2005/06 Edition

FOODS FLAVORS FRAGRANCES

Products and Applications for GC & HPLC

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Introduction

There is an immense range of analytes and matrices present in food, flavor, and fragrance systems, and many governing organizations have developed requirements for their testing. The Nutritional Labeling and Education Act (NLEA) of 1990 requires that labels containing information about nutritional content be placed on nearly all processed foods. The food analyst is called upon to provide the analytical data for these labels. Testing of the packaging materials or a chemical shelf-life study may be requested for a product. In addition, the food and flavor chemist might need to test the quality of incoming raw materials, determine the flavor profile of a product or ingredient, or quantify trace-level nutrients.

The Association of Official Analytical Chemists (AOAC) International has published many methods for the analysis of foods, broken out by analyte and matrix type. Chromatographic techniques are used in a number of these procedures. Other organizations, such as AOCS (American Oil Chemists Society) and AACC (American Association of Cereal Chemists) also have published chromatographic methods for food and ingredient testing. Because of the complexity of many food, flavor, and fragrance matrices, some type of separation or isolation technique may be needed to ensure accurate results. For example, in the analysis of flavors and fragrances, hundreds of volatile species can contribute to an aroma or flavor. Gas and liquid chromatography (GC and HPLC) are powerful techniques that can greatly reduce the amount of sample preparation needed, as well as provide additional selectivity. By separating the compound(s) of interest from the sample matrix, accurate identification and quantitation becomes much more likely.

GC often is used in the analysis of flavor and fragrance compounds, lipids, and preservatives. To analyze a compound by GC, the compound must be volatile and thermally stable; however, a compound can be derivatized to increase its volatility. The original methods used to analyze foods and flavors were developed for packed GC columns, although capillary columns have surpassed these in popularity. Detectors such as the flame ionization detector (FID) and thermal conductivity detector (TCD) are popular in food analysis. In addition, a GC with a mass spectral detector (MSD) is a powerful tool in the analysis of complex flavor and fragrance samples.

HPLC is used in the analysis of carbohydrates, organic acids, preservatives, and some flavor compounds. HPLC offers a wide variety of column types and mobile phases, making this technique applicable to many compound types. Reversed phase, normal phase, ion exchange, size exclusion, and bioaffinity separation techniques are all useful in food, flavor, and fragrance analysis. Detectors used in HPLC include UV-visible, refractive index, fluorescence, conductivity, and mass spectrometers, depending on the application.

This guide shows example foods, flavors, and fragrances analyses obtained by using Restek GC and HPLC columns. Many additional examples, and much information, can be attained from the reference publications, from our general catalog, and from our website.

Rebecca Wittrig, Ph. D.
HPLC Products
Marketing Manager

Becky has more than 14 years experience in HPLC & GC. Prior to joining Restek as the Foods, Flavors, & Fragrances Innovations Manager, she supervised the chromatography labs at The Pillsbury Company and Ecolab, Inc. Becky has a Ph.D. in Analytical Chemistry from Purdue University and a B.A. in Chemistry from Gustavus Adolphus College (Minnesota). If you have any questions or comments about food, flavor, or fragrance analyses, please contact Becky by e-mail at becky.wittrig@restekcorp.com or by phone at 800-356-1688 or 814-353-1300, ext. 2347.

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List is accurate to the best of our knowledge at the time of printing. Consult individual manufacturers or other sources for specific information.

Fats & Oils

Analyzing Fats & Oils

In foods, fats serve several functions—providing flavor, texture, and serving as a source of essential fatty acids and fat-soluble vitamins. Lipids are substances in foods that are soluble in a non-polar solvent, such as hexane, benzene, or chloroform/methanol. They include compounds such as glycerides, free fatty acids, phospholipids, glycolipids, terpenes, sterols, and waxes. Lipids can be divided into three general groups: 1) simple lipids, which include fats and waxes; 2) compound lipids, which include phospholipids and glycolipids; and 3) derived lipids, which include fatty acids, alcohols, and sterols. Over 90% of the lipids found in food are present as triglycerides–esters of fatty acids and glycerol.

Free Fatty Acids

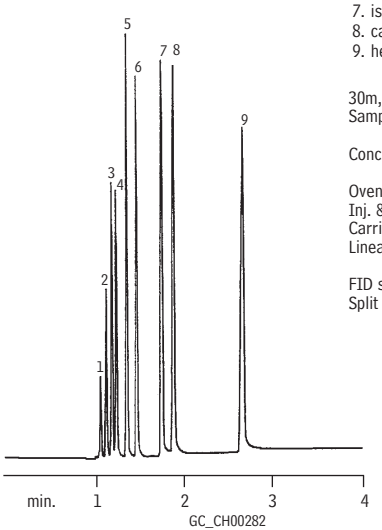
Free fatty acid molecules consist of carbon chains of varying lengths with an acidic group (-COOH) at one end of the molecule. Fatty acids with chain lengths of 2–20 carbon atoms account for up to 10% of the lipid content in food. In general, these fatty acids are straight chain molecules, either fully hydrogenated or with some degree of unsaturation (i.e., double bonds). Because free fatty acids are adsorptive and the longer chain acids lack volatility, analysis of these compounds can be difficult. The acids can be converted to methyl esters and analyzed by GC, but the additional sample preparation required to do this increases time and cost. The analysis of free fatty acids without derivatization can be accomplished using a **Stabilwax®-DA** column, a bonded Carbowax® column specifically deactivated for acidic compounds. To minimize loss from discrimination in the injection port, direct injection is recommended, although splitless injections can be used. For additional examples of organic acid analysis, see pages 14-15.

Fatty Acids (Free)
Rtx®-200

GC

Peak List:
1. acetic acid
2. propionic acid
3. isobutyric acid
4. *n*-butyric acid
5. isovaleric acid
6. *n*-valeric acid
7. isocaproic acid
8. caproic acid
9. heptanoic acid

Also see page 15!



30m, 0.25mm ID, 0.25µm Rtx®-200 (cat.# 15023)

Sample:	0.8µL split injection of a free fatty acid standard.
Conc.:	approximately 10 to 20ng/µL.
Oven temp.:	90°C
Inj. & det. temp.:	250°C
Carrier gas:	hydrogen
Linear velocity:	40cm/sec. (flow rate: 1.4cc/min.)
FID sensitivity:	4 x 10^{11} AFS
Split vent:	40cc/min.

Fatty Acids (Free)
Stabilwax®-DA

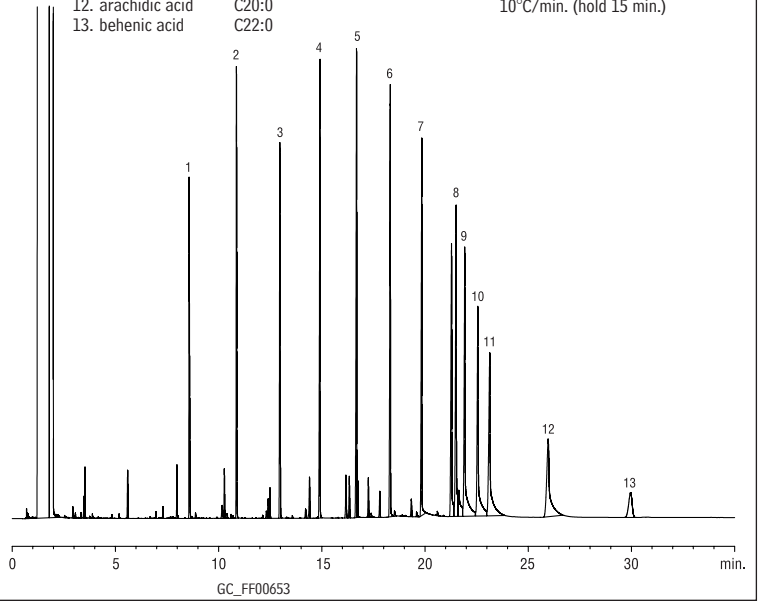
GC

Peak List:

1. butyric acid	C4:0
2. caproic acid	C6:0
3. caprylic acid	C8:0
4. capric acid	C10:0
5. lauric acid	C12:0
6. myristic acid	C14:0
7. palmitic acid	C16:0
8. stearic acid	C18:0
9. oleic acid	C18:1
10. linoleic acid	C18:2
11. linolenic acid	C18:3
12. arachidic acid	C20:0
13. behenic acid	C22:0

Stabilwax®-DA 30m, 0.32mm ID, 0.25µm (cat.# 11024)

Sample:	1.0µL FFA Mix
Solvent:	water
Conc.:	5mg/mL in methanol
Inj.:	splitless/250°C
Splitless hold time:	0.25min.
Carrier gas:	hydrogen (constant flow mode)
Flow rate:	6.0mL/min.
Split flow:	75mL/min.
Det.:	FID/250°C
Inlet liner:	laminar cup splitter
Oven temp.:	40°C to 250°C @ 10°C/min. (hold 15 min.)



for **more** info

Request Applications Note **GC Analysis of Free Fatty Acids on Stabilwax®-DA Columns** (cat.# 59155B).

Triglycerides

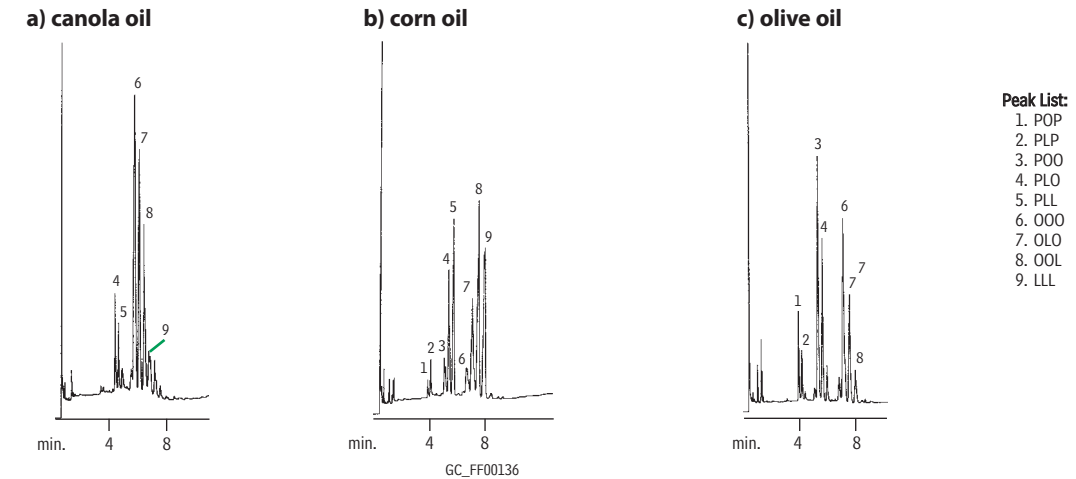
Triglycerides are naturally-occurring esters of fatty acids and glycerol, and the main component (90-95%) of dietary lipids. Mono- and diglycerides also are esters, but contain one or two fatty acid groups, respectively. Triglycerides are classified according to the nature of their esterified fatty acids. The fatty acid groups in the triglyceride molecule can be classified as saturated or fully hydrogenated (e.g., C14:0), or unsaturated (e.g., C18:1 or C18:2).

In general, capillary GC columns are the preferred tool for triglyceride analyses, providing shorter analyses times, higher efficiency, and better quantitation than packed column GC, HPLC, or supercritical fluid chromatography (SFC). Sample preparation is minimal, involving liquefying the sample before diluting with a solvent such as dichloromethane or isooctane. Additional sample preparation is necessary if mono- and diglycerides and free fatty acids are present in significant amounts. Because these compounds have relatively high molecular weights and polarities that increase with the degree of unsaturation, high oven temperatures are necessary. An **Rtx®-65TG** (65% phenyl/35% methyl polysiloxane) column is able to resolve triglycerides according to degree of unsaturation, as well as according to carbon number. The extended thermal stability of this column allows the use of a high oven temperature, yielding short analyses times. In addition, the advanced deactivation techniques used to prepare **Rtx®-65TG** columns result in lower bleed and longer column lifetimes than for traditional columns.

For more information, request Applications Note **GC Analysis of Triglycerides** (cat.# 59580A).

Triglycerides
Rtx®-65TG

GC



Peak List:
1. POP
2. PLP
3. POO
4. PLO
5. PLL
6. OOO
7. OLO
8. OOL
9. LLL

15m, 0.25mm ID, 0.10µm Rtx®-65TG (cat.# 17005)
0.8µL split injection of triglycerides.

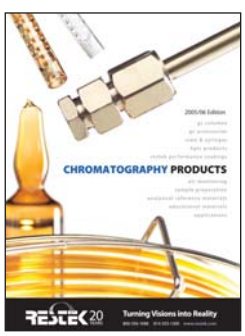
Oven temp.:
a) 355°C (hold 1 min.) to 365°C @ 1°C/min.
b) 350°C (hold 0.5 min.) to 365°C @ 1°C/min.
c) 350°C (hold 1 min.) to 365°C @ 0.5°C/min.

Inj. & det. temp.:	365°C
Carrier gas:	hydrogen
Linear velocity:	50cm/sec.
FID sensitivity:	8 x 10^{-11} AFS
Split ratio:	40:1

for **more** info

Restek offers an extensive line of GC and HPLC columns, accessories, and replacement parts. Call to request one of these catalogs for a full listing of products or visit us on the web at www.restek.com

Agilent GC Replacement Parts, Lit. Cat. #59627E



2005 General Catalog Lit. Cat. #59065

HPLC Products Lit. Cat. #59241B

Fats & Oils

Fatty acid methyl esters (FAMEs)

FAMEs analysis is important in fats and oils characterization and in the determination of total fat content in foods. To prepare the methyl esters, fats are extracted from matrices using non-polar solvents, and saponified to produce free fatty acids. After derivatization to the methyl esters, molecules have increased volatility and decreased activity, which permits more accurate quantitation by GC.

Capillary columns with polyethylene glycol (PEG) or Carbowax® stationary phases are used to analyze saturated and unsaturated FAMEs. For the resolution of the *cis* and *trans* isomers, biscyanopropyl phases typically are used. **Stabilwax®** and **Rtx®-Wax** columns provide excellent resolution of FAMEs derived from both plant and animal sources. **FAMEWAX®** columns offer excellent resolution of polyunsaturated FAMEs with significantly reduced analyses times, compared to traditional Carbowax® stationary phases. Individual *cis* and *trans* isomers are resolved on an **Rt-2560** column, making it the column of choice for analyzing partially hydrogenated fats.

for **more** info

Request Applications Note **Analyzing Fatty Acid Methyl Esters** (cat.# 59584A).

ordering **note**

To order one of the columns highlighted on **pages 1 through 7**, please see the following pages:

FAMEs (Marine Oil)
FAMEWAX™

GC

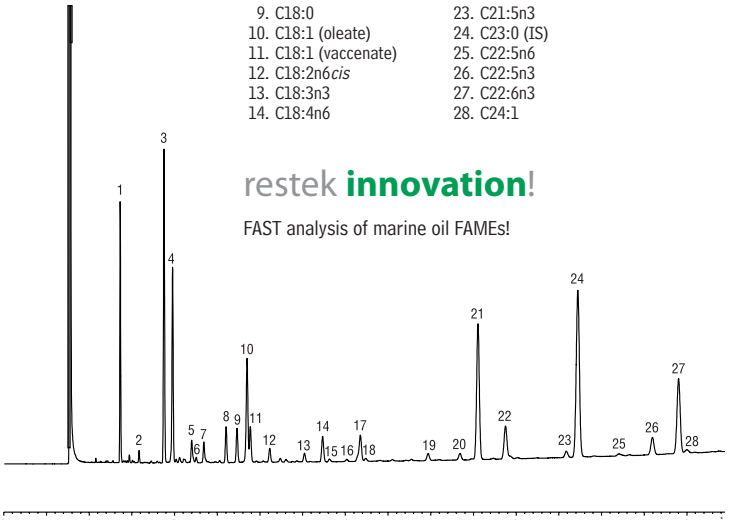
FAMEWAX™ 30m, 0.32mm ID, 0.25µm (cat.# 12498)
Sample: 12mg/mL total FAMEs
Inj.: 0.5µL, split (150:1), 3mm ID split liner for Trace Series GCs, packed with glass wool (cat.# 20936-202.1)
Inj. temp.: 250°C
Carrier gas: hydrogen, constant flow
Linear velocity: 62cm/sec.
Oven temp.: 195°C to 240°C @ 5°C/min. (hold 1 min.)
Det.: FID, 250°C

Peak List:

1. C14:0
2. C15:0
3. C16:0
4. C16:1
5. C16:2
6. C17:0
7. C17:1
8. C16:4
9. C18:0
10. C18:1 (oleate)
11. C18:1 (vaccenate)
12. C18:2n6*cis*
13. C18:3n3
14. C18:4n6
15. C18:4n3
16. C20:0
17. C20:1n7
18. C20:1n9
19. C20:4n6
20. C20:4n3
21. C20:5n3
22. C22:1n7
23. C21:5n3
24. C23:0 (IS)
25. C22:5n6
26. C22:5n3
27. C22:6n3
28. C24:1

restek **innovation**!

FAST analysis of marine oil FAMEs!



GC_FF00568

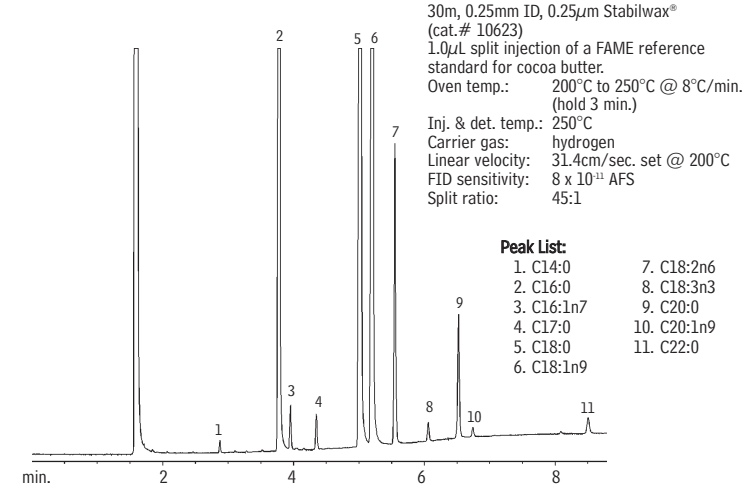
FAMEs (Cocoa Butter)
Stabilwax®

GC

30m, 0.25mm ID, 0.25µm Stabilwax® (cat.# 10623)
1.0µL split injection of a FAME reference standard for cocoa butter.
Oven temp.: 200°C to 250°C @ 8°C/min. (hold 3 min.)
Inj. & det. temp.: 250°C
Carrier gas: hydrogen
Linear velocity: 31.4cm/sec. set @ 200°C
FID sensitivity: 8 x 10^{-11} AFS
Split ratio: 45:1

Peak List:

1. C14:0
2. C16:0
3. C16:1n7
4. C17:0
5. C18:0
6. C18:1n9
7. C18:2n6
8. C18:3n3
9. C20:0
10. C20:1n9
11. C22:0



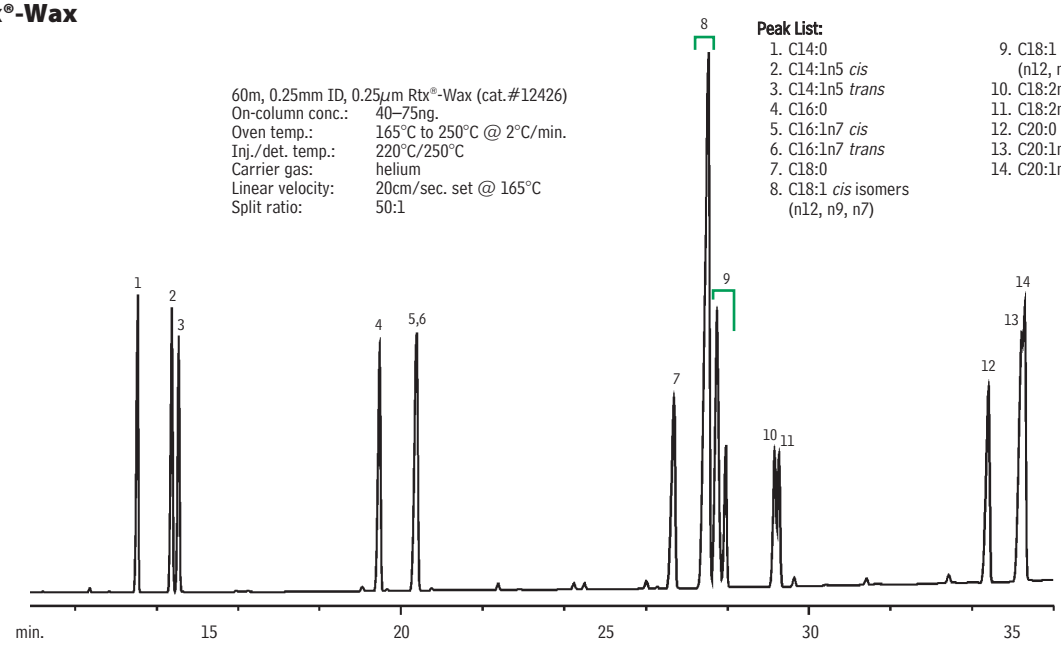
GC_FF00120

FAMEs (*cis/trans* isomers)
Rtx®-Wax

GC

60m, 0.25mm ID, 0.25µm Rtx®-Wax (cat.#12426)
On-column conc.: 40–75ng.
Oven temp.: 165°C to 250°C @ 2°C/min.
Inj./det. temp.: 220°C/250°C
Carrier gas: helium
Linear velocity: 20cm/sec. set @ 165°C
Split ratio: 50:1

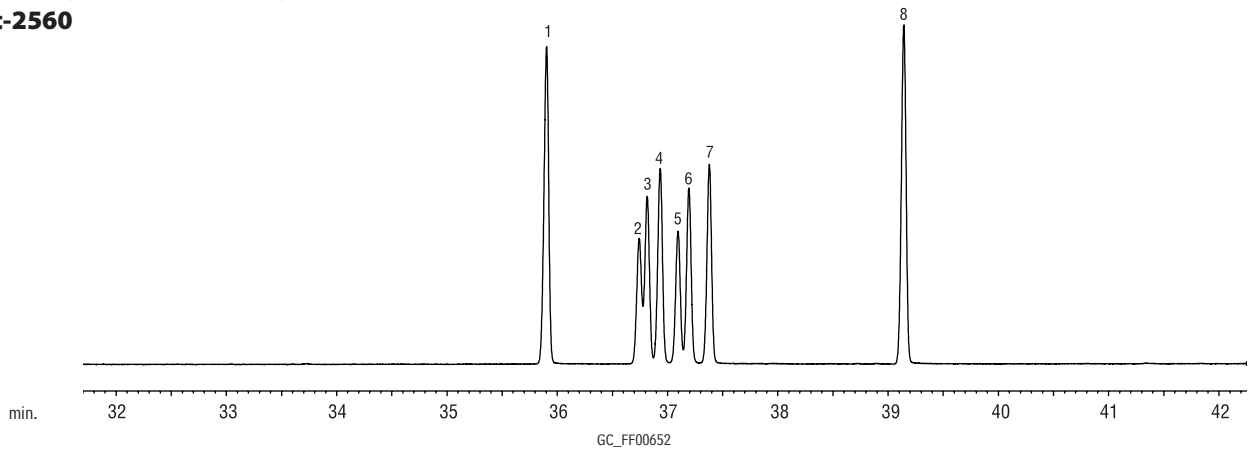
Peak List:
1. C14:0
2. C14:1n5 *cis*
3. C14:1n5 *trans*
4. C16:0
5. C16:1n7 *cis*
6. C16:1n7 *trans*
7. C18:0
8. C18:1 *cis* isomers (n12, n9, n7)
9. C18:1 *trans* isomers (n12, n9, n7)
10. C18:2n6 *cis*
11. C18:2n6 *trans*
12. C20:0
13. C20:1n9 *cis*
14. C20:1n9 *trans*



GC_FF00121

FAMEs (*cis/trans* isomers)
Rt-2560

GC



GC_FF00652

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

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

did you **know**?

Our Technical Service Department is staffed with more than 35 experienced chemists on rotating shifts from various departments. Whether your chromatography problem is simple or complex, call Restek's Technical Service Team at 1-800-356-1688 (ext. 4), or your Restek representative, and we will do everything we can to help you find a solution.

Fats & Oils

The Institute for Nutraceutical Advancement (INA) has published a method for the analysis of the fatty acid content in saw palmetto by GC. The analysis is performed after the triglycerides are transesterified and converted to their methyl esters. An **Rtx®-Wax** column provides the efficiency and selectivity needed to perform this analysis, allowing accurate identification of the FAMEs present.

for **more** info

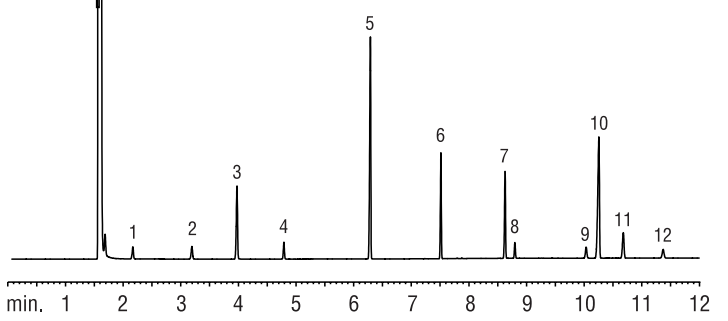
Request Applications Note **The Institute for Nutraceutical Advancement (INA) Validates GC Methods for Saw Palmetto Using Rtx®-5 and Stabilwax® Columns** (cat.# 59136).

FAMEs (Saw Palmetto)
Rtx®-Wax

GC

Peak List	Conc. (mg/mL)
1. methyl caproate (C6:0)	0.4
2. methyl caprylate (C8:0)	0.4
3. methyl nonanoate (C9:0)	2.0
4. methyl caprate (C10:0)	0.4
5. methyl laurate (C12:0)	5.0
6. methyl myristate (C14:0)	2.0
7. methyl palmitate (C16:0)	2.0
8. methyl palmitoleate (C16:1)	0.4
9. methyl stearate (C18:0)	0.4
10. methyl oleate (C18:1)	5.0
11. methyl linoleate (C18:2)	1.0
12. methyl linolenate (C18:3)	0.4

30m, 0.25mm, 0.25µm Rtx®-Wax (cat.# 12423)
1µL split injection of saw palmetto standard
Conc.: see peak list
Oven temp.: 120°C (hold 3 min.) to 220°C at 20°C/min. (hold 12 min.)
Inj./det. temp.: 250°C/300°C
Carrier gas: helium
Linear velocity: 1mL/min. (34 cm/sec.)
Split ratio: 100:1



GC_FF00538

FAMEs (NLEA)
Rtx-2560

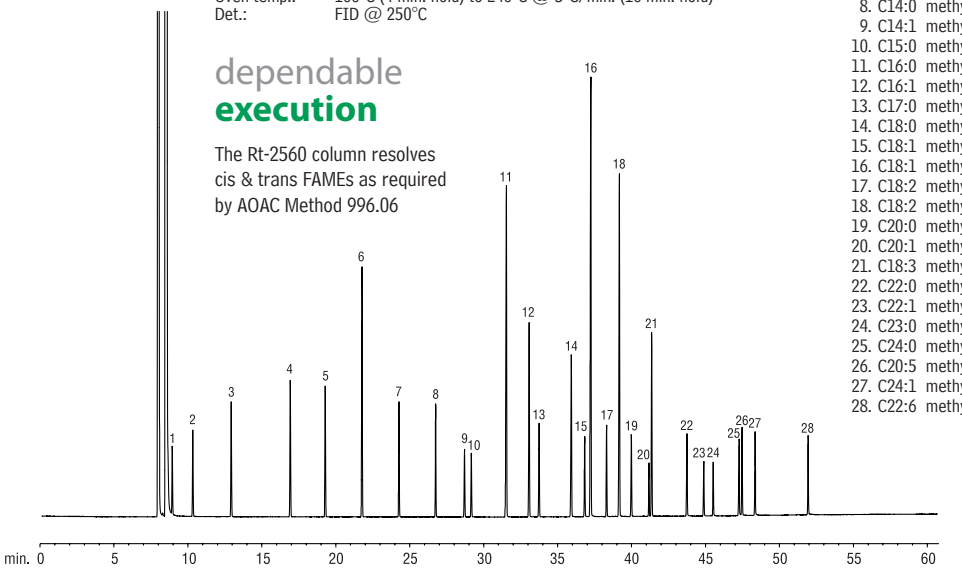
GC

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: 1.2 mL/min.
Oven temp.: 100°C (4 min. hold) to 240°C @ 3°C/min. (10 min. hold)
Det.: FID @ 250°C

dependable
execution

The Rt-2560 column resolves cis & trans FAMEs as required by AOAC Method 996.06

Peak List:
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)

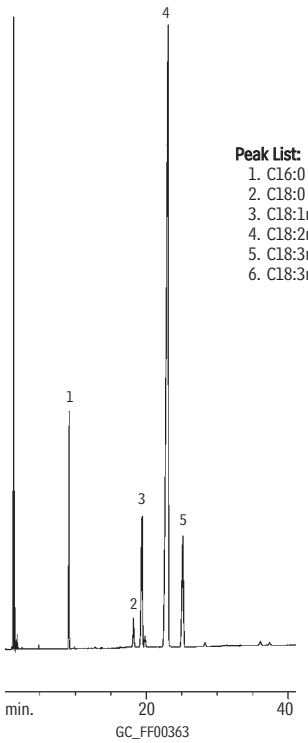


GC_FF00651

FAMEs
FAMEWAX™

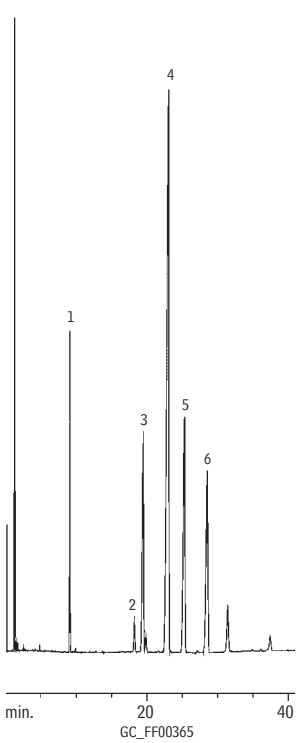
GC

Evening Primrose Oil



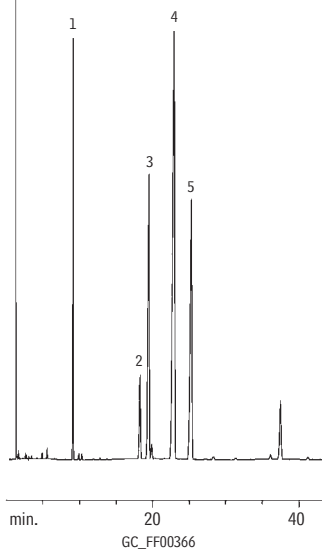
Peak List:
1. C16:0
2. C18:0
3. C18:1n9
4. C18:2n6
5. C18:3n6
6. C18:3n3

Black Currant Seed Oil

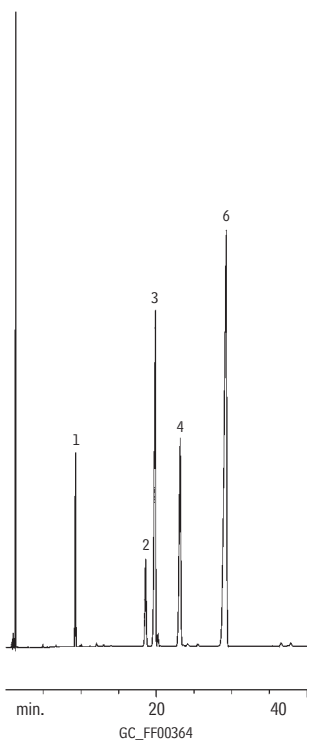


Borage Seed Oil

30m, 0.25mm ID, 0.25µm FAMEWAX™ (cat.# 12497).
Oven temp.: 165°C (hold 30 min.) to 220°C @ 1.5°C/min. (hold 15 min.)
Inj. temp.: 225°C
Det. temp.: 230°C
Carrier gas: helium @ 40cm/sec.



Flax Seed Oil



Essential fatty acids

Essential fatty acids (EFAs) are polyunsaturated fatty acids (PUFAs) that the body needs to perform important functions, including: determining membrane fluidity, reactivity, oxidation rate, and energy production, maintaining body temperature, insulating nerves, and cushioning body tissue. However, the body cannot produce EFAs, they must be obtained through the diet. Two important families of EFAs are the Omega-3 (n-3) series and the Omega-6 (n-6) series. The Omega-3 series includes α-linolenic acid, eicosapentaenoic acid, and docosahexaenoic acid. The Omega-6 series includes linoleic acid, γ-linolenic acid, dihommogamma-linolenic acid, and arachidonic acid.

A **FAMEWAX™** column has excellent selectivity for EFAs. The PEG stationary phase used in the **FAMEWAX™** will resolve the Omega-3 and Omega-6 fatty acids, and the isomers of linolenic acid (C18:3n3 and C18:3n6). The samples are saponified and esterified to form their FAMEs before injection. Accurate determinations of the fatty acid profiles of oils, such as flax seed oil and evening primrose oil, also are possible with this column.

for **more** info

Request Applications Note **Determination of Omega-3 and Omega-6 Fatty Acid Composition in Evening Primrose Oil, Flax Seed Oil, and Borage Oil** (cat.# 59128).

Julie Kowalski
Innovation Chemist

Fats & Oils

Cholesterol and Other Dietary Sterols

Cholesterol is a lipid with a completely different structure than a fatty acid. Cholesterol is present only in foods of animal origin. Because cholesterol content must be included on nutritional label panels, accurate quantitation is important for products such as butter, eggs, and baked goods. Capillary GC is recommended in AOAC Methods 970.51E and 976.26 for the determination of cholesterol content. Cholesterol, and other sterols, must be recovered from the unsaponified fraction of an ether extract. The sterols can be converted to the trimethylsilyl (TMS) or butyl ester derivatives and analyzed on an **Rtx®-5** capillary column, or they can be analyzed underivatized on a highly inert **XTI®-5** column. An **XTI®-5** column offers low reactivity and high thermal stability for accurate quantitation with very short analyses times. For more complex mixtures of sterols, including coprostanone and cholesterol, a more polar **Rtx®-225** column should be used (page 9).

for **more** info

Request Applications Note **Analysis of Cholesterol and Other Dietary Sterols** (cat.# 59581).

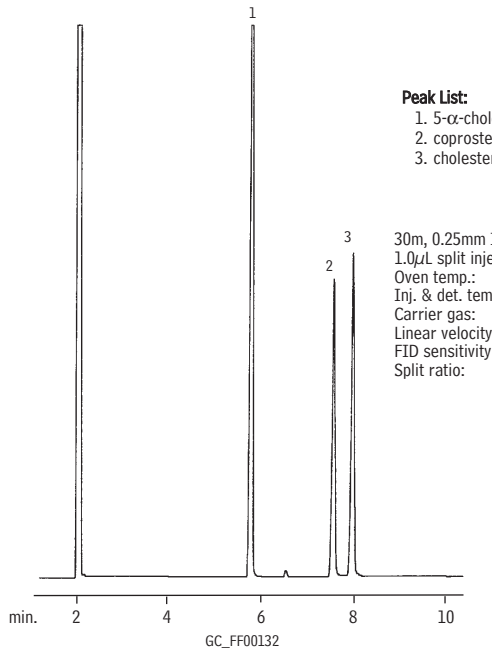
ordering **note**

To order one of the columns highlighted on **page 8 or 9**, please see the following pages:

also **available**

Custom lengths and film thicknesses are available. Call technical service at **800-356-1688 (ext. 4)**, or contact your Restek representative.

Sterols (Cholesterol) **GC**
XTI®-5



Peak List:
1. 5-α-cholestane
2. coprosterol
3. cholesterol

30m, 0.25mm ID, 0.50µm XTI®-5 (cat.# 12238)
1.0µL split injection, 250ng on-column

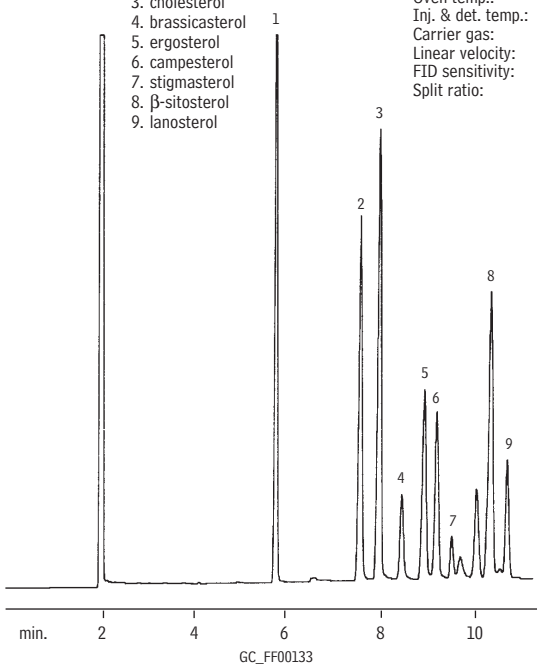
Oven temp.:	330°C
Inj. & det. temp.:	300°C
Carrier gas:	helium
Linear velocity:	30cm/sec. set @ 40°C
FID sensitivity:	8 x 10^{-11} AFS
Split ratio:	100:1

Sterols **GC**
XTI®-5

Peak List:
1. 5-α-cholestane
2. coprosterol
3. cholesterol
4. brassicasterol
5. ergosterol
6. campesterol
7. stigmasterol
8. β-sitosterol
9. lanosterol

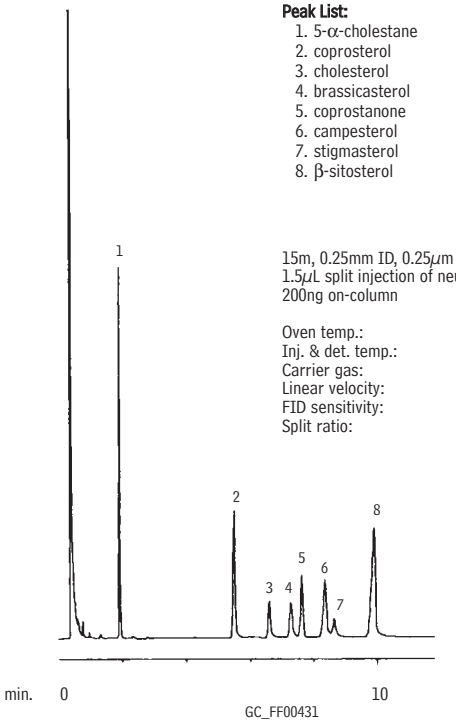
30m, 0.25mm ID, 0.50µm XTI®-5 (cat.# 12238)
1.0µL split injection.

On-column conc.:	250ng
Oven temp.:	330°C
Inj. & det. temp.:	300°C
Carrier gas:	helium
Linear velocity:	30cm/sec. set @ 40°C
FID sensitivity:	8 x 10^{-11} AFS
Split ratio:	100:1



Sterols (Cholesterol)
Rtx®-225

GC



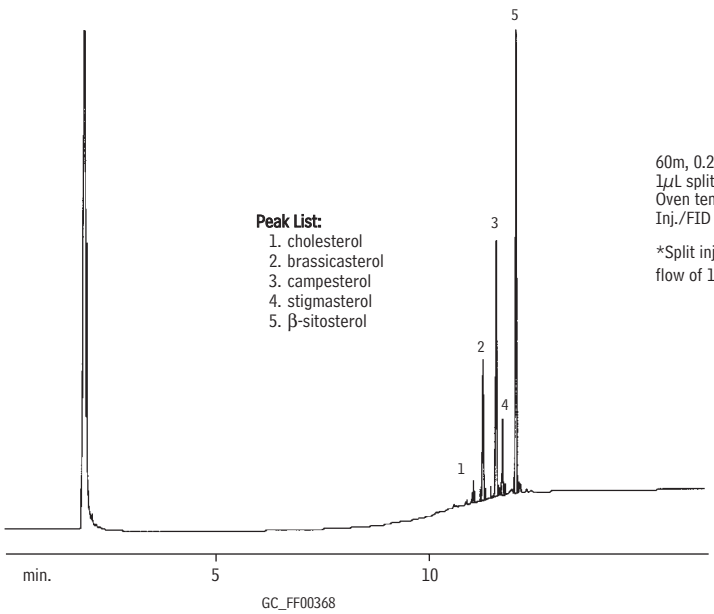
In addition to the method for fatty acid content in saw palmetto (page 6), the INA has published a method for the determination of sterols in saw palmetto by GC. This assay can be applied to stigmasterol, campesterol, brassicasterol, and β-sitosterol in saw palmetto fruit, oil extract, and blended powders. The sample is analyzed after hydrolysis, saponification, and derivatization of the sterols. For this assay, an **Rtx®-5** column is used. This column features the thermal stability needed to provide accurate quantitation of the phytosterols (340°C).

for **more** info

Request Applications Note **The Institute for Nutraceutical Advancement (INA) Validates GC Methods for Saw Palmetto Using Rtx®-5 and Stabilwax Columns** (cat.# 59136).

Phytosterols (Saw Palmetto)
Rtx®-5

GC



60m, 0.25mm ID, 0.25μm Rtx®-5 (cat.# 10226).
1μL splitless injection*
Oven temp.: 200°C (hold 1 min.) to 340°C @ 15°C/min. (hold 10 min.)
Inj./FID temp.: 345°C/355°C.

*Split injection may be used, but results can have greater variability. A split flow of 112mL/min. is suggested.

Chromatogram provided by the Institute for Nutraceutical Advancement (INA)

Carbohydrates

Carbohydrates

Carbohydrates are important constituents of food and beverage products and include simple sugars, oligosaccharides, sugar alcohols, and polysaccharides. Sugar analysis is needed for the generation of nutritional panels, as both the sugar content and the total carbohydrate content must be included. In addition, sugar alcohols are gaining popularity in dietetic foods, and often must be monitored in the presence of other sugars.

Simple sugars include mono- and disaccharides such as fructose, glucose, sucrose, maltose, and lactose. In foods and beverages, they provide sweetness, texture, and color development. The perceived sweetness of each sugar is different and is evaluated on the basis of character, intensity, and duration. Therefore, the ability to profile the individual mono- and disaccharides is important to food chemists. Methods exist for the quantitation of individual sugar species, as well as for the determination of total sugar content.

An oligosaccharide is a polymer of 2–10 simple sugars, including compounds such as lactose, maltose, and maltotriose. A polysaccharide is defined as a polymer of greater than 10 simple sugars, which includes starches and gums. In food systems, they serve as bulking agents, emulsifiers, stabilizers, free-flowing agents, and water binders. The total starch content in foods can be determined by enzymatically digesting the starch, followed by the quantitative measurement of the resulting glucose and maltose.

Sugars: Maple Flavored Syrup
Ultra Amino

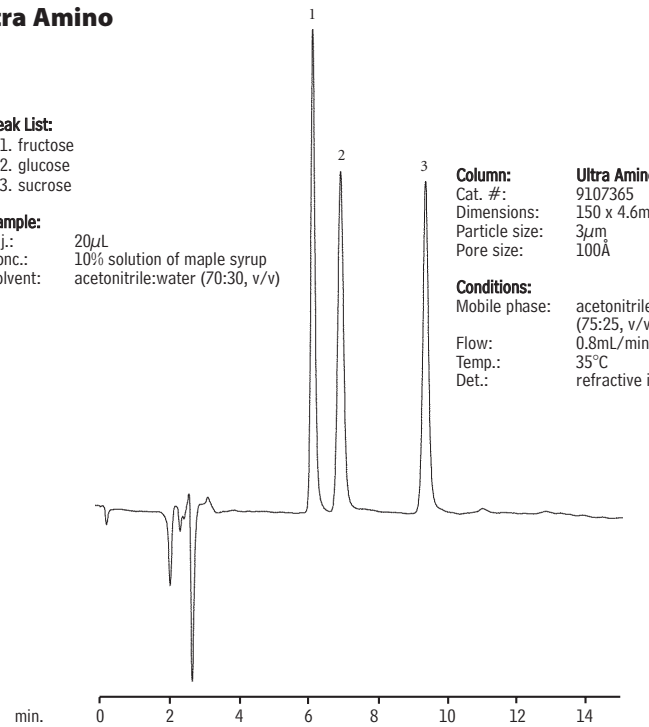
HPLC

Peak List:
1. fructose
2. glucose
3. sucrose

Sample:
Inj.: 20µL
Conc.: 10% solution of maple syrup
Solvent: acetonitrile:water (70:30, v/v)

Column: Ultra Amino
Cat. #: 9107365
Dimensions: 150 x 4.6mm
Particle size: 3µm
Pore size: 100Å

Conditions:
Mobile phase: acetonitrile:water (75:25, v/v)
Flow: 0.8mL/min.
Temp.: 35°C
Det.: refractive index



LC_0159

Sugars Test Mix
Pinnacle II™ Amino (3µm)

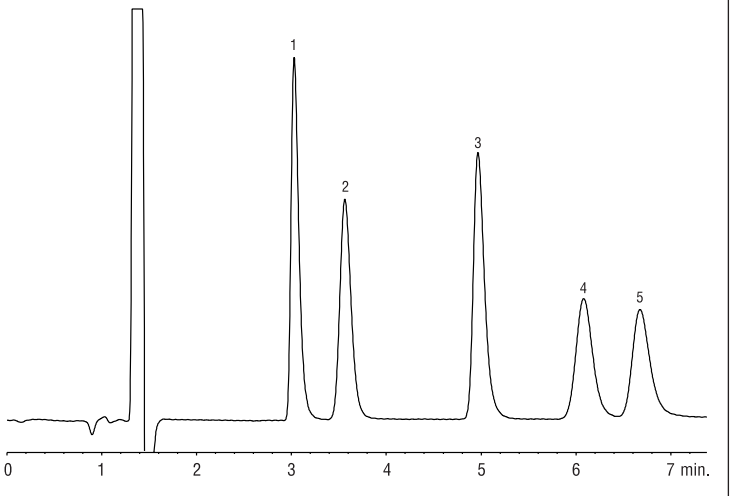
HPLC

Peak List: **Conc. (µg/mL)**
1. fructose 2.0
2. glucose 2.1
3. sucrose 4.0
4. maltose 4.5
5. lactose 4.4

Sample:
Inj.: 5µL
Solvent: mobile phase

Column: Pinnacle II™ Amino
Cat. #: 9217365
Dimensions: 150 x 4.6mm
Particle size: 3µm
Pore size: 110Å

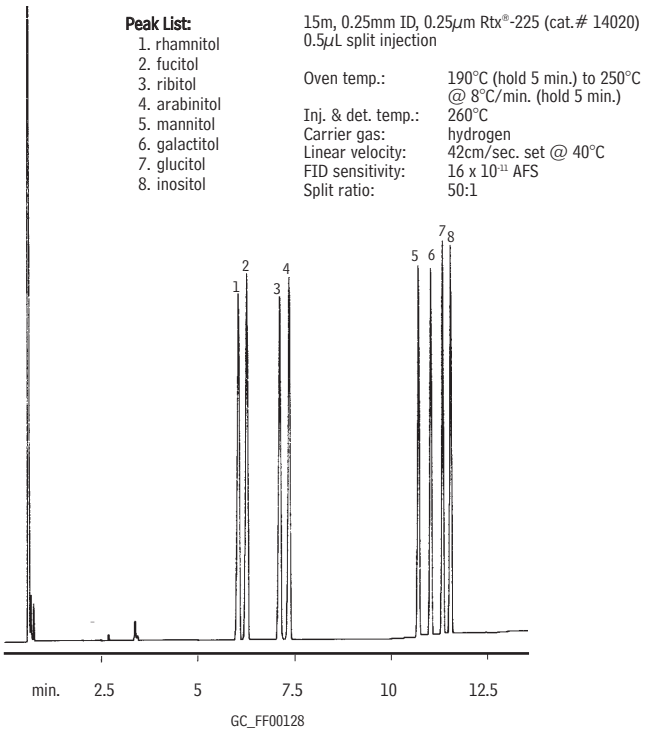
Conditions:
Mobile phase: water:acetonitrile (25:75, v/v)
Flow: 1.5 mL/min.
Temp.: 35°C
Det.: refractive index @ 35°C



LC_022323

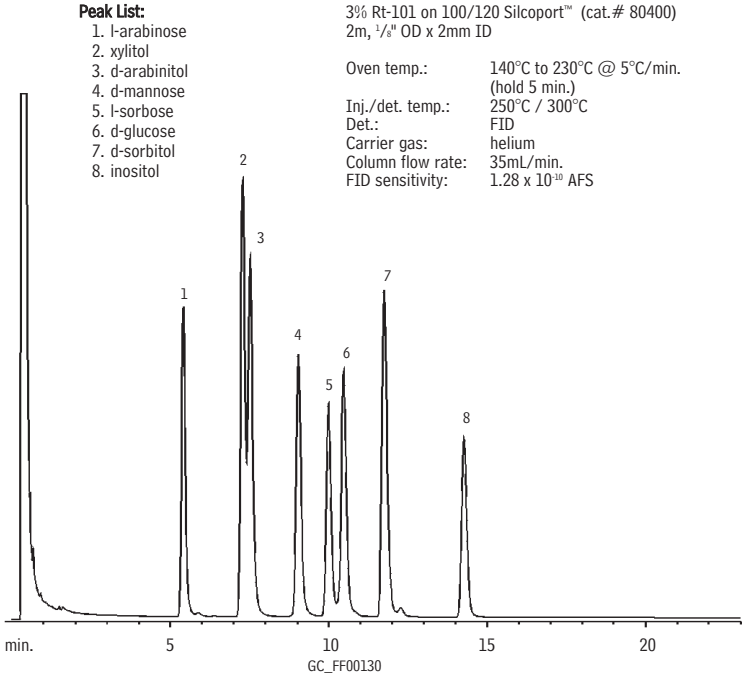
Sugars (as alditol acetates) Rtx®-225

GC



Sugar Alcohols (TMS derivatives) 3% Rt-101 on 100/120 Silcoport™

PACKED GC



Either GC or HPLC, depending on the needs of the analyst and the equipment available, can be used to analyze carbohydrates. Typically, greater sensitivity is possible using GC techniques, although sample preparation will become more involved. HPLC analysis using an amino-based stationary phase is the most popular technique for the routine analysis of simple sugars. This analysis involves isocratic elution (e.g., acetonitrile:water, 75:25) and a refractive index detector (RID). An **Ultra Amino** or **Pinnacle II™ Amino** column can be used to separate fructose, glucose, sucrose, maltose, and lactose. Good resolution can be achieved in less than 15 minutes using a flow rate of 0.8mL/min. This method is applicable to a wide range of food and beverage matrices.

Because sensitivity can be limited when using a refractive index detector, GC often is used for trace-level analyses of simple sugars and sugar alcohols after derivatization, which makes the compounds more volatile and thermally stable. Alditol acetate derivatives of sugars can be analyzed using an **Rtx®-225** capillary column, a cyanopropyl-containing siloxane phase. The TMS derivatives of simple sugars, complex sugars, and sugar alcohols can be analyzed using a bonded packed column, such as **3% Rt-101 on 100/120 Silcoport™** packing.

Vitamins

Vitamins

Vitamins play vital roles in the human body, and include a wide range of organic compounds. The quantitative analysis of vitamins has become a necessity in both the mainstream food and dietary supplement markets. However, because the body needs vitamins in very small quantities, the analyst often must perform trace-level analyses, which can be challenging. Vitamin assays are used to ensure product quality and to verify nutritional label claims. In addition, assays are important in developing manufacturing and storage processes because many vitamins are light- and/or air-sensitive.

Vitamins can be classified broadly into two groups—water-soluble and fat-soluble. Fat-soluble vitamins include A (retinol), E (alpha-tocopherol), D, and K. They are quite hydrophobic and must be dissolved in an organic solvent. The **Ultra C18** HPLC column features a retentive, high-purity packing that is ideal for separating a range of fat-soluble vitamins. The fully end-capped silica eliminates unwanted analyte-silanol interactions and improves column-to-column reproducibility.

ordering **note**

Please see **pages 40–45** for HPLC columns featured in this catalog.

Vitamins (Fat Soluble) Ultra C18

HPLC

Peak List:	Conc.: (mg/mL)
1. solvent front	n/a
2. menadione (vitamin K_3)	0.45
3. all-*trans*-retinol (vitamin A)	0.34
4. vitamin D_3	0.4
5. unknown	n/a
6. alpha tocopherol (vitamin E)	2.4
7. alpha tocopherol acetate (vitamin E acetate)	2.4
8. unknown	n/a
9. phylloquinone (vitamin K_1)	0.84

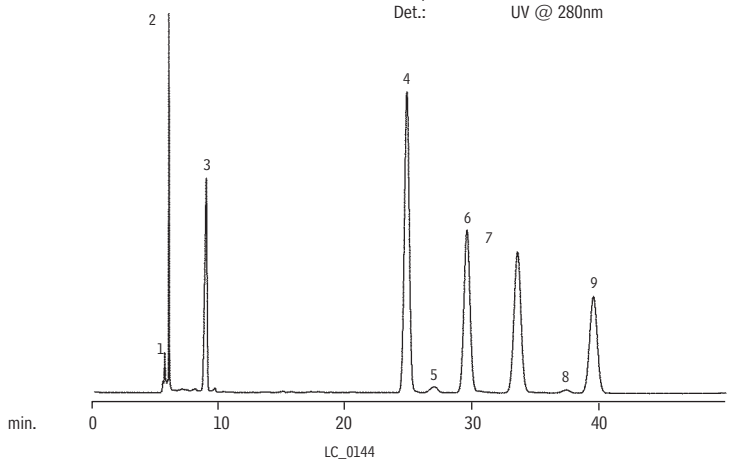
Sample:
Solvent: diethyl ether

Column: **Ultra C18**
Cat. #: 9174575
Dimensions: 250 x 4.6mm
Particle size: 5µm
Pore size: 100Å

Conditions:
Mobile phase: acetonitrile:methanol (90:10, v/v)

Time (min.)	Flow (mL/min.)
1.00	1.00
5.00	1.00
5.01	2.00
50.0	2.00

Temp.: 30°C
Det.: UV @ 280nm



LC_0144

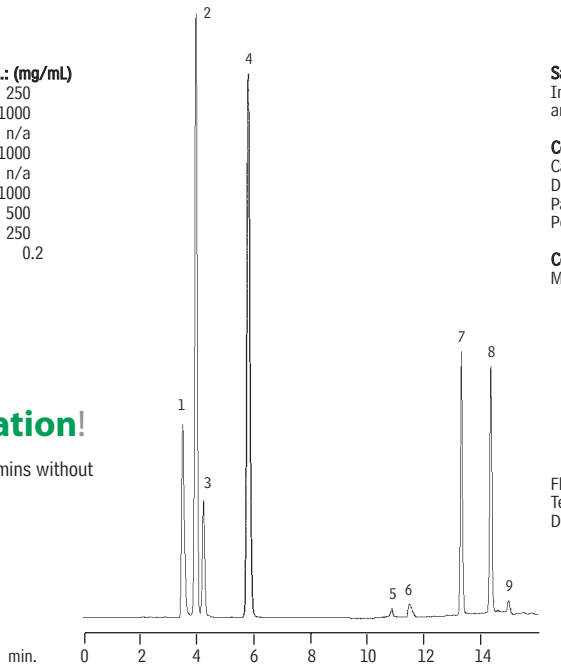
Vitamins (Water Soluble) Ultra Aqueous C18

HPLC

Peak List:	Conc.: (mg/mL)
1. thiamin (B_1)	250
2. ascorbic acid (C)	1000
3. unknown	n/a
4. nicotinic acid (B_3)	1000
5. unknown	n/a
6. pantothenic acid (B_5)	1000
7. folic acid (B_9)	500
8. riboflavin (B_2)	250
9. methyl paraben	0.2

restek **innovation**!

Monitor water-soluble vitamins without ion pairing reagents.



LC_0141

Sample:
Initial dilutions of B_1 and B_2 basified with ammonium hydroxide (to promote solubility)

Column: **Ultra Aqueous C18**
Cat. #: 9178575
Dimensions: 250 x 4.6mm
Particle size: 5µm
Pore size: 100Å

Conditions:
Mobile Phase: A: 25mM potassium phosphate, pH 2.00:methanol (95:5, v/v)
B: methanol:25mM potassium phosphate, pH 3.5 (60:40, v/v)

Time (min.)	% B
0-6	0
6.01	25
6.01-11	25-100
11-16	100

Flow: 1.0mL/min.
Temp.: 27°C
Det.: UV @ 254nm

Cabbage Extract
Ultra Aqueous C18

HPLC

Peak List:
1. phenethyl glucosinolate

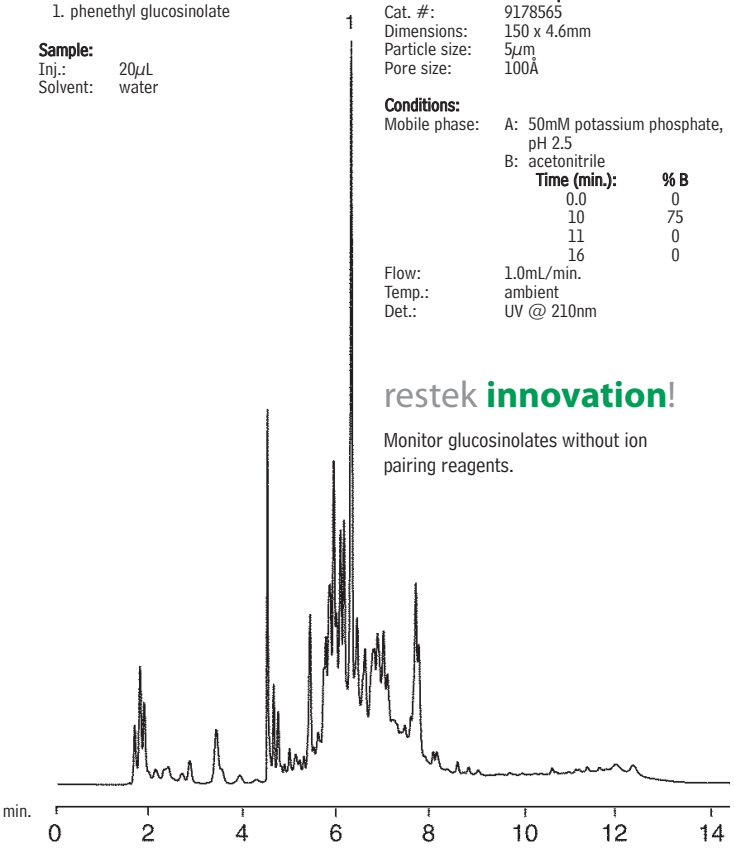
Sample:
Inj.: 20µL
Solvent: water

Column: **Ultra Aqueous C18**
Cat. #: 9178565
Dimensions: 150 x 4.6mm
Particle size: 5µm
Pore size: 100Å

Conditions:
Mobile phase: A: 50mM potassium phosphate, pH 2.5
B: acetonitrile

Time (min.):	% B
0.0	0
10	75
11	0
16	0

Flow: 1.0mL/min.
Temp.: ambient
Det.: UV @ 210nm



LC_0165

restek **innovation**!

Monitor glucosinolates without ion pairing reagents.

Water-soluble vitamins include both acidic and basic compounds, as well as some highly polar molecules, e.g., ascorbic acid (vitamin C), thiamin (B1), riboflavin (B2), nicotinic acid (B3), pyridoxine (B6), and folic acid. The very polar compounds are difficult to retain by reversed phase HPLC, and many methods call for ion-pairing reagents to improve retention. **Ultra Aqueous C18** HPLC columns resolve six water-soluble vitamins using a gradient elution program, without the need for ion pairing reagents.

Consumption of glucosinolates (β-thioglucoside N-hydroxysulfate precursors of isothiocyanates) is associated with a significantly reduced risk for a variety of cancers. Because glucosinolates are highly polar, ion pairing reagents are sometimes used to retain them by reversed phase HPLC.

Due to enhanced retention for polar compounds and compatibility with 100% aqueous mobile phases, an **Ultra Aqueous C18** column can separate glucosinolates by reversed phase HPLC without ion pairing reagents.

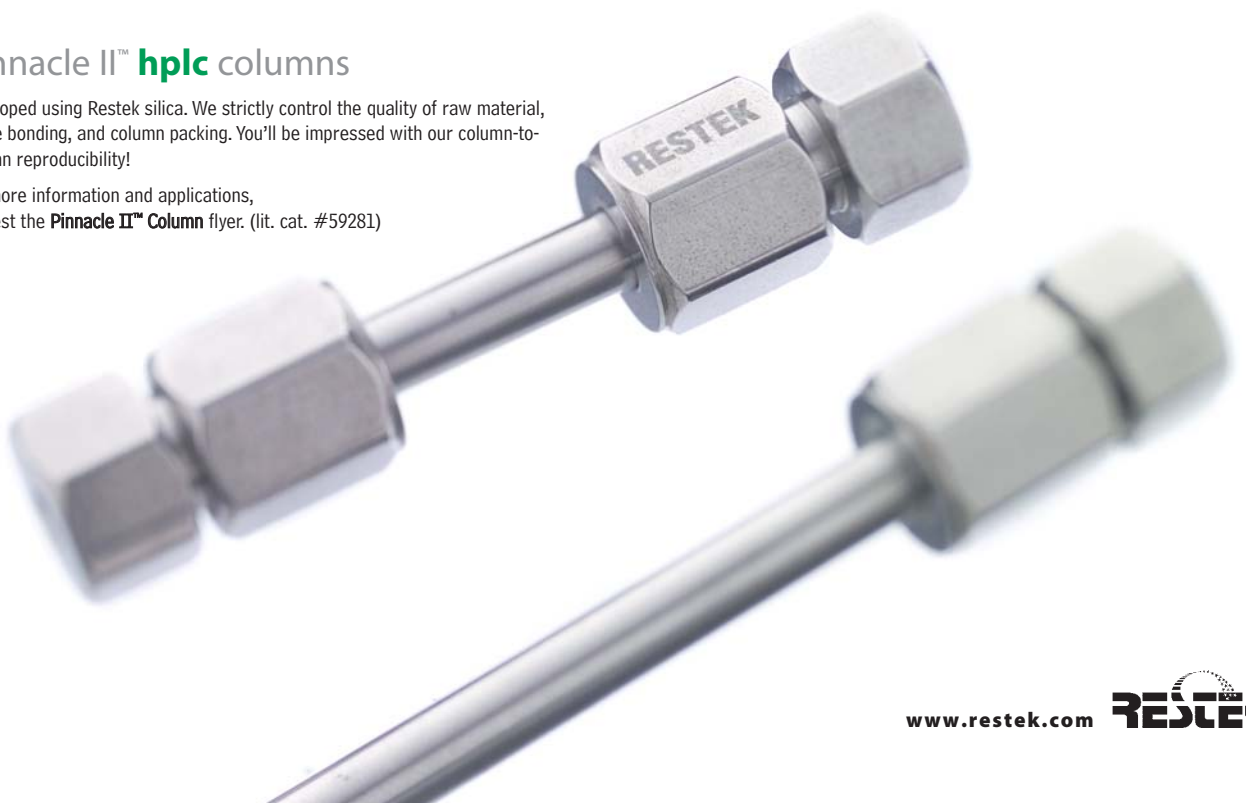
for **more** info

Request Applications Note **Analyze Polar Compounds by Reversed Phase HPLC Using Ultra Aqueous C18 Column** (cat.# 59177).

pinnacle II™ **hplc** columns

Developed using Restek silica. We strictly control the quality of raw material, phase bonding, and column packing. You'll be impressed with our column-to-column reproducibility!

For more information and applications, request the **Pinnacle II™ Column** flyer. (lit. cat. #59281)



Amino Acids, Organic Acids

Amino Acids

Proteins are polymeric materials with molecular weights greater than 5,000. The basic building blocks of proteins are amino acids, which have the nutritional properties, but not the functional properties, of proteins. There are 20 common amino acids in food systems, categorized as essential or nonessential amino acids. Derivatization often is used to provide adequate retention of amino acids, especially the more hydrophilic compounds. An **Ultra Aqueous C18** reversed phase HPLC column can separate many amino acids without derivatization or ion pairing reagents. To maximize retention, the **Ultra Aqueous C18** column can be used with a 100% aqueous mobile phase without compromising the reproducibility of the analysis.

Organic Acids

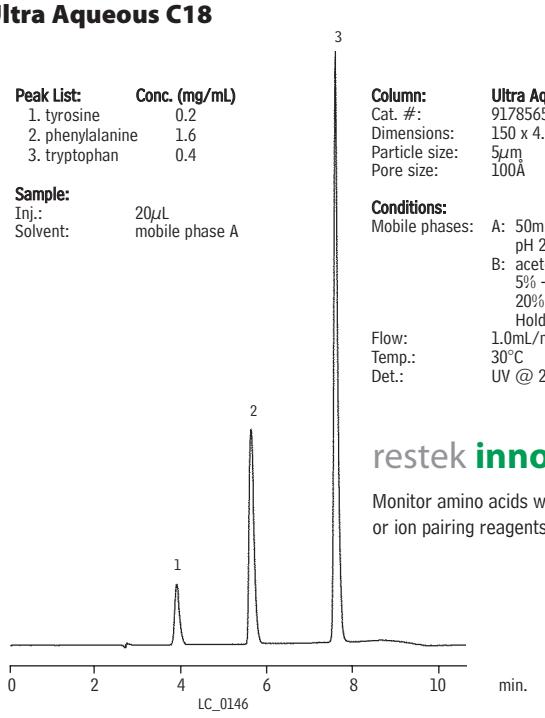
Organic acids play several important roles in food and beverage systems. For example, they are important flavor compounds and indicators of product quality. In some fruit juices, the organic acid profile is monitored to determine the purity of the fruit juice. Malic acid and citric acid can be found in fruits, oxalic acid can be found in spinach and rhubarb, and tartaric acid is present in grapes. In food systems, organic acids may be added as acidulants, to control the pH of the product. Certain organic acids also can be used as antimicrobial agents; for example, propionic acid can be used to inhibit mold growth.

The analysis of polar organic acids can be difficult using conventional reversed phase HPLC columns, even with highly aqueous mobile phases. The **Ultra Aqueous C18** column was designed for challenging applications such as this, and provides enhanced retention and selectivity for organic acids.

Cathy Gross
HPLC Products
Marketing Manager

Amino Acids
Ultra Aqueous C18

HPLC



Peak List:	Conc. (mg/mL)
1. tyrosine	0.2
2. phenylalanine	1.6
3. tryptophan	0.4

Sample:
Inj.: 20µL
Solvent: mobile phase A

Column: Ultra Aqueous C18
Cat. #: 9178565
Dimensions: 150 x 4.6mm
Particle size: 5µm
Pore size: 100Å

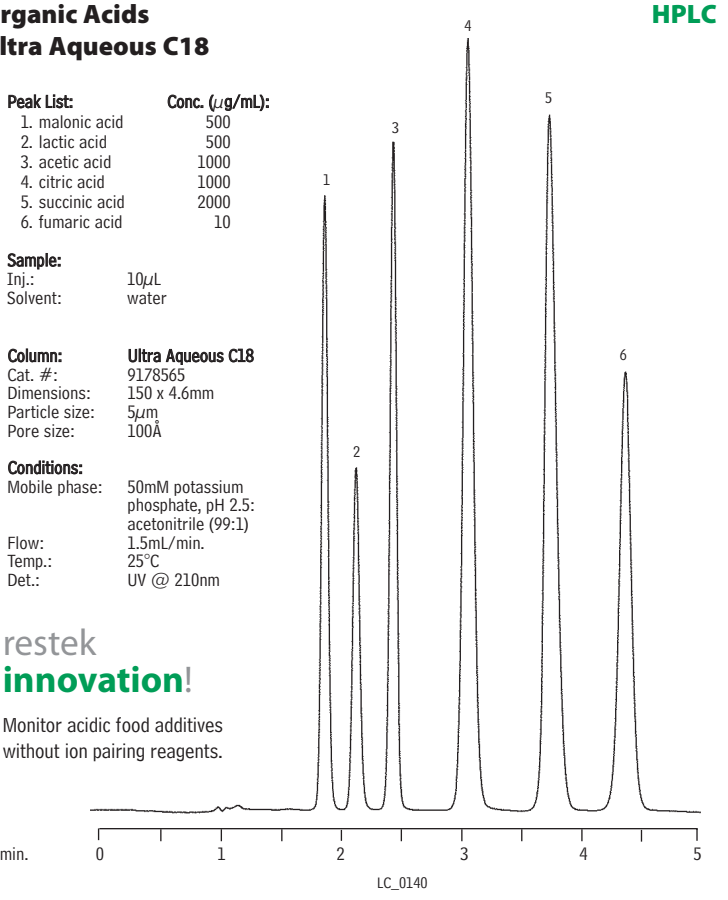
Conditions:
Mobile phases: A: 50mM potassium phosphate, pH 2.5
B: acetonitrile
5% - 20% B: 0-5 min.
20% - 5% B: 5-6 min.
Hold at 5% B: 6-13 min.
Flow: 1.0mL/min.
Temp.: 30°C
Det.: UV @ 254nm

restek **innovation**!

Monitor amino acids without derivatization or ion pairing reagents.

Organic Acids
Ultra Aqueous C18

HPLC



Peak List:	Conc. (µg/mL):
1. malonic acid	500
2. lactic acid	500
3. acetic acid	1000
4. citric acid	1000
5. succinic acid	2000
6. fumaric acid	10

Sample:
Inj.: 10µL
Solvent: water

Column: Ultra Aqueous C18
Cat. #: 9178565
Dimensions: 150 x 4.6mm
Particle size: 5µm
Pore size: 100Å

Conditions:
Mobile phase: 50mM potassium phosphate, pH 2.5: acetonitrile (99:1)
Flow: 1.5mL/min.
Temp.: 25°C
Det.: UV @ 210nm

restek **innovation**!

Monitor acidic food additives without ion pairing reagents.

Organic Acids in Fruit Juice
Allure™ Organic Acids

HPLC

Peak List:	Conc. (mg/mL)
1. tartaric acid	1
2. quinic acid	1
3. malic acid	1
4. citric acid	1
5. fumaric acid	0.005

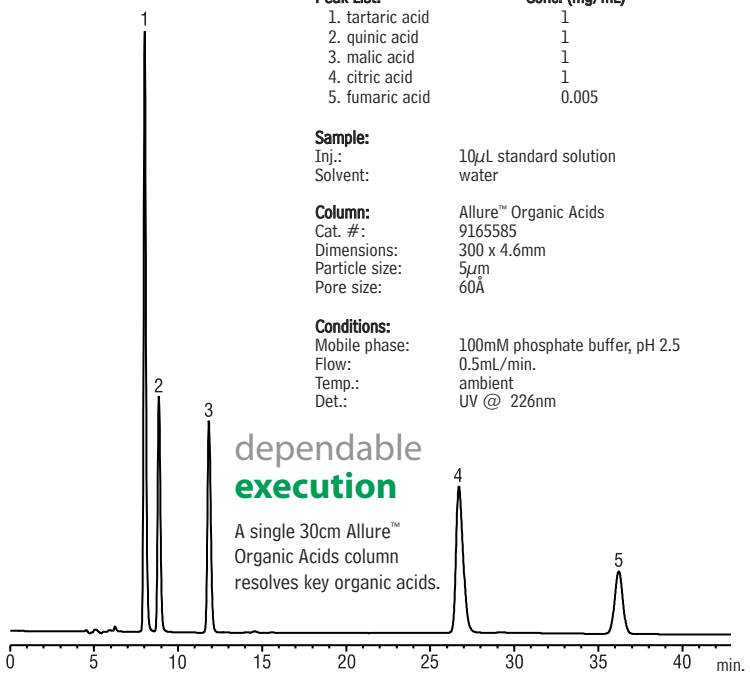
Sample:
Inj.: 10µL standard solution
Solvent: water

Column:
Allure™ Organic Acids
Cat. #: 9165585
Dimensions: 300 x 4.6mm
Particle size: 5µm
Pore size: 60Å

Conditions:
Mobile phase: 100mM phosphate buffer, pH 2.5
Flow: 0.5mL/min.
Temp.: ambient
Det.: UV @ 226nm

dependable
execution

A single 30cm Allure™ Organic Acids column resolves key organic acids.



LC_0238

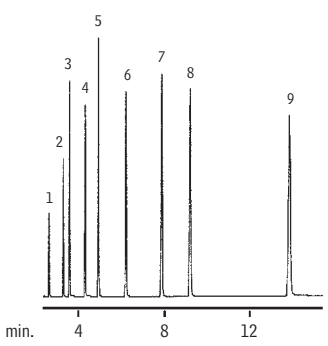
Short Chain Acids

GC

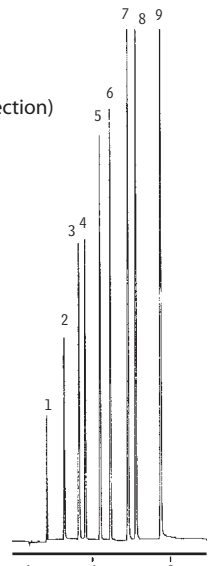
Stabilwax®-DA
(split injection)

Rtx®-1
(direct injection)

Peak List:
1. acetic acid
2. propionic acid
3. isobutyric acid
4. *n*-butyric acid
5. isovaleric acid
6. *n*-valeric acid
7. isocaproic acid
8. caproic acid
9. heptanoic acid



GC_CH00280



GC_CH00281

30m, 0.25mm ID, 0.25µm Stabilwax®-DA (cat.# 11023)
1.0µL split injection of a free acid standard.
Concentration approximately 10 to 20ng/µL.

Oven temp.:	145°C
Inj. & det. temp.:	250°C
Carrier gas:	hydrogen
Linear velocity:	40cm/sec.
FID sensitivity:	2 x 10^{-11} AFS
Split ratio:	50:1

30m, 0.53mm ID, 5.0µm Rtx®-1 (cat.# 10179)
0.2µL injection of a 10–20ng/µL free fatty acid standard in water. Direct injection using a Uniliner® liner.

Oven temp.:	60°C to 180°C @ 15°C/min.
Inj. & det. temp.:	250°C
Carrier gas:	hydrogen
Linear velocity:	50cm/sec. (flow rate: 6cc/min.)
FID sensitivity:	4 x 10^{-11} AFS

The organic acid content of fruit juices, such as cranberry and grape, can be determined using AOAC method 986.13. Because several of the acids are extremely difficult to resolve, this procedure calls for two reversed phase C18 columns in series, on a 100% aqueous mobile phase.

A single 30cm **Allure™ Organic Acids** column effectively resolves key organic acids, such as tartaric and quinic, using the chromatographic conditions specified in AOAC method 986.13!

Organic acids also can be analyzed by GC. Shorter chain, volatile free fatty acids such as acetic, propionic, butyric, and valeric acids can be analyzed using a **Stabilwax®-DA** column, a bonded Carbowax® column specifically deactivated for acidic compounds. Direct injection generally is recommended, to avoid losing volatile low molecular weight free fatty acids through the split vent, thus improving reproducibility.

Less polar columns, such as Rtx®-1 and Rtx®-200 (page 2), can be used to separate short chain acids. However, thicker films are required to improve separation and increase sample capacity for polar compounds.

for **more** info

Request Application Notes **Analyze Polar Compounds by Reversed Phase HPLC, Using Ultra Aqueous C18 Column** (cat.# 59177) and **Single Column Method for HPLC Analysis of Organic Acids in Fruit Juices, Using an Allure™ Organic Acids Column** (cat.# 59530).

Preservatives

Preservatives

Preservation techniques are used in foods and beverages to maintain the quality of the product. Food preservation can be done by both physical and chemical means. Physical techniques might involve drying, heating, freezing, pasteurization, or irradiation; chemical techniques include adding sugar, salt, or preservatives. Several common chemicals, such as acetic acid and citric acid, can be used to prevent the growth of food-spoiling microorganisms. Calcium propionate can be used to prevent mold growth. In addition, benzoate and sorbate salts can be used as mold inhibitors in a range of food and beverage products.

Benzoate and sorbate salts can be analyzed in their protonated form (i.e., as benzoic acid and sorbic acid) by reversed phase HPLC using an **Ultra Phenyl** column and acidified water:methanol (80:20, v/v) as the mobile phase. By monitoring the UV absorbance at 245nm, sensitive detection of benzoic and sorbic acids can be achieved. For optimum sensitivity, monitor benzoic acid at 230nm and sorbic acid at 254nm.

Analyze phenolic antioxidants by reversed phase HPLC using a **Pinnacle II™ C18** column and an acidic mobile phase.

for **more** info

Request Flyer **High Performance Silica Products** (cat.# 59901).

Sorbic Acid and Benzoic Acid
Ultra Phenyl

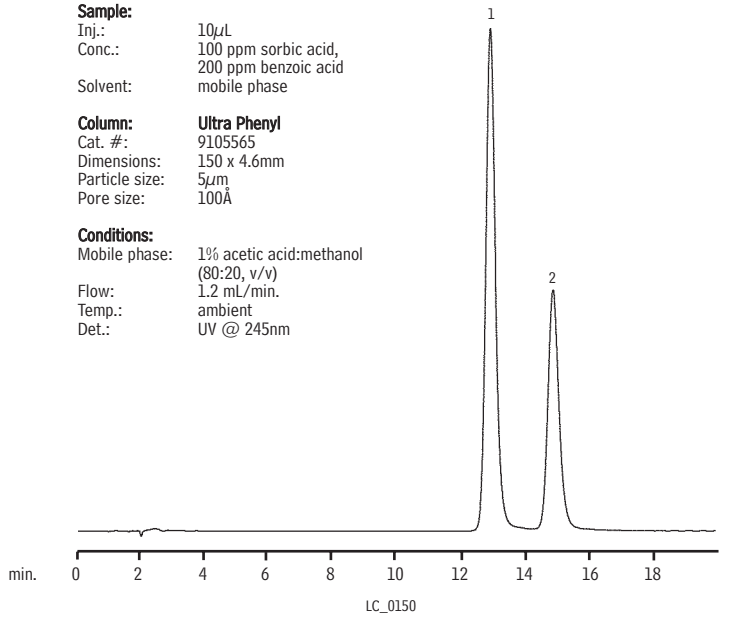
HPLC

Peak List:
1. sorbic acid
2. benzoic acid

Sample:
Inj.: 10µL
Conc.: 100 ppm sorbic acid, 200 ppm benzoic acid
Solvent: mobile phase

Column: **Ultra Phenyl**
Cat. #: 9105565
Dimensions: 150 x 4.6mm
Particle size: 5µm
Pore size: 100Å

Conditions:
Mobile phase: 1% acetic acid:methanol (80:20, v/v)
Flow: 1.2 mL/min.
Temp.: ambient
Det.: UV @ 245nm



LC_0150

Phenolic Antioxidants
Pinnacle II™ C18

HPLC

Peak List:	**conc.: (ppm)**
1. propyl gallate	168
2. TBHQ	182
3. 2-BHA + 3-BHA	197
4. BHT	193

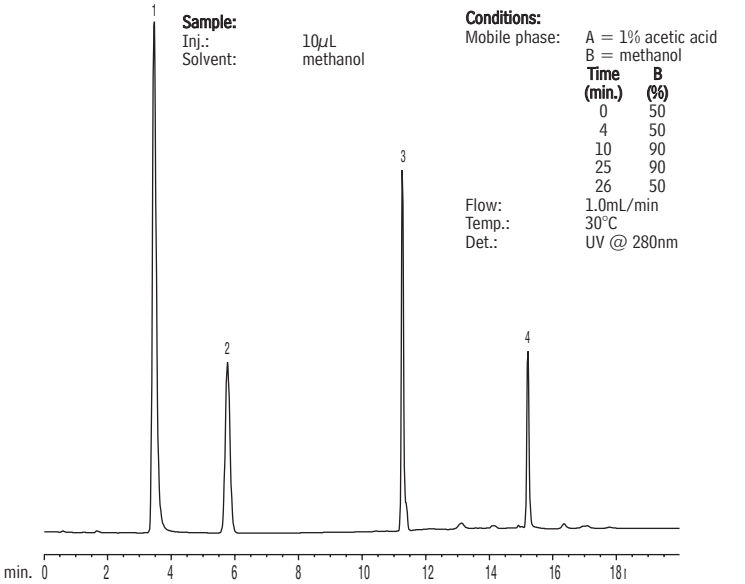
Sample:
Inj.: 10µL
Solvent: methanol

Column: **Pinnacle II™ C18**
Cat. #: 9214565
Dimensions: 150 x 4.6mm
Particle size: 5µm
Pore size: 110Å

Conditions:
Mobile phase: A = 1% acetic acid
B = methanol

Time (min.)	**B (%)**
0	50
4	50
10	90
25	90
26	50

Flow: 1.0mL/min
Temp.: 30°C
Det.: UV @ 280nm



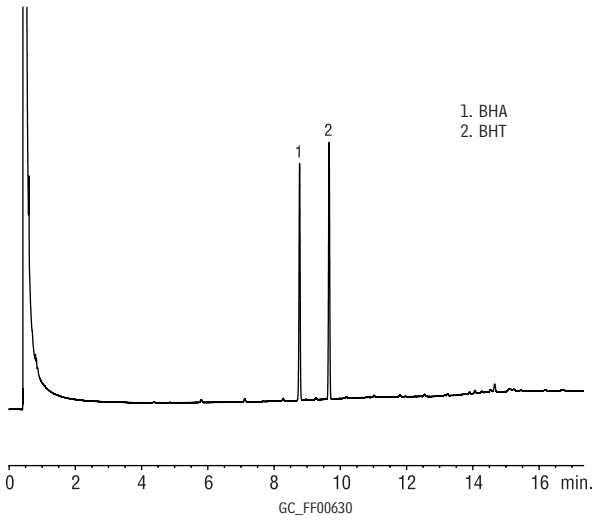
LC_0198

Foods containing fats and oils are prone to lipid oxidation, which can promote off-flavors and limit shelf-life. To inhibit lipid oxidation, antioxidants can be added to the product. Phenolic antioxidants, including butylated hydroxyanisole (BHA), butylated hydroxytoluene (BHT), propyl gallate (PG), and tert-butyl hydroquinone (TBHQ), are used in a variety of products. Phenolic antioxidants are regulated by the FDA and can be added to the product at levels up to 200ppm based on the fat content. Another approach is to use "natural" antioxidants, such as tocopherols and tocotrienols. These compounds inhibit lipid oxidation and promote general health in the consumer.

Phenolic antioxidants can be analyzed by GC using intermediate polarity **Rtx®-50** or **Rtx®-20** capillary columns. Coelutions that can occur with less polar columns can be avoided. Using direct injection and a flame ionization detector, BHA and BHT can be separated in less than 10 minutes. Using an **Rtx®-20** column, tocopherols from the unsaponified fraction of animal and vegetable fats and oils can be analyzed in their free form without derivatization. Baseline resolution is possible, with analyses times of less than 10 minutes.

BHA and BHT
Rtx®-50

GC



Rtx®-50, 30m, 0.53mm ID, 0.50μm (cat.# 10540)

Sample:	50ppm each in methanol
Inj.:	1.0μL direct injection, gooseneck splitless inlet liner, 4mm (cat.# 20798)
Inj. temp.:	280°C
Carrier gas:	helium, constant pressure
Linear velocity:	60cm/sec. @ 50°C
Oven temp.:	50°C to 240°C @15°C/min. (hold 3 min.)
Det.:	FID @280°C

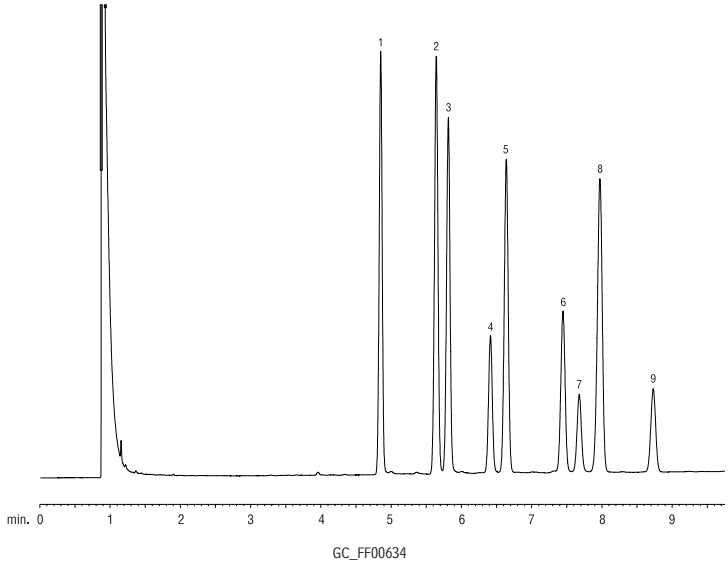
Tocopherols and Tocotrienols
Rtx®-20

GC

1. δ-tocopherol
2. β-tocopherol
3. γ-tocopherol
4. dl-δ-tocotrienol
5. α-tocopherol
6. dl-β-tocotrienol
7. dl-γ-tocotrienol
8. hexadecyl hexadecanoate
9. dl-α-tocotrienol

Rtx®-20, 30m, 0.53mm ID, 0.5μm (cat.# 10340)

Sample:	1mg/mL each component in isooctane
Inj.:	1.0μL split (split ratio 20:1), 4mm inlet liner (cat.# 20814)
Inj. temp.:	320°C
Carrier gas:	hydrogen, constant flow
Flow rate:	5.2mL/min.
Oven temp.:	270°C to 290°C @ 2°C/min. 290°C to 320°C @ 10°C/min. (1 min. hold)
Det.:	FID @ 320°C



for **more** info

Request Application Note **HPLC Analysis of Preservatives Using Ultra Aqueous and Pinnacle II™ Columns** (cat. # 59398).

Flavors & Fragrances

Flavor consists of the taste, the aroma, and the trigeminal response to a compound. The aroma of a compound can be exceedingly complex, with several hundred volatiles playing a role. Because the nose can be extremely sensitive to some odorants, trace-level analyses may be necessary. Off-flavors can result from chemical changes in foods, microbial growth, or contamination. Chemical changes include lipid oxidation, nonenzymatic browning, and enzymatic action in the food.

Vanilla Extracts and Flavorings

One example of flavor analysis is the determination of the compounds present in vanilla extracts and flavorings. Vanilla extracts and flavorings are used in a wide range of food products, including dairy products, beverages, baked goods, and confections. In AOAC Method 990.25, flavor compounds in vanilla extract and artificial vanilla flavor are analyzed using HPLC. The analytes are separated on a C8 column and quantified by comparing their UV absorbance at 254nm to an external standard. An efficient separation can be performed using an **Ultra C8** reversed phase HPLC column and a gradient elution program, with acidified water:methanol as the mobile phase. By using a gradient program and flow rate of 1mL/min., the analysis time can be reduced to 25 minutes.

for **more** info

Request Application Note **Analysis of Vanillin and Ethyl Vanillin in Vanilla Flavors Using Ultra C8 Column** (cat. # 59186).

Vanillin and Ethyl Vanillin
Ultra C8

HPLC

Sample:
Inj.: 10mL
Solvent: 40% ethanol

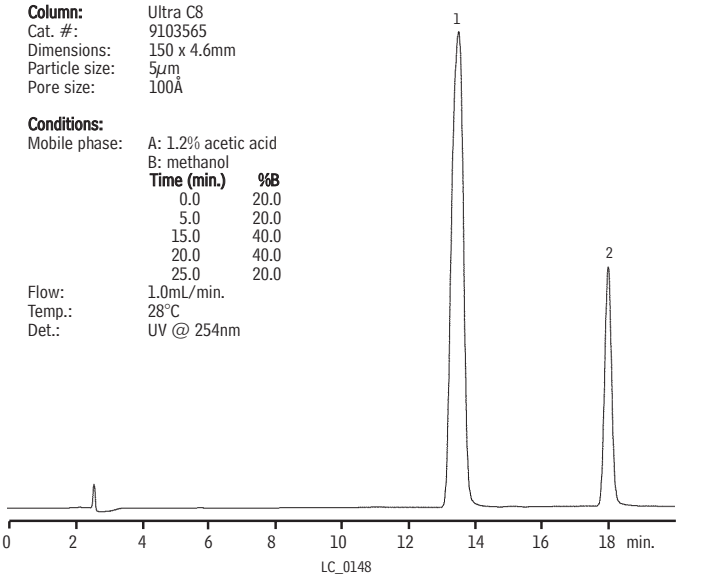
Column: Ultra C8
Cat. #: 9103565
Dimensions: 150 x 4.6mm
Particle size: 5µm
Pore size: 100Å

Conditions:
Mobile phase: A: 1.2% acetic acid
B: methanol

Time (min.)	%B
0.0	20.0
5.0	20.0
15.0	40.0
20.0	40.0
25.0	20.0

Flow: 1.0mL/min.
Temp.: 28°C
Det.: UV @ 254nm

Peak List: **Conc. (mg/mL)**
1. vanillin 0.12
2. ethyl vanillin 0.04



Vanilla Extract
Ultra C8

HPLC

Peak List:
1. vanillin

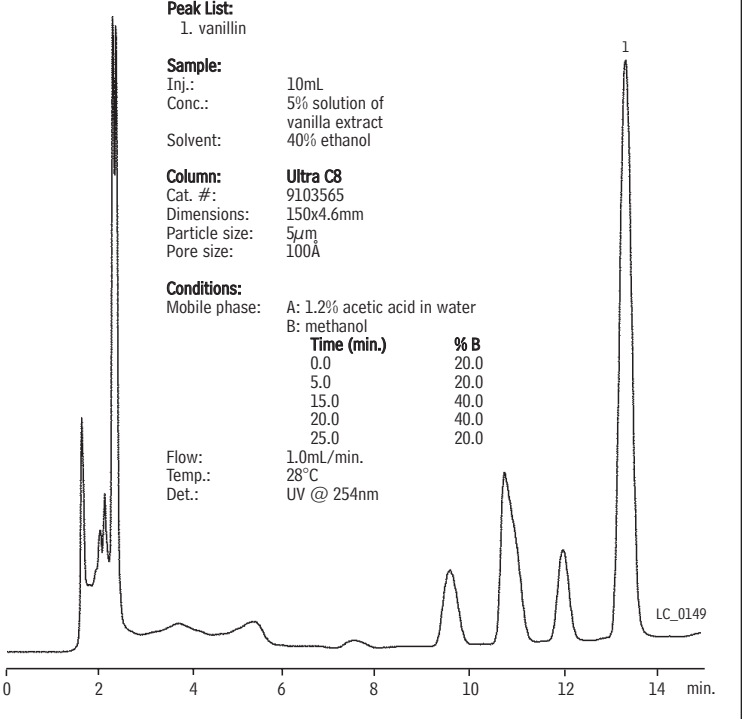
Sample:
Inj.: 10mL
Conc.: 5% solution of vanilla extract
Solvent: 40% ethanol

Column: **Ultra C8**
Cat. #: 9103565
Dimensions: 150x4.6mm
Particle size: 5µm
Pore size: 100Å

Conditions:
Mobile phase: A: 1.2% acetic acid in water
B: methanol

Time (min.)	% B
0.0	20.0
5.0	20.0
15.0	40.0
20.0	40.0
25.0	20.0

Flow: 1.0mL/min.
Temp.: 28°C
Det.: UV @ 254nm



Capsaicinoids: Heat Level Assay Ultra C18

HPLC

Column: Ultra C18
Cat. #: 9174565
Dimensions: 150 x 4.6mm
Particle size: 5µm
Pore size: 100Å

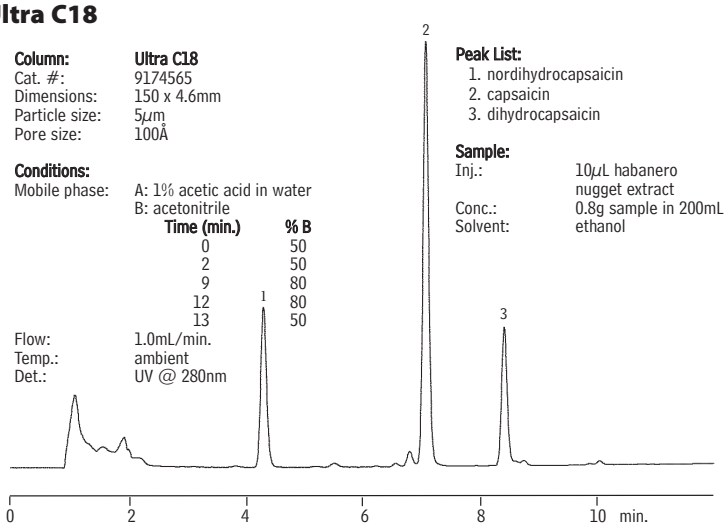
Conditions:
Mobile phase: A: 1% acetic acid in water
B: acetonitrile

Time (min.)	% B
0	50
2	50
9	80
12	80
13	50

Flow: 1.0mL/min.
Temp.: ambient
Det.: UV @ 280nm

Peak List:
1. nordihydrocapsaicin
2. capsaicin
3. dihydrocapsaicin

Sample:
Inj.: 10µL habanero nugget extract
Conc.: 0.8g sample in 200mL
Solvent: ethanol

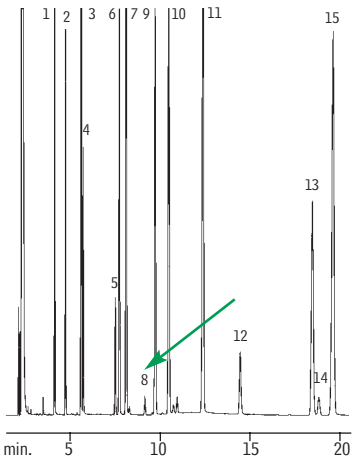


LC_0156

Flavor & Fragrance Compounds Rt-CW20M™ F&F

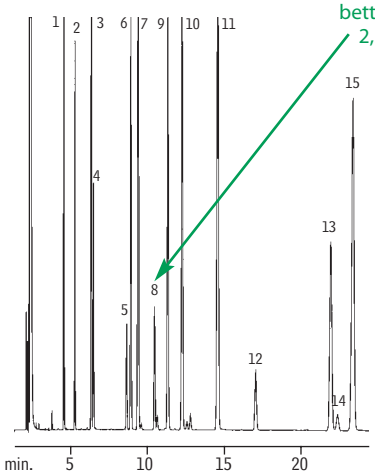
GC

Traditional Carbowax® column



1. methyl heptanoate
2. hexanol
3. methyl octanoate
4. nonanal
5. menthone
6. citronellal
7. methyl nonanoate
8. 2,3-butanediol
9. linalool
10. linalyl acetate
11. methyl decanoate
12. menthol
13. α-terpineol
14. γ-terpineol
15. methyl undecanoate

Rt-CW20M™ F&F column



50m, 0.32mm ID, 0.33µm, Carbowax® 20M or Rt-CW20M™ F&F (cat.# 12539)
On-column injection of 5ng to 150ng each compound in methylene chloride, split 10:1

Carrier gas: hydrogen, 40cm/sec.
Inj. & det. temp.: 220°C
Oven temp.: 110°C

GC_FF00433

Heat Levels of Spicy Foods

The hotness of chili peppers, salsas, and other spicy foods can be monitored using HPLC. By measuring the levels of three different capsaicinoid species in the sample, the heat level in Scoville Heat Units (SHUs) can be calculated. AOAC Method 995.03 is a reversed phase HPLC method that calls for a C18 column and acidified water:acetonitrile as the mobile phase to separate nordihydrocapsaicin, capsaicin, and dihydrocapsaicin. This separation can be performed using an **Ultra C18** column. Using a gradient elution program, an efficient separation can be performed in less than 10 minutes. The high percentage of organic in the mobile phase at the end of the analysis helps elute any strongly retained species.

Flavor & Fragrance Volatiles

Flavor and fragrance analysts have compiled retention index libraries for thousands of compounds. Unfortunately, even slight changes in column selectivity can result in misidentification of compounds. With this in mind, Restek developed the **Rtx®-1 F&F** column. This polymer matches the selectivity required by the industry, while offering higher thermal stability. Additionally, **Rt-CW20M™ F&F** columns feature a non-bonded phase designed specifically for flavor and fragrance compounds. **Rt-CW20M™ F&F** columns exhibit better inertness than other non-bonded Carbowax® columns.

for **more** info

Request Application Note **Analyzing the Heat Level of Spicy Foods Using an Ultra C18 HPLC column** (cat. # 59199).

Flavors & Fragrances

Alcoholic Beverages

The chromatographic profile of alcoholic beverages consists of a wide range of compounds, including acids, alcohols, and aldehydes. GC can be used to analyze these compounds without the need for preliminary extractions.

An **Rtx®-1301** or **MXT®-1301** capillary column provides efficient separation of the volatile organic compounds in alcoholic beverages. Packed columns, such as **CarboBlack™ B** with a **5% Carbowax® 20M** phase, are an excellent alternative for these compounds. **CarboBlack™** columns are made using SilcoSmooth™ stainless steel tubing with a deactivated silica inner layer. This improves inertness, durability, and flexibility over traditional glass packed columns.

for **more** info

Request Technical Guide **Analyzing Alcoholic Beverages by Gas Chromatography** (cat.# 59462).

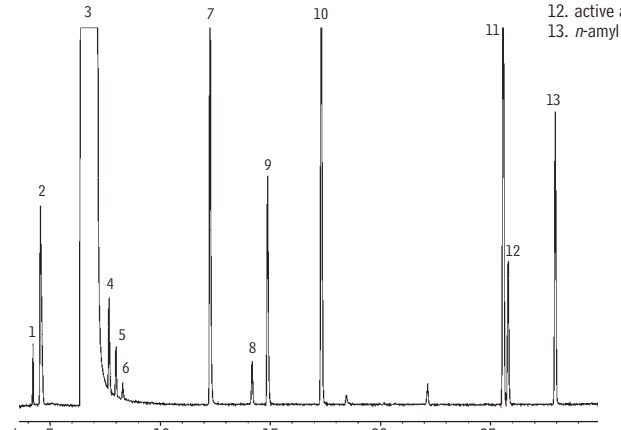
Rum
Rtx®-1301

GC

60m, 0.25mm ID, 1.4µm Rtx®-1301 (cat.# 16016)
1.0µL split injection using a Cyclosplitter® liner (cat.# 20706).
Conc.: neat

Oven temp.: 35°C (hold 5 min.) to 100°C @ 1°C/min.
Inj./det. temp.: 150°C / 200°C
Carrier gas: hydrogen @ 40cm/sec.
Split ratio: 100:1

1. acetaldehyde
2. methanol
3. ethanol
4. acetone
5. ethyl formate
6. isopropanol
7. *n*-propanol
8. ethyl acetate
9. *sec*-butanol
10. isobutanol
11. isoamyl alcohol
12. active amyl alcohol
13. *n*-amyl alcohol



GC_FF00110

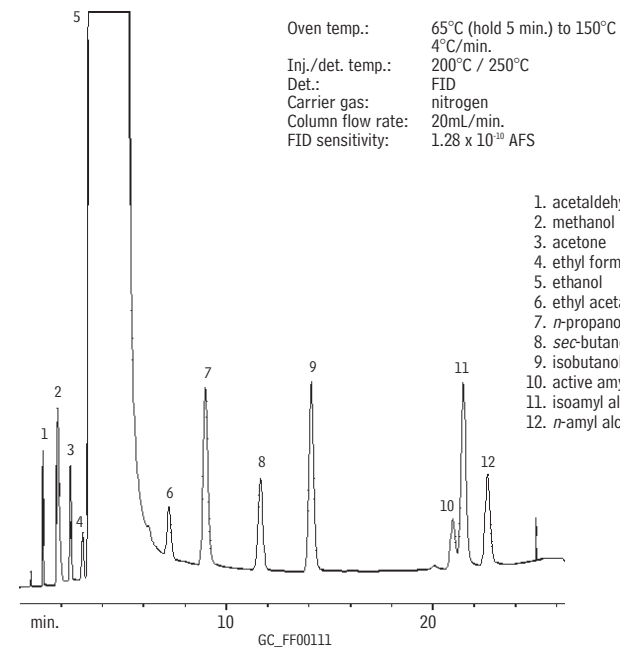
Rum
CarboBlack™ B

PACKED GC

5% Carbowax® 20M 80/120 CarboBlack™ B (cat.# 80105)
2m, 1/8" OD x 2mm ID SilcoSmooth™ tubing
0.5µL on-column injection
Conc.: neat

Oven temp.: 65°C (hold 5 min.) to 150°C @ 4°C/min.
Inj./det. temp.: 200°C / 250°C
Det.: FID
Carrier gas: nitrogen
Column flow rate: 20mL/min.
FID sensitivity: 1.28 x 10^{-10} AFS

1. acetaldehyde
2. methanol
3. acetone
4. ethyl formate
5. ethanol
6. ethyl acetate
7. *n*-propanol
8. *sec*-butanol
9. isobutanol
10. active amyl alcohol
11. isoamyl alcohol
12. *n*-amyl alcohol

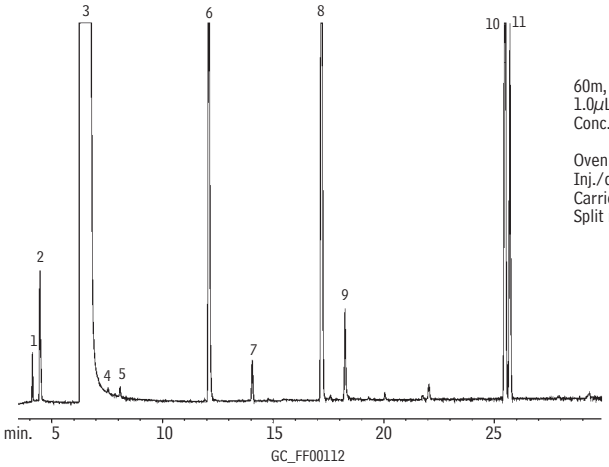


GC_FF00111

Scotch Rtx®-1301

GC

1. acetaldehyde
2. methanol
3. ethanol
4. acetone
5. isopropanol
6. *n*-propanol
7. ethyl acetate
8. isobutanol
9. acetic acid
10. isoamyl alcohol
11. active amyl alcohol



GC_FF00112

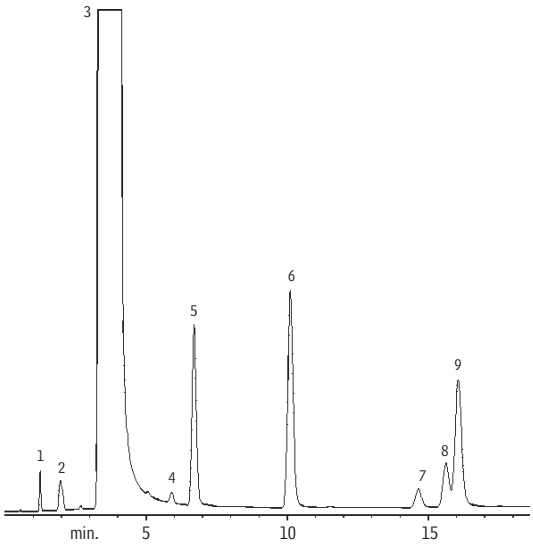
60m, 0.25mm ID, 1.4µm Rtx®-1301 (cat.# 16016)
1.0µL split injection using a Cyclosplitter® inlet liner (cat.# 20706).
Conc.: neat

Oven temp.: 35°C (hold 5 min.) to 100°C @ 1°C/min.
Inj./det. temp.: 150°C / 200°C
Carrier gas: hydrogen @ 40cm/sec.
Split ratio: 100:1

Scotch CarboBlack™ B

PACKED GC

1. acetaldehyde
2. methanol
3. ethanol
4. ethyl acetate
5. *n*-propanol
6. isobutanol
7. acetic acid
8. active amyl alcohol
9. isoamyl alcohol



GC_FF00113

5% Carbowax® 20M 80/120 CarboBlack™ B (cat.# 80105)
2m, 1/8" OD x 2mm ID Silcosmooth™ tubing
0.5µL on-column injection
Conc.: neat

Oven temp.: 70°C to 150°C @ 4°C/min.
Inj./det. temp.: 200°C / 250°C
Det.: FID
Carrier gas: nitrogen
Column flow rate: 20mL/min.
FID sensitivity: 1.28 x 10^{-10} AFS

for **more** info

Request Technical Guide **Analyzing Alcoholic Beverages by Gas Chromatography** (cat.# 59462).

Flavors & Fragrances

Essential Oils

Essential oil samples are very complex; hundreds of components can be present and some are present at ppm levels. **Rtx®-1, Rtx®-5** and **Stabilwax®** capillary GC columns are very effective for these analyses. A comprehensive list of retention times for flavor & fragrance compounds on **Rtx®-1** and **Stabilwax®** columns is on pages 28–29.

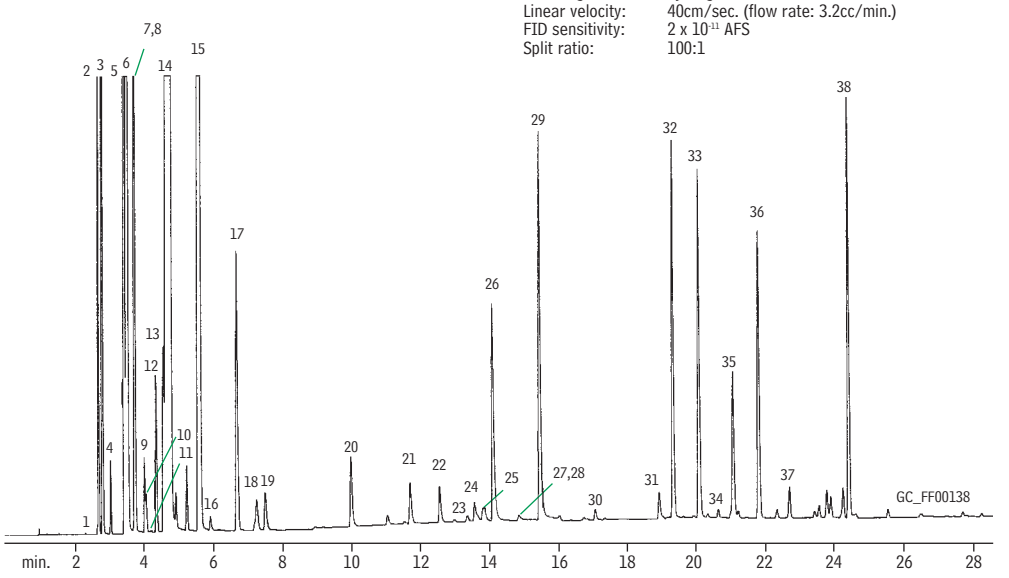
To determine the enantiomeric ratios of volatile components in essential oils, see Chiral Separations (pages 23–26).

Lemon Oil
Rtx®-5

GC

30m, 0.32mm ID, 0.25µm Rtx®-5 (cat.# 10224)
Wet needle split injection of a neat lemon oil

Oven temp.:	75°C (hold 8 min.) to 250°C @ 4°C/min.
Inj. & det. temp.:	250°C
Carrier gas:	hydrogen
Linear velocity:	40cm/sec. (flow rate: 3.2cc/min.)
FID sensitivity:	2 x 10^{-11} AFS
Split ratio:	100:1



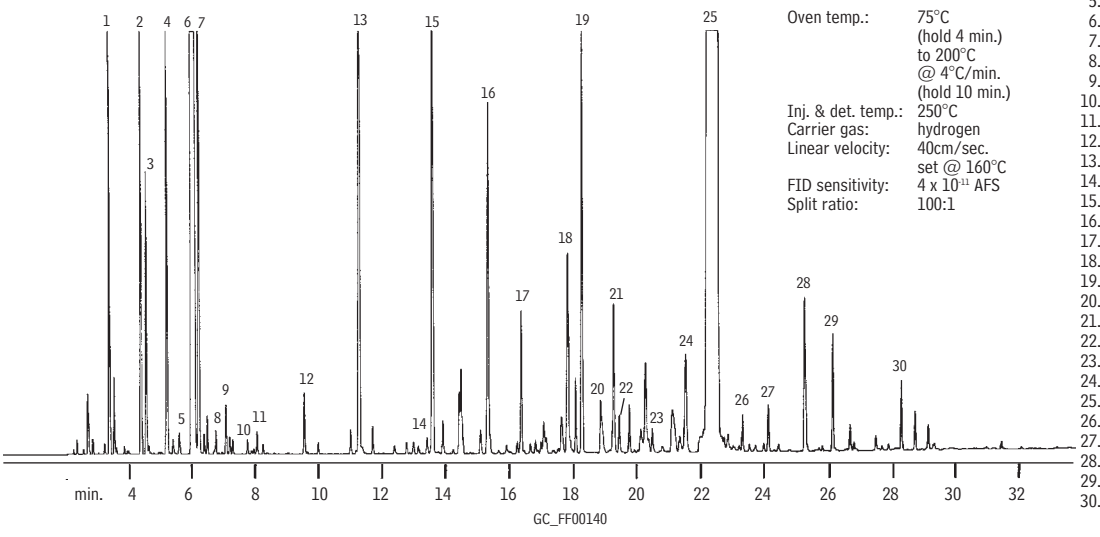
1. heptanol
2. α-thujene
3. α-pinene
4. camphene
5. sabinene
6. β-pinene
7. 6-methyl-5-hepten-2-one
8. myrcene
9. octanal
10. α-phellandrene
11. 3-carene
12. α-terpinene
13. *p*-cymene
14. limonene
15. γ-terpinene
16. octanol
17. terpinolene
18. linalool
19. nonanal
20. citronellal
21. terpinene-4-ol
22. α-terpineol
23. decanol
24. octyl acetate
25. nerol
26. neral
27. carvone
28. geraniol
29. geranial
30. nonyl acetate
31. citronellyl acetate
32. neryl acetate
33. geranyl acetate
34. dodecanal
35. β-caryophyllene
36. *trans*-α-bergamotene
37. α-humulene
38. β-bisabolene

Spearmint Oil (Native)
Stabilwax®

GC

60m, 0.25mm ID, 0.25µm
Stabilwax® (cat.# 10626)
0.2µL split injection of a neat spearmint oil

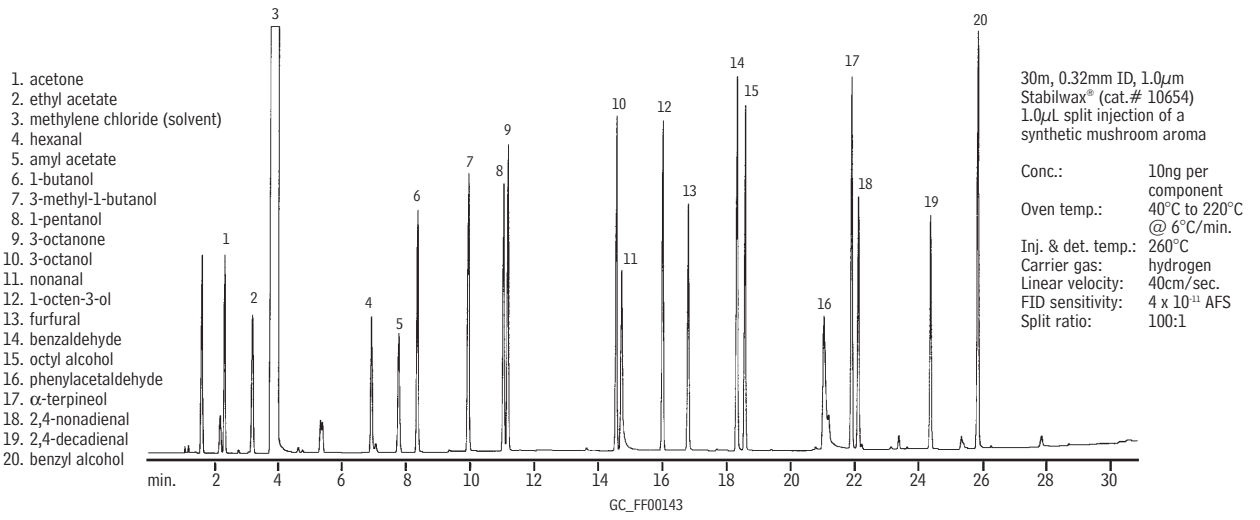
Oven temp.:	75°C (hold 4 min.) to 200°C @ 4°C/min. (hold 10 min.)
Inj. & det. temp.:	250°C
Carrier gas:	hydrogen
Linear velocity:	40cm/sec. set @ 160°C
FID sensitivity:	4 x 10^{-11} AFS
Split ratio:	100:1



1. α-pinene
2. β-pinene
3. sabinene
4. myrcene
5. α-terpinene
6. l-limonene
7. 1,8-cineole
8. *cis*-ocimene
9. γ-terpinene
10. *p*-cymene
11. terpinolene
12. 3-octyl acetate
13. 3-octanol
14. l-menthone
15. *trans*-sabinenehydrate
16. β-bourbonene
17. linalool
18. terpinene-4-ol
19. β-caryophyllene
20. dihydrocarvone
21. *trans*-dihydrocarvyl acetate
22. *trans*-β-farnesene
23. α-terpineol
24. germacrene-Δ
25. carvone
26. *cis*-carvyl acetate
27. *trans*-carveol
28. *cis*-carveol
29. *cis*-jasmone
30. viridiflorol

Synthetic Mushroom Aroma
Stabilwax®

GC



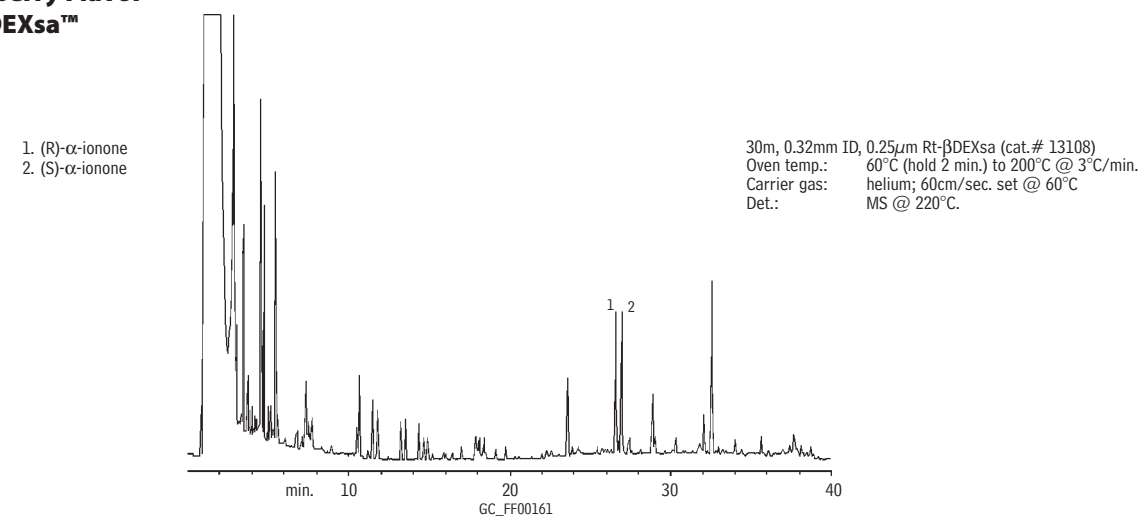
Chiral Separations

Chiral chromatography is the separation of enantiomeric compounds, which are mirror images of each other that are not superimposable. Common liquid stationary phases used in GC typically are not able to resolve enantiomeric compounds. However, the addition of derivatized cyclodextrin molecules to common stationary phases makes such separations possible. Restek's five chiral capillary columns incorporate various combinations of alkylated β-cyclodextrins into a cyanopropyl-dimethyl siloxane liquid stationary phase. The unique combinations of cyclodextrins allow analysis of a wide range of enantiomeric compounds.

Chiral capillary chromatography is a relatively new technique for determining the enantiomeric ratios of volatile components in essential oils. Enantiomeric ratios can be used for determining the authenticity of an essential oil or for characterizing regional differences among oils. The separation of enantiomeric compounds in flavor and fragrance samples can be optimized through column selection. Each of the five Restek chiral columns offers a different selectivity. The **Rt-βDEXsp™** column is optimized for menthol analysis, while the **Rt-βDEXsa™** column provides the best separation for 1-octen-3-ol, carvone, camphor, 1-phenylethanol, β-citronellol, and rose oxides. **Rt-βDEXsm™** and **Rt-βDEXse™** columns, used in combination, provide the best resolution for *cis*- and *trans*-linalool oxides, linalool, and linalyl acetate. The **Rt-βDEXcst™** column is ideal for semivolatile chiral compounds, including the irone isomers and γ- and δ-lactones.

Raspberry Flavor
Rt-βDEXsa™

GC



Chiral Separations

Flavor chemists can use chiral chromatography to monitor the ratios of various enantiomeric compounds. γ-lactones, for example, can be monitored to determine if a peach flavor has been adulterated. Ethyl-2-methylbutyrate and 2-methylbutyrate are important contributors to apple flavor, and both are naturally present in predominantly the (S) form in apple juices. The enantiomers of these two compounds can be resolved on an **Rt-βDEXsm™** column.

for **more** info

Request **Chiral Column Technical Guide** (cat.# 59889).

tech tip

To optimize chiral separations, use:

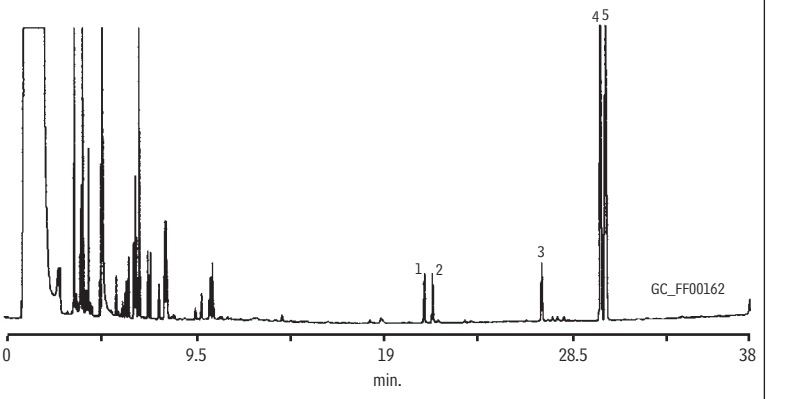
1) Faster linear velocities (80cm/sec.) with hydrogen carrier gas.
2) Slower temperature ramp rates (1–2°C/min.).
3) Appropriate minimum operating temperature (40 or 60°C).
4) On-column concentrations of 50ng or less.

Peach/Vanilla Flavor
Rt-βDEXsa™

GC

1. (R)-γ-octalactone
2. (S)-γ-octalactone
3. (R)-γ-decalactone
4. (R)-γ-undecalactone
5. (S)-γ-undecalactone

30m, 0.32mm ID, 0.25μm Rt-βDEXsa™ (cat.# 13108)
Oven temp.: 60°C (hold 2 min.) to 100°C @ 15°C/min. to 220°C @ 3°C/min.
Carrier gas: helium, 60cm/sec. set @ 60°C
Det.: MS @ 220°C

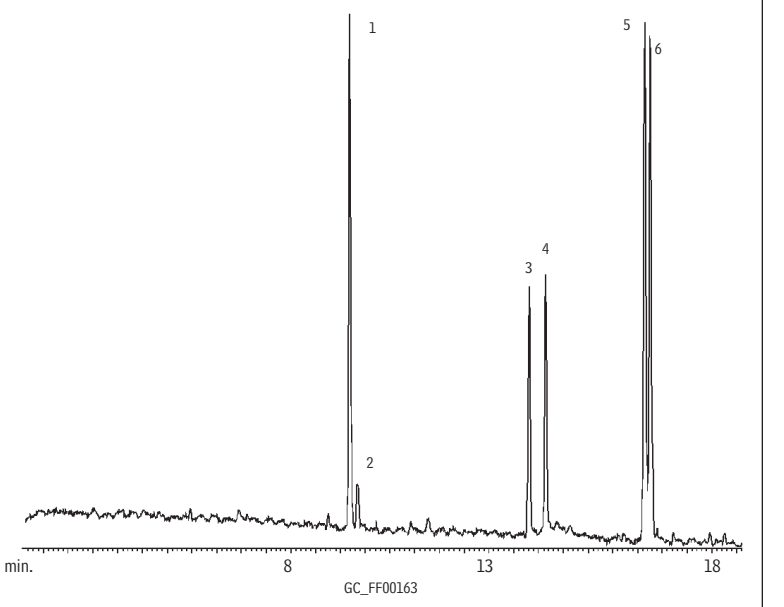


Bergamot Flavor
Rt-βDEXse™

GC

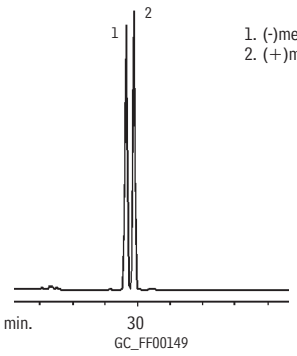
1. (S)-limonene
2. (R)-limonene
3. (R)-linalool
4. (S)-linalool
5. (R)-linalyl acetate
6. (S)-linalyl acetate

30m, 0.32mm ID, 0.25μm Rt-βDEXse™ (cat.# 13106)
Oven temp.: 40°C (hold 1 min.) to 200°C @ 4°C/min.
Carrier gas: helium, 60cm/sec. set @ 40°C
Det.: MS @ 220°C



GC

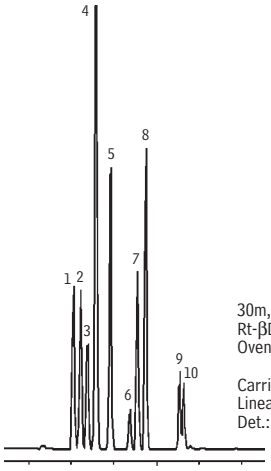
Menthol - Rt-βDEXsp™



1. (-)menthol
2. (+)menthol

30m, 0.32mm ID, 0.25μm
Rt-βDEXsp™ (cat.# 13110)
Oven temp.: 60°C (hold 1 min.) to 200°C @ 2°C/min.
Carrier gas: hydrogen
Linear velocity: 80cm/sec. set @ 40°C
Det.: FID @ 220°C

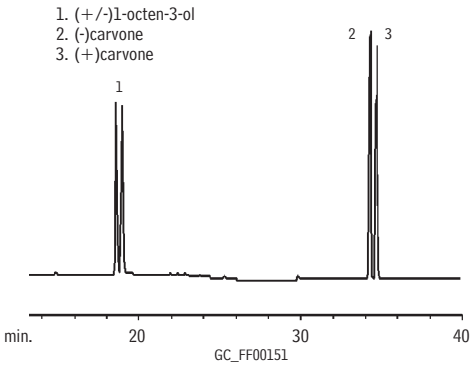
Irone Isomers - Rt-βDEXcst™



1. (-)-(2R,6R)-*trans*-α-irone
2. (+)-(2S,6S)-*trans*-α-irone
3. (+)-(2R,6R)-*trans*-γ-irone
4. (-)-(2S,6S)-*trans*-γ-irone
5. (+)-(2R,6S)-*cis*-α-irone
6. (+)-(2R,6S)-*cis*-γ-irone
7. (-)-(2S,6R)-*cis*-γ-irone
8. (-)-(2S,6R)-*cis*-α-irone
9. (+)-(2R)-β-irone
10. (-)-(2R)-β-irone

30m, 0.32mm ID, 0.25μm
Rt-βDEXcst™ (cat.# 13108)
Oven temp.: 40°C (hold 1 min.) to 230°C @ 2°C/min. (hold 3 min.)
Carrier gas: hydrogen
Linear velocity: 80cm/sec. set @ 40°C
Det.: FID @ 220°C

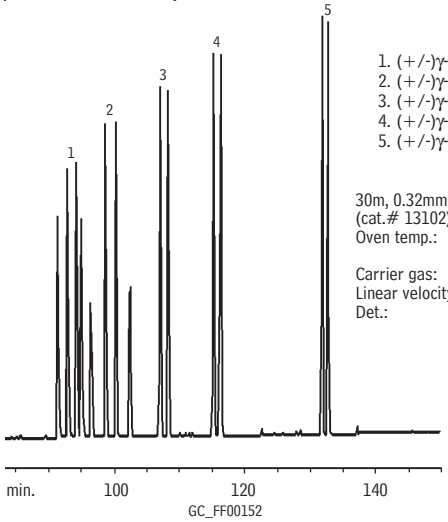
1-octen-3-ol and carvone - Rt-βDEXsa™



1. (+/-)1-octen-3-ol
2. (-)carvone
3. (+)carvone

30m, 0.32mm ID, 0.25μm
Rt-βDEXsa™ (cat.# 13108)
Oven temp.: 40°C (hold 1 min.) to 230°C @ 2°C/min. (hold 3 min.)
Carrier gas: hydrogen
Linear velocity: 80cm/sec. set @ 40°C
Det.: FID @ 220°C

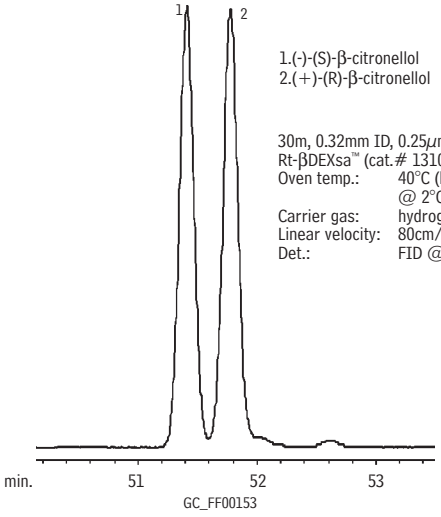
γ-lactones - Rt-βDEXcst™



1. (+/-)γ-heptalactone
2. (+/-)γ-octalactone
3. (+/-)γ-nonalactone
4. (+/-)γ-decalactone
5. (+/-)γ-dodecalactone

30m, 0.32mm ID, 0.25μm Rt-βDEXcst™ (cat.# 13102)
Oven temp.: 60°C (hold 1 min.) to 200°C @ 1°C/min.
Carrier gas: hydrogen
Linear velocity: 40cm/sec. set @ 60°C
Det.: FID @ 220°C

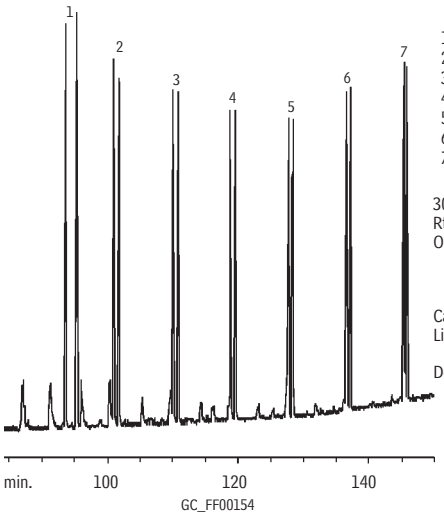
β-citronellol - Rt-βDEXsa™



1.(-)-(S)-β-citronellol
2.(+)-(R)-β-citronellol

30m, 0.32mm ID, 0.25μm
Rt-βDEXsa™ (cat.# 13108)
Oven temp.: 40°C (hold 1 min.) to 230°C @ 2°C/min. (hold 3 min.)
Carrier gas: hydrogen
Linear velocity: 80cm/sec. set @ 40°C
Det.: FID @ 220°C

δ-lactones - Rt-δDEXcst™



1. (+/-)δ-pentalactone
2. (+/-)δ-hexalactone
3. (+/-)δ-heptalactone
4. (+/-)δ-octalactone
5. (+/-)δ-nonalactone
6. (+/-)δ-decalactone
7. (+/-)δ-dodecalactone

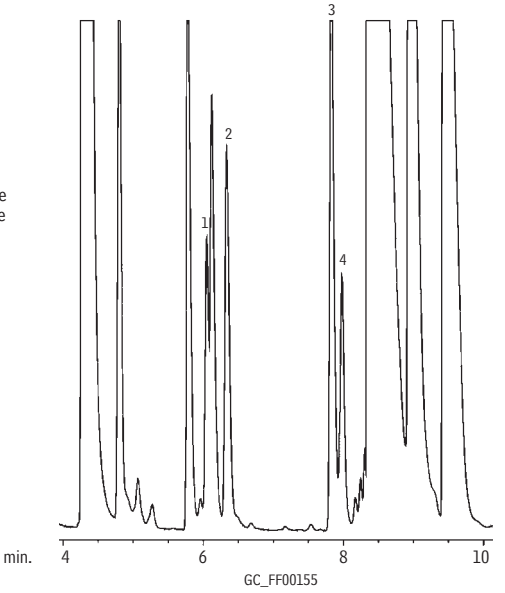
30m, 0.32mm ID, 0.25μm
Rt-βDEXcst™ (cat.# 13102)
Oven temp.: 60°C (hold 1 min.) to 200°C @ 1°C/min.
Carrier gas: hydrogen
Linear velocity: 40cm/sec. set @ 60°C
Det.: FID @ 220°C

Chiral Separations

GC

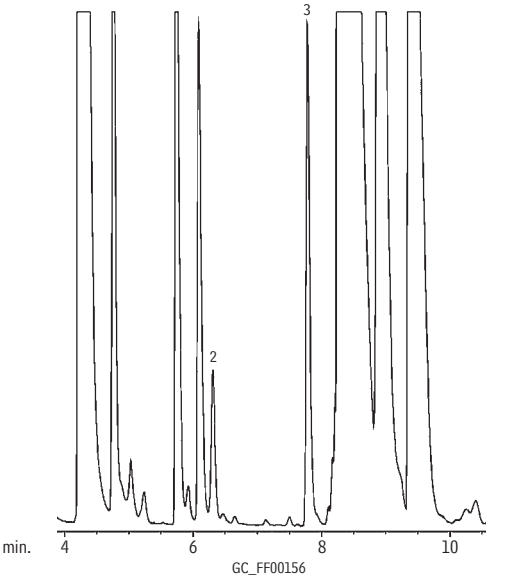
1. (R)-ethyl 2-methylbutyrate
2. (S)-ethyl 2-methylbutyrate
3. (R)-2-methylbutyrate
4. (S)-2-methylbutyrate

Apple Juice with Added Standards
Rt-βDEXsm™



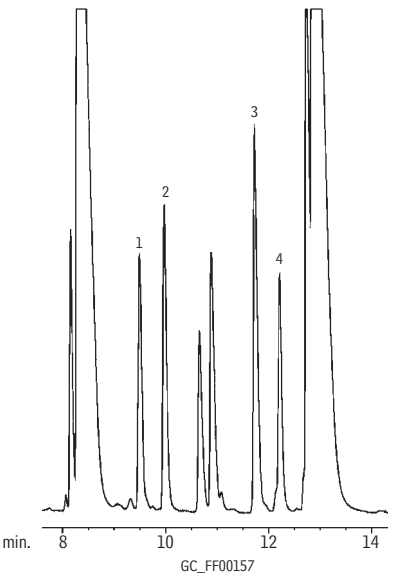
30m, 0.32mm ID, 0.25μm Rt-βDEXsm™ (cat.# 13104)
On-column conc. (standards): ~50ng

Apple Juice
Rt-βDEXsm™



30m, 0.32mm ID, 0.25μm Rt-βDEXsm™ (cat.# 13104)

Apple Juice with Added Standards
Rt-βDEXse™



30m, 0.32mm ID, 0.25μm Rt-βDEXse™ (cat.# 13106)
On-column conc. (standards): ~50ng

Apple Juice
Rt-βDEXse™

30m, 0.32mm ID, 0.25μm Rt-βDEXse™ (cat.# 13106)

1.0μL split injection.

Oven temp.:	40°C (hold 1 min.) to 220°C @ 2°C/min.
Inj. & det. temp.:	220°C
Carrier gas:	hydrogen
Linear velocity:	80cm/sec.

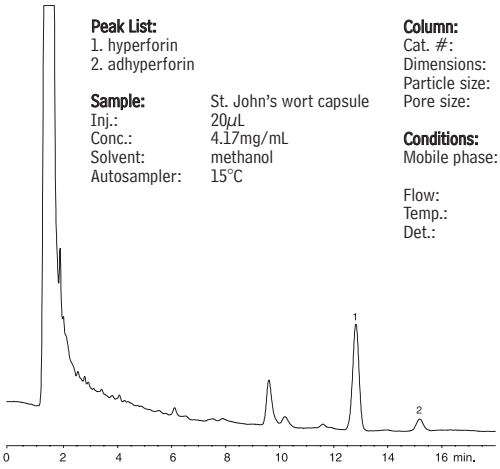
Hyperforin in St. John's Wort
Pinnacle II™ C18

HPLC

Peak List:
1. hyperforin
2. adhyperforin

Sample:	St. John's wort capsule
Inj.:	20µL
Conc.:	4.17mg/mL
Solvent:	methanol
Autosampler:	15°C

Column:	**Pinnacle II™ C18**
Cat. #:	9214565
Dimensions:	150 x 4.6mm
Particle size:	5µm
Pore size:	110Å
Conditions:	
Mobile phase:	0.01N phosphate buffer, pH 2.5: acetonitrile (15:85, v/v)
Flow:	1.2mL/min.
Temp.:	30°C
Det.:	UV @ 270nm



Phenolics in *Echinacea*
Pinnacle II™ C18

HPLC

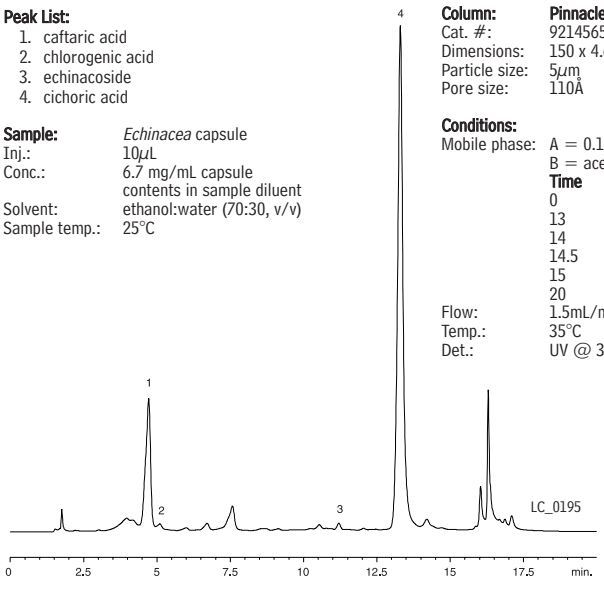
Peak List:
1. caftaric acid
2. chlorogenic acid
3. echinacoside
4. cichoric acid

Sample:	*Echinacea* capsule
Inj.:	10µL
Conc.:	6.7 mg/mL capsule contents in sample diluent
Solvent:	ethanol:water (70:30, v/v)
Sample temp.:	25°C

Column:	**Pinnacle II™ C18**
Cat. #:	9214565
Dimensions:	150 x 4.6mm
Particle size:	5µm
Pore size:	110Å
Conditions:	
Mobile phase:	A = 0.1% phosphoric acid B = acetonitrile

Time	%B
0	10
13	22
14	40
14.5	40
15	10
20	10

Flow:	1.5mL/min.
Temp.:	35°C
Det.:	UV @ 330nm



for **more** info

Request Applications Note **Analyzing Nutraceutical Products by Liquid and Gas Chromatography** (cat.# 59364).

Dietary Supplements

Over the past decade, the nutraceutical industry has seen rapid growth as more people add flowers, leaves, roots, and fruits of botanicals to their diets in hope of gaining health benefits.

Herbal products are very complex, often containing hundreds of compounds, and it is not always clear which compounds are responsible for the beneficial properties. Marker compounds—phytochemicals that have been identified and are known to have some relationship to the reported health benefit—can be evaluated qualitatively to identify a raw material or to verify purity. To determine the concentration or strength of a material, quantitative analysis is necessary.

Hyperforin in St. John's Wort

According to the Institute for Nutraceutical Advancement (INA), INA Method 112.001—the HPLC analysis of hyperforin and adhyperforin in St. John's wort—the samples are extracted with methanol in an ultrasonic bath. Chromatographic separation is performed on a C18 reversed phase column with acetonitrile and phosphate buffer as the mobile phase. Analysis of encapsulated St. John's wort using a **Pinnacle II™ C18** column shows excellent peak shapes for the active ingredients in this herbal product.

Phenolics in *Echinacea*

The active compounds in *echinacea* are thought to be caffeic acid derivatives such as caftaric acid, cichoric acid, chlorogenic acid, and echinacoside.

Conclusion

Gas and liquid chromatography are powerful tools for the analysis of foods, flavors, and fragrances. This technical guide describes columns and analytical conditions that will help you achieve more accurate identification and quantitation of target analytes. However, if you have questions, please don't hesitate to contact Restek's technical service by e-mail (support@restekcorp.com) or by phone (extension 4), or contact your Restek representative. We will do everything we can to help you find a solution.

References
1. Fennema, O. R. Food Chemistry (1996), 3rd edition.
2. Bensinger, M. "How Hot is that 'Devil' Sauce?" in Fiery Foods Magazine (1997), Sept/Oct.
3. Brandt, Laura. "The Creation and Use of Vanilla", Food Product Design (1996), editorial archives.
4. AOAC Official Methods of Analysis (2000), 17th edition, AOAC International.
5. Official Methods and Recommended Practices (1998), 5th edition, American Oil Chemists' Society.
6. AACC Approved Methods (2000), 10th edition, American Association of Cereal Chemists.

References are not available from Restek.

Flavor and Fragrance Compounds Retention Time Index

Retention time data collected using 60m, 0.25mm ID, 0.25µm Rtx®-1 and Stabilwax® columns.
Oven temp.: 100°C to 260°C @ 4°C/min.; **Carrier gas:** helium; **Linear velocity:** 27.2cm/sec. @ 100°C; **Dead time:** 3.68 min. @ 100°C.

Component	Retention Time (min.) Rtx®-1	Stabilwax®
isopropyl alcohol	3.66	3.93
allyl alcohol	3.67	4.05
tert-butyl alcohol	3.68	3.89
1-propanol	3.70	4.13
3-buten-2-ol	3.71	4.12
ethyl formate	3.71	3.84
acetone	3.72	3.86
methyl acetate	3.75	3.86
2-butanol	3.76	4.03
propyn-1-ol	3.77	6.26
tert-amyl alcohol	3.79	4.14
isobutyraldehyde	3.79	3.84
2-methyl-3-buten-2-ol	3.82	4.12
methyl ethyl ketone	3.84	3.83
cis-2-buten-1-ol	3.84	5.01
ethyl acetate	3.86	3.90
propyl formate	3.87	3.83
2-methylfuran	3.88	3.87
isobutyl alcohol	3.89	4.72
methyl propanoate	3.89	4.03
3-buten-1-ol	3.91	4.76
3-methyl-2-butanol	3.92	4.25
2-butenal	3.94	4.26
2-pentanol	3.95	4.42
isopropyl acetate	3.96	4.03
1-butanol	3.96	4.57
neopentanol	3.99	4.60
methyl isobutyrate	4.03	4.08
2-pentanone	4.03	3.95
isoamyl alcohol	4.04	4.96
allyl acetate	4.05	4.14
ethyl acrylate	4.06	4.08
3-pentanone	4.07	4.08
pentanal	4.07	4.08
tert-butyl acetate	4.09	3.93
pinacolone	4.09	4.00
propyl acetate	4.10	4.04
2-ethylfuran	4.10	3.99
2,5-dimethylfuran	4.12	3.98
3-methyl-1-butanol	4.18	4.88
3-penten-2-one	4.18	4.45
2-methyl-1-butanol	4.20	4.88
pinacol alcohol	4.20	4.38
thiophene	4.21	4.16
methylisobutylketone (MIBK)	4.22	4.15
methyl butanoate	4.22	4.09
2-methyl-3-pentanone	4.27	4.15
ethyl isobutyrate	4.28	4.03
cis-2-penten-1-ol	4.29	5.85
3-methyl-3-pentanol	4.29	4.37
1-pentanol	4.30	5.24
3-hexanone	4.30	4.28
3-methyl-2-buten-1-ol	4.32	5.81
isobutyl acetate	4.34	4.13
butryolactone	4.34	7.07
2-methyl-3-pentanol	4.36	4.59

Component	Retention Time (min.) Rtx®-1	Stabilwax®
2-hexanone	4.41	4.11
ethyl butanoate	4.41	4.18
cyclopentanol	4.42	5.74
cyclopentanone	4.46	4.96
2,4-dimethyl-2-pentanol	4.47	4.45
3-hexanol	4.47	4.84
2-hexanol	4.48	5.01
4-methyl-3-penten-2-one	4.48	4.61
hexanal	4.48	4.41
2,4-dimethyl-3-pentanone	4.49	3.95
pyridine	4.50	4.91
propyl propanoate	4.51	4.22
a-angelicalactone	4.51	7.26
butyl acetate	4.54	4.29
methyl pentanoate	4.61	4.36
furfural	4.64	7.65
2,2-dimethyl-3-pentanol	4.65	4.63
2-methyl-1-pentanol	4.65	5.63
4-hexen-3-one	4.67	4.88
isopropyl butyrate	4.72	4.19
furfuryl alcohol	4.74	11.07
2,4-dimethyl-3-pentanol	4.75	4.76
trans-2-hexenal	4.78	5.08
pinacol	4.79	7.91
ethyl-2-methyl butanoate	4.80	4.26
2-ethyl-1-butanol	4.80	5.72
trans-2-hexenol	4.82	6.56
5-methyl-2-hexanone	4.84	4.54
1-hexanol	4.92	6.16
3-ethyl-3-pentanol	4.94	4.94
isoamyl acetate	4.98	4.49
cis-3-hexen-1-ol	4.98	6.58
4-heptanone	4.99	4.45
trans-2-hexen-1-ol	5.01	6.81
anisole	5.06	6.13
3-heptanone	5.08	4.62
1,3-xylene	5.09	4.67
1,4-xylene	5.09	4.64
2-heptanone	5.10	4.85
4-heptanol	5.14	5.45
propyl butyrate	5.16	4.49
ethyl pentanoate	5.17	4.54
cyclohexanone	5.19	5.85
2-heptanol	5.20	5.63
heptanal	5.21	4.35
butyl propionate	5.24	4.56
amyl acetate	5.29	4.73
1,2-xylene	5.30	4.93
nonane	5.32	3.80
isobutyl isobutyrate	5.34	4.39
methyl hexanoate	5.41	3.81
tetrahydro-2-fufanmethanol	5.50	8.53
d-valerolactone	5.51	9.57
cumene	5.62	4.84
5-methyl-3-heptanone	5.65	4.94
ethyl amyl ketone	5.65	4.94

Component	Retention Time (min.) Rtx®-1	Stabilwax®
5-methylfurfural	5.73	9.64
a-pinene	5.81	4.84
benzaldehyde	5.90	8.76
tricyclene	5.91	4.16
1-heptanol	5.95	7.54
camphene	6.02	4.24
2,6-dimethyl-4-heptanone	6.03	4.81
1-octen-3-ol	6.09	7.33
furfuryl acetate	6.09	8.77
3-octanone	6.16	5.35
2-octanone	6.20	6.35
sec-butylbenzene	6.28	5.37
tert-butylbenzene	6.32	5.15
myrcene	6.32	4.53
butyl butyrate	6.34	5.02
b-pinene	6.38	4.40
octanal	6.39	5.73
2-octanol	6.39	7.00
hexyl acetate	6.49	5.41
decane	6.58	4.08
2-methylanisole	6.60	6.97
a-phellandrene	6.69	6.13
3-methylanisole	6.74	7.39
4-methylanisole	6.78	7.42
2-ethyl-1-hexanol	6.85	8.10
benzyl alcohol	6.86	16.48
3-carene	6.89	4.67
p-cymene	6.91	5.38
a-terpinene	6.93	12.38
limonene	7.09	4.84
salicaldehyde	7.09	11.93
camphor	7.11	8.77
trans-ocimene	7.13	4.72
1,8-cineole	7.16	5.06
eucalyptol	7.16	5.06
cis-ocimene	7.21	5.06
a-methylbenzylalcohol	7.34	18.34
p-cresol	7.45	21.40
g-terpinene	7.54	5.26
1-octanol	7.55	9.37
2,6-dimethylanisole	7.55	7.16
5-nonanone	7.57	6.39
tetrahydrofurfuryl acetate	7.60	9.84
fenchone	7.68	7.08
linalool oxide	7.81	7.56
3-nonanone	7.82	6.38
2-nonanone	7.89	7.17
methyl benzoate	8.03	10.72
linalool	8.13	9.02
2-nonanol	8.15	8.65
nonanal	8.16	6.86
terpinyl acetate	8.18	12.51
maltol	8.23	18.48

Flavor and Fragrance Compounds Retention Time Index

Retention time data collected using 60m, 0.25mm ID, 0.25µm Rtx®-1 and Stabilwax® columns.
Oven temp.: 100°C to 260°C @ 4°C/min.; **Carrier gas:** helium; **Linear velocity:** 27.2cm/sec. @ 100°C; **Dead time:** 3.68 min. @ 100°C.

Component	Retention Time (min.) Rtx®-1	Stabilwax®
trans-sabinene hydrate	8.37	9.06
2,4-dimethylanisole	8.39	8.45
2,5-dimethylanisole	8.39	8.42
undecane	8.41	4.38
a-thujone	8.46	15.01
methyl octanoate	8.57	6.69
b-thujone	8.68	7.63
2,3-dimethylanisole	8.87	9.30
citronellal	9.19	7.99
benzyl acetate	9.31	13.02
menthone	9.42	7.97
borneol	9.53	12.52
ethyl benzoate	9.62	11.74
1-nonanol	9.70	11.56
isoborneol	9.72	11.69
menthofuran	9.73	8.14
isomenthone	9.75	8.57
neomenthol	9.85	10.22
a-terpineol	9.91	5.58
menthol	9.95	11.16
dihydrocarveol	10.09	13.64
terpinen-4-ol	10.11	10.31
2-decanone	10.14	8.41
a-terpinolene	10.32	7.36
4-allylanisole	10.35	11.75
estragole	10.35	11.75
decanal	10.48	8.51
trans-dihydrocarvone	10.59	23.12
verbenone	10.67	12.88
dodecane	10.75	4.90
cis-dihydrocarvone	10.80	10.80
linalyl acetate	10.93	9.36
b-citronellol	11.06	13.93
cis-nerol	11.14	13.82
carveol	11.24	16.29
benzyl acetone	11.27	16.25
citral a	11.39	12.13
geranial	11.39	12.13
cuminaldehyde	11.43	14.40
pulegone	11.43	11.46
p-anisaldehyde	11.47	20.15

Component	Retention Time (min.) Rtx®-1	Stabilwax®
r-carvone	11.48	13.28
s-carvone	11.51	13.36
geraniol	11.74	15.84
trans-cinnamaldehyde	11.97	20.50
citral b	12.12	13.25
neral	12.12	13.25
propyl benzoate	12.16	13.82
1-decanol	12.36	13.99
perillaldehyde	12.37	14.52
citronellyl formate	12.38	10.69
trans-menthyl acetate	12.56	9.01
indole	12.57	29.33
trans-anethole	12.67	15.41
cumin alcohol	12.68	21.88
thymol	12.71	23.82
2-undecanone	12.81	10.45
carvacrol	12.87	24.56
bornyl acetate	12.88	10.09
trans-cinnamyl alcohol	12.94	26.11
cis-menthyl acetate	13.02	9.62
perillyl alcohol	13.02	19.36
tridecane	13.47	5.72
2-methylcinnamaldehyde	13.59	19.52
triacetin	13.67	21.33
methyl decanoate	13.69	10.26
cis-carvyl acetate	14.09	13.23
cumic acid	14.40	34.95
g-valerolactone	14.48	10.55
citronellyl acetate	14.49	11.81
eugenol	14.55	23.53
thiazole	14.67	5.23
neryl acetate	14.76	13.08
trans-carvyl acetate	14.88	14.05
dihydrocoumarin	14.91	26.02
geranyl acetate	15.26	13.08
dihydrojasmone	15.34	16.24
vanillin	15.34	32.21
ethyl decanoate	15.69	11.22
2-dodecanone	15.72	12.83
cis-jasmone	15.75	18.34
trans-cinnamyl acid	16.07	37.16

Component	Retention Time (min.) Rtx®-1	Stabilwax®
carvone hydrate	16.25	27.44
tetradecane	16.38	6.95
coumarin	16.54	29.90
cis-carvyl propionate	16.63	14.68
a-ionone	16.88	16.23
trans-cinnamyl acetate	16.88	23.12
ethyl vanillin	17.08	31.44
isoeugenol	17.09	27.57
3-methyl-*p*-anisaldehyde	17.23	20.08
b-caryophyllene	17.32	10.56
trans-carvyl propionate	17.65	15.76
a-methylcinnamic acid	18.15	4.64
a-humulene	18.29	12.05
2,3-dimethylanisaldehyde	18.46	25.74
b-ionone	18.57	18.37
vanillin acetate	18.93	30.85
pentadecane	19.34	8.60
valencene	19.40	13.15
2,5-dimethylanisaldehyde	19.50	21.72
6-methylcoumarin	20.22	32.66
carvone acetate	20.50	26.09
7-methylcoumarin	20.65	32.52
ethyl laurate	21.69	16.17
caryophyllene oxide	21.88	19.47
hexadecane	22.27	10.64
cinnamide	22.36	45.53
amyl cinnamaldehyde	23.08	25.95
cis-trans-farnesol	24.61	27.48
heptadecane	25.10	12.94
trans-trans-farnesol	25.28	28.09
guaiazulene	27.04	28.98
nootketone	27.69	31.89
octadecane	27.83	15.40
nonadecane	30.44	17.92
eicosane	32.94	20.44
heneicosane	35.32	22.91
docosane	37.62	25.35
tricosane	39.79	27.68
tetracosane	42.02	29.95
hexacosane	47.40	34.26

rtx®-1 F&F **gc** columns

for flavor and fragrance compounds

- Specifically tailored to meet the demanding selectivity criteria of the flavor and fragrance industry.
- Excellent thermal stability and column lifetimes.
- Stringent QA ensures column-to-column reproducibility.

www.restek.com RESTEK

See **page 30** for product listing.

GC Columns

for **more** info

For a complete overview of Restek's **Analytical Reference Program** request literature cat.# 59214.

Rtx®-1 (Crossbond® 100% dimethyl polysiloxane)

- General-purpose non-polar phase, ideal for flavor and fragrance compounds.
- Thermally stable to 350°C.
- Polarity similar to DB-1, SPB-1, HP-1, Ultra-1 phases.
- Equivalent to USP G1, G2, G38 phases.

Rtx®-1 (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		10114
	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		10115
	0.25	-60 to 330/350°C	10121	10124	10127		10130
	0.50	-60 to 330/350°C	10136	10139	10142		10145
	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	10113		
	0.25	-60 to 320/340°C	10122	10125	10128		
	0.50	-60 to 310/330°C	10137	10140	10143		
	1.00	-60 to 310/330°C	10152	10155	10158		
	1.50	-60 to 310/330°C	10167	10170	10173		
	3.00	-60 to 270/290°C	10182	10185	10188		10189
	5.00	-60 to 270/290°C	10177	10179	10183		10194
	7.00	-60 to 240/260°C	10191	10192	10193		

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

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

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

- Application-specific non-polar phase for flavor and fragrance compounds.
- Thermally stable to 350°C.
- Polarity similar to HP-1 phase.

Rtx®-1 F&F (fused silica)

(Crossbond® 100% dimethyl polysiloxane)

ID	df (µm)	temp. limits	15-Meter	30-Meter	50-Meter	60-Meter
0.25mm	0.25	-60 to 330/350°C		18023		18026
	0.50	-60 to 330/350°C		18038		18041
	1.00	-60 to 320/340°C		18053		18056
0.32mm	0.25	-60 to 330/350°C		18024		18027
	0.50	-60 to 330/350°C		18039	18010	18042
	1.00	-60 to 320/340°C		18054		18057
0.53mm	0.50	-60 to 310/330°C	18037	18040		18043
	1.00	-60 to 310/330°C	18052	18055		18058
	1.50	-60 to 310/330°C	18067	18070		18073

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

- General-purpose low polarity phase.
- Thermally stable to 350°C.
- Polarity similar to DB-5, SPB-5, HP-5, Ultra-2 phases.
- Equivalent to USP G27, G36 phases.

Rtx®-5 (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	

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

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

- High temperature, ultra-low bleed, low polarity phase, ideal for sterols.
- Thermally stable to 360°C.
- Polarity similar to DB-5HT, DB-5XLT, PTE-5 phases.
- Equivalent to USP G27, G36 phases.

XTI®-5 (fused silica)

(Crossbond® 5% phenyl/95% dimethyl polysiloxane - extended temperature and inertness)

ID	df (µm)	temp. limits	15-Meter	30-Meter
0.25mm	0.25	-60 to 360°C	12220	12223
	0.50	-60 to 330/350°C	12235	12238
	1.00	-60 to 325/350°C	12250	12253
0.32mm	0.25	-60 to 360°C	12221	12224
	0.50	-60 to 330/350°C	12236	12239
	1.00	-60 to 325/350°C	12251	12254
0.53mm	0.50	-60 to 330/360°C	12237	12240
	1.00	-60 to 325/350°C	12252	12255
	1.50	-60 to 310/330°C	12267	12270

a **plus 1**™ story

Going above and beyond her normal job responsibilities, Santina has helped collect production data for new columns, closely inspects columns during various steps of production and has developed a system of identifying problems in "wax-phase" columns. Because of her keen attention to detail, we have resolved several persistent problems with wax-phase columns.

Santina Newlen, GC Column Manufacturing Technician

GC Columns

also **available**

Other ID's available—for more information refer to our general catalog.

did you **know**?

Restek's MXT® columns—rugged, flexible, inert Silcosteel®-treated stainless steel

Rtx®-50 (Crossbond® 50% methyl / 50% phenyl polysiloxane)

- General-purpose mid-polarity phase, ideal for antioxidants.
- Thermally stable to 320°C.
- Polarity similar to DB-17, DB-608, HP-17, SPB-50, SP-2250 phases.
- Equivalent to USP G3 phase.

Rtx®-50 (fused silica)

(Crossbond® 50% methyl/50% phenyl polysiloxane)

ID	df (µm)	temp. limits*	15-Meter	30-Meter	60-Meter
0.53mm	0.25	0 to 280/300°C	10522		
	0.50	0 to 270/290°C	10537	10540	10543
	0.83	0 to 270/290°C		10569	
	1.00	0 to 260/280°C	10552	10555	10558
	1.50	0 to 250/270°C	10567	10570	10573

Rtx®-65TG / MXT®-65TG (Crossbond® 65% diphenyl / 35% dimethyl polysiloxane)

- Application-specific column, designed for triglycerides.
- Specially tested with triglyceride mixture.
- Thermally stable to 370°C.

Rtx®-65TG (fused silica)

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

ID	df (µm)	temp. limits	15-Meter	30-Meter
0.25mm	0.10	40 to 370°C	17005	17008
0.32mm	0.10	40 to 370°C	17006	17009
0.53mm	0.10	40 to 360/370°C	17007	17010

MXT®-65TG (Silcosteel®-treated stainless steel)

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

ID	df (µm)	temp. limits	15-Meter	30-Meter
0.25mm	0.10	20 to 370°C	77005	77008
0.53mm	0.10	20 to 370°C	77007	77010

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

- General-purpose low to mid-polarity phase, ideal for flavor compounds, alcoholic beverage analysis.
- Thermally stable to 320°C.
- Polarity similar to SPB-20, VOCOL phases.
- Equivalent to USP G28, G32 phases.

Rtx®-20 (fused silica)

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

ID	df (µm)	temp. limits*	15-Meter	30-Meter	60-Meter	105-Meter
0.25mm	0.10	-20 to 300/320°C	10305	10308	10311	10314
	0.25	-20 to 300/320°C	10320	10323	10326	10329
	0.50	-20 to 290/310°C	10335	10338	10341	10344
	1.00	-20 to 280/300°C	10350	10353	10356	10359
0.32mm	0.10	-20 to 300/320°C	10306	10309	10312	10315
	0.25	-20 to 300/320°C	10321	10324	10327	10330
	0.50	-20 to 290/310°C	10336	10339	10342	10345
	1.00	-20 to 280/300°C	10351	10354	10357	10360
	1.50	-20 to 270/290°C	10366	10369	10372	10375
	3.00	-20 to 250/270°C	10381	10384	10387	10390
0.53mm	0.10	-20 to 260/280°C	10307	10310	10313	
	0.25	-20 to 260/280°C	10322	10325	10328	
	0.50	-20 to 260/280°C	10337	10340	10343	
	1.00	-20 to 260/280°C	10352	10355	10358	
	1.50	-20 to 250/270°C	10367	10370	10373	
	3.00	-20 to 240/260°C	10382	10385	10388	

ID	df (µm)	temp. limits	10-Meter	20-Meter	40-Meter
0.18mm	0.20	-20 to 300/320°C	40301	40302	40303
	0.40	-20 to 300/320°C	40310	40311	40312

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

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

- General-purpose polar phase, ideal for FAMEs, carbohydrates, sterols, flavor compounds.
- Thermally stable to 240°C.
- Polarity similar to DB-225, HP-225 phases.
- Equivalent to USP G7, G19 phases.

Rtx®-225 (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

FAMEWAX™ (Crossbond® polyethylene glycol)

- Application-specific column, designed for FAMEs.
- Specially tested with FAME mixture.
- Thermally stable to 250°C.
- Polarity similar to Omegawax phase.

FAMEWAX™ (fused silica)

(Crossbond® polyethylene glycol)

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

Rtx®-Wax (Crossbond® Carbowax® polyethylene glycol)

- General-purpose polar phase, ideal for FAMEs, flavor compounds.
- 20°C minimum operating temperature.
- Thermally stable to 250°C.
- Polarity similar to DB-WAX, HP-Wax phases.
- Equivalent to USP G14, G15, G16, G20, G39 phases.

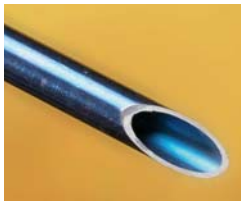
Rtx®-Wax (fused silica)

(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.

did you **know**?



Siltek®/Sulfinert® and Silcosteel® tubing & fittings are ideal for transporting active compounds such as polar organics and sulfur compounds.

Stabilwax® / MXT®-WAX (Crossbond® Carbowax® polyethylene glycol)

- General-purpose polar phase, ideal for FAMEs, flavor compounds.
- Resistant to oxidative damage.
- Thermally stable to 250°C.
- Polarity similar to DB-WAXetr, HP-Innowax, Supelcowax 10 phases.
- Equivalent to USP G14, G15, G16, G20, G39 phases.

Stabilwax® (fused silica)

(Crossbond® Carbowax® polyethylene glycol—provides oxidation resistance)

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		

did you **know**?

We have over 2,000 pure, characterized, neat compounds in our inventory! If you do not see the EXACT mixture you need listed on any of these pages, call us.

See **page 48** for our Custom Reference Materials Request Form.

Rt-CW20M™ F&F (Carbowax® polyethylene glycol)

- Application-specific column, designed for flavor and fragrance compounds.
- True non-bonded Carbowax® 20M polarity.
- Thermally stable to 220°C.
- Polarity similar to HP-20M, Carbowax® 20M phases.

Rt-CW20M™ F&F (fused silica)

(nonbonded Carbowax® polyethylene glycol)

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

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

- Application-specific column, designed for underivatized free acids.
- No need for sample derivatization.
- Resistant to oxidative damage.
- Thermally stable to 250°C.
- Polarity similar to DB-FFAP, HP-FFAP, NUKOL, OV-351 phases.
- Equivalent to USP G25, G35 phases.

Stabilwax®-DA (fused silica)

(Crossbond® Carbowax® polyethylene glycol for acidic compounds)

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

Rtx®-200 (Crossbond® trifluoropropylmethyl polysiloxane)

- General-purpose mid-polarity phase, ideal for alcohols, ketones, glycols.
- Thermally stable to 340°C.
- Polarity similar to DB-200, DB-210 phases.
- Equivalent to USP G6 phase.

Rtx®-200 (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	

Rtx®-1301 (G43) (Crossbond® 6% cyanopropylphenyl / 94% dimethyl polysiloxane)

- General-purpose low to mid-polarity phase, ideal for alcohols, flavor compounds.
- Thermally stable to 280°C.
- Polarity similar to DB-1301, DB-624, SPB-1301, SPB-624 phases.
- Equivalent to USP G43 phase.

for **more** info

Request the Fast Facts for **Rtx®/MXT®-1301** columns (lit. cat. #59317).

Rtx®-1301 (G43) (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	0.10	-20 to 280°C	16005	16008	16011		16014
	0.25	-20 to 280°C	16020	16023	16026		16029
	0.50	-20 to 270°C	16035	16038	16041		16044
	1.00	-20 to 260°C	16050	16053	16056		16059
	1.40	-20 to 240°C			16016		
0.32mm	0.10	-20 to 280°C	16006	16009	16012		16015
	0.25	-20 to 280°C	16021	16024	16027		16030
	0.50	-20 to 270°C	16036	16039	16042		16045
	1.00	-20 to 260°C	16051	16054	16057		16060
	1.50	-20 to 250°C	16066	16069	16072		16075
0.53mm	0.10	-20 to 280°C	16007	16010	16013		
	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.

Rt-2560 (biscyanopropyl polysiloxane)

- Application-specific column, designed for aseparating *cis* and *trans* FAMEs.
- Thermally stable to 250°C.
- Polarity similar to SP-2560 phase.

Rt-2560

(biscyanopropyl polysiloxane)

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

Rt-βDEXse™ (fused silica)

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

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

Uses: Similar in performance to Rt-βDEXsm™ but provides better resolution for limonene, linalool, linalyl acetate, ethyl-2-methylbutyrate, 2,3-butane diol.

free literature

FREE applications notes to assist you with your analysis. Request your copies today!

- **Grape Flavor Analysis, Using an Rt-γDEXsa™ GC Column** (lit. cat.# 59553)
- **GC Analysis of Chiral Flavor Compounds in Apple Juices, Using Rt-βDEXsm™ and Rt-βDEXse™ Columns** (lit. cat.# 59546)

Rt-βDEXsp™ (fused silica)

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

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

Uses: Often useful in dual-column configurations, with the Rt-βDEXsm™ column, for complex enantiomeric separations.

Rt-βDEXsa™ (fused silica)

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

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

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

Rt-βDEXcst™ (fused silica)

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

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

Uses: This proprietary stationary phase was developed specifically for the fragrance industry, and also has been used for pharmaceutical applications.

Rt-βDEXsm™ (fused silica)

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

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

Uses: Excellent column for most components of essential oils.

Related Literature

All of the following publications are free on request.
All are Restek application notes, unless otherwise indicated.

Lit. cat.#	Title
59128	Determination of Omega-3 (n-3) and Omega-6 (n-6) Fatty Acid Composition in Evening Primrose Oil, Flax Seed Oil, Black Currant Oil, and Borage Oil
59136	The Institute for Nutraceutical Advancement (INA) Validates GC Methods for Saw Palmetto, Using Rtx®-5 and Stabilwax® Columns
59155B	GC Analysis of Volatile Free Fatty Acids on the Stabilwax®-DA Column
59177	Analyze Polar Compounds by Reversed Phase HPLC, Using Ultra Aqueous C18 Columns
59181	HPLC Analysis of Vitamins
59186	Analysis of Vanillin and Ethyl Vanillin in Vanilla Flavors, Using Ultra C8 Column
59199	Analyzing the Heat Level of Spicy Foods, Using an Ultra C18 HPLC Column
59348	Monitoring Volatile Compounds in Food Contact Packaging, Using Purge and Trap GC/MS and an Rtx®-5MS Capillary Column
59364	Analyzing Nutraceutical Products by Liquid and Gas Chromatography
59398	Analysis of Preservatives, Using HPLC
59462	Analyzing Alcoholic Beverages by Gas Chromatography (technical guide)
59530	Single-Column Method for HPLC Analysis of Organic Acids in Fruit Juices, Using an Allure™ Organic Acids Column
59546	GC Analysis of Chiral Flavor Compounds in Apple Juices, Using the Rt-βDEXsm™ and Rt-βDEXse™ Columns
59553	Grape Flavor Analysis, Using an Rt-βDEXsa™ GC Column
59580A	Fast, Selective Triglyceride Analysis
59581	Analysis of Cholesterol and Other Dietary Sterols
59584A	High-Resolution Analyses of Fatty Acid Methyl Esters (FAMEs) by Gas Chromatography
59889	A Guide to the Analysis of Chiral Compounds by GC (technical guide)
59890	Selection Guide for Polar WAX GC Column Phases (technical guide)
59901	High Performance Silica Products
59012	Genuine Restek Replacement Parts for HPLC Systems (flyer)
59627E	Genuine Restek Replacement Parts for Agilent GCs (brochure)
59241B	HPLC Columns and Accessories (HPLC catalog)
59065	Restek Chromatography Supplies Catalog (current edition)

View these electronic publications on our website: www.restek.com

HPLC Analysis of Preservatives
Using Ultra Aqueous and Pinnacle II™ Columns
Restek Advantage 2002 vol. 2

High-Resolution Analysis of Fatty Acid Methyl Esters (FAMEs)
Using an Rt-2560 Capillary GC Column to Resolve *cis* and *trans* Isomers
Restek Advantage 2003 vol. 1

Analyzing Fatty Acid Methyl Esters (FAMEs) by GC
Using Restek Capillary Columns and Analytical Reference Materials
Restek Advantage 2002 vol. 4

free literature

Many example chromatograms in our 24-page chiral analysis guide will help you find the best chiral column, or columns, for your application.

Request **A Guide to the Analysis of Chiral Compounds by GC** (lit. cat.# 59889) for more information about chiral separations.

Call Restek at **800-356-1688 or 814-353-1300, ext. 5**, or contact your Restek representative, to request your free copy.

tech tip

To optimize chiral separations, use:

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

Packed GC Columns

please **note**

All stock CarboBlack™ columns are PRE-CONDITIONED

Column Configurations


General Configuration
Suffix -800


Agilent 5880, 5890, 5987, 6890:
Suffix -810


Varian 3700, Vista Series, FID:
Suffix -820

PE 900-3920 Sigma 1,2,3:
Suffix -830

PE Auto System 8300, 8400, 8700 (Not On-Column):
Suffix -840

See page 103 for custom configurations

Note: Initial 2" of column will be empty, to accommodate a needle. For a completely filled column add suffix -901.

CarboBlack™ Solid Supports

Graphitized carbon black offers unique selectivity and very little adsorption for alcohol analyses. Two types of CarboBlack™ supports are available, CarboBlack™ B and CarboBlack™ C. CarboBlack™ B support, with its higher surface area, can hold up to a 10% loading of a non-silicone liquid phase. CarboBlack™ C support can hold up to a 1% loading of a non-silicone liquid phase. Many Carbowax® 20M-loaded CarboBlack™ packings are available. CarboBlack™ packings are treated with KOH or picric acid for basic or acidic compounds, and special alcoholic beverage loadings are available. CarboBlack™ supports provide resolution and retention similar to Carbopack™ and Carbograph™ supports.

		Stainless Steel Tubing				SilcoSmooth™ Tubing**			
On CarboBlack™ B	Mesh	L (ft.)	OD (in.)	ID (mm)	cat.#*	L (m)	OD (in.)	ID (mm)	cat.#*
5% Carbowax® 20M	80/120	—	—	—	—	2	1/8	2	80105-
5% Carbowax® 20M	60/80	6	1/8	2.1	88012-	1.8	1/8	2	80106-
6.6% Carbowax® 20M	80/120	6	1/8	2.1	80451-	2	1/8	2	80107-
4% Carbowax® 20M/ 0.8% KOH	60/80	—	—	—	—	2	1/8	2	80116-
1% Rt-1000	60/80	8	1/8	2.1	88013-	2.4	1/8	2	80206-
1% Rt-1000	60/80	6	1/8	2.1	80452-	2	1/8	2	80207-
3% Rt-1500	80/120	10	1/8	2.1	80453-	3.05	1/8	2	80211-
1% Rt-1510	60/80	10	1/8	2.1	80454-	3.05	1/8	2	80216-
1.5% XE-60/1% H_3PO_4	60/80	6	1/8	2.1	80455-	1.8	1/8	2	80305-

		Nickel 200 Tubing			
On CarboBlack™ B	Mesh	L (m)	OD (in.)	ID (mm)	cat.#*
5% Krytox (Ni 200 tubing)	60/80	3.05	1/8	2.1	80127-

		Stainless Steel Tubing				SilcoSmooth™ Tubing**			
On CarboBlack™ C	Mesh	L (ft.)	OD (in.)	ID (mm)	cat.#*	L (m)	OD (in.)	ID (mm)	cat.#*
0.2% Carbowax® 1500	60/80	6	1/8	2.1	80456-	2	1/8	2	80121-
0.2% Carbowax® 1500	80/100	6	1/8	2.1	80457-	2	1/8	2	80122-
0.1% Rt-1000	80/100	6	1/8	2.1	80458-	1.8	1/8	2	80205-
0.19% picric acid	80/100	6	1/8	2.1	80459-	2	1/8	2	80311-
0.3% Carbowax® 20M/0.1% H_3PO_4	60/80	2.5	3/16	3.2	80460-	0.75	3/16	3.2	80111-

*Please add configuration suffix number to cat.# when ordering.
**Silcosteel®-deactivated stainless steel.

Chromosorb® Diatomaceous Earth Supports

Restek offers the full line of Chromosorb® solid supports that are specially sieved to remove fines and ensure tight particle distribution. Choosing the appropriate support will depend on your application. Need assistance? Call Technical Service at 800-356-1688 or 814-353-1300, ext. 4, or contact your local Restek representative for more information.

Chromosorb® P (used to prepare Silcoport™ P)

Chromosorb® P support is manufactured from hard firebrick, making it a rugged material. This support is available acid washed (AW), non-acid washed (NAW), and traditional dimethyldichlorosilane (DMDCS) treated. Chromosorb® P support can hold up to 30 weight% of liquid stationary phase, making it the highest loading support available.

Chromosorb® W (used to prepare Silcoport™ W and Silcoport™ BW)

Chromosorb® W support is a flux-calcinated diatomite. This solid support is very fragile but offers the highest inertness of all diatomaceous earth supports. It can be prepared with up to 25 weight% of liquid stationary phase. Chromosorb® W support is available in AW, NAW, and DMDCS, or treated with Restek's proprietary (Silcoport™) deactivation. Chromosorb® W-HP is an acid washed, silanized version of Chromosorb® W.

Chromosorb® G

Chromosorb® G support is the hardest support available and has the lowest surface area of all the diatomaceous earth supports. Chromosorb® G support is available as AW, NAW, and DMDCS-treated. It can hold up to 10 weight% of liquid stationary phase.

Chromosorb® T

Chromosorb T support is made from PTFE and is an extremely inert solid support.

Call Restek at 800-356-1688 or 814-353-1300, ext. 3, or contact your local Restek representative for quotes on any Chromosorb® material. Some of the popular Chromosorb®-based stock columns and packings available are:

Restek's packed columns deliver the

1-2-3 PUNCH!

1. Bonded stationary phases mean short conditioning times, low bleed, and unsurpassed column lifetimes.
2. SilcoSmooth™ tubing provides the inertness of glass and the durability of stainless steel.
3. Silcoport™ diatomaceous earth provides unsurpassed inertness for trace analysis.

Chromosorb®-Based Packed Columns

		Stainless Steel Tubing				SilcoSmooth™ Tubing**			
On 100/120 Silcoport™ W***		L (ft.)	OD (in.)	ID (mm)	cat.#*	L (m)	OD (in.)	ID (mm)	cat.#*
3% Rt-101		6	1/8	2.1	80461-	2	1/8	2	80400-
3% Rt-2100		6	1/8	2.1	80462-	2	1/8	2	80420-
5% Rt-1200/1.75% Bentone 34		6	1/8	2.1	80463-	2	1/8	2	80125-
5% Rt-1200/5% Bentone 34		6	1/8	2.1	80464-	2	1/8	2	80129-
		Stainless Steel Tubing				**SilcoSmooth™ Tubing****			
On Chromosorb® PAW	Mesh	L (ft.)	OD (in.)	ID (mm)	cat.#*	L (m)	OD (in.)	ID (mm)	cat.#*
10% TCEP	100/120	8	1/8	2.1	80465-	2.5	1/8	2	80126-
23% Rt-1700	80/100	30	1/8	2.1	80466-	9.2	1/8	2	80128-

*Please add configuration suffix number to cat.# when ordering.
**Silcosteel®-deactivated stainless steel.
***Modified version of Chromosorb® W; highest inertness, most consistent performance.

GC Accessories

Leak Detector

- Affordable thermal conductivity leak detector - every analyst should have one.
- Compact, portable, ergonomic design is easy to hold and operate.
- Sensitive - detects helium, hydrogen*, or nitrogen at $1x10^{-4}$ cc/sec
- Fast results - responds to leaks in less than 2 seconds.
- Autozeroing with the touch of a button.
- Battery-operated, for portability.
- Built-in rechargeable battery—charging adaptor included.

In continuing our efforts to provide chromatographers with the best available columns, tools, and accessories, we have enhanced our popular Restek Electronic Leak Detector. New features include internal battery charge capability, a low battery indicator, a battery charge indicator light, yellow lights to signal a nitrogen leak, a repositioned on/off switch, to eliminate accidentally powering on the unit, and a new probe tip design that prevents debris from entering the unit. The new leak detector maintains the microchip technology that enables high sensitivity in a compact unit, the autozero feature that allows instantaneous zeroing with the touch of a button, and the ergonomic design that puts all controls at your fingertips, for maximum ease of use.

Easy-to-clean probe assembly.

The new Restek Electronic Leak Detector is the affordable solution for GC leak detection. Leaks can cause detector noise and baseline instability, waste carrier gas, and shorten column lifetimes. The leak detector responds in less than 2 seconds to leaks of gases with thermal conductivities different from air, indicating leaks with both an audible alarm and an LED readout. The leak detector detects minute gas leaks that can go undetected by liquid leak detectors. And, remember - you should never use liquid leak detectors on a capillary system, because liquids can be drawn into the column through the leaks.

Description	qty.	cat.#
Leak Detector with 110Volt Battery Charger	ea.	22451
Leak Detector with 220Volt European Battery Charger	ea.	22451-EUR
Leak Detector with 220Volt UK Battery Charger	ea.	22451-UK

*Caution: The Restek Electronic Leak Detector is NOT designed for determining leaks of combustible gases. A combustible gas detector should be used for determining combustible gas leaks in possible hazardous conditions.

Each kit is sealed in a factory-clean Mylar® bag.

FastPack™ Inlet Kits for Agilent GCs

- Convenient: the parts you use are all in one package—no hunting for individual parts.
- Economical: costs less than the sum of the individual parts.
- Clean: Mylar® bag is factory sealed; no contamination of the products from weeks in the lab.

FastPack™ Inlet Kits are a great way to make routine maintenance easy. Each kit includes one:

- Inlet liner—choose from four popular styles.
- Viton® O-ring.
- 0.8mm ID gold-plated inlet seal.
- Inlet seal washer.
- 11mm Thermolite® septum.

FastPack™ Inlet Kits make routine injection port maintenance easy!

1 pack includes 5 maintenance kits

Deactivated Liner	cat.#	pack of 5 kits	5 or more packs	20 or more packs
4mm Splitless*	21101			
4mm Splitless Gooseneck*	21102			
4mm Splitless Double Gooseneck*	21103			
4mm Split with Fused Silica Wool**	21104			

*Liner dimensions: 4mm ID, 6.5mm OD, 78.5mm long.
**Liner dimensions: 4mm ID, 6.3mm OD, 78.5mm Long.

Thermolite® Septa

- Usable to 340°C inlet temperature.
- Each batch tested with FIDs, ECDs, and MSDs to ensure lowest bleed.
- Excellent puncturability.
- Preconditioned and ready to use.
- Do not adhere to hot metal surfaces.
- Packaged in non-contaminating glass jars.

Septum Diameter	25-pk.	50-pk.	100-pk.
5mm (3/16")	20351	20352	20353
6mm (1/4")	20355	20356	20357
7mm	20381	20382	20383
8mm	20370	20371	—
9mm	20354	20358	20362
9.5mm (3/8")	20359	20360	20361
10mm	20378	20379	20380
11mm (7/16")	20363	20364	20365
11.5mm	22385	22386	22387
12.5mm (1/2")	20367	20368	20369
17mm	20384	20385	20386
Shimadzu Plug	20372	20373	20374

InfraRed™ Septa

- Usable to 325°C inlet temperature.
- Preconditioned and ready to use.
- Excellent puncturability.
- Do not adhere to hot metal surfaces.
- Low bleed.
- Packaged in non-contaminating glass jars.

Septum Diameter	25-pk.	50-pk.	100-pk.
9mm	21417	21418	21419
9.5mm (3/8")	21421	21422	21423
10mm	21424	21425	21426
11mm (7/16")	21427	21428	21429
11.5mm	21430	21431	21432
12.5mm (1/2")	21433	21434	21435
17mm	21436	21437	21438
Shimadzu Plug	21439	21440	21441

IceBlue™ Septa

- Usable to 250°C inlet temperature.
- General-purpose septa.
- Excellent puncturability.
- Preconditioned and ready to use.
- Do not adhere to hot metal surfaces.
- Packaged in non-contaminating glass jars.
- Ideal for SPME.

Septum Diameter	50-pk.	100-pk.
9mm	22381	22382
9.5mm (3/8")	22388	22389
10mm	22390	22391
11mm (7/16")	22392	22393
11.5mm	22383	22384
12.5mm (1/2")	22394	22395
17mm	22396	22397
Shimadzu Plug	22398	22399

septum sizes

Reference Chart

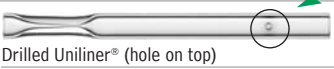
Instrument	Septum Size (mm)
Agilent (HP)	
5880A, 5890, 6890, 6850, PTV	11
5700, 5880	9.5/10
On-Column Injection	5
CE Instruments (TMQ)	
TRACE™ GC	17
Finnigan (TMQ)	
GC 9001	9.5
GCQ	9.5
GCQ w/TRACE™, PTV	17
QCQ™	9.5
TRACE™ 2000	9.5
Fisons/Carlo Erba (TMQ)	
8000 series	17
Gow-Mac	
6890 series	11
All other models	9.5
PerkinElmer	
Sigma series	11
900,990	11
8000 series	11
Auto SYS	11
Auto SYS XL	11
Pye/Unicam	
All models	7
Shimadzu	
All models	Plug
SRI	
All models	Plug
Tracor	
540	11.5
550,560	9.5
220,222	12.5
Varian	
Injector type:	
Packed column	9.5/10
Split/splitless	
1078/1079	10/11
1177	9
1075/1077	11

Measure your old septum here (size in mm)

GC Accessories

Hole in Drilled Uniliner® makes direct injection possible with EPC-equipped 6890 GCs!

DI Liners for Agilent 5890 & 6890 GCs

For 0.25/0.32/0.53mm ID Columns	Benefits/Uses	ID*/OD & Length (mm)	Similar to Agilent part #	cat.# ea.	cat.# 5-pk.	cat.# 25-pk.
 Drilled Uniliner® (hole on top)	trace, active samples, high recovery & linearity	4.0 ID 6.3 OD x 78.5	—	21054	21055	20998
 Siltek® Drilled Uniliner® (hole on top)	trace, active samples, high recovery & linearity	4.0 ID 6.3 OD x 78.5	—	21054-214.1	21055-214.5	20998-214.25
 Drilled Uniliner® (hole on bottom)	trace, active samples, high recovery & linearity	4.0 ID 6.3 OD x 78.5	G1544-80730	20756	20771	—
 Double Gooseneck Drilled Uniliner® (hole on top)	trace, active samples, high recovery & linearity	4.0 ID 6.3 OD x 78.5	—	20508	20509	—
 Double Gooseneck Drilled Uniliner® (hole on bottom)	trace, active samples, high recovery & linearity	4.0 ID 6.3 OD x 78.5	G1544-80700	20954	20989	—
 Siltek® 1mm Drilled Uniliner® (hole on top)	trace, active samples, high recovery & linearity	1.0 ID 6.3 OD x 78.5	—	21390-214.1	21391-214.5	—

DI Liners for Varian 1177 GCs

For 0.25/0.32/0.53mm ID Columns	Benefits/Uses	ID*/OD & Length (mm)	Similar to Varian part #	cat.# ea.	cat.# 5-pk.
 Drilled Uniliner® (hole on top)	trace, active samples, high recovery & linearity	4.0 ID 6.3 OD x 78.5	—	21470	21471
 Drilled Uniliner® (hole on bottom)	trace, active samples, high recovery & linearity	4.0 ID 6.3 OD x 78.5	—	21468	21469

DI Liners for Shimadzu GCs

For 0.32/0.53mm ID Columns	Benefits/Uses	ID*/OD & Length (mm)	Similar to Shimadzu part #	cat.# ea.	cat.# 5-pk.	cat.# 25-pk.
 Open-top Drilled Uniliner® (hole on top)	trace, active samples, high recovery & linearity	3.5 ID 5.0 OD x 95	—	21285	21286	—
 Open-top Drilled Uniliner® (hole on bottom)	trace, active samples, high recovery & linearity	3.5 ID 5.0 OD x 95	—	21287	21288	—
 Gooseneck Drilled Uniliner® (hole on top)	trace, active samples, high recovery & linearity	3.5 ID 5.0 OD x 95	—	21289	21290	—
 Gooseneck Drilled Uniliner® (hole on bottom)	trace, active samples, high recovery & linearity	3.5 ID 5.0 OD x 95	—	21291	21292	—

DI Liners for PerkinElmer GCs

For 0.32/0.53mm ID Columns	Benefits/Uses	ID*/OD & Length (mm)	Similar to PE part #	cat.# ea.	cat.# 5-pk.
 Auto SYS Drilled Uniliner® (hole on top)	trace, active samples, high recovery & linearity	4.0 ID 6.2 OD x 92.1	—	20819	20822
 Auto SYS Drilled Uniliner® (hole on bottom)	trace, active samples, high recovery & linearity	4.0 ID 6.2 OD x 92.1	—	21293	21294
 Auto SYS Gooseneck Drilled Uniliner® (hole on top)	trace, active samples, high recovery & linearity	4.0 ID 5.0 OD x 92.1	—	21295	21296
 Auto SYS Gooseneck Drilled Uniliner® (hole on bottom)	trace, active samples, high recovery & linearity	4.0 ID 6.2 OD x 92.1	—	21297	21298

Direct Injection Liners for Thermo Finnigan 8000 & TRACE™ Series GCs

0.32 & 0.53mm ID columns	Benefits/Uses	ID*/OD & Length (mm)	Similar to TF part #	cat.# ea.	cat.# 25-pk.
 Drilled Uniliner® (hole on top)	trace, active samples, high recovery, & linearity	5.0 ID 8.0 OD x 105	—	22411	22412	—
 Drilled Uniliner® (hole on bottom)	trace, active samples, high recovery, & linearity	5.0 ID 8.0 OD x 105	—	22413	22414	—

All liners are **100% deactivated**. All liners are shipped intermediate polarity (IP) deactivated unless otherwise requested.

Viton® O-Rings for Agilent GCs

- Fit split (6.3mm OD) or splitless (6.5mm OD) liners.

Description	Max. temp.	Similar to Agilent part #	qty.	cat.#
Viton® O-Rings for Agilent GCs	250°C	5180-4182	25-pk.	20377

Graphite O-Rings for Agilent and Varian 1177 GCs

- Excellent thermal stability at injection port temperatures up to 450°C!

Description	Max. temp.	Similar to Agilent part #	Restek cat.# 10-pk.	50-pk.
Graphite O-rings for split liners (6.35mm ID)	450°C	5180-4168	20296	20297
Graphite O-rings for splitless liners (6.5mm ID)	450°C	5180-4173	20298	20299

Liner Seals for Varian 1078/1079

Description	Max. temp.	Similar to Varian part #	qty.	cat.#
5mm Graphite Liner Seals for Varian 1078/1079 GCs	450°C	392611919 392534201	10-pk.	22683

Viton® O-Rings for PerkinElmer AutoSys GCs

Description	Max. temp.	Similar to PE part #	qty.	cat.#
Viton® O-Rings for PerkinElmer AutoSys GCs	250°C	N6101374	10-pk.	20262

Graphite O-Rings for PerkinElmer AutoSys XL PSS

Description	Max. temp.	Similar to PE part #	qty.	cat.#
Graphite O-Rings for PerkinElmer AutoSys XL PSS	450°C	N610-1751	10-pk.	21475
Graphite O-Rings for PerkinElmer AutoSys XL PSS	450°C	N610-1751	25-pk.	21476

Viton® O-Rings for PerkinElmer PSS

Description	Max. temp.	Similar to PE part #	qty.	cat.#
Viton® O-Rings for PerkinElmer PSS	250°C	N6101747	10-pk.	20366

Graphite O-Rings for Shimadzu 17A and 2010 GCs

Description	Max. temp.	Similar to Shimadzu part #	qty.	cat.#
Graphite O-Rings for Split Liners	450°C	221-48393-91	5-pk.	20243
Graphite O-Rings for Splitless Liners	450°C	221-47222-91	5-pk.	20244

Viton® O-Rings for Shimadzu 17A and 2010 GCs

Description	Max. temp.	Similar to Shimadzu part #	qty.	cat.#
Viton® O-Rings for Shimadzu 17A and 2010 GCs	250°C	036-11203-84	10-pk.	21477

Septum Puller

Remove septum, O-rings, stuck ferrule fragments; you'll find many more uses.

Description	qty.	cat.#
Septum Puller	ea.	20117

Inlet Liner Removal Tool

- Easily remove liner from injector—no more burned fingers.
- Made from high-temperature silicone.
- Won't chip or crack the liner.

Description	qty.	cat.#
Inlet Liner Removal Tool	3-pk.	20181

GC Accessories

Dual Vespel® Ring Inlet Seals

Washerless, Leak-Tight Seals for Agilent GCs

- Vespel® ring embedded in bottom surface eliminates need for washer.
- Vespel® ring embedded in top surface reduces operator variability by requiring minimal torque to seal.
- Prevents oxygen from permeating the carrier gas, increasing column lifetime.

0.8mm ID Dual Vespel® Ring Inlet Seal	2-pk.	10-pk.
Siltek®	21242	21243
Gold-Plated	21240	21241
Stainless Steel	21238	21239
1.2mm ID Dual Vespel® Ring Inlet Seal	**2-pk.**	**10-pk.**
Siltek®	21248	21249
Gold-Plated	21246	21247
Stainless Steel	21244	21245

Replacement Inlet Seals with Washers

- Special grade of stainless steel that is softer and deforms more easily, creating a better seal.
- Increases column lifetime because oxygen cannot permeate into the carrier gas.
- Reduced noise benefits high-sensitivity detectors (e.g., ECDs, MSDs).
- Siltek® treatment provides the inertness similar to fused silica.
- Highly-polished stainless steel increases inertness to active compounds.
- All seals include washers.

Single-Column Installation, 0.8mm Opening*		0.25/0.32mm ID Dual-Column Installation, 1.2mm Opening		0.53mm ID Dual-Column Installation (1/16-inch opening)	
2-pk.	10-pk.	2-pk.	10-pk.	2-pk.	10-pk.
			Stainless Steel Inlet Seal		
21315	21316	20390	20391	20392	20393
			Gold-Plated Inlet Seal		
21317	21318	21305	21306	—	—
			Siltek® Inlet Seal		
21319	21320	21307	21308	—	—

*0.8mm ID stainless steel inlet seal is similar to Agilent part #18740-20880,
0.8mm ID gold-plated inlet seal is similar to Agilent part #18740-20885.

Alumaseal™ Ferrules*

- Aluminum construction, will not crack or fragment.
- Eliminate out-gassing, make leak-tight seals, for less detector noise.
- No retightening required after temperature cycles—excellent for GC/MS.
- Unique two-piece design permanently locks on fused silica tubing without causing breakage.
- Will not stick in fittings, unlike Vespel® or graphite.
- Use with any 1/16" compression-type fitting.

Ferrule ID	Fits Column ID	qty.	cat.#
0.4mm	0.25mm	10-pk.	21472
0.5mm	0.32mm	10-pk.	21473
0.8mm	0.53mm	10-pk.	21474

*Patent pending.

Vespel® Ferrules
- 100% high-temperature polyimide.
- Stable to 350°C.
- Durable, leak-tight.

Graphite Ferrules
- High-purity, high-density graphite.
- Smoother surface and cleaner edges than conventional graphite ferrules.
- Contain no binders that can off-gas or adsorb analytes.
- Stable to 450°C.

Vespel®/Graphite Ferrules
- 60%/40% Vespel®/graphite blend, offering the best combination of sealing and ease of workability.
- Seal with minimal torque, reusable, and preferred for vacuum and high-pressure uses.
- Stable to 400°C.
- Recommended for mass spec transfer lines.

Capillary Ferrules—For 1/16-Inch Compression-Type Fittings

Ferrule ID	Fits Column ID	qty.	Vespel®	Graphite	Vespel®/Graphite
0.3mm	≤ 0.20mm	10-pk.	22213	20233	20275
0.4mm	0.25/0.28mm	10-pk.	22214	20200	20211
0.4mm	0.25/0.28mm	50-pk.	—	20227	20229
0.5mm	0.28/0.32mm	10-pk.	22215	20201	20212
0.5mm	0.28/0.32mm	50-pk.	—	20228	20231
0.6mm	0.28mm**	10-pk.	—	—	20232
0.8mm	0.45/0.53mm	10-pk.	22216	20202	20213
0.8mm	0.45/0.53mm	50-pk.	—	20224	20230
1.0mm	0.75mm*	10-pk.	22217	21058	—
1.2mm	0.75mm	10-pk.	22218	—	—
1.6mm	1.00mm*	10-pk.	—	21060	—

save **money**!

Buy ferrules in bulk 50-packs!

Compact Ferrules—For Agilent 5890/6890/6850 GCs

Ferrule ID	Fits Column ID	qty.	Graphite	Vespel®/Graphite
0.4mm	0.25/0.28mm	10-pk.	20250	20238
0.4mm	0.25/0.28mm	50-pk.	20251	20239
0.5mm	0.28/0.32mm	10-pk.	21007	20248
0.5mm	0.28/0.32mm	50-pk.	21008	20249
0.8mm	0.45/0.53mm	10-pk.	20252	20263
0.8mm	0.45/0.53mm	50-pk.	20253	20264
1.0mm	0.75mm*	10-pk.	21059	21056
1.6mm	1.00mm*	10-pk.	21061	21057

*For micropacked columns.
**For 0.28mm MXT® columns.

Encapsulated Ferrules—For 1/16-Inch Compression Fittings
- Reusable—will not deform and stick in fittings.
- Less torque needed to seal ferrule.
- Restek's unique blend of graphite minimizes fragmentation and outgassing.

Ferrule ID	Fits Column ID	qty.	cat.#
0.4mm	0.25mm	10-pk.	21036
0.5mm	0.32mm	10-pk.	21037
0.8mm	0.53mm	10-pk.	21038

GC Accessories

Inlet and FID Maintenance Kits for Agilent GCs

- Include the most common consumable supplies.
- All parts meet or exceed performance by instrument manufacturer's parts.
- Parts list makes reordering easy.

FID Maintenance Kit

Inlet Maintenance Kit

FID kits include:

- 1/4-inch, 0.4, 0.5, and 0.8mm ID graphite ferrules.
- FID/NPD capillary adaptor.
- Capillary nuts.
- Jet reamers/ferrule removers.
- 1/4-inch nut.
- Scoring wafer.
- Capillary column caps.
- Ignitor for either Agilent 5890 or 6890/6850 GCs.
- FID flow measuring adaptor.
- 1/4- x 5/16-inch wrench.
- Installation gauge.
- Wire cleaning brush.
- High-performance Siltek®-treated FID jet for either Agilent 5890 (adaptable jet) or 6890/6850 (dedicated jet) GCs.
- 1/4-inch nut driver for jet removal.

Inlet kit includes:

- 0.4, 0.5, and 0.8mm IDgraphite ferrules.
- Viton® O-rings.
- Capillary nuts.
- Inlet seals.
- Reducing nut.
- Scoring wafer.
- 11mm Thermolite® septa.
- 4.0mm single gooseneck liner.
- 4.0mm split liner with wool.
- Capillary column caps.
- 1/4- x 5/16-inch wrench.
- Septum puller.
- Installation gauge.
- Wire cleaning brush.
- Jet reamers/ferrule removers.
- Inlet liner removal tool.

Description	qty.	cat.#
Inlet Maintenance Kit for Agilent 5890/6890/6850 GCs	kit	21069
FID Maintenance Kit for Agilent 5890 GCs	kit	21070
FID Maintenance Kit for Agilent 6890/6850 GCs	kit	21071

Crimp-Top Vials, 2.0mL, 12 x 32mm, 11mm Crimp Finish

White graduated marking spots are a standard feature unless otherwise noted.

2.0mL, 11mm, Crimp-Top Vial

Crimp-Top Vial, Snap Seal™ Style (12 x 32mm, 11mm Crimp)

Description	100-pk.	1000-pk.
2.0mL Clear Glass Vial w/White Graduated Marking Spot*	24383	24384
2.0mL Amber Glass Vial w/White Graduated Marking Spot*	24385	24386
2.0mL Clear Glass Vial without Graduated Marking Spot	21152	21153

11mm Aluminum Crimp Seals w/Septa

Description	100-pk.	500-pk.	1000-pk.
Silver Seal, PTFE/Natural Rubber Septa	21174	—	21175
Mixed Colors, PTFE/Natural Rubber Septa***	—	21724	—
Silver Seal, PTFE/Silicone Septa**	24359	—	24360
Mixed Colors, PTFE/Silicone Septa***	—	21725	—


11mm Aluminum Crimp Seals with Septa

Convenience Kits: Vials, Caps, & Septa

Description	100-pk.	1000-pk.
2.0mL Clear Vial, deactivated, PTFE/Natural Rubber Seal†	24671	24672
2.0mL Amber Vial, deactivated, PTFE/Natural Rubber Seal†	24673	24674
2.0mL Clear Vial, untreated, PTFE/Natural Rubber Seal	21196	21197
2.0mL Amber Vial, untreated, PTFE/Natural Rubber Seal	21198	21199
2.0mL Clear Vial, untreated, PTFE/Silicone Seal	24646	24647
2.0mL Amber Vial, untreated, PTFE/Silicone Seal	24648	24649

Limited Volume Inserts for 2mL Crimp-Top & Short-Cap, Screw-Thread Vials

Description	100-pk.	1000-pk.
50µL Glass, Polypropylene, Bottom Spring	24513	21782
250µL Glass, Big Mouth Insert w/ Bottom Spring	21776	21777
250µL Glass, Big Mouth Insert w/ Glass Flange (Step™ Design)‡	24516	21779
350µL Glass, Flat Bottom Insert	21780	24517
350µL Glass, Flat Bottom Insert w/ ID Ring	24692	24693
250µL Polypropylene, Bottom Spring	24518	—
250µL Polypropylene, Top Flange	24519	—
250µL Polypropylene, No Spring	24520	—


Glass, Limited Volume Insert with Bottom Spring

*Colored marking spots available on request in blue, green, rust, or yellow (1000 packs only).

**PTFE/Silicone/PTFE available on request (1000 packs only).

***Individual colored seals available on request.

†Silcote™ CL7 deactivation.

‡Not to be used with 9mmn screw-thread vials.

Standard Micro-Liter Syringes for Agilent 7673, 7683, and 6850 Autosamplers

- Hamilton and SGE syringes are designed and tested to meet critical autosampler performance.
- SGE manufactures autosampler syringes for every major GC instrument company.
- Needle point styles are designed to withstand multiple, fast injections through a septum.

Hamilton Syringes

Volume	Needle Term.	Needle Gauge	Needle Length	Point Style	Hamilton Model	Hamilton cat.#	Hamilton qty.	Restek cat.#
5µL	ASN	23s	1.71"	Agilent	75	87990	6-pk.	20170
5µL	ASN	26s	1.71"	Agilent	75	87989	6-pk.	21230
5µL	ASN	23s–26s	1.71"	Agilent	75	87994	6-pk.	24594
10µL	ASN	23s	1.71"	Agilent	701	80390*	6-pk.	20169
10µL	ASN	26s	1.71"	Agilent	701	80389	6-pk.	24599
10µL	ASN	23s–26s	1.71"	Agilent	701	80391	6-pk.	24600

SGE Syringes

Volume	Needle Term.	Needle Gauge	Needle Length	Point Style	SGE Model	SGE cat.#	SGE qty.	Restek cat.#
5µL	F	23	42mm	Cone	SK-5F-HP-0.63	001814	6-pk.	24783
5µL	F	26	42mm	Cone	SK-5F-HP-0.47	001804	6-pk.	24782
5µL	F	23-26s	42mm	Cone	SK-5F-HP-0.63/0.47	001822	6-pk.	21214
10µL	F	23	42mm	Cone	SK-10F-HP-0.63	002814	6-pk.	24787
10µL	F	26	42mm	Cone	SK-10F-HP-0.47	002804	6-pk.	24786
10µL	F	23–26s	42mm	Cone	SK-10F-HP-0.63/0.47	002822	6-pk.	21215

*Designated by Agilent as #80397.

23s—Single Gauge Needle
- The most popular gauge for Agilent 7673.
- Stocked for same-day shipment.
- Best for Merlin Microseal® septum and standard septum-equipped GCs.
- Packed column injection ports.
- Split/splitless injection ports.

26s—Single Gauge Needle
- On-column injection ports.
- Split/splitless injection ports.

23s-26s—Dual Gauge (tapered)
- Durability of a 23s gauge needle.
- Ability of a 26s gauge needle to perform split/splitless and on-column injections.

Needle Termination Codes

Hamilton: (ASN) Autosampler Cemented Needle

SGE: (F) Fixed Needle

HPLC Columns

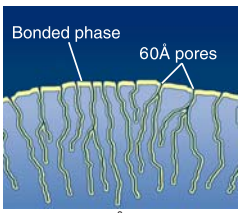
Allure™ Organic Acids

Physical Characteristics:

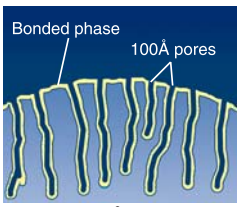
particle size: 5µm, spherical
pore size: 60Å
non-endcapped
pH range: 2.5 to 7.5
temperature limit: 80°C

Chromatographic Properties:

Allure™ Organic Acids columns provide enhanced retention and selectivity for polar organic acids, allowing separations to be performed on a single 30cm column. An Allure™ Organic Acids column effectively resolves key organic acids such as tartaric and quinic acids, using the chromatographic conditions specified in AOAC method 986.13. Retention is stable and reproducible, even with the 100% aqueous mobile phase specified in the AOAC method.



Allure™ 60Å pore size provides maximum retention.



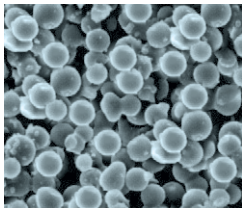
Ultra 100Å pore size provides moderate retention.

Length	3.2mm ID cat.#	4.6mm ID cat.#
5µm Column		
150mm	9165563	9165565
250mm		9165575
300mm		9165585

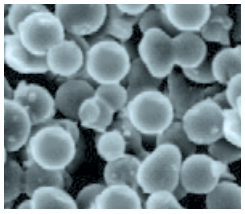
To order a 2.1mm, 3.2mm, or 4.6mm ID column with a Trident™ Integral Inlet Fitting, add "-700" to the catalog number for the column.
Example: 100mm x 4.6mm ID Ultra C18 column with Trident™ Integral Inlet Fitting: 9174315-700

Nominal additional charge

For guard cartridges for these columns, see page 44.



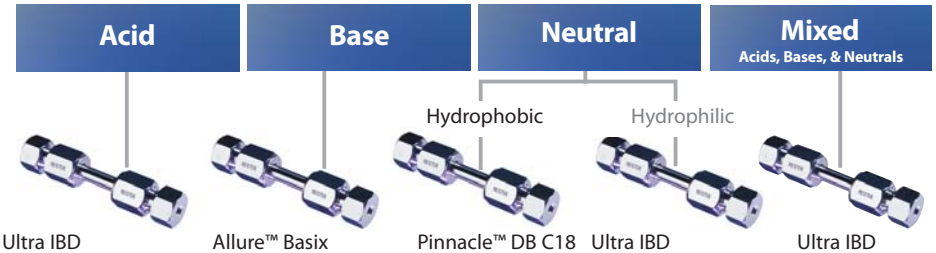
3µm particles provide fast separations.



5µm particles are ideal for general screening and initial method development.

Choose the best stationary phase for your application based on analyte functionality.

Analyte Functional Group



Acid	Base	Neutral: Hydrophobic	Neutral: Hydrophilic	Mixed: Acids, Bases, & Neutrals
Ultra IBD	Allure™ Basix	Pinnacle™ DB C18	Ultra IBD	Ultra IBD
Ultra Aqueous C18	Allure™ PFP Propyl	Ultra C18	Ultra Aqueous C18	Allure™ Basix
Allure™ Aqueous C18	Ultra IBD	Pinnacle II™ C18	Allure™ Aqueous C18	
Allure™ Organic Acids	Ultra PFP	Allure™ C18	Allure™ Organic Acids	
	Pinnacle™ DB Cyano	Ultra C8		
	Ultra Cyano	Pinnacle II™ C8		
	Ultra Amino	Pinnacle II™ Phenyl		
	Pinnacle II™ Amino			

Ultra C8 (USP L7)
Excellent All-Purpose Reversed Phase Columns

Physical Characteristics:

particle size: 3µm or 5µm, spherical
pore size: 100Å
carbon load: 12%
fully end-capped
pH range: 2.5 to 7.5
temperature limit: 80°C

Chromatographic Properties:

A very retentive, high-purity, base-deactivated reversed phase packing that exhibits excellent peak shape for a wide range of compounds.

Length	1.0mm ID cat.#	2.1mm ID cat.#	3.2mm ID cat.#	4.0mm ID cat.#	4.6mm ID cat.#
3µm Columns					
30mm	9103331	9103332	9103333	—	9103335
50mm	9103351	9103352	9103353	—	9103355
100mm	9103311	9103312	9103313	—	9103315
5µm Columns					
30mm	9103531	9103532	9103533	—	9103535
50mm	9103551	9103552	9103553	—	9103555
100mm	9103511	9103512	9103513	9103514	9103515
150mm	9103561	9103562	9103563	9103564	9103565
200mm	9103521	9103522	9103523	—	9103525
250mm	9103571	9103572	9103573	—	9103575

Ultra C18 (USP L1)
Excellent All-Purpose Reversed Phase Columns

Physical Characteristics:

particle size: 3µm or 5µm, spherical
pore size: 100Å
carbon load: 20%
fully end-capped
pH range: 2.5 to 7.5
temperature limit: 80°C

Chromatographic Properties:

A very retentive, high-purity packing that exhibits excellent peak shape for a wide range of compounds. Excellent general-purpose reversed phase column.

Length	1.0mm ID cat.#	2.1mm ID cat.#	3.2mm ID cat.#	4.0mm ID cat.#	4.6mm ID cat.#
3µm Columns					
30mm	9174331	9174332	9174333	—	9174335
50mm	9174351	9174352	9174353	—	9174355
100mm	9174311	9174312	9174313	—	9174315
5µm Columns					
30mm	9174531	9174532	9174533	—	9174535
50mm	9174551	9174552	9174553	—	9174555
100mm	9174511	9174512	9174513	9174514	9174515
150mm	9174561	9174562	9174563	9174564	9174565
200mm	9174521	9174522	9174523	—	9174525
250mm	9174571	9174572	9174573	—	9174575

To order a 2.1mm, 3.2mm, or 4.6mm ID column with a Trident™ Integral Inlet Fitting, add "-700" to the catalog number for the column.
Example: 100mm x 4.6mm ID Ultra C18 column with Trident™ Integral Inlet Fitting: 9174315-700

Nominal additional charge

For guard cartridges for these columns, see page 44.

HPLC Columns

Ultra Amino

Physical Characteristics:

particle size: 3µm or 5µm, spherical
pore size: 100Å
carbon load: 2%
pH range: 2.5 to 7.5
temperature limit: 80°C

Chromatographic Properties:

Recommended for normal phase analyses of mono- and disaccharides, or similar compounds. Also can serve as a weak anion exchanger, with aqueous buffers.

Length	1.0mm ID cat.#	2.1mm ID cat.#	3.2mm ID cat.#	4.6mm ID cat.#
3µm Columns				
30mm	9107331	9107332	9107333	9107335
50mm	9107351	9107352	9107353	9107355
100mm	9107311	9107312	9107313	9107315
5µm Columns				
30mm	9107531	9107532	9107533	9107535
50mm	9107551	9107552	9107553	9107555
100mm	9107511	9107512	9107513	9107515
150mm	9107561	9107562	9107563	9107565
200mm	9107521	9107522	9107523	9107525
250mm	9107571	9107572	9107573	9107575

Pinnacle II™ Amino

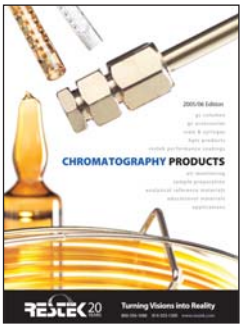
Physical Characteristics:

particle size: 3µm or 5µm, spherical
pore size: 110Å
carbon load: 2%
pH range: 2.5 to 7.5
temperature limit: 80°C

Chromatographic Properties:

HPLC analysis using an amino-based stationary phase is the most popular technique for routine analyses of simple sugars, using isocratic elution (e.g., acetonitrile:water, 75:25) and a refractive index detector (RID). The Pinnacle II™ Amino column is ideal for the purpose.

Length	1.0mm ID cat.#	2.1mm ID cat.#	3.2mm ID cat.#	4.6mm ID cat.#
3µm Columns				
30mm	9217331	9217332	9217333	9217335
50mm	9217351	9217352	9217353	9217355
100mm	9217311	9217312	9217313	9217315
5µm Columns				
30mm	9217531	9217532	9217533	9217535
50mm	9217551	9217552	9217553	9217555
100mm	9217511	9217512	9217513	9217515
150mm	9217561	9217562	9217563	9217565
200mm	9217521	9217522	9217523	9217525
250mm	9217571	9217572	9217573	9217575



for **more** info

Restek offers an extensive array of HPLC columns, accessories, and instrument parts. Call to request our HPLC catalog (cat. # 59241B) or visit us on the web at www.restek.com

Ultra Aqueous C18 (USP L1)

Physical Characteristics:

particle size: 3µm or 5µm, spherical
pore size: 100Å
not end-capped
pH range: 2.5 to 7.5
temperature limit: 80°C

Chromatographic Properties:

Highly retentive and selective for reversed phase separations of polar analytes. Highly base deactivated. Compatible with highly aqueous (up to 100%) mobile phases.

Length	1.0mm ID cat.#	2.1mm ID cat.#	3.2mm ID cat.#	4.6mm ID cat.#
3µm Columns				
30mm	9178331	9178332	9178333	9178335
50mm	9178351	9178352	9178353	9178355
100mm	9178311	9178312	9178313	9178315
5µm Columns				
30mm	9178531	9178532	9178533	9178535
50mm	9178551	9178552	9178553	9178555
100mm	9178511	9178512	9178513	9178515
150mm	9178561	9178562	9178563	9178565
200mm	9178521	9178522	9178523	9178525
250mm	9178571	9178572	9178573	9178575

Ultra Phenyl (USP L11)

Physical Characteristics:

particle size: 3µm or 5µm, spherical
pore size: 100Å
carbon load: 10%
fully end-capped
pH range: 2.5 to 7.5
temperature limit: 80°C

Chromatographic Properties:

High-purity, highly retentive, base-deactivated phase with alternative selectivity to straight chain hydrocarbon phases, especially for aromatic analytes.

Length	1.0mm ID cat.#	2.1mm ID cat.#	3.2mm ID cat.#	4.6mm ID cat.#
3µm Columns				
30mm	9105331	9105332	9105333	9105335
50mm	9105351	9105352	9105353	9105355
100mm	9105311	9105312	9105313	9105315
5µm Columns				
30mm	9105531	9105532	9105533	9105535
50mm	9105551	9105552	9105553	9105555
100mm	9105511	9105512	9105513	9105515
150mm	9105561	9105562	9105563	9105565
200mm	9105521	9105522	9105523	9105525
250mm	9105571	9105572	9105573	9105575

To order a 2.1mm, 3.2mm, or 4.6mm ID column with a Trident™ Integral Inlet Fitting, add "-700" to the catalog number for the column.
Example: 100mm x 4.6mm ID Ultra C18 column with Trident™ Integral Inlet Fitting: 9174315-700

Nominal additional charge

For guard cartridges for these columns, see page 44.

did you know?

Ultra Aqueous C18 is the ideal column for high water solubility or low organic solubility compounds that require >90% water in the mobile phase. Excellent for water soluble vitamins and organic acids.

HPLC Columns, Syringe Filters, Guard Cartridges

Pinnacle II™ C18 (USP L1)

Physical Characteristics:

particle size: 3µm or 5µm, spherical
pore size: 110Å
carbon load: 13%
fully end-capped
pH range: 2.5 to 7.5
temperature limit: 80°C

Chromatographic Properties:

Excellent choice as a general purpose C18 column. Intermediate carbon loading and surface area, suitable for a wide range of neutral hydrophobic compounds. Replaces Hypersil® ODS and Pinnacle™ C18.

Length	1.0mm ID cat.#	2.1mm ID cat.#	3.2mm ID cat.#	4.0mm ID cat.#	4.6mm ID cat.#
3µm Columns					
30mm	9214331	9214332	9214333	—	9214335
50mm	9214351	9214352	9214353	—	9214355
100mm	9214311	9214312	9214313	—	9214315
5µm Columns					
30mm	9214531	9214532	9214533	—	9214535
50mm	9214551	9214552	9214553	—	9214555
100mm	9214511	9214512	9214513	9214514	9214515
150mm	9214561	9214562	9214563	9214564	9214565
200mm	9214521	9214522	9214523	—	9214525
250mm	9214571	9214572	9214573	—	9214575

To order a 2.1mm, 3.2mm, or 4.6mm ID column with a Trident™ Integral Inlet Fitting, add "-700" to the catalog number for the column.
Example: 100mm x 4.6mm ID Ultra C18 column with Trident™ Integral Inlet Fitting: 9174315-700

Nominal additional charge

For guard cartridges for these columns, see below.

please **note**

For additional sample preparation products, request our chromatography products catalog.

Resprep™ Syringe Filters

- Solvent-resistant polypropylene housing.
- Glass fiber prefilter ensures better flow characteristics.
- Most popular filter sizes and membrane porosities.
- Non-leaching nylon or PTFE.

Filter Diameter	Porosity	qty.	Nylon	PTFE
13mm	0.20µm	100-pk.	26066	26068
13mm	0.45µm	100-pk.	26067	26069
25mm	0.20µm	50-pk.	26070	26072
25mm	0.45µm	50-pk.	26071	26073
25mm	1.00µm	50-pk.	—	26074

10 & 20mm Guard Cartridges

Trident™ HPLC Guard Column Cartridges

Guard Column Cartridges	3-pk. (10 x 2.1mm)	3-pk. (10 x 4.0mm)	2-pk. (20 x 2.1mm)	2-pk. (20 x 4.0mm)
Allure™ Organic Acids	916550212	916550210	916550222	916550220
Pinnacle II™ Amino	921750212	921750210	921750222	921750220
Pinnacle II™ C18	921450212	921450210	921450222	921450220
Ultra Amino	910750212	910750210	910750222	910750220
Ultra Aqueous C18	917850212	917850210	917850222	917850220
Ultra C8	910350212	910350210	910350222	910350220
Ultra C18	917450212	917450210	917450222	917450220
Ultra Phenyl	910550212	910550210	910550222	910550220

Trident™ Direct Guard Column System

Easy to Use, Low Dead Volume—The Ultimate Combination of Convenience and Column Protection

Unlike "one size fits all" guard systems, the Trident™ Direct system gives you the power to select the right level of protection for your analysis. The system offers three levels of protection and guard cartridges in four dimensions, with a variety of bonded phases to match your analytical column. The economical, leak-free cartridge design provides an unprecedented combination of convenience, economy, and reliability. The foundation of the Trident™ Direct system is a reusable direct connect holder that easily attaches to any HPLC column using CPI- or Waters®-style end fittings.* The system is available in configurations to match different protection level needs: in-line filter, in-line filter with holder for 10mm guard cartridge, and in-line filter with holder for 20mm guard cartridge. The guard cartridges are available in 2.1 and 4.0mm ID and are interchangeable within the appropriate length holder.

Description	qty.	cat.#
High-pressure filter	ea.	25082
10mm guard cartridge holder without filter	ea.	25083
10mm guard cartridge holder with filter	ea.	25084
20mm guard cartridge holder without filter	ea.	25085
20mm guard cartridge holder with filter	ea.	25086
Connection tip for Waters®-style end fittings	ea.	25088
PEEK® tip standard fittings	ea.	25087
Replacement cap frits: 4mm, 2.0µm	5-pk.	25022
Replacement cap frits: 4mm, 0.5µm	5-pk.	25023
Replacement cap frits: 2mm, 2.0µm	5-pk.	25057

*The standard PEEK® tip in Trident™ Direct systems is compatible with Parker®, Upchurch®, Valco®, and other CPI-style fittings. To use Trident™ Direct systems with Waters®-style end fittings, replace the tip with cat.# 25088.

Trident™ Direct provides three levels of protection

Trident™ Direct high-pressure filter
Protection against particulate matter.

Trident™ Direct 10mm guard cartridge holder with filter
Protection against particulate matter and moderate protection against irreversibly adsorbed compounds.

Trident™ Direct 20mm guard cartridge holder with filter
Protection against particulate matter and maximum protection against irreversibly adsorbed compounds.

Restek's Trident™ Integral System

- Convenient and economical leak-free guard column system, extremely easy to install.
- Versatile configuration protects against all levels of contamination.
- Integral design eliminates troublesome tubing connections.

The system's foundation consists of the analytical column configured with our exclusive Trident™ end fitting and XF fitting. This configuration contains the standard internal frit as well as a replaceable cap frit, which can easily be changed without disturbing the packed bed. Changing the external frit can reverse the effects of accumulated particles, such as high backpressure or peak distortion. To obtain this basic configuration, simply order any Restek HPLC column, and add the suffix -700 to the catalog number for the column. Nominal additional charge.

For maximum protection against contaminants and particulate matter, the system can be configured with an integral guard cartridge holder (XG-XF), a guard cartridge, and a replaceable external frit. To obtain this configuration, simply order any Restek HPLC column, add the suffix -700 to the catalog number for the column, and order the appropriate XG-XF male fitting (cat.# 25026 or 25062) and Trident™ guard cartridges.

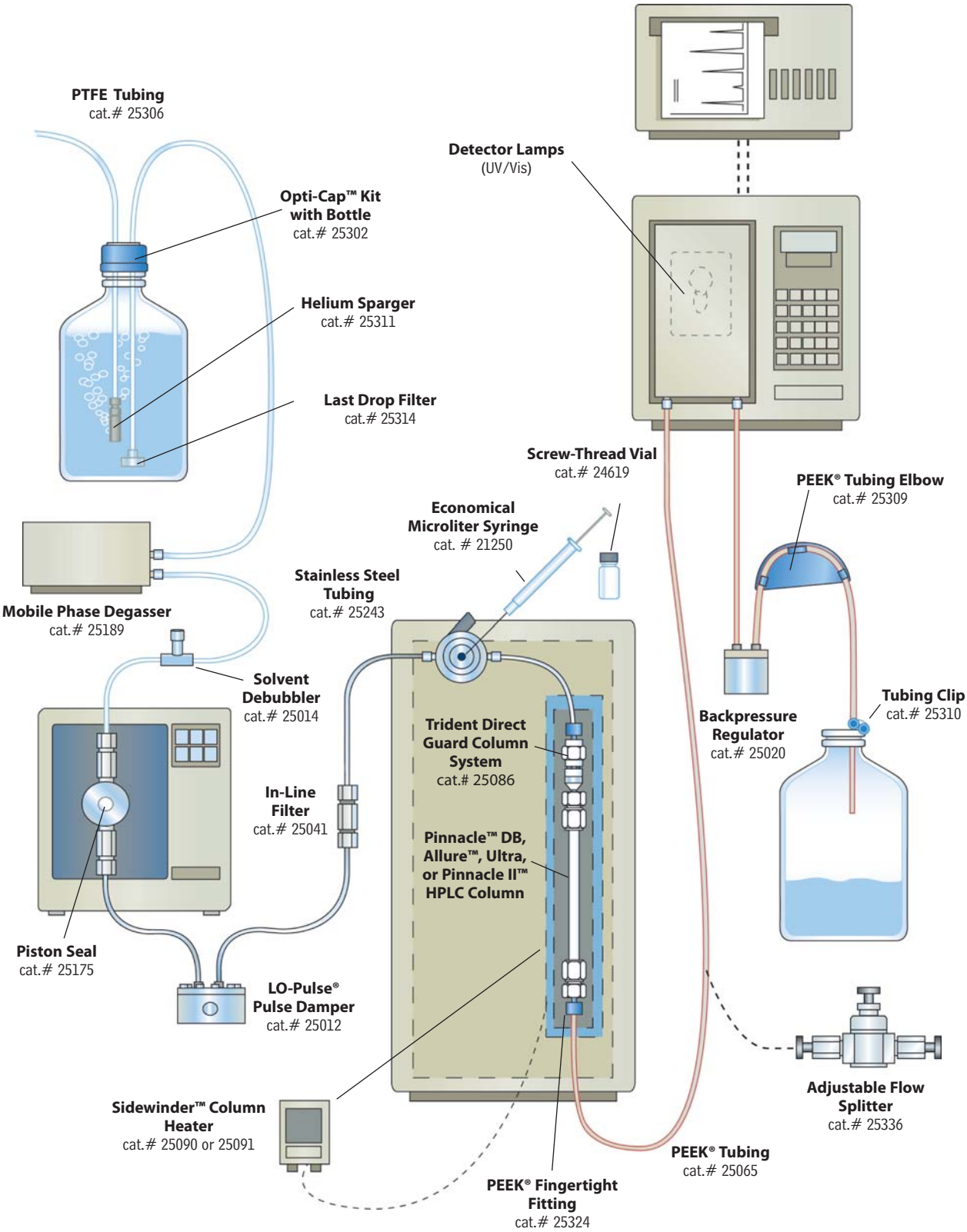
Description	qty.	cat.#
XG-XF Fitting for 10mm Guard Cartridge	ea.	25026
XG-XF Fitting for 20mm Guard Cartridge	ea.	25062
Replacement XF Filter Fitting	ea.	25024
Replacement cap frits: 4mm, 2.0µm	5-pk.	25022
Replacement cap frits: 4mm, 0.5µm	5-pk.	25023
Replacement cap frits: 2mm, 2.0µm	5-pk.	25057

HPLC column (with -700 extension) with guard cartridge, XG-XF fitting, cap frit, and XF end fitting.

HPLC Accessories

Restek has the HPLC Columns and Accessories You Need.

We offer a wide selection of HPLC replacement parts and accessories, such as mobile phase degassers, tubing, flow splitters, syringes, vials, and column protection products. Use the page numbers shown here to locate specific categories of products.



High-Pressure Frit-Type In-Line Filters

Restek's high-pressure in-line filter is a stand-alone version of the Trident™ column protection system. The filter is specifically designed for ease of use, low dead-volume, and flexibility. The filter has a replaceable, PEEK® encapsulated 316 stainless steel frit with a surface area of 12mm². The standard frit shipped with the filter has a 2.0µm porosity; however, it may be replaced with an optional 0.5µm porosity frit. Use of this filter can greatly extend column life, thereby reducing costs and saving maintenance time. Tubing OD 1/16"; Connectors–CPI

Description	Porosity	qty.	cat.#
Frit-Type In-Line Filter	2.0µm	ea.	25041
Replacement cap frits: 4mm	0.5µm	5-pk.	25023
Replacement cap frits: 4mm	2.0µm	5-pk.	25022

High-Pressure Cup-Type In-Line Filters

High-pressure cup-type filters can be used in fluid streams operating to 15,000psi. The cup-shaped filter elements have a large (2.5 cm²) surface area to give long operating lifetime. Mounted in screw-type adapters, they are easily removed for cleaning. Normally, backflushing and cleaning in an ultrasonic bath with an appropriate solvent will restore them. If they become permanently clogged, replacement elements are available.

Housings and all wetted parts are type 316 stainless steel. Filters are packaged with appropriate gland nuts and ferrules. A bulkhead type is available for thru-panel mounting. Tubing OD 1/16"; Connectors–CPI

Description	Porosity	qty.	cat.#
Cup-Type In-Line Filter	0.5µm	ea.	25000
Cup-Type In-Line Filter	2.0µm	ea.	25001
Replacement Filter Elements & Seals	0.5µm	2-pk.	25002
Replacement Filter Elements & Seals	2.0µm	2-pk.	25003

Low-Pressure Slip-On Inlet Filter for Mobile Phase Reservoir

A type 316 stainless steel tip with a Tefzel® collar seals to a corrosion-resistant type 316 stainless steel filter element. The slip-on filter easily attaches to the pump inlet line, without the use of wrenches. The universal tip accommodates standard PTFE tubing inner diameters. The cylindrical filter is standard 10µm porosity. 1/8" OD (fits Altex, ISCO, LDC, Varian, Waters, PerkinElmer, and other pumps)

Description	qty.	cat.#
Slip-on Inlet Filter	ea.	25008

Low-Pressure CPI Inlet Filter for Mobile Phase Reservoir

A type 316 stainless steel knurled cap and Tefzel® CPI ferrule seals to 1/8" OD PTFE tubing when finger-tightened onto the precision-machined filter holder. The filter element is replaceable. Standard 10µm porosity protects delicate pump components from particles but introduces very little pressure drop. 1/8" OD. May be used as a helium sparging diffuser.

Description	qty.	cat.#
CPI Inlet Filter	ea.	25009
Replacement Elements: 10µm filter	2-pk.	25010

Mobile Phase Spargers and Filters

These helium spargers offer an inexpensive way to prepare and maintain mobile phases free of dissolved gas. They are made from 316 stainless steel and PEEK® and are compatible with most solvents.

Description	qty.	cat.#
Sparge Filter: 2µm	ea.	25311
Inlet Filter: 10µm	ea.	25312
Inlet Filter: 20µm	ea.	25313

HPLC Accessories

Last Drop Filter

The flat filter element sits parallel to the bottom of the mobile phase reservoir, allowing the filter to draw 98% of the mobile phase without drawing air into the system. Conventional cylindrical mobile phase filters begin to draw air into the system when approximately 10% of the solvent remains in the reservoir. The Last Drop Filter allows more analyses per batch of mobile phase and helps reduce hazardous waste. 22.1mm OD.

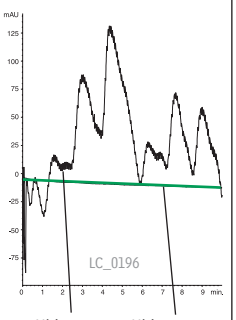
Description	qty.	cat.#
Last Drop Filter: 2µm	ea.	25314
Last Drop Filter: 10µm	ea.	25315

Kontes All-Glass Microfiltration Apparatus

47mm filtration apparatus with fritted glass support is recommended for routine filtration of corrosive liquids and removal of particles from HPLC solvents. The ground joint connection eliminates phthalate contamination that can occur when using silicone or neoprene stoppers. The support base has a coarse porosity glass frit and an integral vacuum connection, located above the drip tip to prevent contamination of the vacuum line with filtrate droplets. Each apparatus includes a funnel, an anodized aluminum clamp, a 47mm fritted glass support base, and a filtration flask.

Description	qty.	cat.#
300mL Funnel, 1000mL Flask	ea.	KT953825-0000
500mL Funnel, 2000mL Flask	ea.	KT953835-0000
1000mL Funnel, 4000mL Flask	ea.	KT953845-0000

Degasys Ultimate Degasser provides highly stable baselines



Ultimate Degasser Off | Ultimate Degasser On

Mobile Phase: water:methanol 50:50
Flow: 1.0 mL/min.
Det.: UV @ 210nm

Mobile Phase Degasser

Dissolved oxygen can cause flow rate instability and increased baseline noise. Also, it has a quenching effect on fluorescence detection and increases the background of UV detectors. Dissolved gases can out-gas in the HPLC system, forming bubbles in check valves, at connections, or in detector flow cells.

In-line vacuum degassing is more effective at removing dissolved gas from mobile phases than sonication or helium sparging. In-line degassers work by withdrawing gas across a gas-permeable membrane encased in a sealed chamber. Traditionally, the membrane has been made of PTFE tubing, but the Degasys Ultimate Degasser uses tubing composed of an amorphous fluoropolymer that is 200 to 300 times more gas permeable than PTFE. This translates into the ability to use shorter tubing for removing dissolved gas. This new material also has better tubular burst strength than PTFE. To prevent cross contamination, each channel on this Degasys unit is individually encased within its own vacuum chamber.

Specifications:

Residual Oxygen[1]	Pressure Loss[1]	Internal Volume	Wetted Parts	Max Flow Rate
0.9ppm	0.24psi	500µL	PTFE	7mL/min./channel
			PTFE	
			ETFE	
			PPS	

[1] At a flow rate of 1mL/min.

Description	qty.	cat.#
110V Mobile Phase Degasser (4 Channel, 7mL/min./channel)	ea.	25189
220V Mobile Phase Degasser (4 Channel, 7mL/min./channel)	ea.	25194

Solvent Debubbler

Bubbles in an HPLC system can cause check valve malfunctions and pump cavitation, seriously affecting pump performance. The debubbler removes bubbles from the fluid stream before it enters the pump.

Special geometry at the base of the housing allows bubbles entrained in the inlet fluid stream to rise and be trapped in the reservoir. The gas/liquid interface is easily visible through the translucent wall of the device. Loosening the airtight cap releases the trapped gas. The debubbler is fitted with a bracket and universal connecting tips.

Description	qty.	cat.#
Solvent Debubbler with Bracket	ea.	25014

Sonic Debubbler

- Fast.
- Easy to use.
- Less solvent waste; less clean-up.

Just touch the Sonic Debubbler to the inlet line or check valve — sonic vibrations will quickly dislodge or redissolve trapped air bubbles. Reduces downtime or conversion time from one mobile phase to another.

Description	qty.	cat.#
Sonic Debubbler (110V)	ea.	20444
Sonic Debubbler (220V)	ea.	25098

Sidewinder™ Column Heater

- Easy to set up!
- Controls temperature from 5°C above ambient to 85°C.
- Lightweight, compact design fits in small spaces.
- Column holder can be placed in any orientation.
- Automatically shuts down when samples are finished.
- Power requirements of 100-240VAC.

This unique design completely encloses any HPLC analytical column up to 25cm in length. Two lengths of heater jackets are available: the smaller jacket accommodates columns up to 10cm in length, while the longer one holds columns up to 25cm in length. The control module provides optimum heating performance, accuracy to within 1°C, and stability to within 0.1°C.

Description	qty.	cat.#
Temperature Control Module and Long Column Holder	ea.	25090
Temperature Control Module and Short Column Holder	ea.	25091

Mobile Phase Pre-heater

- Minimizes temperature changes, to help keep analyte peaks sharp.
- Heats mobile phase before entering heated column.

Description	qty.	cat.#
Mobile Phase Pre-heater	ea.	25099

Survival Kits for HPLC

For start-up and standard use in all HPLC systems.

The Restek Survival Kit is an invaluable spare parts kit that contains the tools and supplies essential for setting up and maintaining your HPLC system.

Restek Survival Kit includes:

- PEEK® Column Connector (beige, round body), 10-pk.
- PEEK® Tubing, 1/16" OD x 0.005" ID x 3m (red stripe), ea.
- PEEK® Tubing, 1/16" OD x 0.007" ID x 3m (yellow stripe), ea.
- PEEK® Tubing, 1/16" OD x 0.010" ID x 3m (blue stripe), ea.
- PEEK® Tubing Elbow 90°, 5-pk.
- PEEK® Tubing Elbow 180°, 5-pk.
- PTFE Tubing, 1/8" OD x 0.063" ID x 3m (1.6mm ID), ea.
- PTFE Tubing, 1/8" OD x 0.094" ID x 3m (2.4mm ID), ea.
- Tubing Clip, 5-pk.
- ValvTool Wrench, ea.
- Open-End Wrenches (1/4" x 5/16"), 2-pk.
- Clean-Cut™ Tubing Cutter, ea.
- Replacement Blade for Clean-Cut™ Cutter, ea.
- PEEK® Union Connector 1/16", 2-pk.
- Sparge Filter: 2µm, ea.
- Inlet Filter: 10µm, ea.

Stainless Steel Survival Kit includes:

- HPLC Capillary Tubing, SS 1/16" x 0.005" x 5cm, 3-pk.
- HPLC Capillary Tubing, SS, 1/16" x 0.005" x 10cm, 3-pk.
- HPLC Capillary Tubing, SS, 1/16" x 0.005" x 20cm, 3-pk.
- HPLC Capillary Tubing, SS, 1/16" x 0.005" x 30cm, 3-pk.
- HPLC Capillary Tubing, SS, 1/16" x 0.007" x 5cm, 3-pk.
- HPLC Capillary Tubing, SS, 1/16" x 0.007" x 10cm, 3-pk.
- HPLC Capillary Tubing, SS, 1/16" x 0.007" x 20cm, 3-pk.
- HPLC Capillary Tubing, SS, 1/16" x 0.007" x 30cm, 3-pk.
- HPLC Capillary Tubing, SS, 1/16" x 0.010" x 5cm, 3-pk.
- HPLC Capillary Tubing, SS, 1/16" x 0.010" x 10cm, 3-pk.
- HPLC Capillary Tubing, SS, 1/16" x 0.010" x 20cm, 3-pk.
- HPLC Capillary Tubing, SS, 1/16" x 0.010" x 30cm, 3-pk.
- HPLC Capillary Tubing, SS, 1/16" x 0.020" x 5cm, 3-pk.
- HPLC Capillary Tubing, SS, 1/16" x 0.020" x 10cm, 3-pk.
- HPLC Capillary Tubing, SS, 1/16" x 0.020" x 20cm, 3-pk.
- HPLC Capillary Tubing, SS, 1/16" x 0.020" x 30cm, 3-pk.
- 1/16" Rheodyne® Style Nut, 10-pk.
- 1/16" Rheodyne® Style Ferrule, 10-pk.
- ValvTool Wrench, ea.
- 1/16" Stainless Steel Ferrules, 10-pk.
- 1/16" Stainless Steel Nuts, 10-pk.
- Zero-Dead-Volume Internal Union, ea.

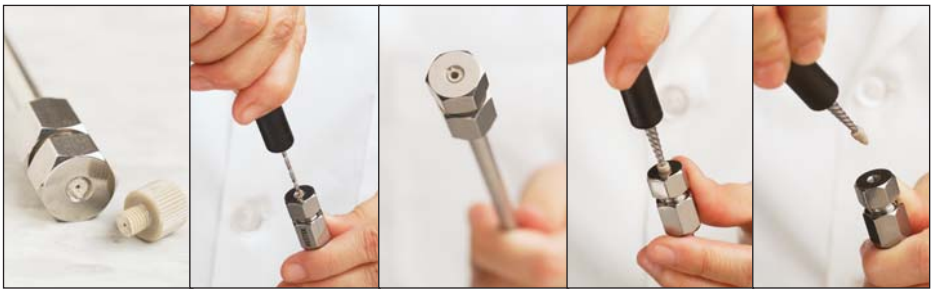
Restek Survival Kit

Stainless Steel Survival Kit

Description	qty.	cat.#
Restek Survival Kit for HPLC	kit	25322
Stainless Steel Survival Kit for HPLC	kit	25097

PEEK® Fitting Extractor

Drill into the broken fitting, then screw the extractor into the fitting and remove it easily.



Description	qty.	cat.#
PEEK® Fitting Extractor	ea.	25325

PEEK® Union Connector

Allows you to quickly and reliably connect two pieces of 1/16-inch tubing. End fittings included.

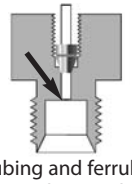
Description	qty.	cat.#
PEEK® Union Connector 1/16"	2-pk.	25323

Zero-Dead-Volume Internal Union

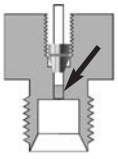
Ends of tubing seat squarely at bottoms of fitting details. 300 series stainless steel. For 1/16-inch OD tubing. Stainless steel ferrules included.

Description	Union Bore	Valco® #	qty.	cat.#
Internal Union	0.15mm	ZU1XC	ea.	20147
Internal Union	0.25mm	ZU1C	ea.	20148
Internal Union	0.75mm	ZU1	ea.	20149
Internal Union	1/16"	ZU1T	ea.	20150

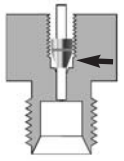
Figure 1 Problems arise from incompatible fittings.



Tubing and ferrule seated correctly



Tubing not seated, causing dead volume



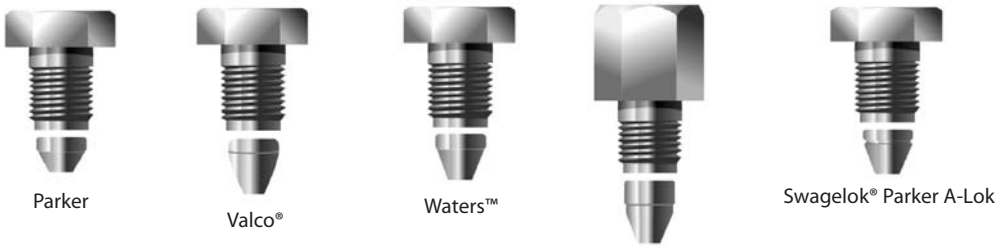
Ferrule can't seal

Improving Column Connections

A good connection is necessary for trouble-free chromatography. Connecting incompatible fittings from different manufacturers can result in leaks, poor peak shape, and increased void volume (Figure 1). Each type of end-fitting has a unique seat depth or style. Generally, Restek, Valco®, Parker, and Upchurch Scientific fittings are interchangeable; whereas Waters™, SSI, Rheodyne®, and Gasukura fittings are not (Figure 2).

Our wrenchless universal 10-32 PEEK® column connector (cat.# 25015) can be used with any style of end fitting, and all 1/16-inch tubing. It is reusable and will adjust to any seat, depth, or style.

Figure 2 Fitting styles differ among various manufacturers.

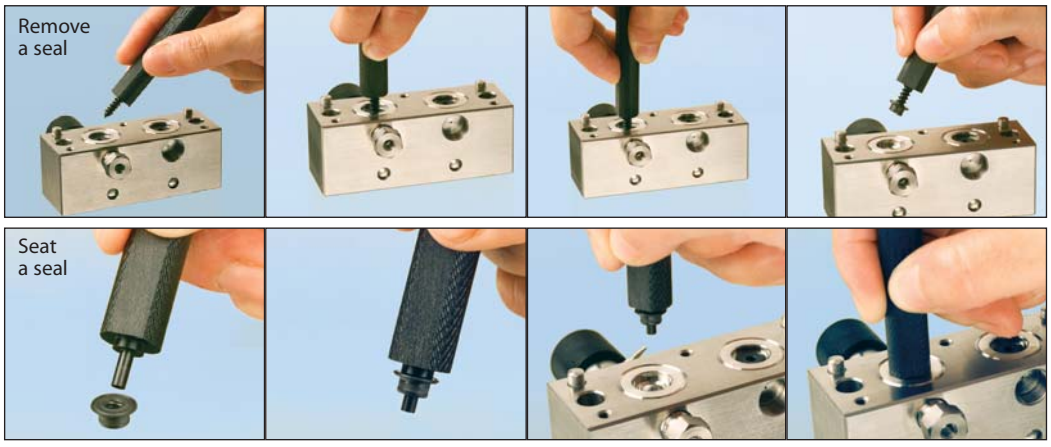


Parker | Valco® | Waters™ | Rheodyne® | Swagelok® Parker A-Lok

HPLC Piston Seal Insertion Tool

- Simplify pump maintenance.
- One end removes old piston seal, other end easily and securely installs new seal.

Do you have to search for a paper clip or screw to remove worn seals from your HPLC pump? Then, once you get the old seal out, do you struggle to correctly seat the new seal? Now Restek has a tool that can help. Use one end to remove your old seal, then simply slip your new seal on the other end and push it flush into position. The tool cannot mar the surrounding metal surface of the pump housing.



Use the flat side of the Piston Seal Insertion Tool to seat a Waters™ face seal.

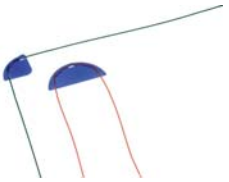
Description	qty.	cat.#
HPLC Piston Seal Insertion Tool	ea.	21356

Secure-Fit Fittings

A good connection between HPLC components is necessary for trouble-free chromatography. Secure-Fit connectors from Restek and Selerity Technologies ensure a consistent, leak-free seal—and they eliminate excess dead volume! An internal spring mechanism holds the capillary tubing at the proper depth in the female fitting. This seal is maintained while you finger-tighten the nut. These fittings are available in stainless steel or PEEK®, and in a variety of tubing lengths and internal diameters.

Length	0.005" ID	0.007" ID	0.010" ID
Stainless Steel Secure-Fit Fittings—Single Ended			
6cm	25181	25185	25190
10cm	25182	25186	25191
20cm	25183	25187	25192
30cm	25184	25188	25193
Stainless Steel Secure-Fit Fittings—Double Ended			
10cm	25208	25211	25214
20cm	25209	25212	25215
30cm	25210	25213	25216
PEEK® Secure-Fit Fittings—Single Ended			
6cm	25230	25234	25217
10cm	25231	25235	25218
20cm	25232	25236	25219
30cm	25233	25237	25220
PEEK® Secure-Fit Fittings—Double Ended			
10cm	25221	25224	25227
20cm	25222	25225	25228
30cm	25223	25226	25229

HPLC Accessories



PEEK® Tubing Elbows

Tubing Elbows (90° and 180°) are ideal for routing 1/16-inch PEEK® tubing through your system. Simply snap the tubing into the elbow. Prevent pinching of PEEK® tubing which can cause high pressure.

Description	qty.	cat.#
PEEK® Tubing Elbow 90°	5-pk.	25308
PEEK® Tubing Elbow 180°	5-pk.	25309

Tubing Dressing Tool

Opens stainless steel tubing bore and removes burrs. For 1/16-inch OD tubing or 1/8-inch OD tubing.

Description	qty.	cat.#
1/16" Tubing Dressing Tool	ea.	20188
Replacement Insert for 1/16" Tubing Dressing Tool	ea.	20189
1/8" Tubing Dressing Tool	ea.	20190
Replacement Insert for 1/8" Tubing Dressing Tool	ea.	20191

Clean-Cut™ Tubing Cutter

- Burr-free, perpendicular cuts that will not distort the tubing OD or close the ID.
- Use on PEEK ,PTFE , Tefzel , other polymeric tubing.

Description	qty.	cat.#
Clean-Cut™ Tubing Cutter	ea.	25069
Replacement Blade for Clean-Cut™ Cutter	ea.	25070

Universal 10-32 PEEK® Column Connectors and Plugs

Universal PEEK® Connectors allow easy installation of all 1/16-inch tubing, including stainless steel. See "Improving Column Connections" data on page 254.

Description	qty.	cat.#
PEEK® Column Connector (beige, round body)	10-pk.	25015
PEEK® Column Plug (black)	10-pk.	25016
PEEK® Fingertight Fittings (blue, flat-sided)	10-pk.	25324

Rheodyne® Style Nut and Ferrule

Replacement long nut for connecting stainless steel tubing to a Rheodyne® 6-port valve or other Rheodyne® part.

Description	qty.	cat.#
1/16" Rheodyne® Style Nut	10-pk.	25095
1/16" Rheodyne® Style Ferrule	10-pk.	25096

ValvTool Wrench

The ValvTool is a time-saving device that provides easy access to many hard-to-reach Rheodyne® or Valco® valves. For 1/4-inch nuts.

Description	qty.	cat.#
ValvTool Wrench	ea.	25321

Inert PEEK® Tubing

- Replaces stainless steel, titanium, PTFE and Tefzel® tubing.
- Less oxygen permeable and more temperature resistant (to 350°C) than PTFE or Tefzel® tubing.
- Use with PEEK® fingertight or flangeless fittings.
- Use to 7,000psi.

Description	Color Code	qty.	cat.#
PEEK® Tubing, 1/16" OD x 0.0025" ID x 1m (natural)	natural	3-pk.	25320
PEEK® Tubing, 1/16" OD x 0.005" ID x 3m (red stripe)	red stripe	ea.	25065
PEEK® Tubing, 1/16" OD x 0.007" ID x 3m (yellow stripe)	yellow stripe	ea.	25066
PEEK® Tubing, 1/16" OD x 0.010" ID x 3m (blue stripe)	blue stripe	ea.	25067
PEEK® Tubing, 1/16" OD x 0.020" ID x 3m (orange stripe)	orange stripe	ea.	25068

HPLC Stainless Steel Capillary Tubing

- 316 grade stainless steel.
- Precise pre-cut lengths.
- Smooth surface finish.
- Ultra clean.

Whether you need to replace system tubing as part of your troubleshooting or are looking to reduce the dwell volume of your system as you move to narrower columns, Restek has the quality tubing in the lengths and IDs you need. Each ID is color-coded so it is easy to identify and replace correctly.

Length	ID	OD	qty.	cat.#
5cm	0.005"	1/16"	3-pk.	25240
10cm	0.005"	1/16"	3-pk.	25241
20cm	0.005"	1/16"	3-pk.	25242
30cm	0.005"	1/16"	3-pk.	25243

PTFE Tubing

- Ideal for mobile phase inlet lines.
- Chemically inert.
- Use to 500psi and 80°C.

Description	qty.	cat.#
PTFE Tubing, 1/8" OD x 0.063" ID x 3m (1.6mm ID)	ea.	25306
PTFE Tubing, 1/8" OD x 0.094" ID x 3m (2.4mm ID)	ea.	25307

Tubing Clip

Securely holds 1/16-inch or 1/8-inch tubing in beaker, flask, or bottle up to 4mm thick.

Description	qty.	cat.#
Tubing Clip	5-pk.	25310

LCLocker™ HPLC Organizer

Deluxe BenchBooster™ Organizer

Mini pHPerch™ Storage Unit

TopLoader™ BalanceBank™ Storage Unit

HPLC 30-Column Storage Cabinet

Book Holders

Open Supply Bins, 13-bin unit

Glove Box Dispensers

Description	dimensions	qty.	cat.#
LCLocker™ HPLC Organizer	24 x 12 x 6"	ea.	25149
Deluxe BenchBooster™ Organizer	24 x 7 x 12"	ea.	25150
Mini pHPerch™ Storage Unit	13 x 12 x 6"	ea.	25147
TopLoader™ BalanceBank™ Storage Unit	12 x 12 x 7"	ea.	25148
HPLC 30-Column Storage Cabinet	17 3/8 x 15 x 2 7/8"	ea.	25159
Book Holder, Small	0.75" ID	ea.	25151
Book Holder, Large	1.5" ID	ea.	25152
Open Supply Bin, 4-bin Unit	24 x 12 x 10"	ea.	25153
Open Supply Bin, 5-bin Unit	12 x 16 x 10.5"	ea.	25154
Open Supply Bin, 13-bin Unit	12 x 7.5 x 12"	ea.	25155
Glove Box Dispenser, Single	5 3/8 x 11 1/2 x 4 1/2"	ea.	25156
Glove Box Dispenser, Double	10 3/8 x 11 1/2 x 4 1/2"	ea.	25157
Glove Box Dispenser, Triple	15 3/8 x 11 1/2 x 4 1/2"	ea.	25158

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Marine Oil FAME Mix (20 components)

Chain	Description	% by Weight
C14:0	methyl myristate	6.0
C14:1	methyl myristoleate	1.0
C16:0	methyl palmitate	16.0
C16:1	methyl palmitoleate	5.0
C18:0	methyl stearate	8.0
C18:1	methyl oleate	13.0
C18:1	methyl vaccenate	4.0
C18:2	methyl linoleate	2.0
C18:3	methyl linolenate	2.0
C20:0	methyl arachidate	1.0
C20:1	methyl 11-eicosenoate	9.0
C20:2	methyl 11-14-eicosadienoate	1.0
C20:4	methyl arachidonate	3.0
C20:3	methyl 11-14-17-eicosatrienoate	1.0
C20:5	methyl eicosapentaenoate	10.0
C22:0	methyl behenate	1.0
C22:1	methyl erucate	3.0
C22:6	methyl docosahexaenoate	12.0
C24:0	methyl lingnocerate	1.0
C24:1	methyl nervonate	1.0

cat. # 35066 (100mg)

Food Industry FAME Mix (37 components)

Chain	% by Weight	Chain	% by Weight
C4:0	4.0	C18:2(all-*cis*-9,12)	2.0
C6:0	4.0	C18:3(all-*cis*-6,9,12)	2.0
C8:0	4.0	C18:3(all-*cis*-9,12,15)	2.0
C10:0	4.0	C20:0	4.0
C11:0	2.0	C20:1(*cis*-11)	2.0
C12:0	4.0	C20:2(all-*cis*-11,14,)	2.0
C13:	2.0	C20:3(all-*cis*-8,11,14)	2.0
C14:0	4.0	C20:3(all-*cis*-11,14,17)	2.0
C14:1(*cis*-9)	2.0	C20:4(all-*cis*-5,8,11,14)	2.0
C15:0	2.0	C20:5(all-*cis*-5,8,11,14,17)	2.0
C15:1(*cis*-10)	2.0	C21:0	2.0
C16:0	6.0	C22:0	4.0
C16;1(*cis*-9)	2.0	C22:1(*cis*-13)	2.0
C17:0	2.0	C22:2(all-*cis*-13,16)	2.0
C17:1(*cis*-10)	2.0	22:6	
C18:0	4.0	(all-*cis*-4,7,10,13,16,19)	2.0
C18:1(*trans*-9)	2.0	C23:0	2.0
C18:1(*cis*-9)	4.0	C24:0	4.0
C18:2(all-*trans*-9,12)	2.0	C24:1(*cis*-15)	2.0

30mg/mL total in methylene chloride, 1mL/ampul
cat. # 35077 (ea.)

NLEA FAME Mix (28 components)

Chain	% by Weight		
C4:0	1.5	C18:1(*trans*-9)	2.5
C6:0	1.5	C18:1(*cis*-9)	15.0
C8:0	2.0	C18:2(all-*trans*-9,12)	2.5
C10:0	2.5	C18:2(all-*cis*-9,12)	10.0
C11:0	2.5	C18:3(all-*cis*-9,12,15)	5.0
C12:0	5.0	C20:0	2.5
C13:	2.5	C20:1(*cis*-11)	1.5
C14:0	2.5	C20:5(all-*cis*-5,8,11,14,17)	2.5
C14:1(*cis*-9)	1.5	C22:0	2.5
C15:0	1.5	C22:1(*cis*-13)	1.5
C16:0	10.0	C22:6 (all-*cis*-4,7,10,13,16,19)	2.5
C16:1(*cis*-9)	5.0	C23:0	1.5
C17:0	2.5	C24:0	2.5
C18:0	5.0	C24:1(*cis*-15)	2.5

30mg/mL total in methylene chloride, 1mL/ampul
cat. # 35078 (ea.)

Fruit Juice Organic Acid Standard

citric acid	2000µg/ml	quinic acid	2000
fumaric acid	10*	tartaric acid	2000
malic acid	2000		

In water, 1mL/ampul
cat. # 35080 (ea.)

In water, 5mL/ampul
cat. # 35081 (ea.)

*Fumaric acid is a trace impurity in malic acid, as well as an added component of the mix. The amount of fumaric acid in malic acid will not affect the stated concentration of malic acid, but can represent a significant and variable deviation from the low concentration of fumaric acid stated to be in the mix. All other components of the mix are at the specified concentration.

cis/trans FAME Mix (8 components)

Description	% by Weight
methyl elaidate (C18:1 *trans*-9)	10.0
methyl linoleate (C18:2 *cis*-9,12)	20.0
methyl oleate (C18:1 *cis*-9)	10.0
methyl petroselinate (C18:1 *cis*-6)	8.0
methyl petroselaidate (C18:1 *trans*-6)	8.0
methyl stearate (C18:0)	20.0
methyl transvaccenate (C18:1 *trans*-11)	12.0
methyl vaccenate (C18:1 *cis*-11)	12.0

10mg/mL total in methylene chloride, 1mL/ampul
cat. # 35079 (ea.)

Fragrance Materials Test Mix

The Fragrance Materials Association (FMA) has proposed a method for analyzing essential oils on polar and non-polar capillary GC columns. A performance evaluation mixture should be used to aid in detecting inlet problems, stationary phase degradation, loss of resolution, changes in sensitivity, and the presence of reactive sites in the sample pathway. Our test mix is consistent with the mixture proposed by the FMA. The required 5% test solution is made by diluting the 0.5mL of neat mixture to 10mL with acetone. The working solution will be stable for up to one week if transferred to a dark container and stored refrigerated.

benzyl salicylate	362 parts	geraniol	6 parts
cinnamic aldehyde	5 parts	hydroxycitronellal	50 parts
cinnamic alcohol	3 parts	d-limonene	200 parts
cinnamyl acetate	3 parts	thymol crystal	3 parts
ethyl butyrate	362 parts	vanillin	1 part
eucalyptol	5 parts	benzoic acid	1% of mix

Neat, 0.5mL in an amber ampul
cat. # 31807 (ea.)

No data pack available.

HPLC Reversed Phase Test Mix #1

Routine analysis using this product can assist in determining the need to perform column and/or system maintenance.

benzene	3.00mg/mL
uracil	0.02
naphthalene	0.50
biphenyl	0.06

In methanol:water (75:25), 1mL/ampul
cat. # 35005 (ea.)

HPLC Normal Phase Test Mix #1

Routine analysis using this product can assist in determining the need to perform column and/or system maintenance.

benzene	1.00mg/mL
benzaldehyde	0.04
benzyl alcohol	3.00
4-methoxybenzyl alcohol	2.00

In hexane, 1mL/ampul
cat. # 35004 (ea.)

Carbohydrate HPLC Performance Check Mix

Performance qualification (PQ) determines the precision of the HPLC system. Our performance check mix for HPLC / RI consists of five simple sugars in varied concentrations. We prepare the reference material in water, lyophilize it, and pack it dry for enhanced stability.

glucose	2.0µg/mL*
fructose	2.1
lactose	4.4
maltose	4.5
sucrose	4.0

Dry components in 4mL screw-cap vial.
Reconstitute in 1mL acetonitrile:water (75:25) to 2.0, 2.1, 4.4, 4.5, 4.0 mg/mL, respectively.
cat. # 31809 (ea.)

*Final concentration when 1mL solvent added.

Grob Test Mix (Capillary GC)

*n*C10-FAME	0.42mg/mL
*n*C11-FAME	0.42
*n*C12-FAME	0.41
2,3-butanediol	0.53
dicyclohexylamine	0.31
2,6-dimethylaniline	0.32
2,6-dimethylphenol	0.32
2-ethylhexanoic acid	0.38
nonanal	0.40
1-octanol	0.36
undecane	0.29
decane	0.28

In methylene chloride, 1mL/ampul
cat. # 35000 (ea.)

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Take these eight steps to create the right solution:

1. Mixture Description: _____

2. Solvent: _____

3. Number of Components: _____

4. Volume per ampul (select): 1mL, 2mL, 5mL, 10mL or other _____mL

5. Quantity of ampuls: _____

6. Testing and documentation that best meets your requirements:

- ❍ Gravimetric Documentation: Lot Sheet with balance printout attached.
- ❍ Qualitative Documentation: Certificate of Composition, Chromatogram, and Gravimetric Documentation.
- ❍ Quantitative Documentation: Certificate of Analysis and Data Pack.

7. Compound(s): (list or attach sheet; include CAS number)

Compound 01:	_____	Concentration:	_____
Compound 02:	_____	Concentration:	_____
Compound 03:	_____	Concentration:	_____
Compound 04:	_____	Concentration:	_____
Compound 05:	_____	Concentration:	_____
Compound 06:	_____	Concentration:	_____
Compound 07:	_____	Concentration:	_____
Compound 08:	_____	Concentration:	_____
Compound 09:	_____	Concentration:	_____
Compound 10:	_____	Concentration:	_____
Compound 11:	_____	Concentration:	_____
Compound 12:	_____	Concentration:	_____
Compound 13:	_____	Concentration:	_____
Compound 14:	_____	Concentration:	_____
Compound 15:	_____	Concentration:	_____
Compound 16:	_____	Concentration:	_____
Compound 17:	_____	Concentration:	_____
Compound 18:	_____	Concentration:	_____
Compound 19:	_____	Concentration:	_____
Compound 20:	_____	Concentration:	_____

8. Concentration Units

❍ mg/mL ❍ µg/mL ❍ ng/mL ❍ vol./wt. % ❍ wt./wt. % ❍ other_____

Contact Information:

Name: _____ Date: _____

Company/Location: _____

_____

Phone #:_____ FAX #: _____

E-mail: _____

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FAX#: (814) 355-2895

email: standards@restekcorp.com

online form: www.restek.com

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