GC COLUMNS
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Selecting a GC Column

Strategic column choices can improve lab productivity by assuring that speed and resolution are optimized. While the number of choices available can be daunting, consideration of the resolution equation variables—selectivity, retention (capacity), and efficiency—simplifies the decision. Selectivity determines which stationary phase is most appropriate, and it can be approximated using retention indices or existing applications. Once the phase has been chosen, physical dimensions (internal diameter, film thickness, length) can be selected based on retention and efficiency. Understanding how selectivity, retention, and efficiency influence separations allows analysts to make effective, informed choices and quickly select the best column for specific separations.

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

Efficiency | Retention | Selectivity

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

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 between the analyte and 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 the attractive forces are strong. If they are dissimilar, then analyte to stationary phase attraction is weak, and less retention is observed. Therefore, when selecting a stationary phase, knowledge of the structure of the analytes of interest and the stationary phase is crucial. The reference table on page 27 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". Since benzene solvates more readily with the stationary phase, it has 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.

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Pro *ez*GC Methods Development Software

- Optimize temperature and flow programs with a single analysis.
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- Optimize dual-column run conditions, columns in parallel or in series.

Take the guesswork out of selecting the best column and conditions for your GC analysis. Pro *ez*GC software accurately predicts separations on any capillary column, and is useful for selecting a column and conditions from a single GC run. Using your retention data, or the extensive library, you can automatically evaluate thousands of combinations of column dimensions, oven temperature programs, and carrier gas pressure programs to determine the best separation with the fastest analysis time.

Pro *ez*GC includes a master set of retention index libraries at no extra charge! These libraries contain more than 3,000 compounds analyzed on the most commonly used stationary phases, in ten application areas, including pesticides, PCBs, dioxins/furans, flavor and fragrance compounds, drugs of abuse, FAMEs, semivolatile and volatile pollutants, petroleum hydrocarbons, and solvents and chemicals. The libraries permit computer simulation without entering actual laboratory data.

Description	qty.	cat.#	price
Pro *ez*GC Method Development Software CD-ROM	ea.	21487	$201

Table I lists the Kovats retention indices for the more common stationary phases. 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 column selectivity for 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

Retention, k

The capacity of the column relates to how much material can be injected onto a column without adversely affecting peak shape. If the amount of a compound (mass) exceeds the capacity of a column (WCOT), the peak will front, which sometimes can look like a "shark fin". The goal is to select a column with sufficient capacity such that peak shape will not suffer. Peak symmetry is typically used to calculate the degree of sample overload. 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 the detector and how much flow it can optimally work under. For example, some MS detectors can only handle column flow rates of up to 1.5 mL/min.; therefore, a 0.53 mm ID column, which requires higher flows for proper chromatography, is not an option for this detector. The third consideration is sample capacity of the column. If the concentration of the sample exceeds the column capacity, loss of resolution, poor reproducibility, and peak distortion will result. Table II shows several typical column characteristics for various column IDs.

Table II Typical characteristics for columns with the same phase ratio, such as 0.10 mm ID x 0.10 µm and 0.18 mm ID x 0.18 µm, etc.

	Column ID					
Characteristic	0.10mm	0.15mm	0.18mm	0.25mm	0.32mm	0.53mm
Helium Flow (@ 20cm/sec.)	0.16mL/min.	0.3mL/min.	0.3mL/min.	0.7mL/min.	1.2mL/min.	2.6mL/min.
Hydrogen Flow (@ 40cm/sec.)	0.32mL/min.	0.6mL/min.	0.6mL/min.	1.4mL/min.	2.4mL/min.	5.2mL/min.
Sample Capacity (max load per component)	<10ng	<40ng	<50ng	50–100ng	400–500ng	1000–2000ng
Theoretical Plates/Meter	8000	4000	3500	3200	2500	1800

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, such as purity analysis.

Film thickness directly affects phase ratio (β), which is an important consideration when changing internal diameter. When internal diameter increases, film thickness (df) must increase in order to provide similar resolution and retention. Table III shows values for common dimensions of columns. Similar values indicate similar elution for different IDs.

Table III Phase ratio (β) values for common column dimensions.*

	Film Thickness (df) / β Value						
Column ID	0.10μm	0.25μm	0.50μm	1.0μm	1.5μm	3.0μm	5.0μm
0.18mm	450	180	90	45	30	15	9
0.25mm	625	250	125	63	42	21	13
0.32mm	800	320	160	80	53	27	16
0.53mm	1325	530	265	128	88	43	27

*β = r/2df (r=internal radius of tubing; df = phase film thickness)

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.

Conclusion

A basic understanding of the resolution equation allows analysts to make more effective column choices. Phase choice is influenced primarily by selectivity, which can be approximated by considering phase and analyte structures, as well as by referencing retention indices or existing applications. Column retention (capacity) and efficiency also affect separations and should influence decisions on column internal diameter, film thickness, and length. By considering these factors, analysts can simplify the column selection process and increase lab productivity by optimizing separations.

Selection of Capillary Column Summary

Selecting a capillary column for an analysis can be done by following these basic steps:

1) Choose the proper phase for the compounds being chromatographed

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

2) Select column ID, film thickness, and length

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

3) Set optimum parameters for your analysis

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

What Are the Operating Temperatures for My Column?

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

Rtx®-VMS (fused silica)

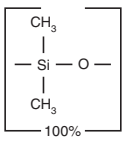
ID	df (µm)	temp. limits
0.25mm	1.40	-40 to 240/260°C
0.32mm	1.80	-40 to 240/260°C
0.45mm	2.55	-40 to 240/260°C
0.53mm	3.00	-40 to 240/260°C

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

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

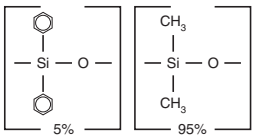
Structures, polarities, properties, and uses for Restek capillary column phases, in order of increasing polarity

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



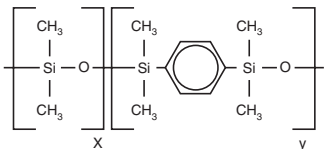
Polarity: nonpolar
Uses: solvents, petroleum products, pharmaceutical samples, waxes
[G1]

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



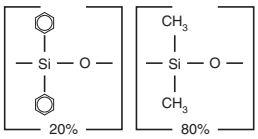
Polarity: slightly polar
Uses: flavors, environmental, aromatic hydrocarbons
[G27]

Rxi®-5Sil MS
5% phenyl
95% dimethyl arylene polysiloxane



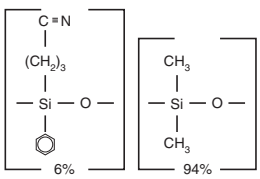
Polarity: slightly polar
Uses: flavors, environmental, pesticides, PCBs, aromatic hydrocarbons

Rtx®-20
20% diphenyl
80% dimethyl polysiloxane



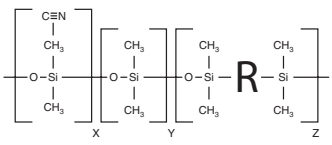
Polarity: slightly polar
Uses: volatile compounds, alcohols
[G32]

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



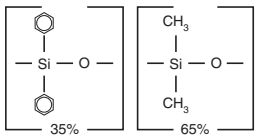
Polarity: slightly polar
Uses: volatile compounds, insecticides, residue solvents in pharmaceutical products
[G43]

Rxi®-624Sil MS
6% cyanopropylphenyl
94% dimethyl arylene polysiloxane



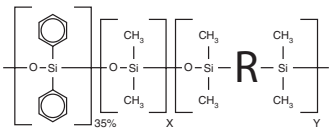
Polarity: intermediately polar
Uses: volatile compounds, insecticides, residue solvents in pharmaceutical products

Rtx®-35
35% diphenyl
65% dimethyl polysiloxane



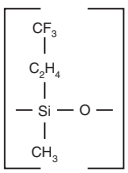
Polarity: intermediately polar
Uses: pesticides, Aroclor PCBs, amines, nitrogen-containing herbicides
[G42]

Rxi®-35Sil MS
35% phenyl
65% dimethyl arylene polysiloxane



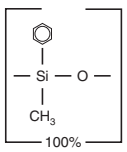
Polarity: intermediately polar
Uses: pesticides, Aroclor PCBs, amines, nitrogen-containing herbicides

Rtx®-200
trifluoropropylmethyl polysiloxane



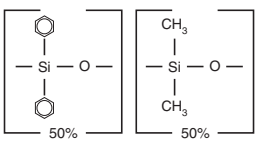
Polarity: selective for lone pair electrons
Uses: environmental, solvents, Freon® gases, drugs, ketones, alcohols
[G6]

Rtx®-50
50% phenyl
50% methyl polysiloxane



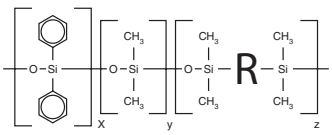
Polarity: intermediately polar
Uses: FAMEs, carbohydrates
[G3]

Rxi®-17
50% diphenyl
50% dimethyl polysiloxane



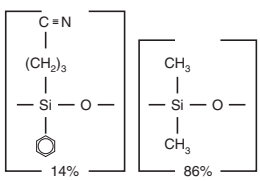
Polarity: intermediately polar
Uses: triglycerides, phthalate esters, steroids, phenols
[G3]

Rxi®-17Sil MS
50% phenyl
50% dimethyl arylene polysiloxane



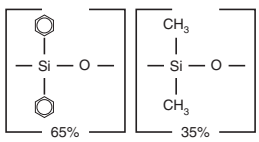
Polarity: intermediately polar
Uses: triglycerides, phthalate esters, steroids, phenols

Rtx®-1701
14% cyanopropylphenyl
86% dimethyl polysiloxane



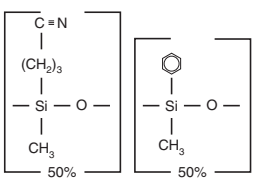
Polarity: intermediately polar
Uses: pesticides, Aroclor PCBs, alcohols, oxygenates
[G46]

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



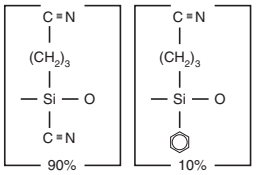
Polarity: intermediately polar
Uses: triglycerides, rosin acids, free fatty acids

Rtx®-225
50% cyanopropylmethyl
50% phenylmethyl polysiloxane



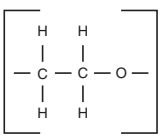
Polarity: polar
Uses: FAMEs, carbohydrates
[G7]

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]

note

Structures, polarities, and properties also apply to metal MXT® stationary phases.

Columns by Phase

Restek	Phase Composition	USP Nomenclature*	Agilent	Varian-Chrompack	SGE	Phenomenex	Macherey-Nagel	Supelco	Alltech	Quadrex
Rtx-1 (p. 49)	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-1HT (p. 47)	100% dimethyl polysiloxane		DB-1HT	VF-1HT		ZB-1HT			EC-1, AT-1HT	
Rxi-1ms (p. 41)	100% dimethyl polysiloxane (low bleed)		HP-1/ HP-1ms DB-1/ DB-1ms Ultra-1	VF-1ms / CP-Sil 5 CB Low Bleed/MS	BP-1	ZB-1, ZB-1ms	Optima-1ms, Optima-1ms Accent	SPB-1, Equity-1	AT-1	007-1
Rtx-5 (p. 50)	5% diphenyl 95% dimethyl polysiloxane	G27, G36	HP-5/ DB-5	CP Sil 8 CB	BP-5	ZB-5	Optima-5	SPB-5	EC-5, AT-5	007-5
Rxi-5HT (p. 47)	5% diphenyl 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	CP-Sil 8 CB	BP-5	ZB-5, ZB-5ms	Optima-5, Optima-5ms	SPB-5, Equity-5	AT-5ms	007-5
Rxi-5Sil MS (p. 42, 87, 95, 97)	5% phenyl/95% dimethyl arylene polysiloxane		DB-5ms, DB-5ms UI	VF-5ms / CP-Sil 8 CB Low Bleed/MS	BPX-5	ZB-5ms	Optima-5ms Accent	SLB-5ms		007-5MS
Rxi-XLB (p. 44, 94)	Arylene/methyl modified polysiloxane		DB-XLB	VF-XMS		MR1	Optima-XLB			
Rtx-20 (p. 51)	20% diphenyl 80% dimethyl polysiloxane	G28, G32						SPB-20	EC-20, AT-20	007-20
Rtx-35 (p. 51)	35% diphenyl 65% dimethyl polysiloxane	G42	HP-35, DB-35		BPX-35, BPX-608	ZB-35		SPB-35, SPB-608	AT-35	007-35
Rxi-35Sil MS (p. 44)	35% phenyl/65% dimethyl arylene polysiloxane		DB-35ms	VF-35ms	BP-35	MR2	Optima-35ms			
Rtx-50 (p. 52)	50% phenyl 50% methyl polysiloxane	G3	HP-50		AT-50		Optima-17	SPB-50	AT-50	007-17
Rxi-17 (p. 44)	50% diphenyl 50% dimethyl polysiloxane		HP-50+, HP-17, DB-17, DB-608	CP-Sil 24 CB		ZB-50	Optima-17			
Rxi-17Sil MS (p. 45, 73, 98)	50% phenyl/50% dimethyl arylene polysiloxane		HP-17, DB-17, DB-17ms	CP-Sil 24 CB, VF-17ms	BPX-50	ZB-50	Optima-17ms			
Rtx-65 (p. 52)	65% diphenyl 35% dimethyl polysiloxane	G17								007-65HT
Rxi-624Sil MS (p. 46, 83, 103)	6% cyanopropyl phenyl/94% dimethyl arylene polysiloxane	G43	HP-624, DB-624	VF-624ms	BP-624	ZB-624	Optima-624			
Rtx-1301 (p. 55) Rtx-624 (p. 55)	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, AT-1301	007-1301
Rtx-1701 (p. 56)	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. 54)	trifluoropropyl methyl polysiloxane	G6	DB-210, DB-200	VF-200ms			Optima-210		AT-210	007-210
Rtx-200ms (p. 54)	trifluoropropyl methyl polysiloxane (low bleed)			VF-200ms						
Rtx-225 (p. 56)	50% cyanopropyl 50% phenylmethyl polysiloxane	G7, G19	HP-225, DB-225	CP Sil 43 CB	BP-225		Optima-225	SPB-225	AT-225	007-225
Rtx-440 (p. 53)	modified polysiloxane (unique phase)		unique column							
Rt-2330 (p. 57)	90% biscyanopropyl 10% cyanopropyl phenyl polysiloxane	G48			BPX-70			SP-2330, SP-2331, SP-2380	AT-Silar	
Rt-2560 (p. 57, 69)	bicyanopropyl polysiloxane		HP-88	CP Sil 88				SP-2560		
Rtx-Wax (p. 58)	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. 59, 84)	polyethylene glycol	G14, G15, G16, G20, G39	Innowax	CP Wax 52 CB, VF-WAX MS		ZB-WAX Plus		Supelcowax-10		
Restek PLOT Columns	**Phase Composition**	**USP Nomenclature**	**Agilent**	**Varian**	**SGE**	**Phenomenex**	**Macherey-Nagel**	**Supelco**	**Alltech**	**Quadrex**
Rt-Alumina BOND/Na_2SO_4 (p. 108) MXT-Alumina BOND/Na_2SO_4	Na_2SO_4 deactivation		GS-Alumina, HP PLOT S	CP-AL_2O_3 / Na_2SO_4				AluminaSulfate-PLOT	AT-Alumina	
Rt-Alumina BOND/KCl (p. 108, 76)	KCl deactivation		GS-Alumina/KCl, HP-PLOT Al_2O_3/KCl	CP-Al_2O_3/KCl				AluminaChloride -PLOT		
Rt-Alumina BOND/CFC (p. 108, 74)			unique column							
Rt-Msieve 5A (p. 109) MXT-Msieve 5A			GS-Msieve, HP PLOT Molsieve	CP-Molsieve 5A				Molsieve 5A	AT-Molsieve	PLT-5A
Rt-Q-BOND (p. 110) MXT-Q-BOND	100% divinylbenzene			CP-PoraPLOT Q, CP-PoraBond Q				Supel-Q-PLOT	AT-Q	
Rt-QS-BOND (p. 110)	porous divinyl benzene homopolymer		GS-Q							
Rt-S-BOND (p. 110) MXT-S-BOND	divinylbenzene 4-vinylpyridine			CP-PoraPLOT S						
Rt-U-BOND (p. 110)	divinylbenzene ethylene glycol/dimethylacrylate		HP-PLOT U	CP-PoraPLOT U, CP-PoraBond U						

*See page 139 for our USP Liquid P

Columns by Application/Industry

Restek	Applications	Agilent	Supelco	Macherey-Nagel	SGE	Varian-Chrompack	Phenomenex
Specially deactivated phases							
Rtx-Volatile Amine (p. 63)	Volatile amines					CP-VolAmine	
Rtx-5Amine (p. 64)	Amines					CP-Sil 8 CB	
Rtx-35Amine (p. 65)	Amines	unique column					
Stabilwax-DB (p. 66)	Amines	CAM	Carbowax Amine			CP WAX 51	
Stabilwax-DA (p. 67)	Free fatty acids	HP-FFAP, DB-FFAP	Nukol	Permabond FFAP, Optima FFAP	BP-21	VF-DA, CP WAX 58 CB	ZB-FFAP
Chiral Columns							
Rt-βDEXm, Rt-βDEXsm, Rt-βDEXse, Rt-βDEXsp, Rt-βDEXsa, Rt-βDEXcst, Rt-γDEXsa (p. 68)	Chiral compounds						
Foods, Flavors, & Fragrances							
Rt-2560 (p. 69)	*cis/trans* FAMEs	HP-88	SPB-2560				
FAMEWAX (p. 70)	Marine oils		Omegawax				
Rt-CW20M F&F (p. 71)	Flavors & fragrance	HP-20m, CarboWax 20			BP-20M		
Rtx-1 F&F (p. 71)	Flavors & fragrance						
Rtx-65 TG (p. 72)	Triglycerides	unique column					
Petroleum & Petrochemical							
Rt-Alumina BOND/CFC (p. 74)	Chlorinated fluorocarbons (CFCs)						
Rtx-DHA (p. 75)	Detailed hydrocarbon analysis	HP-PONA, DB-Petro	Petrocol DH		BP1-PONA	CP Sil PONA CB	
Rtx-2887 (p. 77)	Hydrocarbons - ASTM 2887	DB-2887	Petrocol 2887, Petrocol EX2887				
MXT-2887 (p. 77)	Hydrocarbons - ASTM 2887						
D3606 (p. 128)	Ethanol - ASTM 3606	unique column					
Rt-TCEP (p. 80)			TCEP			CP-TCEP	
MXT-1HT SimDist (p. 77)	Simulated distillation	DBHT-SimDist				CP-SIMDIST	ZB-1T SimDist
MXT-1 SimDist (p. 79)	Simulated distillation	DBHT-SMD				CP-SIMDIST	Ultimetal
MXT-500 SimDist (p. 79)	Simulated distillation	unique column					
Rtx-Biodiesel TG (p. 81) MXT-Biodiesel TG (p. 81)	Triglycerides in biodiesel	unique column					
Clinical/Forensic - Blood Alcohol Testing							
Rtx-BAC1 (p. 82)	Blood alcohol testing	DB-ALC1					ZB-BAC1
Rtx-BAC2 (p. 82)	Blood alcohol testing	DB-ALC2					ZB-BAC2
Pharmaceutical							
Rtx-G27 w/IntegraGuard (p. 86)	Organic volatile impurities (OVI) - USP 467						
Rtx-G43 w/IntegraGuard (p. 86)	Organic volatile impurities (OVI) - USP 467		OVI-G43				
Rxi-624Sil MS (p. 83)	Organic volatile impurities (OVI) - USP 467	HP-624, DB-624			BP-624	VF-624	ZB-624
Rtx-5 (G27) (p. 85)	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 (G16) (p. 84)	Organic volatile impurities (OVI) - USP 467	Innowax	Supelcowax-10		BP-624	CP Wax 52 CB	ZB-WaxPlus
Environmental							
Rxi-5Sil MS (p. 87, 95, 97)	Semivolatiles - EPA Methods 8270, 625, 525	DB-5ms	SLB-5	Optima-5ms		VF-5ms	ZB-5ms
Rtx-VMS (p. 100)	Volatiles - EPA Methods 8260, 624, 524	unique column					
Rxi-624Sil MS (p. 103)	Volatiles - EPA Method 624	DB-624				VF-624ms	ZB-624
Rtx-502.2 (p. 102)	Volatiles - EPA Methods 8010, 8020, 502.2, 601, 602	DB-502.2	VOCOL				
Rtx-Volatiles (p. 102)	Volatiles - EPA Methods 8010, 8020, 502.2, 601, 602		VOCOL				
Rtx-VRX (p. 101)	Volatiles - EPA Methods 8010, 8020, 502.2, 601, 602	DB-VRX					
Rtx-CLPesticides (p. 88)	Organochlorine pesticides - EPA Methods 8081, 8082, 608, 505, 508	unique column					
Rtx-CLPesticides2 (p. 88)	Organochlorine pesticides - EPA Methods 8081, 8082, 608, 505, 508	unique column					
Stx-CLPesticides (p. 90)	Organochlorine pesticides - EPA Methods 8081, 8082, 608, 505, 508	unique column					
Stx-CLPesticides2 (p. 90)	Organochlorine pesticides - EPA Methods 8081, 8082, 608, 505, 508	unique column					
Rtx-1614 (p. 92)	Brominated flame retardants	unique column					
Rtx-PCB (p. 93)	Polychlorinated biphenyl - EPA Methods 8082, 608, PCB congeners	unique column					
Rxi-XLB (p. 94)	Polychlorinated biphenyl - EPA Methods 8082, 608, PCB congeners	DB-XLB				VF-XMS	MR1
Rtx-OPPesticides (p. 91)	Organophosphorus pesticides - EPA Method 8141	unique column					
Rtx-OPPesticides2 (p. 91)	Organophosphorus pesticides - EPA Method 8141	unique column					
Rtx-Dioxin2 (p. 96)	Dioxin & Furans - EPA Methods	unique column					
Rxi-17Sil MS (p. 98)	Polycyclic aromatic hydrocarbons	HP-17, DB-17, DB-17ms		Optima-17ms	BPX-50	CP-Sil 24 CB, VF-17ms	ZB-50
Rtx-Mineral Oil (p. 99)	DIN ENISO 9377-2					Select Mineral Oil	

GC Column Installation Checklist

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

Instrument Preparation & Column Installation

1. Cool all heated zones.
2. Visually inspect indicating oxygen and moisture traps. Replace saturated traps.
3. Examine the inlet and the detector. Clean or replace all dirty or corroded parts.
4. Replace the inlet liner and septum, and the injector seals (O-rings, inlet seals, ferrules, etc.).
5. Mount the column in the oven with a support that protects it from scratches. Center the column in the oven. This ensures uniform heat exposure generating consistent retention times.
   - Restek has two types of cages for fused silica columns, an 11-pin cage and the original cage that uses high temperature string to hold the column in place. **If you have the cage with high temperature string, do not remove the string that holds the column in the cage!**
6. Uncoil the ends to make sure the ends are long enough to reach the injector and detector. Cut a few centimeters 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 2 cm 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 25-30 m column and 10 minutes for a 50-60 m 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 detector connections for leaks, using a Restek Electronic Leak Detector (cat.# 22839).
14. Verify the carrier gas flow is at the rate you intend to use for your analysis. (Use the Restek ProFlow 6000 flowmeter, cat.# 22656, to ensure accurate flow measurement.) 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. The type of detector and column type will determine which compound to inject. 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 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 $> 1\,\mu m$) 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 carrier gas flowing 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.

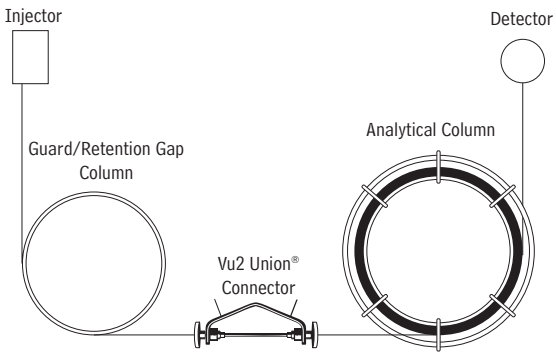
Guard Columns and Retention Gaps

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.

did you know?

We test our guard columns/ transfer lines with a comprehensive test mix to ensure high inertness.

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



please note

For superior inertness, try our Siltek® guard columns!
See page 33 for details.

Having trouble making a leak-free connection? Try our "built in" Integra-Guard® columns!
See page 35 for details.

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 forming 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). As the oven temperature is increased, the solvent and target compounds are vaporized and move unretained through the retention gap (Figure 2b). When the target compounds come in contact with the stationary phase, they are refocused in a narrow band (Figure 2c), improving the chromatography.

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.

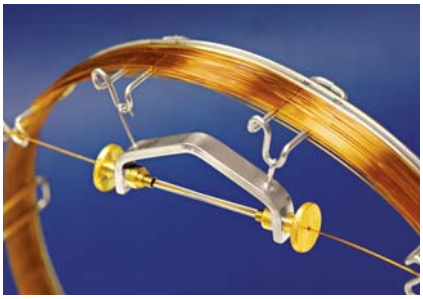
b) As oven temperature increases, the solvent evaporates and the target compounds elute unretained through the retention gap until they contact the analytical column.

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 that may leak and to ensure longer column lifetime, use our unique Integra-Guard® Column. See **page 35**.

Connectors for Fused Silica Columns



Vu2 Union® Connector
(See page 289.)

Press-Tight® Connectors
(See pages 287-288.)

MXT® Union Connector Kit
for Fused Silica
(See page 292.)

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 10-20 cm, 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.

Using guard columns is advantageous, because they prevent contamination that can cause active sites as well as change the conditions of the focusing zone of the analytical column. Another advantage is that the resolution of closely eluting compounds will not be affected when the column is trimmed during maintenance, because the guard column does not contribute to the resolving power of the analytical column. Using guard columns is a simple, cost-effective way to extend analytical column lifetime.

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. However, polar-deactivated guard columns are not resistant to harsh "water vaporization", which 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 solvent beading 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 287 to 292 for information about these connectors.

Fused Silica Guard/Retention Gap Columns

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)

- Tested with a comprehensive 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 a comprehensive 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 a comprehensive 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

*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 35**.

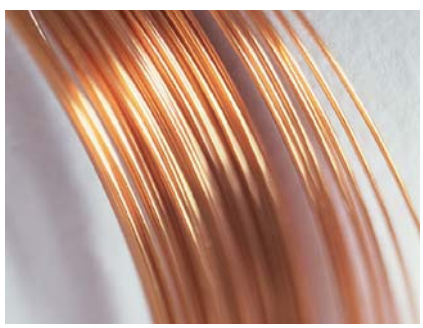
also **available**

Metal MXT® Guard/Retention Gap Columns
Rugged, flexible, Siltek® treated stainless steel tubing; inertness comparable to fused silica tubing. See **page 114**.

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!

best **choice**

Siltek® treated tubing (cat.# 22505, **page 320**) is recommended for purge and trap transfer lines.

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, Rtx®-Volatile Amine, and Stabilwax®-DB capillary columns.
- Batch test chromatogram included.
- Maximum temperature: 315 °C.

Chemists using guard columns in the 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, as well as base-deactivated inlet liners, 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

also **available**

Base-deactivated inlet liners
See page 213.

did you **know**?

We test our guard columns/transfer lines with a comprehensive test mix to ensure high inertness.

Hydroguard® Water-Resistant Guard/Retention Gap Columns/Transfer Lines (fused silica)

- Extend analytical column lifetime by preventing degradation from harsh "steam-cleaning" water injections.
- Tested with a comprehensive test mix, to ensure high inertness.
- 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:

- Headspace analyzers.
- Air analysis equipment and concentrator units.

also **available**

Metal MXT® Guard Columns
Rugged, flexible, Siltek® treated stainless steel tubing; inertness comparable to fused silica tubing. See **page 114**.

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

*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.

Fused Silica Guard/Retention Gap Columns

Innovative Integra-Guard® Columns

- No leaks for a more robust method.
- No column connections for easier, faster maintenance.
- No peak distortions due to connector dead volume and thermal capacity.

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

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

Description	qty.	cat.#	price
Rtx-1			
30m, 0.25mm ID, 0.25µm Rtx-1 w/5m Integra-Guard Column	ea.	10123-124	
30m, 0.53mm ID, 1.00µm Rtx-1 w/5m Integra-Guard Column	ea.	10155-126	
30m, 0.53mm ID, 5.00µm Rtx-1 w/5m Integra-Guard Column	ea.	10179-126	
Rtx-5			
30m, 0.25mm ID, 0.25µm Rtx-5 w/5m Integra-Guard Column	ea.	10223-124	
30m, 0.25mm ID, 0.25µm Rtx-5 w/10m Integra-Guard Column	ea.	10223-127	
30m, 0.25mm ID, 1.00µm Rtx-5 w/5m Integra-Guard Column	ea.	10253-124	
30m, 0.32mm ID, 0.25µm Rtx-5 w/5m Integra-Guard Column	ea.	10224-125	
30m, 0.32mm ID, 1.00µm Rtx-5 w/5m Integra-Guard Column	ea.	10254-125	
30m, 0.53mm ID, 5.00µm Rtx-5 w/5m Integra-Guard Column	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	
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	
15m, 0.25mm ID, 0.50µm Rxi-5Sil MS w/5m Integra-Guard Column	ea.	13635-124	
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	
30m, 0.32mm ID, 1.00µm Rxi-5Sil MS w/5m Integra-Guard Column	ea.	13654-125	
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	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	

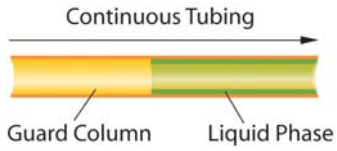
restek **innovation**!

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

similar **products**

DuraGuard, EZ-Guard, Guardian

Integra-Guard® built-in guard column



String indicates where the analytical column begins.

Tag indicates guard column end.

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.

Rxi® GCColumns

3-IN-1 TECHNOLOGY

Highest Inertness • Lowest Bleed • Exceptional Reproducibility

Lower Detection Limits with Ground-Breaking Column Technology

Rxi® technology unifies outstanding inertness, low bleed, and high reproducibility into a single high performance column line. Take variation out of the equation and get the most consistent results for trace level analysis with Rxi® columns.

Visit us at **www.restek.com/rxi**

phases available

- Rxi®-1ms (p. 41)
- Rxi®-1HT (p. 47)
- Rxi®-5ms (p. 41)
- Rxi®-5Sil MS (p. 42)
- Rxi®-5HT (p. 47)
- Rxi®-XLB (p. 44)
- Rxi®-624Sil MS (p. 46)
- Rxi®-35Sil MS (p. 44)
- Rxi®-17 (p. 44)
- Rxi®-17Sil MS (p. 45)
- Rxi® guard/retention gap columns (p. 40)

Make the Switch to Rxi® columns!

Experience what Rxi® did for many others

- Lower detection limits
- Better peak shape
- Accurate results

Rxi 3-IN-1 TECHNOLOGY

Highest Inertness • Lowest Bleed • Exceptional Reproducibility

Lower Detection Limits with Ground-Breaking Column Technology

Rxi® columns deliver more accurate, reliable trace-level results than any other fused silica column on the market. To ensure the highest level of performance, all Rxi® capillary columns are manufactured and individually tested to meet stringent requirements for exceptional inertness, low bleed, and unsurpassed column-to-column reproducibility.

Highest Inertness

Inertness is one of the most difficult attributes to achieve in an analytical column, but it is one of the most critical as it improves peak shape, response, and retention time stability. Rxi® technology produces the most inert columns available, providing:

- Increased signal-to-noise ratios to improve low-level detection.
- Reproducible retention times for positive identifications.
- Improved response for polar, acidic, and basic compounds.

Increased Signal and Reproducible Retention Times

When capillaries are not sufficiently deactivated, peaks become asymmetric, resulting in reduced signal and unpredictable retention times. As column activity increases, peak tailing becomes more pronounced, reducing peak height and causing retention time to drift (Figure 1). In practice, this means that sensitivity is lost and trace-level analytes cannot be reliably determined. In addition, even compounds at higher concentrations may be misidentified, due to retention time shifting.

A more significant problem for sample analysis is that retention time can vary with analyte concentration if the column is not highly inert. Since the amount of target analyte in samples is unknown, retention times on a poorly deactivated column can easily vary enough to move compounds outside of the retention time window (Figure 2). This can result in inaccurate identifications and the need for manual integration and additional review or analysis before results can be reported. Using inert Rxi® columns ensures that compounds elute with good signal-to-noise ratios at expected retention times, regardless of analyte concentration.

Figure 1 As column activity increases, signal decreases and retention time shifts.

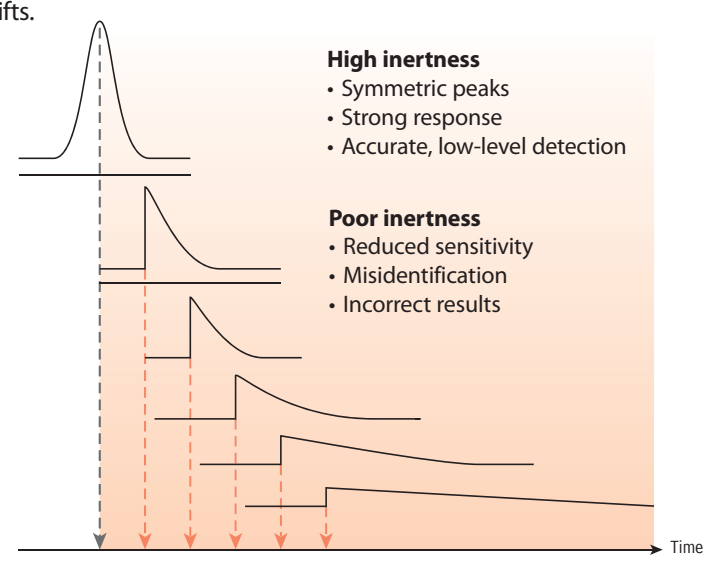
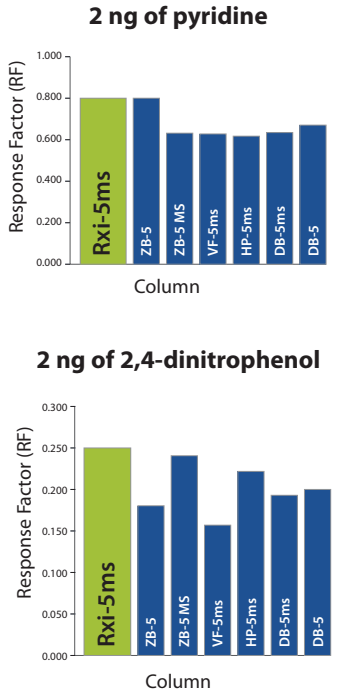
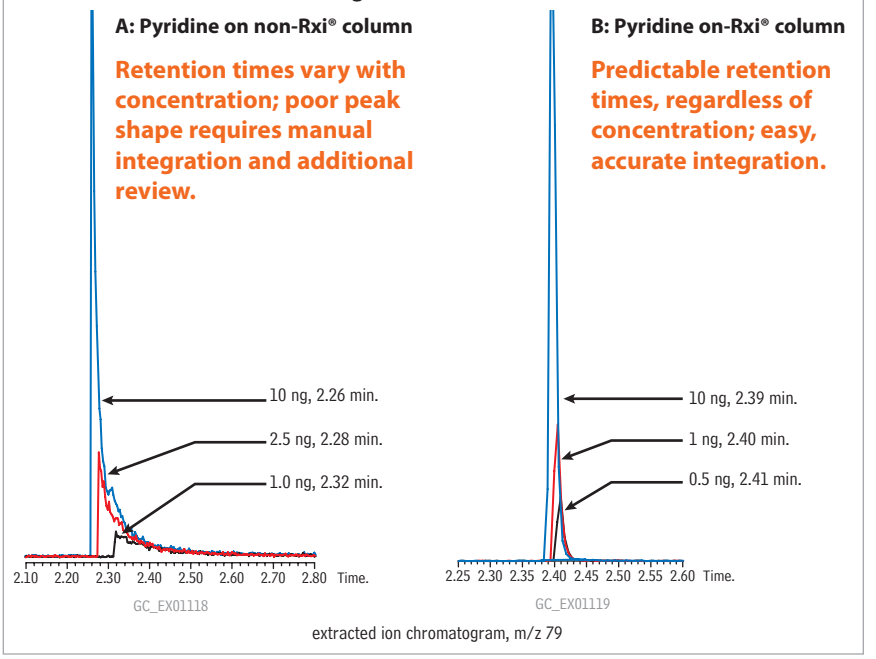


Figure 3 An Rxi®-5ms column gives the highest response for both basic and acidic compounds.



Comparison of 30m x 0.25mm ID, 0.25µm columns.

Figure 2 Analyte levels in samples are unknown; only inert columns, which prevent concentration from affecting retention time, can assure accurate results.



extracted ion chromatogram, m/z 79

Improved Response for Difficult Compounds

Another reason column inertness is important for trace-level analysis is that many acidic, basic, and polar compounds will tail significantly and become difficult to analyze if the column contains active sites. The remarkable neutrality of Rxi® columns solves this problem and allows a wide range of compounds to be analyzed with high sensitivity, often on a single column. All Rxi® columns are exceptionally inert as demonstrated in Figure 3 by high response factors for both pyridine (basic) and 2,4-dinitrophenol (acidic). Rxi® columns reliably produce highly symmetric peaks and improved responses for difficult compounds, indicating greater inertness than columns produced by other manufacturers (Figure 4).

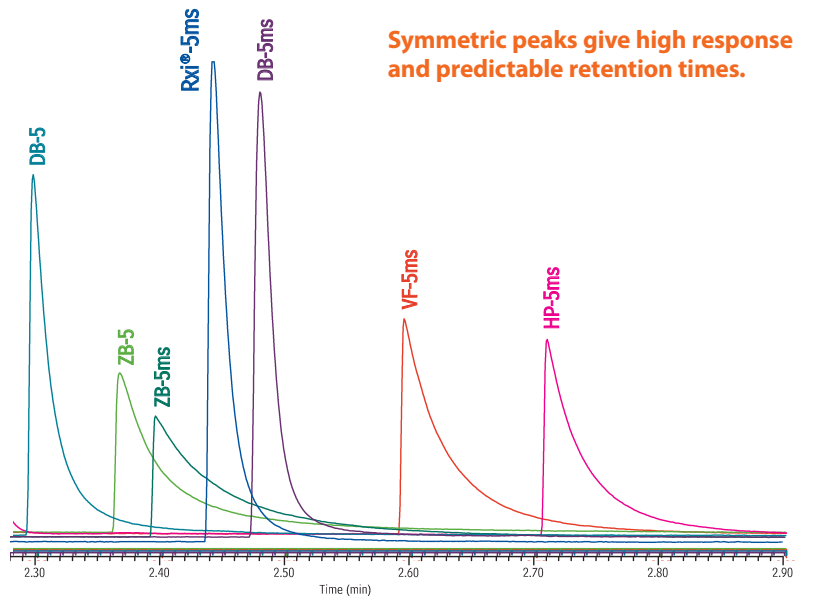
Innovation & Service

"When my research group needed a GC column for a chiral separation, Restek was the only company that offered to provide us with test columns to evaluate. The willingness of Restek to work with us to find a solution to our separation problem is exceptional."

Joe Dinnocenzo,
Professor of Chemistry
Director, Center for
Photoinduced Charge Transfer
University of Rochester

How can we help you today?
Contact support@restek.com or your local Restek representative for helpful, knowledgeable technical support.

Figure 4 Rxi® columns are the most inert columns on the market providing the most symmetric peak shape for basic compounds, such as pyridine.



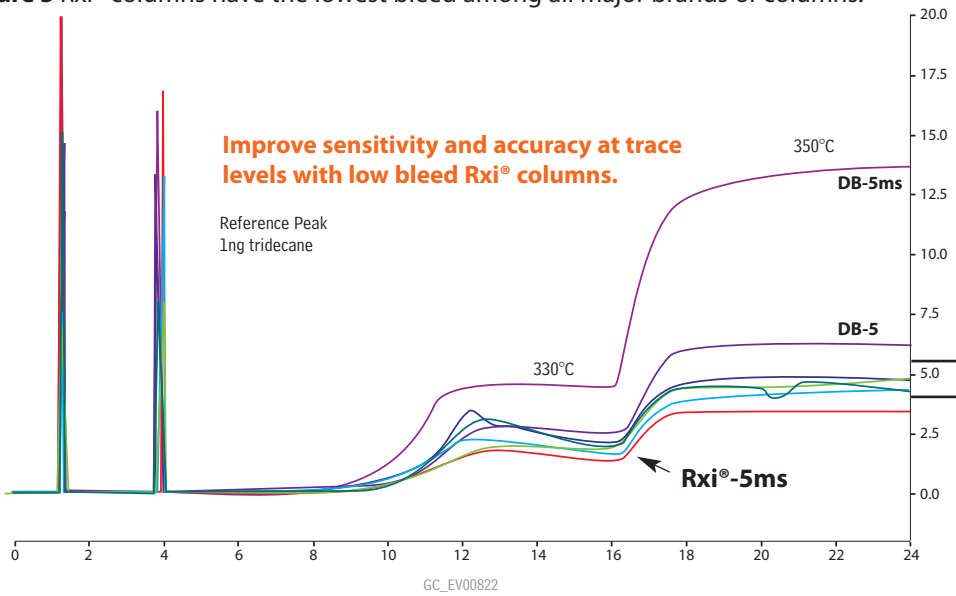
Comparison of 30m x 0.25mm ID, 0.25µm 5% diphenyl columns, 2ng pyridine on-column, helium carrier gas, Oven temp.: 50°C (3 min.) to 180°C @ 35°C/min. (5 min.), Det.: FID @ 250°C

Lowest Bleed

Rxi® columns are more stable at high temperatures than any other manufacturer's column (Figure 5), resulting in higher system sensitivity. This low-bleed characteristic is the result of superior stabilization achieved by optimizing polymer cross-linking and surface deactivation technologies. Benefits of using ultra-low bleed Rxi® columns include:

- Increased sensitivity, for lower detection limits and better matches to mass spectral libraries.
- Faster system stabilization.
- Reduced detector contamination and less downtime for maintenance.

Figure 5 Rxi® columns have the lowest bleed among all major brands of columns.

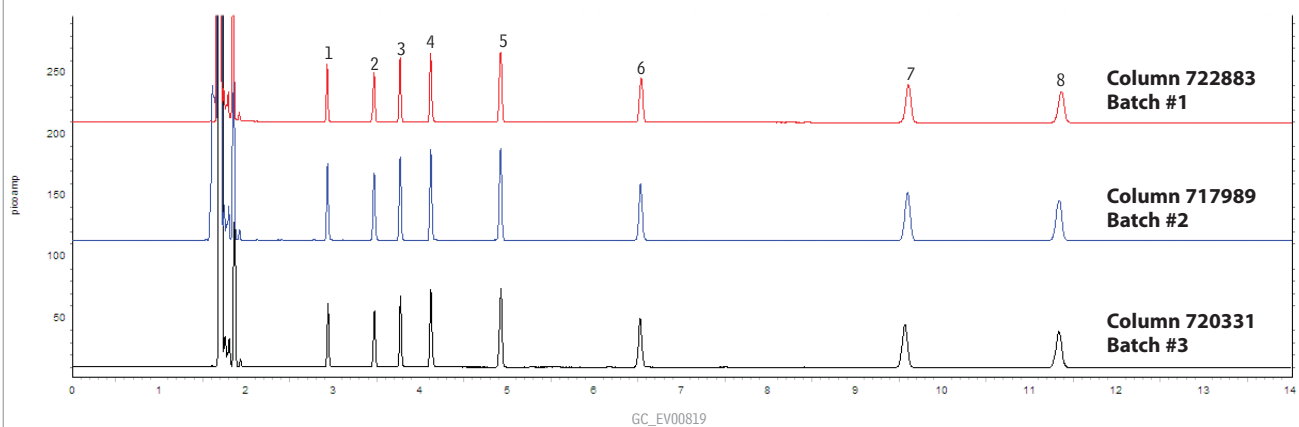


Comparison of 30m x 0.25mm ID, 0.25µm 5%-diphenyl columns at 330°C through 350°C; hydrogen carrier gas; flame ionization detection.

Exceptional Reproducibility

Chromatographers today need to know that every column they receive is going to perform the same way as the column it replaces. Unmatched manufacturing precision and stringent quality control mean Rxi® columns exceed industry standards, resulting in the best column-to-column reproducibility available as measured by efficiency, retention, bleed, and inertness (Figure 6).

Figure 6 Rxi® columns are engineered to assure column-to-column and lot-to-lot reproducibility.



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

Rxi® Columns Overview

Column Cross-Reference Table

Rxi® columns produce the same selectivity as competitor columns, but are much more inert, exhibit lower bleed, and offer exceptional reproducibility. For more accurate, reliable trace-level results, choose Rxi® columns.

POLARITY: non-polar → + polar

Restek	Phase Composition	Agilent	Varian/ Chrompack	SGE	Phenomenex	Machery-Nagel	Supelco
Rxi-1ms	100% dimethyl polysiloxane	HP-1ms UI, DB-1ms UI, HP-1, HP-1ms, DB-1 DB-1ms, Ultra-1	VF-1ms CP-Sil 5 CP Sil 5 CB Low Bleed/MS	BP-1	ZB-1 ZB-1ms	Optima-1 Optima-1ms Optima-1ms Accent	SPB-1 Equity-1
Rxi-1HT	100% dimethyl polysiloxane	DB-1HT	VF-1HT		ZB-1HT		
Rxi-5ms	5% diphenyl/ 95% dimethyl polysiloxane	HP-5ms UI, HP-5, HP-5ms, DB-5, Ultra-2	CP-Sil 8 CP Sil 8 CB	BP-5	ZB-5 ZB-5ms	Optima-5 Optima-5ms	SPB-5 Equity-5
Rxi-5Sil MS	5% phenyl, 95% dimethyl arylene polysiloxane	DB-5ms UI, DB-5ms	VF-5ms CP-Sil 8 CB Low Bleed/MS	BPX-5	ZB-5ms	Optima-5ms Accent	SLB-5ms
Rxi-5HT	5% diphenyl/95% dimethyl polysiloxane	DB-5HT	VF-5HT		ZB-5HT		
Rxi-XLB	arylene/methyl modified polysiloxane	DB-XLB	VF-Xms		MR1	Optima-XLB	
Rxi-624Sil MS	6% cyanopropylphenyl, 94% dimethyl arylene polysiloxane	DB-624, HP-624	VF-624ms	BP-624	ZB-624	Optima-624	
Rxi-35Sil MS	35% phenyl, 65% dimethyl arylene polysiloxane	DB-35ms	VF-35ms	BP-35	MR2	Optima-35ms	
Rxi-17	50% diphenyl/50% dimethyl polysiloxane	HP-17, DB-17, DB-608, HP-50+	CP-Sil 24 CB		ZB-50	Optima-17	
Rxi-17Sil MS	50% phenyl, 50% dimethyl arylene polysiloxane	DB-17ms, HP-17, DB-17	VF-17ms CP-Sil 24 CB	BPX-50	ZB-50	Optima-17ms	

Visit **www.restek.com/rxi** for detailed comparisons and to learn how exceptional Rxi® inertness, bleed, and reproducibility can improve your data.

Use **Rxi® Guard/Retention Gap Columns** to protect your analytical column and help focus analytes.

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

Rxi®-1ms Columns (fused silica)

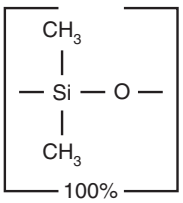
(nonpolar phase, Crossbond® 100% dimethyl polysiloxane)

- General purpose columns for drugs of abuse, essential oils, hydrocarbons, pesticides, PCB congeners (e.g. Aroclor mixes), sulfur compounds, amines, solvent impurities, simulated distillation, oxygenates, gasoline range organics (GRO), refinery gases.
- Tested and guaranteed for 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.

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

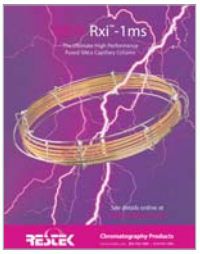
ID	df	temp. limits	10-Meter	12-Meter	20-Meter	25-Meter	50-Meter
0.10mm	0.10µm	-60 to 330/350°C	13301				
0.18mm	0.18µm	-60 to 330/350°C			13302		
	0.36µm	-60 to 330/350°C			13311		
0.20mm	0.33µm	-60 to 330/350°C		13397		13398	13399

Rxi®-1ms Structure



similar phases

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



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

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lit. cat.# 580075B

Rxi®-5ms Columns (fused silica)

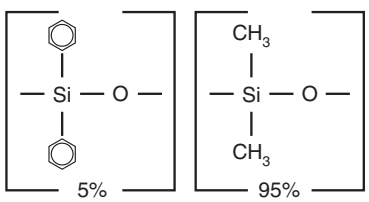
(low polarity phase, Crossbond® 5% diphenyl/95% dimethyl polysiloxane)

- General purpose columns for semivolatiles, phenols, amines, residual solvents, drugs of abuse, pesticides, PCB congeners (e.g. Aroclor mixes), solvent impurities.
- Most inert column on the market.
- Tested and guaranteed for 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.

ID	df	temp. limits	15-Meter	30-Meter	60-Meter
0.25mm	0.25µm	-60 to 330/350°C	13420	13423	13426
	0.40µm	-60 to 330/350°C		13481	
	0.50µm	-60 to 330/350°C	13435	13438	13441
	1.00µm	-60 to 330/350°C	13450	13453	13456
0.32mm	0.25µm	-60 to 330/350°C	13421	13424	13427
	0.50µm	-60 to 330/350°C	13436	13439	13442
	1.00µm	-60 to 330/350°C	13451	13454	13457
0.53mm	0.25µm	-60 to 330/350°C	13422	13425	
	0.50µm	-60 to 330/350°C	13437	13440	
	1.00µm	-60 to 330/350°C	13452	13455	
	1.50µm	-60 to 330/350°C	13467	13470	

ID	df	temp. limits	10-Meter	12-Meter	20-Meter	25-Meter	50-Meter
0.10mm	0.10µm	-60 to 330/350°C	13401				
0.18mm	0.18µm	-60 to 330/350°C			13402		
	0.30µm	-60 to 330/350°C			13409		
	0.36µm	-60 to 330/350°C			13411		
0.20mm	0.33µm	-60 to 330/350°C		13497		13498	13499

Rxi®-5ms Structure



similar phases

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

free literature

Rxi®-5ms Columns

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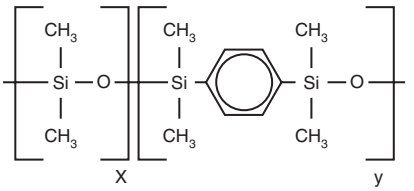
lit. cat.# 580046A

Rxi®-5Sil MS Structure



similar **phases**

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

Rxi®-5Sil MS Columns (fused silica)

(low polarity Crossbond® silarylene phase; selectivity close to 5% phenyl/ 95% dimethyl arylene 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.

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

ID	df	temp. limits	10-Meter	20-Meter	40-Meter
0.10mm	0.10µm	-60 to 330/350°C	43601		
0.18mm	0.10µm	-60 to 320/350°C			
	0.18µm	-60 to 330/350°C		43602	43605
	0.36µm	-60 to 330/350°C		43604	

Rxi®-5Sil MS with Integra-Guard®

Get the protection without the connection!

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

Description	qty.	cat.#	price
15m, 0.25mm ID, 0.25µm Rxi-5Sil MS w/10m Integra-Guard Column	ea.	13620-127	
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	
15m, 0.25mm ID, 0.50µm Rxi-5Sil MS w/5m Integra-Guard Column	ea.	13635-124	
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	
30m, 0.32mm ID, 1.00µm Rxi-5Sil MS w/5m Integra-Guard Column	ea.	13654-125	

free literature

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

lit. cat.# GNFL1061

Developing New Methods for Pesticides in Dietary Supplements

lit. cat.# PHAN1242

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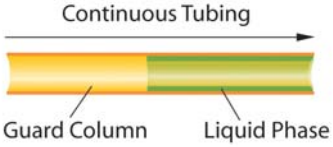
Integra-Guard® built-in guard column



Phases currently available as Integra-Guard® columns

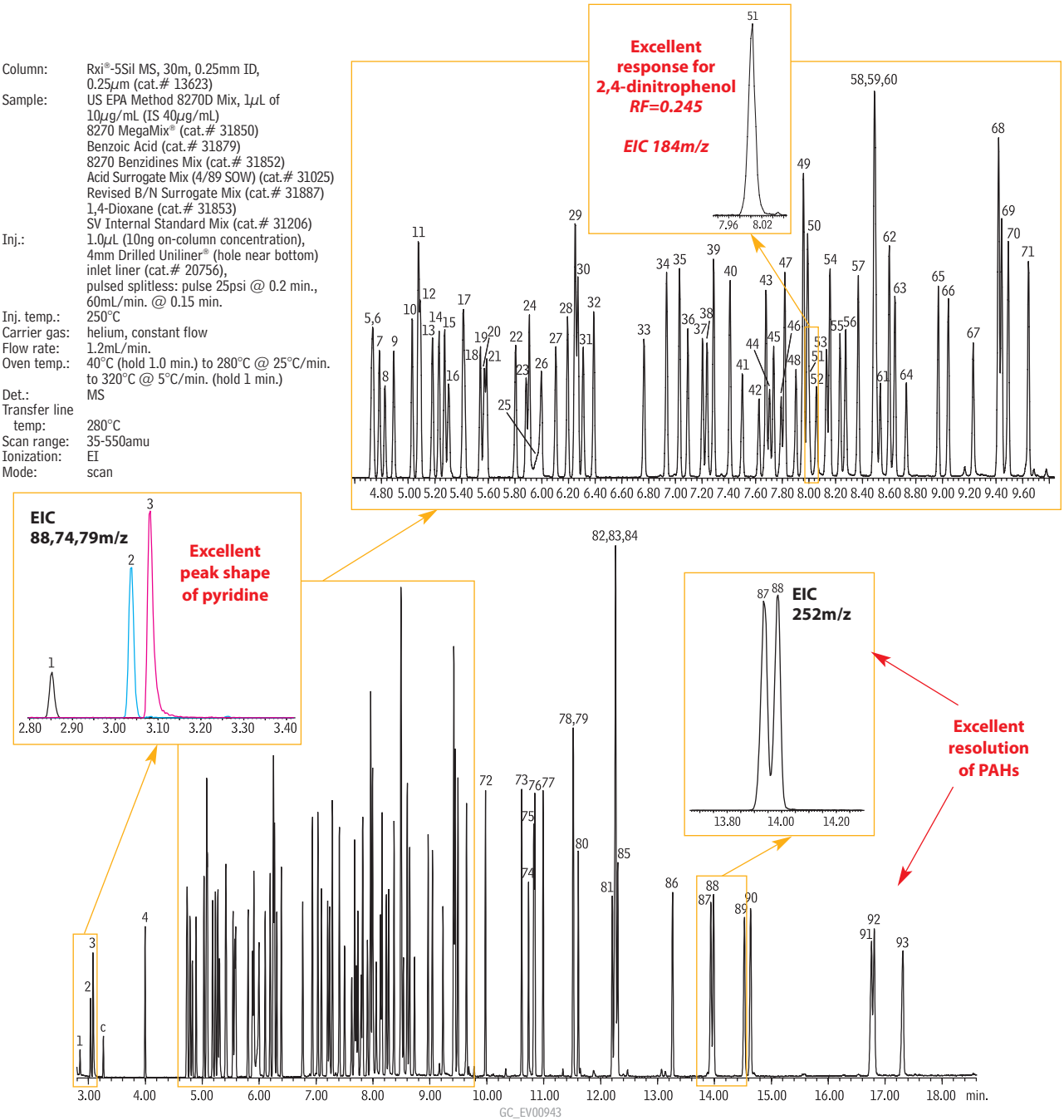
Rtx®-1
Rtx®-5
Rtx®-5MS
Rxi®-5Sil MS
Rtx®-624
Rtx®-1301
Rtx®-1701
Stabilwax®

See page 35 for more information.

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.

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



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

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.

Rxi®-XLB Columns (fused silica)

(low polarity proprietary phase)

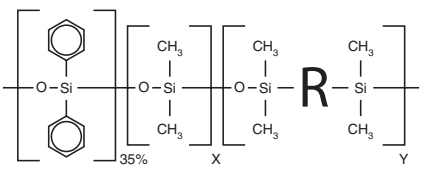
- General purpose columns exhibiting extremely low bleed. Ideal for many GC/MS applications, including pesticides, PCB congeners (e.g. Aroclor mixes), PAHs.
- Unique selectivity.
- Temperature range: 30 °C to 360 °C.

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

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

Rxi®-35Sil MS Structure



similar phases

DB-35ms, MR2, VF-35ms

Rxi®-35Sil MS Columns (fused silica)

(midpolarity phase; equivalent to 35% phenyl/65% dimethyl arylene polysiloxane)

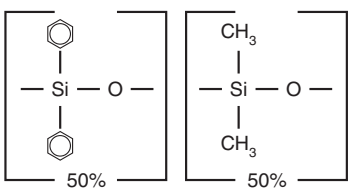
- Special selectivity and excellent inertness for substituted polar compounds, such as drugs, pesticides, herbicides, PCBs, phenols, etc.
- Very low bleed phase for GC/MS analysis.
- Extended temperature range: 50 °C to 340/360 °C.

ID	df	temp. limits	15-Meter	30-Meter
0.25mm	0.25µm	50 to 340/360°C	13820	13823
	0.50µm	50 to 340/360°C	13835	13838
	1µm	50 to 320/340°C	13850	13853
0.32mm	0.25µm	50 to 340/360°C	13821	13824
	0.50µm	50 to 340/360°C	13836	13839
	1µm	50 to 320/340°C	13851	13854
0.53mm	0.50µm	50 to 320/340°C	13837	13840
	1µm	50 to 320/340°C	13852	13855

NEW!

More dimensions are now available!

Rxi®-17 Structure



similar phases

DB-17, DB-608, CP-Sil 24 CB, HP-50+

Rxi®-17 Columns (fused silica)

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

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

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

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

Rxi®-17Sil MS Columns (fused silica)

(midpolarity Crossbond® silarylene phase; equivalent to 50% phenyl/50% dimethyl arylene polysiloxane)

NEW!

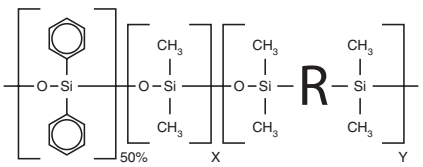
- 340/360 °C upper temperature limits.
- Excellent inertness and selectivity for active environmental compounds, such as PAHs.
- Equivalent to USP phase G3.
- Low-bleed for use with sensitive detectors, such as MS.
- Excellent separation of EU-PAHs, including fluoranthenes.

ID	df	temp. limits*	15-Meter	30-Meter	60-Meter
0.25mm	0.25µm	40 to 340/360°C	14120	14123	14126
0.32mm	0.25µm	40 to 340/360°C	14121	14124	

ID	df	temp. limits	10-Meter	20-Meter
0.10mm	0.10µm	40 to 340/360°C	14101	
0.18mm	0.18µm	40 to 340/360°C		14102
	0.36µm	40 to 340/360°C		14111

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

Rxi®-17Sil MS Structure

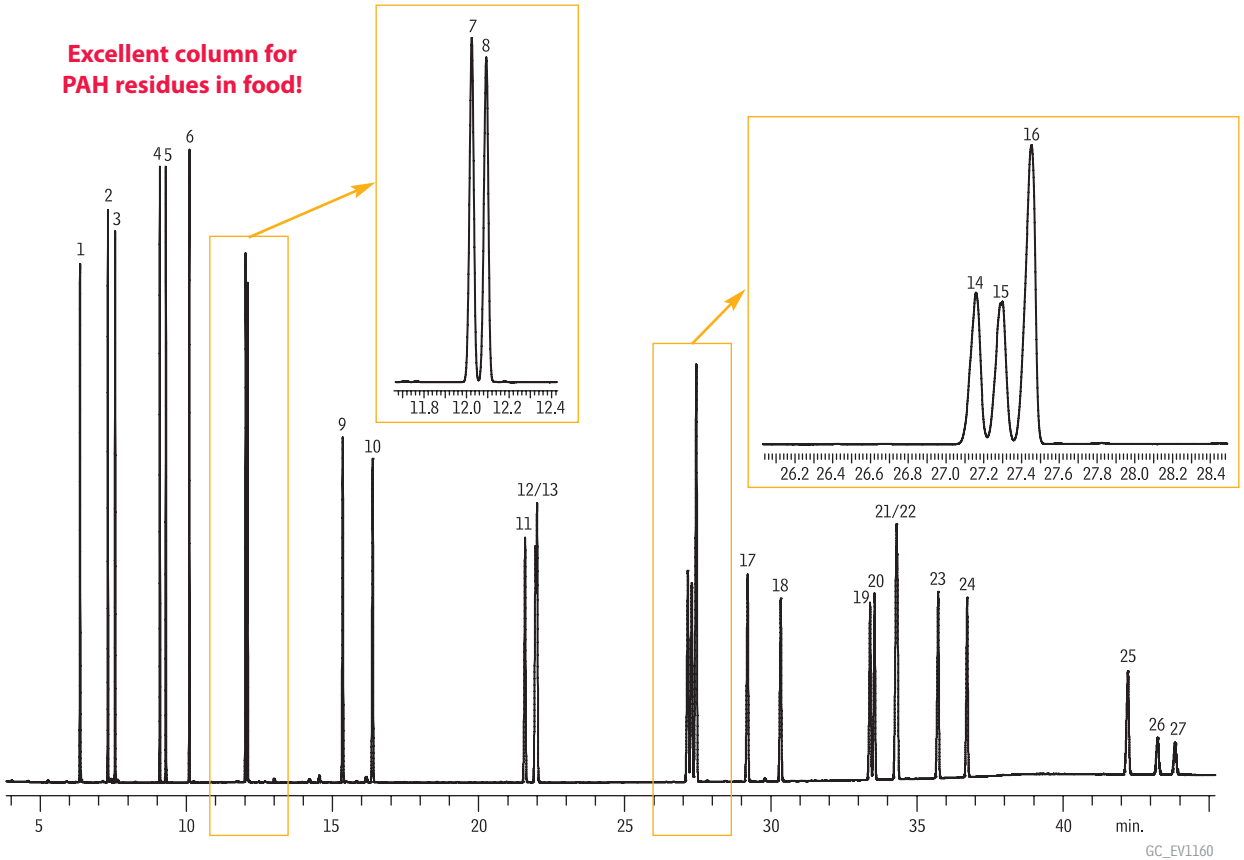


similar phases

DB-17ms, VF-17ms, BPX-50

Polycyclic Aromatic Hydrocarbons on Rxi®-17Sil MS

Excellent column for PAH residues in food!



GC_EV1160

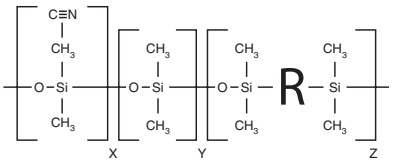
1. Naphthalene
2. 2-Methylnaphthalene
3. 1-Methylnaphthalene
4. Acenaphthylene
5. Acenaphthene
6. Fluorene
7. Phenanthrene
8. Anthracene
9. Fluoranthene
10. Pyrene
11. Benz[a]anthracene
12. Chrysene
13. Triphenylene
14. Benzo[b]fluoranthene
15. Benzo[k]fluoranthene
16. Benzo(j)fluoranthene
17. Benzo[a]pyrene
18. 3-Methylcholanthrene
19. Dibenz(a,h)acridine
20. Dibenz[a,j]acridine
21. Indeno[1,2,3-cd]pyrene
22. Dibenz[a,h]anthracene
23. Benzo[ghi]perylene
24. 7H-Dibenzo[c,g]carbazole
25. Dibenzo[a,e]pyrene
26. Dibenzo(a,i)pyrene
27. Dibenzo(a,h)pyrene

Column	Rxi®-17Sil MS, 30 m, 0.25 mm ID, 0.25 µm (cat.# 14123)
Sample	SV Calibration Mix #5 / 610 PAH Mix (cat.# 31011) EPA Method 8310 PAH Mixture (cat.# 31841)
Diluent:	dichloromethane
Conc.:	10 ppm
Injection	
Inj. Vol.:	0.5 µL splitless (hold 1.75 min.)
Liner:	Auto SYS XL PSS Split/Splitless w/Wool (cat.# 21718)
Inj. Temp.:	320 °C
Purge Flow:	75 mL/min.
Oven	
Oven Temp:	65 °C (hold 0.5 min.) to 220 °C at 15 °C/min. to 330 °C at 4 °C/min. (hold 15 min.)
Carrier Gas	He, constant flow
Flow Rate:	2.0 mL/min.
Detector	FID @ 320 °C
Instrument	PE Clarus 600 GC
Acknowledgement	Instrument provided by PerkinElmer

Rxi®-624Sil MS

Rxi®-624Sil MS Structure

NEW!



similar **phases**

DB-624, HP-624, VF-624, BP-624, ZB-624, AT-624, 007-1301, G43R

Rxi®-624Sil MS Columns (fused silica)

(midpolarity Crossbond® silarylene phase; equivalent to 6% cyanopropylphenyl/ 94% dimethyl arylene polysiloxane)

- Low bleed, high thermal stability column—maximum temperatures up to 320 °C.
- Inert—excellent peak shape for a wide range of compounds, including acidic and basic compounds.
- Selective—highly selective for residual solvents, great choice for USP<467>.
- Manufactured for column-to-column reproducibility—well-suited for validated methods.

ID	df	temp. limits	20-Meter	30-Meter	60-Meter
0.18mm	1.00µm	-20 to 300/320°C	13865		
0.25mm	1.40µm	-20 to 300/320°C		13868	
0.32mm	1.80µm	-20 to 300/320°C		13870	13872
0.53mm	3.00µm	-20 to 280/300°C		13871	

free literature

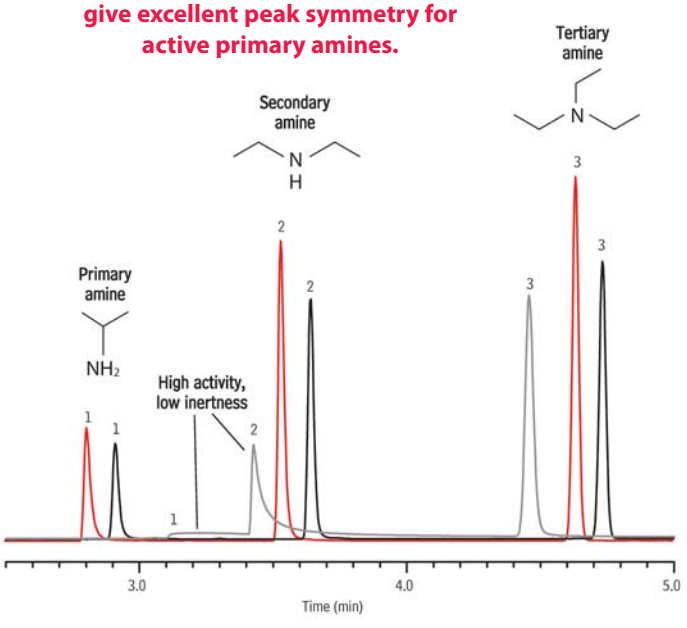
Rxi®-624Sil MS: The "Go To" GC Column for Fast, Effective Volatile Impurities Method Development

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

lit. cat.# PHFL1245

Inertness comparison (basic compounds): primary, secondary, and tertiary amines on an Rxi®-624Sil MS column.

Highly inert Rxi®-624Sil MS columns give excellent peak symmetry for active primary amines.



GC_PH1162

Peaks	Conc. (µg/mL)
1. Isopropylamine	100
2. Diethylamine	100
3. Triethylamine	100

Column	Rxi®-624SilMS, 30 m, 0.32 mm ID, 1.8 µm (cat.# 13870)
Sample	
Diluent:	DMSO
Conc.:	100 µg/mL
Injection	
Inj. Vol.:	1 µL split (split ratio 20:1)
Liner:	5mm Single Gooseneck with Wool (cat.# 22973-200.1)
Inj. Temp.:	250 °C
Oven	
Oven Temp:	50 °C (hold 1 min.) to 200 °C at 20 °C/min. (hold 5 min.)
Carrier Gas	He, constant flow
Linear Velocity:	37 cm/sec.
Detector	FID @ 250 °C
Instrument	Agilent/HP6890 GC

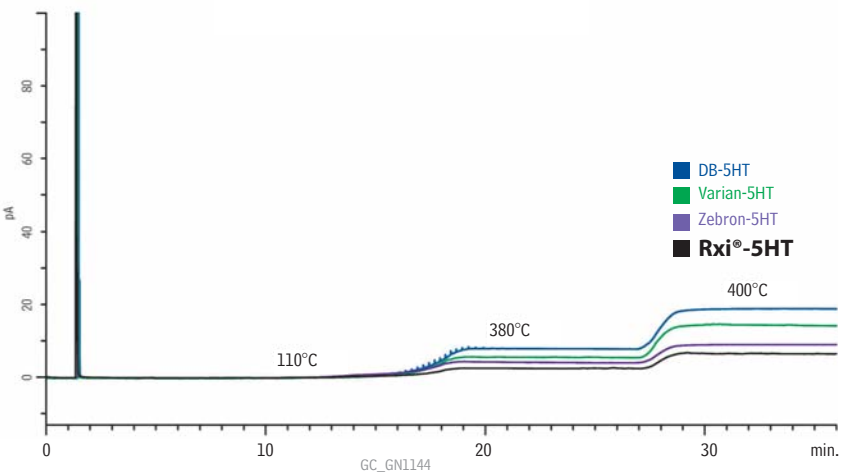
NEW!

Looking for an **Inert** and **Low Bleed** High Temp Column?

Rxi GCColumns

High temperature columns have thin films so they need to be thoroughly deactivated. Restek's Rxi® process offers better inertness and lower bleed than any other manufacturer.

Bleed Profiles of 5HT Columns



Column: Rxi®-5HT (see notes for competitors), 30 m, 0.25 mm ID, 0.10 µm (cat.# 13908)
For analytical conditions, visit www.restek.com and search for chromatogram GC_GN1144

Replace DB-5ht, ZB-5HT, and VF-5ht and benefit from better data and lower bleed!

Rxi®-5HT Columns (fused silica)

(low polarity phase; 5% diphenyl/95% dimethyl polysiloxane)

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

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

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

Rxi®-1HT Columns (fused silica)

(100% dimethyl polysiloxane)

NEW!

- Columns processed for high temperature applications.
- Temperature range: -60 to 400 °C*.

ID	df	temp. limits	15-Meter	30-Meter
0.25mm	0.10µm	-60 to 400°C	13950	13951
	0.25µm	-60 to 400°C		13952
0.32mm	0.10µm	-60 to 400°C	13953	13954
	0.25µm	-60 to 400°C		13955
0.53mm	0.15µm	-60 to 400°C		13956

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

General Purpose Columns

Chemically bonded capillary columns

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

Extensive 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:

Rtx® GC Columns

Rtx®-1, Rtx®-5, Rtx®-5MS, Rtx®-20, Rtx®-35, Rtx®-50, Rtx®-65, Rtx®-440, Rtx®-200, Rtx®-200MS, Rtx®-1301, Rtx®-624, Rtx®-1701, Rtx®-225, Rtx®-2330, Rtx®-Wax, Stabilwax®

visit **www.restek.com** for complete product listings

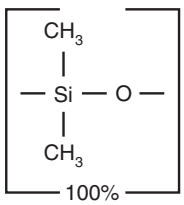
Rtx®-1 Columns (fused silica)

(nonpolar phase; Crossbond® 100% dimethyl polysiloxane)

- General purpose columns for solvent impurities, PCB congeners (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



ID	df	temp. limits*	15-Meter	30-Meter	60-Meter	105-Meter
0.25mm	0.10µm	-60 to 330/350°C	10105	10108	10111	
	0.25µm	-60 to 330/350°C	10120	10123	10126	10129
	0.50µm	-60 to 330/350°C	10135	10138	10141	10144
	1.00µm	-60 to 320/340°C	10150	10153	10156	10159
0.32mm	0.10µm	-60 to 330/350°C	10106	10109	10112	
	0.25µm	-60 to 330/350°C	10121	10124	10127	10130
	0.50µm	-60 to 330/350°C	10136	10139	10142	
	1.00µm	-60 to 320/340°C	10151	10154	10157	10160
	1.50µm	-60 to 310/330°C	10166	10169	10172	10175
	3.00µm	-60 to 280/300°C	10181	10184	10187	10190
	4.00µm	-60 to 280/300°C		10198		
	5.00µm	-60 to 260/280°C	10176	10178	10180	
0.53mm	0.10µm	-60 to 320/340°C	10107	10110		
	0.25µm	-60 to 320/340°C	10122	10125	10128	
	0.50µm	-60 to 310/330°C	10137	10140	10143	
	1.00µm	-60 to 310/330°C	10152	10155	10158	
	1.50µm	-60 to 310/330°C	10167	10170	10173	
	3.00µm	-60 to 270/290°C	10182	10185	10188	10189
	5.00µm	-60 to 270/290°C	10177	10179	10183	10194
	7.00µm	-60 to 240/260°C	10191	10192	10193	

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

Metal MXT® Columns
Rugged, flexible, Siltek® treated stainless steel tubing; inertness comparable to fused silica tubing. See **page 115** for our MXT®-1 columns.

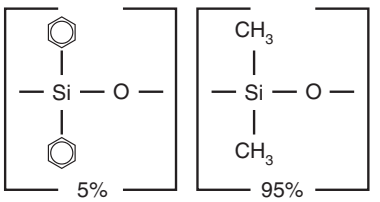
it's a fact

For exceptional inertness, ultra-low bleed, and unsurpassed performance, choose Rxi®-1ms columns! See **pages 36-41**.

crossbond® technology

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

Rtx®-5/Rtx®-5MS Structure

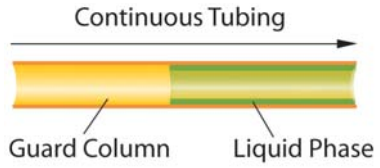


similar **phases**

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 35**.

also **available**

Metal MXT® Columns
Rugged, flexible, Siltek® treated stainless steel tubing; inertness comparable to fused silica tubing. See **page 116** for our MXT®-5 columns.

Rtx®-5 Amine Columns
See **page 64**.

it's a **fact**

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

Rtx®-5/Rtx®-5MS (fused silica)

- General purpose columns for drugs, solvent impurities, pesticides, hydrocarbons, PCB congeners (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)

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

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

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

30-meter	6-pack cat.#	6-pack price	price if bought separately	savings of
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)

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

Column specifically tested for low bleed performance.

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

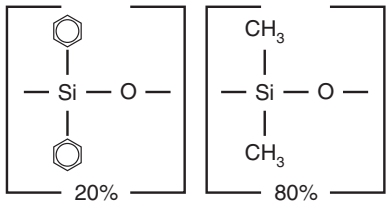
Rtx®-20 Columns (fused silica)

(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 monomodal distribution and extremely low bleed.

Rtx®-20 Structure



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

similar **phase**

SPB-20, AT-20, 007-7

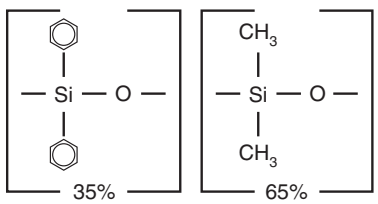
Rtx®-35 Columns (fused silica)

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

- General purpose columns for organochlorine pesticides, PCB congeners (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



ID	df	temp. limits	15-Meter	30-Meter
0.25mm	0.25µm	40 to 320°C	10420	10423
	0.50µm	40 to 310°C	10435	10438
	1.00µm	40 to 290°C	10450	10453
0.32mm	0.25µm	40 to 320°C	10421	10424
	0.50µm	40 to 310°C	10436	10439
	1.00µm	40 to 290°C	10451	10454
0.53mm	0.25µm	40 to 260/280°C	10422	10425
	0.50µm	40 to 300°C	10437	10440
	1.00µm	40 to 290°C	10452	10455
	1.50µm	40 to 280°C	10467	10470
	3.00µm	40 to 240/260°C	10482	10485

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

similar **phases**

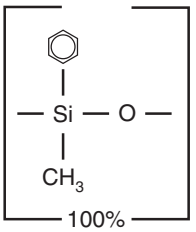
DB-35, HP-35, SPB-35, SPB-608

also **available**

Metal MXT® Columns
Rugged, flexible, Siltek® treated stainless steel tubing; inertness comparable to fused silica tubing. See **page 116** for our MXT®-20 columns and **page 117** for our MXT®-35 columns.

Rtx®-35 Amine Columns
See **page 65.**

Rtx®-50 Structure



similar **phases**

HP-50, SPB-50, SP-2250

also **available**

Metal MXT® Columns
Rugged, flexible, Siltek® treated stainless steel tubing; inertness comparable to fused silica tubing. See **page 117** for our MXT®-50 columns.

Rtx®-50 Columns (fused silica)

(midpolarity phase; Crossbond® 50% phenyl/50% methyl polysiloxane)

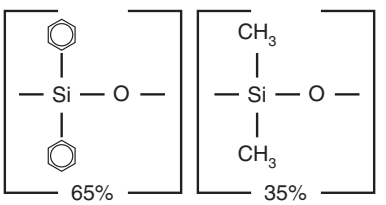
- General purpose columns for pesticides, herbicides, rosin acids, phthalate esters, triglycerides, sterols.
- Temperature range: 40 °C to 320 °C.
- Equivalent to USP G3 phase.

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.

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

ID	df	temp. limits	10-Meter	20-Meter
0.18mm	0.20µm	40 to 310/330°C	40501	40502
	0.40µm	40 to 300/320°C	40510	40511

Rtx®-65 Structure



similar **phases**

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

also **available**

Metal MXT® Columns
Rugged, flexible, Siltek® treated stainless steel tubing; inertness comparable to fused silica tubing. See **page 117** for our MXT®-65 columns.

Rtx®-65 Columns (fused silica)

(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.

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

also **available**

Rtx®-65TG Columns
Tested specifically for triglycerides.
See **page 72.**

crossbond® **technology**

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

restek **innovation**!

Rtx®-440 Columns (fused silica)

(midpolarity proprietary Crossbond® phase)

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

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

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

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

Column: Rtx®-440 30m, 0.32mm 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

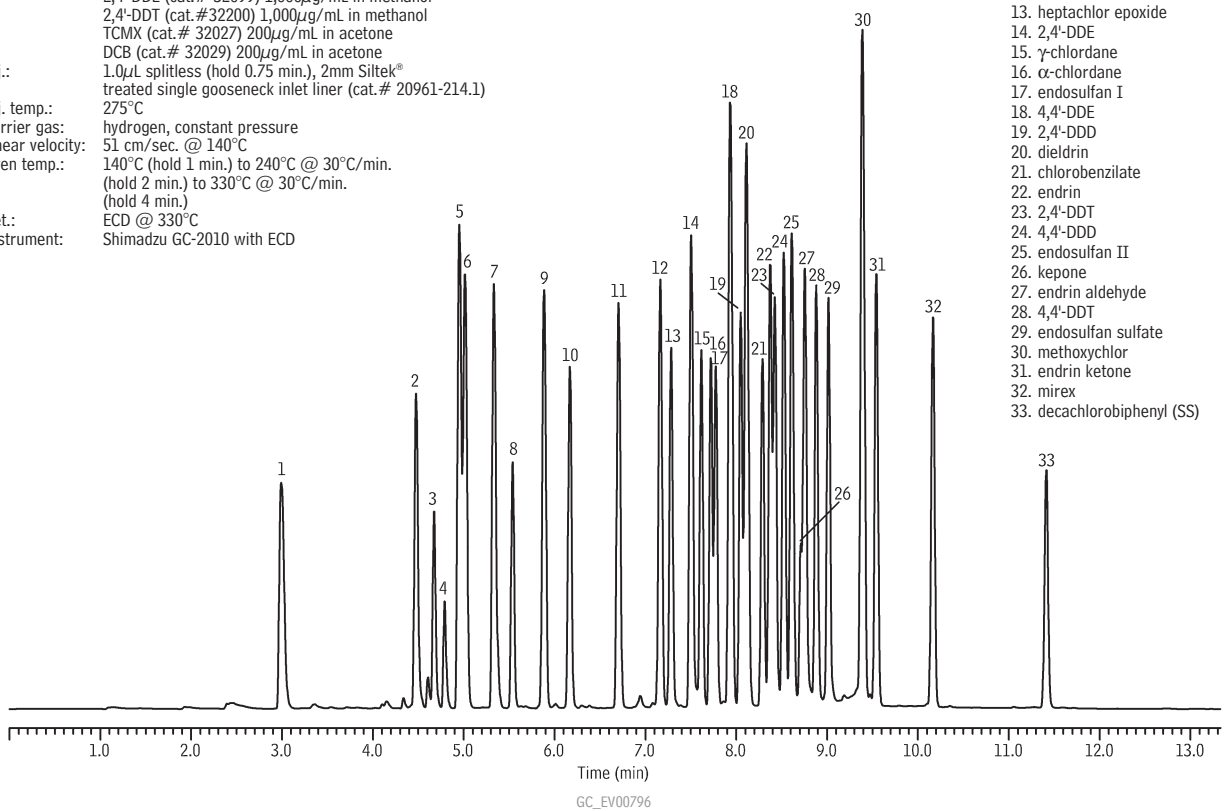
Carrier gas: hydrogen, constant pressure

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.)

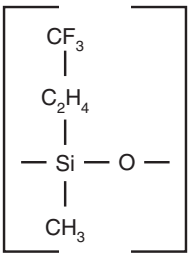
Det.: ECD @ 330°C

Instrument: Shimadzu GC-2010 with ECD



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

Rtx®-200 Structure



similar **phases**

DB-200, DB-210, VF-200ms

Rtx®-200/Rtx®-200MS (fused silica)

- 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)

(midpolarity phase; Crossbond® trifluoropropylmethyl polysiloxane)

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

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

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

also **available**

Metal MXT® Columns
Rugged, flexible, Siltek® treated stainless steel tubing; inertness comparable to fused silica tubing. See **page 118** for our MXT®-200 columns.

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

(midpolarity phase; Crossbond® trifluoropropylmethyl polysiloxane)

Column specifically tested for low bleed performance.

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

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

(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 cyanosiloxane 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.

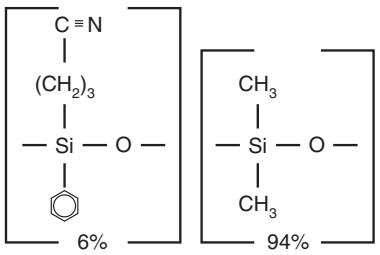
ID	df	temp. limits*	15-Meter	30-Meter		60-Meter	75-Meter	105-Meter
0.25mm	0.25µm	-20 to 280°C	16020	16023	$450	16026		
	0.50µm	-20 to 270°C	16035	16038	$450	16041		
	1.00µm	-20 to 260°C	16050	16053	$450	16056		
	1.40µm	-20 to 240°C				16016		
0.32mm	0.25µm	-20 to 280°C	16021	16024	$480	16027		
	0.50µm	-20 to 270°C	16036	16039	$480	16042		
	1.00µm	-20 to 260°C	16051	16054	$480	16057		
	1.50µm	-20 to 250°C	16066	16069	$480	16072		
	1.80µm	-20 to 240°C		16092	$480	16093		
0.53mm	0.25µm	-20 to 280°C	16022	16025	$540	16028		
	0.50µm	-20 to 270°C	16037	16040	$540	16043		
	1.00µm	-20 to 260°C	16052	16055	$540	16058		
	1.50µm	-20 to 250°C	16067	16070	$540	16073		
	3.00µm	-20 to 240°C	16082	16085	$540	16088	16076	16091

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

please note

Rtx®-1301 columns and Rtx®-624 columns are exactly the same columns.

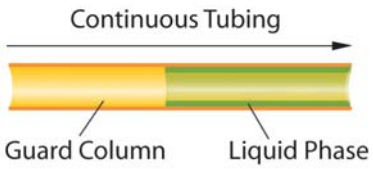
Rtx®-1301 Structure



similar phases

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

Integra-Guard® built-in guard column



Get the protection without the connection!
For Rtx®-1301 and Rtx®-624 columns with built-in Integra-Guard® guard columns, see **page 35**.

Rtx®-624 Columns (fused silica)

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

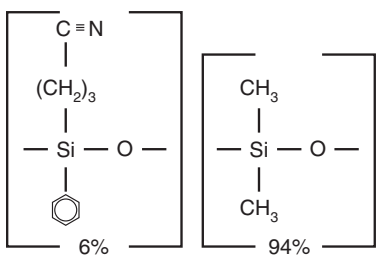
- Application-specific columns for volatile organic pollutants. Recommended in US EPA methods for volatile organic pollutants.
- Temperature range: -20 °C to 240 °C.
- Equivalent to USP G43 phase.

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.

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

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

Rtx®-624 Structure



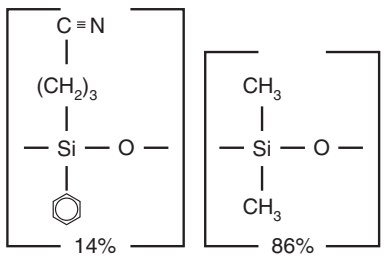
similar phases

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

also available

Metal MXT® Columns
Rugged, flexible, Siltek® treated stainless steel tubing; inertness comparable to fused silica tubing. See **page 117** for our MXT®-1301 columns and **page 121** for our MXT®-624 columns.

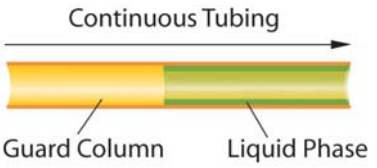
Rtx®-1701 Structure



similar **phases**

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

Integra-Guard® built-in guard column

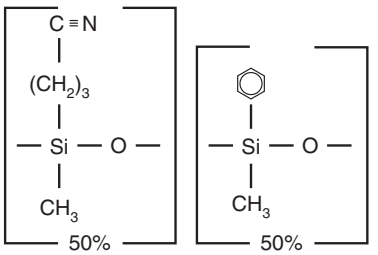


Get the protection without the connection!
For Rtx®-1701 columns with built-in Integra-Guard® guard columns, see **page 35**.

also **available**

Metal MXT® Columns
Rugged, flexible, Siltek® treated stainless steel tubing; inertness comparable to fused silica tubing. See **page 118** for our MXT®-1701 columns.

Rtx®-225 Structure



similar **phases**

DB-225, HP-225, SPB-225, CP-Sil 43 CB

Rtx®-1701 Columns (fused silica)

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

- General purpose columns for alcohols, oxygenates, PCB congeners (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.

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

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

Rtx®-225 Columns (fused silica)

(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.

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

Rt®-2330 Columns (fused silica)

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

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

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

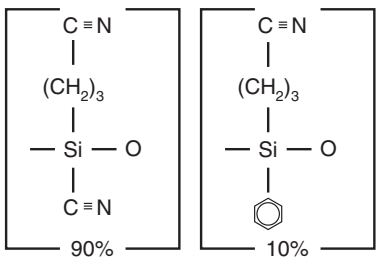
Because the Rt®-2330 stationary phase is not bonded, it should not be solvent rinsed.

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

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

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

Rt®-2330 Structure



similar phases

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

Doing Dioxin Analysis?
Rtx®-Dioxin2 columns provide better resolution and higher maximum temperatures than conventional columns. See **page 96**.

Rt®-2560 Column (fused silica)

(highly polar phase; biscyanopropyl polysiloxane—not bonded)

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

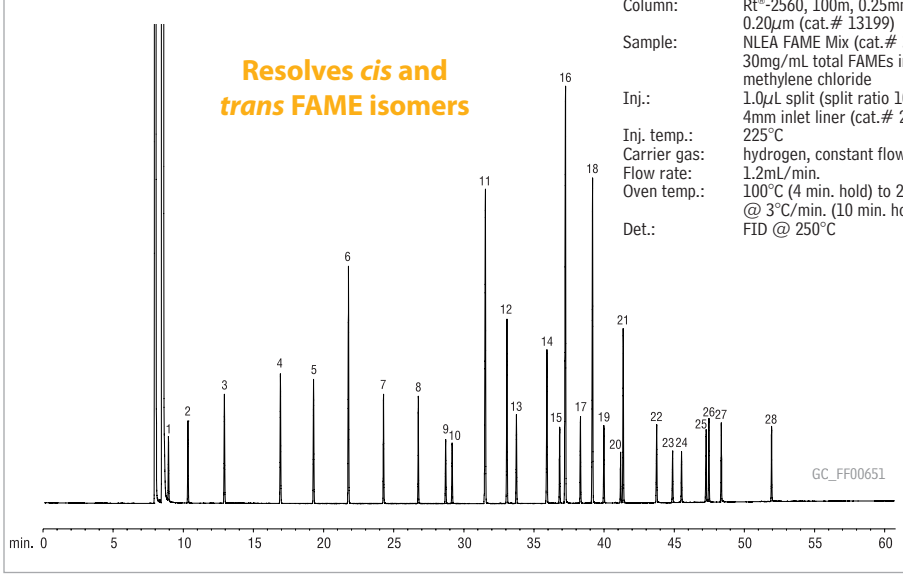
Because the Rt®-2560 stationary phase is not bonded, it should not be solvent rinsed.

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

similar phases

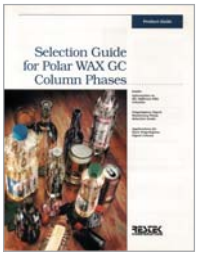
SPB-2560, HP-88, Silar 10C, CP-Sil 88 FAME, CP-Sil 88

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)



free literature

Selection Guide for Polar Wax GC Column Phases

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

lit. cat.# 59890

similar phases

DB-WAX, HP-Wax

Rtx®-Wax Columns (fused silica)

(polar phase; Crossbond® Carbowax® polyethylene glycol)

- Best polyethylene glycol (PEG) phase for alkenols, glycols, and aldehydes.
- Temperature range: 20 °C to 250 °C.
- Equivalent to USP G14, G15, G16, G20, G39 phases.

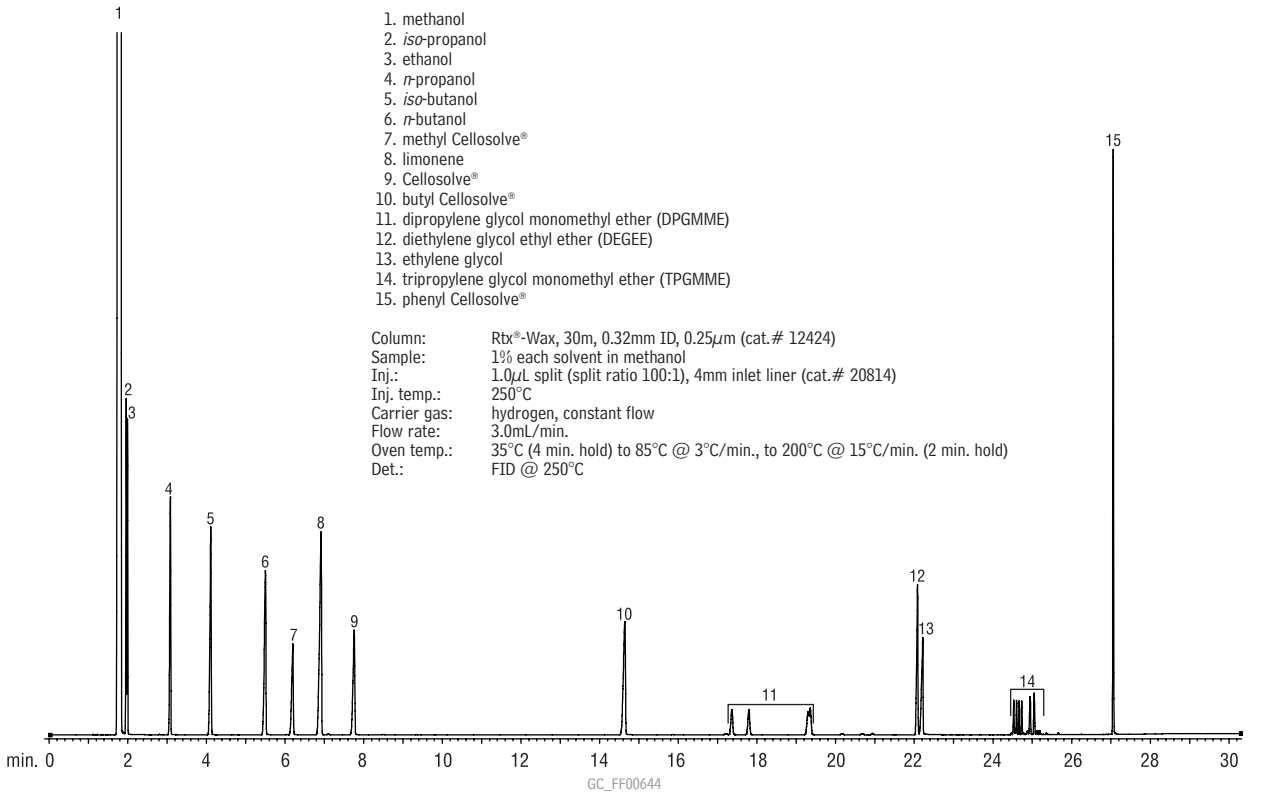
Rtx®-Wax columns are the most inert and efficient PEG columns currently available. The extended operating temperature range allows analysis of compounds having a wide volatility range, and ensures low bleed at temperatures as high as 250 °C. Selectivity is comparable to other Carbowax® columns, for compounds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

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

ID	df	temp. limits	10-Meter	20-Meter
0.10mm	0.10µm	20 to 250°C	41601	41602
	0.20µm	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.

Cleaning solvents on an Rtx®-Wax column.



Stabilwax® Columns (fused silica)

(polar phase; Crossbond® Carbowax® polyethylene glycol)

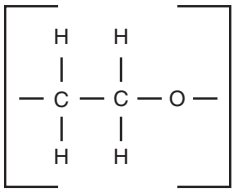
- Most stable polyethylene glycol (PEG) column available.
- Rugged enough to withstand repeated water injections.
- Lowest bleed PEG column on the market; long column lifetimes are assured
- Temperature range: 40 °C to 260 °C.
- Equivalent to USP G14, G15, G16, G20, and G39 phases.

Restek's polar-deactivated surface tightly binds the Carbowax® polymer and increases thermal stability, relative to competitive columns. Because of the increased stability produced by the bonding process, Stabilwax® columns exhibit long column lifetimes, even when programming repeatedly up to 260 °C. The bonding mechanism of the column also produces polar compound retention times that do not shift as is often observed on other wax-type columns. In addition, this bonding mechanism produces a column that can be rejuvenated by solvent washing. Stabilwax® columns are used for a wide range of compounds and matrices including: FAMEs, flavor compounds, essential oils, solvents, aromatics including xylene isomers, acrolein/acrylonitrile (EPA 603), and oxygenated compounds. Also used for purity testing of chemicals and analyzing impurities in water matrices and alcoholic beverages.

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

ID	df	temp. limits	10-Meter	20-Meter
0.10mm	0.10µm	40 to 250/260°C	42601	
0.18mm	0.18µm	40 to 250/260°C		40602

Stabilwax® Structure



NEW! manufacturing procedure

Better column-to-column reproducibility

similar phases

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

Six columns for the price of five!

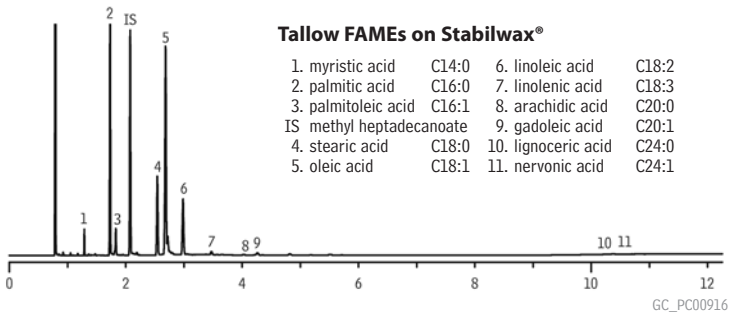
Call 800-356-1688, ext. 4, or your Restek representative for details!

also available

Metal MXT® Columns

Rugged, flexible, Silcosteel® treated stainless steel tubing; inertness comparable to fused silica tubing. See **page 118** for our MXT®-WAX columns.

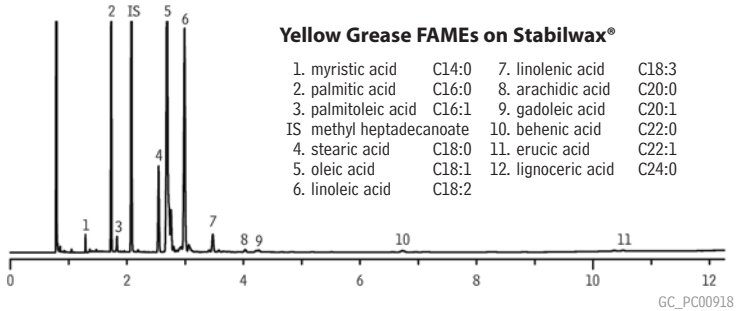
FAMEs in biodiesel oils on a Stabilwax® column.



GC_PC00916

Tallow FAMEs on Stabilwax®

1.	myristic acid	C14:0	6.	linoleic acid	C18:2
2.	palmitic acid	C16:0	7.	linolenic acid	C18:3
3.	palmitoleic acid	C16:1	8.	arachidic acid	C20:0
IS	methyl heptadecanoate		9.	gadoleic acid	C20:1
4.	stearic acid	C18:0	10.	lignoceric acid	C24:0
5.	oleic acid	C18:1	11.	nervonic acid	C24:1



GC_PC00918

Yellow Grease FAMEs on Stabilwax®

1.	myristic acid	C14:0	7.	linolenic acid	C18:3
2.	palmitic acid	C16:0	8.	arachidic acid	C20:0
3.	palmitoleic acid	C16:1	9.	gadoleic acid	C20:1
IS	methyl heptadecanoate		10.	behenic acid	C22:0
4.	stearic acid	C18:0	11.	erucic acid	C22:1
5.	oleic acid	C18:1	12.	lignoceric acid	C24:0
6.	linoleic acid	C18:2			

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

See page 646 for Soy FAMEs and Rapeseed FAMEs analysis.

Fast GC

Fast GC Using 0.10 mm and 0.15 mm ID Capillary Columns

- Significantly reduces analysis time without sacrificing resolution.
- Higher column efficiencies speed up separations.
- Ideal for GC/MS.
- Excellent for comprehensive GC (GCxGC) as second dimension column.

Narrow bore (less than or equal to 0.15 mm 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. Therefore, resolution can be achieved with a shorter column, which decreases analysis time. In addition, narrow bore columns are more compatible with GC/MS since typical flow rates are 1.0 mL/min. or less, eliminating the need to split the column flow at the MS interface. Conventional methods are easily converted to narrow bore columns, but some research may be necessary due to lower column capacities and higher back pressures.

Rxi®-1ms Columns for Fast GC (fused silica)

(nonpolar phase, Crossbond® 100% dimethyl polysiloxane)

ID	df	temp. limits	10-Meter	20-Meter
0.10mm	0.10µm	-60 to 330/350°C	13301	
0.15mm	0.15µm	-60 to 330/350°C	43800	43801
	2.0µm	-60 to 330/350°C		43802

Rxi®-5ms Columns for Fast GC (fused silica)

(low polarity phase, Crossbond® 5% diphenyl/95% dimethyl polysiloxane)

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

Rxi®-5Sil MS Columns for Fast GC (fused silica)

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

ID	df	temp. limits	10-Meter		20-Meter
0.10mm	0.10µm	-60 to 330/350°C	43601		
0.15mm	0.15µm	-60 to 330/350°C	43815	$295	43816
	2.0µm	-60 to 330/350°C			43817

Rxi®-17 Columns for Fast GC (fused silica)

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

ID	df	temp. limits	10-Meter
0.10mm	0.10µm	40 to 280/320°C	13501

Rxi®-17Sil MS Columns for Fast GC (fused silica)

(midpolarity Crossbond® silarylene phase; equivalent to 50% phenyl methyl polysiloxane)

ID	df	temp. limits	10-Meter	20-Meter
0.15mm	0.15µm	40 to 340/360°C	43820	43821

Rtx®-200 Columns for Fast GC (fused silica)

(midpolarity phase; Crossbond® trifluoropropylmethyl polysiloxane)

ID	df	temp. limits	10-Meter	20-Meter
0.15mm	0.15µm	-20 to 320/340°C	43835	43836

Stabilwax® Columns for Fast GC (fused silica)

(polar phase; Crossbond® Carbowax® polyethylene glycol)

ID	df	temp. limits	10-Meter	20-Meter
0.10mm	0.10µm	40 to 250/260°C	42601	
0.15mm	0.15µm	40 to 250/260°C	43830	43831

Rt®-LC50 Columns for Fast GC (fused silica)

(polar, dimethyl [50% liquid crystal] polysiloxane)

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

Rtx®-CLPesticides for Fast GC (fused silica)

(proprietary Crossbond® phase)

ID	df	temp. limits	10-Meter
0.10mm	0.10µm	-60 to 310/330°C	43101

Rtx®-CLPesticides2 for Fast GC (fused silica)

(proprietary Crossbond® phase)

ID	df	temp. limits	10-Meter	20-Meter
0.10mm	0.10µm	-60 to 310/330°C	43301	43302

tech tip

Operating considerations for 0.10 mm ID columns

The small degree of extra care involved in using 0.10 mm ID columns will be more than repaid by faster analyses and higher column efficiencies. 0.10 mm ID columns require higher operating pressures (>40 psig), 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 0.10 mm 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.

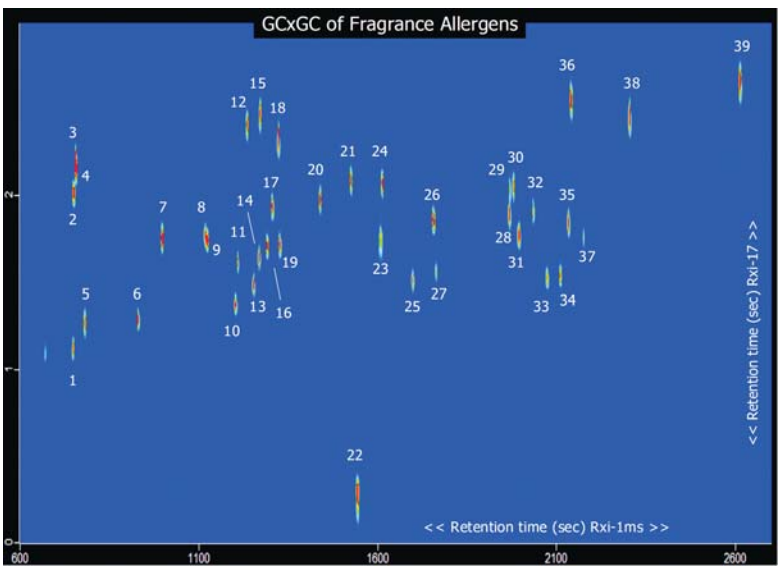
GCxGC Second Dimension Selectivity Kit

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

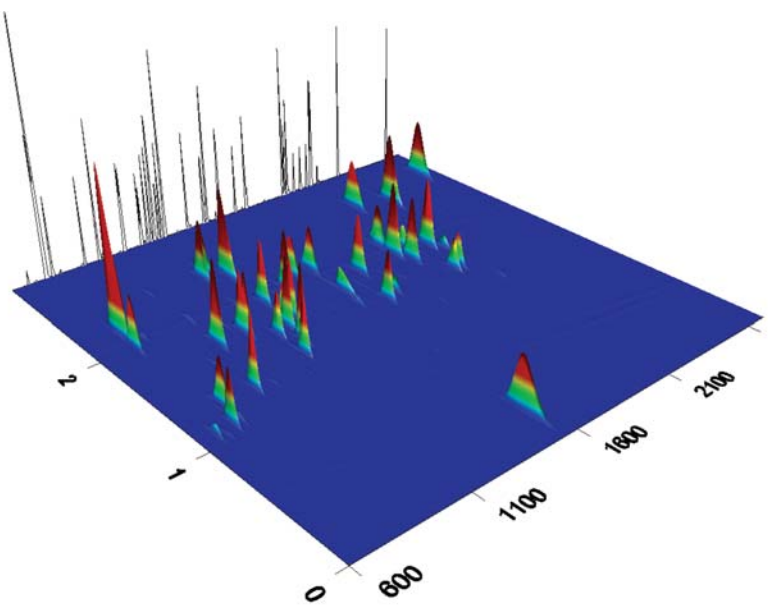
- Rxi®-17, 50% diphenyl dimethylpolysiloxane
- Rtx®-CLPesticides, trifluoropropyl containing polymer
- Stabilwax®, polar polyethylene glycol
- Rt®-LC350, liquid crystalline phase selective for aromatic compounds

Description	qty.	cat.#	price
GCxGC Second Dimension Selectivity Kit	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



GC_FF01011

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

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

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
- Petroleum & Petrochemical
- Clinical, Forensic & Toxicology
- Pharmaceutical
- Environmental

Unique stationary phases and applications

- Designed to help solve chromatographic challenges.
- Optimized stationary phases for best separations, accurate quantification, and best choice for shorter analysis times.

Basic Compounds Analysis

Rtx®-Volatile Amine Columns (fused silica)

- Unique selectivity for baseline resolution of all volatile amines.
- Excellent inertness assures accuracy and sensitivity for volatile amines, including free ammonia.
- Highly robust phase withstands repeated water injections, resulting in longer column lifetime.
- High temperature stability (290 °C) ensures elution of amines up to C16 and allows contaminants to be removed by "baking out" the column.

NEW!

The Rtx®-Volatile Amine column was designed specifically for analyzing volatile amines in difficult matrices, such as water. The unique base deactivation creates an exceptionally inert surface for these sensitive compounds, resulting in highly symmetric peaks which allow low detection limits. The stable bonded phase yields a column that is not only retentive and highly selective for these compounds, but is also very robust and able to withstand repeated water injections. Comparisons made by customers performing routine volatile amine applications have shown the Rtx®-Volatile Amine column outperforms other amine-specific columns, especially for peak shape and lifetime. Each Rtx®-Volatile Amine column is held to stringent quality specifications and tested with a specially designed test mix that includes basic compounds to ensure exceptional inertness, reliability, and reproducibility. These qualities assure consistent performance and make the Rtx®-Volatile Amine column the best choice for volatile amines analysis.

ID	temp. limits	15-Meter	30-Meter	60-Meter
0.32mm	-60 to 290°C	18076	18077	18078

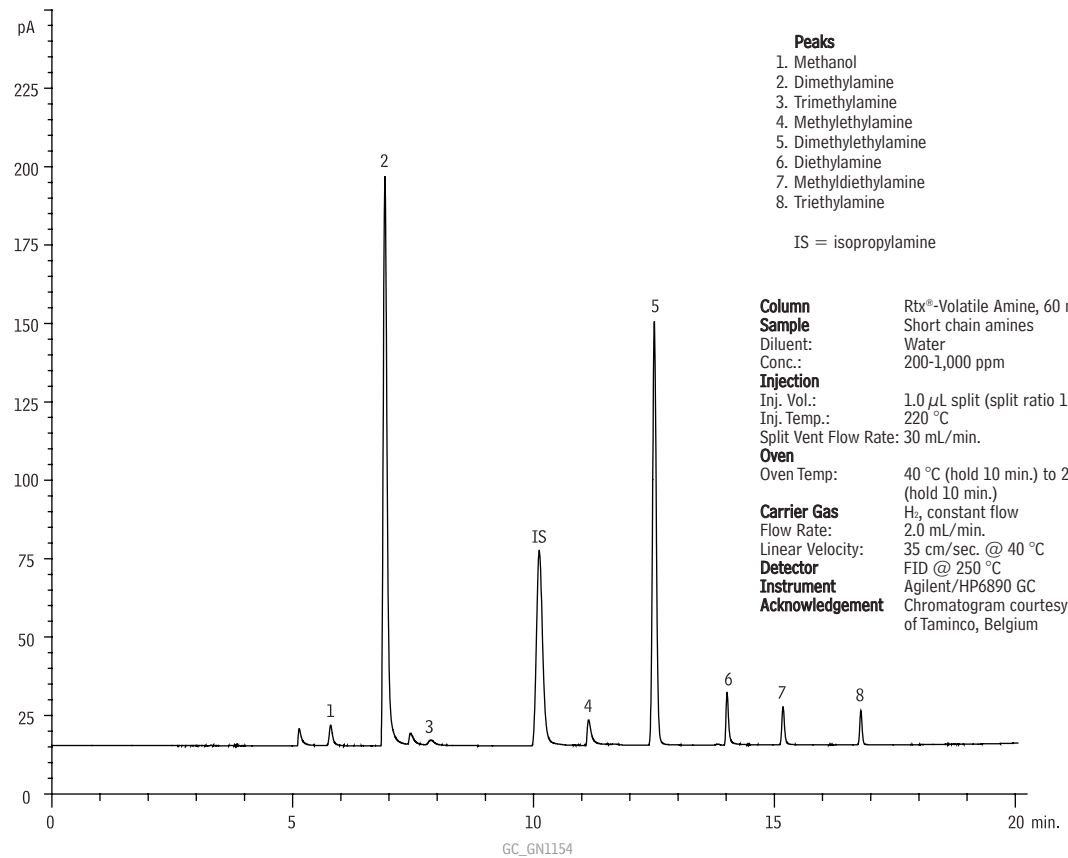
similar **phases**

Direct replacement for CP-Volamine, thick-film CP-Sil 8 for amines, and other amine-deactivated columns coated with low polarity polysiloxane phases.

please **note**

We recommend using base-deactivated fused silica guard columns **(page 34)** and base-deactivated liners (**page 213**) with Rtx®-Volatile Amine columns.

Short chain amines in water on an Rtx®-Volatile Amine column.



Peaks
1. Methanol
2. Dimethylamine
3. Trimethylamine
4. Methylethylamine
5. Dimethylethylamine
6. Diethylamine
7. Methyldiethylamine
8. Triethylamine

IS = isopropylamine

Column	Rtx®-Volatile Amine, 60 m, 0.32 mm ID (cat.# 18078)
Sample	Short chain amines
Diluent:	Water
Conc.:	200-1,000 ppm
Injection	
Inj. Vol.:	1.0 µL split (split ratio 15:1)
Inj. Temp.:	220 °C
Split Vent Flow Rate:	30 mL/min.
Oven	
Oven Temp:	40 °C (hold 10 min.) to 250 °C at 20 °C/min. (hold 10 min.)
Carrier Gas	H_2, constant flow
Flow Rate:	2.0 mL/min.
Linear Velocity:	35 cm/sec. @ 40 °C
Detector	FID @ 250 °C
Instrument	Agilent/HP6890 GC
Acknowledgement	Chromatogram courtesy of Mr. Gilbert Baele of Taminco, Belgium

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innovation!

Basic Compounds Analysis

Rtx®-5 Amine Columns (fused silica)
(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.

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

similar **phase**

PTA-5, CP-Sil CB

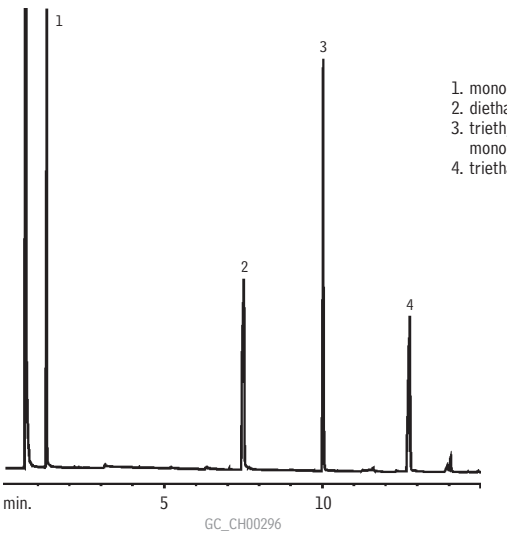
also **available**

See **page 65** for Rtx®-35 Amine columns.

please **note**

We recommend using base-deactivated fused silica guard columns **(page 34)** and base-deactivated liners (**page 213**) with Rtx®-5 Amine columns.

Ethanolamines on an Rtx®-5 Amine column.



1. monoethanolamine
2. diethanolamine
3. triethylene glycol monomethylether (IS)
4. triethanolamine

Column:	Rtx®-5 Amine, 15m, 0.25mm ID, 0.50µm (cat.# 12335)
Sample:	1.0µL split injection of ethanolamine mix in methanol
On-column conc.:	34ng
Oven temp.:	50°C (hold 2 min.) to 180°C @ 10°C/min. (hold 2 min.)
Inj./det. temp.:	280°C/300°C
Carrier gas:	hydrogen
Linear velocity:	43cm/sec. set @ 50°C
FID sensitivity:	6.4 x 10^{-11} AFS
Split ratio:	58:1

Basic Compounds Analysis

Rtx®-35 Amine Columns (fused silica)
(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.

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

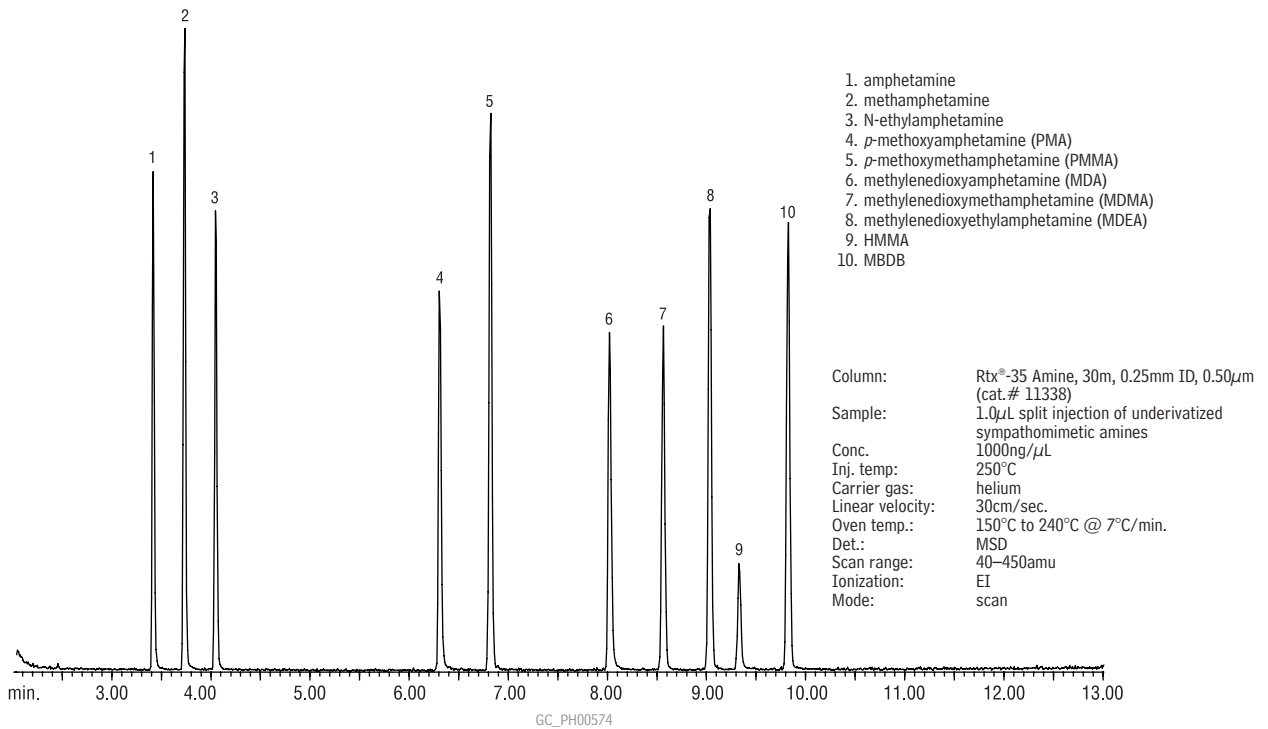
restek **innovation!**

please **note**

We recommend using base-deactivated fused silica guard columns **(page 34)** and base-deactivated liners (**page 213**) with Rtx®-35 Amine columns.

Table of Contents for
GC Chromatograms
see **page 542**

Sympathomimetic amines (basic drugs) (underivatized) on an Rtx®-35 Amine column.



1. amphetamine
2. methamphetamine
3. N-ethylamphetamine
4. *p*-methoxyamphetamine (PMA)
5. *p*-methoxymethamphetamine (PMMA)
6. methylenedioxyamphetamine (MDA)
7. methylenedioxymethamphetamine (MDMA)
8. methylenedioxyethylamphetamine (MDEA)
9. HMMA
10. MBDB

Column:	Rtx®-35 Amine, 30m, 0.25mm ID, 0.50µm (cat.# 11338)
Sample:	1.0µL split injection of underivatized sympathomimetic amines
Conc.	1000ng/µL
Inj. temp:	250°C
Carrier gas:	helium
Linear velocity:	30cm/sec.
Oven temp.:	150°C to 240°C @ 7°C/min.
Det.:	MSD
Scan range:	40–450amu
Ionization:	EI
Mode:	scan

Basic Compounds Analysis

free literature

GC Analysis of Non-Purgeable Solvents in Pharmaceutical Discharges

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lit. cat.# 580027

similar phases

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

Stabilwax®-DB Columns (fused silica)

(polar phase; Crossbond® base-deactivated Carbowax® polyethylene glycol—for amines and basic compounds)

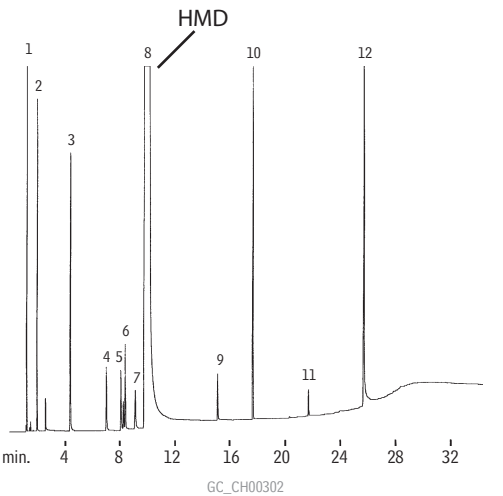
- Application-specific columns for underivatized amines and other basic compounds, including alkylamines, diamines, triamines, nitrogen-containing heterocyclics. No need for column priming.
- Temperature range: 40 °C to 220 °C.

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.

ID	df	temp. limits	15-Meter	30-Meter	60-Meter
0.25mm	0.25µm	40 to 210/220°C	10820	10823	
	0.50µm	40 to 210/220°C		10838	
0.32mm	0.25µm	40 to 210/220°C	10821	10824	
	0.50µm	40 to 210/220°C		10839	
	1.00µm	40 to 210/220°C	10851	10854	10857
0.53mm	0.50µm	40 to 210/220°C		10840	
	1.00µm	40 to 210/220°C	10852	10855	10858
	1.50µm	40 to 210/220°C		10869	

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



GC_CH00302

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 Columns (fused silica)

(polar phase; Crossbond® acid-deactivated Carbowax® polyethylene glycol—for acidic compounds)

- 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

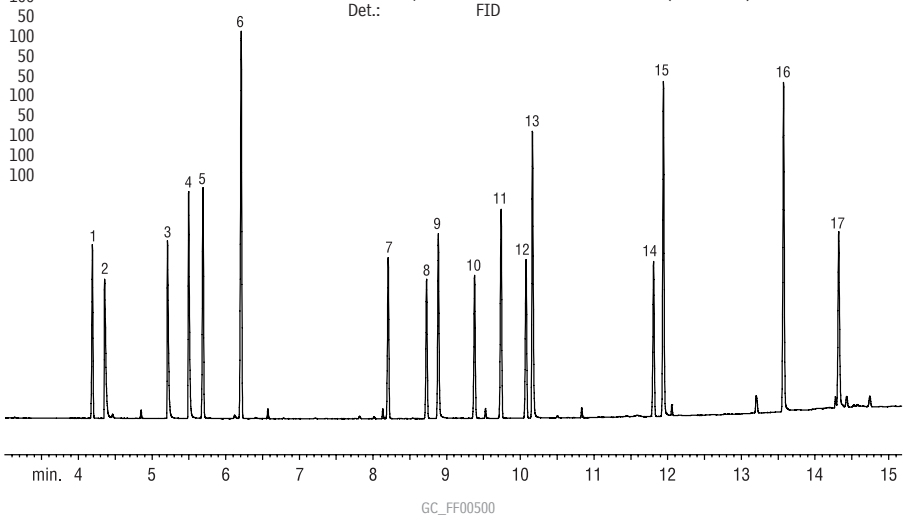
reduces bleed, prolongs column lifetime, and allows rejuvenation through solvent rinsing.

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



GC_FF00500

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.

Rt®-βDEXm Columns (fused silica)

(permethylated beta cyclodextrin doped into 14% cyanopropylphenyl/86% dimethyl polysiloxane)
Uses: General purpose chiral phase with many published applications.

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

Rt®-βDEXsm Columns (fused silica)

(2,3-di-O-methyl-6-O-*tert*-butyl dimethylsilyl beta cyclodextrin doped into 14% cyanopropylphenyl/86% dimethyl polysiloxane)
Uses: Excellent column for most chiral compounds in essential oils.

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

Rt®-βDEXse Columns (fused silica)

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

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

Rt®-βDEXsp Columns (fused silica)

(2,3-di-O-propyl-6-O-*tert*-butyl dimethylsilyl beta cyclodextrin doped into 14% cyanopropylphenyl/86% dimethyl polysiloxane)
Uses: Often useful in dual-column configurations, with the Rt-βDEXsm column, for complex enantiomeric separations.

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

Rt®-βDEXsa Columns (fused silica)

(2,3-di-acetoxy-6-O-*tert*-butyl dimethylsilyl beta cyclodextrin doped into 14% cyanopropylphenyl/86% dimethyl polysiloxane)
Uses: Unique selectivity for esters, lactones, and other fruit flavor components.

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

Rt®-βDEXcst Columns (fused silica)

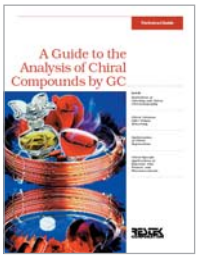
(Proprietary cyclodextrin material doped into 14% cyanopropylphenyl/86% dimethyl polysiloxane)
Uses: Proprietary stationary phase, developed specifically for the fragrance industry. Also used for pharmaceutical applications.

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

Rt®-γDEXsa Columns (fused silica)

(2,3-di-acetoxy-6-O-*tert*-butyl dimethylsilyl gamma cyclodextrin doped into 14% cyanopropylphenyl/86% dimethyl polysiloxane)
Uses: Larger organic molecules. Also useful for flavor compounds in fruit juices.

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



free literature

A Guide to the Analysis of Chiral Compounds by GC

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lit. cat.# 59889

please **note**

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

tech tip

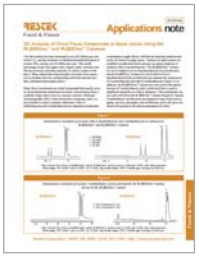
Chiral selectivity improves significantly by realizing lower elution temperatures.
This can be achieved by:

- Faster linear velocities (80 cm/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 50 ng or less.

free literature

Grape Flavor Analysis, Using an Rt®-γDEXsa GC Column

lit. cat.# 59553



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

lit. cat.# 59546

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cis/trans FAMEs

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

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

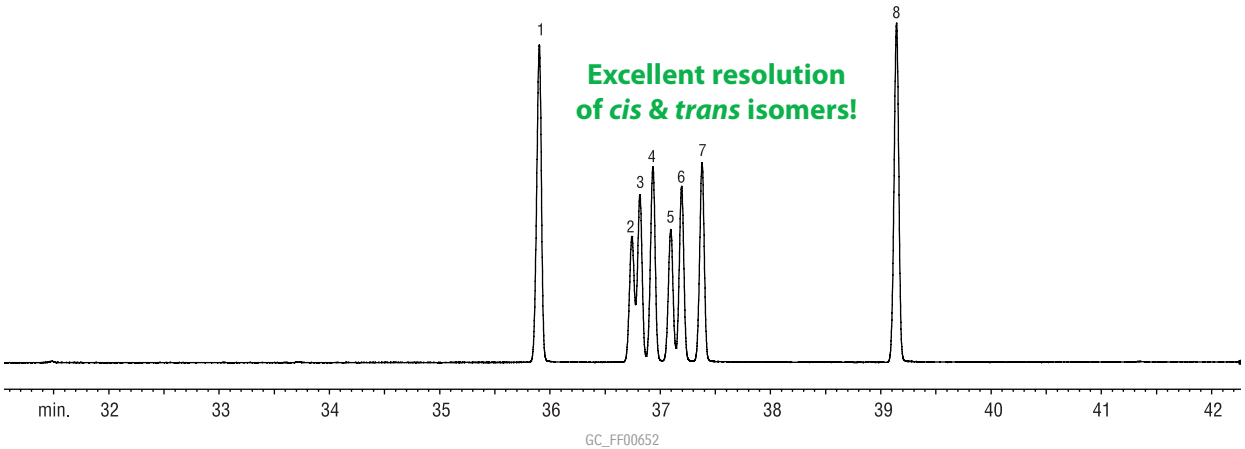
Because the Rt®-2560 stationary phase is not bonded, it should not be solvent rinsed.

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

similar **phases**

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

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



GC_FF00652

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 Columns (fused silica)
(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**

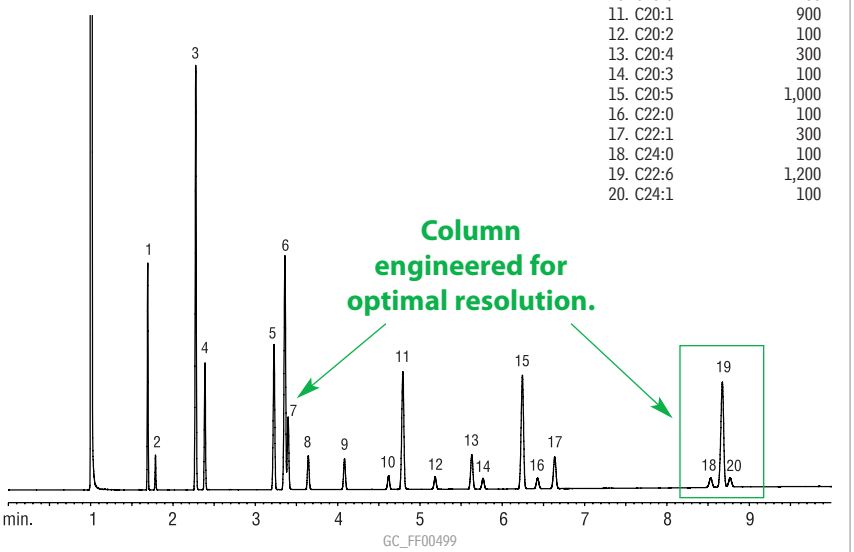
Omegawax

ID	df	temp. limits	30-Meter
0.25mm	0.25µm	20 to 250°C	12497
0.32mm	0.25µm	20 to 250°C	12498
0.53mm	0.50µm	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	1,600
4. C16:1	500
5. C18:0	800
6. C18:1 (oleate)	1,300
7. C18:1 (vaccenate)	400
8. C18:2	200
9. C18:3	200
10. C20:0	100
11. C20:1	900
12. C20:2	100
13. C20:4	300
14. C20:3	100
15. C20:5	1,000
16. C22:0	100
17. C22:1	300
18. C24:0	100
19. C22:6	1,200
20. C24:1	100



Flavor & Fragrance Compounds Analysis

Perfect confirmation column for F&F analysis!

Rt®-CW20M F&F Columns (fused silica)

(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.

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

similar **phases**

HP-20M, Carbowax® 20M

Rtx®-1 F&F Columns (fused silica)

(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.

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

similar **phase**

HP-1

Al Carusone, Technical Service

Technical Service

Do you have a technical question? Restek's Technical Service group has answers! Drawing from our extensive libraries of technical information and many years of collective chromatography experience, the experts in Technical Service can help you from set-up to method development.

Contact us:

For quick answers to commonly asked questions any time of the day, visit **www.restek.com/answers** or contact us directly:

In the U.S.

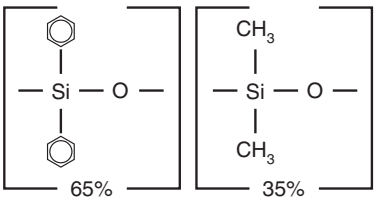
Phone: 1-800-356-1688, ext. 4
Fax: 814-353-1568
e-mail: support@restek.com

Outside the U.S.

Contact your Restek representative.

Triglycerides in Foods Analysis

Rtx®-65TG Structure



save **money**!

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

crossbond® **technology**

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

please **note**

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

- Vu2 Union® (see page 289)
- MXT®-Union Connector Kits for Fused Silica (see page 292)

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

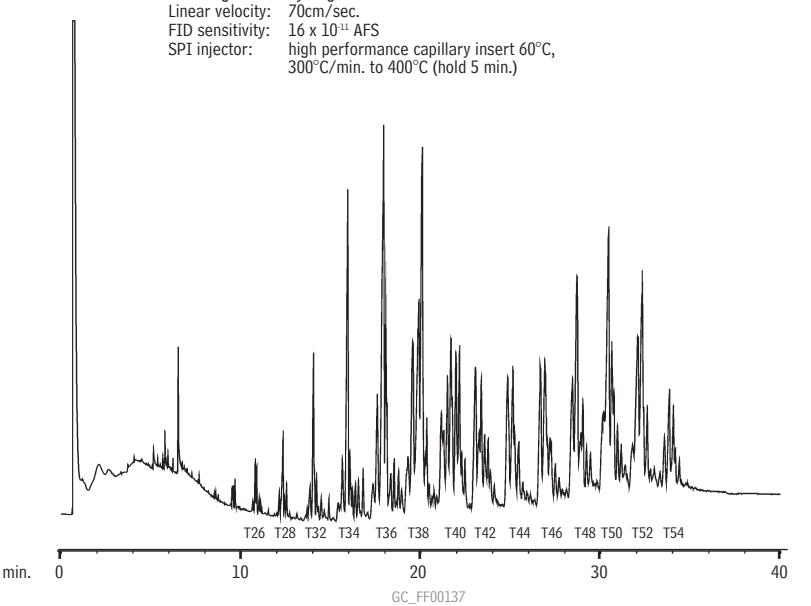
- Application-specific columns, specially tested for triglycerides.
- Stable to 370 °C.

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 the analyses of polar compounds.

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

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

Column: Rtx®-65TG, 30m, 0.25mm ID, 0.10µm (cat.# 17008)
Sample: 0.2µL cold on-column injection of 1% butterfat in 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.)



PAHs in Foods Analysis

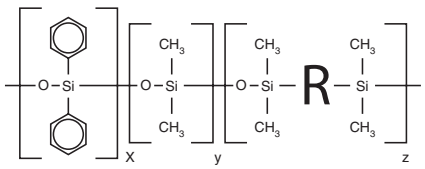
Rxi®-17Sil MS Columns (fused silica)

(midpolarity Crossbond® silarylene phase; equivalent to 50% phenyl/ 50% dimethyl arylene polysiloxane)

- 340/360 °C upper temperature limits.
- Excellent inertness for active compounds.
- Equivalent to USP phase G3.
- Low-bleed for use with sensitive detectors, such as GC/MS.
- Excellent separation of EU-PAHs, including fluoranthenes.

NEW!

Rxi®-17Sil MS Structure



ID	df	temp. limits*	15-Meter	30-Meter	60-Meter
0.25mm	0.25µm	40 to 340/360°C	14120	14123	14126
0.32mm	0.25µm	40 to 340/360°C	14121	14124	

ID	df	temp. limits	20-Meter
0.18mm	0.18µm	40 to 340/360°C	14102
	0.36µm	40 to 340/360°C	14111

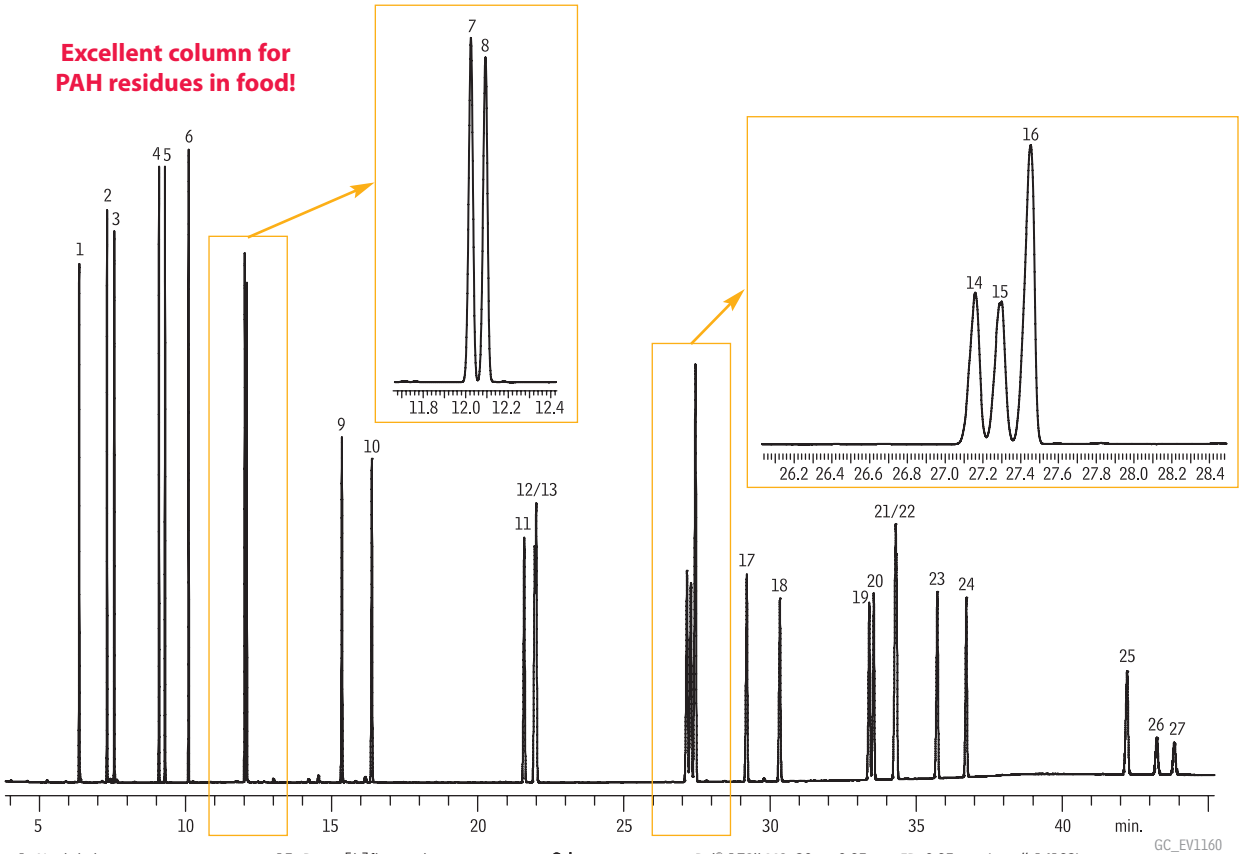
*Maximum temperatures listed are for 15- and 30-meter lengths. Longer lengths may have a slightly reduced maximum temperature.

similar phases

DB-17ms, VF-17ms, BPX-50

Polycyclic Aromatic Hydrocarbons on an Rxi®-17Sil MS column.

Excellent column for PAH residues in food!



1. Naphthalene
2. 2-Methylnaphthalene
3. 1-Methylnaphthalene
4. Acenaphthylene
5. Acenaphthene
6. Fluorene
7. Phenanthrene
8. Anthracene
9. Fluoranthene
10. Pyrene
11. Benz[a]anthracene
12. Chrysene
13. Triphenylene
14. Benzo[b]fluoranthene
15. Benzo[k]fluoranthene
16. Benzo(j)fluoranthene
17. Benzo[a]pyrene
18. 3-Methylcholanthrene
19. Dibenz(a,h)acridine
20. Dibenz[a,j]acridine
21. Indeno[1,2,3-cd]pyrene
22. Dibenz[a,h]anthracene
23. Benzo[ghi]perylene
24. 7H-Dibenzo[c,g]carbazole
25. Dibenzo[a,e]pyrene
26. Dibenzo(a,i)pyrene
27. Dibenzo(a,h)pyrene

Column	Rxi®-17Sil MS, 30 m, 0.25 mm ID, 0.25 µm (cat.# 14123)
Sample	SV Calibration Mix #5 / 610 PAH Mix (cat.# 31011) EPA Method 8310 PAH Mixture (cat.# 31841)
Diluent:	dichloromethane
Conc.:	10 ppm
Injection	
Inj. Vol.:	0.5 µL splitless (hold 1.75 min.)
Liner:	Auto SYS XL PSS Split/Splitless w/Wool (cat.# 21718)
Inj. Temp.:	320 °C
Purge Flow:	75 mL/min.
Oven	
Oven Temp:	65 °C (hold 0.5 min.) to 220 °C at 15 °C/min. to 330 °C at 4 °C/min. (hold 15 min.)
Carrier Gas	He, constant flow
Flow Rate:	2.0 mL/min.
Detector	FID @ 320 °C
Instrument	PE Clarus 600 GC
Acknowledgement	Instrument provided by PerkinElmer

Chlorinated Fluorocarbons (CFC) Analysis

NEW!

Rt®-Alumina BOND/CFC Columns (fused silica PLOT)

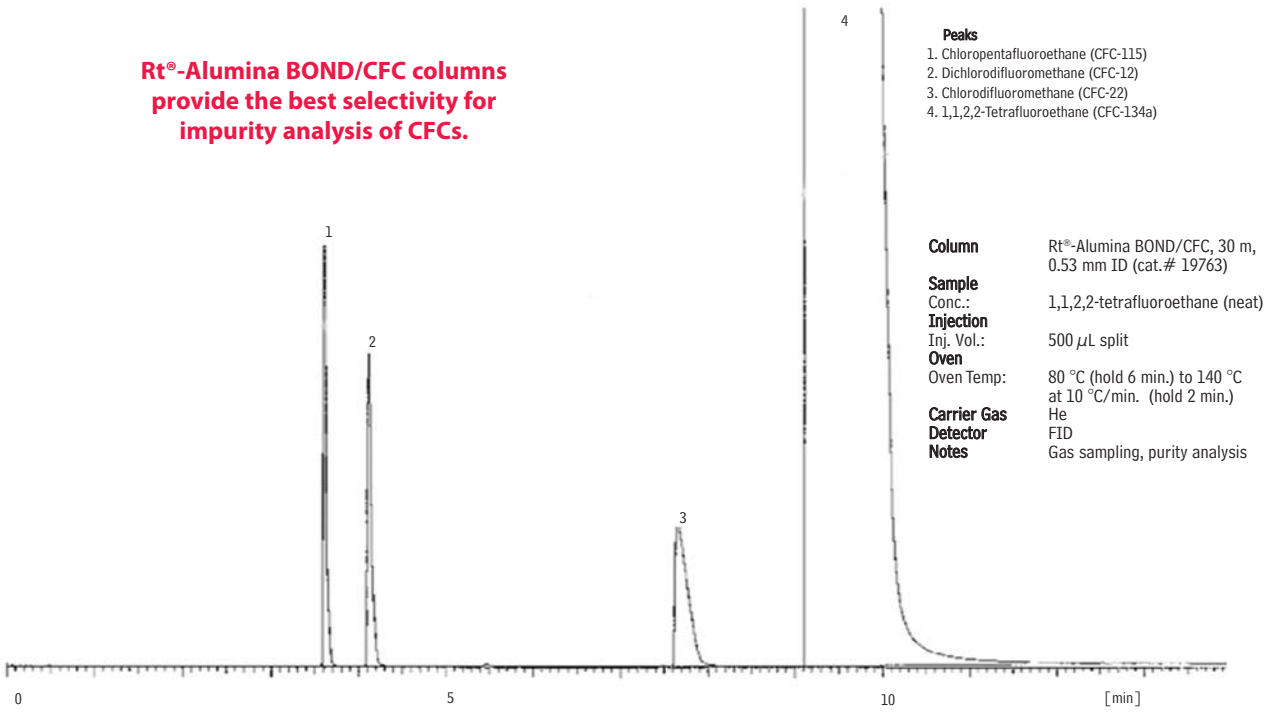
- Improved inertness for halogenated compounds.
- Highly selective alumina-based column, separates most CFCs.
- High retention and capacity for CFCs.

The alumina adsorbent is ideal for retaining halogenated compounds, especially CFC (chlorinated flourocarbons, freons). It offers high selectivity, allowing a wide range of CFC isomers to be resolved at above ambient temperatures. The Rt®-Alumina BOND/CFC column is thoroughly deactivated to reduce the reactivity of alumina. Even though there is still some residual reactivity for some mono- or di-substituted halogenated hydrocarbons, the majority of these compounds can be accurately quantified from main stream processes or in impurity analyses.

ID	df	temp. limits	30-Meter
0.53mm	10µm	to 200°C	19763

Impurity analysis of 1,1,2,2-tetrafluoroethane (CFC-134a) on an Rt®-Alumina BOND/CFC column.

Rt®-Alumina BOND/CFC columns provide the best selectivity for impurity analysis of CFCs.



Peaks
1. Chloropentafluoroethane (CFC-115)
2. Dichlorodifluoromethane (CFC-12)
3. Chlorodifluoromethane (CFC-22)
4. 1,1,2,2-Tetrafluoroethane (CFC-134a)

Column	Rt®-Alumina BOND/CFC, 30 m, 0.53 mm ID (cat.# 19763)
Sample Conc.:	1,1,2,2-tetrafluoroethane (neat)
Injection Inj. Vol.:	500 µL split
Oven Oven Temp:	80 °C (hold 6 min.) to 140 °C at 10 °C/min. (hold 2 min.)
Carrier Gas	He
Detector	FID
Notes	Gas sampling, purity analysis

Detailed Hydrocarbon Analysis (DHA)

Rtx®-DHA Columns (fused silica)

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

- Columns meet or exceed all ASTM D6730-01 and CAN/CGSB 3.0 No. 14.3-99 method guidelines; test report for method D6730 supplied with each column.
- Excellent responses and peak symmetry for polar oxygenates.

Gasolines are complex mixtures of hundreds of compounds. Information about concentrations of the individual components is important for evaluating raw materials and for controlling refinery processes. ASTM D6730-01 outlines a high-resolution GC method for detailed hydrocarbon analysis (DHA) of gasolines. Rtx®-DHA columns are ideal for DHA methods and easily meet or exceed both ASTM D6730-01 and Canadian General Standards Board CAN/CGSB 3.0 No. 14.3-99 requirements. Every Rtx®-DHA column is tested for retention, efficiency, stationary phase selectivity, and bleed—guaranteeing reproducible column-to-column performance.

ID	df	temp. limits	50-Meter	100-Meter	150-Meter
0.20mm	0.50µm	-60 to 300/340°C	10147		
0.25mm	0.50µm	-60 to 300/340°C		10148	
	1.00µm	-60 to 300/340°C			10149

Rtx®-5 DHA Tuning Column (fused silica)

(Crossbond® 5% diphenyl/95% dimethyl polysiloxane—optimized for hydrocarbon analysis)

ID	df	temp. limits	5-Meter
0.25mm	1.00µm	-60 to 340°C	10165

NOTE: Rtx®-1PONA columns have been renamed as Rtx®-DHA columns. There are no changes in the manufacturing process or column performance.

NEW!

Method Recommended

ASTM Method	Column	cat. #	Dimensions
D6729	Rtx-DHA-100	10148	100m x 0.25mm, 0.50µm
D6730	Rtx-DHA-100 & Rtx-5 DHA Tuning Column	10148 & 10165	100m x 0.25mm, 0.50µm w/ precolumn
D6733	Rtx-DHA-50	10147	50m x 0.20mm, 0.50µm
D5501	Rtx-DHA-150	10149	150m x 0.25mm, 1.0µm

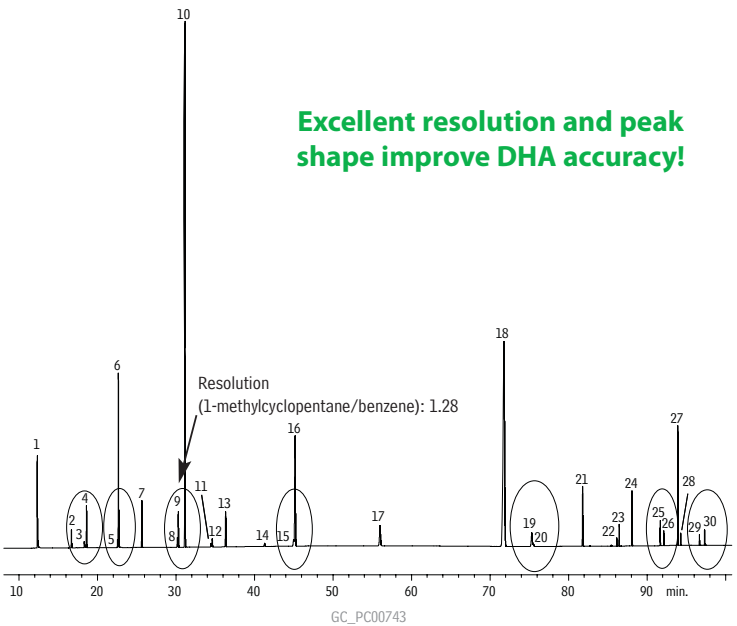
similar **phases**

Petrocol DH, DB-Petro, HP-PONA, CP-Sil PONA C8

did you **know**?

Using hydrogen instead of helium can cut analysis time in half! Visit **www.restek.com/petro** for complete analytical details.

Critical pairs of gasoline components resolved per ASTM specifications on an Rtx®-DHA column.



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®-DHA, 100m, 0.25mm ID, 0.5µm (cat.# 10148) plus Rtx®-5DHA 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

Circles indicate critical pairs that must be resolved.

Light Hydrocarbon Analysis

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

Rt®-Alumina BOND Columns

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

also available

Metal MXT® Columns
Rugged, flexible, Siltek® treated stainless steel tubing; inertness comparable to fused silica tubing. See **page 108** for our MXT®-Alumina BOND/Na_2SO_4 columns.

Rt®-Alumina BOND/Na_2SO_4 Columns (fused silica PLOT)

(Na_2SO_4 deactivation)

ID	df	temp. limits	30-Meter	50-Meter
0.25mm	4µm	to 200°C	19775	
0.32mm	5µm	to 200°C	19757	19758
0.53mm	10µm	to 200°C	19755	19756

Rt®-Alumina BOND/KCl Columns (fused silica PLOT)

(KCl deactivation)

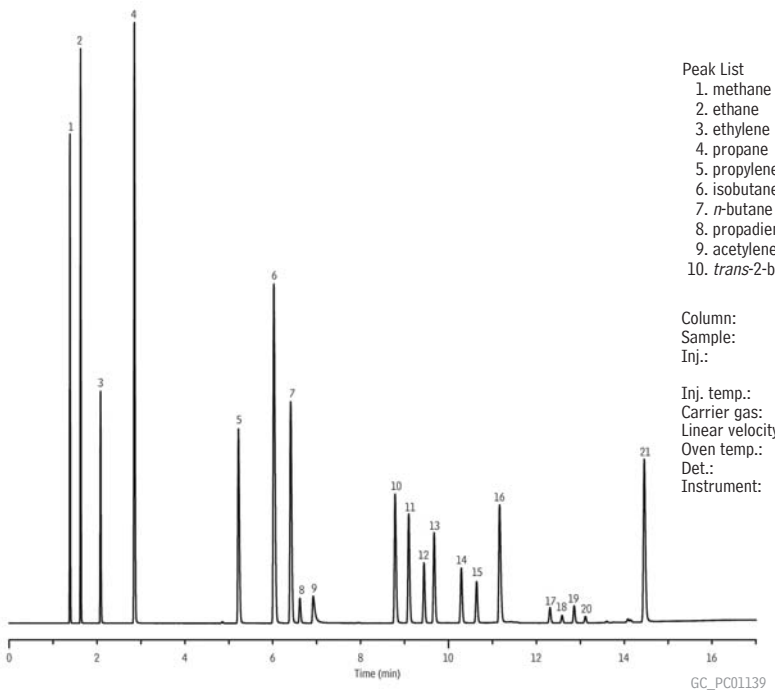
- Acetylene elutes before C4 hydrocarbons (impurities in butane/isobutane).
- Methyl acetylene (impurity in 1,3-butadiene) elutes before 1,3-butadiene.

similar phases

GC-Alumina KCl, CP-Al_2O_3/KCl

ID	df	temp. limits	30-Meter	50-Meter
0.25mm	4µm	to 200°C	19776	
0.32mm	5µm	to 200°C	19761	19762
0.53mm	10µm	to 200°C	19759	19760

Refinery gas hydrocarbons on an Rt®-Alumina BOND/Na_2SO_4 column.



GC_PC01139

Peak List
1. methane
2. ethane
3. ethylene
4. propane
5. propylene
6. isobutane
7. *n*-butane
8. propadiene
9. acetylene
10. *trans*-2-butene
11. 1-butene
12. isobutylene
13. *cis*-2-butene
14. isopentane
15. *n*-pentane
16. 1,3-butadiene
17. *trans*-2-pentene
18. 2-methyl-2-butene
19. 1-pentene
20. *cis*-2-pentene
21. *n*-hexane

Column:	Rt®-Alumina BOND/Na_2SO_4, 30m, 0.53mm ID, 10.0µm (cat.# 19755)
Sample:	refinery gas hydrocarbons through C6
Inj.:	10µL split, 40mL/min. split vent flow rate 2mm split Precision® liner w/wool (cat.# 20823)
Inj. temp.:	200°C
Carrier gas:	helium, constant pressure (5.0psi, 34.5kPa)
Linear velocity:	37.3cm/sec. @ 60°C
Oven temp.:	60°C (hold 2 min.) to 200°C @ 10°C/min. (hold 1 min.)
Det.:	FID @ 200°C
Instrument:	Agilent 5890

Simulated Distillation (C5-C44) Analysis

Rtx®-2887 Column (fused silica)

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

- 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.

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

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

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

- Application-specific columns for simulated distillation.
- Stable to 400 °C.

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

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

NEW!

(nonpolar phases)

- Stable up to 400 °C—lowest bleed for longest column lifetime.
- Reliably meets all ASTM D2887 specifications.
- 100% dimethyl polysiloxane phase allows easy comparisons to historical data.

ID	df	temp. limits	10-Meter
0.53mm	2.65µm	-60 to 360/400°C	70132

also available

Rtx®-1 SimDist 2887—a packed column for process instrumentation. See **page 126**.

similar phases

DB-2887, Petrocol EX2887

similar phases

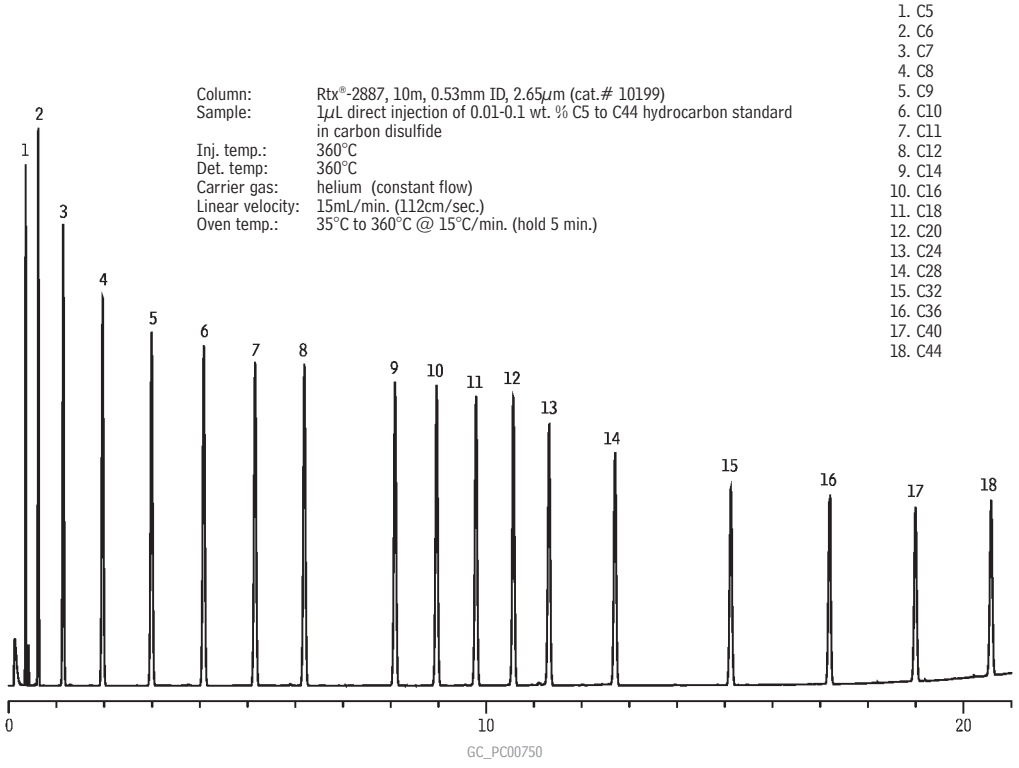
DB-2887, Petrocol EX2887, CP-HT-Simdist CB

similar phases

DB-1HT, CP-HT-Simdist CB

See page 78 for more dimensions.

Simulated distillation on an Rtx®-2887 column.



Simulated Distillation (C44-C100) Analysis

similar **phases**

DB-1HT, CP-HT-Simdist CB

NEW!

Method Recommended Columns

ASTM Method	Hydrocarbon Range	cat. #	Configuration
D2887	C5 - C44	70131	5m x 0.53mm, 0.88µm
		70132	10m x 0.53mm, 2.65µm
D7213 (D2887-ext)	C5 - C60	70131	5m x 0.53mm, 0.88µm
		70115	5m x 0.53mm, 0.20µm
		70112	5m x 0.53mm, 0.10µm
D3710	gasoline up to C14	70132	10m x 0.53mm, 2.65µm
D5307	crude up to C42	70115	5m x 0.53mm, 0.20µm
D6352	C10 - C90	70112	5m x 0.53mm, 0.10µm
		70115	5m x 0.53mm, 0.20µm
D7500	C7 - C110	70112	5m x 0.53mm, 0.10µm
		70115	5m x 0.53mm, 0.20µm
D7169	C5 - C100	70112	5m x 0.53mm, 0.10µm
		70115	5m x 0.53mm, 0.20µm

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

(nonpolar phases)

- Stable up to 450 °C—lowest bleed for longest column lifetime.
- Reliably meet all ASTM D6352, D7169, and D7500 specifications.
- 100% dimethyl polysiloxane phase allows easy comparisons to historical data.

Accurate boiling point determination for medium and heavy fractions using GC simulated distillation requires columns and phase polymers that are robust enough to withstand high temperatures without significant degradation. Metal columns are a better alternative than fused silica, and the MXT®-1HT SimDist columns are the lowest bleed, highest efficiency columns available, outperforming other metal columns for critical method parameters.

ID	df	temp. limits	5-Meter	10-Meter
0.53mm	0.10µm	-60 to 430/450°C	70112	
	0.20µm	-60 to 430/450°C	70115	
	0.21µm	-60 to 430/450°C		70118
	0.88µm	-60 to 400/430°C	70131	70134
	1.00µm	-60 to 380/400°C		70130
	1.20µm	-60 to 380/400°C		70119
	2.65µm	-60 to 360/400°C		70132
	5.00µm	-60 to 360/400°C		70133

Low bleed, high efficiency MXT®-1HT SimDist columns outperform competitors (ASTM D6352 conditions).

Lower bleed means:

- Longer column lifetime.
- More stable calibrations.
- Accurate boiling point determinations.

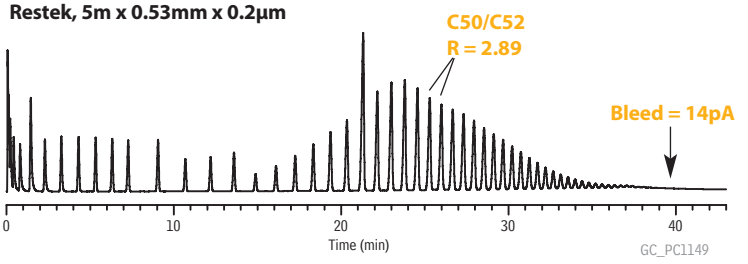
RESTEK ADVANTAGE:
Longer column lifetime and more accurate data!

Higher efficiency means:

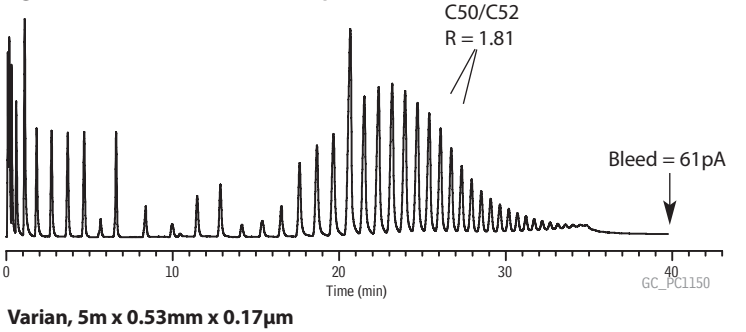
- Greater resolution; analyze more samples before method criteria are reached.
- Assured method performance.

RESTEK ADVANTAGE:
Run more samples within method specifications!

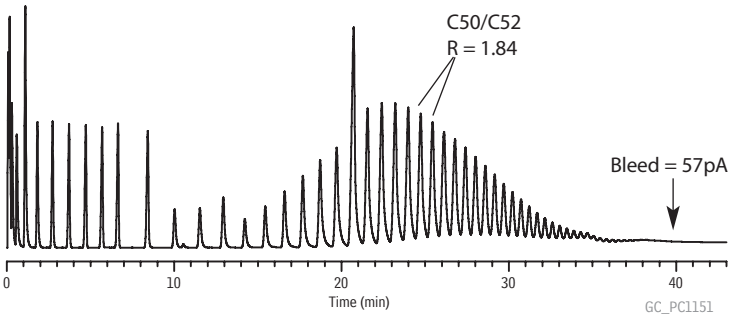
Restek, 5m x 0.53mm x 0.2µm



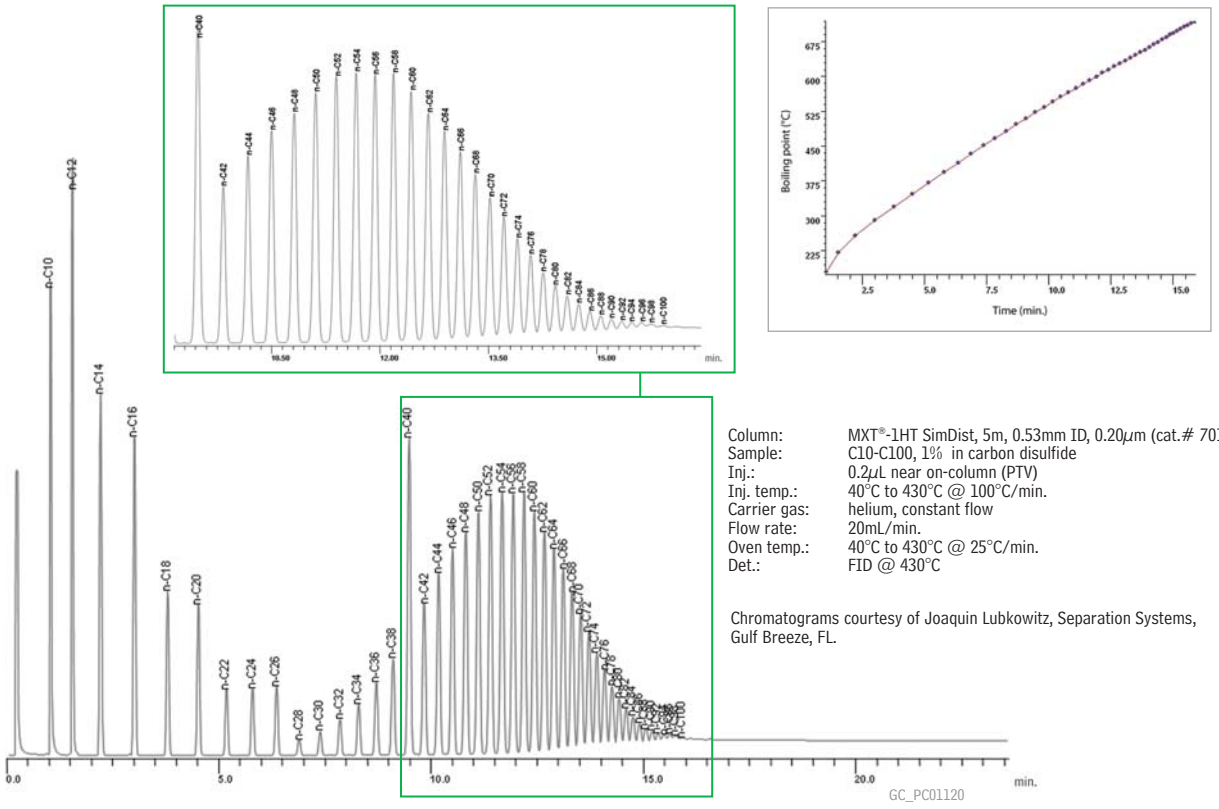
Agilent/ J&W, 5m x 0.53mm x 0.15µm



Varian, 5m x 0.53mm x 0.17µm



Robust MXT®-1HT SimDist columns meet all ASTM D6352 requirements, even under accelerated conditions.



Column: MXT®-1HT SimDist, 5m, 0.53mm ID, 0.20µm (cat.# 70115)
Sample: C10-C100, 1% in carbon disulfide
Inj.: 0.2µL near on-column (PTV)
Inj. temp.: 40°C to 430°C @ 100°C/min.
Carrier gas: helium, constant flow
Flow rate: 20mL/min.
Oven temp.: 40°C to 430°C @ 25°C/min.
Det.: FID @ 430°C

Chromatograms courtesy of Joaquin Lubkowitz, Separation Systems, Gulf Breeze, FL.

MXT®-1 SimDist/MXT®-500 SimDist

- 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®-1 SimDist phases offer true methyl silicone polarity; MXT®-500 SimDist phase is a carborane siloxane polymer.
- Stable to 430 °C.

MXT®-1 SimDist Column (Siltek® treated stainless steel)
(nonpolar phase)

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

MXT®-500 SimDist Column (Siltek® treated stainless steel)
(nonpolar phase)

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

Polywax® Calibration Materials

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

Aromatics & Oxygenates in Gasoline Analysis

Rt®-TCEP Columns (fused silica)
(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.

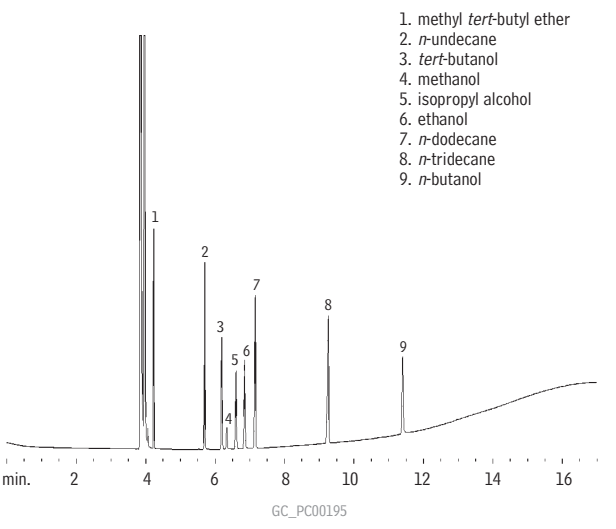
The Rt®-TCEP column incorporates a nonbonded stationary phase coated on a surface specialized for enhanced polymer stability and extended column lifetime. Solvent rinsing should be avoided. Conditioning is necessary only if the column is to be used at temperatures near the maximum operating temperature.

similar **phases**

SPB-TCEP, CP-TCEP

ID	df	temp. limits	30-Meter	60-Meter
0.25mm	0.40µm	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.

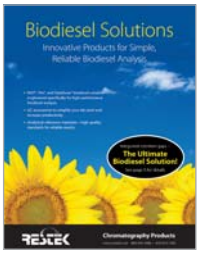
Biodiesel Fuels Analysis

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

- 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 0.53 mm ID column eliminates column coupling completely.

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

*Total column length = 16 meters.
**Connected with low-dead-volume MXT connector.



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Biodiesel Solutions: Innovative Products for Simple, Reliable Biodiesel Analysis

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lit. cat.# 580207

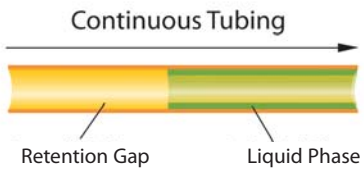
Rtx®-Biodiesel TG Columns (fused silica)

- 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 glycerides analysis, according to ASTM D6584 and EN 14105 methods.

Description	temp. limits	cat.#	price
10m, 0.32mm ID, 0.10µm	to 330/380°C	10292	
10m, 0.32mm ID, 0.10µm with 2m x 0.53mm ID Retention Gap	to 330/380°C	10291	
15m, 0.32mm ID, 0.10µm	to 330/380°C	10294	
15m, 0.32mm ID, 0.10µm with 2m x 0.53mm ID Retention Gap	to 330/380°C	10293	

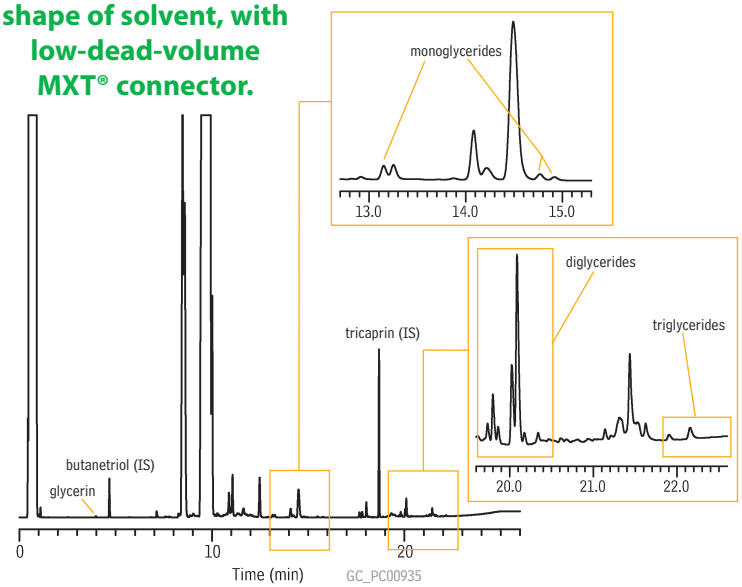
Integra-Gap® technology

- Built-in retention gap.
- Eliminates connector and leaks.
- Extends analytical column lifetime.



Derivatized B100 and internal standards on an MXT®-Biodiesel TG column with 2 m x 0.53 mm ID coupled 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

restek **innovation**!

Baseline resolution in less than 3 minutes.

similar **phases**

DB-ALC1, DB-ALC2

Rtx®-BAC1/Rtx®-BAC2

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

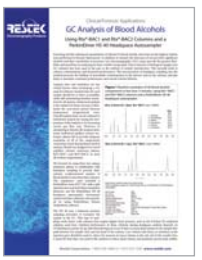
These columns separate to baseline all blood alcohol compounds in blood, breath, or urine, in less than 3 minutes, under isothermal conditions. Isothermal analysis increases productivity by eliminating the need for oven cycling. Confirmation is easily achieved with this tandem set because there are four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

Rtx®-BAC1 Columns (fused silica)
(proprietary Crossbond® phase)

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

Rtx®-BAC2 Columns (fused silica)
(proprietary Crossbond® phase)

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



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GC Analysis of Blood Alcohols

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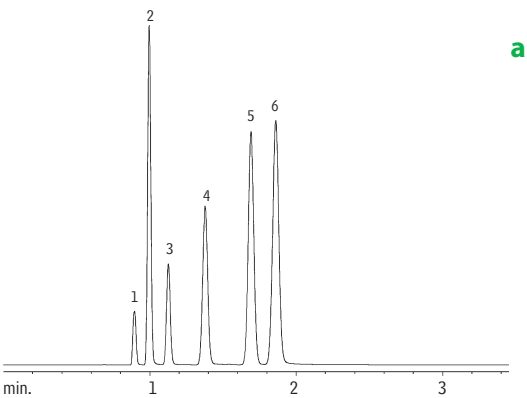
lit. cat.# 59598A

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

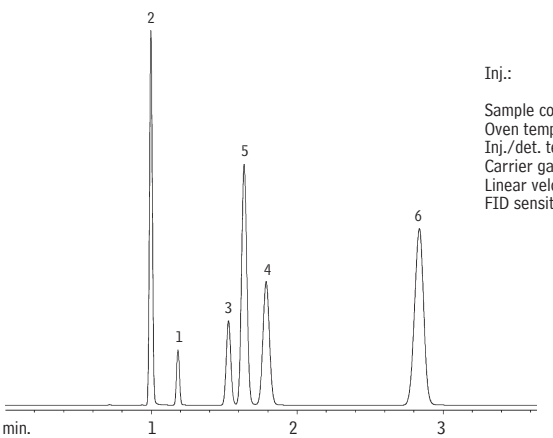
Rtx®-BAC1 30 m, 0.53 mm ID, 3.0 µm (cat.# 18001)



Blood alcohol analysis in less than 3 minutes!

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

Rtx®-BAC2 30 m, 0.53 mm ID, 2.0 µm (cat.# 18000)



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

GC_PH00239

Organic Volatile Impurities (OVI) Analysis

Rxi®-624Sil MS Columns

for USP<467> Residual Solvents analysis

NEW!

Improve system suitablility pass rates with the best resolution of acetonitrile and dichloromethane on any G43.

- Symmetric peak shape for bases provides accurate integration and unmatched sensitivity.
- High thermal stability ensures a consistent baseline, making it the only MS friendly column in its class.
- Reproducible Rxi® technology provides the column-to-column reproducibility needed in validated methods.

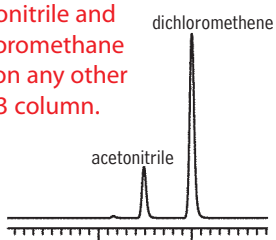
Rxi®-624Sil MS Columns (fused silica)
(midpolarity Crossbond® silarylene phase; equivalent to 6% cyanopropylphenyl/ 94% dimethyl arylene polysiloxane)

- Low bleed, high thermal stability column—maximum temperatures up to 320 °C.
- Inert—excellent peak shape for a wide range of compounds, including acidic and basic compounds.
- Selective—highly selective for residual solvents, great choice for USP<467>.
- Manufactured for column-to-column reproducibility—well-suited for validated methods.

ID	df	temp. limits	20-Meter	30-Meter	60-Meter
0.18mm	1.00µm	-20 to 300/320°C	13865		
0.25mm	1.40µm	-20 to 300/320°C		13868	
0.32mm	1.80µm	-20 to 300/320°C		13870	13872
0.53mm	3.00µm	-20 to 280/300°C		13871	

Class 2 Mix A

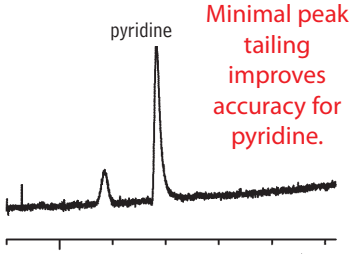
Better resolution of acetonitrile and dichloromethane than on any other G43 column.



GC_PH01116

Class 2 Mix B

Minimal peak tailing improves accuracy for pyridine.



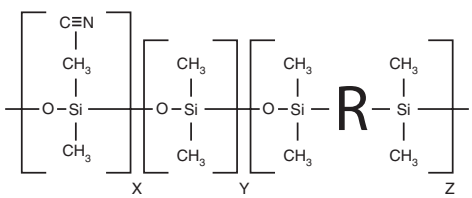
GC_PH01117

Column:	Rxi®-624Sil MS, 30m, 0.32mm ID, 1.8µm (cat.# 13870)
Inj.:	1.0mL manual headspace injection, split (3:1), 1mm split liner (cat.# 20972)
Inj. temp.:	140°C
Carrier gas:	helium, constant flow
Flow rate:	2.2mL/min.
Oven temp.:	40°C (hold 20 min.) to 240°C @ 10°C/min. (hold 20 min.)
Det:	FID @ 250°C
Hydrogen:	40mL/min.
Air:	450mL/min.
Makeup:	45mL/min.
Instrument:	Agilent 6890

Make the Switch to Rxi® columns!

Replaces: DB-624, HP-624, VF-624, BP-624, ZB-624, AT-624, 007-1301, G43R

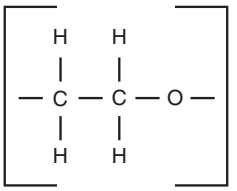
Rxi®-624Sil MS Structure



Visit **www.restek.com/ovi** for a complete product listing.

G16 phase

Stabilwax® Structure



similar phases

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

Organic Volatile Impurities (OVI) Analysis

Stabilwax® Columns (fused silica)
(polar phase; Crossbond® Carbowax® polyethylene glycol)

- Most stable polyethylene glycol (PEG) column available.
- Rugged enough to withstand repeated water injections.
- Lowest bleed PEG column on the market; long column lifetimes are assured
- Temperature range: 40 °C to 260 °C.
- Equivalent to USP G14, G15, G16, G20, and G39 phases.

Restek's polar-deactivated surface tightly binds the Carbowax® polymer and increases thermal stability, relative to competitive columns. Because of the increased stability produced by the bonding process, Stabilwax® columns exhibit long column lifetimes, even when programming repeatedly up to 260 °C. The bonding mechanism of the column also produces polar compound retention times that do not shift as is often observed on other wax-type columns. In addition, this bonding mechanism produces a column that can be rejuvenated by solvent washing.

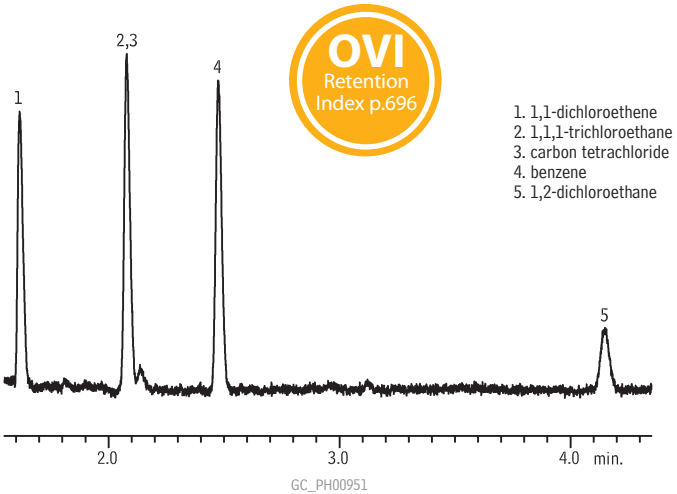
ID	df	temp. limits	30-Meter
0.32mm	0.25µm	40 to 250/260°C	10624
0.53mm	0.25µm	40 to 250/260°C	10625

For our complete listing of Stabilwax® columns, see **page 59**.

ordering note

Get the protection without the connection!
For Stabilwax® columns with built-in Integra-Guard® guard columns, see **page 35**.

Class 1 residual solvents 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.

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Residual Solvent Analysis

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lit. cat.# PHFL1018A

Organic Volatile Impurities (OVI) Analysis

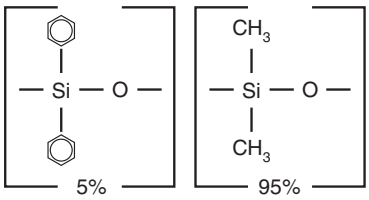
G27 phase

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

- General purpose columns for drugs, solvent impurities, pesticides, hydrocarbons, PCB congeners (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 Structure



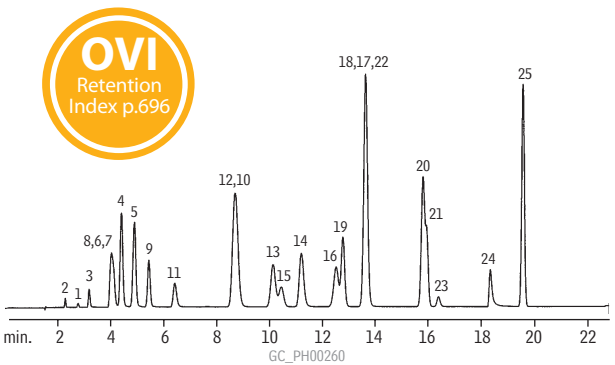
ID	df	temp. limits	30-Meter
0.53mm	5.00µm	-60 to 270/290°C	10279

For our complete listing of Rtx®-5 columns, see **page 50**.

similar phases

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

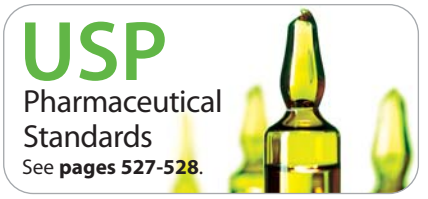
Organic volatile impurities on an Rtx®-5 (Rtx®-G27) column.



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



See **pages 527-528**.

Organic Volatile Impurities (OVI) Analysis

Rtx®-G27 Column (fused silica with 5-meter Integra-Guard® guard column)
(Crossbond® 5% diphenyl/95% dimethyl polysiloxane)

- Application-specific columns for residual solvents in pharmaceutical products. Meet all requirements of USP <467>.
- Analytical column with Integra-Guard® guard column eliminates connecting problems and leaks.
- Rtx®-G27 stable to 290 °C.

Some USP <467> methods require the use of a guard column. Our Integra-Guard® integrated guard column system makes it easy to comply.

ID	df	temp. limits	30-Meter with 5-Meter, 0.53mm ID Integra-Guard Guard Column
0.53mm	5.00µm	-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)

- Application-specific columns for residual solvents in pharmaceutical products. Meet all requirements of USP <467>.
- Analytical column with Integra-Guard® guard column eliminates connecting problems and leaks.
- Rtx®-G43 stable to 240 °C.

Some USP <467> methods require the use of a guard column. Our Integra-Guard® integrated guard column system makes it easy to comply.

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

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A Technical Guide for Static Headspace Analysis Using GC

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lit. cat.# 59895A

Diane Thompson, Customer Service

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Online: www.restek.com—24-hours a day

Outside the U.S.

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

Semivolatiles Analysis

Rxi®-5Sil MS Columns (fused silica)
(low polarity Crossbond® silarylene phase; selectivity close to 5% phenyl/95% dimethyl arylene polysiloxane)

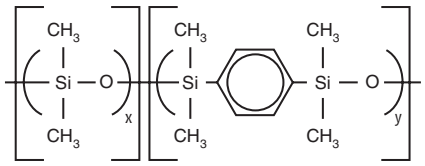
- Engineered to be a low bleed GC/MS column.
- Excellent inertness for active compounds.
- General purpose columns—ideal for GC/MS analysis of polycyclic aromatic compounds, chlorinated hydrocarbons, phthalates, phenols, amines, organochlorine pesticides, organophosphorus pesticides, drugs, solvent impurities,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

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

ID	df	temp. limits	10-Meter	20-Meter	40-Meter
0.10mm	0.10µm	-60 to 330/350°C	43601		
0.18mm	0.10µm	-60 to 320/350°C			
	0.18µm	-60 to 330/350°C		43602	43605
	0.36µm	-60 to 330/350°C		43604	

Rxi®-5Sil MS Structure



similar **phases**

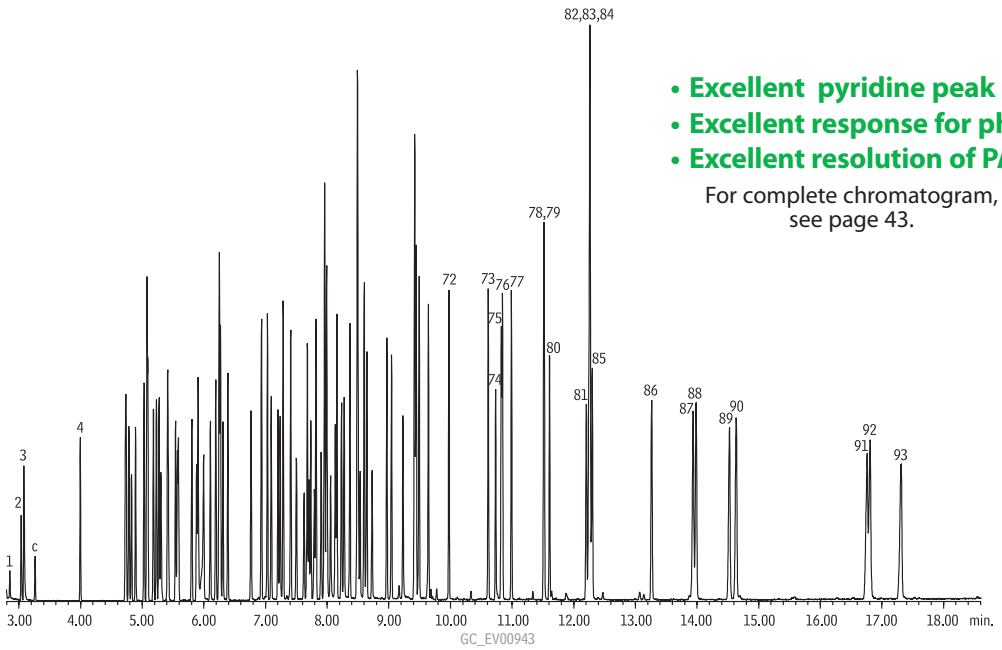
DB-5MS, VF-5ms, CP-Sil 8 Low-Bleed/MS

ordering **note**

Get the protection without the connection!
For Rxi®-5Sil MS columns with built-in Integra-Guard® guard columns, see **page 35**.

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

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



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

For complete chromatogram, see page 43.

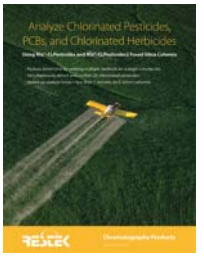
Chlorinated Pesticides Analysis

restek **innovation**!

- Very low bleed provides highest sensitivity.
- Faster analysis time with full separation of chlorinated pesticides.

CarboPrep® SPE Cartridges
See page 393.

How much time do column changes cost you? Switch to Rtx®-CLPesticides columns and analyze pesticides, herbicides, PCBs and more on a single column set.



Analyze Chlorinated Pesticides, PCBs and Chlorinated Herbicides

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lit. cat.# EVFL1013

Rtx®-CLPesticides/Rtx®-CLPesticides2

(proprietary Crossbond® phases)

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

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

Rtx®-CLPesticides Columns (fused silica)

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

Rtx®-CLPesticides2 Columns (fused silica)

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

Rtx®-CLPesticides Column Kits

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

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

Rtx-CLPesticides Kit (0.25mm ID) **cat.# 11199 (kit), $1050** **SAVE $100**

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, Deactivated	20403-261	
5m, 0.25mm ID Siltek Guard Column	10026	

Rtx-CLPesticides Kit (0.32mm ID) **cat.# 11196 (kit), $1080** **SAVE $135**

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, Deactivated	20403-261	
5m, 0.32mm ID Siltek Guard Column	10027	

Rtx-CLPesticides Kit (0.53mm ID) **cat.# 11197 (kit), $1155** **SAVE $180**

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, Deactivated	20403-261	
5m, 0.53mm ID IP Deactivated Guard Column	10045	$67

ordering **note**

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

also **available**

For a wide variety of column connectors, see **pages 287-293**.

Add a reference mix to your kit order and save!

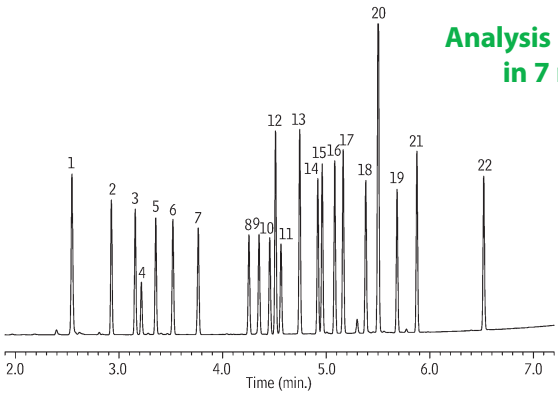
Description	list price	price with/kit	suffix #
Organochlorine Pesticide Mix AB #1 (cat.# 32291)	$50	$35	
Organochlorine Pesticide Mix AB #2 (cat.# 32292)	$40	$25	

Chlorinated Pesticides Analysis

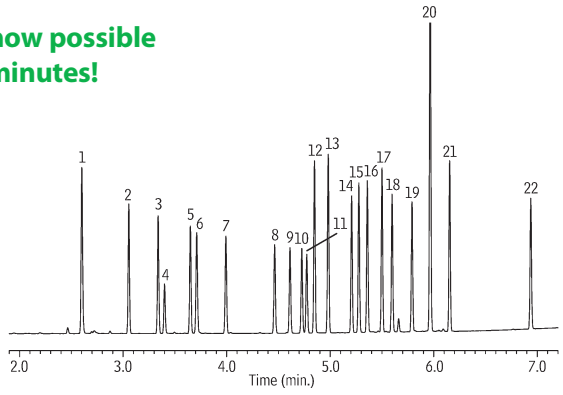
Fast GC analyses of chlorinated pesticides on Rtx®-CLPesticides and Rtx®-CLPesticides2 columns.

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

Rtx®-CLPesticides



Rtx®-CLPesticides2

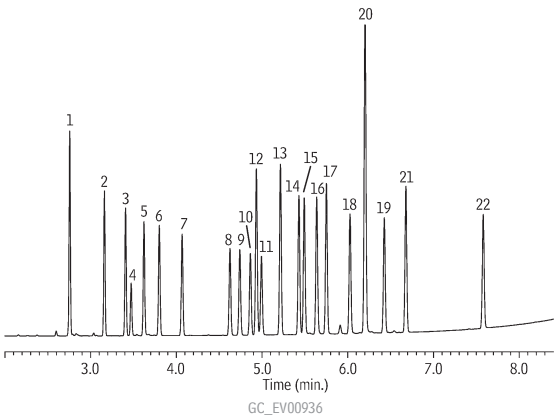


Columns:	Rtx®-CLPesticides, 30m, 0.32mm ID, 0.32µm (cat.# 11141) and Rtx®-CLPesticides2, 30m, 0.32mm ID, 0.25µm (cat.# 11324) with 5m x 0.32mm ID Rxi® deactivated guard tubing (cat.# 10039), connected using Deactivated Universal "Y" Press-Tight® connector (cat.# 20405-261)
Sample:	Organochlorine Pesticide 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.:	Agilent 6890 w/µ-ECD @ 330°C

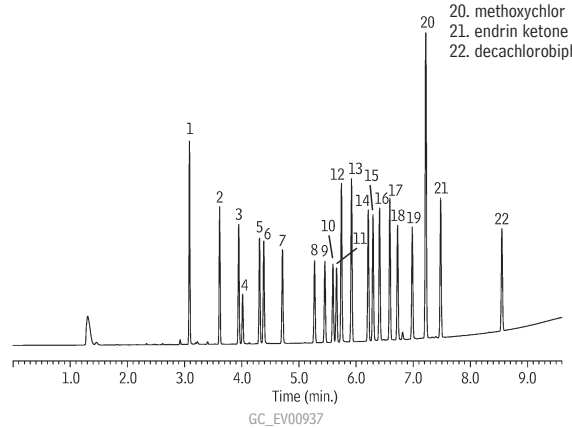
1. 2,4,5,6-tetrachloro-*m*-xylene (SS)
2. α-BHC
3. γ-BHC
4. β-BHC
5. δ-BHC
6. heptachlor
7. aldrin
8. heptachlor epoxide (isomer B)
9. γ-chlordane
10. α-chlordane
11. endosulfan I
12. 4,4'-DDE
13. dieldrin
14. endrin
15. 4,4'-DDD
16. endosulfan II
17. 4,4'-DDT
18. endrin aldehyde
19. endosulfan sulfate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

Rtx®-CLPesticides & Rtx®-CLPesticides2 columns (0.53 mm 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 320°C (hold 2 min.) @ 20°C/min.
Det.:	Agilent 6890 w/µ-ECD @ 330°C

restek **innovation**!

Chlorinated Pesticides Analysis

Stx®-CLPesticides/Stx®-CLPesticides2

(proprietary Crossbond® phases)

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

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

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

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

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

Stx®-CLPesticides Kits

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

kit

Stx-CLPesticides Kit (0.25mm ID) cat.# 11190 (kit), $1050 SAVE $100

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, Deactivated	20403-261	
5m, 0.25mm ID Siltek Guard Column	10026	

kit

Stx-CLPesticides Kit (0.32mm ID) cat.# 11193 (kit), $1080 SAVE $135

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, Deactivated	20403-261	
5m, 0.32mm ID Siltek Guard Column	10027	
Total cost if purchased separately		$1215

ordering **note**

Kits include Siltek® deactivated guard column.

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

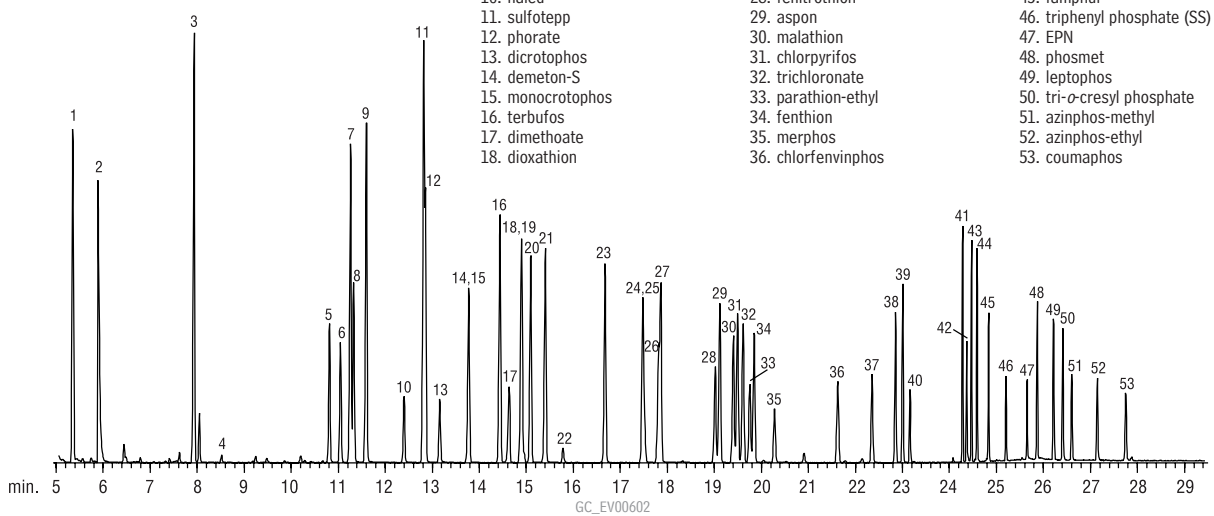
Rtx®-OPPesticides2 Columns (fused silica)

ID	df	temp. limits	20-Meter		30-Meter
0.18mm	0.20µm	-20 to 310/330°C	11244	$460	
0.25mm	0.25µm	-20 to 310/330°C			11243
0.32mm	0.32µm	-20 to 310/330°C			11241
0.53mm	0.50µm	-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)	Carrier gas:	helium, constant flow
	Triphenylphosphate Standard (cat.# 32281)	Flow rate:	1.0mL/min.
	Tributylphosphate Standard (cat.# 32280)	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.)
	8140/8141 OP Pesticides Calibration Mix A (cat.# 32277)		
	8141 OP Pesticides Calibration Mix B (cat.# 32278)	Det:	MS
	Custom Mixes: Call Restek for Information	Transfer line temp.:	280°C
Inj.:	1.0µL splitless (hold 0.4 min.), 4mm double gooseneck inlet liner (cat.# 20785)	Scan range:	35-400amu
		Ionization:	EI

Brominated Flame Retardants Analysis

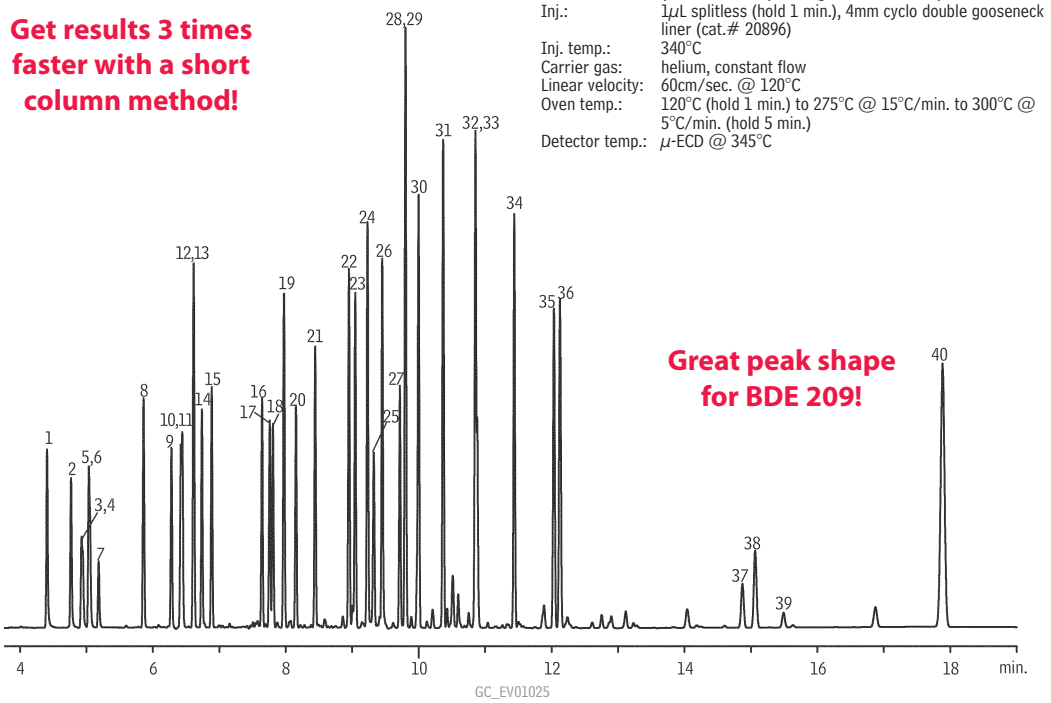
Rtx®-1614 Columns (fused silica)
(5% phenyl methyl)

- 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.

Table of Contents for
GC Chromatograms
see **page 542**

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

Brominated flame retardants on an Rtx®-1614 column.



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

PCB Congeners Analysis

restek **innovation**!

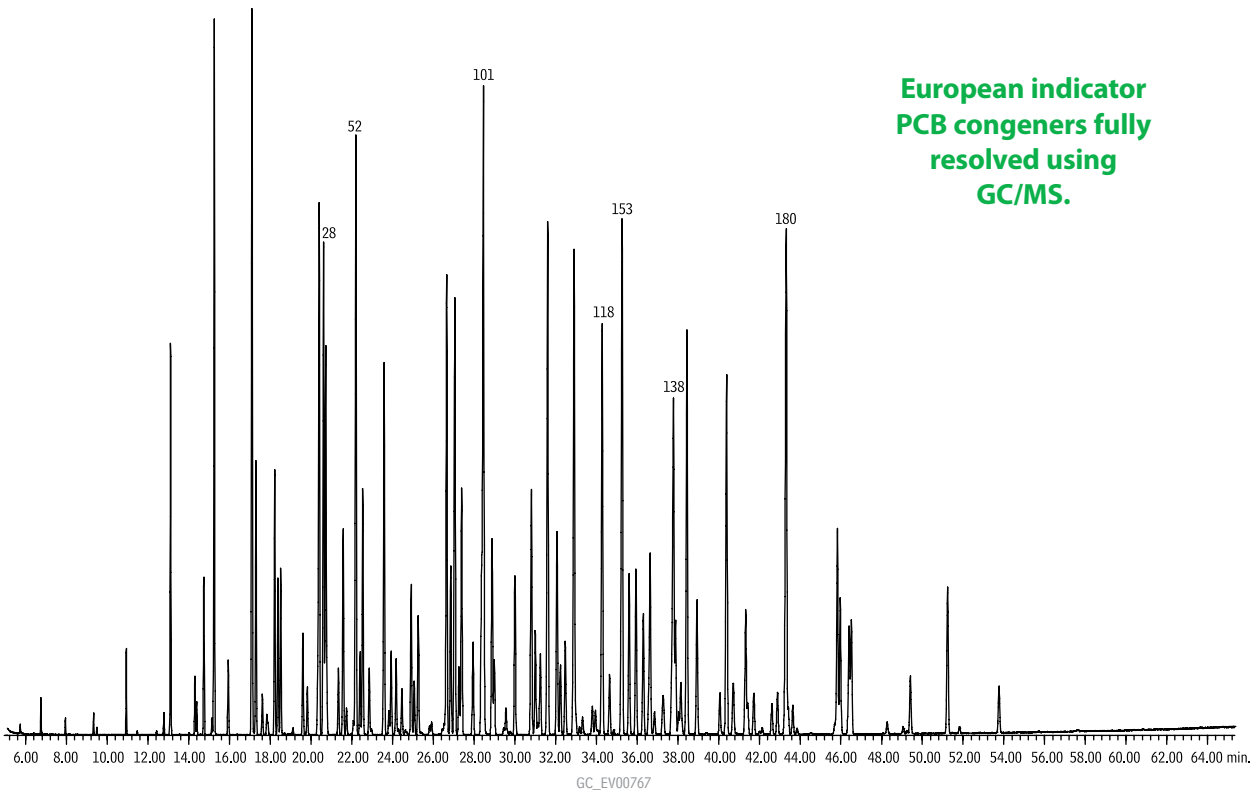
Rtx®-PCB Columns (fused silica)
(proprietary Crossbond® phase)

- 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.

ID	df	temp. limits*	20-Meter	30-Meter	40-Meter	60-Meter
0.18mm	0.18µm	30°C to 320/340°C	41302		41303	41304
0.25mm	0.25µm	30°C to 320/340°C		13223		13226
0.32mm	0.50µm	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 Columns (fused silica)
(low polarity proprietary phase)

- General purpose columns exhibiting extremely low bleed. Ideal for many GC/MS applications, including pesticides, PCB congeners (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).

similar **phases**

DB-XLB, VF-Xms

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

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

Dioxin & Furan Congeners Analysis

Rxi®-5Sil MS Columns (fused silica)
(low polarity Crossbond® silarylene phase; selectivity close to 5% phenyl/95% dimethyl arylene polysiloxane)

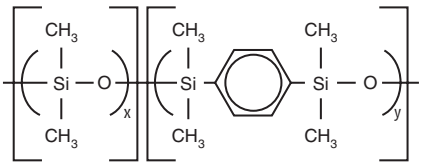
- Engineered to be a low bleed GC/MS column.
- Excellent inertness for active compounds.
- General purpose columns—ideal for GC/MS analysis of polycyclic aromatic compounds, chlorinated hydrocarbons, phthalates, phenols, amines, organochlorine pesticides, organophosphorus pesticides, drugs, solvent impurities,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

ID	df	temp. limits	30-Meter	60-Meter*
0.18mm	0.10µm	-60 to 320/350°C		43607
0.25mm	0.25µm	-60 to 330/350°C	13623	

*60m, 0.18mm ID, 0.10µm column (cat.# 43607) intended for dioxin and furan analysis only.

Rxi®-5Sil MS Structure



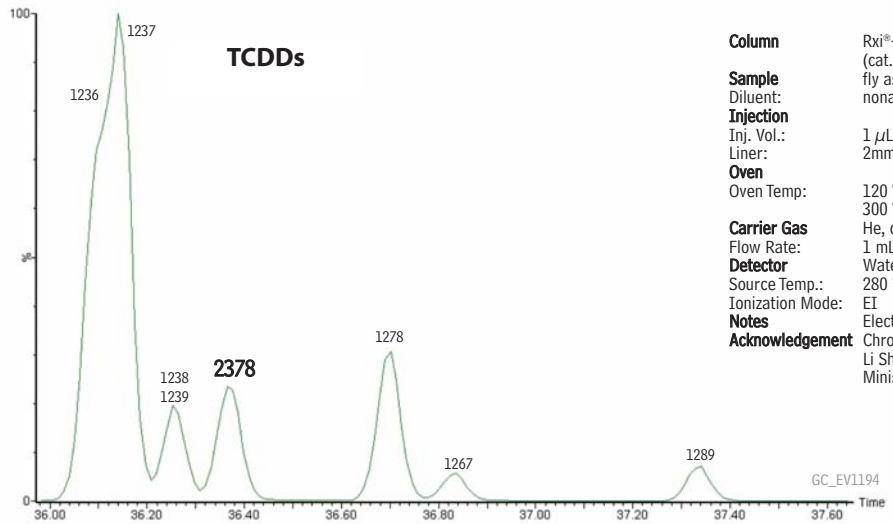
similar **phases**

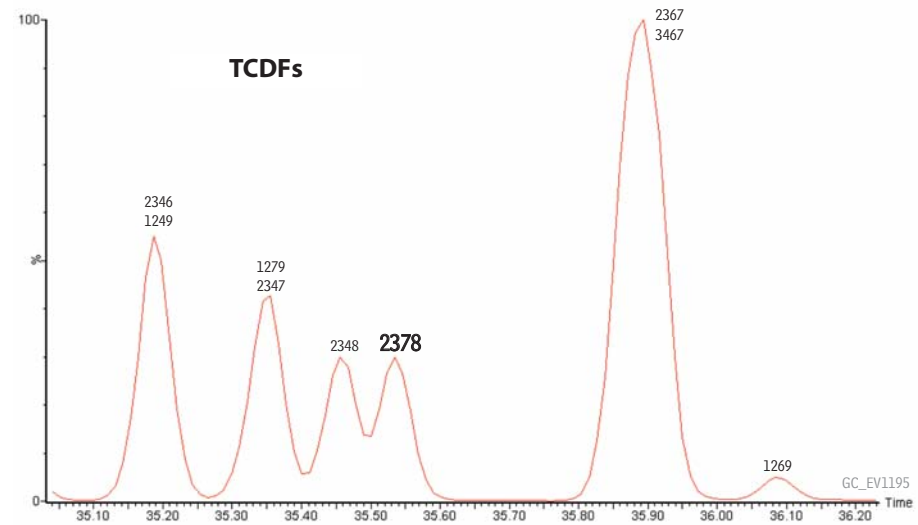
DB-5MS, VF-5ms, CP-Sil 8 Low-Bleed/MS

also **available**

Other Dimensions!
See **page 42** for our complete listing of Rxi®-5Sil MS columns.

Dioxins (TCDDs) and furans (TCDFs) in fly ash on an Rxi®-5Sil MS column.





Column	Rxi®-5Sil MS , 60 m, 0.18 mm ID, 0.10 µm (cat.# 43607)
Sample	fly ash extract
Diluent:	nonane
Injection	
Inj. Vol.:	1 µL splitless
Liner:	2mm Splitless liner (cat.# 20712)
Oven	
Oven Temp:	120 °C (hold 1 min.) to 160 °C at 10 °C/min. to 300 °C at 2.5 °C/min.
Carrier Gas	He, constant flow
Flow Rate:	1 mL/min.
Detector	Waters AutoSpec Ultima Mass Spectrometer
Source Temp.:	280 °C
Ionization Mode:	EI
Notes	Electron Ionization at 40eV
Acknowledgement	Chromatogram courtesy of Karen MacPherson, Li Shen, Terry Kolic, and Eric Reiner at the Ontario Ministry of the Environment

Dioxin & Furan Congeners Analysis

restek **innovation**!

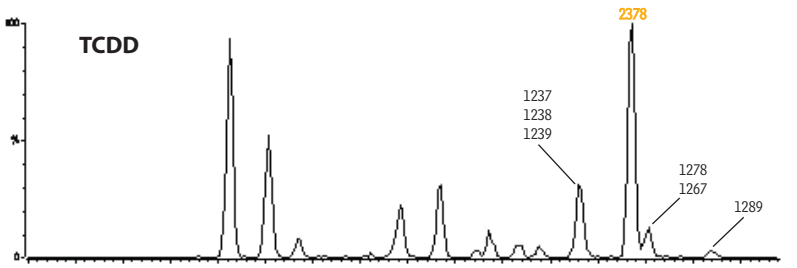
Excellent for dioxins or furans.

Rtx®-Dioxin2 Columns (fused silica)
(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 confirmation GC column.

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

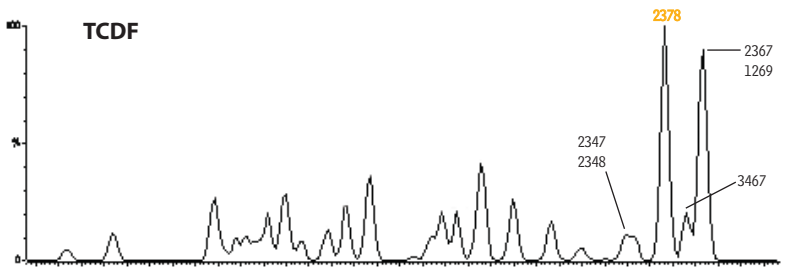
2,3,7,8-Tetrachlorodibenzodioxin resolved from other TCDD congeners, using an Rtx®-Dioxin2 column.



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

Polycyclic Aromatic Hydrocarbon (PAH) Analysis

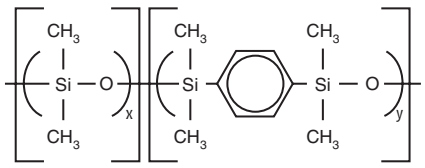
Rxi®-5Sil MS Columns (fused silica)
(low polarity Crossbond® silarylene phase; selectivity close to 5% phenyl/95% dimethyl arylene polysiloxane)

- 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.

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

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

Rxi®-5Sil MS Structure



similar **phases**

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

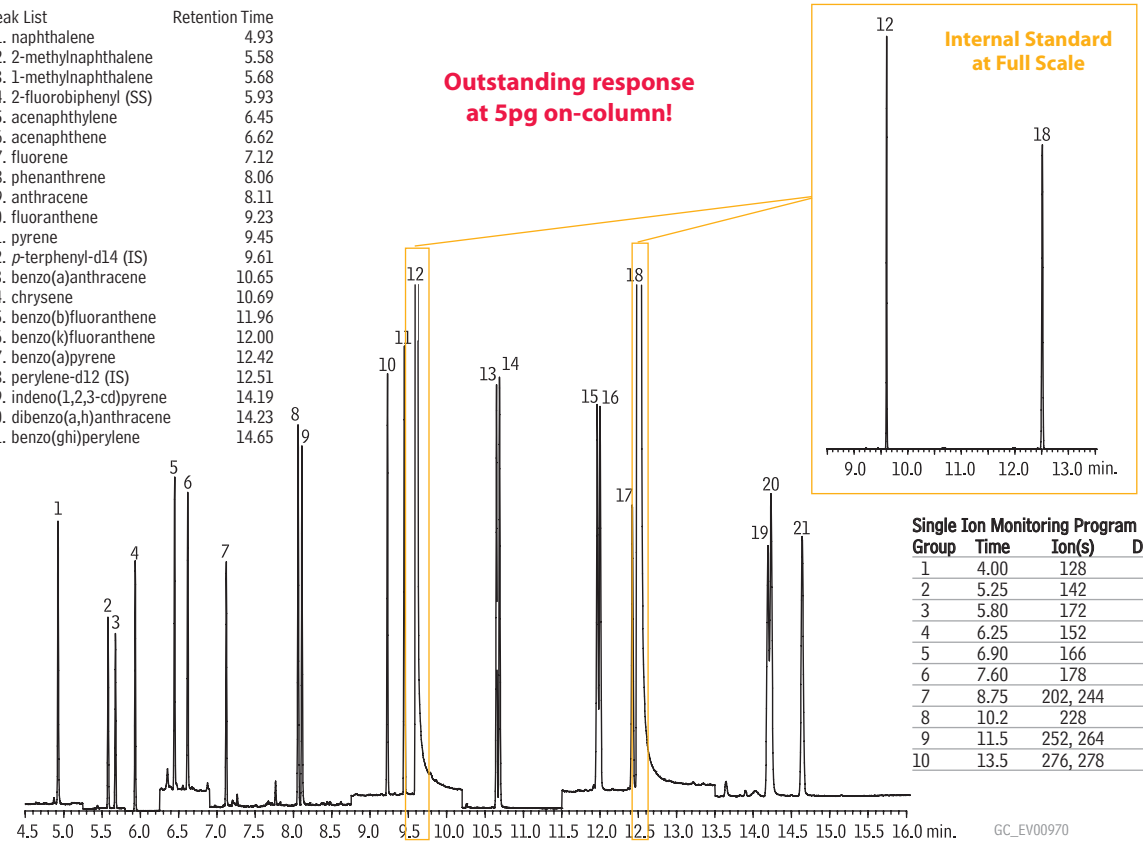
also **available**

Get the protection without the connection!
For Rxi®-5Sil MS columns with built-in Integra-Guard® guard columns, see **page 35**.

Other Dimensions!
See **page 42** for our complete listing of Rxi®-5Sil MS columns.

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

NEW!

Polycyclic Aromatic Hydrocarbon (PAH) Analysis

Rxi®-17Sil MS Columns (fused silica)

(midpolarity Crossbond® silarylene phase; equivalent to 50% phenyl/50% dimethyl arylene polysiloxane)

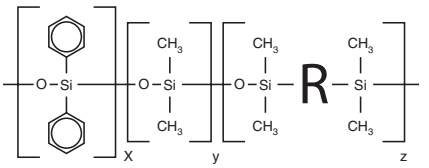
- 340/360 °C upper temperature limits.
- Excellent inertness for active compounds.
- Equivalent to USP phase G3.
- Low-bleed for use with sensitive detectors, such as MS.
- Excellent separation of EU-PAHs, including fluoranthenes.

ID	df	temp. limits*	15-Meter	30-Meter	60-Meter
0.25mm	0.25µm	40 to 340/360°C	14120	14123	14126
0.32mm	0.25µm	40 to 340/360°C	14121	14124	

ID	df	temp. limits	20-Meter
0.18mm	0.18µm	40 to 340/360°C	14102
	0.36µm	40 to 340/360°C	14111

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

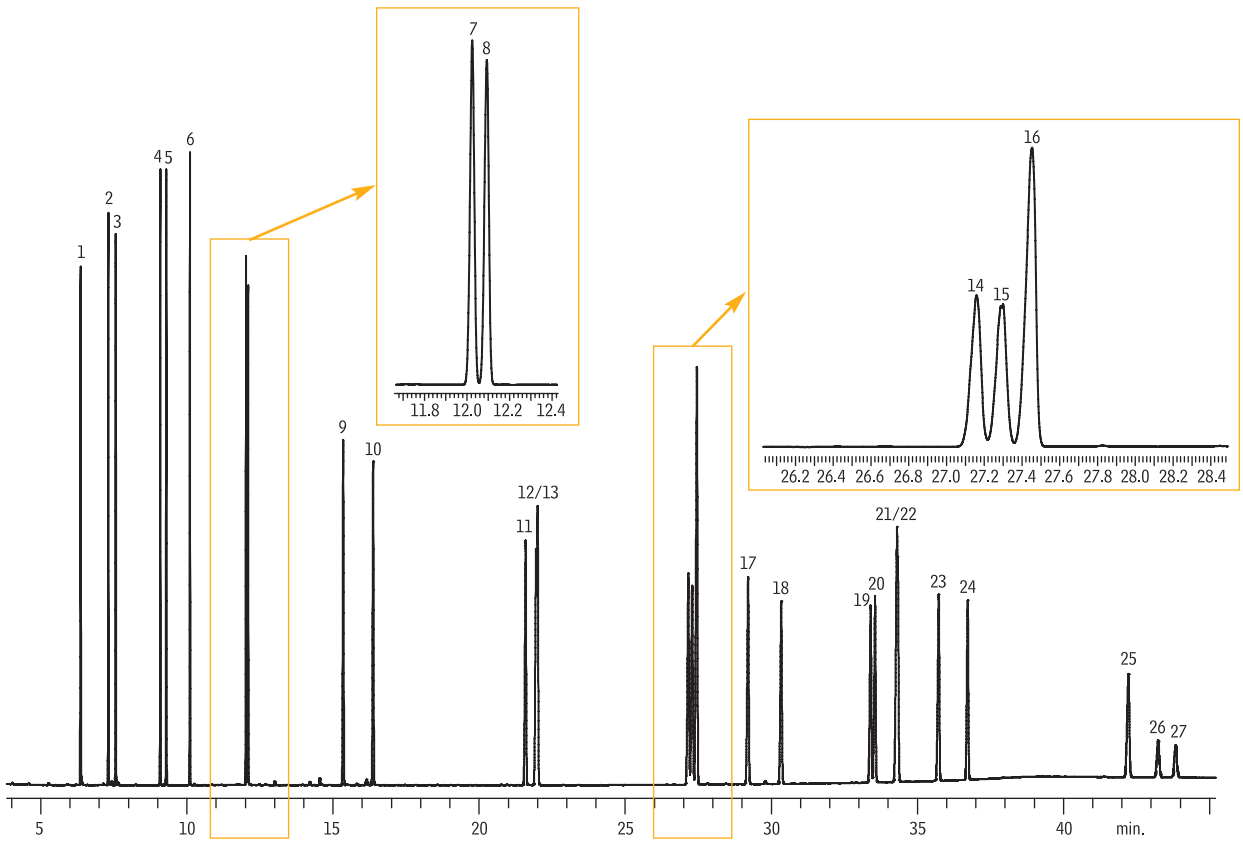
Rxi®-17Sil MS Structure



similar **phases**

DB-17ms, VF-17ms, BPX-50, DB-EUPAH

Polycyclic aromatic hydrocarbons on an Rxi®-17Sil MS column.



GC_EV1160

1. Naphthalene
2. 2-Methylnaphthalene
3. 1-Methylnaphthalene
4. Acenaphthylene
5. Acenaphthene
6. Fluorene
7. Phenanthrene
8. Anthracene
9. Fluoranthene
10. Pyrene
11. Benz[a]anthracene
12. Chrysene
13. Triphenylene
14. Benzo[b]fluoranthene
15. Benzo[k]fluoranthene
16. Benzo(j)fluoranthene
17. Benzo[a]pyrene
18. 3-Methylcholanthrene
19. Dibenz(a,h)acridine
20. Dibenz[a,j]acridine
21. Indeno[1,2,3-cd]pyrene
22. Dibenz[a,h]anthracene
23. Benzo[ghi]perylene
24. 7H-Dibenzo[c,g]carbazole
25. Dibenzo[a,e]pyrene
26. Dibenzo(a,i)pyrene
27. Dibenzo(a,h)pyrene

Column	Rxi®-17Sil MS, 30 m, 0.25 mm ID, 0.25 µm (cat.# 14123)
Sample	SV Calibration Mix #5 / 610 PAH Mix (cat.# 31011) EPA Method 8310 PAH Mixture (cat.# 31841)
Diluent:	dichloromethane
Conc.:	10 ppm
Injection	
Inj. Vol.:	0.5 µL splitless (hold 1.75 min.)
Liner:	Auto SYS XL PSS Split/Splitless w/Wool (cat.# 21718)
Inj. Temp.:	320 °C
Purge Flow:	75 mL/min.
Oven	
Oven Temp:	65 °C (hold 0.5 min.) to 220 °C at 15 °C/min. to 330 °C at 4 °C/min. (hold 15 min.)
Carrier Gas	He, constant flow
Flow Rate:	2.0 mL/min.
Detector	FID @ 320 °C
Instrument	PE Clarus 600 GC
Acknowledgement	Instrument provided by PerkinElmer

Mineral Oil Analysis

Rtx®-Mineral Oil Columns (fused silica)

- Application specific columns meet DIN EN ISO 9377-2:2000 requirements.
- Optimized column dimensions for fast mineral oil screening.
- Surface linked phase guarantees long lifetime, robustness, and stability to 400 °C.

NEW!

The Rtx®-Mineral Oil stationary phase and column dimensions were optimized for the fast screening of mineral oils in extracts from solids and water samples according to DIN EN ISO 9377-2: 2000. The 0.10 µm column is the gold standard for the method, whereas the 0.15 µm column provides more complete separation of C10 from the solvent peak when large injection sizes are used. Compared with common industry solutions, the unique surface bonding of the Rtx®-Mineral Oil column ensures long column lifetime, even at higher temperatures. These unique columns can be used at temperatures ranging from 380 °C (isothermal) to 400 °C (programmable), and each column is tested individually for bleed to ensure exceptional performance at these extreme conditions.

ID	df	temp. limits	15-Meter
0.32mm	0.10µm	-60 to 380/400°C	18079
	0.15µm	-60 to 380/400°C	18074
	0.30µm	-60 to 380/400°C	18075

similar **phases**

Varian Select Mineral Oil, VF-5HT, DB-1HT, DB-5HT

Volatile Organics Analysis

Rtx®-VMS Columns (fused silica)
(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.

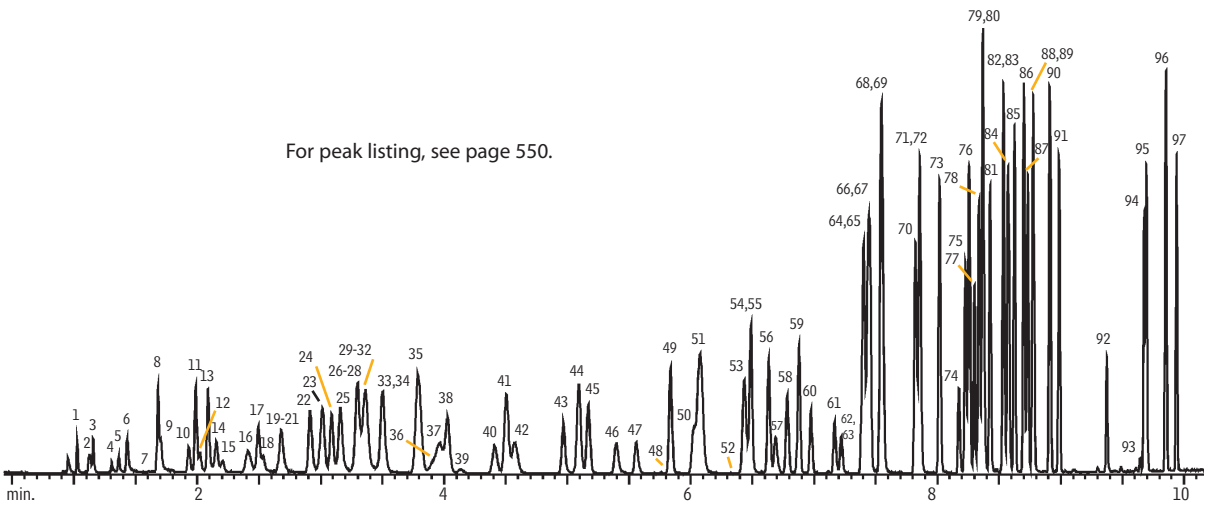
Rtx®-VMS columns offer lower bleed, better selectivity, and overall faster analysis for separating volatile organic compounds, such as those listed in US EPA Method 8260B. The Rtx®-VMS stationary phase is a highly stable polymer that provides outstanding analysis of volatile compounds, in combination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

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

ID	df	temp. limits	20-Meter		40-Meter	
0.18mm	1.00µm	-40 to 240/260°C	49914	$450	49915	$755

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

For peak listing, see page 550.



GC_EV00428

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 Columns (fused silica)
(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.

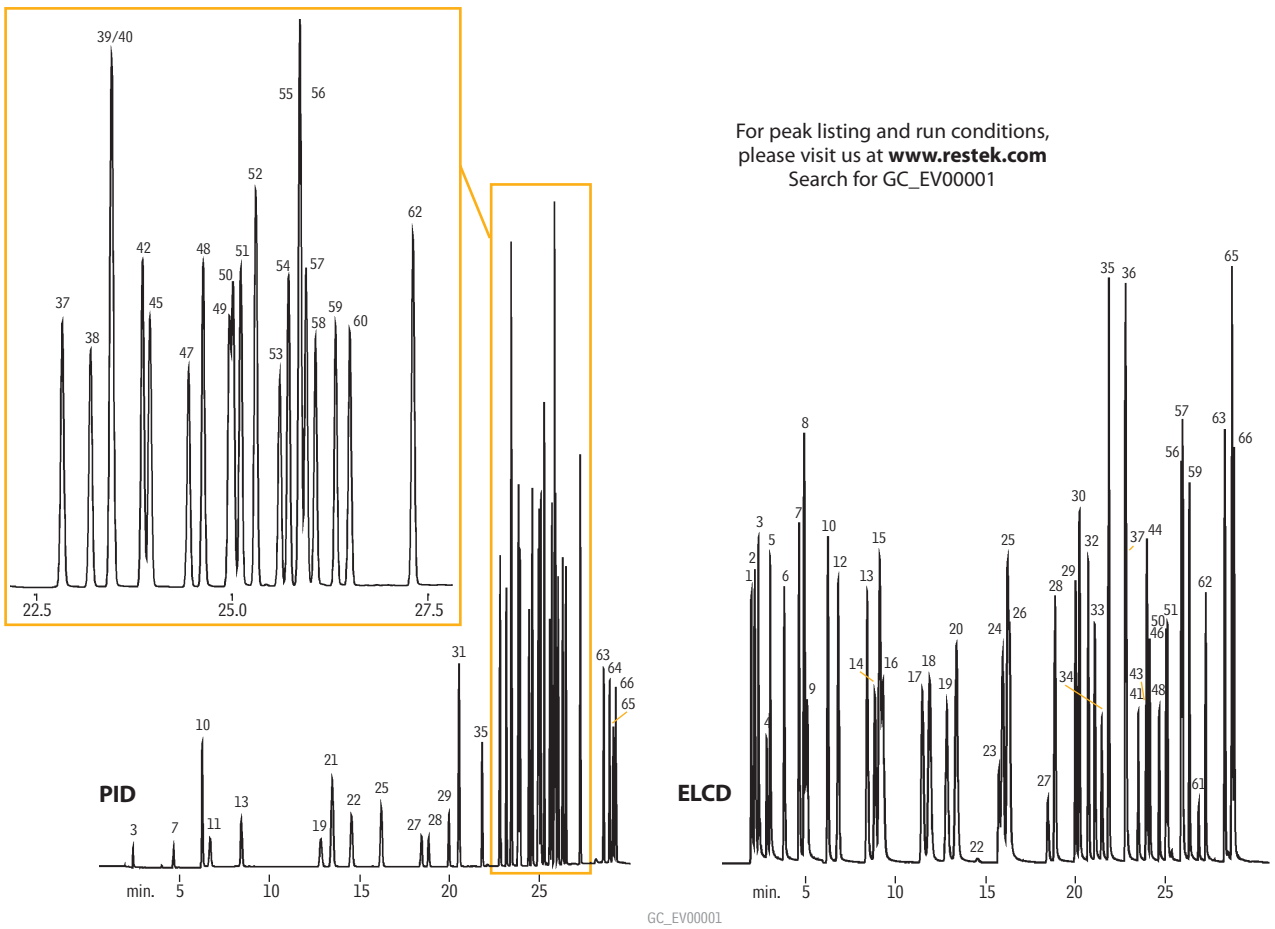
ID	df	temp. limits	30-Meter	60-Meter	75-Meter	105-Meter
0.25mm	1.40µm	-40 to 240/260°C	19315	19316		
0.32mm	1.80µm	-40 to 240/260°C	19319	19320		
0.45mm	2.55µm	-40 to 240/260°C	19308		19309	
0.53mm	3.00µm	-40 to 240/260°C	19385	19388	19374	19389

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

similar **phases**

DB-VRX

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



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 Columns (fused silica)

(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.

similar phase

DB-502.2

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

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

also available

Metal MXT® Columns
Rugged, flexible, Siltek® treated stainless steel tubing; inertness comparable to fused silica tubing. See **page 121** for our MXT®-502.2 and MXT®- Volatiles columns.

Rtx®-Volatiles Columns (fused silica)

(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.

similar phase

VOCOL

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

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

Volatile Organics Analysis

NEW!

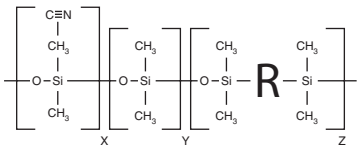
Rxi®-624Sil MS Columns (fused silica)

(midpolarity Crossbond® silarylene phase; equivalent to 6% cyanopropylphenyl/ 94% dimethyl arylene polysiloxane)

- Low bleed, high thermal stability column—maximum temperatures up to 320 °C.
- Inert—excellent peak shape for a wide range of compounds, including acidic and basic compounds.
- Selective—highly selective for residual solvents, great choice for USP<467>.
- Manufactured for column-to-column reproducibility—well-suited for validated methods.

ID	df	temp. limits	20-Meter	30-Meter	60-Meter
0.18mm	1.00µm	-20 to 300/320°C	13865		
0.25mm	1.40µm	-20 to 300/320°C		13868	
0.32mm	1.80µm	-20 to 300/320°C		13870	13872
0.53mm	3.00µm	-20 to 280/300°C		13871	

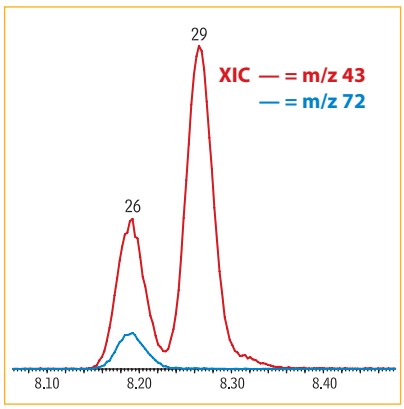
Rxi®-624Sil MS Structure



similar phases

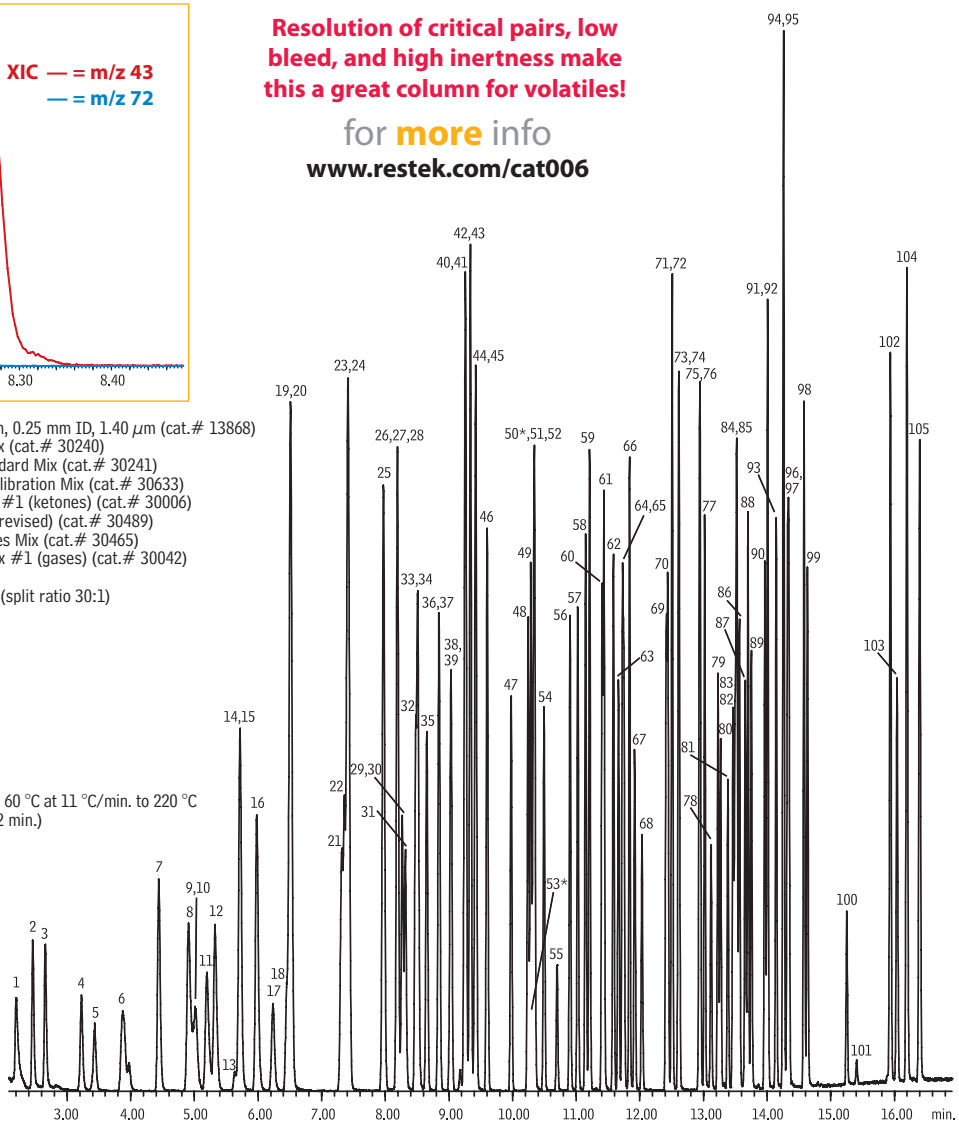
DB-624, HP-624, VF-624, BP-624, ZB-624, AT-624, 007-1301, G43R

Volatiles by EPA Method 8260 on Rxi®-624Sil MS (30m, 0.25mm ID, 1.40µm)



Resolution of critical pairs, low bleed, and high inertness make this a great column for volatiles!

for more info
www.restek.com/cat006



Column:	Rxi®-624Sil MS, 30 m, 0.25 mm ID, 1.40 µm (cat.# 13868)
Sample:	8260A Surrogate Mix (cat.# 30240) 8260A Internal Standard Mix (cat.# 30241) 8260B MegaMix® Calibration Mix (cat.# 30633) VOA Calibration Mix #1 (ketones) (cat.# 30006) 8260B Acetate Mix (revised) (cat.# 30489) California Oxygenates Mix (cat.# 30465) 502.2 Calibration Mix #1 (gases) (cat.# 30042)
Conc.:	25 ppb in RO water
Injection	purge and trap split (split ratio 30:1)
Inj. Temp.:	225 °C
Purge and Trap	
Instrument:	OI Analytical 4660
Trap Type:	10 Trap
Purge:	11 min. @ 20 °C
Desorb Preheat Temp.:	180 °C
Desorb:	0.5 min. @ 190 °C
Bake:	5 min. @ 210 °C
Interface Connection:	injection port
Oven	
Oven Temp:	35 °C (hold 5 min.) to 60 °C at 11 °C/min. to 220 °C at 20 °C/min. (hold 2 min.)
Carrier Gas:	He, constant flow
Flow Rate:	1.0 mL/min.
Detector:	MS
Mode:	Scan
Transfer Line Temp.:	230 °C
Analyzer Type:	Quadrupole
Source Temp.:	230 °C
Quad Temp.:	150 °C
Electron Energy:	70 eV
Solvent Delay Time:	1.5 min.
Tune Type:	BFB
Ionization Mode:	EI
Scan Range:	36-260 amu
Instrument:	Agilent 7890A GC & 5975C MSD

GC_EV1169

For peak list and complete conditions, see page 547.