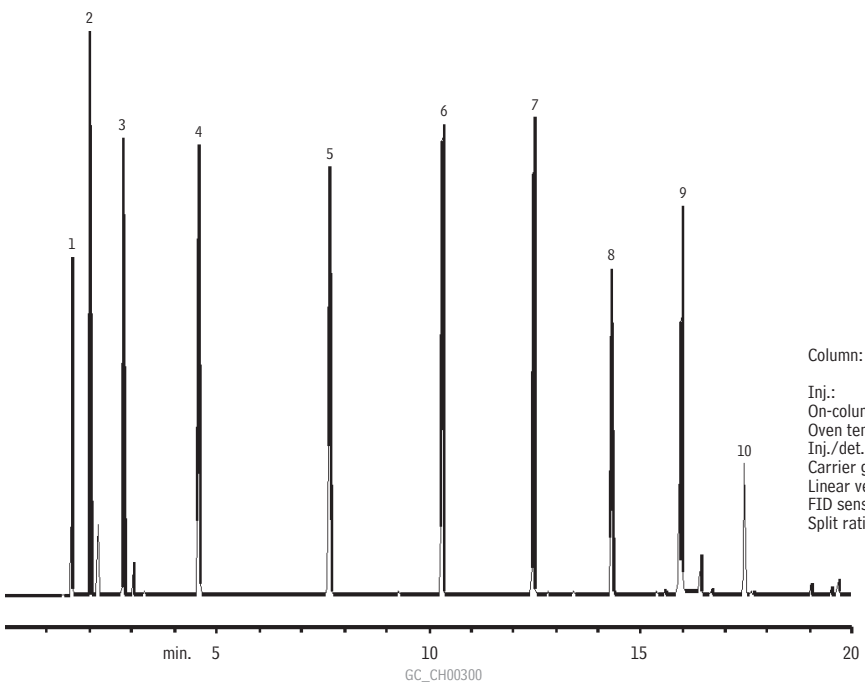
(Crossbond® Carbowax® polyethylene glycol)

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
0.53mm	0.25	20 to 250°C	12422	12425	
	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.



1. ethanal
2. propanal
3. butenal
4. pentanal
5. hexanal
6. heptanal
7. octanal
8. nonanal
9. decanal
10. undecanal

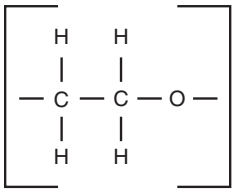
Column:	Rtx®-Wax, 30m, 0.25mm ID, 0.50µm (cat.# 12438)
Inj.:	split injection of C2-C11 aldehydes mixture
On-column conc.:	250ng
Oven temp.:	40°C (hold 5 min.) to 200°C @ 10°C/min.
Inj./det. temp.:	200°C
Carrier gas:	hydrogen
Linear velocity:	35cm/sec. set @ 40°C
FID sensitivity:	82 x 10^{11} AFS
Split ratio:	100:1

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® Structure



NEW! manufacturing procedure
Better column-to-column reproducibility

Stabilwax® Columns (fused silica)

(Crossbond® Carbowax® polyethylene glycol)

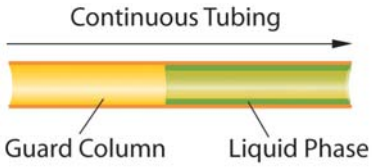
ID	df (µm)	temp. limits	15-Meter	30-Meter	60-Meter
0.25mm	0.10	40 to 250/260°C	10605	10608	10611
	0.25	40 to 250/260°C	10620	10623	10626
	0.50	40 to 250/260°C	10635	10638	10641
0.32mm	0.25	40 to 250/260°C	10621	10624	10627
	0.50	40 to 250/260°C	10636	10639	10642
	1.00	40 to 240/260°C	10651	10654	10657
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

similar phases

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

Integra-Guard™ built-in guard column

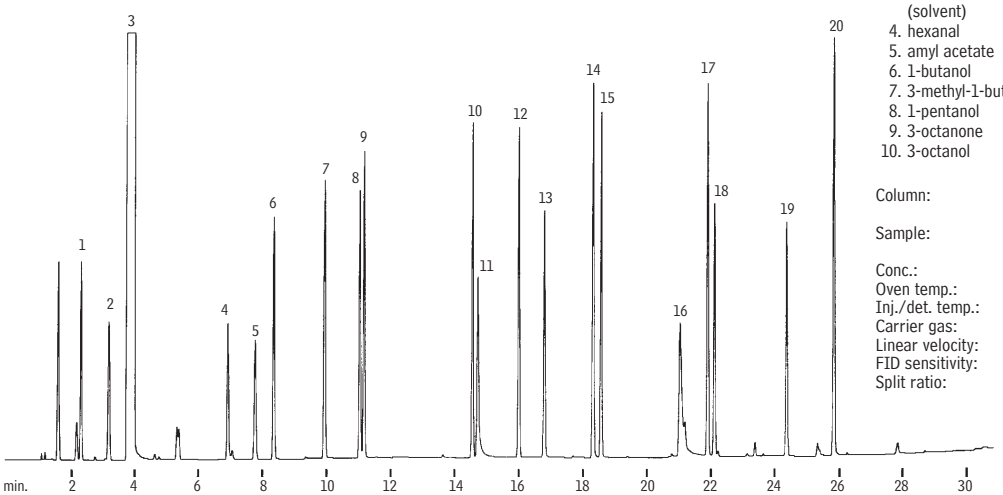


Get the protection without the connection!
For Stabilwax® columns with built-in Integra-Guard™ guard columns, see **page 33**.

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.

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 10^{-11} 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)

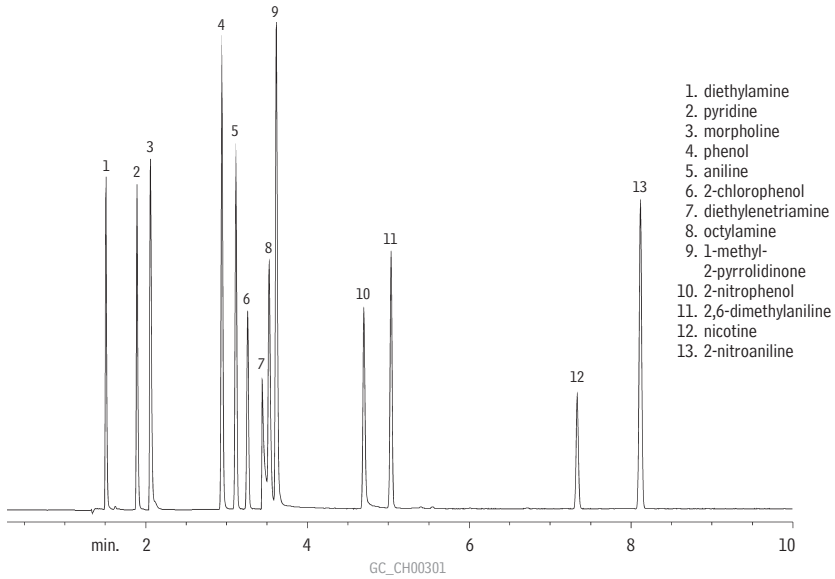
- Application-specific columns for amines and other basic compounds, including alkylamines, diamines, triamines, ethanolamines, and nitrogen-containing heterocyclics.
- Stable to 315°C.

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

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



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 10^{-11} AFS
Split ratio:	25:1

restek **innovation**!

similar **phase**

PTA-5

also **available**

See **page 60** for Rtx®-35 Amine columns.

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**

restek
innovation!

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.

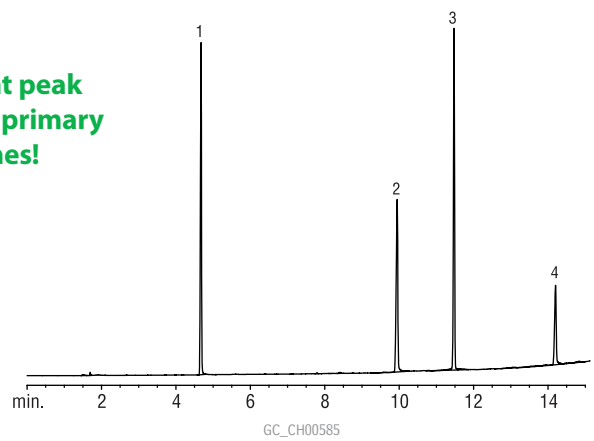
Active basic compounds that otherwise require derivatization, or an alternative analytical technique, can be analyzed on an Rtx®-35 Amine column. The tubing surface is chemically altered to reduce tailing of basic compounds, eliminating the need for column priming. An Rtx®-35 Amine column is ideal for 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.

Excellent peak shape for primary amines!



1. monoethanolamine
2. diethanolamine
3. triethyleneglycol 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.

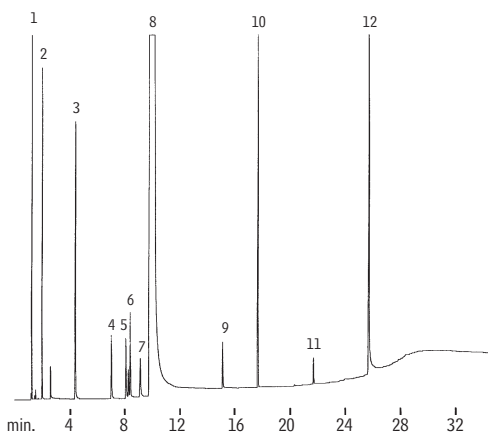
Stabilwax®-DB Columns (fused silica)
(Crossbond® Carbowax® polyethylene glycol for amines and basic compounds)

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	
	1.00	40 to 210/220°C	10851	10854	10857
0.53mm	0.50	40 to 210/220°C		10840	
	1.00	40 to 210/220°C	10852	10855	10858
	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!

1. cyclohexane
2. hexamethyleneimine
3. 1,4-diaminobutane
4. pentamethylenediamine
5. 1,2-diaminocyclohexane
6. 1,5-diamino-2-methylpentane
7. aminomethylcyclopentylamine
8. hexamethylenediamine
9. 6-aminocapronitrile
10. *n*-valeramide
11. adiponitrile
12. 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.

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.

Stabilwax®-DA Columns (fused silica)

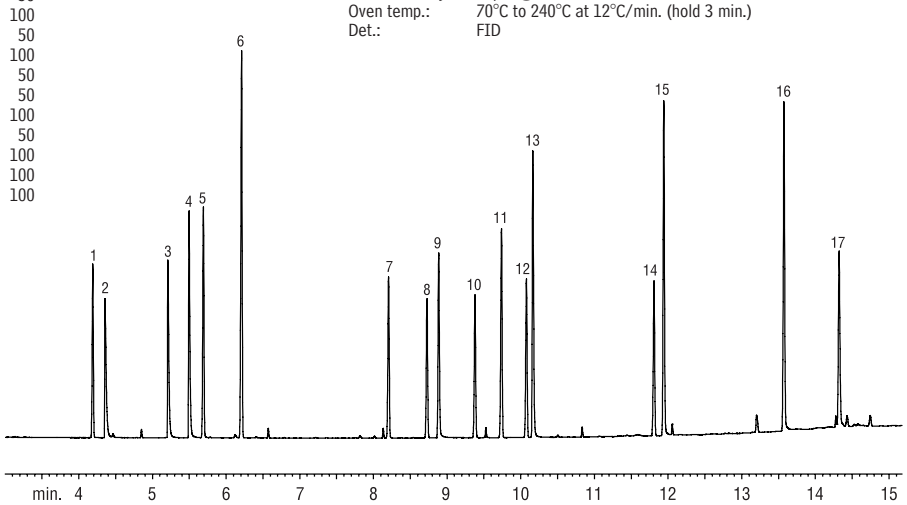
(Crossbond® Carbowax® polyethylene glycol for acidic compounds)

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: Stabilwax®-DA, 30m, 0.18mm ID, 0.18µm (cat.# 550752)
Inj.: 1µL 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®-βDEXm 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®-βDEXsm 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®-βDEXse 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-βDEXsm but provides better resolution for limonene, linalool, linalyl acetate, ethyl-2-methylbutyrate, 2,3-butane diol, and styrene oxides.

Rt®-βDEXsp 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-βDEXsm column, for complex enantiomeric separations.

Rt®-βDEXsa 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®-βDEXcst 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

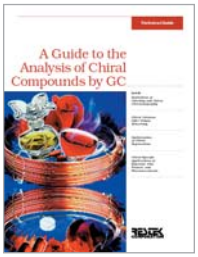
Uses: Proprietary stationary phase, developed specifically for the fragrance industry. Also used for pharmaceutical applications.

Rt®-γDEXsa 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®-γDEXsa GC Column

Applications Note
lit. cat.# 59553

GC Analysis of Chiral Flavor Compounds in Apple Juices, Using Rt®-βDEXsm and Rt®-βDEXse Columns

Applications Note
lit. cat.# 59546

Download your free copies from **www.restek.com**.

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.

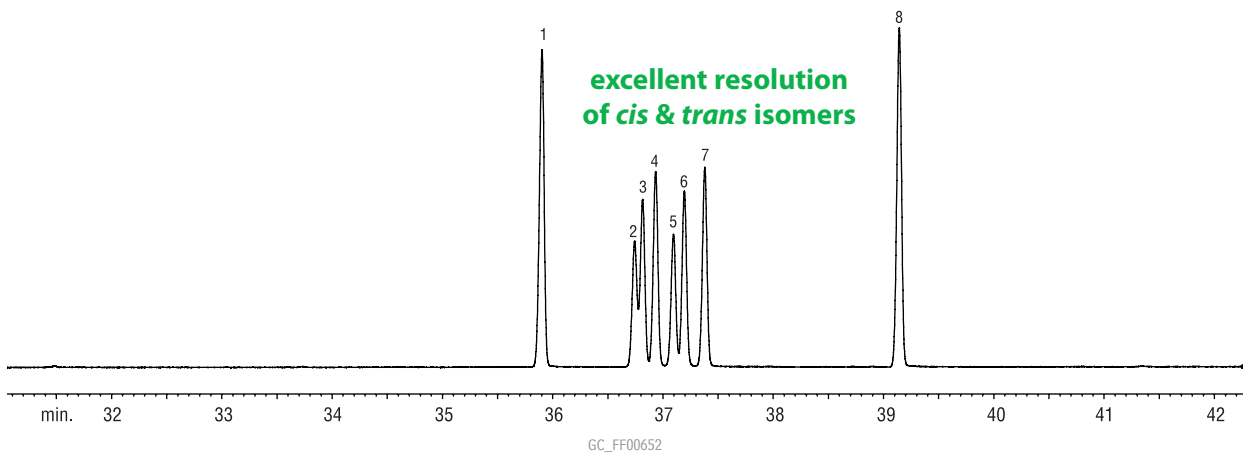
similar **phases**

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 (*trans*-6)	8.0
3. C18:1 methyl elaidate (*trans*-9)	10.0
4. C18:1 methyl transvaccenate (*trans*-11)	12.0
5. C18:1 methyl petroselinate (*cis*-6)	8.0
6. C18:1 methyl oleate (*cis*-9)	10.0
7. C18:1 methyl vaccenate (*cis*-11)	12.0
8. C18:2 methyl linoleate (*cis*-9,12)	20.0

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.

similar **phase**

Omegawax

FAMEWAX Columns (fused silica)

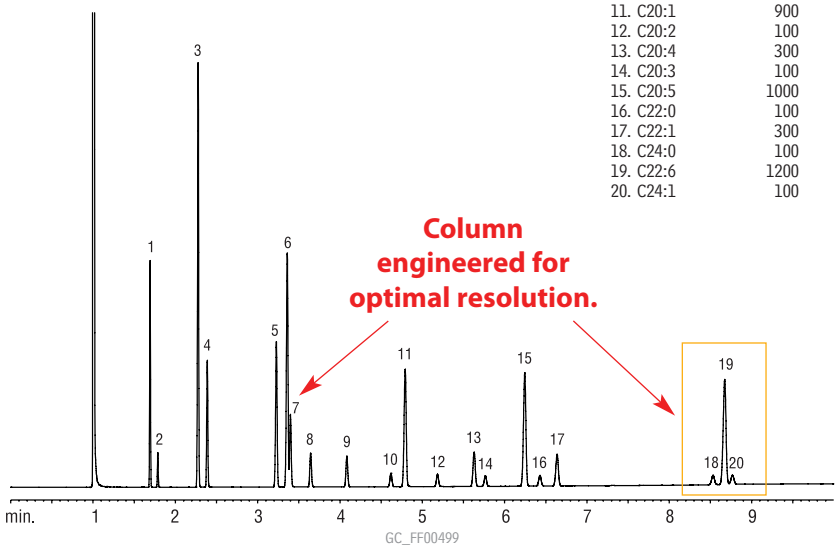
(Crossbond® polyethylene glycol)

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

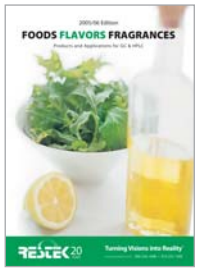
FAMEs (marine oil standard) on a FAMEWAX column.

Column: FAMEWAX, 30m, 0.32mm ID, 0.25µm (cat.# 12498)
Inj.: 1µL
Conc.: 10,000µg/mL in isooctane (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



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**.

Flavor & Fragrance Compounds Analysis

Perfect confirmation column for F&F analysis!

similar **phases**

HP-20M, Carbowax® 20M

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.

similar **phase**

HP-1

Rtx®-1 F&F Columns (fused silica)
(Crossbond® 100% dimethyl polysiloxane)

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

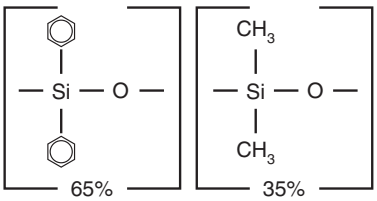
Triglycerides in Foods Analysis

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 Structure



Rtx®-65TG Columns (fused silica)
(Crossbond® 65% diphenyl/35% dimethyl polysiloxane)

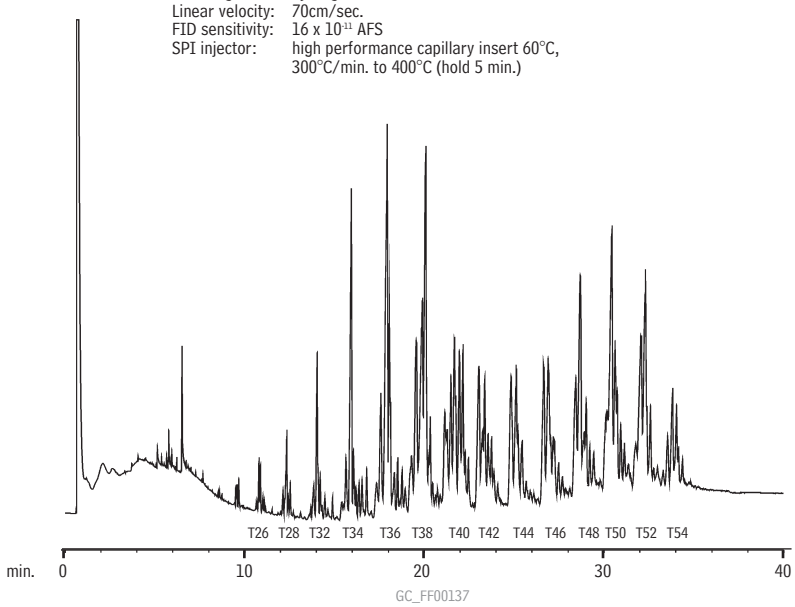
ID	df (µm)	temp. limits	15-Meter	30-Meter
0.25mm	0.10	40 to 370°C	17005	17008
0.32mm	0.10	40 to 370°C	17006	17009
0.53mm	0.10	40 to 370°C	17007	17010

save **money**!

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

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 isooctane
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.)



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)

Detailed Hydrocarbon Analysis (DHA)

NEW! 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.

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.

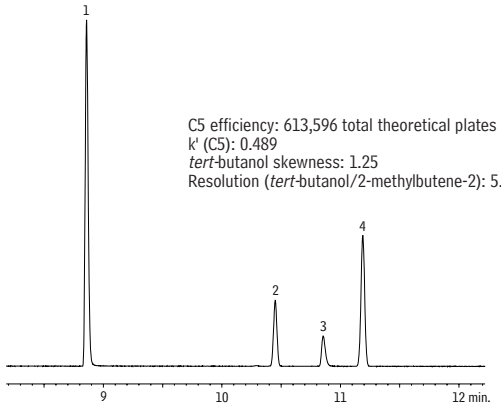
Rtx®-1PONA Column (fused silica)
(Crossbond® 100% dimethyl polysiloxane—optimized for hydrocarbon analysis)

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.**



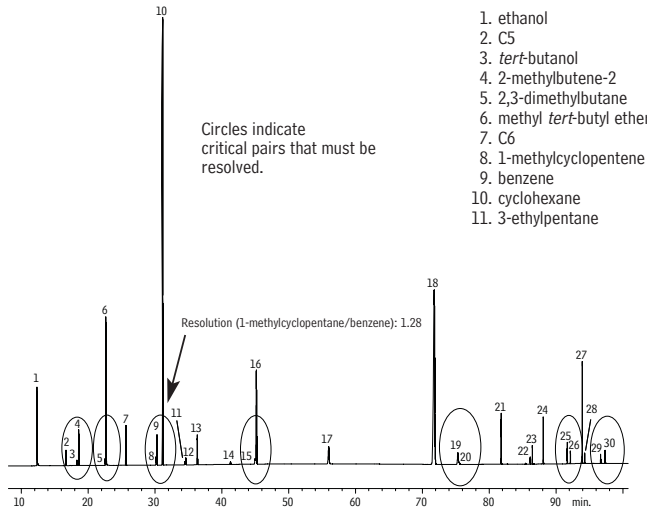
C5 efficiency: 613,596 total theoretical plates
k' (C5): 0.489
tert-butanol skewness: 1.25
Resolution (*tert*-butanol/2-methylbutene-2): 5.60

1. ethanol
2. C5
3. *tert*-butanol
4. 2-methylbutene-2

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.



GC_PC00743

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-*tert*-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 (undecane)
26. 1,2,3,5-tetramethylbenzene
27. naphthalene
28. C12 (dodecane)
29. 1-methylnaphthalene
30. C13 (tridecane)

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.

also **available**

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

similar **phases**

DB-2887, Petrocol EX2887

Rtx®-2887 Column (fused silica)

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

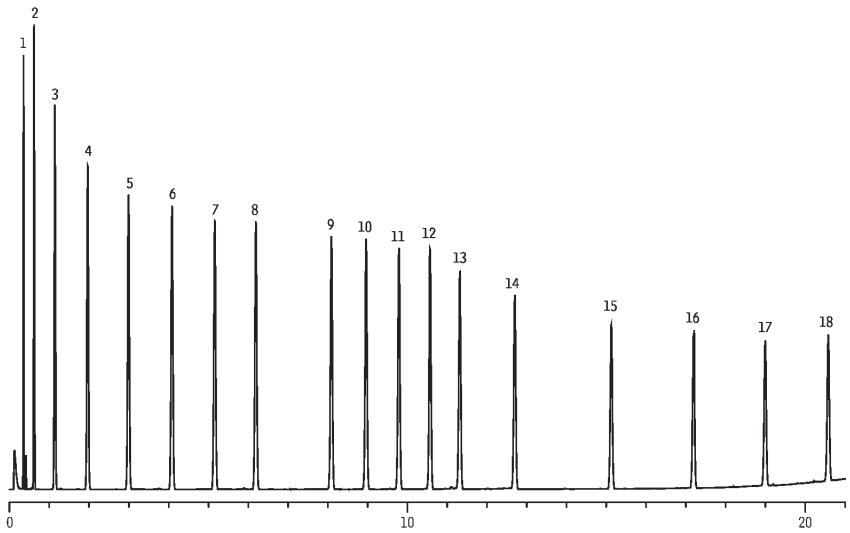
ID	df (µm)	temp. limits	10-Meter
0.53mm	2.65	-60 to 360°C	10199

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

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

GC_PC00750

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.

NEW! MXT®-1HT Sim Dist column now available in 0.20µm film thickness.

similar phases

DB-1HT, CP-HT-Simdist CB

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

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

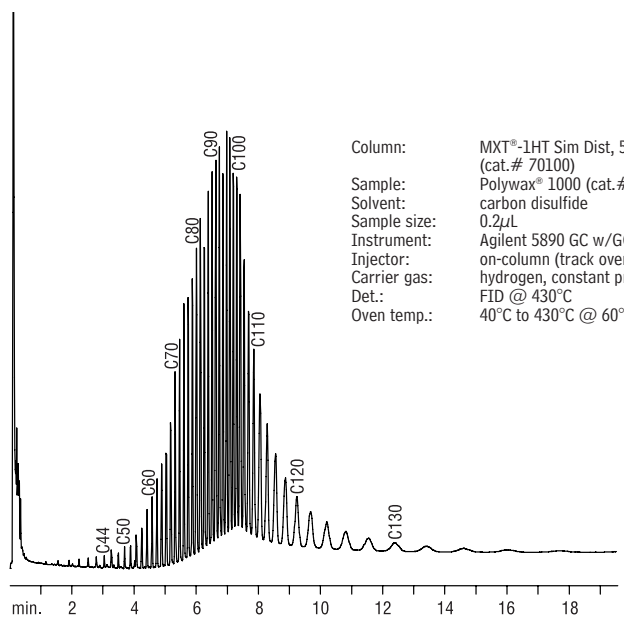
MXT®-500 Sim Dist Column (Siltek® treated stainless steel)

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

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.



Column: MXT®-1HT Sim Dist, 5m, 0.53mm ID, 0.10µm (cat.# 70100)
Sample: Polywax® 1000 (cat.# 36227)
Solvent: carbon disulfide
Sample size: 0.2µL
Instrument: Agilent 5890 GC w/GC Racer
Injector: on-column (track oven)
Carrier gas: hydrogen, constant pressure (1.0psi)
Det.: FID @ 430°C
Oven temp.: 40°C to 430°C @ 60°C/min. (hold 30 min.)

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.

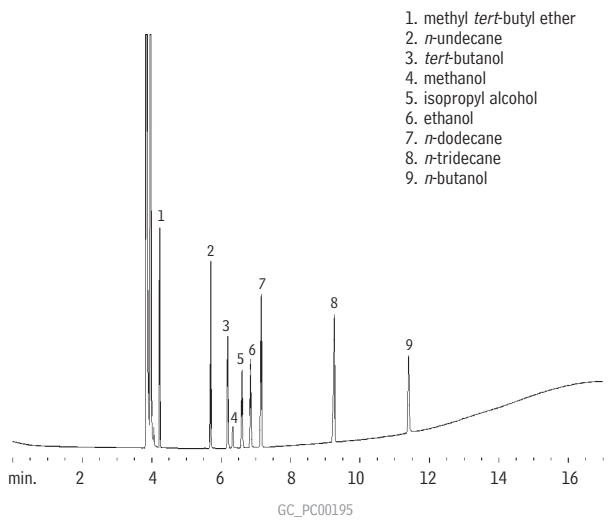
similar **phases**

SPB-TCEP, CP-TCEP

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.



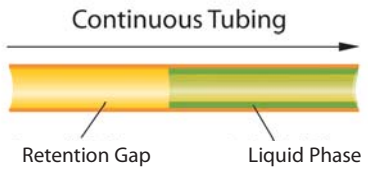
Column:	Rt®-TCEP, 60m, 0.25mm ID, 0.4µm (cat.# 10999)
Inj.:	1.0µL split injection, components @ 500ppm.
Oven temp.:	60°C (hold 5 min.) to 100°C @ 5°C/min. (hold 10 min.)
Inj./det. temp.:	200°C
Carrier gas:	helium
Linear velocity:	30cm/sec. set @ 80°C
FID sensitivity:	6.4 x 10^{-11} AFS
Split flow:	46mL/min.

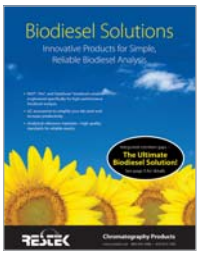
Biodiesel Fuels Analysis

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

Integra-Gap™ technology

- Built-in retention gap
- Eliminates connector





free literature

Biodiesel Solutions: Innovative Products for Simple, Reliable Biodiesel Analysis

Download your free copy from **www.restek.com**.

Flyer
lit. cat.# 580207

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.

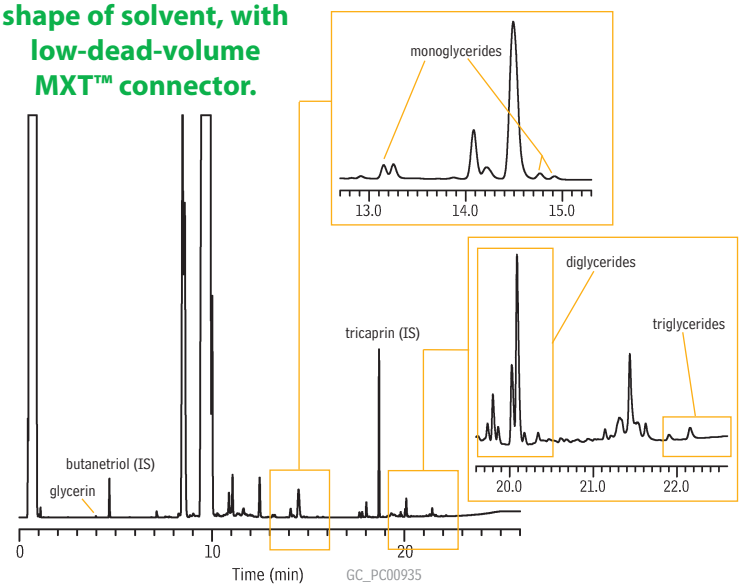
MXT®-Biodiesel TG Columns (Siltek® treated stainless steel)

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		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:	MXT®-Biodiesel TG, 10m, 0.32mm ID, 0.1µm with 2m x 0.53mm retention gap (cat.# 70290)
Sample:	B100 + IS butanetriol & tricaprin derivatized with MSTFA as per ASTM D-6584
Inj.:	1.0µL 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

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.

restek **innovation**!

Baseline resolution in less than 3 minutes.

similar **phases**

DB-ALC1, DB-ALC2

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)

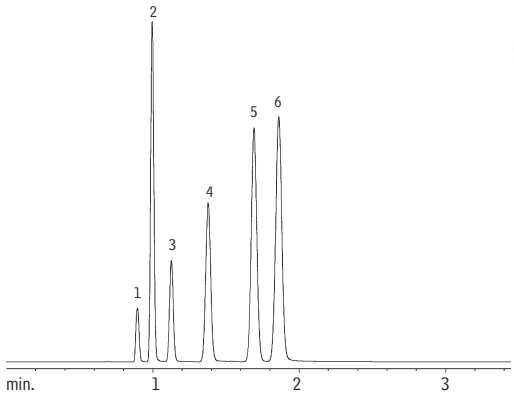
ID	df (µm)	temp. limits	30-Meter
0.32mm	1.20	-20 to 240/260°C	18002
0.53mm	2.00	-20 to 240/260°C	18000

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**.

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

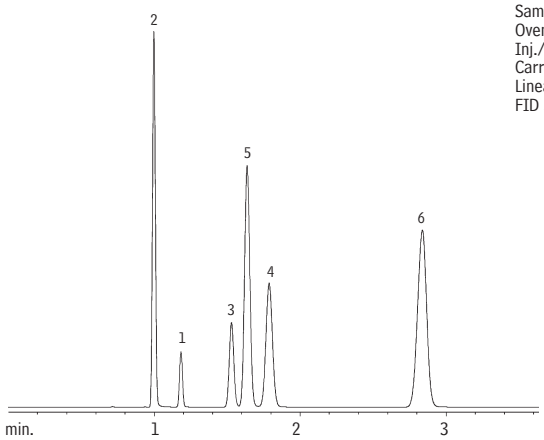
Rtx®-BAC1
30m, 0.53mm ID, 3.0µm (cat.# 18001)



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, 2.0µm (cat.# 18000)

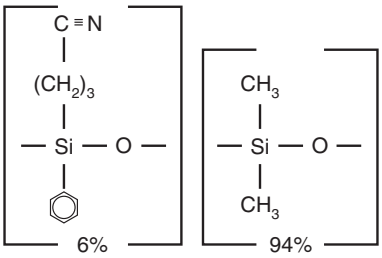


Inj.:	1.0mL headspace sample of a blood alcohol mix
Sample conc.:	0.1% per compound
Oven temp.:	40°C
Inj./det. temp.:	200°C
Carrier gas:	helium
Linear velocity:	80cm/sec. set @ 40°C
FID sensitivity:	1.28 x 10^{-10} AFS

GC_PH00239

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.

OVI Retention Index p.691

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

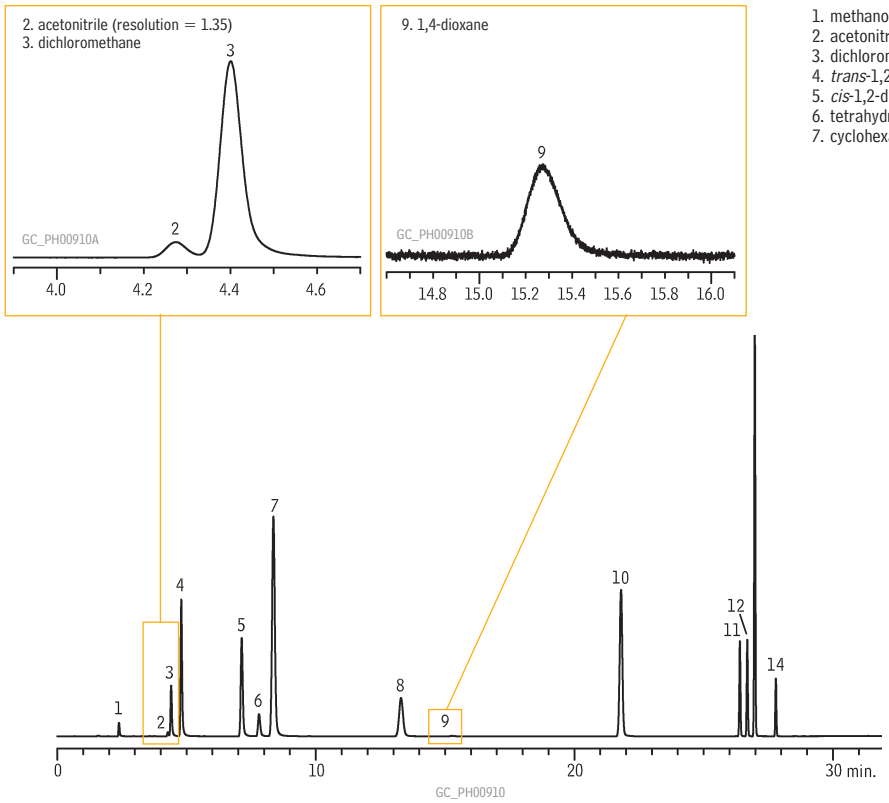
Rtx®-624 Columns (fused silica)

(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.



1. methanol
2. acetonitrile (resolution=1.35)
3. dichloromethane
4. *trans*-1,2-dichloroethene
5. *cis*-1,2-dichloroethene
6. tetrahydrofuran
7. cyclohexane
8. methylcyclohexane
9. 1,4-dioxane
10. toluene
11. chlorobenzene
12. ethyl benzene
13. *m*-xylene/*p*-xylene
14. *o*-xylene

Column:	Rtx®-624, 30m, 0.32 ID, 1.8µm (cat.# 10970)
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.

Organic Volatile Impurities (OVI) Analysis

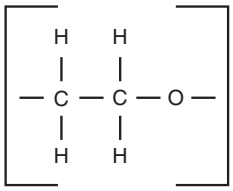
G16 phase

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® Structure



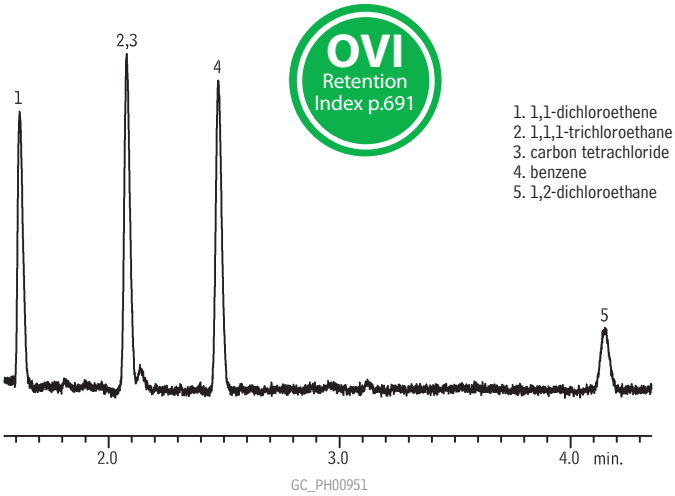
Stabilwax® Columns (fused silica)
(Crossbond® Carbowax® polyethylene glycol)

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

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**

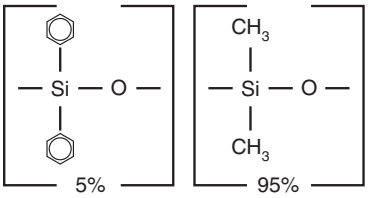
Get the protection without the connection!
For Stabilwax® columns with built-in Integra-Guard™ guard columns, see **page 33**.

also **available**

Other Dimensions!
For our complete listing of Stabilwax® columns, see **page 57**.

G27 phase

Rtx®-5 Structure



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.

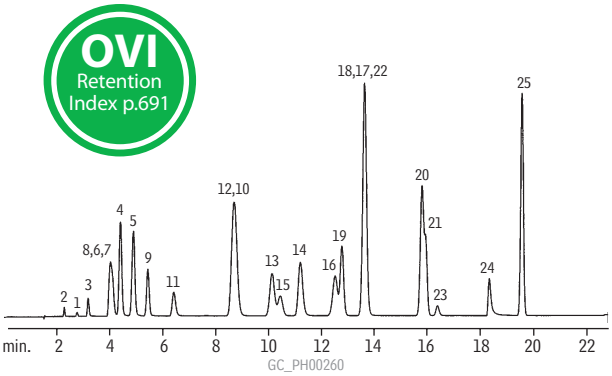
similar **phases**

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 on an Rtx®-5 (Rtx®-G27) column.



Rtx®-5 (Rtx®-G27) with 5m phenylmethyl Integra-Guard™ guard column, 30m, 0.53mm ID, 5.0µm (cat.# 10279-126)

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

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 10^{-11} AFS
Carrier gas:	helium, 35cm/sec. set @ 35°C
Split ratio:	2:1

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.

please **note**

Analytical Reference Materials for USP <467> are available. See **pages 479-480**.

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

free literature

A Technical Guide for Static Headspace Analysis Using GC

Download your free copy from **www.restek.com**.

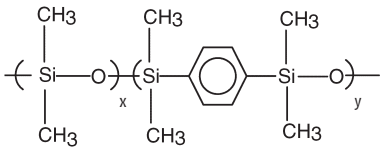
Technical Guide
lit. cat.# 59895A

"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)

Semivolatiles Analysis

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.

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.

Rxi®-5Sil MS Columns (fused silica)

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

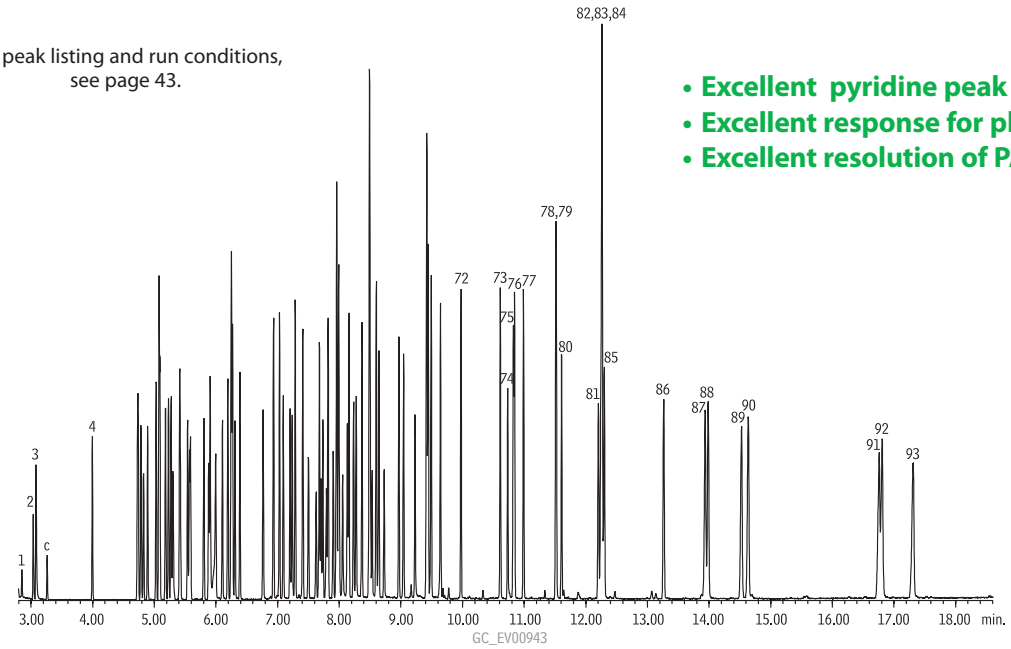
ID	df (µm)	temp. limits	15-Meter	30-Meter	60-Meter
0.25mm	0.10	-60 to 330/350°C	13605	13608	
	0.25	-60 to 330/350°C	13620	13623	13626
	0.50	-60 to 330/350°C	13635	13638	
	1.00	-60 to 325/350°C	13650	13653	13697
0.32mm	0.25	-60 to 330/350°C	13621	13624	
	0.50	-60 to 330/350°C		13639	
	1.00	-60 to 325/350°C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

- **Excellent pyridine peak shape.**
- **Excellent response for phenols.**
- **Excellent resolution of PAHs.**



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.

FAST efficient analysis of OPPs in EPA Method 8141A

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.

restek innovation!

- Better separations
- Faster analysis

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

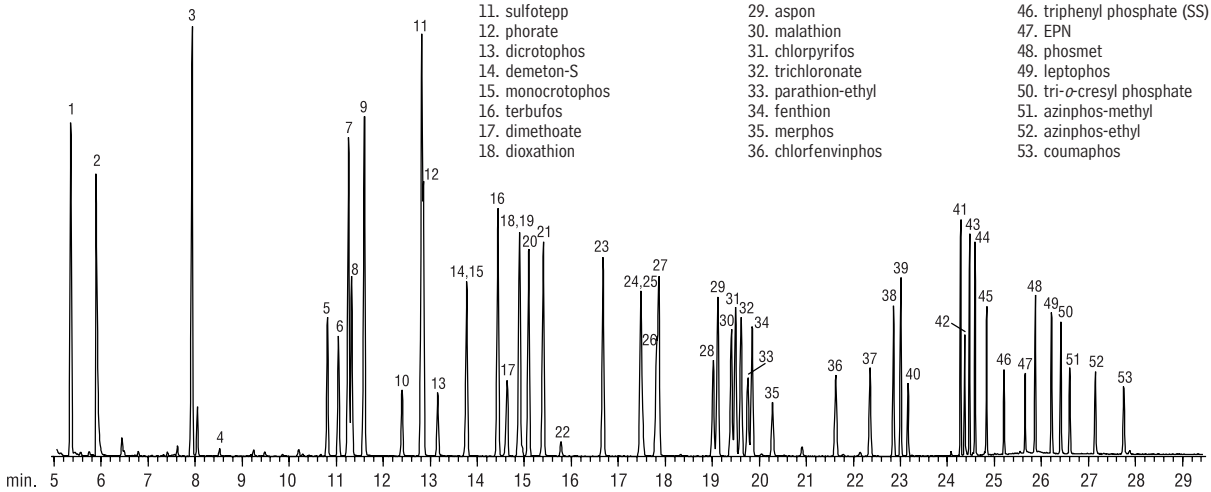
Rtx®-OPPesticides2 Columns (fused silica)

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. sulfotepp
12. phorate
13. dicrotophos
14. demeton-S
15. monocrotophos
16. terbufos
17. dimethoate
18. dioxathion
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. chlorfenvinphos
37. crotoxyphos
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)	Inj. temp.:	250°C
Sample:	US EPA Method 8141A Custom Standard Mix 1µL 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*	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
Inj.:	1.0µL splitless (hold 0.4 min.), 4mm double gooseneck inlet liner (cat.# 20785)	Transfer line temp.:	280°C
		Scan range:	35-400amu
		Ionization:	EI

Chlorinated Pesticides Analysis

restek **innovation**!

- Very low bleed
- Faster 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.

free literature

Fast GC Analysis of Chlorinated Pesticides

Download your free copy from **www.restek.com**

Flyer
lit. cat.# 59547A

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	

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.

Rtx®-CLPesticides Column Kits

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

kit

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	

kit

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	

kit

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	

ordering **note**

Add "-530" or "-535" to the catalog number for the kit, to save on the cost of the reference mix.

Add a reference mix to your kit order and save!

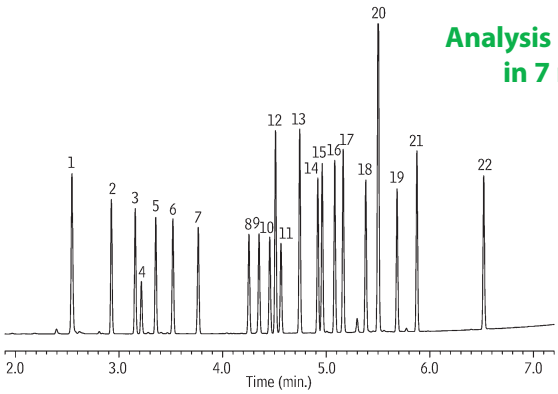
Description	list price	price with/kit	suffix #
Organochlorine Pesticide Mix AB #1 (cat.# 32291)		enquire	-530
Organochlorine Pesticide Mix AB #2 (cat.# 32292)		enquire	-535

Chlorinated Pesticides Analysis

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

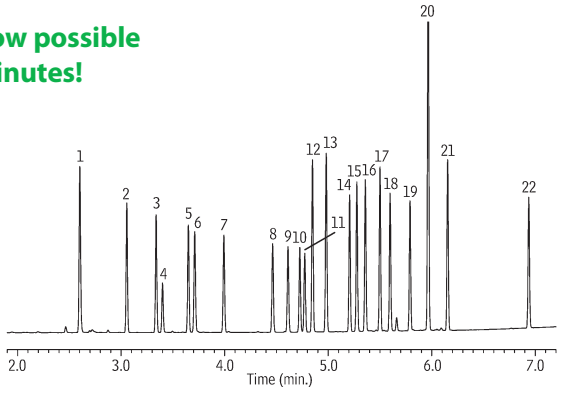
Rtx®-CLPesticides & Rtx®-CLPesticides2 columns (0.32mm ID)

Rtx®-CLPesticides



Analysis now possible in 7 minutes!

Rtx®-CLPesticides2

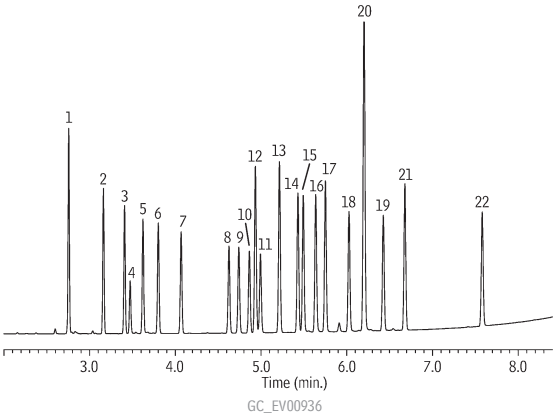


Columns:	Rtx®-CLPesticides, 30m, 0.32mm ID, 0.32µm (cat.# 11141) and Rtx®-CLPesticides2, 30m, 0.32mm ID, 0.25µm (cat.# 11324) with 5m x 0.32mm ID Rxi® deactivated guard tubing (cat.# 10039), connected using Deactivated Universal "Y" Press-Tight® connector (cat.# 20405-261)
Sample:	Organochlorine Pesticide Mix AB #2, 8-80µg/mL each component in hexane/toluene (cat.# 32292), Pesticide Surrogate Mix, 200µg/mL each component in acetone (cat.# 32000)
Inj.:	1.0µL 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

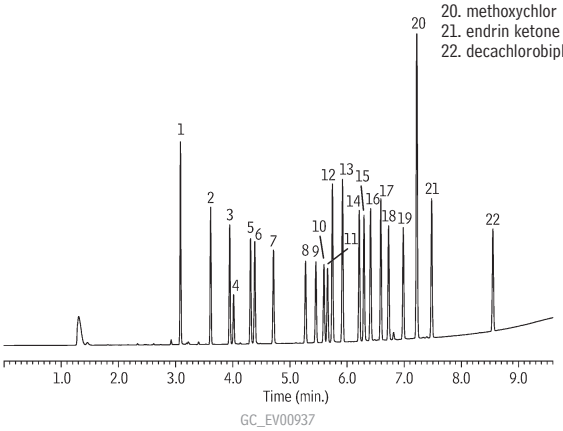
1. 2,4,5,6-tetrachloro-*m*-xylene (SS)
2. α-BHC
3. γ-BHC
4. β-BHC
5. δ-BHC
6. heptachlor
7. aldrin
8. heptachlor epoxide (isomer B)
9. γ-chlordane
10. α-chlordane
11. endosulfan I
12. 4,4'-DDE
13. dieldrin
14. endrin
15. 4,4'-DDD
16. endosulfan II
17. 4,4'-DDT
18. endrin aldehyde
19. endosulfan sulfate
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, 0.50µm (cat.# 11140) and Rtx®-CLPesticides2, 30m, 0.53mm ID, 0.42µm (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, 8-80µg/mL each component in hexane/toluene (cat.# 32292), Pesticide Surrogate Mix, 200µg/mL each component in acetone (cat.# 32000)
Inj.:	1.0µL 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

Chlorinated Pesticides Analysis

restek **innovation**!

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.

it's a **fact**

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

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

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.)

kit

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	

kit

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.

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.

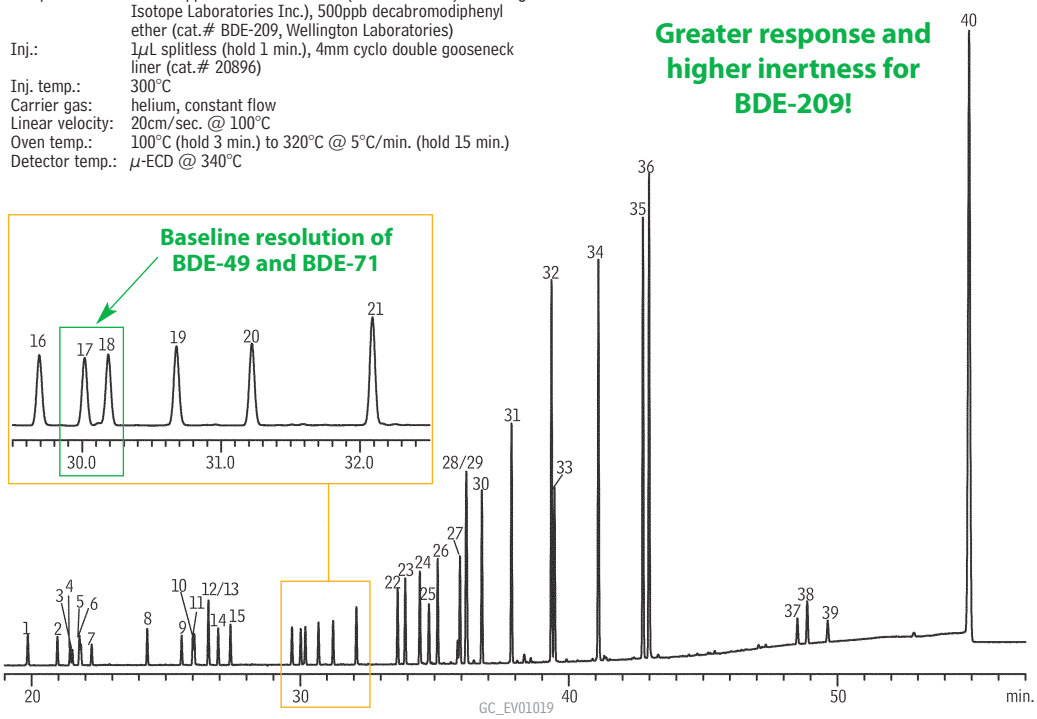
NEW!

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



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

restek **innovation**!

PCB Congeners Analysis

Rtx®-PCB (proprietary Crossbond® phase)

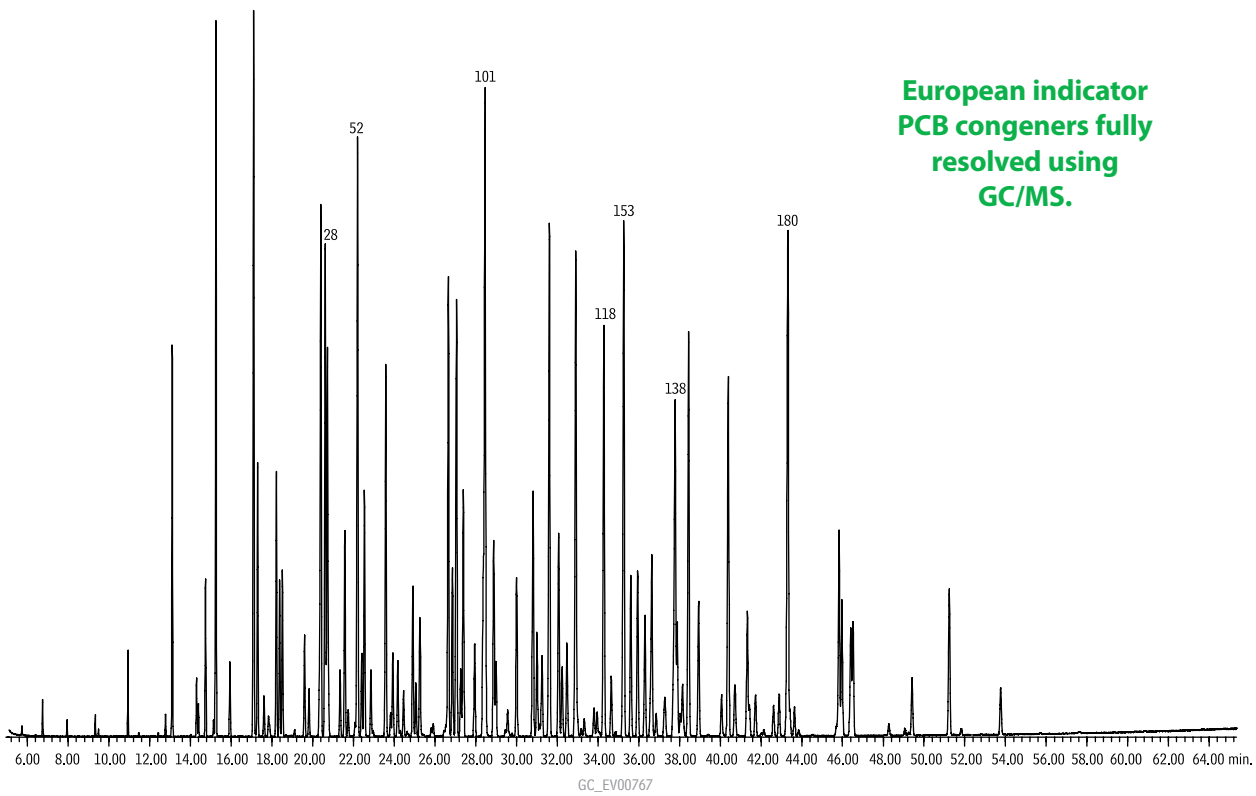
- Unique polymer for PCBs analysis by GC/ECD or GC/MS.
- Good results for other semivolatiles.
- Low polarity; inert to active compounds.
- Stable to 340°C.

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.



European indicator PCB congeners fully resolved using GC/MS.

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).

also **available**

Other Dimensions!
See **page 44** for our complete listing of Rxi®-XLB columns.

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.

similar **phases**

DB-XLB, VF-Xms

restek **innovation**!

also **available**

Rtx®-Dioxin2 columns.
See **page 87**.

Dioxin & Furan Congeners Analysis

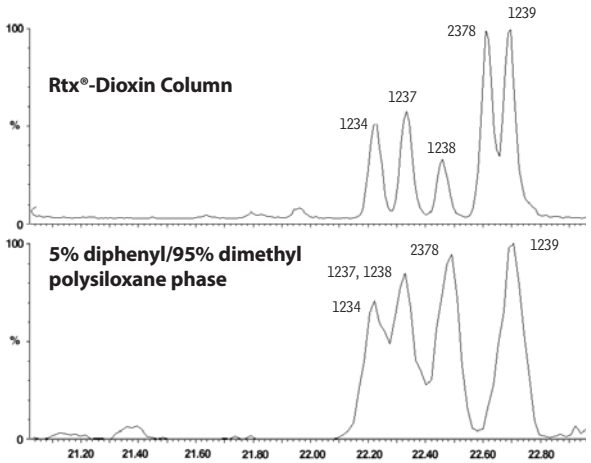
Rtx®-Dioxin (proprietary Crossbond® phase)

- 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.



Temperature program:

	Time (min.)	Rate (ºC/min.)	Temp. (ºC)
	0	52	200
	10.2	2.9	235
	10	6.9	300
	24		

Injector temp.: 270°C
Flow: 1.2mL/min. (constant pressure)

Column: Rtx®-Dioxin, 40m, 0.18mm ID, 0.11µm
Initial temp.: 130ºC
Instrument: Micromass Altima high resolution GC/MS

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.

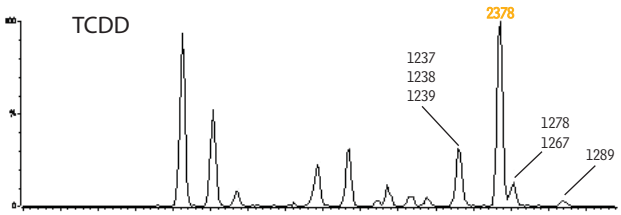
restek innovation!

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	

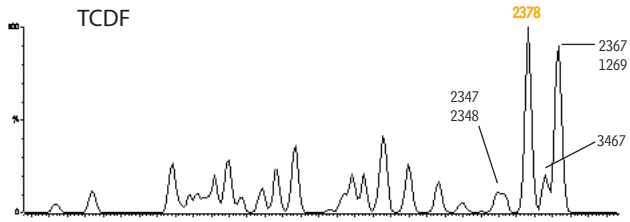
2,3,7,8-Tetrachlorodibenzodioxin resolved from other TCDD congeners, using an Rtx®-Dioxin2 column.



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

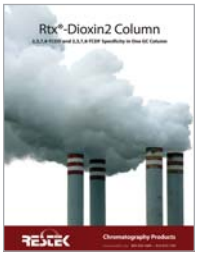
Tetrachlorodibenzofuran congeners on an Rtx®-Dioxin2 column.



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

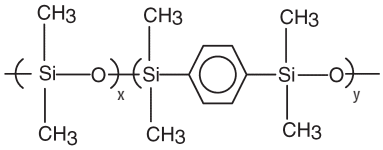
All 128 tetra through octa dioxin and furan congeners acquired on the Rtx®-Dioxin2 column.

Download your free copy from **www.restek.com**

Flyer
lit. cat.# 580119A

Polycyclic Aromatic Hydrocarbon (PAH) Analysis

Rxi™-5Sil MS Structure



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.

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.

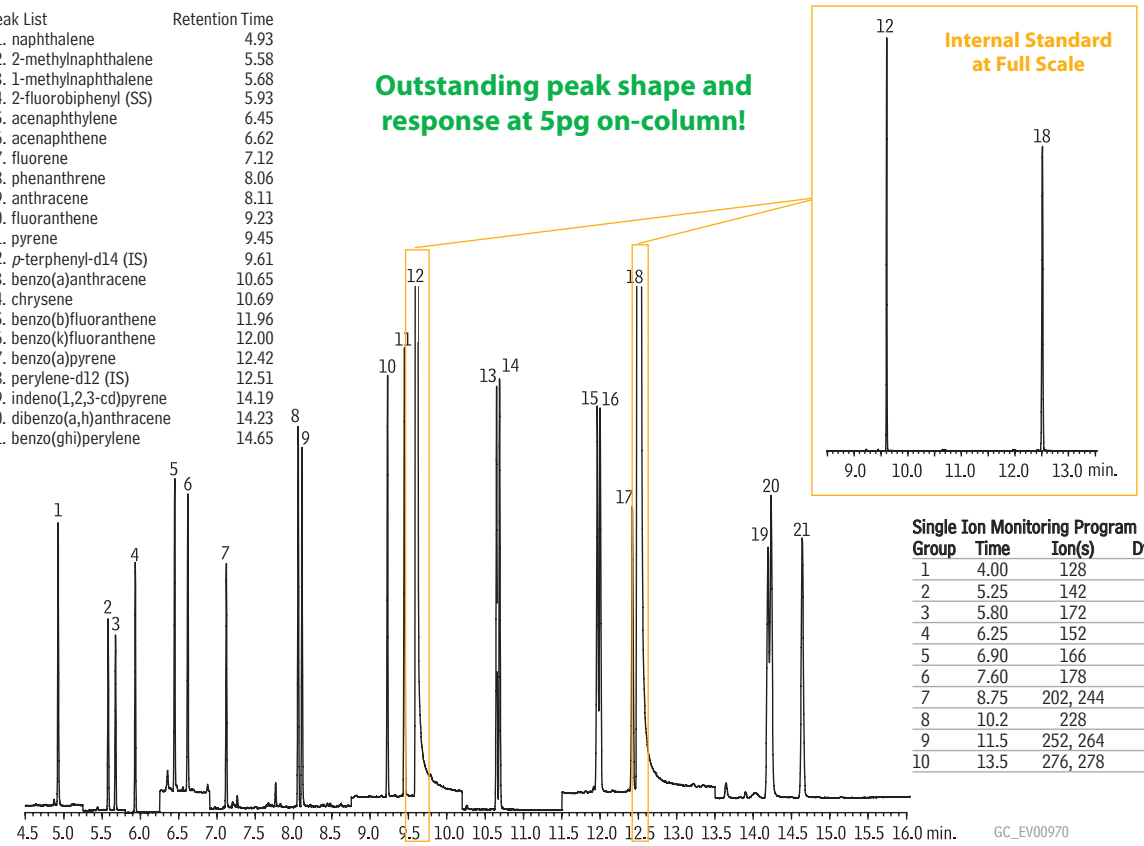
Rxi®-5Sil MS Columns (fused silica)
(Crossbond®, selectivity close to 5% diphenyl/95% dimethyl polysiloxane)

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



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

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

Polycyclic Aromatic Hydrocarbon (PAH) Analysis

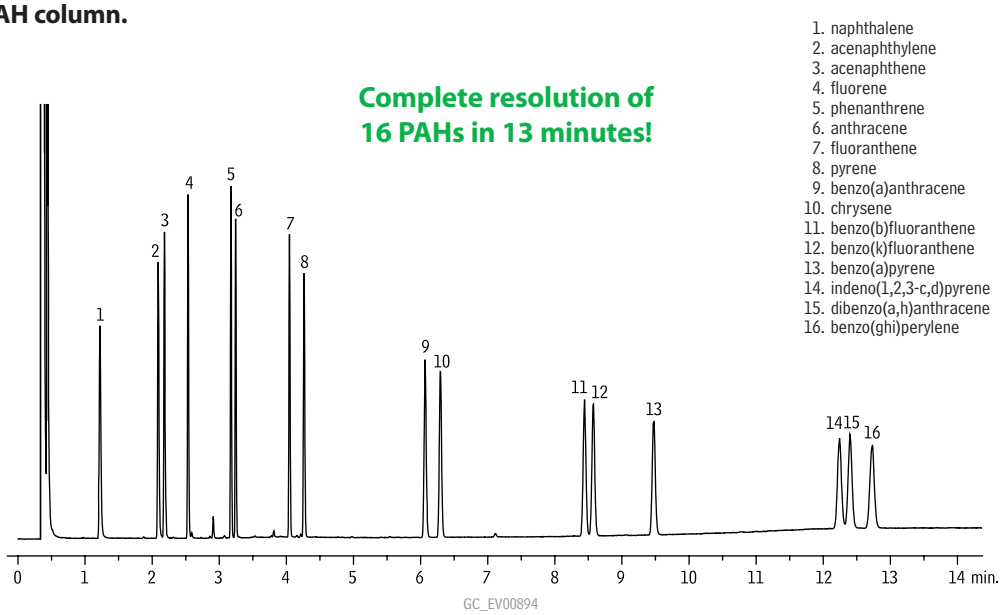
Rt®-PAH (polar, proprietary liquid crystalline phase)

- 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.



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
Oven 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	

Volatile Organics Analysis

restek **innovation**!

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

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

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.

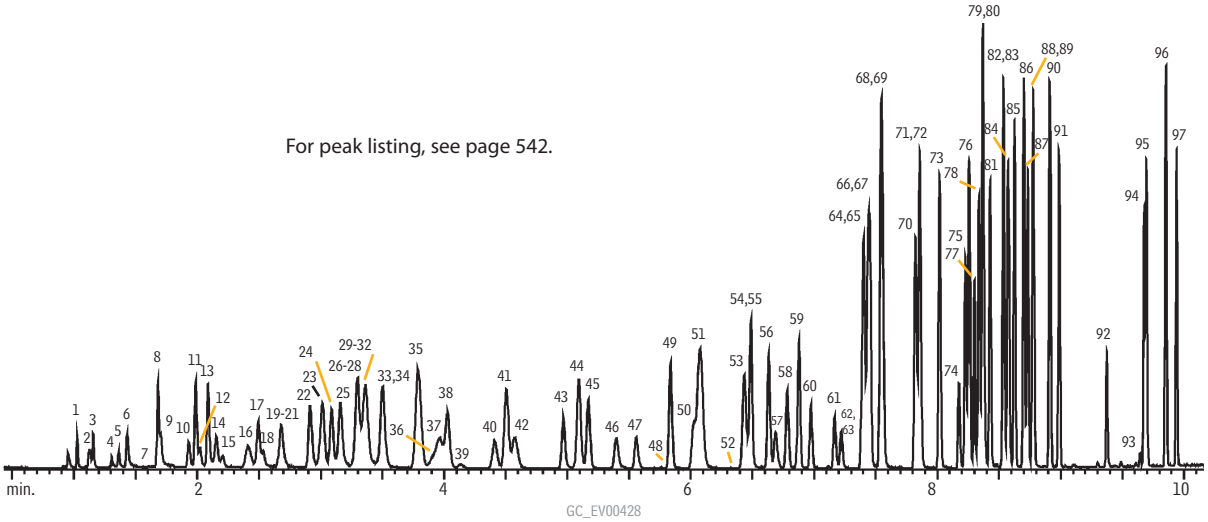
Rtx®-VMS Columns (fused silica)

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.

For peak listing, see page 542.



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

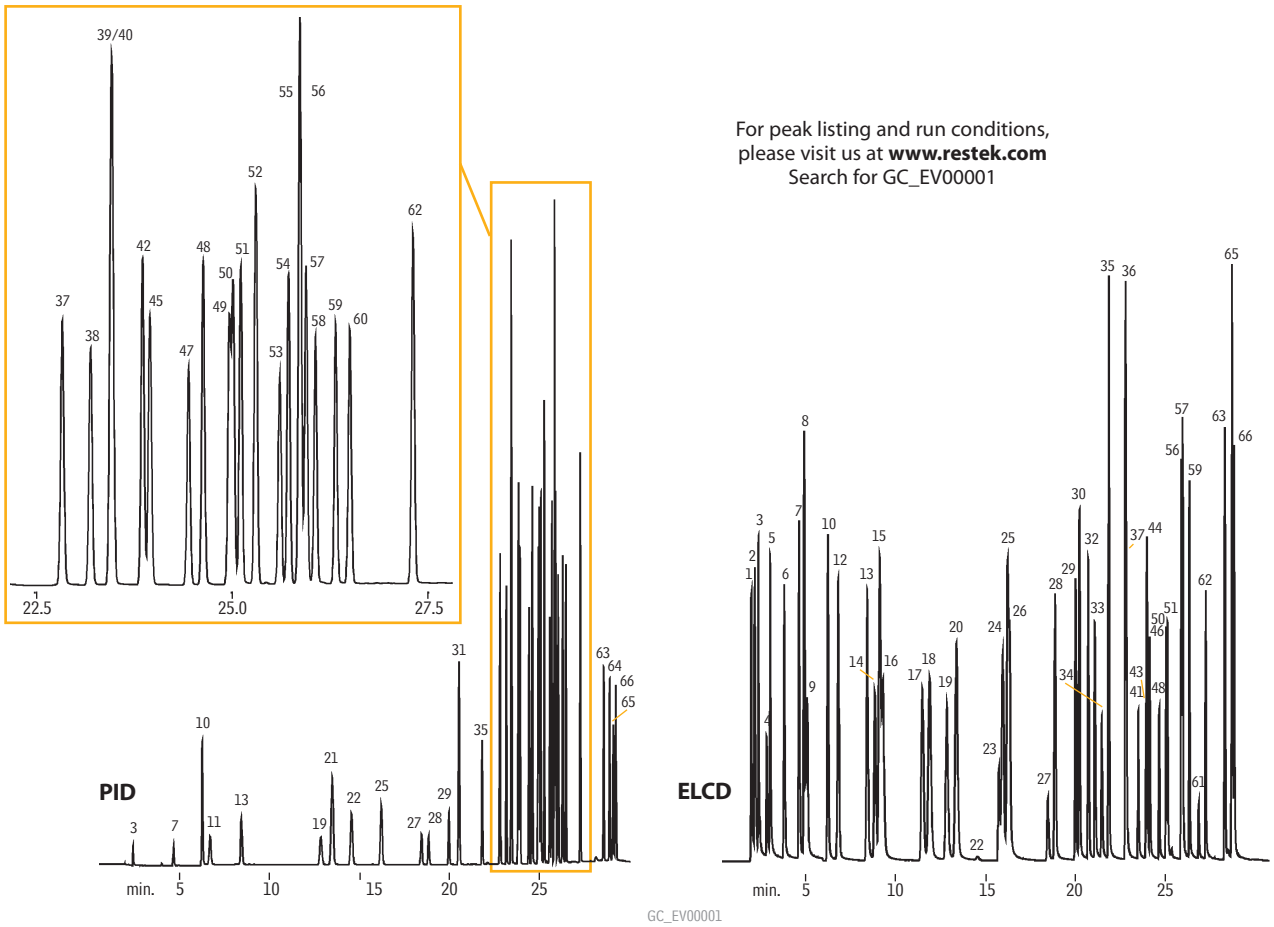
similar **phases**

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)

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

similar **phase**

DB-502.2

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)

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

similar **phase**

VOCOL

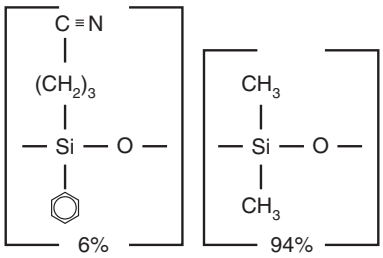
Volatile Organics Analysis

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 Structure



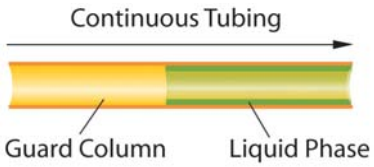
Rtx®-624 Columns (fused silica)
(Crossbond® 6% cyanopropylphenyl/94% dimethyl polysiloxane)

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.



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.