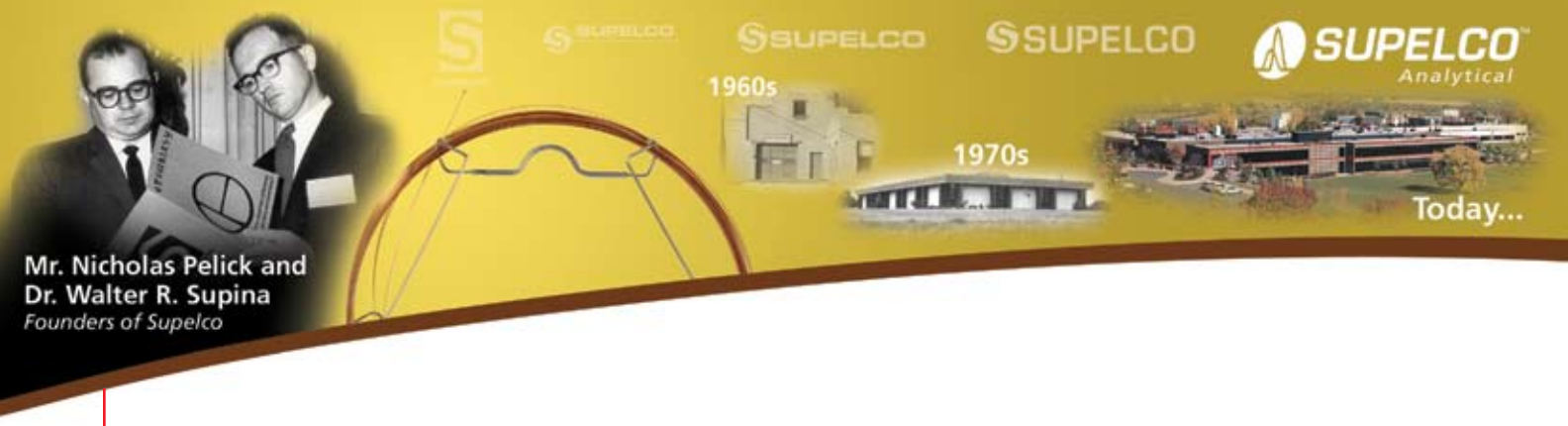
GC Column Selection Guide

Achieve Optimal Method Performance

SUPELCO™ Analytical

- Performance
- Reliability
- Service

SIGMA-ALDRICH™



The History of Supelco and the Capillary Column

Supelco began in 1966 in a tiny garage in a small central Pennsylvania (USA) town manufacturing packed gas chromatography (GC) columns. Walt Supina and Nick Pelick knew exactly what they wanted to do, make quality products that serve customers' needs, back every product with excellent technical service, and maintain steady growth by creating new products through a strong research and development program. By 1977, glass capillary GC columns were being manufactured and in 1982, production began on fused silica capillary GC columns.

Supelco has had a long history of providing specialty products for specific applications. In 1983, the first special purpose fused silica capillary GC column was introduced. Since then, an impressive list of special purpose fused silica capillary GC columns has followed.

Supelco is still dedicated to the development of leading-edge technology to meet the needs of our customers. We strive to demonstrate the belief that our customers' needs come first. Our goal is to offer only the finest products, backed by the most reliable technical service offered anywhere in the world. That was our philosophy in the beginning, and with over forty years in business, it remains our philosophy today.

Providing total customer fulfillment through the quality of our product and service is reflected in our ISO 9001 registration. We test every capillary column we manufacture according to strict quality assurance processes, and guarantee satisfactory performance.

Year Introduced	Special Purpose Fused Silica Capillary GC Column
1983	SP™-2560
1984	SPB™-608, SUPELCOWAX™ 10
1985	SP-2331
1986	VOCOL™
1987	Sup-Herb™, Nukol™, SP-2380
1988	Petrocol™ DH
1989	Petrocol DH 150, Petrocol 2887
1990	Omegawax™ 320, Petrocol DH 50.2
1991	Omegawax 250, SPB-1 SULFUR, Petrocol EX2887, Carbowax Amine
1993	α-DEX™ 120, β-DEX 110, γ-DEX 120, SAC™-5, TCEP
1994	SPB-Octyl, β-DEX 120, OVI-G43, Carboxen™-1006 PLOT, Mol Sieve 5A PLOT, Supel-Q™ PLOT, SCOT Columns
1995	SPB-624, SPB-PUFA, Petrocol DH Octyl, PTA-5
1996	α-DEX 225, β-DEX 225, γ-DEX 225, α-DEX 325, β-DEX 325, γ-DEX 325, Omegawax 530, SPB-1000
1997	SPB-HAP, Carboxen-1010 PLOT
2003	Equity® 1701, Alumina chloride PLOT, Alumina sulfate PLOT
2005	SLB™-5ms
2007	Astec CHIRALDEX™, Omegawax 100

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How to Use this Guide

This brochure was assembled to provide the gas chromatographer a valuable resource. Novice and expert users alike should both find this reference guide useful.

An optimized chromatographic separation begins with selecting the proper column. A section explaining **how to choose a capillary column** (page 4) is included in this brochure. Step-by-step instructions cover topics such as proper phase selection, the importance of phase polarity, non-bonded versus bonded phases, column internal diameter (I.D.), film thickness considerations, phase ratio (β), and column length.

Want additional information beyond what this brochure provides? Listings of **Supelco product literature and additional reading** (page 7) recommend many published GC articles written by gas chromatography experts and researchers.

The main purpose of this brochure is to assist the chromatographer in identifying the proper column phase for their application. This can be accomplished by referring to the twelve easy-to-read **column phase selection guides** (page 8). These guides detail common applications performed in ten distinct industries plus two applications that are independent of any industry.

Need to switch to a Supelco column from a column from a different manufacturer? A **cross-reference chart** (page 15) will be helpful. This chart list Supelco columns along with comparable columns from several other manufacturers.

Looking for information or specifications for a particular phase? A section on **capillary column phases** (page 16) includes many of the most popular phases and provides application, USP code, polymer, and temperature limit information. This section is organized primarily in order of increasing phase polarity to assist in phase selection when performing method development.

A brief listing of the most commonly replaced **injection port items** (page 22) is included. Routinely performing preventative maintenance is the surest way to maximize the performance of your GC system.

Additionally, **Supelco Technical Service** chemists are a valuable resource for providing guidance with the selection and use of capillary columns. Supelco Technical Service can be reached at 800-359-3041 (US and Canada only), 814-359-3041, or at *techservice@sial.com*

How to Choose a Capillary Column

An optimized chromatographic separation begins with the column. The selection of the proper capillary column for any application should be based on four significant factors: stationary phase, column I.D., film thickness, and column length. The practical effects of these factors on the performance of the column are discussed briefly on the next few pages, in order of importance. Note that this information is general. Specific situations may be exceptions to these guidelines.

This section should make choosing the best capillary column for an application an easier process. To obtain additional information, contact Supelco Technical Service at 800-359-3041 (US and Canada only), 814-359-3041, or at *techservice@sial.com*

Stationary Phase

Choosing a stationary phase is the most important step in selecting a column. A stationary phase is the polymeric film coated on the inner wall of a capillary column and should be chosen based on the application to be performed. The differences in the chemical and physical properties of an injected organic compound and its interaction with the stationary phase are the basis of the separation process. When the energy of the analyte-phase interactions differs significantly for two compounds, one is retained longer than the other. How long they are retained in the column (retention time) is a measure of the analyte-phase interactions.

Changing the chemical features of the polymeric stationary phase alters its physical properties. Two compounds that co-elute (do not separate) on a particular stationary phase might separate on another phase of a different polarity, if the difference in the analyte-phase interactions is significant. This is the reason for providing a wide variety of capillary column phases. Each phase provides a specific combination of interactions for each class of chemical analytes.

The phase selection charts on pages 8 to 14 are conveniently arranged by industry to simplify the process of selecting the proper phase. First, find the chart that matches your industry. Then, locate the application within that industry to identify a recommended column phase.

The stationary phase also dictates the minimum and maximum temperatures at which a column can be used. Therefore, it is critical to ensure the selected stationary phase can withstand the temperature requirements of the GC method. Temperature limitations can be located in the capillary column phase section on pages 16 to 21.

Phase Polarity

This is the single most important characteristic in selecting a capillary column because it dictates selectivity, or the ability of the column to separate sample components. Phase selection is based on the general chemical principle that "likes dissolves like." A non-polar column is best for the analyses of non-polar compounds. Polar columns most effectively separate polar compounds.

Non-polar compounds are generally composed only of carbon and hydrogen atoms and contain carbon-carbon single bonds. Normal hydrocarbons (n-alkanes) are the most common non-polar compounds analyzed by capillary gas chromatography. Non-polar capillary columns separate these compounds very well. Interaction between non-polar compounds and a non-polar phase are dispersive, meaning that they are governed by Van der Waals forces. These are intermolecular attractions that increase with the size of the compound. Thus, larger compounds with higher boiling points have longer retention. Elution order is based on the boiling points of the compounds.

Polar compounds are composed primarily of carbon and hydrogen atoms, but also contain one or more atoms of bromine, chlorine, fluorine, nitrogen, oxygen, phosphorus, or sulfur. Alcohols, amines, carboxylic acids, diols, esters, ethers, ketones, and thiols are typical polar compounds analyzed by capillary GC. Intermediate polarity or polar capillary columns separate these compounds well. In addition to dispersive interactions, interactions between polar compounds and the phase include dipole, pi-pi, and/or acid-base interactions. Separations are determined by differences in the overall effects of these interactions.

Polarizable compounds are compounds composed of carbon and hydrogen, but contain one or more double or triple carbon-carbon bonds. These compounds include alkenes and aromatic (benzene-ring containing) hydrocarbons. High polarity capillary columns are generally used to separate these compounds.

Phase Polarity Based on Compound Polarity

Compound Polarity	Compound Examples	Recommended Phases
Non-Polar		
C and H atoms only C-C bonds	alkanes	Petrocol, SPB-Octyl, Equity-1, SPB-1, SLB-5ms, Equity-5, SPB-5
Polar		
Primarily C and H atoms; Also contain Br, Cl, F, N, O, P, S	alcohols, amines, carboxylic acids, diols, esters, ethers, ketones, thiols	SPB-624, OVI-G43, VOCOL, SPB-20, SPB-35, Equity-1701, SPB-50, SPB-225, PAG, Omegawax, SPB-1000, Nukol, SUPELCOWAX 10
Polarizable		
C and H atoms only C=C or C≡C bonds	alkenes, alkynes, aromatic hydrocarbons	SP-2330, SP-2331, SP-2380, SP-2560, SP-2340, TCEP

Bonded/Non-Bonded Phases

Bonded phases are immobilized/chemically bonded (crosslinked) within the tubing, while non-bonded phases are simply coated on the wall. Generally a bonded phase is preferred, because it has less bleed during use, can be used to higher temperatures, and, when necessary, can be rinsed with solvents to remove accumulated non-volatile materials. When a bonded phase is not available, such as for the high polarity phases, look for a stabilized phase. These phases are not as permanent as bonded phases (cannot be rinsed), but have greater thermal stability than non-bonded phases. For some applications, the only choice is a non-bonded phase. In these instances, extra care must be taken so the maximum temperature limit is not exceeded.

Column I.D.

The current range of commercially available capillary column internal diameters enables the balancing of two factors: efficiency (i.e. number of theoretical plates) and sample capacity (i.e. the amount of any one sample component that can be applied to the column without causing the desired sharp peak to overload). Maximizing one of these factors requires a sacrifice from the other. The ideal I.D. for a given application is dependent on the analytical needs.

Maximum efficiency (peak sharpness and analyte resolution) is achieved with narrow bore columns (0.10 to 0.18 mm I.D.). If the sample to be analyzed contains many compounds, or has compounds eluting closely together, then a column with great efficiency is desirable. Note that these columns may require specialized equipment, such as a pressure regulator that allows greater column head pressure. Another benefit of narrow bore columns is that they allow Fast GC to be performed (see *Fast GC Brochure* inset on right), maximizing sample throughput without sacrificing quality.

Maximum capacity is provided from wide bore columns (0.53 mm I.D.). If the samples to be analyzed contain compounds at high concentrations, or represent a wide range of concentrations, then a column with great capacity is best. These columns provide sufficient sensitivity to obtain peaks for the minor components without being overloaded with the major components. The analyst must decide if the loss in efficiency resulting from using a wide bore column is problematic for their application. Wide bore columns can be used without sample splitting devices. Note that the nature of the sample components and the phase polarity affect sample capacity. Non-polar phases have higher capacities for non-polar analytes, and polar phases have higher capacities for polar analytes.

The use of 0.20 to 0.32 mm I.D. columns allows a **compromise between efficiency and capacity.** This is represented in Table 1. Hence, 0.25 mm proves to be the most popular I.D. for capillary GC columns. Columns with a smaller or larger I.D. allow the user to maximize either efficiency or capacity, based on the requirements of their application.

Table 1. Effects of Column I.D.

Internal Diameter (mm)	Efficiency: Plates/Meter (N/m)	Efficiency: Total Plates (N)	Capacity Each Analyte (ng)
0.53	1,300	39,000	1000-2000
0.32	2,300	69,000	400-500
0.25	2,925	87,750	50-100
0.20	3,650	109,500	<50
0.18	4,050	121,500	<50
0.10	7,300	219,000	<10

Theoretical values for 30 m long columns, calculated @ a k' = 6.00 and 85% coating efficiency

Film Thickness

As shown in Table 2, the benefits of decreasing film thickness are that peak shapes will sharpen (may lead to increased resolution) and that column bleed will be reduced, resulting in increased signal-to-noise. Additionally, the column's maximum allowable operating temperature (MAOT) will be increased. The drawbacks are that analytes will interact more freely with the tubing wall and that analyte capacity is decreased. Decreasing film thickness also allows analytes to elute with shorter retention times and at lower temperatures. Depending on the application, these last effects may be either desirable or undesirable.

Fast GC Brochure

The brochure *"Fast GC: A Practical Guide for Increasing Sample Throughput without Sacrificing Quality"* (T407096 JTW) contains valuable information concerning Fast GC principles that is not covered in this space. Included are practical considerations, theoretical discussions, a listing of columns in Fast GC dimensions, twenty-six chromatograms, a listing of related products designed to maximize performance, plus a list of literature for additional reading. A copy of this brochure can be obtained at no-charge by contacting Supelco Technical Service at 800-359-3041 (US and Canada only), 814-359-3041, or at **techservice@sial.com**

A column with a film thickness of 0.10 to 0.25 µm should be used for analytes with high (>300 °C) boiling points (such as pesticides, PCBs, FAMEs, phthalate esters, and other semivolatile compounds) or for trace analyses.

The benefits of increasing the film thickness are that analyte interaction with the tubing wall will be reduced and that analyte capacity will be increased. The drawbacks of increasing the film thickness are that peak width will be increased (may reduce resolution), column bleed will be greater, and that the MAOT will be reduced. Increasing film thickness also leads to increased analyte retention times (may also increase resolution, specifically for compounds with low k') and increased temperature at which an analyte will elute from the column. Depending on the application, these last effects may be either desirable or undesirable.

A column with a film thickness of 1 to 5 µm is best suited for analytes with low boiling points (such as volatile organic compounds and gases). This is because these analytes are retained longer on the thicker film, possibly eliminating the need to use cryogenics. The higher sample capacity of thick film columns may reduce sample overloading (peaks that broaden or front) for highly concentrated components.

Phase Ratio (β)

Effects of phase film thickness are interdependent with column I.D. The phase ratio, beta (β), expresses the ratio of the gas volume and the stationary phase volume in a column:

$$\beta = \frac{\text{column radius (µm)}}{\text{2 x film thickness (µm)}}$$

In contrast to relative terms ("thick film" and "thin film"), β values establish a distinct ranking for columns. As a general rule, select columns by β values as follows:

β Value	Uses
<100	Highly volatile, low molecular weight compounds
100-400	General purpose analyses Wide range of compounds
>400	High molecular weight compounds Trace analyses

β values are also useful when changing column I.D. and film thickness combinations for a particular analysis, because columns with the same phase ratio will provide very similar retention times and elution order under the same analytical conditions.

Columns With Similar β Values

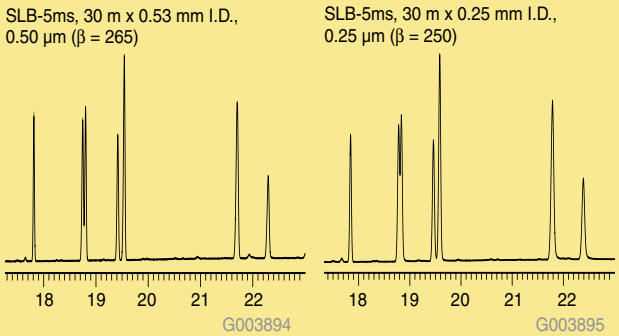


Table 2. Effects of Film Thickness

	0.10 to 0.25 µm film	1 to 5 µm film
Benefits	Sharper peak shape May increase resolution Decreased column bleed Increased signal-to-noise Increased MAOT	Reduced interaction w/tubing Increased analyte capacity
Drawbacks	Increased interaction w/tubing Decreased analyte capacity	Increased peak width May decrease resolution Increased column bleed Decreased MAOT
Other	Decreased retention Decreased elution temp.	Increased retention May increase resolution Increased elution temperature
Uses	High boiling point analytes Semivolatiles Trace analyses	Low boiling point analytes Volatiles, gases High analyte concentrations

Column Length

The last of the four significant factors to consider when selecting a column is column length. A longer column will provide greater resolution than a shorter column. However, there are practical limits to increasing column length. With an isothermal analysis, a 60 m column does in fact increase resolution by almost 40%, relative to a 30 m column (resolution increases according to the square root of the column length), but will increase the analysis time and also the pressure required to move the sample through the column. Selecting a column length is a compromise between speed and low pressure on one side and resolution on the other. Table 3 summarizes the effects of column length on various performance and operating parameters of 0.25 mm I.D. columns.

It should be stressed that doubling column length will NOT double resolution (resolution increases according to the square root of the column length). If resolution between a critical pair is less than 1, doubling column length will not bring it to baseline (resolution value of at least 1.5). Increasing column length to increase resolution should be a last resort.

A 15 m, or shorter, column can be used when great resolution is not required, such as for screening purposes or for simple samples whose components are dissimilar in chemical nature. Note that decreasing column I.D. to offset the low resolution provided by short columns can be done to allow Fast GC to be performed (see *Fast GC Brochure* inset on page 5), maximizing sample throughput without sacrificing quality.

Generally a 30 m column provides the best balance of resolution vs. analysis time and column pressure. Note that a 30 m column with a thicker film may be as useful as a 60 m column for analyzing difficult samples.

Use a 60 m column when higher resolution is required. Samples that are more complex or volatile (gases at room temperature) or samples containing analytes that may elute very closely together (e.g., isomers) are commonly analyzed on 60 m long columns.

Very long, 100 m or longer, columns are also available for use when there is a need for extreme resolving ability for highly complex samples (such as gasoline). Longer columns also reduce the optimum linear velocity for an analysis.

Table 3. Effects of Column Length

Column Length (m)	Inlet Pressure (psi)	Peak 1 Retention (min)	Peak 1/2 Resolution (R)	Efficiency: Total Plates (N)
15	5.9	8.33	0.8	43,875
30	12.0	16.68	1.2	87,750
60	24.9	33.37	1.7	175,500

Theoretical values for 0.25 mm I.D. columns with 85% coating efficiency, 145 °C isothermal analyses, helium at 21 cm/sec, k'(peak 1) = 6.00

Fused Silica Tubing Inner/Outer Diameters

Tubing I.D.	Tubing I.D. Range	Tubing O.D. Range
0.10 mm ▲	0.094 – 0.106 mm	0.349 – 0.369 mm
0.10 mm ▼	0.094 – 0.106 mm	0.290 – 0.310 mm
0.18 mm ▲	0.174 – 0.186 mm	0.349 – 0.369 mm
0.18 mm ▼	0.174 – 0.186 mm	0.330 – 0.350 mm
0.20 mm ◆	0.194 – 0.206 mm	0.349 – 0.370 mm
0.25 mm ◆	0.244 – 0.256 mm	0.349 – 0.370 mm
0.32 mm ◆	0.314 – 0.326 mm	0.425 – 0.450 mm
0.53 mm ◆	0.526 – 0.546 mm	0.640 – 0.680 mm
0.75 mm ◆	0.737 – 0.758 mm	0.875 – 0.925 mm

▲ Analytical columns with non-polar or intermediate polarity stationary phases.

▼ Analytical columns with polar stationary phases. Guard columns regardless of deactivation.

◆ Analytical columns regardless of polarity. Guard columns regardless of deactivation.

Product Literature

The following list of Supelco-published literature provides additional GC column information. To obtain any of these literature pieces at no-charge, either visit our web site at sigma-aldrich.com/gc, or contact Supelco Technical Service at 800-359-3041 (US and Canada only), 814-359-3041, or at *techservice@sial.com*

Title	Identification
GC Column Literature	
SLB-5ms Capillary GC Columns	T405130 (IKA)
Dioxin & PCB Analysis	(JXB)
Petroleum/Chemical Application Guide	T109858 (AYD)
Alumina PLOT Capillary GC Columns	T403145 (GFE)
Carboxen PLOT Capillary GC Columns	T403146 (GFF)
Mol Sieve 5A PLOT Capillary GC Columns	T403147 (GFG)
Supel-Q PLOT Capillary GC Columns	T403148 (GFH)
Analyzing Fatty Acids by Capillary GC	T110855 (AYC)
37-Component FAME Mix on Four Capillary Columns	T196907 (AZC)
Capillary Column Choices for Residual Solvents	T103933 (FLX)
Astec CHIRALDEX Chiral Capillary GC Columns	T407123 (JCH)
Chiral Cyclodextrin Capillary GC Columns	T194877 (AXA)
Supelco Columns for USP Methods (Poster)	T403109 (FWK)
Fast GC Brochure	T407096 (JTW)
Equity Capillary GC Columns	T402049 (FAQ)
General Purpose Non-Polar Capillary GC Columns	T405132 (IKC)
General Purpose Polar Capillary GC Columns	T405131 (IKB)
General Purpose Intermediate Polarity Capillary GC Columns	T405133 (IKD)
Capillary GC Troubleshooting Guide	T112853 (AIP)
Installation/Maintenance of 0.25 & 0.32 mm I.D. Columns	T195895 (DLV)
Installation/Maintenance of 0.53 mm I.D. Columns	T195897
Packed GC Column Application Guide	T195890 (AYT)
Sulfur Gases by Packed GC	T100722 (AXP)
Permanent Gases and Light Hydrocarbons by Packed GC	T396112 (BYL)
Packed GC Troubleshooting Guide	T109792 (AIS)

Title	Identification
Related Product Literature	
GC Accessories and Gas Purification/Management	T407103 (JWE)
Capillary Injector Products for Agilent Technologies GCs	T401027 (DWM)
Molded Thermogreen LB-2 Septa	T407082 (JQV)
Ferrules and Fittings for Packed and Capillary GC	T100741 (AXR)
Capillary GC Inlet Liner Selection Guide	T196899 (BBB)
Selecting The Appropriate Inlet Liner (Poster)	T404081 (HCH)
The Supelco Guide to Leak-Free Connections	T100741 (AXR)
Selecting Purifiers for Gas Chromatography	T197918 (BIT)
Gas Management Systems for GC	T196898 (AYW)
Gas Generators	T407110 (JXP)
Purge-and-Trap Troubleshooting Guide	T197916 (BIN)
A Tool for Selecting an Adsorbent for Thermal Desorption	T402025 (EQF)
Carbon Adsorbent Kits	T406044 (IPS)
Syringes for Chromatographic & Analytical Applications	T406108 (JCS)
Vials	(IXH)
Vial Selection Guide (Poster)	T405074 (IBV)
Supelco Solid Phase Extraction Products	T402150 (FEB)
Discovery Ag-Ion SPE for cis/trans FAME Fractionation	T406062 (IRV)
Solid Phase Microextraction Application Guide (CD-ROM)	T199925 (CJQ)
SPME: Theory and Optimization of Conditions	T198923 (BQT)
Solid Phase Microextraction Troubleshooting Guide	T101928 (EDV)
A Practical Guide to Quantitation with SPME	T101929 (EDW)
Analytical Standards	(GVQ)
Analytical Standards Searchable Guide (CD-ROM)	(HWP)
Guide to Derivatization Reagents for GC	T196909 (BGL)

Additional Reading

The following is a list of GC literature written by gas chromatography experts and researchers. Consult these references to learn more about the many facets of gas chromatography.

1. Harold McNair and James Miller, "Basic Gas Chromatography" (1997), Wiley, ISBN 0-471-17261-8.
2. David Grant, "Capillary Gas Chromatography" (1996), Wiley, ISBN 0-471-95377-6.
3. Dean Rood, "A Practical Guide to the Care, Maintenance, and Troubleshooting of Capillary Gas Chromatographic Systems" (1991), Hüthig, ISBN 3-7785-1898-4.
4. Konrad Grob, "Split and Splitless Injection in Capillary GC" (1993), Hüthig, ISBN 3-7785-2151-9.
5. Konrad Grob, "On-Column Injection in Capillary Gas Chromatography" (1991), Hüthig, ISBN 3-7785-2055-5.
6. William McFadden, "Techniques of Combined Gas Chromatography/Mass Spectrometry: Applications in Organic Analysis" (1988), Robert E. Krieger Publishing Company, ISBN 0-89464-280-4.
7. Marvin McMaster and Christopher McMaster, "GC/MS: A Practical User's Guide" (1998), Wiley-VCH, ISBN 0-471-24826-6.
8. Janusz Pawliszyn, "Solid Phase Microextraction: Theory and Practice" (1997), Wiley-VCH, ISBN 0-471-19034-9.

Column Selection by Industry

Supelco has developed the most extensive line of special purpose columns designed for industry specific applications. These columns are manufactured to deliver high resolution, great analyte response, low bleed, and long column life; allowing analysts to achieve the analytical performance they require. The easy-to-read phase selection charts on the next several pages are conveniently arranged by industry to simplify the process of selecting the proper phase. First, find the chart that matches your industry. Then, locate the application within that industry to identify a recommended phase.

The stationary phase also dictates the minimum and maximum temperatures at which a column can be used. Therefore, it is critical to ensure the selected stationary phase can withstand the temperature requirements of the GC method. Temperature limitations can be located in the capillary column phase section on pages 16 to 21.

Environmental Industry

The environmental columns offered here can be used with many specific methods for the analyses of volatiles, semivolatiles, pesticides, PCBs, herbicides, and dioxins.

Supelco GC Columns for the **Environmental Industry**

	GC-MS Volatiles	GC Volatiles	GC-MS Semivolatiles	GC Semivolatiles	GC-MS Dioxins	GC-MS PCB Congeners	GC-MS PBDE Congeners	Toxic Organics - TO-1/TO-2	Toxic Organics - TO-4/TO-10	Toxic Organics - TO-9	Toxic Organics - TO-13	Toxic Organics - TO-14/TO-15/TO-17	Hazardous Air Pollutants
SPB-Octyl						■							
SPB-HAP													■
Equity-1								■				■	
SLB-5ms			■	■	■	■	■		■	■	■		
SPB-624	■	■											
VOCOL	■	■											
SPB-608				■					■				
Sup-Herb				■									
Equity-1701				■					■				
SPB-50				■									
SPB-225					■					■			
SP-2331					■					■			

Industrial Hygiene Industry

These columns can be used with methodologies for determining indoor air quality as well as outdoor organic compounds.

Supelco GC Columns for the **Industrial Hygiene Industry**

	Indoor Air Quality - EPA IP-8	Indoor Air Quality - NIOSH 1003	Indoor Air Quality - NIOSH 1403	Indoor Air Quality - NIOSH 1500/1501	Indoor Air Quality - NIOSH 2530	Indoor Air Quality - NIOSH 2542	Indoor Air Quality - NIOSH 5503	Indoor Air Quality - OSHA 53	Indoor Air Quality - OSHA 56	Indoor Air Quality - OSHA 62	Indoor Air Quality - OSHA 80	Toxic Organics - TO-1/TO-2	Toxic Organics - TO-4/TO-10	Toxic Organics - TO-9	Toxic Organics - TO-13	Toxic Organics - TO-14/TO-15/TO-17	Hazardous Air Pollutants
SPB-HAP																	■
Equity-1			■	■		■		■		■						■	
SLB-5ms	■				■		■		■			■	■	■			
VOCOL		■															
SPB-608												■					
Equity-1701												■					
SPB-225														■			
SUPELCOWAX 10									■								
SP-2331														■			

Pharmaceutical Industry

Use these columns for analyses of residual solvents, basic drugs, small chiral molecules of interest to this industry, and for methods following specific monographs.

Supelco GC Columns for the **Pharmaceutical Industry**

	Residual Solvents [USP <467>]	Oxygen containing analytes in the form of alcohols, ketones, acids, aldehydes, and lactones; halogenated compounds	Aliphatic and aromatic amines; aliphatic and some aromatic esters; polar racemates	Lactones and aromatic amines; epoxides; styrene oxide	Amino acids; amines; furans	Aliphatic, olefenic, and aromatic enantiomers	Terpenes and tertiary amines	Heterocyclic amines	Xylenes, menthols, cresols, substituted phenols, substituted benzenes, epoxide enantiomers	Acids, alcohols, amines, diols, esters, ethers, halohydrocarbons, hydrocarbons, ketones, positional isomers, silanes, terpenes, terpineols	α-BHC, carvone, carboxylic acids, methamphetamine	Basic Compounds	Individual USP/NF Monographs
PTA-5												■	
Equity-5	■												
OVI-G43	■												
Carbowax Amine												■	
SUPELCOWAX 10	■												
Various Cap. Columns													■
Astec CHIRALDEX TA		■											
Astec CHIRALDEX DP			■										
Astec CHIRALDEX PN				■									
Astec CHIRALDEX BP					■								
Astec CHIRALDEX DM						■							
Astec CHIRALDEX PM							■						
Astec CHIRALDEX DA								■					
Astec CHIRALDEX PH						■							
Supelco α-DEX									■				
Supelco β-DEX										■			
Supelco γ-DEX											■		
Various Pkd. Columns													■

Clinical Industry

Use these columns for the analyses of antihistamines, basic drugs, cold/sinus medications, steroids, and tricyclic antidepressants from biological samples.

Supelco GC Columns for the **Clinical Industry**

	Antiepileptics	Antihistamines	Basic Drug Screen	Benzodiazepines (acetic anhydride)	Benzodiazepines (TBDMS)	Cold and Sinus Medications	Phenothiazines	Steroids	Sympathomimetic Amines	Sympathomimetic Amines (HFBA)	Sympathomimetic Amines (TFAA)	Tricyclic Antidepressants
Equity-1				■				■				
SLB-5ms			■				■	■		■	■	
PTA-5		■	■			■			■			
SAC-5								■				
SPB-20	■											
SPB-35			■		■							
Equity-1701	■											■
Carbowax® Amine		■	■			■			■			
SP-2510 Packed Column	■											

NOTE: Parentheses indicate analytes analyzed as the specified derivative.

Flavor & Fragrance Industry

Volatiles, essential oils, and small chiral molecules of interest to this industry can be analyzed using the following columns.

Supelco GC Columns for the Flavor & Fragrance Industry

	Flavor & Fragrance Volatiles	Essential Oils	Oxygen containing analytes in the form of alcohols, ketones, acids, aldehydes, and lactones; halogenated compounds	Aliphatic and aromatic amines; aliphatic and some aromatic esters; polar racemates	Lactones and aromatic amines; epoxides; styrene oxide	Amino acids; amines; furans	Aliphatic, olefenic, and aromatic enantiomers	Terpenes and tertiary amines	Heterocyclic amines	Xylenes, menthols, cresols, substituted phenols, substituted benzenes, epoxide enantiomers	Acids, alcohols, amines, diols, esters, ethers, halo-hydrocarbons, hydrocarbons, ketones, positional isomers, silanes, terpenes, terpineols	α-BHC, carvone, carboxylic acids, methamphetamine
SLB-5ms	■	■										
SUPELCOWAX 10	■	■										
Astec CHIRALDEX TA			■									
Astec CHIRALDEX DP				■								
Astec CHIRALDEX PN					■							
Astec CHIRALDEX BP						■						
Astec CHIRALDEX DM							■					
Astec CHIRALDEX PM								■				
Astec CHIRALDEX DA									■			
Astec CHIRALDEX PH							■					
Supelco α-DEX										■		
Supelco β-DEX											■	
Supelco γ-DEX												■

Forensics Industry

Use these columns for the analyses of accelerants from arson samples, or for blood alcohols, drugs of abuse, and glycols from biological samples.

Supelco GC Columns for the Forensics Industry

	Accelerants	Blood Alcohols	Drugs of Abuse - Barbiturates	Drugs of Abuse - Basic Drug Screen	Drugs of Abuse - Cannabinoids (TMS)	Drugs of Abuse - Cocaine (TMS)	Drugs of Abuse - Drug Screen (TBDMS)	Drugs of Abuse - Drug Screen (TMS)	Drugs of Abuse - GHB (MTBSTFA)	Drugs of Abuse - Inhalants	Drugs of Abuse - Ketamines (MBTFA)	Drugs of Abuse - LSD (TMS)	Drugs of Abuse - MDMA/Ecstasy (HFBPC)	Drugs of Abuse - Opiates (TMS)	Drugs of Abuse - Phencyclidine [PCP]	Drugs of Abuse - Steroids	Drugs of Abuse - Tryptamines	Glycols
Equity-1	■	■																
SLB-5ms	■		■	■	■	■			■		■	■	■	■	■		■	
PTA-5				■														
SAC-5																■		
Equity-5										■						■		
VOCOL		■								■								
SPB-35			■	■			■	■										
Equity-1701			■															
SPB-1000																		■
Nukol																		■
Carbowax Amine				■														

NOTE: Parentheses indicate analytes analyzed as the specified derivative.

Food & Beverage Industry

Supelco is the recognized leader in specialty columns for the Food & Beverage industry. These columns are written into many methods, and are considered the benchmark columns in the industry. Analytes such as free fatty acids, fatty acid methyl esters, alcohols, trigylcerides, glycols, and sterols can be separated on these special purpose columns.

Supelco GC Columns for the
Food & Beverage Industry

	Alcoholic Beverage Analyses	Sulfur Compounds in Alcoholic Beverages	Solvents	Free Fatty Acids	Polyunsaturated FAMEs by Chain Length	Omega-3 and Omega-6 FAMEs	cis/trans FAME Isomers	Triglycerides	Glycols	Preservatives [Phenolic Antioxidants]	Sterols	Sugars as Alditol Acetates	Pesticide Residues
SPB-1 SULFUR		■											
SLB-5ms			■							■	■		■
HT-5								■					
SAC-5											■		
SPB-624	■		■									■	
SPB-20	■		■							■			
SPB-608													■
Sup-Herb													■
Equity-1701	■		■									■	■
SPB-50										■			■
SPB-PUFA					■	■							
SPB-1000	■		■	■	■	■			■				
Nukol	■		■	■	■	■			■				
Omegawax					■	■							
SUPELCOWAX 10	■	■	■		■	■							
SP-2380							■					■	
SP-2560							■						
Supel-Q PLOT		■											

Personal Care and Cleaning Products Industry

Commercial products, such as shampoos, cosmetics, and rug cleaners, must continuously be monitored to ensure that they do not contain items hazardous to the user. These columns can be used for this purpose.

Supelco GC Columns for the
Personal Care and Cleaning Products Industry

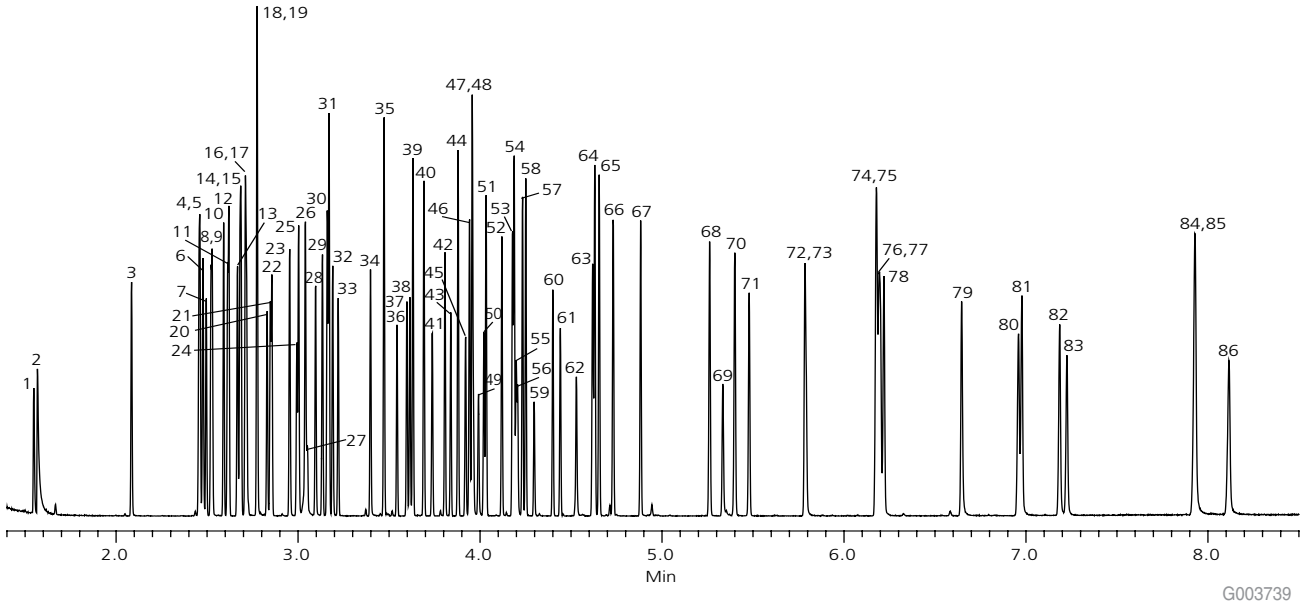
	Alkalis	Coloring Compounds	Fragrance Compounds	Glycols	Preservatives [Phenolic Antioxidants]	Solvents in Cleaning Products	Surfactants [Anionic]	Surfactants [Nonionic]
Equity-1								■
SLB-5ms		■	■			■		■
PTA-5	■							
SPB-20					■			
SPB-50					■			
SPB-1000		■	■	■		■	■	
Nukol		■	■	■		■	■	
Carbowax Amine	■							
SUPELCOWAX 10		■	■			■		

Petroleum Industry

This family of columns can be used for analyses such as purity, boiling point composition, aromatics, light hydrocarbons, freons, and sulfur-containing compounds in petroleum products.

Supelco GC Columns for the **Petroleum Industry**

	Detailed Hydrocarbon Analyses [DHA]	Simulated Distillation [Sim Dis]	Aromatics	$H_2/O_2/N_2/CO/CH_4/CO_2$	$H_2/N_2/CO/CH_4/CO_2$	$H_2/O_2/N_2/CO/CH_4$	O_2/Argon	C1-C3 Hydrocarbons	C1-C5 Alkanes, Alkenes, and Alkynes	C1-C12 Hydrocarbon	Freons	Sulfur Compounds	Process Analyzers	Natural Gas Liquids / Natural Gas	Biodiesel
Petrocol DH Octyl	■														
Petrocol DH 50.2	■													■	
Petrocol DH	■													■	
Petrocol DH 150	■													■	
Petrocol 2887		■													■
Petrocol EX2887		■													■
SPB-1 SULFUR												■			
HT-5		■													■
SP-2380			■												
TCEP			■												
Alumina sulfate PLOT								■	■						
Alumina chloride PLOT								■	■		■				
Carboxen-1010 PLOT				■	■	■		■							
Carboxen-1006 PLOT					■			■							
Mol Sieve 5A PLOT						■	■	■							
Supel-Q PLOT			■					■		■	■	■			
Bentone 34/DNDP SCOT			■										■		
BMEA SCOT													■		
Squalane SCOT													■		
TCEP SCOT													■		
Fluorocol™ Packed Column											■				
GPA Packed Columns														■	
Micropacked Columns													■		

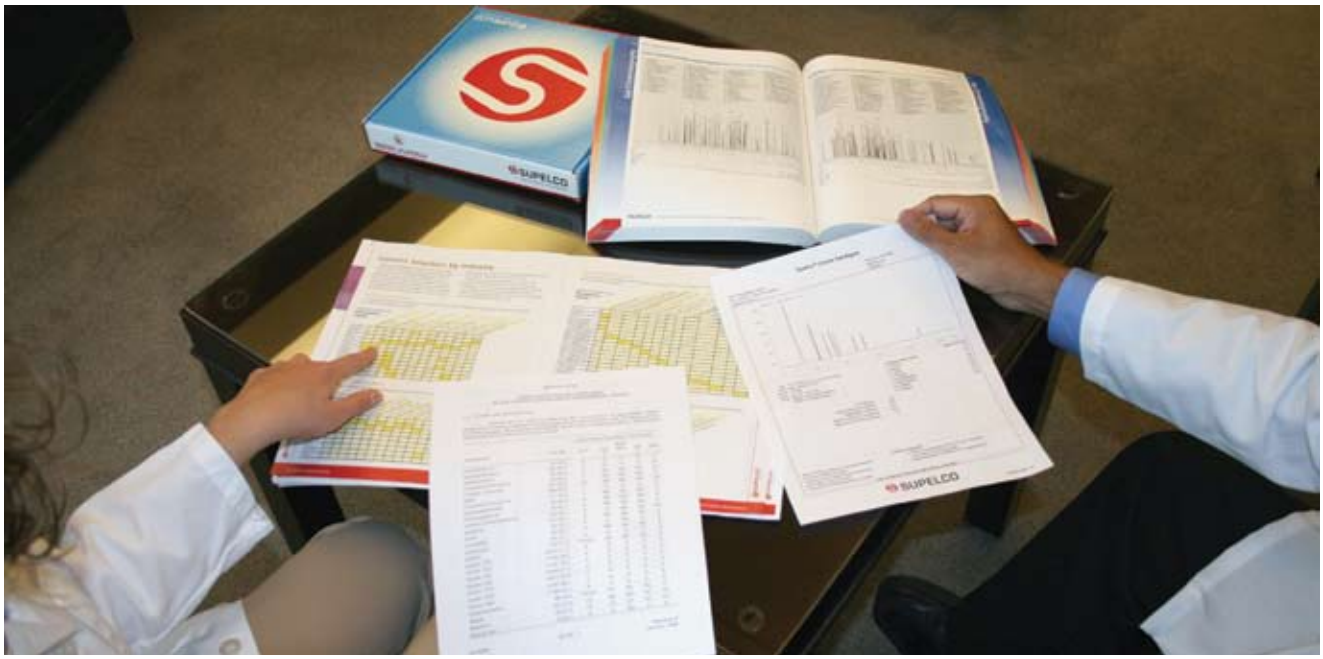


Chemical Industry

These special purpose columns can be selected for analyses such as solvents, aromatics, light hydrocarbons, freons, sulfur-containing compounds, glycols, or basic compounds.

Supelco GC Columns for the Chemical Industry

	Solvents on a Nonpolar Column	Solvents on a Polar Column	Aromatics	$H_2/O_2/N_2/CO/CH_4/CO_2$	$H_2/N_2/CO/CH_4/CO_2$	$H_2/O_2/N_2/CO/CH_4$	O_2/Argon	C1-C3 Hydrocarbons	C1-C5 Alkanes, Alkenes, and Alkynes	C1-C12 Hydrocarbons	Freons	Sulfur Compounds	Acidic Compounds / Glycols	Basic Compounds	Process Analyzers
SPB-1 SULFUR	■											■			
SLB-5ms	■		■												
PTA-5														■	
SPB-1000		■											■		
Nukol		■											■		
Carbowax Amine														■	
SUPELCOWAX 10		■	■												
TCEP			■												
Alumina sulfate PLOT								■	■						
Alumina chloride PLOT								■	■		■				
Carboxen-1010 PLOT				■	■	■		■							
Carboxen-1006 PLOT					■			■							
Mol Sieve 5A PLOT						■	■	■							
Supel-Q PLOT			■					■		■	■	■			
Bentone 34/DNDP SCOT			■												■
BMEA SCOT															■
Squalane SCOT															■
TCEP SCOT															■
Fluorocol Packed Column											■				
Micropacked Columns															■



Column Selection by Application

In addition to the industry specific selection charts on the preceding pages, these two easy-to-read phase selection charts highlight choices for two applications that are independent of any industry. Simply locate the application to identify a recommended column phase.

The stationary phase also dictates the minimum and maximum temperatures at which a column can be used. Therefore, it is critical to ensure the selected stationary phase can withstand the temperature requirements of the GC method. Temperature limitations can be located in the capillary column phase section on pages 16 to 21.

Fast GC Applications

Applying the principles of Fast GC is an effective way to increase sample throughput by decreasing the analysis time. These columns have all the characteristics necessary for developing a successful Fast GC method.

Supelco GC Columns for **Fast GC Applications**

	Environmental Volatiles	Environmental Semivolatiles	Environmental Pesticides and PCBs	Petroleum Aromatics	Food & Beverage Omega-3 and -6 FAMEs	Food & Beverage cis/trans FAME Isomers	General Purpose Polar	General Purpose Nonpolar
SPB-624	■							
VOCOL	■							
SLB-5ms		■	■					
Equity-1701			■					
TCEP				■				
Omegawax 100					■			
SP-2560						■		
SUPELCOWAX 10							■	
Equity-1								■
SPB-1								■
Equity-5								■
SPB-5								■

General Purpose Applications

Supelco's general purpose columns are tested to ensure they meet acceptable values for general chromatographic parameters such as retention, efficiency, and selectivity. These columns are recommended for applications that do not fall under those covered by our special purpose, industry specific columns.

Supelco GC Columns for **General Purpose Applications**

	Nonpolar Column	Intermediate Polarity Column	Polar Column	High Polarity Column
SPB-Octyl	■			
Equity-1	■			
SPB-1	■			
Equity-5	■			
SPB-5	■			
SPB-20		■		
SPB-35		■		
Equity-1701		■		
SPB-50		■		
SPB-225			■	
PAG			■	
SUPELCOWAX 10			■	
SP-2330				■
SP-2380				■
SP-2340				■

Cross-Reference Chart

Table 4. Supelco Capillary GC Columns with Comparable Columns from Other Manufacturers

Supelco	Agilent	Grace	Macherey-Nagel	Phenomenex®	Restek	SGE	Varian
TRADITIONAL (phases by increasing phase polarity)							
Petrocol DH Octyl	-	-	-	-	-	-	-
SPB-Octyl	-	-	-	-	-	-	CP-Sil 2 CB
SPB-HAP	-	-	-	-	-	-	-
Petrocol DH 50.2	DB-Petro, HP-PONA	-	-	-	-	BP1 PONA	-
Petrocol DH	DB-Petro	AT-Petro	-	-	Rtx-1PONA	BP1 PONA	CP-Sil PONA CB
Petrocol DH 150	-	-	-	-	-	-	-
Petrocol 2887, Petrocol EX2887	DB-2887	AT-2887	-	-	Rtx-2887	-	CP-SimDist
SPB-1 SULFUR	-	AT-Sulfur	-	-	-	-	CP-Sil 5 CB for Sulfur
Equity-1, SPB-1	DB-1, HP-1	AT-1	Optima-1	ZB-1	Rtx-1	BP1	CP-Sil 5 CB
SLB-5ms	DB-5ms, HP-5ms	AT-5ms	Optima-5 MS	ZB-5ms	Rtx-5Sil MS	BPX5	VF-5ms
HT-5 (aluminum clad)	DB-5ht	-	-	ZB-5ht	-	HT-5	VF-5ht
PTA-5	-	AT-Amine	-	-	Rtx-5 Amine	-	CP-Sil 8 CB for Amines
SAC-5	-	-	-	-	-	-	-
Equity-5, SPB-5	DB-5, HP-5	AT-5	Optima-5	ZB-5	Rtx-5	BP5	CP-Sil 8 CB
SPB-624	DB-624, DB-VRX	AT-624	Optima-624	ZB-624	Rtx-624	BP624	CP-Select 624 CB
OVI-G43	HP-Fast Residual Solvent	-	-	-	Rtx-G43	-	-
VOCOL	DB-502.2, HP-VOC	AT-502.2	-	-	Rtx-502.2, Rtx-Volatiles	-	-
SPB-20	-	AT-20	-	-	Rtx-20	-	-
SPB-608	DB-608	AT-Pesticide	-	-	-	-	-
Sup-Herb	-	-	-	-	-	-	-
SPB-35	DB-35, HP-35	AT-35	-	ZB-35	Rtx-35	-	-
Equity-1701	DB-1701	AT-1701	Optima-1701	ZB-1701	Rtx-1701	BP10	CP-Sil 19 CB
SPB-50	DB-17, HP-50	AT-50	Optima-17	ZB-50	-	-	CP-Sil 24 CB
SPB-225	DB-225	AT-225	Optima-225	-	Rtx-225	BP225	CP-Sil 43 CB
SPB-PUFA	-	-	-	-	-	-	-
PAG	-	-	-	-	-	-	-
SPB-1000, Nukol	DB-FFAP, HP-FFAP	AT-1000, AT-AquaWax-DA	Optima-FFAP	ZB-FFAP	Stabilwax-DA	BP21	CP-FFAP CB
Carbowax Amine	CAM	AT-CAM	-	-	Stabilwax-DB	-	CP-Wax 51 for Amines
Omegawax	-	AT-FAME	-	-	FAMEWAX	-	-
SUPELCOWAX 10	DB-WAX	AT-WAX, AT-AquaWax	Optima-WAX	ZB-WAX	Rtx-WAX, Stabilwax	BP20	CP-Wax 52 CB
SP-2330	HP-88	-	-	-	Rtx-2330	-	-
SP-2331	DB-Dioxin	-	-	-	Rtx-Dioxin2	-	CP-Sil 88 for Dioxins
SP-2380	-	AT-Silar 90	-	-	-	-	-
SP-2560	-	-	-	-	Rt-2560	-	CP-Sil 88 for FAME
SP-2340	-	AT-Silar 100	-	-	-	-	CP-Sil 88
TCEP	-	-	-	-	Rt-TCEP	-	CP-TCEP
CHIRAL PHASES							
Astec CHIRALDEX	-	-	-	-	-	-	-
α-DEX	-	-	FS-LIPODEX	-	-	-	-
β-DEX	CycloSil-B	-	FS-LIPODEX, FS-HYDRODEX	-	Rt-βDEX	CYDEX-B	-
γ-DEX	-	-	FS-LIPODEX	-	Rt-γDEX	-	-
PLOT COLUMNS							
Alumina sulfate PLOT	HP-PLOT Al2O3 "S"	-	-	-	-	-	CP-Al_2O_3 PLOT Na_2SO_4
Alumina chloride PLOT	HP-PLOT Al2O3 "KCl"	-	-	-	-	-	CP-Al_2O_3 PLOT KCl
Carboxen-1010 PLOT	-	-	-	-	-	-	CP-CarboPLOT P7
Carboxen-1006 PLOT	GS-Carbon PLOT	Carbograph VOC	-	-	-	-	CP-CarboBOND
Mol Sieve 5A PLOT	HP-PLOT Molesieve	AT-Mole Sieve	-	-	Rt-Msieve 5A	-	CP-Molsieve 5A
Supel-Q PLOT	HP-PLOT Q	AT-Q	-	-	Rt-QPLOT	-	CP-PoraPLOT Q
SCOT COLUMNS							
SCOT Columns	-	-	-	-	-	-	-

Capillary Columns by Phase

Looking for information or specifications for a particular phase? This section includes the most popular phases and provides application, USP code, polymer, and temperature limit information. Where two maximum temperatures are listed (i.e. 200/220 °C), the first is for isothermal oven analyses, whereas the second is for oven temperature programmed analyses. Where only one maximum temperature is listed, it can be used for either isothermal or temperature programmed oven analyses.

This section is organized primarily in order of increasing phase polarity to assist in phase selection when performing method development. Other, less popular, phases are available. However, these are not listed here due to space constraints. To learn more about any phases listed, or to inquire about a phase not listed, contact Supelco Technical Service at 800-359-3041 (US and Canada only), 814-359-3041, or at ***techservice@sial.com***

TRADITIONAL PHASES

(By increasing phase polarity)

Petrocol DH Octyl

- **Application:** This column, for detailed analyses of petroleum products, is known within the petroleum and chemical industries for its unique selectivity. Baseline separations of benzene/1-methylcyclopentene and toluene/2,3,3-trimethylpentane that are possible with this column are not obtainable with classical poly(dimethylsiloxane) columns.
- **USP Code:** None
- **Polymer:** Bonded; poly(50% n-octyl/ 50% methylsiloxane)
- **Temperature Limits:** -60 °C to 220 °C

SPB-Octyl

- **Application:** The low polarity of this column approaches squalane, making it substantially less polar than that of the widely used non-polar poly(dimethylsiloxane) columns. This column offers unique selectivity compared to non-polar and intermediate polarity columns, and can be used for confirmational analyses of PCB-containing samples.
- **USP Code:** None
- **Polymer:** Bonded; poly(50% n-octyl/ 50% methylsiloxane)
- **Temperature Limits:** -60 °C to 260 °C

SPB-HAP

- **Application:** This column was developed to provide the best resolution of very volatile hazardous air pollutants. The thick film helps to focus analytes on the column, possibly eliminating the need to employ cryogenic focusing techniques.
- **USP Code:** This column meets USP G1, G2, and G9 requirements.
- **Polymer:** Bonded; poly(dimethylsiloxane)
- **Temperature Limits:** -60 °C to 300 °C

Petrocol DH 50.2, DH, DH 150

- **Application:** These highly reproducible columns have considerable theoretical plate numbers and are designed for detailed analyses of petroleum products for PIANO, PONA, and PNA-type analytes. The 100 m version includes an extensive retention index data sheet of 400+ analytes.
- **USP Code:** These columns meet USP G1, G2, and G9 requirements.
- **Polymer:** Bonded; poly(dimethylsiloxane)
- **Temperature Limits:** -60 °C to 320 °C

Petrocol 2887, EX2887

- **Application:** These columns are designed for ASTM Method D2887 (simulated distillation [SIM DIS] of petroleum fractions). Choose Petrocol 2887 for samples having boiling points up to 1000 °F. Use Petrocol EX2887 for samples having boiling points greater than 1000 °F.
- **USP Code:** These columns meet G1, G2, and G9 requirements.
- **Polymer:** Bonded; poly(dimethylsiloxane)
- **Temperature Limits:**
  Petrocol 2887: Subambient to 350 °C
  Petrocol EX2887: Subambient to 380 °C

SPB-1 SULFUR

- **Application:** A specialized version of the SPB-1, this column was developed for analyses of sulfur gases and other volatile sulfur compounds. The column displays relatively low column bleed, which makes it compatible for use with sulfur-specific detectors.
- **USP Code:** This column meets USP G1, G2, and G9 requirements.
- **Polymer:** Bonded; poly(dimethylsiloxane)
- **Temperature Limits:** -60 °C to 300 °C

Equity-1

- **Application:** This column is designed for general purpose applications where a non-polar column is required. Analytes will be separated primarily according to boiling point.
- **USP Code:** This column meets USP G1, G2, and G9 requirements.
- **Polymer:** Bonded; poly(dimethylsiloxane)
- **Temperature Limits:**
  -60 °C to 325/350 °C for 0.10 - 0.32 mm I.D.
  -60 °C to 300/320 °C for 0.53 mm I.D. (≤1.5 µm)
  -60 °C to 260/280 °C for 0.53mm I.D. (>1.5 µm)

SPB-1

- **Application:** This column is often used for traditional general purpose applications, where a non-polar column is required. Analytes will be separated primarily according to boiling point.
- **USP Code:** This column meets USP G1, G2, and G9 requirements.
- **Polymer:** Bonded; poly(dimethylsiloxane)
- **Temperature Limits:** -60 °C to 320 °C

SLB-5ms

- **Application:** The 5% phenyl equivalent phase provides a boiling point elution order with a slight increase in selectivity, especially for aromatic compounds. The low bleed characteristics, inertness, and durable nature make it the column of choice for environmental analytes (such as semivolatiles, pesticides, PCBs, and herbicides) or anywhere a low bleed non-polar column is required.
- **USP Code:** This column meets USP G27 and G36 requirements.
- **Polymer:** Bonded and highly crosslinked; silphenylene polymer virtually equivalent in polarity to poly (5% diphenyl/95% dimethylsiloxane)
- **Temperature Limits:**
  -60 °C to 340/360 °C for 0.10 - 0.32 mm I.D.
  -60 °C to 330/340 °C for 0.53 mm I.D.

HT-5 (aluminum clad)

- **Application:** This column offers the highest maximum temperature of any commercially available column. It is well suited for simulated distillation (SIM DIS) analyses of petroleum samples.
- **USP Code:** None
- **Polymer:** Bonded; siloxane-carborane equivalent in polarity to poly(5% diphenyl/ 95% dimethylsiloxane)
- **Temperature Limits:** 10 °C to 460/480 °C

PTA-5

- **Application:** This column is designed for analyses of amines and other basic analytes.
- **USP Code:** None
- **Polymer:** Bonded; base-modified poly(5% diphenyl/ 95% dimethylsiloxane)
- **Temperature Limits:** -60 °C to 320 °C

SAC-5

- **Application:** This column is an application specific non-polar column, designed for reproducible analyses of plant sterols, cholesterol, and other animal sterols.
- **USP Code:** None
- **Polymer:** Bonded; poly(5% diphenyl/ 95% dimethylsiloxane)
- **Temperature Limits:** -60 °C to 320 °C

Equity-5

- **Application:** This popular column is designed for general purpose applications where a non-polar column is required. The low phenyl content provides thermal stability compared to 100% poly(dimethylsiloxane) columns.
- **USP Code:** This column meets USP G27 and G36 requirements.
- **Polymer:** Bonded; poly(5% diphenyl/ 95% dimethylsiloxane)
- **Temperature Limits:**
  -60 °C to 325/350 °C for 0.10 - 0.32 mm I.D.
  -60 °C to 300/320 °C for 0.53 mm I.D. (≤1.5 µm)
  -60 °C to 260/280 °C for 0.53 mm I.D. (>1.5 µm)

SPB-5

- **Application:** This non-polar general purpose column provides primarily a boiling point elution order with a slight increase in selectivity, especially for aromatic compounds.
- **USP Code:** This column meets USP G27 and G36 requirements.
- **Polymer:** Bonded; poly(5% diphenyl/ 95% dimethylsiloxane)
- **Temperature Limits:** -60 °C to 320 °C

SPB-624

- **Application:** This column is specially tested for separation, efficiency, and low bleed. It is designed for purge-and-trap analyses of volatile halogenated, non-halogenated, and aromatic contaminants from environmental samples.
- **USP Code:** This column meets USP G43 requirements.
- **Polymer:** Bonded; proprietary
- **Temperature Limits:**
  Subambient to 250 °C for ≤0.32 mm I.D.
  Subambient to 230 °C for 0.53 mm I.D.

OVI-G43

- **Application:** This column is specially prepared and tested to meet the requirements of United States Pharmacopoeia and European Pharmacopoeia methods for determining residual solvents in pharmaceutical preparations.
- **USP Code:** This column meets USP G43 requirements.
- **Polymer:** Bonded; poly(6% cyanopropylphenyl/ 94% dimethylsiloxane)
- **Temperature Limits:** -20 °C to 260 °C

VOCOL

- **Application:** This intermediate polarity column, designed for analyses of volatile organic compounds (VOCs), offers great retention and resolution of highly volatile compounds. Use this column in direct injection ports or coupled to purge-and-trap systems.
- **USP Code:** None
- **Polymer:** Bonded; proprietary
- **Temperature Limits:**
  Subambient to 250 °C (≤1.8 µm)
  Subambient to 230 °C (>1.8 µm)

SPB-20

- **Application:** This column has intermediate polarity due to the higher (20%) phenyl content, producing a different elution order of polar compounds for confirmational information. It is often used for analyses of aromatic analytes.
- **USP Code:** This column meets USP G32 requirements.
- **Polymer:** Bonded; poly(20% diphenyl/ 80% dimethylsiloxane)
- **Temperature Limits:** -25 °C to 300 °C

SPB-608

- **Application:** This column is specially tested with low concentrations of 18 chlorinated pesticides, using an ECD detector. In addition to selectivity and efficiency, it is also tested to ensure minimum breakdown of 4,4'-DDT and endrin. This column is also suitable for use in herbicide analyses.
- **USP Code:** None
- **Polymer:** Bonded; proprietary
- **Temperature Limits:** Subambient to 300 °C

Sup-Herb

- **Application:** This is a specially tested intermediate polarity column for analyses of herbicides, specifically for US EPA Method 507.
- **USP Code:** None
- **Polymer:** Bonded; proprietary
- **Temperature Limits:** Subambient to 300 °C

SPB-35

- **Application:** With a phenyl content of 35%, this column offers a higher polarity option compared to columns containing a lower phenyl content. This column is useful for analyses of polar compounds because they are retained longer relative to non-polar compounds.
- **USP Code:** This column meets USP G42 requirements.
- **Polymer:** Bonded; poly(35% diphenyl/ 65% dimethylsiloxane)
- **Temperature Limits:** 0 °C to 300 °C

Equity-1701

- **Application:** Increased phase polarity, due to cyanopropylphenyl functional group substitution, offers unique selectivity compared to other phases. This column works well with systems employing ECD, NPD, and MSD detectors, and is often used for alcohols, oxygenates, pharmaceuticals, pesticides, and PCB applications.
- **USP Code:** This column meets G46 requirements
- **Polymer:** Bonded; poly(14% cyanopropylphenyl/ 86% dimethylsiloxane)
- **Temperature Limits:**
  Subambient to 280 °C for 0.10 - 0.32 mm I.D.
  Subambient to 260 °C for 0.53 mm I. D.

SPB-50

- **Application:** This column has the highest phenyl content of the common phenyl-containing series of phases. The column is useful for analyses of polar analytes and provides useful confirmational information. It also offers additional selectivity for polynuclear aromatic hydrocarbon isomers over columns with lower phenyl content.
- **USP Code:** This column meets USP G3 requirements.
- **Polymer:** Bonded; poly(50% diphenyl/ 50% dimethylsiloxane)
- **Temperature Limits:** 30 °C to 310 °C

SPB-225

- **Application:** Supelco offers the broadest range of cyanopropyl columns in the industry, such as this intermediate polarity column.
- **USP Code:** This column meets USP G7 and G19 requirements.
- **Polymer:** Bonded; poly(50% cyanopropylphenyl/ 50% dimethylsiloxane)
- **Temperature Limits:** 45 °C to 220/240 °C

SPB-PUFA

- **Application:** This column provides the necessary polarity for analyses of polyunsaturated fatty acids (PUFAs) as fatty acid methyl esters (FAME). This column is specifically tuned to provide highly reproducible analyses.
- **USP Code:** This column meets USP G18 requirements.
- **Polymer:** Bonded; poly(alkylene glycol)
- **Temperature Limits:** 50 °C to 220 °C

PAG

- **Application:** This column fills the polarity space between a 50% phenyl substituted column and a classical wax-type column, due to its polarity being slightly lower than a wax-type column. It is well suited for analyses of FAMEs and alcohols.
- **USP Code:** This column meets USP G18 requirements.
- **Polymer:** Bonded; poly(alkylene glycol)
- **Temperature Limits:** 30 °C to 220 °C

SPB-1000

- **Application:** The incorporation of acid functional groups into the phase lends an acidic character to this column, useful for analyses of volatile acidic compounds. It offers great performance for analyses of glycols. It is the recommended column for ethylene glycol analysis.
- **USP Code:** This column meets USP G25 and G35 requirements.
- **Polymer:** Bonded; acid-modified poly(ethylene glycol)
- **Temperature Limits:** 60 °C to 200/220 °C

Nukol

- **Application:** The incorporation of acid functional groups into the phase lends an acidic character to this column, useful for analyses of volatile acidic compounds. Difficult to analyze carboxylic acids (free fatty acids) can be analyzed with excellent peak shape and minimal adsorption.
- **USP Code:** This column meets USP G25 and G35 requirements.
- **Polymer:** Bonded; acid-modified poly(ethylene glycol)
- **Temperature Limits:** 60 °C to 200/220 °C

Carbowax Amine

- **Application:** This specially prepared base-deactivated column is designed for analyses of primary, secondary, and tertiary amines, as well as other volatile basic compounds.
- **USP Code:** None.
- **Polymer:** Non-bonded; base-modified poly(ethylene glycol)
- **Temperature Limits:** 60 °C to 200 °C

Omegawax

- **Application:** This column allows highly reproducible analyses of fatty acid methyl esters (FAMEs), specifically the omega-3 and -6 fatty acids. It is tested to ensure reproducible FAME equivalent chain length (ECL) values and resolution of key components.
- **USP Code:** This column meets USP G16 requirements.
- **Polymer:** Bonded; poly(ethylene glycol)
- **Temperature Limits:** 50 °C to 280 °C

SUPELCOWAX 10

- **Application:** This column is based on one of the most widely used polar phases, Carbowax 20M, and is a polar column suitable for analyses of fatty acid methyl esters (FAMEs), food, flavor and fragrance compounds, alcohols, and aromatics. Additionally, this column is a great choice when a polar general purpose column is required.
- **USP Code:** This column meets USP G16 requirements.
- **Polymer:** Bonded; poly(ethylene glycol)
- **Temperature Limits:** 35 °C to 280 °C

SP-2330

- **Application:** Supelco offers the broadest range of biscyanopropyl phases in the industry. This column is a highly specialized column that offers both polar and polarizable features due to the substitution of biscyanopropyl and phenyl groups onto the polymer backbone. It can be used for both high and low temperature separations for analytes such as geometric isomers of fatty acid methyl esters (FAMEs), dioxins, and aromatic compounds
- **USP Code:** This column meets USP G8 requirements.
- **Polymer:** Non-bonded; poly(80% biscyanopropyl/ 20% cyanopropylphenyl siloxane)
- **Temperature Limits:** Subambient to 250 °C

SP-2331

- **Application:** A highly polar cyanosiloxane column specially tested for analyses of dioxins, specifically tetrachlorodibenzodioxin (TCDD) isomers. Because the phase is stabilized, it has a maximum temperature slightly higher than non-bonded cyanosiloxane columns.
- **USP Code:** None
- **Polymer:** Stabilized; proprietary
- **Temperature Limits:** Subambient to 275 °C

SP-2380

- **Application:** A highly polar cyanosiloxane column commonly used for separation of geometric (cis/trans) fatty acid methyl ester (FAME) isomers as a group. Also useful when a highly polar general purpose column with good thermal stability is required.
- **USP Code:** This column meets USP G48 requirements.
- **Polymer:** Stabilized; poly(90% biscyanopropyl/ 10% cyanopropylphenyl siloxane)
- **Temperature Limits:** Subambient to 275 °C

SP-2560

- **Application:** This highly polar biscyanopropyl column was specifically designed for the separation of geometric-positional (cis/trans) isomers of fatty acid methyl esters (FAMEs). It is extremely effective for FAME isomer applications.
- **USP Code:** This column meets USP G5 requirements.
- **Polymer:** Non-bonded; poly(biscyanopropyl siloxane)
- **Temperature Limits:** Subambient to 250 °C

SP-2340

- **Application:** This non-bonded column offers the highest polarity in its class. As with all general purpose biscyanopropyl columns, it is highly effective for both high and low temperature separations of geometric isomers of fatty acid methyl esters (FAMEs), dioxins, carbohydrates, and aromatic compounds.
- **USP Code:** This column meets USP G5 requirements.
- **Polymer:** Non-bonded; poly(biscyanopropyl siloxane)
- **Temperature Limits:** Subambient to 250 °C

TCEP

- **Application:** This is the highest polarity column offered by Supelco. The unique chemistry of the phase allows for specialized separations. It is often used for analyses of alcohols and aromatics in mineral spirits, aliphatic constituents in gasoline, impurities in individual aromatics, and oxygenates.
- **USP Code:** None
- **Polymer:** Non-bonded; 1,2,3-tris(2-cyanoethoxy)propane
- **Temperature Limits:** Subambient to 145 °C

CHIRAL PHASES

Chiral GC phases consist of derivatives of α-, β-, or γ-cyclodextrin for the separation of enantiomers. These phases can routinely separate a variety of underivatized non-aromatic enantiomers and several aromatic enantiomers that remain difficult to resolve by HPLC. These phases specifically and effectively separate many of these types of molecules, including thousands of compounds that are starting materials or intermediates for chiral synthesis, biochemical and pharmaceutical intermediates and metabolites, environmental contaminants, flavors, etc.

Astec CHIRALDEX

- **Application:** These columns are used for analyses of enantiomers to determine biological activity (pharmaceutical industry), aroma (flavor & fragrance and food & beverage industries), whether hazardous (environmental industry), and purity (chemical industry).
- **USP Code:** None
- **Polymer:** Sixteen specialized phase chemistries comprised of complex derivatives of cyclodextrins that impart a broad range of selectivities
- **Temperature Limits:**
  TA Phases: -5 °C to 180 °C
  All Other Phases: -5 °C to 220 °C

Supelco DEX

- **Application:** These columns are used for analyses of enantiomers to determine biological activity (pharmaceutical industry), aroma (flavor & fragrance and food & beverage industries), whether hazardous (environmental industry), and purity (chemical industry).
- **USP Code:** None
- **Polymer:** Ten unique phases comprised of derivatives of cyclodextrins that are able to perform many enantiomeric separations
- **Temperature Limits:** 30 °C to 230 °C

PLOT COLUMNS

PLOT (Porous Layer Open Tubular) technology permits a uniform layer of solid adsorbent particles to be attached to the inside wall of fused silica tubing. The use of porous adsorbents in these columns allows for gas-solid chromatography to be performed. A proprietary and patented procedure is used to fix particles to the fused silica tubing, and ensures they will not be dislodged in normal use.

Alumina sulfate PLOT

- **Application:** This highly dependable column has the necessary selectivity for the separation of alkanes, alkenes, and alkynes in mixtures of C1-C4 hydrocarbons. It provides elution of acetylene after n-butane and the elution of methyl acetylene after n-pentane and 1,3-butadiene. The polymer surface is deactivated to reduce peak tailing.
- **USP Code:** None
- **Polymer:** Sulfate-deactivated alumina
- **Temperature Limits:** Subambient to 180 °C

Alumina chloride PLOT

- **Application:** This column allows for the separation of C1-C4 hydrocarbons. Because this column is slightly less polar than the Alumina sulfate PLOT, it provides a different elution order pattern when alkane, alkene, and alkyne mixtures of light hydrocarbons are analyzed. It also provides excellent separation of many common fluorinated compounds, such as freons.
- **USP Code:** None
- **Polymer:** Chloride-deactivated alumina
- **Temperature Limits:** Subambient to 180 °C

Carboxen-1010 PLOT

- **Application:** This column is ideal for the separation of all major components in permanent gas (helium, hydrogen, oxygen, nitrogen, carbon monoxide, methane, and carbon dioxide) and light hydrocarbons (C2-C3) in the same analysis. It is the only column commercially available that is able to separate all major components in permanent gas. This column can also separate oxygen from nitrogen at subambient temperatures.
- **USP Code:** None
- **Polymer:** Carbon molecular sieve
- **Temperature Limits:** Subambient to 250 °C

Carboxen-1006 PLOT

- **Application:** This column is ideal for the separation of many permanent gas components (such as helium, hydrogen, nitrogen, carbon monoxide, methane, and carbon dioxide), and light hydrocarbons (C2-C3) in the same analysis. It is ideal for resolving formaldehyde/water/methanol (formalin) mixtures and monitoring impurities in ethylene. This column can be used with high flow rates and rapid temperature programs to ensure excellent, fast separations.
- **USP Code:** None
- **Polymer:** Carbon molecular sieve
- **Temperature Limits:** Subambient to 250 °C

Mol Sieve 5A PLOT

- **Application:** This column can be used for the separation of many permanent gas components, such as oxygen, nitrogen, carbon monoxide, and methane, in less than five minutes. More difficult separations, such as argon from oxygen, can be achieved by using subambient temperatures. These columns possess the strongest adsorption strength of any PLOT column.
- **USP Code:** None
- **Polymer:** Aluminosilicate
- **Temperature Limits:** Subambient to 300 °C

Supel-Q PLOT

- **Application:** This column exhibits very little bleed, even at its maximum temperature, and effectively resolves carbon dioxide and C1-C4 hydrocarbons at above ambient temperatures. It is also suitable for analyses of sulfur gases, alcohols, ketones, aldehydes, and many polar compounds. Gasoline and other petroleum fractions can be analyzed as well.
- **USP Code:** None
- **Polymer:** Divinylbenzene
- **Temperature Limits:** Subambient to 250 °C

SCOT COLUMNS

SCOT (Support Coated Open Tubular) technology permits a uniform layer of support particles that have been coated with liquid phase to be deposited onto the inner wall of stainless steel tubing. This technology allows access to many phases that are inaccessible to conventional wall coated open tubular capillary column manufacturing technology. These columns combine the sensitivity and excellent sample resolution of capillary GC with the extensive stationary phase library of packed column GC.

Bentone 34/DNDP SCOT

- **Application:** Use for analyses of xylene isomers.
- **USP Code:** None
- **Polymer:** Bentone 34/di-n-decyl phthalate
- **Temperature Limits:** 10 °C to 150 °C

BMEA SCOT

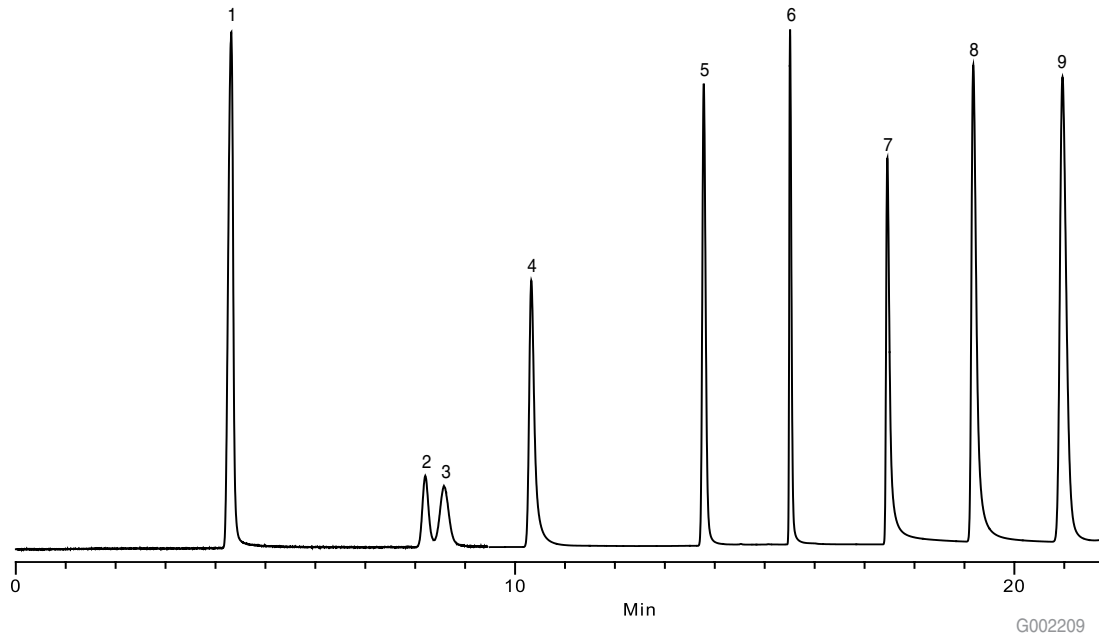
- **Application:** Use for analyses of olefins.
- **USP Code:** None
- **Polymer:** bis-methoxyethyladipate
- **Temperature Limits:** Ambient to 100 °C

Squalane SCOT

- **Application:** Use for boiling point separations.
- **USP Code:** None
- **Polymer:** Squalane
- **Temperature Limits:** 20 °C to 120 °C

TCEP SCOT

- **Application:** Use for analyses of aromatic analytes.
- **USP Code:** None
- **Polymer:** 1,2,3-tris(2-cyanoethoxy)propane
- **Temperature Limits:** 0 °C to 150 °C



Injection Port Items

For the practicing gas chromatographer, choosing the correct items when upgrading and replacing parts and accessories for their system can bring on many challenges due to the vast array of commercially available products. At Supelco, we offer our own unique products, as well as products from some of the most trusted names in the industry, to assist in making the selection process easier.

Molded Thermogreen™ LB-2 Septa

P001208

Molded Thermogreen LB-2 septa offer easier installation and also provide a better seal inside the injection port because every septum conforms to the same mold shape with crisp, clean sides. A version with an injection hole is available, allowing needle penetration through the same location, time after time, reducing septum coring and preventing septum fragments from entering the injection port.

- Ultra low bleed over a wide range of inlet temperatures (100 °C to 350 °C)
- Easier needle penetration and high puncture tolerance
- Already conditioned, ready to use

P001227

Description	Pkg	Cat. No.
9.5 mm	50 ea	28670-U
9.5 mm, with injection hole	50 ea	28331-U
10 mm	50 ea	28673-U
10 mm, with injection hole	50 ea	28333-U
11 mm	50 ea	28676-U
11 mm, with injection hole	50 ea	28336-U
Plug (for Shimadzu)	50 ea	20633

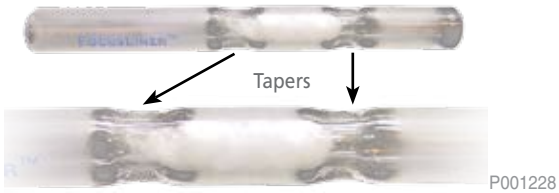
Septum Pullers / Forceps

The hook septum puller is great for removing soft silcone septa. It has dozens of uses around the lab. The screw septum puller is perfect for removing harder high temperature septa in addition to soft silicone septa.

Use forceps to prevent contamination of septa with finger oils while handling, or for picking up hot injector liners and detector parts.

Description	Pkg	Cat. No.
Hook Septum Puller	1 ea	20352
Screw Septum Puller	1 ea	20353
Stainless Steel Forceps	1 ea	22435-U

FocusLiner™ Inlet Liners



P001228

The use of a wool plug in inlet liners has been used for many years to promote the rapid vaporization of the entire sample, minimize mass discrimination, and prevent non-volatile material from entering the column. FocusLiner inlet liners incorporate a unique design that prevents shifting of the wool plug during repeated injections or sudden inlet pressure changes.

- Typically reduce injection variability by at least 96%
- Provide maximum sensitivity and improved detection levels

Description	Pkg	Cat. No.
For Agilent® 5890/6890/7890 (78.5 mm x 6.3 mm O.D.)		
Split/splitless, 2.3 mm I.D., wool packed	5 ea	2879605-U
Split/splitless w/single taper, 2.3 mm I.D., wool packed	5 ea	2879505-U
For Finnigan		
Same catalog numbers as Agilent		
For PerkinElmer® AutoSystem™ and Clarus® (92 mm x 6.3 mm O.D.)		
Split/splitless, 4 mm I.D., wool packed	5 ea	2879205-U
Split/splitless w/single taper, 4 mm I.D., wool packed	5 ea	2879105-U
For Shimadzu® 17A with SPL-17 Injector (95 mm x 5 mm O.D.)		
Split/splitless, 3.4 mm I.D., wool packed	5 ea	2878605-U
Split/splitless w/single taper, 3.4 mm I.D., wool packed	5 ea	2878405-U
For Thermo ThermoQuest 8000/TRACE™ (105 mm x 8 mm O.D.)		
Split/splitless w/single taper, 5 mm I.D., wool packed	5 ea	2877505-U
For Varian® 1075/1077 Injectors (72 mm x 6.3 mm O.D.)		
Split, 2.3 mm I.D., wool packed	5 ea	2874705-U
For Varian 1078/1079 Injectors (54 mm x 5 mm O.D.)		
Split/splitless w/single taper, 3.4 mm I.D., wool packed	5 ea	2875705-U
For Varian CP-1177 Injectors		
Same catalog numbers as Agilent		

Capillary Cleaving Tool / Magnifiers

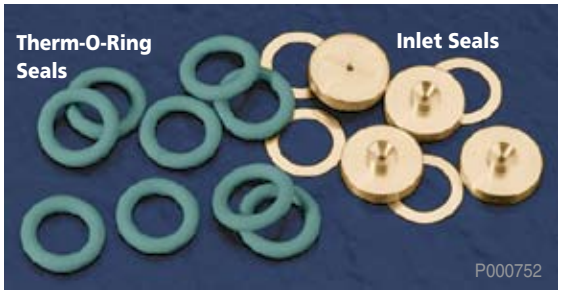
Chromatographers must ensure that the column ends are cut cleanly. These products are designed to assist the chromatographer in that endeavor.

Description	Pkg	Cat. No.
Capillary Cleaving Tool, retractable blade	1 ea	23814
Coddington Magnifier, 20X	1 ea	23139
Lenscope Illuminating Magnifier, 10X	1 ea	23135

Therm-O-Ring™ Seals

For proper operation of Inlet liners used in Agilent GCs, an O-ring is placed near the top to ensure that the only path for carrier gas to get to the outside of the inlet liner is through the grooves in the inlet seal at the bottom of the injection port.

- Fit 6.3 mm, 6.5 mm, or 1/4" O.D. capillary liners that use an O-ring seal
- Can be used with inlet temperatures up to 375 °C without sticking or fragmenting
- Superior replacements for O-rings made from Viton®



Description	Pkg	Cat. No.
Therm-O-Ring Seals	10 ea	21003-U
Therm-O-Ring Seals	25 ea	21004-U

Inlet Seals

The inlet seals in an Agilent GC must be regularly changed to prevent sample adsorption due to accumulation of sample residue and/or septum fragments. Supelco manufactures replacement inlet seals of the highest quality.

- Stainless steel for analyses of non-reactive compounds
- Seals plated with pure gold for applications requiring more inertness
- Cross design intended for high split flows (>200 mL/min.)
- Packs of ten include one washer for each seal

Material	Pkg	Cat. No.
Non-plated	10 ea	23317-U
Gold-plated	10 ea	23319-U
Gold-plated, cross design	10 ea	23415-U

Column Nuts

We offer the following replacements for damaged and misplaced nuts.

P000777, P000920, P000282, P000915

Description	Ferrules Used	Cat. No.	Pkg
Agilent nut	Short design	24833-U	2 ea
Supelco ferrule nut adapter	General purpose	22470-U	2 ea
Agilent MSD source nut	Long design	28034-U	5 ea
PerkinElmer nut	Long design	28034-U	5 ea
1/16 inch compression nut	General purpose	22021	10 ea
Varian nut	Long design	28033-U	1 ea

COLUMN FERRULES

Improper nut/ferrule combinations create dead volume (empty space between the ferrule and the injection port that is not swept by carrier gas). This may result in poor chromatography, as evidenced by fronting peaks and band broadening.

Short design ferrules fit:

- The original nuts that ship with Agilent GCs

Long design ferrules fit:

- MSD source nuts for Agilent GCs
- The original nuts that ship with PerkinElmer GCs
- The original nuts that ship with Varian GCs

General purpose ferrules fit:

- Supelco Ferrule Nut Adapters for Agilent GCs
- 1/16 inch compression nuts for PerkinElmer GCs

Supeltex™ M-2A Ferrules

- Max. Temp.: 400 °C
- Composition: VESPEL® SP-21 (85% polyimide/15% graphite)
- Characteristics: Seal at 1/4-turn past fingertight.
- Benefits: High reusability. Won't stick to metal or glass. Form leaktight seals without sticking to the column. Do not require back ferrules.

CapSeal Bullet™ Ferrules

- Available exclusively from Supelco
- Max. Temp.: 450 °C
- Composition: Graphite material captured in aluminum base
- Characteristics: Seal at 1/8-turn past fingertight.
- Benefits: Reusable. A special end taper reduces graphite extrusion into fitting. Aluminum base keeps the ferrule from adhering to the fitting, making it easy to remove.

Column I.D.	Ferrule I.D.	Pkg	Cat. No.
Supeltex M-2A, Short Design			
0.10-0.25 mm	0.4 mm	10 ea	24803-U
0.10-0.25 mm	0.4 mm	50 ea	24807-U
CapSeal Bullet, Short Design			
0.10-0.25 mm	0.4 mm	10 ea	23864
0.10-0.25 mm	0.4 mm	50 ea	23867
Supeltex M-2A, Long Design			
0.10-0.25 mm	0.4 mm	10 ea	24826-U
0.10-0.25 mm	0.4 mm	50 ea	28022-U
CapSeal Bullet, Long Design			
0.10-0.25 mm	0.4 mm	12 ea	23488
0.10-0.25 mm	0.4 mm	48 ea	23493
Supeltex M-2A, General Purpose			
0.10-0.25 mm	0.4 mm	10 ea	503258
0.10-0.25 mm	0.4 mm	50 ea	22474
CapSeal Bullet, General Purpose			
0.10-0.25 mm	0.4 mm	12 ea	23480-U
0.10-0.25 mm	0.4 mm	48 ea	23485

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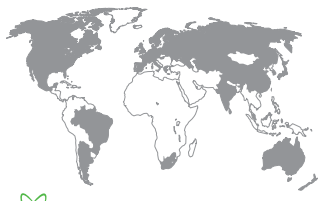

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