GC Columns

GC Columns

Packed Columns & Packing Materials

Detailed Table of Contents - GC Columns

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Applications by Compound Class Index.

Fused Silica Capillary GC

Top: Jess Andrus, GC Column Manufacturing Technician

Bottom: Raymond Ciampichini, GC Column Manufacturing Manager

Selecting a GC Column

Capillary column selection can be a challenging task for many chromatographers. Several simple principles can be kept in mind to simplify the selection process and result in the optimum column for the analytical task at hand. Keep in mind that in selecting the proper capillary column, the chromatographer is faced with many options that require optimizing analysis speed, retention or capacity, and resolution. These three analysis goals are affected by several factors or variables contained in the resolution equation:

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

Efficiency Capacity Selectivity

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

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

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Selectivity, α

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

An example of selectivity can be shown using benzene and butanol (both have nearly the same boiling point) eluting through the 5% diphenyl/95% dimethyl polysiloxane stationary phase (Rtx®-5/Rtx®-5ms). The benzene molecule will dissolve into the stationary phase more readily than the butanol based on the concept that "likes dissolve likes". Benzene desolvating more readily with the stationary phase results in more interactions with the stationary phase as it elutes through the column. Therefore, the elution of these two compounds on the Rtx®-5/Rtx®-5ms stationary phase will be butanol eluting 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 will more readily desolvate into the polyethylene glycol stationary phase; therefore, the butanol will have more interaction with the phase and elute after benzene.

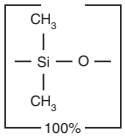
Table I lists the Kovats retention indices for the stationary phases in Table II. Assigning a retention index to each probe listed provides a basis for comparing several stationary phases and their relative retention to one another for a set of molecular probes. For example, when Kovats indices are identical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

Table I Retention indices for Restek phases

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

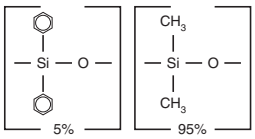
Table II Structures, polarities, properties, and uses for Restek capillary column phases, in order of increasing polarity

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



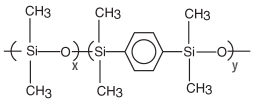
Polarity: non-polar
Uses: solvents, petroleum products, pharmaceutical samples, waxes
[G1]

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



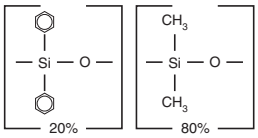
Polarity: slightly polar
Uses: flavors, environmental, aromatic hydrocarbons
[G27]

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



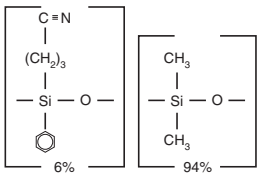
Polarity: slightly polar
Uses: flavors, environmental, pesticides, PCBs, aromatic hydrocarbons

Rtx®-20
20% diphenyl
80% dimethyl polysiloxane



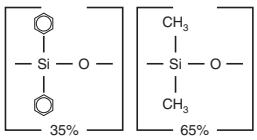
Polarity: slightly polar
Uses: volatile compounds, alcohols
[G32]

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



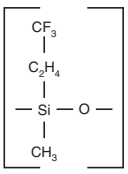
Polarity: slightly polar
Uses: volatile compounds, insecticides, residue solvents in pharmaceutical products
[G43]

Rtx®-35
35% diphenyl
65% dimethyl polysiloxane



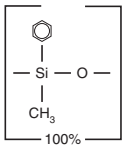
Polarity: intermediately polar
Uses: pesticides, Aroclor® PCBs, amines, nitrogen-containing herbicides
[G42]

Rtx®-200
trifluoropropylmethyl polysiloxane



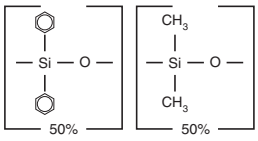
Polarity: selective for lone pair electrons
Uses: environmental, solvents, Freon® gases, drugs, ketones, alcohols
[G6]

Rtx®-50
100% methylphenyl polysiloxane



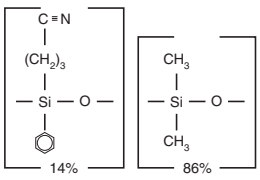
Polarity: intermediately polar
Uses: FAMEs, carbohydrates
[G3]

Rxi®-17
50% diphenyl
50% dimethyl polysiloxane



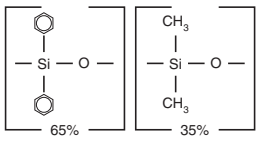
Polarity: intermediately polar
Uses: triglycerides, phthalate esters, steroids, phenols
[G3]

Rtx®-1701
14% cyanopropylphenyl
86% dimethyl polysiloxane



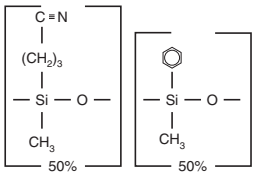
Polarity: intermediately polar
Uses: pesticides, Aroclor® PCBs, alcohols, oxygenates
[G46]

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



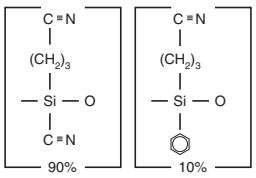
Polarity: intermediately polar
Uses: triglycerides, rosin acids, free fatty acids

Rtx®-225
50% cyanopropylmethyl
50% phenylmethyl polysiloxane



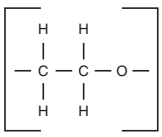
Polarity: polar
Uses: FAMEs, carbohydrates
[G7]

Rt™-2330
90% biscyanopropyl
10% cyanopropylphenyl polysiloxane



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

Stabilwax®, Rtx®-Wax
Carbowax® PEG



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

ordering **note**

Designations in [brackets] are USP codes. We recommend this phase when your application calls for this code. See **page 125**.

Selecting a GC Column

Gary Stidsen
GC Columns
Product Manager
11+ years of service!

did you **know**?

Restek On-The-Road training seminars are full-day courses presented in an engaging multimedia format. They are equally valuable to beginning chromatographers, those who have moderate experience and want a better understanding of the subject matter, and those interested in the "best practices" and latest technologies. **No sales pitch is presented**, just the facts on how to make your chromatography results better. The bulk of each course is lecture, but numerous demonstrations and problem-solving exercises facilitate and reinforce the understanding of important principles. See **page 11** for more information.

Capacity, k

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

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

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

Film thickness (μ) has a direct affect 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, versus a thinner film.

Table III Typical column characteristics

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

Efficiency, N

Column efficiency (N) is the column length divided by the height equivalent of 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.

reference **pages**

Choosing a Volatiles GC column
see page 563

Table of Contents for Applications
see pages 518-519

Applications by Phase Index, GC
see pages 561-562

Applications by Compound Class Index
see pages 734-735

ordering **note**

Prefer a different column cage?
5-inch column cage/Agilent 6850: add the suffix "6850" to your column catalog number. No additional cost.

Uncaged: add the suffix "051" to your column catalog number. No additional cost.

4-inch column cage (not available for 0.53mm ID columns): add the suffix "280" to your column catalog number. Additional cost

In your cage: add the suffix "031" to your column catalog number. Additional cost

What Are the Operating Temperatures for My Column?

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

Rtx®-VMS (fused silica)

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

Many phases list 2 maximum operating temperatures. The first temperature is the maximum isothermal operating temperature, 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). The maximum isothermal operating temperature usually is 10–20°C lower than the temperature-programmed temperature. If only one temperature is listed, it is both the isothermal and the maximum temperature.

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

Selection of Capillary Column Summary

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

1) Choose proper phase

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

2) Select column ID, film thickness, and length

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

3) Set optimum parameters for your analysis

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

Column Cross-References

Columns by Phase

Restek	Phase Composition	USP Nomenclature*	Agilent	Varian	SGE	Phenomenex	Macherey-Nagel	Supelco	Alltech	Quadrex
Rtx-1 (p. 43)	100% dimethyl polysiloxane	G1, G2, G38	HP-1 / DB-1	CP Sil 5 CB	BP-1	ZB-1	Optima-1	SPB-1	AT-1	007-1
Rxi-1ms (p. 36)	100% dimethyl polysiloxane (low bleed)		HP-1/ HP-1ms DB-1/ DB-1ms Ultra-1	VF-1ms / CP-Sil 5 CB Low Bleed/MS		ZB-1ms	Optima-1/ Optima-1ms	SPB-1, Equity-1	AT-1	007-1
Rtx-5 (p. 44, 74)	5% diphenyl 95% dimethyl polysiloxane	G27, G36	HP-5/ DB-5	CP-Sil 8 / CP Sil 8 CB	BP-5	ZB-5	Optima-5	SPB-5	AT-5	007-2
Rxi-5ms (p. 37)	5% diphenyl 95% dimethyl polysiloxane (low bleed)		HP-5/ HP-5ms DB-5, Ultra-2					SPB-5, Equity-5	AT-5ms	007-2
Rxi-5Sil MS (p. 38, 76)	5% phenyl arylene 95% dimethyl polysiloxane		DB-5ms	VF-5ms / CP-Sil 8 CB Low Bleed/MS	BPX-5	ZB-5ms	Optima-5ms	MDN-12		
Rxi-XLB (p. 40)	Arylene/methyl modified polysiloxane		DB-XLB	VF-XMS						
Rtx-20 (p. 45)	20% diphenyl 80% dimethyl polysiloxane	G28, G32						SPB-20, VOCOL	AT-20	007-7
Rtx-35 (p. 46)	35% diphenyl 65% dimethyl polysiloxane	G42	HP-35, DB-35	VF-35ms	BPX-35, BPX-608	ZB-35		SPB-35, SPB-608	AT-35	007-11
Rtx-35ms (p. 46)	35% diphenyl 65% dimethyl polysiloxane (low bleed)		HP-35 / HP-35ms, DB-35	VF-35ms					AT-35 / AT-35ms	
Rtx-50 (p. 47)	100% phenyl methyl polysiloxane (50% phenyl)	G3	HP-50		AT-50		Optima-17	SPB-50	AT-50	007-17
Rxi-17 (p. 41)	50% diphenyl 50% dimethyl polysiloxane		HP-17, DB-17	CP-Sil 24 CB / VF-17ms		ZB-50				
Rtx-65 (p. 47)	65% diphenyl 35% dimethyl polysiloxane	G17								400-65HT, 007-65HT
Restek	**Phase Composition**	**USP Nomenclature**	**Agilent**	**Varian**	**SGE**	**Phenomenex**	**Macherey-Nagel**	**Supelco**	**Alltech**	**Quadrex**
Rtx-1301 (p. 50, 73) Rtx-624 (p. 50, 73, 91)	6% cyanopropyl phenyl 94%dimethyl polysiloxane	G43	HP-1301, HP-624, DB-1301, DB-624	CP-1301, VF-1301ms, VF-624ms	BP-624	ZB-624	Optima-1301, Optima-624	SPB-1301	AT-624	007-1301
Rtx-1701 (p. 51)	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. 49)	trifluoropropyl methyl polysiloxane	G6	DB-210, DB-200	VF-200ms			Optima-210		AT-210	007-210
Rtx-200ms (p. 49)	trifluoropropyl methyl polysiloxane (low bleed)			VF-200ms						
Rtx-225 (p. 52)	50% cyanopropyl 50% phenylmethyl polysiloxane	G7, G19	HP-225, DB-225	CP Sil 43 CB	BP-225		Optima-225		AT-225	007-225
Rtx-440 (p. 48)	modified polysiloxane (unique phase)		unique **column**							
Rt-2330 (p. 53)	90% biscyanopropyl 10% cyanopropyl phenyl polysiloxane	G48			BPX-70			SP-2330, SP-2331, SP-2380	AT-Silar	
Rt-2560 (p. 53)	bicyanopropyl polysiloxane		HP-88	CP Sil 88				SP-2560		
Stx-500 (p. 48, 83)	phenyl carborane-siloxane				HT-5					
Rtx-Wax (p. 54)	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. 55, 75)	polyethylene glycol	G14, G15, G16, G20, G39	Innowax	CP Wax 52 CB				Supelcowax-10		
Restek	**Phase Composition**	**USP Nomenclature**	**Agilent**	**Varian**	**SGE**	**Phenomenex**	**Macherey-Nagel**	**Supelco**	**Alltech**	**Quadrex**
Rt-Alumina (p. 94, 95)	Na_2SO_4 deactivation		GS-Alumina, HP PLOT S	CP-AL2O3 / Na2SO4				Alumina-PLOT	AT-Alumina	
Rt-Msieve 5A (p. 96)			GS-Msieve, HP PLOT Molsieve	CP-Molsieve 5A				Molsieve 5A	AT-Molsieve	PLT-5A
Rt-QSPLOT (p. 97)			GS-Q							
Rt-QPLOT (p. 97)				CP-PoraPLOT Q, CP-PoraBond Q				Supel-Q-PLOT	AT-Q	
Rt-SPLOT (p. 97)				CP-PoraPLOT S				Supel-G45		
Rt-UPLOT (p. 97)			HP-PLOT U	CP-PoraPLOT U, CP-PoraBond U				Supel-N PLOT		

Columns by Application

Restek	Applications	Agilent	Supelco	Macherey-Nagel	SGE	Varian	Phenomenex
Specially deactivated phases							
Rtx-5Amine (p. 57)	Amines					CP-Sil 8 CB	
Rtx-35Amine (p. 58)	Amines	unique column					
Stabilwax-DB (p. 59)	Amines	CAM	Carbowax Amine			CP WAX 51	
Stabilwax-DA (p. 60)	Free acids	HP-FFAP, DB-FFAP	Nukol	Permabond FFAP, Optima FFAP	BP-21	CP WAX 58 CB	
Chiral Columns							
Rt-βDEXm (p. 61)	Chiral						
Rt-βDEXsm (p. 61)	Chiral						
Rt-βDEXse (p. 61)	Chiral						
Rt-βDEXsp (p. 61)	Chiral						
Rt-βDEXsa (p. 61)	Chiral						
Rt-βDEXcst (p. 61)	Chiral						
Rt-γDEXsa (p. 61)	Chiral						
Foods, Flavors, & Fragrances							
FAMEWAX (p. 63)	Marine oils		Omegawax				
Rt-CW20M F&F (p. 63)	Flavors & fragrance	HP-20m, CarboWax 20			BP-20M	007-CW	
Rtx-1 F&F (p. 64)	Flavors & fragrance						
Rtx-65 TG (p. 65)	Triglycerides	unique column					
Petroleum							
Rtx-1PONA (p. 66)	Detailed hydrocarbon analysis	HP-PONA, DB-Petro	Petrocol DH		BP1-PONA	CP Sil PONA CB	
Rtx-2887 (p. 67)	Hydrocarbons - ASTM 2887	DB-2887	Petrocol 2887, Petrocol EX2887				
MXT-2887 (p. 67, 102)	Hydrocarbons - ASTM 2887						
D3606 (p. 114)	Ethanol - ASTM 3606	unique column					
Rt-TCEP (p. 69)			TCEP			CP-TCEP	
MXT-1 Sim Dist (p. 68, 103)	Simulated distillation	DBHT-SMD				CP-SIMDIST	
MXT-500 (p. 68, 103)	Simulated distillation	unique column					
Rtx-Biodiesel TG (p. 70) MXT-Biodiesel TG (p. 70, 102)	Triglycerides in biodiesel	unique column					
Clinical/Forensic - Blood Alcohol Testing							
Rtx-BAC1 (p. 71)	Blood alcohol testing	DB-ALC1					
Rtx-BAC2 (p. 71)	Blood alcohol testing	DB-ALC2					
Pharmaceutical							
Rtx-G27 w/IntegraGuard (p. 72)	Organic volatile impurities (OVI) - USP 467						
Rtx-G43 w/IntegraGuard (p. 72)	Organic volatile impurities (OVI) - USP 467		OVI-G43				
Rtx-1301 (p. 50, 73) Rtx-624 (p. 50, 73, 91)	Organic volatile impurities (OVI) - USP 467	HP-1301, HP-624, DB-1301, DB-624	SPB-1301		BP-624	CP-1301, VF-1301ms, VF-624	ZB-624
Rtx-5 (p. 44, 74)	Organic volatile impurities (OVI) - USP 467	HP-5/ DB-5	SPB-5, Equity-5	Optima-1301, Optima-624	BP-5	CP-Sil 8, CP Sil 8 CB	ZB-5
Stabilwax (p. 55, 75)	Organic volatile impurities (OVI) - USP 467	Innowax	Supelcowax-10		BP-624	CP Wax 52 CB	
Environmental							
Rxi-5Sil MS (p. 38, 76)	Semivolatiles - EPA Methods 8270, 625, 525	DB-5ms	SLB-5	Optima-5ms		VF-5ms	
Rtx-VMS (p. 87)	Volatiles - EPA Methods 8260, 624, 524	unique column					
Rtx-624 (p. 50, 73, 91)	Volatiles - EPA Method 624	HP-624, DB-624	SPB-1301	Optima-624		VF-1301ms	ZB-624
Rtx-502.2 (p. 90)	Volatiles - EPA Methods 8010, 8020, 502.2, 601, 602	DB-502.2	VOCOL				
Rtx-VRX (p. 89)	Volatiles - EPA Methods 8010, 8020, 502.2, 601, 602	DB-VRX					
Rtx-VGC (p. 88)	Volatiles - EPA Methods 8010, 8020, 502.2, 601, 602	unique column					
Rtx-CLPesticides (p. 78)	Organochlorine pesticides - EPA Methods 8081, 8082, 608, 505, 508	unique column					
Rtx-CLPesticides2 (p. 78)	Organochlorine pesticides - EPA Methods 8081, 8082, 608, 505, 508	unique column					
Stx-CLPesticides (p. 80)	Organochlorine pesticides - EPA Methods 8081, 8082, 608, 505, 508	unique column					
Stx-CLPesticides2 (p. 80)	Organochlorine pesticides - EPA Methods 8081, 8082, 608, 505, 508	unique column					
Rtx-PCB (p. 82)	Polychlorinated biphenyl - EPA Methods 8082, 608, PCB congeners	unique column					
Rxi-XLB (p. 40)	Polychlorinated biphenyl - EPA Methods 8082, 608, PCB congeners	DB-XLB				VF-XMS	
Rtx-OPPesticides (p. 77)	Organophosphorus pesticides - EPA Method 8141	unique column					
Rtx-OPPesticides2 (p. 77)	Organophosphorus pesticides - EPA Method 8141	unique column					
Rtx-Dioxin2 (p. 84)	Dioxin & Furans - EPA Methods	unique column					
Rtx-Dioxin (p. 83)	Dioxin & Furans - EPA Methods	unique column					
Rt-PAH (p. 85)	Polycyclic aromatic hydrocarbons	unique column					
Rtx-TNT & Rtx-TNT2 (p. 86)	Explosives - EPA Method 8095	unique column					

Column Installation

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, septum, and the injector seals (o-rings, inlet seals, ferrules, etc.).
5. Mount the column in the oven with a support that protects it from scratches. Center the column in the oven. This ensures uniform heat exposure generating consistent retention times.
   - Restek has two types of cages for fused silica columns, an 11-pin cage and the original cage that uses high temperature string to hold the column in place. **If you have the cage with high temperature string, do not remove the string that holds the column in the cage!**
6. Uncoil the ends to make sure the ends are long enough to reach the injector and detector. Cut 10cm from each end of the column.
   - To cut a fused silica column, use the smooth edge of a ceramic scoring wafer (cat.# 20116).
7. While pointing the inlet end of the column downward (to prevent shards from falling into the column), slide the nut and appropriate size ferrule onto the inlet end of the column. Cut an additional 2cm from the end of the column to remove any material scraped from the ferrule onto the edge of the column.
8. Install the column the appropriate distance in the injector, as indicated in your instrument manual.
9. Set the carrier gas to the flow rate or inlet pressure recommended for the column or to your method flow rate/pressure. Confirm presence of column flow by immersing the column outlet in a vial of solvent.
10. Flush the column at ambient temperature with carrier gas: at least 5 minutes for a 25-30m column and 10 minutes for a 50-60m column.
11. Set the injector temperatures. Do not exceed the column's maximum operating temperature (listed on the column tag). Check inlet for leaks.
12. Install the column into the detector as described in the instrument manual. Set the detector gases and temperatures to proper settings.
13. Check the detection connections for leaks, using a thermal conductivity leak detector (cat.# 22451).
14. Verify the carrier gas flow is at the rate you intend to use for your analysis. Set the split vent, septum purge, and any other applicable gas rates as appropriate.
15. Inject an unretained compound to verify the column is installed correctly and to determine the dead volume time for checking column flow. A symmetric peak indicates the column is installed correctly. Adjust the carrier gas flow as necessary.
16. Condition the column 20°C above the final analysis temperature of your method. Do not exceed the column's maximum operating temperature. For most applications, 1 hour of conditioning is sufficient. For sensitive detectors or low level analysis, longer conditioning times or conditioning the column at the maximum temperature may be beneficial. Extended time at high temperatures will not adversely affect column performance as long as precautions are taken to make sure the carrier gas is clean and is filtered for oxygen and water.
17. To check for instrument performance, analyze a column test mix for a new method, or a known standard to confirm proper column and system performance.
18. Your GC system is now ready to be calibrated and acquire samples.

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

Note 2: 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 the carrier gas flow on at an oven temperature of 100-150°C.

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

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

Custom Phases

Over the years, we have developed numerous proprietary phases for specific separations. We have more than 35 custom stationary phases in stock. Also note that some of our "common" phases are available in variations for specific purposes. If you don't see it in this catalog, call us.

Paul Silvis
Founder, Inventor, Coach
23+ years of service!

Custom Phases Currently in Stock*

Apiezon® L	DEGS (G4)	OV®-351 (G35)	Squalane
Butane 1,4 diol succinate	DEXSIL 300	Rt™-2330 (G8)	Squalene
Carbowax® 300	DIIDP (G24)	Rt™-2340 (G5)	Superox® 20M
Carbowax® 600	FFAP	SE®-30 (G1,G2)	TCEP
Carbowax®1000 (G14)**	OS®-124	SE®-54 (G36)	Tricresyl phosphate
Carbowax® 8000 (G47)	OS®-138	Silar® 5CP	UCON® 50HB
Carbowax® 20M (G16)	OV®-202	Silar® 9CP (G8)	XE®-60
DC-550 (G28)	OV®-275	Silar® 10CP	XF®-1150

*Other phases available on request.
**Codes in parentheses are USP designations—see page 125.

Custom Column Dimensions

Need a specific film thickness? Locked into a method that uses a 42-meter column? If you need it, we can make it. We have shipped lengths from 3 to 150 meters, and film thicknesses from 0.1µm to 10.0µm.

Inverse Gas Chromatography Columns

We have extensive experience in coating capillary columns with a wide variety of polymers. If you need an IGC column, contact Technical Service at 800-356-1688 or 814-353-1300, ext. 4, or contact your Restek representative. We'll assist you in coating a column with your polymer.

PIE service

Plus 1
Exceeding your expectations in everything we do.

Innovation
Turning Visions into Reality®.

Execution
On-time delivery of products and services.

Restek's vision is to be the company that chromatographers trust by providing the highest quality, most innovative products and services throughout the world.

We will soon reach our goal of 100% employee ownership. As owners, our success depends on your success.

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) take place when a piece of deactivated tubing is connected to an analytical column as in Figure 1.

please **note**

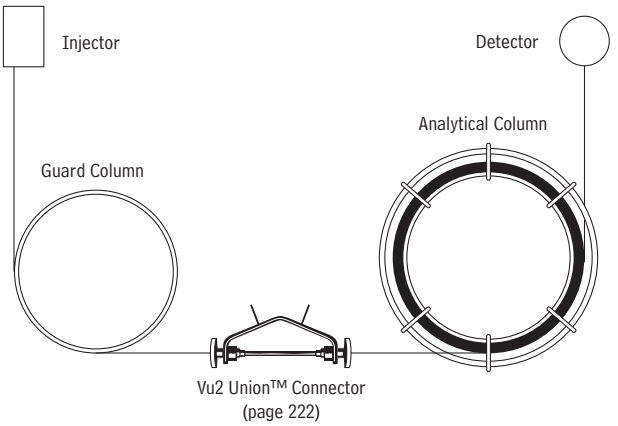
For superior inertness, try our Siltek® guard columns!

See **page 28** for details.

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

See **page 30** for details.

Figure 1 A guard column connected to an analytical column



Analyte Focusing

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

For cool on-column injection, the use 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.

did you **know**?

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

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.

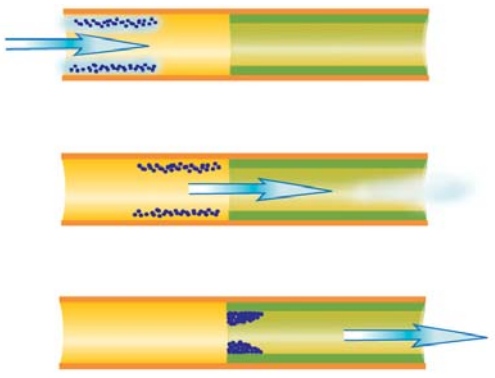
Protecting the Analytical Column

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

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

AJ Saclyn
Associate Product Marketing Manager

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



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

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

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.

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

Siltek® deactivation creates a highly inert surface for very active compounds such as chlorinated 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?

We offer Vu2-Union™, Press-Tight®, and other connectors for attaching guard columns to fused silica columns. MXT™ unions are available for connecting stainless steel MXT® columns and guard columns. See pages 224 to 227 for information about these connectors.

it's a **fact**

To eliminate connections, use our unique Integra-Guard™ Column. See **page 30**.

Guard/Retention Gap Columns

it's a fact

To eliminate connections, use an Integra-Guard™ Column. See page 30.

also available

MXT® Guard/Retention Gap Columns
Rugged, flexible, Siltek® treated stainless steel tubing; inertness comparable to fused silica tubing. See page 100 for our Intermediate-Polarity Deactivated MXT® Guard/Retention Gap Columns/Transfer Lines.

it's a fact

Use guard columns to:

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

did you know?

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

Rxi® Guard/Retention Gap Columns (Fused Silica)

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

*Not tested with the Grob test mix because of a large pressure drop.
**30- and 60-meter lengths are banded in 5-meter sections.
†Recommendation: Cut 60m guard columns into shorter lengths. Using full length may cause peak distortion.

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

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

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

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

Chris English
Innovations Team Manager
11+ years of service!

did you know?

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

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

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

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

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

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

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

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

*Not tested with the Grob test mix because of a large pressure drop.
**30- and 60-meter lengths are banded in 5-meter sections.
†Recommendation: Cut 60m guard columns into shorter lengths. Using full length may cause peak distortion.

also available

MXT® Guard Columns
Rugged, flexible, Siltek® treated stainless steel tubing; inertness comparable to fused silica tubing. See **page 100** for our Hydroguard™ MXT® Guard Tubing/Transfer Lines.

best choice

Siltek® treated tubing (cat.# 22505, page 394) is recommended for purge and trap transfer lines.

Guard Columns: Integra-Guard™ Columns

restek
innovation!

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

similar
products

DuraGuard, EZ-Guard, Guardian

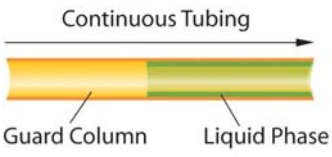
Innovative Integra-Guard™ Columns

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

Our wide variety of Integra-Guard™ capillary columns are listed in the figure 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.

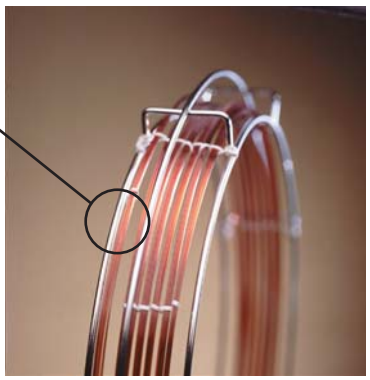
Ordering is simple. Just add the appropriate suffix number and price to the analytical column's catalog number and price. For example, a 30m, 0.25mm ID, 0.25µm Rtx®-5 column with a 5-meter Integra-Guard™ column is cat.# 10223-124.

Integra-Guard™ built-in guard column



ID	Length	Suffix #
0.25mm	5m	-124
	10m	-127
0.28mm	5m	-243
	10m	-244
0.32mm	5m	-125
	10m	-128
0.53mm	5m	-126
	10m	-129

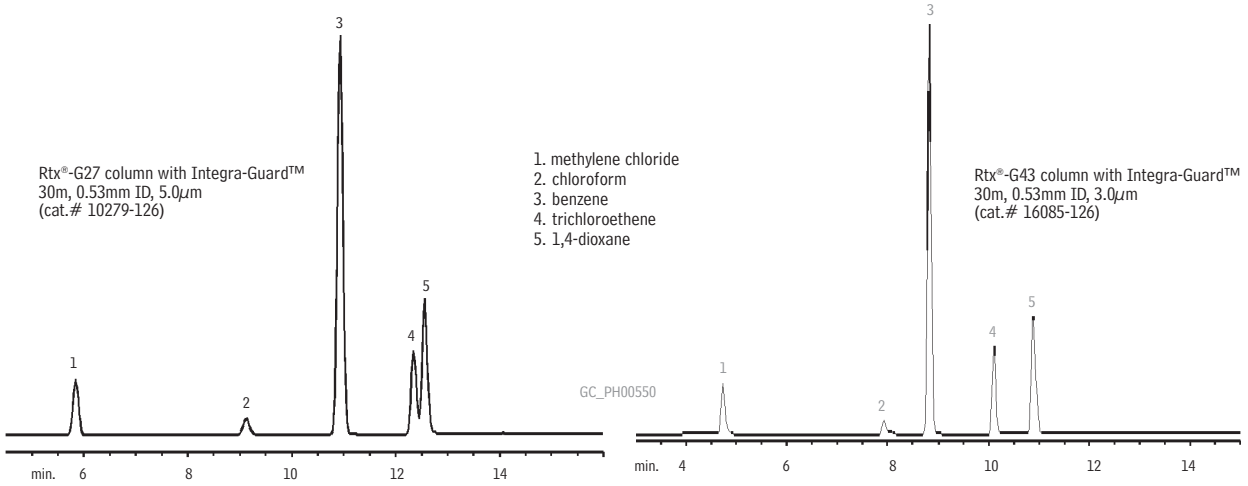
Phases currently available as Integra-Guard™ columns



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

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

An Rtx®-G27 or Rtx®-G43 column with a 5-meter Integra-Guard™ column meets the requirements of USP 467 methods for residual solvents in pharmaceuticals.



Inj.	1.0µL direct injection of USP <467> Mix #3, cat.# 36004
Oven temp.:	35°C (hold 5 min.) to 175°C @ 8°C/min. to 260°C @ 35°C/min.
Inj./det. temp.:	200°C/240°C
Carrier gas:	helium
Linear velocity:	34cm/sec. set @ 35°C
FID sensitivity:	1 x 10^{-11} AFS
Recommended liner:	Uniliner®

Fast GC Using 0.10mm ID Capillary Columns

- Significantly reduces analysis time without sacrificing resolution.
- Highest column efficiencies, great for GC/MS.
- Excellent for comprehensive GC (2D-GC) as second dimension column.

Jaap de Zeeuw
International
GC Specialist

Narrow bore (0.10mm ID) columns are attractive alternatives to conventional-diameter capillary columns because they provide faster analysis times and higher resolving power. As column ID decreases, column efficiency (plates/meter) greatly increases. For instance, a 0.10mm ID column (6,700 plates/meter) is 160% more efficient than a 0.25mm ID column (2,500 plates/meter). Therefore, resolution can be achieved with a shorter column, which decreases the analysis time.

The low flow rates used with a 0.10mm ID column are compatible with the pumping capacity of most GC/MS systems. In addition, a 0.10mm ID column prevents "pumping out the column" or operating below atmospheric pressure, thereby minimizing instrument downtime.

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

Rxi®-1ms Columns (fused silica)

(Crossbond® 100% dimethyl polysiloxane)

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

Rxi®-5ms Columns (fused silica)

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

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

Rxi®-5Sil MS Columns (fused silica)

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

ID	df (µm)	temp. limits	10-Meter	
0.10mm	0.10	-60 to 330/350°C	43601	new!

Rxi®-17 Columns (fused silica)

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

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

Rtx®-Wax Columns (fused silica)

(Crossbond® Carbowax® polyethylene glycol)

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

Rt™-LC50 Columns (fused silica)

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

Rtx®-CLPesticides (fused silica)

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

Rtx®-CLPesticides2 (fused silica)

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

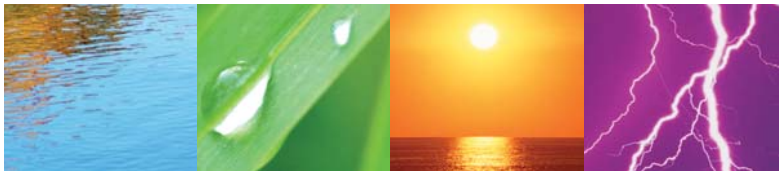
tech tip

Operating considerations for 0.10mm ID columns

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

Rxi® Columns

Exceptionally Inert Capillary Columns



Unsurpassed inertness

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

Ultra-low bleed

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

Guaranteed reproducibility

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

Unmatched performance

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

Restek's Exceptionally Inert (Rxi®) Capillary GC Columns

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

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

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

Low Bleed

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

Highly Inert

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

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

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

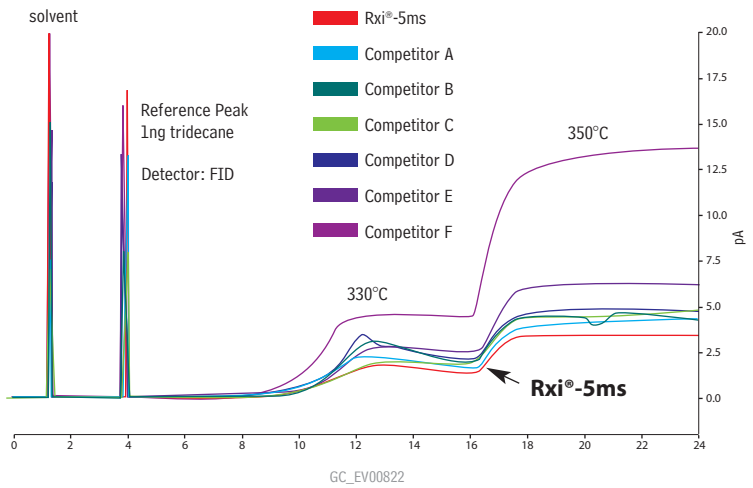
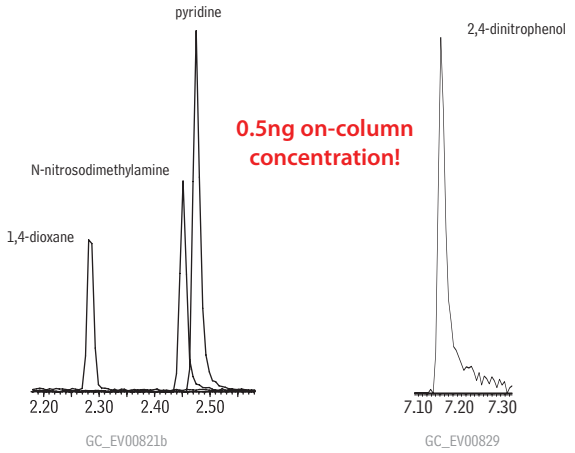


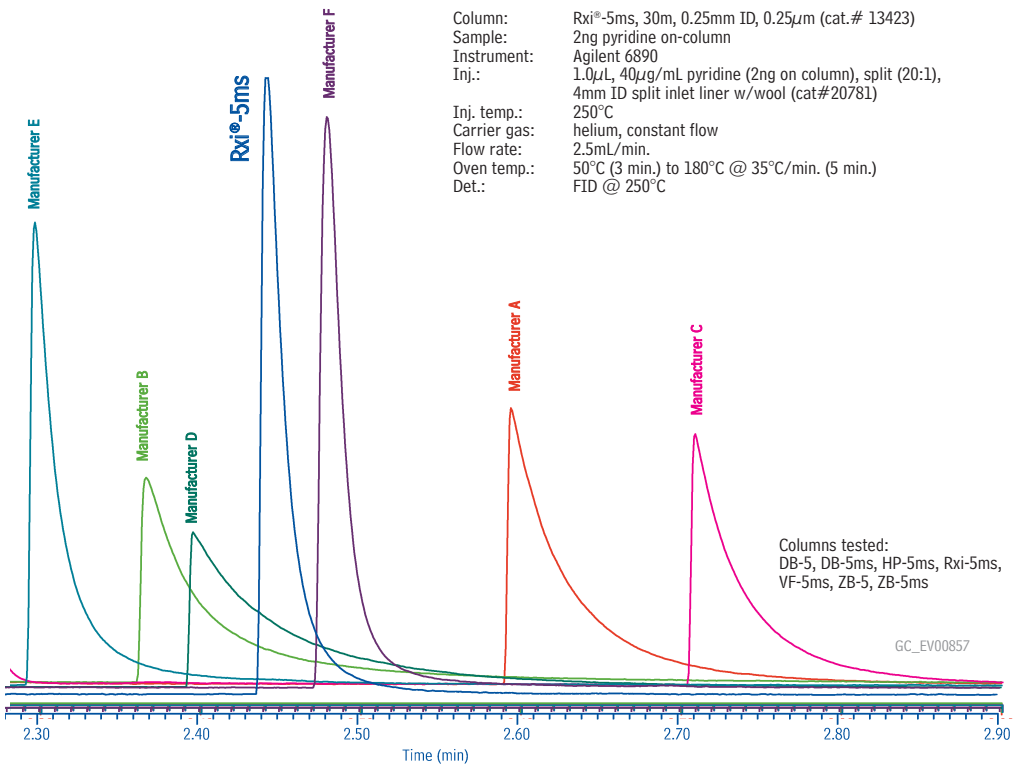
Figure 2 Peak symmetry for pyridine or 2,4-dinitrophenol is excellent from an Rxi®-5ms column, even with 0.5ng on-column!



Amanda Rigdon
Innovations Chemist

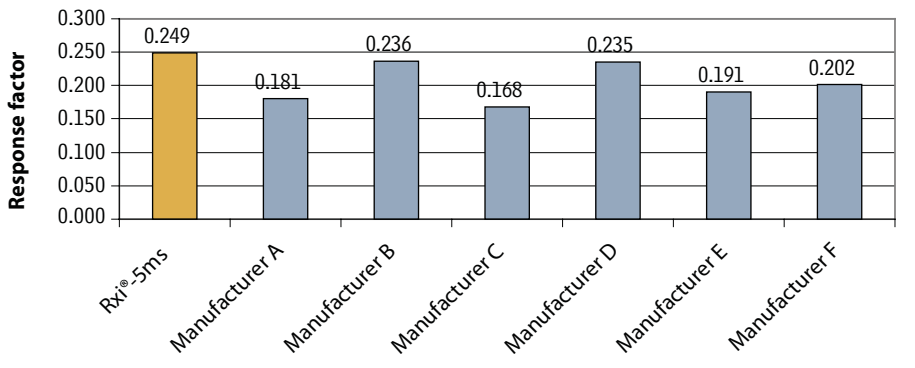
To further compare the inertness of the Rxi®-5ms column toward basic compounds to other columns on the market, 2ng of pyridine was used as a test probe. As shown in Figure 3, the tailing of pyridine is a very sensitive marker for inertness. The excellent peak symmetry on the Rxi®-5ms column demonstrates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

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



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

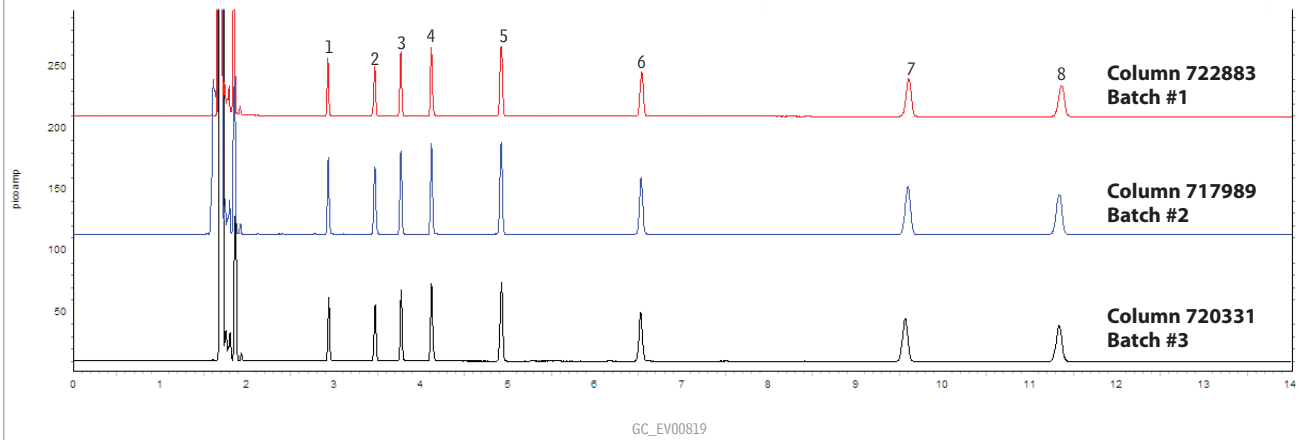
Figure 4 The Rxi®-5ms column gives the highest response factor for the acidic compound 2,4-dinitrophenol.



Column-to-Column Reproducibility

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

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



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

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

Summary

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

Rxi® Guard/Retention Gap Columns

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

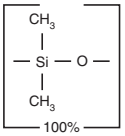
Restek West
Roy Lautamo, Bill Bromps, Ryan Smith, Shawn Reese

Fused Silica

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

Rxi®-1ms

Rxi®-1ms Structure



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

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

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

Rxi®-1ms Columns (fused silica)

(Crossbond® 100% dimethyl polysiloxane)

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

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

free literature

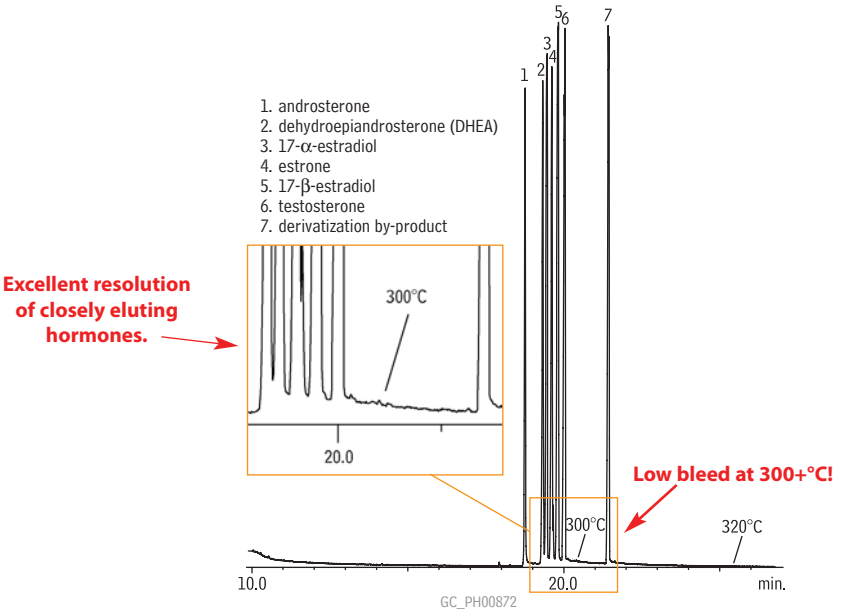
Rxi®-1ms: The Ultimate High Performance Fused Silica Capillary Column

Download your free copy from www.restek.com.

Flyer
lit. cat.# 580075B

Rob Freeman
Innovations Chemist
1+ year of service!

Steroids: Hormones on an Rxi®-1ms column.

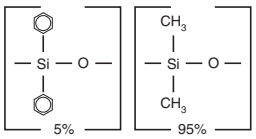


Column:	Rxi®-1ms, 30m, 0.25mm ID, 0.25µm (cat.# 13323)
Sample:	100µg/mL each hormone in methanol or ethanol; compounds derivatized using 2% methoxylamine HCl (CH_3ONH_2) in pyridine, then N-trimethylsilylimidazole (TMSI), then analyzed
Inj.:	1.0µL splitless (hold 0.5 min.), 3.5mm single gooseneck inlet liner (cat.# 20961)
Inj. temp.:	250°C
Carrier gas:	helium, constant flow
Flow rate:	1mL/min.
Oven temp.:	100°C to 320°C @ 10°C/min. (hold 10 min.)
Det:	MS: Shimadzu 17A with QP5000
Transfer line temp.:	280°C
Scan range:	40-700amu
Ionization:	EI
Mode:	scan

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

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

Rxi®-5ms Structure



Rxi®-5ms Columns (fused silica)

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

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

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

similar phases

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

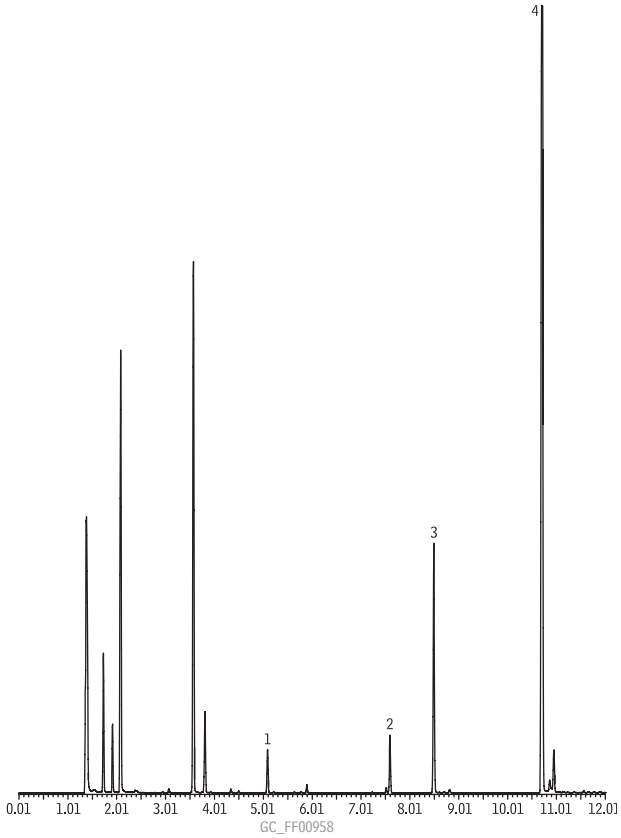
free literature

Rxi®-5ms Columns

Download your free copy from www.restek.com.

Flyer
lit. cat.# 580046A

Fresh garlic on an Rxi®-5ms column.



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

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

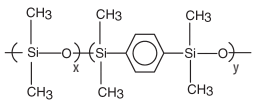
Headspace Conditions

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

Rxi®-5Sil MS

new!

Rxi®-5Sil MS Structure



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

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

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

similar phases

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

Rxi®-5Sil MS Columns (fused silica)

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

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

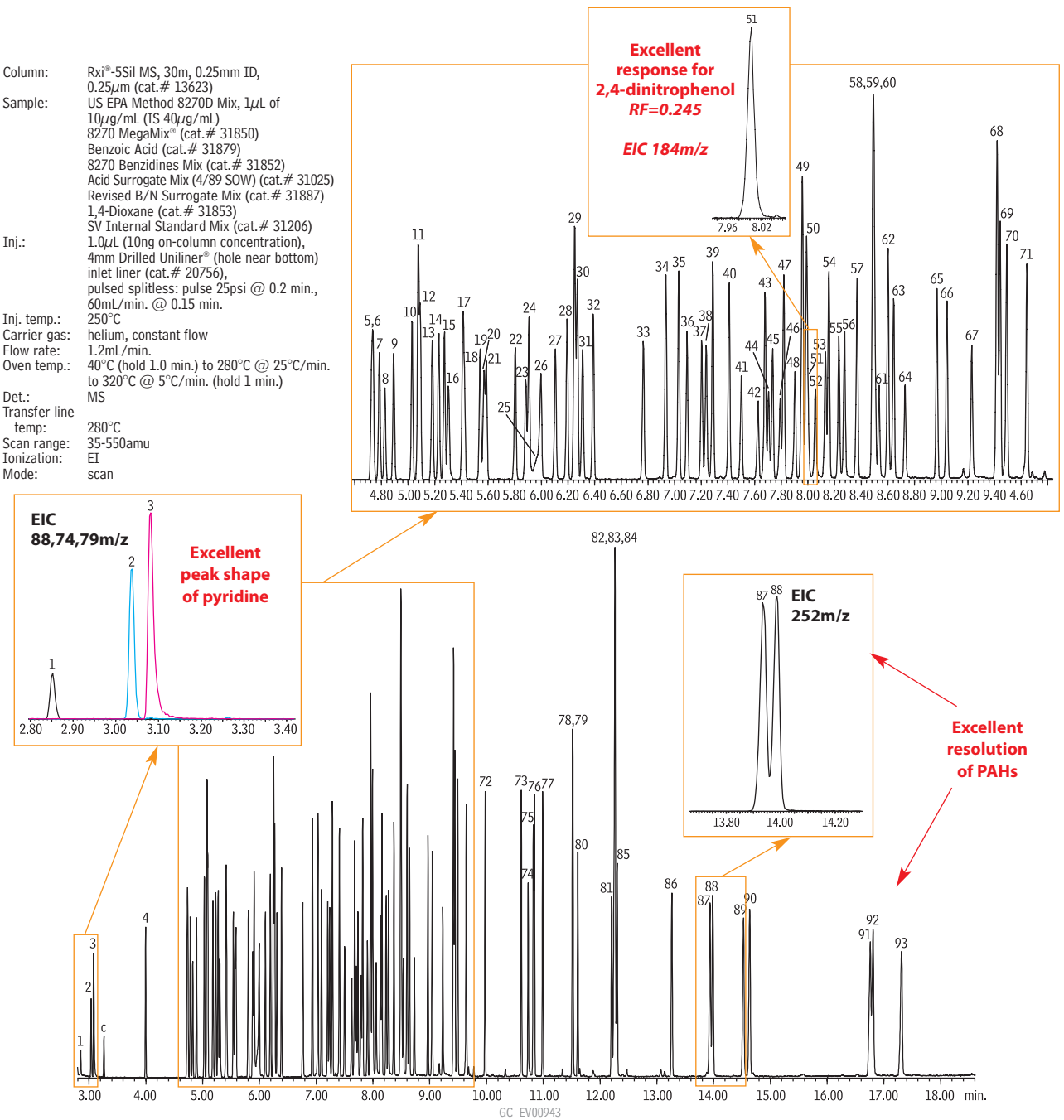
ID	df (µm)	temp. limits	10-Meter	20-Meter
0.10mm	0.10	-60 to 330/350°C	43601	
0.18mm	0.18	-60 to 330/350°C		43602
	0.36	-60 to 330/350°C		43604

Innovations Group

Michelle Long, Dave Shelow, Silvia Martinez, Kristi Sellers, Rick Lake, Rob Freeman, Chris English, Barry Burger, Jason Thomas, Lydia Nolan, Julie Kowalski, Scott Grossman, Amanda Rigdon

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. dibenzo(a,h)anthracene
92. indeno(1,2,3-cd)pyrene
93. benzo(ghi)perylene

c = contaminant

Rxi®-XLB

new!

Rxi®-XLB (low polarity proprietary phase)

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

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

similar phases

DB-XLB, VF-Xms

Rxi®-XLB Columns (fused silica)

(low-polarity proprietary phase)

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

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

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

tech tip

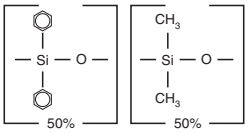
In combination with an Rxi®-XLB column, simple adjustments to the injection conditions can greatly improve sensitivity for active and high molecular weight Method 525.2 target compounds.

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

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

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

Rxi®-17 Structure



Rxi®-17 Columns (fused silica)

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

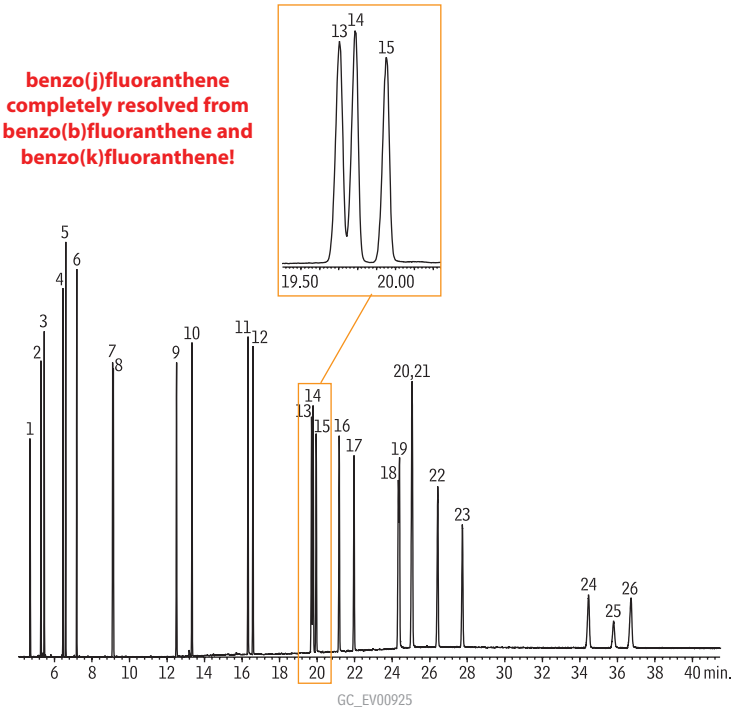
ID	df (µm)	temp. limits	15-Meter	30-Meter
0.25mm	0.25	40 to 280/320°C	13520	13523
	0.50	40 to 280/320°C	13535	13538
	1.00	40 to 280/320°C	13550	13553
0.32mm	0.25	40 to 280/320°C	13521	13524
	0.50	40 to 280/320°C	13536	13539
	1.00	40 to 280/320°C	13551	13554
0.53mm	0.25	40 to 280/320°C	13522	13525
	0.50	40 to 280/300°C	13537	13540
	0.83	40 to 280/320°C		13569
	1.00	40 to 280/320°C	13552	13555
	1.50	40 to 280/320°C	13567	13570

similar phases

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

Polycyclic aromatic hydrocarbons on an Rxi®-17 column.

benzo(j)fluoranthene completely resolved from benzo(b)fluoranthene and benzo(k)fluoranthene!



GC_EV00925

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

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

Christine Vargo
Director of Sales
20+ years of service!

General Purpose Columns

Chemically bonded capillary columns

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

Comprehensive selection of GC columns

- 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 higher resolution power.

Large range of stationary phases

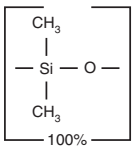
- Columns based on polysiloxane backbone; functional groups added to the polymers to vary selectivity.
- Polyethylene glycol (PEG) phases.

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

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

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

Rtx®-1 Structure



Rtx®-1 Columns (fused silica)

(Crossbond® 100% dimethyl polysiloxane)

ID	df (µm)	temp. limits	15-Meter	30-Meter	60-Meter	75-Meter	105-Meter
0.25mm	0.10	-60 to 330/350°C	10105	10108	10111		
	0.25	-60 to 330/350°C	10120	10123	10126		10129
	0.50	-60 to 330/350°C	10135	10138	10141		10144
	1.00	-60 to 320/340°C	10150	10153	10156		10159
0.32mm	0.10	-60 to 330/350°C	10106	10109	10112		
	0.25	-60 to 330/350°C	10121	10124	10127		10130
	0.50	-60 to 330/350°C	10136	10139	10142		
	1.00	-60 to 320/340°C	10151	10154	10157		10160
	1.50	-60 to 310/330°C	10166	10169	10172		10175
	3.00	-60 to 280/300°C	10181	10184	10187		10190
	4.00	-60 to 280/300°C		10198			
	5.00	-60 to 260/280°C	10176	10178	10180		
0.45mm	2.55	-60 to 270/290°C				10992	
0.53mm	0.10	-60 to 320/340°C	10107	10110			
	0.25	-60 to 320/340°C	10122	10125	10128		
	0.50	-60 to 310/330°C	10137	10140	10143		
	1.00	-60 to 310/330°C	10152	10155	10158		
	1.50	-60 to 310/330°C	10167	10170	10173		
	3.00	-60 to 270/290°C	10182	10185	10188		10189
	5.00	-60 to 270/290°C	10177	10179	10183		10194
	7.00	-60 to 240/260°C	10191	10192	10193		

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

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

similar phases

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

also available

MXT® Columns
Rugged, flexible, Siltek® treated stainless steel tubing; inertness comparable to fused silica tubing. See **page 101** for our MXT®-1 columns.

it's a fact

For exceptional inertness, ultra-low bleed, and unsurpassed performance, choose Rxi®-1ms columns! See **pages 32-36**.

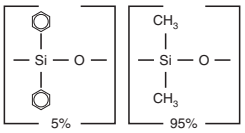
crossbond® technology

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

Dave Krantz
Vice President of Operations
5+ years of service!

Rtx®-5 and Rtx®-5MS

Rtx®-5/Rtx®-5MS Structure



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

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

similar **phases**

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

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

also **available**

MXT® Columns
Rugged, flexible, Siltek® treated stainless steel tubing; inertness comparable to fused silica tubing. See **page 102** for our MXT®-5 columns.

Rtx®-5 Amine Columns
See **page 57**.

Rtx®-5 Columns (fused silica)

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

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

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

30-meter	6-pack cat.#
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.

it's a **fact**

For exceptional inertness, ultra-low bleed, and unsurpassed performance, choose Rxi®-5ms columns! See **pages 33-35, 37**.

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

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

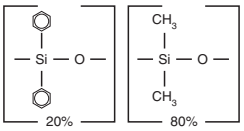
- Column specifically tested for low bleed performance.

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

Rtx®-20 (low to midpolarity phase; Crossbond® 20% diphenyl/80% dimethyl polysiloxane)
- General purpose columns for volatile compounds, flavor compounds, alcoholic beverages.
- Temperature range: -20°C to 320°C.
- Equivalent to USP G28, G32 phases.

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

Rtx®-20 Structure



Rtx®-20 Columns (fused silica)
(Crossbond® 20% diphenyl/80% dimethyl polysiloxane)

ID	df (µm)	temp. limits*	15-Meter	30-Meter	60-Meter
0.25mm	0.25	-20 to 300/320°C	10320	10323	10326
	0.50	-20 to 290/310°C	10335	10338	
	1.00	-20 to 280/300°C	10350	10353	
0.32mm	0.25	-20 to 300/320°C	10321	10324	
	0.50	-20 to 290/310°C	10336	10339	
	1.00	-20 to 280/300°C	10351	10354	10357
	1.50	-20 to 270/290°C	10366	10369	
	3.00	-20 to 250/270°C	10381	10384	
0.53mm	0.25	-20 to 260/280°C	10322	10325	
	0.50	-20 to 260/280°C		10340	
	1.00	-20 to 260/280°C	10352	10355	
	3.00	-20 to 240/260°C	10382	10385	

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

similar phase

SPB-20

did you know?

Rtx®-20 columns are available with Integra-Guard™ built-in guard columns. Get the protection without the connection! See page 30 for descriptions and ordering information.

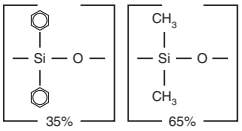
also available

MXT® Columns
Rugged, flexible, Siltek® treated stainless steel tubing; inertness comparable to fused silica tubing. See page 103 for our MXT®-20 columns.

Applied Sciences Group
Wendy Henninger, Brian Salisbury, Rick Crago, Jennifer Weston, Tom Vezza

Rtx®-35 and Rtx®-35MS

Rtx®-35 Structure



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

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

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

similar phases

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

ordering note

Rtx®-35 columns are available with Integra-Guard™ built-in guard columns. Get the protection without the connection! See **page 30** for descriptions and ordering information.

also available

MXT® Columns
Rugged, flexible, Siltek® treated stainless steel tubing; inertness comparable to fused silica tubing. See **page 104** for our MXT®-35 columns.

Rtx®-35 Amine Columns
See **page 58.**

Rtx®-35 Columns (fused silica)

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

ID	df (µm)	temp. limits*	15-Meter	30-Meter	60-Meter
0.25mm	0.25	40 to 320°C	10420	10423	
	0.50	40 to 310°C	10435	10438	
	1.00	40 to 290°C	10450	10453	10456
0.32mm	0.25	40 to 320°C	10421	10424	10427
	0.50	40 to 310°C	10436	10439	
	1.00	40 to 290°C	10451	10454	
	1.50	40 to 270/290°C	10466	10469	
	3.00	40 to 250/270°C	10481	10484	
0.53mm	0.25	40 to 260/280°C	10422	10425	
	0.50	40 to 300°C	10437	10440	
	1.00	40 to 290°C	10452	10455	
	1.50	40 to 280°C	10467	10470	
	3.00	40 to 240/260°C	10482	10485	

ID	df (µm)	temp. limits	10-Meter	20-Meter	40-Meter
0.18mm	0.20	40 to 300/320°C	40401	40402	40403
	0.40	40 to 290/310°C	40410	40411	40412

Rtx®-35MS—Low-bleed GC/MS Columns (fused silica)

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

- Column specifically tested for low bleed performance.

ID	df (µm)	temp. limits	15-Meter	30-Meter
0.25mm	0.10	40 to 320°C	14605	14608
	0.25	40 to 320/340°C	14620	14623
	0.50	40 to 310/330°C	14635	14638
	1.00	40 to 290/310°C	14650	14653
0.32mm	0.10	40 to 320/340°C	14606	14609
	0.25	40 to 320/340°C	14621	14624
	0.50	40 to 310/330°C	14636	14639
	1.00	40 to 290/310°C	14651	14654
0.53mm	0.50	40 to 300/320°C	14637	14640
	1.00	40 to 290°C	14652	14655
	1.50	40 to 280/300°C	14667	14670

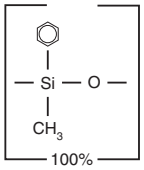
*Maximum temperatures listed are for 15- and 30-meter lengths. Longer lengths may have a slightly reduced maximum temperature.

Rtx®-50 (midpolarity phase; Crossbond® 100% methylphenyl polysiloxane)

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

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

Rtx®-50
Structure



Rtx®-50 Columns (fused silica)

(Crossbond® 100% methylphenyl polysiloxane)

ID	df (µm)	temp. limits*	15-Meter	30-Meter	60-Meter
0.25mm	0.25	40 to 300/320°C	10520	10523	10526
	0.50	40 to 290/310°C	10535	10538	10541
	1.00	40 to 280/300°C	10550	10553	10556
0.32mm	0.25	40 to 300/320°C	10521	10524	10527
	0.50	40 to 290/310°C	10536	10539	10542
	1.00	40 to 280/300°C	10551	10554	10557
0.53mm	0.25	40 to 280/300°C	10522		
	0.50	40 to 270/290°C	10537	10540	10543
	0.83	40 to 270/290°C		10569	
	1.00	40 to 260/280°C	10552	10555	10558
	1.50	40 to 250/270°C	10567	10570	10573

ID	df (µm)	temp. limits	10-Meter	20-Meter	40-Meter
0.18mm	0.20	40 to 310/330°C	40501	40502	40503
	0.40	40 to 300/320°C	40510	40511	40512

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

similar **phases**

HP-50, SPB-50, SP-2250

also **available**

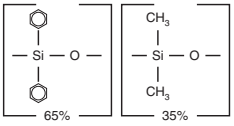
MXT® Columns
Rugged, flexible, Siltek® treated stainless steel tubing; inertness comparable to fused silica tubing. See **page 104** for our MXT®-50 columns.

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

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

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

Rtx®-65
Structure



Rtx®-65 Columns (fused silica)

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

ID	df (µm)	temp. limits	15-Meter	30-Meter
0.25mm	0.25	50 to 300°C	17020	17023
	0.50	50 to 280/300°C	17035	17038
	1.00	50 to 260/280°C	17050	17053
0.32mm	0.25	50 to 300°C	17021	17024
	0.50	50 to 280/300°C	17036	17039
	1.00	50 to 260°C	17051	17054
0.53mm	0.25	50 to 290/300°C	17022	17025
	0.50	50 to 270/290°C	17037	17040
	1.00	50 to 250/270°C	17052	17055

similar **phases**

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

also **available**

MXT® Columns
Rugged, flexible, Siltek® treated stainless steel tubing; inertness comparable to fused silica tubing. See **page 104** for our MXT®-65 columns.

also **available**

Rtx®-65TG Columns
See **page 65.**

crossbond® **technology**

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

Rtx®-440 and Stx™-500

restek **innovation**!

Julie Kowalski
Innovations Chemist
3+ years of service!

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

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

Rtx®-440 Columns (fused silica)
(intermediate-polarity proprietary Crossbond® phase)

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

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

similar **phase**

HT-8

Stx™-500 (Crossbond® carborane/dimethyl polysiloxane)

- Application-specific columns for brominated flame retardants, coplanar PCB congeners, and other analytes with high boiling temperatures.
- Low bleed—ideal for GC/FPD, GC/NPD, or GC/MS analyses.
- Stable to 380°C.
- Stx™ is used for columns that have been deactivated using Restek's Siltek® deactivation.

The Stx™-500 column gives excellent results for neutral or slightly acidic compounds. It is not recommended for analyses of basic compounds.

did you **know**?

Carborane phases are active. Active compounds may not chromatograph well with this phase.

Stx™-500 Columns (fused silica)
(Crossbond® carborane/dimethyl polysiloxane)

ID	df (µm)	temp. limits*	30-Meter	60-Meter
0.25mm	0.15	-60°C to 380°C	10750	10751
0.53mm	0.15	-60°C to 380°C	10752	

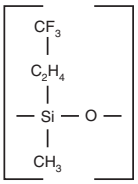
*Maximum temperatures listed are for 15- and 30-meter lengths. Longer lengths may have a slightly reduced maximum temperature.

Table of Contents for
Applications
see **pages 518-519**

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

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

Rtx®-200 Structure



Rtx®-200 columns have accomplished many difficult separations not possible on any other bonded stationary phase. Many analysts consider these the best, most inert midpolarity 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.

similar phases

DB-200, DB-210

Rtx®-200 Columns (fused silica)
(Crossbond® trifluoropropylmethyl polysiloxane)

ID	df (µm)	temp. limits*	15-Meter	30-Meter	60-Meter	105-Meter
0.25mm	0.10	-20 to 320/340°C	15005	15008	15011	
	0.25	-20 to 320/340°C	15020	15023	15026	15029
	0.50	-20 to 310/330°C	15035	15038	15041	15044
	1.00	-20 to 290/310°C	15050	15053	15056	15059
0.32mm	0.10	-20 to 320/340°C	15006	15009	15012	
	0.25	-20 to 320/340°C	15021	15024	15027	15030
	0.50	-20 to 310/330°C	15036	15039	15042	15045
	1.00	-20 to 290/310°C	15051	15054	15057	15060
	1.50	-20 to 280/300°C	15066	15069	15072	15075
0.53mm	0.10	-20 to 310/330°C	15007	15010	15013	
	0.25	-20 to 310/330°C	15022	15025	15028	
	0.50	-20 to 300/320°C	15037	15040	15043	
	1.00	-20 to 290/310°C	15052	15055	15058	
	1.50	-20 to 280/300°C	15067	15070	15073	
	3.00	-20 to 260/280°C	15082	15085	15088	15091

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

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

also available

MXT® Columns
Rugged, flexible, Siltek® treated stainless steel tubing; inertness comparable to fused silica tubing. See page 105 for our MXT®-200 columns.

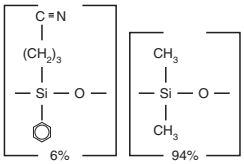
Rtx®-200MS—Low-bleed GC/MS Columns (fused silica)
(Crossbond® trifluoropropylmethyl polysiloxane)

- Column specifically tested for low bleed performance.

ID	df (µm)	temp. limits	15-Meter	30-Meter
0.25mm	0.10	-20 to 320/340°C	15605	15608
	0.25	-20 to 320/340°C	15620	15623
	0.50	-20 to 310/330°C	15635	15638
	1.00	-20 to 290/310°C	15650	15653
0.32mm	0.10	-20 to 320/340°C	15606	15609
	0.25	-20 to 320/340°C	15621	15624
	0.50	-20 to 310/330°C	15636	15639
	1.00	-20 to 290/310°C	15651	15654
0.53mm	0.50	-20 to 300/320°C	15637	15640
	1.00	-20 to 290/310°C	15652	15655
	1.50	-20 to 280/300°C	15667	15670

Rtx®-1301 and Rtx®-624

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

please note

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

also available

MXT® Columns
Rugged, flexible, Siltek® treated stainless steel tubing; inertness comparable to fused silica tubing. See **pages 105 and 107** for our MXT®-1301 and MXT®-624 columns.

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

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

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

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

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

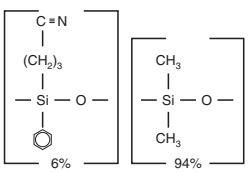
ID	df (µm)	temp. limits*	15-Meter	30-Meter	60-Meter	75-Meter	105-Meter
0.25mm	0.25	-20 to 280°C	16020	16023	16026		
	0.50	-20 to 270°C	16035	16038	16041		
	1.00	-20 to 260°C	16050	16053	16056		
	1.40	-20 to 240°C			16016		
0.32mm	0.25	-20 to 280°C	16021	16024	16027		
	0.50	-20 to 270°C	16036	16039	16042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

*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 available with Integra-Guard™ built-in guard columns. Get the protection without the connection! See **page 30** for descriptions and ordering information.

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

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

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

Rtx®-624 Columns (fused silica)

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

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

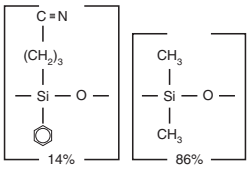
ID	df (µm)	temp. limits	10-Meter	20-Meter	40-Meter
0.18mm	1.00	-20 to 240°C		40924	40925

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

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

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

Rtx®-1701 Structure



Rtx®-1701 Columns (fused silica)

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

ID	df (µm)	temp. limits*	15-Meter	30-Meter	60-Meter	105-Meter
0.25mm	0.10	-20 to 280°C			12011	
	0.25	-20 to 280°C	12020	12023	12026	
	0.50	-20 to 270/280°C	12035	12038	12041	
	1.00	-20 to 260/280°C	12050	12053	12056	
0.32mm	0.10	-20 to 280°C		12009		
	0.25	-20 to 280°C	12021	12024	12027	
	0.50	-20 to 270/280°C	12036	12039	12042	
	1.00	-20 to 260/280°C	12051	12054	12057	12060
	1.50	-20 to 240/260°C	12066	12069	12072	
0.53mm	0.10	-20 to 270/280°C	12007			
	0.25	-20 to 270/280°C	12022	12025	12028	
	0.50	-20 to 260/270°C	12037	12040	12043	
	1.00	-20 to 250/270°C	12052	12055	12058	
	1.50	-20 to 240/260°C	12067	12070	12073	
	3.00	-20 to 230/250°C	12082	12085	12088	

ID	df (µm)	temp. limits	10-Meter	20-Meter	40-Meter
0.10mm	0.10	-20 to 280°C	42201	42202	
0.18mm	0.20	-20 to 280°C	42001	42002	42003
	0.40	-20 to 270/280°C	42010	42011	42012

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

similar phases

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

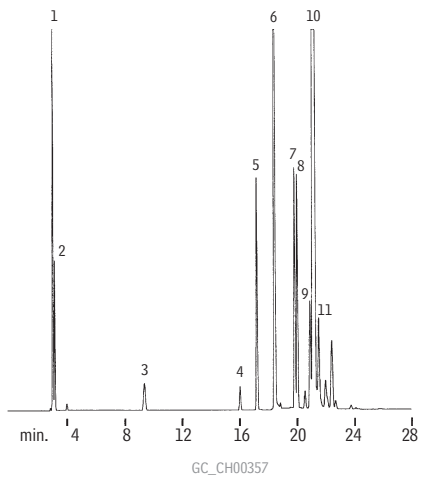
please note

Rtx®-1701 columns are available with Integra-Guard™ built-in guard columns. Get the protection without the connection! See **page 30** for descriptions and ordering information.

also available

MXT® Columns
Rugged, flexible, Siltek® treated stainless steel tubing; inertness comparable to fused silica tubing. See **page 105** for our MXT®-1701 columns.

Styrene impurities on an Rtx®-1701 column.



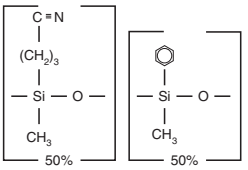
1. 1,3-butadiene
2. butene
3. acrylonitrile
4. diethylhydroxylamine
5. toluene
6. vinylcyclohexene
7. ethylbenzene
8. *m*-xylene
9. *o*-xylene
10. styrene
11. cumene

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

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

Rtx®-225

Rtx®-225 Structure



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

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

The cyanopropyl-containing Rtx®-225 phase is slightly less polar than bonded polyethylene glycol (PEG) phases, but it can be used for many of the same applications. Some popular applications for the Rtx®-225 column are analyses of fatty acid methyl esters (FAMES), sugar derivatives, and food and flavor compounds.

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.

similar phases

DB-225, HP-225, SPB-225

Rtx®-225 Columns (fused silica)

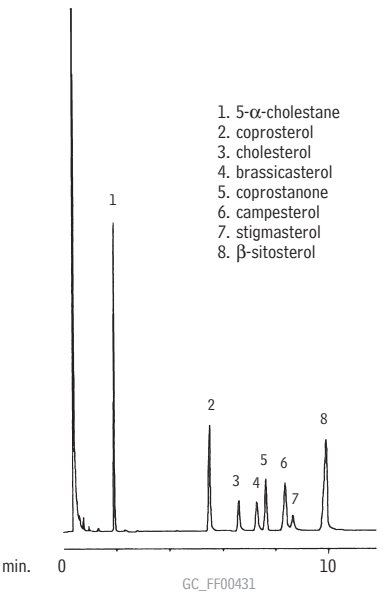
(Crossbond® 50% cyanopropylmethyl/50% phenylmethyl polysiloxane)

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

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

Scott Grossman
Innovations Chemist
1+ years of service!

Neutral sterols resolved on an Rtx®-225 column.



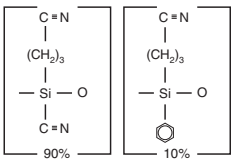
1. 5-α-cholestane
2. coprosterol
3. cholesterol
4. brassicasterol
5. coprostanone
6. campesterol
7. stigmasterol
8. β-sitosterol

Column:	Rtx®-225, 15m, 0.25mm ID, 0.25µm (cat.# 14020)
Inj.:	1.5µL split injection of neutral sterols and phytosterols, 200ng on-column
Oven temp.:	260°C
Inj./det. temp.:	260°C
Carrier gas:	helium
Linear velocity:	45cm/sec. set @ 240°C
FID sensitivity:	8 x 10^{-11}AFS
Split ratio:	30:1

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

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

Rt™-2330 Structure



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

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

Rt™-2330 Columns (fused silica)
(90% biscyanopropyl/10% phenylcyanopropyl polysiloxane)

ID	df (µm)	temp. limits*	15-Meter	30-Meter	60-Meter	105-Meter
0.25mm	0.10	0 to 260/275°C	10705	10708	10711	10714
	0.20	0 to 260/275°C	10720	10723	10726	10729
0.32mm	0.10	0 to 260/275°C	10706	10709	10712	10715
	0.20	0 to 260/275°C	10721	10724	10727	10730
0.53mm	0.10	0 to 260/275°C	10707	10710	10713	
	0.20	0 to 260/275°C	10722	10725	10728	

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

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

similar phases

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

Doing Dioxin Analysis?
Rtx®-Dioxin and Rtx®-Dioxin2 columns provide better resolution and higher maximum temperatures than conventional columns. See **pages 84 and 83**.

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

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

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

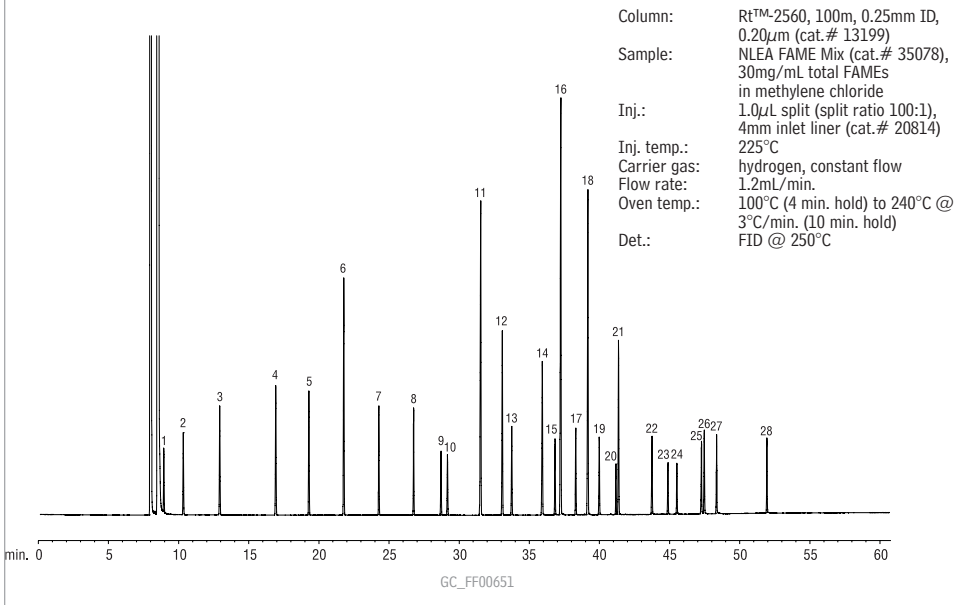
Rt™-2560 Column (fused silica)
(biscyanopropyl polysiloxane)

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

similar phases

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

NLEA FAMEs resolved on an Rt™-2560 column.



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

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

Rtx®-Wax

a plus 1 story

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

Steve Rowlands, Quest International (Kent UK)

similar phases

DB-WAX, HP-Wax

free literature

Selection Guide for Polar Wax GC Column Phases

- Performance information about six polyethylene glycol (PEG) columns.

- Applications for each column.

Download your free copy from www.restek.com.

Technical Guide
lit. cat.# 59890

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

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

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

Rtx®-Wax Columns (fused silica)

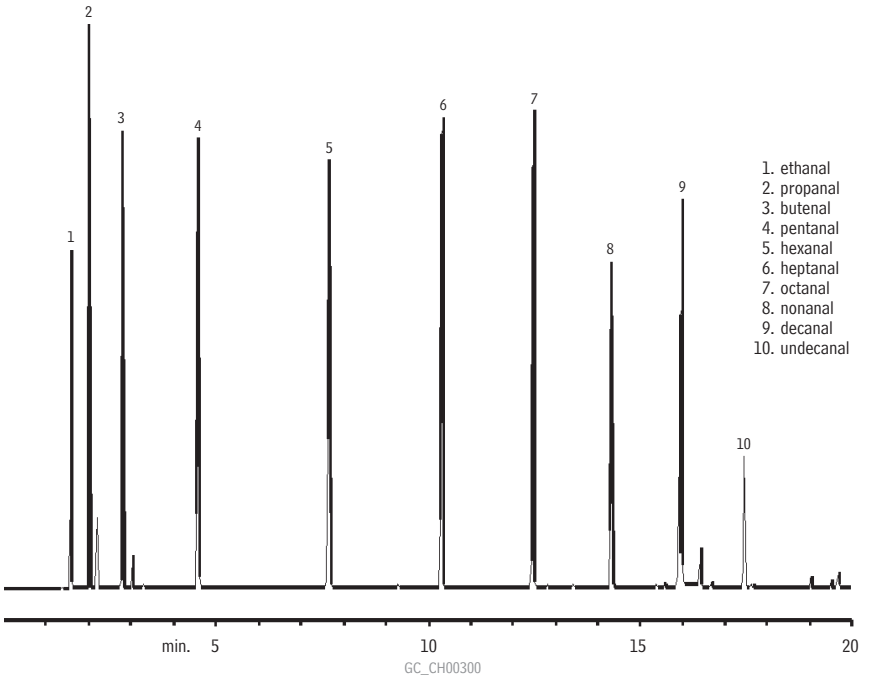
(Crossbond® Carbowax® polyethylene glycol)

ID	df (µm)	temp. limits*	15-Meter	30-Meter	60-Meter
0.25mm	0.10	20 to 250°C	12405	12408	
	0.25	20 to 250°C	12420	12423	12426
	0.50	20 to 250°C	12435	12438	12441
0.32mm	0.10	20 to 250°C	12406	12409	
	0.25	20 to 250°C	12421	12424	12427
	0.50	20 to 250°C	12436	12439	12442
	1.00	20 to 240/250°C	12451	12454	12457
0.53mm	0.25	20 to 250°C	12422	12425	
	0.50	20 to 250°C	12437	12440	12443
	1.00	20 to 240/250°C	12452	12455	12458

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

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

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



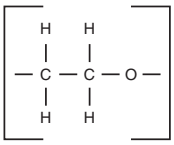
Column:	Rtx®-Wax, 30m, 0.25mm ID, 0.50µm (cat.# 12438)
Inj.:	split injection of C2-C11 aldehydes mixture
On-column conc.:	250ng
Oven temp.:	40°C (hold 5 min.) to 200°C @ 10°C/min.
Inj./det. temp.:	200°C
Carrier gas:	hydrogen
Linear velocity:	35cm/sec. set @ 40°C
FID sensitivity:	82 x 10^{-11} AFS
Split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

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

- General purpose columns for FAMEs, flavor compounds, essential oils, solvents, xylene isomers, US EPA Method 603 (acrolein/acrylonitrile).
- Resistant to oxidative damage.
- Temperature range: 40°C to 250°C.
- Equivalent to USP G14, G15, G16, G20, G39 phases.

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

Stabilwax® Structure



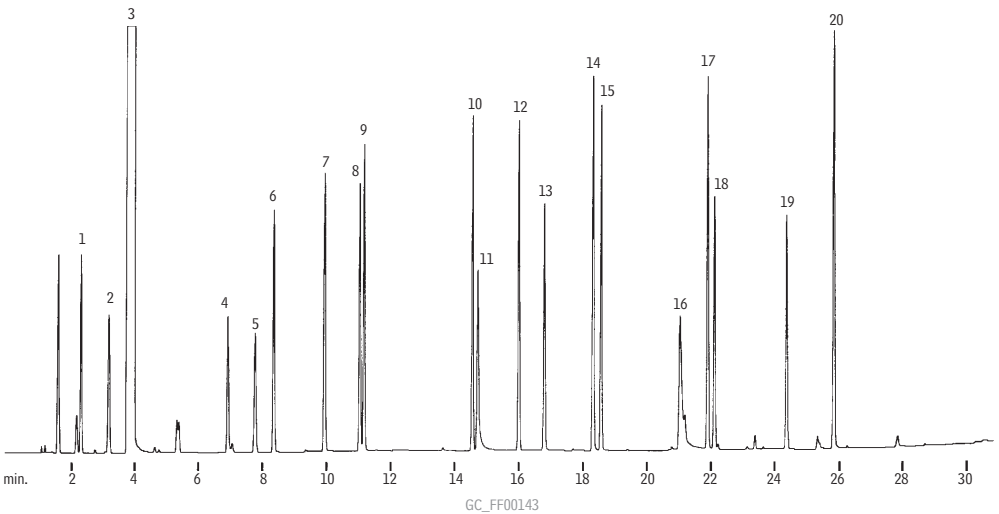
Stabilwax® Columns (fused silica)

(Crossbond® Carbowax® polyethylene glycol)

ID	df (µm)	temp. limits	15-Meter	30-Meter	30-Meter 6/pk.	60-Meter
0.25mm	0.10	40 to 250°C	10605	10608		10611
	0.25	40 to 250°C	10620	10623		10626
	0.50	40 to 250°C	10635	10638		10641
0.32mm	0.10	40 to 250°C	10606	10609		10612
	0.25	40 to 250°C	10621	10624		10627
	0.50	40 to 250°C	10636	10639		10642
	1.00	40 to 240/250°C	10651	10654	10654-600	10657
0.53mm	0.10	40 to 250°C	10607	10610		10613
	0.25	40 to 250°C	10622	10625		10628
	0.50	40 to 250°C	10637	10640		10643
	1.00	40 to 240/250°C	10652	10655	10655-600	10658
	1.50	40 to 230/240°C	10666	10669		10672
	2.00	40 to 220/230°C	10667	10670		

Synthetic mushroom aroma on a Stabilwax® column.

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



GC_FF00143

Column:	Stabilwax®, 30m, 0.32mm ID, 1.0µm (cat.# 10654)
Inj.:	1.0µL split injection of a synthetic mushroom aroma
Conc.:	10ng per component
Oven temp.:	40°C to 220°C @ 6°C/min.
Inj./det. temp.:	260°C
Carrier gas:	hydrogen
Linear velocity:	40cm/sec.
FID sensitivity:	4 x 10^{-11} AFS
Split ratio:	100:1

similar phases

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

ordering note

Stabilwax® columns are available with Integra-Guard™ built-in guard columns. Get the protection without the connection! See **page 30** for descriptions and ordering information.

also available

MXT® Columns

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