

Analyzing Cleaning and Personal Care Products by Gas and Liquid Chromatography



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Product Types

Ingredients

Product Listing



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Introduction

The cleaning products industry is a multi-billion dollar industry.¹ The average consumer uses a wide range of products to promote both personal and public health. Of the products used in one's home, there are several basic categories: personal cleansing, laundry, dishwashing, and household cleaning. These products are designed to improve personal hygiene, reduce levels of microorganisms, and improve personal appearance.

As with all consumer products, there is a need to test both final products and raw materials. This helps to ensure consistent product performance, as well as personal and environmental safety. Quantifying individual components also is useful for optimizing the manufacturing process, for determining product shelf life, and for comparing competitive products.

Chromatographic techniques such as gas chromatography (GC) and high pressure liquid chromatography (HPLC) are powerful tools in the analysis of cleaning and personal care products. In this technical guide, we explore how GC and HPLC can be used to quantify components of these important products. For GC assays, general detectors, such as the flame ionization detector (FID), or more information-rich detectors, such as the mass spectrometer (MS), can be used. GC/MS is particularly useful for analyzing complex formulations, such as fragrance blends, and for identifying unknown components or contaminants. HPLC is applicable to a wide range of personal care product ingredients, such as antimicrobial agents, preservatives, and some surfactants. In general, UV-visible or light-scattering detectors can be used.

Product Types

Cleaning and personal care products can be categorized in a number of ways. The Soap and Detergent Association (SDA)² groups soaps and detergents into four general categories: personal cleansing, laundry, dishwashing, and household cleansing. Personal cleansing products include liquid and bar soaps, and heavy duty cleaners. Laundry detergents and laundry cleaning aids can be purchased in a variety of forms: powders, gels, liquids, sprays, and sheets. In addition to dirt and stain removal, they are used to bleach, soften, and freshen laundry. Dishwashing products also are marketed in a variety of forms: liquids, gels, and powders. Although they fall within the same category, hand dishwashing detergents and automatic dishwashing detergents generally have different formulations, as conditions for their use are quite different.

Household cleaners include a wide variety of products, as no single product will work well on all surfaces and soils. All-purpose cleaners are intended for general use, and can be used on a variety of surfaces, including various combinations of plastic, paint, metal, porcelain, glass, and wood. Specialty cleaners, for more specific applications, include products for glass, tubs and tile, ovens, toilet bowls,

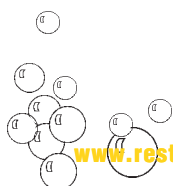
or rugs and upholstery. Abrasive cleaners contain small mineral or metal particles for removing heavy soil loads from small areas. For unclogging kitchen and bathroom drains, drain openers incorporate caustic ingredients that generate heat to melt fatty deposits and chemicals that oxidize soil deposits.

In addition to these cleaning products, a wide range of products promote personal hygiene: deodorants, mouthwashes, oral hygiene products, moisturizing lotions, and more. These products contain ingredients to cleanse, disinfect, deodorize, moisturize, and/or scent the user.

Basic Ingredients in Cleaning and Personal Care Products

Surfactants and Builders

The major components of cleaning products are surfactants and builders.¹ Surfactants (surface active agents) are used to reduce the surface tension of water, enabling the cleaning solution to more efficiently wet the surface to be cleaned. Without the surfactant, water's high surface tension causes it to bead on a surface, and cleaning is much more difficult. In addition, surfactants emulsify oils and other soils, and hold them in solution so they can be rinsed away.



Surfactant-containing solutions can be applied to a wide variety of surfaces, including tile, ceramic, and cloth - and hair. Builders often are used to increase the effectiveness of a surfactant. Builders reduce water hardness by “tying up” hardness minerals, through chelation with the minerals or by forming an insoluble precipitate. Examples of builders/chelating agents include sodium citrate (the sodium salt of citric acid) and ethylenediamine tetraacetic acid (EDTA). Other builders, such as sodium carbonate, reduce water hardness by forming insoluble precipitates (e.g., calcium carbonate).

Surfactants generally are classified by their ionic properties in water. Anionic surfactants, such as alcohol ethoxylates, alkyl sulfates, and soaps, are negatively charged in solution. Anionic surfactants are used in laundry detergents and some dishwashing detergents, household clean-

ers, and personal cleaning products. Cationic surfactants, such as quaternary ammonium compounds, carry a positive charge in solution. They are used in products such as fabric softeners. Amphoteric surfactants, which can be either positively or negatively charged, often are used in personal cleansing products, due to their mildness. Nonionic surfactants, such as alcohol ethoxylates, are uncharged in solution; they are used in laundry detergents and automatic dishwasher detergents. An example analysis of a nonionic surfactant, Triton® X-100, an octylphenol ethylene oxide with an average of 9.5 ethylene oxide units per molecule, is shown in Figure 1. This surfactant can be analyzed by GC, using a nonpolar phase, such as MXT®-1.

As described above, soaps are anionic surfactants. Basically, soaps are sodium or potassium salts of fatty acids, produced by reacting animal or vegetable fats or oils with a strong alkali. The fat or oil, in its original form, consists primarily of triglycerides—three fatty acids attached to a glycerol backbone. After conversion to the soap—saponification—there is both a hydrophilic (car-

boxylate group) and a hydrophobic end (alkyl chain) to the molecule. Water, a polar molecule, can now interact with the hydrophilic alkyl chains, while the alkyl chain can interact with relatively non-polar surfaces such as countertops, tile, or skin.

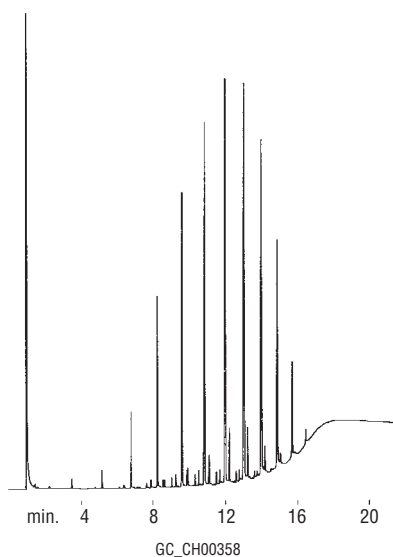
Fatty acids that make up a soap can be analyzed either in the free fatty acid form or after derivatization to the methyl esters (FAMES). Figure 2 shows an analysis of free fatty acids by GC, using a Stabilwax®-DA capillary column. The acid-deactivated phase in the Stabilwax® DA column gives excellent peak shapes for free fatty acids. Figure 3 is an analysis of fatty acids as methyl esters, separated on an Rtx®-Wax column. FAMES also can be easily quantified by using a Stabilwax® column.

Solvents

Solvents are used primarily to dissolve organic soils. They also clean without leaving residue, making them very useful in products such as glass cleaners. The main criterion for cleaning product solvents is water miscibility, as the solvent must form a solution with the other water-soluble components. Alcohols and

Figure 1

Triton® X-100 surfactant separated by number of ethylene oxide units on an MXT®-1 column.



MXT®-1, 30m, 0.28mm ID, 0.10µm (cat.# 70109)
 Inj.: 1.0µL split injection of Triton® X-100 (40:1) in methylene chloride
 Oven temp.: 150°C to 400°C @ 15°C/min. (hold 10 min.)
 Inj. / det. temp.: 250°C / 400°C
 Carrier gas: hydrogen
 Linear velocity: 40cm/sec.
 FID sensitivity: 102 x 10¹¹ AFS

Figure 2

Free fatty acids analysis saves time and materials, relative to preparing and analyzing fatty acid methyl esters.

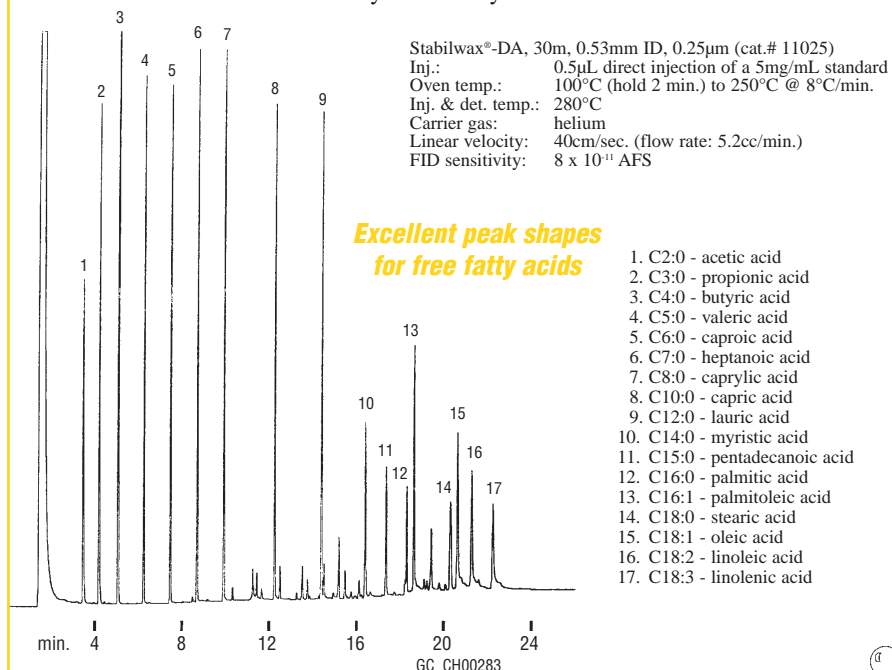
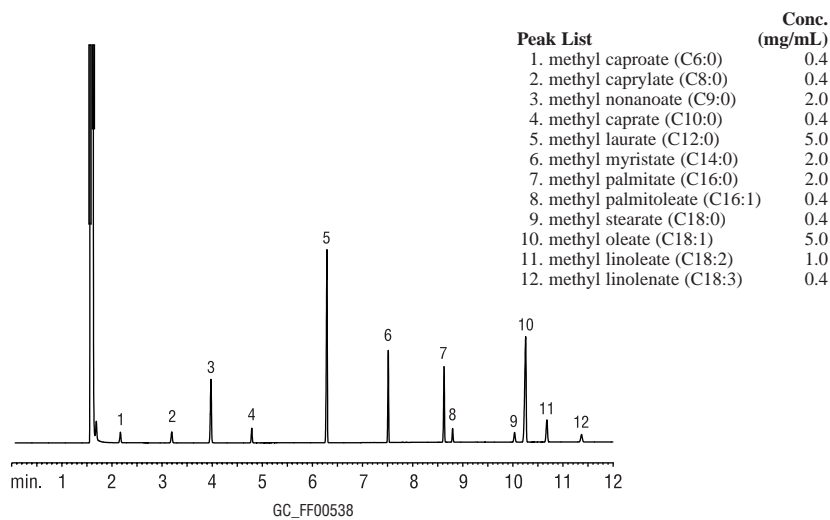




Figure 3

FAMES analysis on an Rtx®-Wax column.



Rtx®-Wax, 30m, 0.25mm, 0.25µm (cat.# 12423)
Inj.: 1µL split injection (100:1) of FAME standard; 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.)

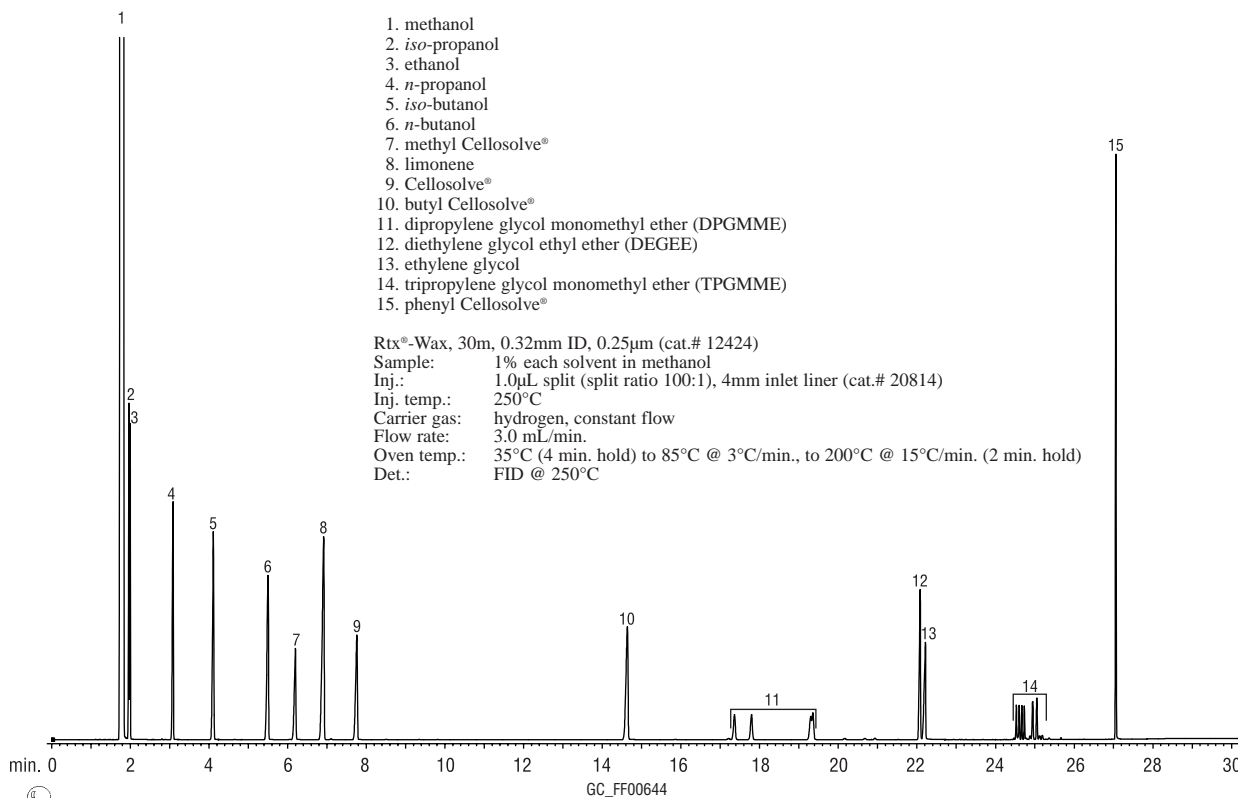


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Figure 4

Alcohols, glycols, and other cleaning solvents can be quantified, using an Rtx®-Wax column.



Rtx®-Wax, 30m, 0.32mm ID, 0.25µm (cat.# 12424)
Sample: 1% each solvent in methanol
Inj.: 1.0µL split (split ratio 100:1), 4mm inlet liner (cat.# 20814)
Inj. temp.: 250°C
Carrier gas: hydrogen, constant flow
Flow rate: 3.0 mL/min.
Oven temp.: 35°C (4 min. hold) to 85°C @ 3°C/min., to 200°C @ 15°C/min. (2 min. hold)
Det.: FID @ 250°C

Figure 5

Excellent, alternative selectivity for cleaning solvents, using an Rtx®-VMS column.

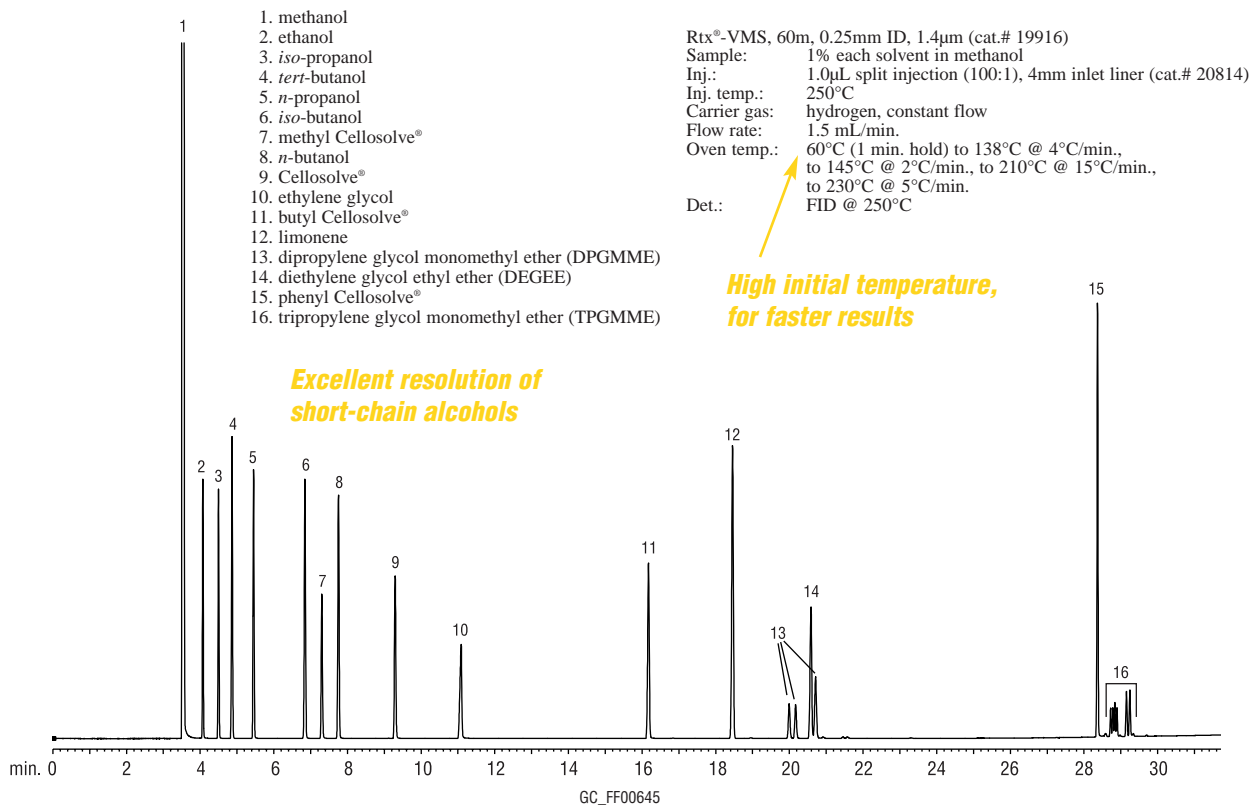
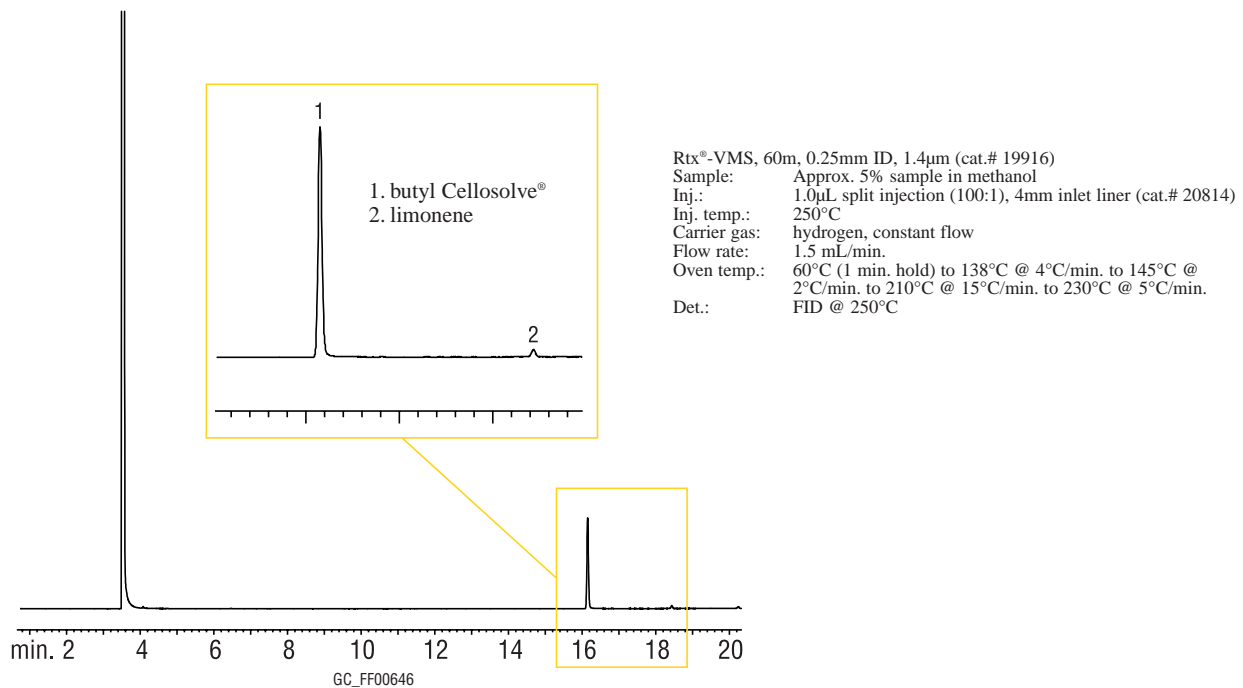


Figure 6

Quantify volatile ingredients in an all-purpose cleaner, using an Rtx®-VMS column.





glycols are popular choices. Cleaning solvents can be resolved using an Rtx®-Wax column (Figure 4) or an Rtx®-VMS column (Figure 5). The latter column gives excellent selectivity and peak shape for a wide range of cleaning solvents.

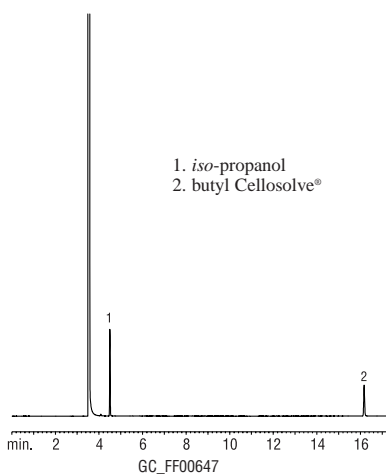
Analysis of an all-purpose cleaner is shown in Figure 6, and a glass cleaner is shown in Figure 7. Analyses of glycols and alcohols are shown in Figures 8–10.

Acids

Organic acids, such as acetic and citric acids, are used to reduce the pH of cleaning products, to remove mineral build-up. Inorganic acids, such as hydrochloric, phosphoric, and sulfuric acid also can be included in a formulation. Organic acids can be analyzed either by HPLC or by GC, but HPLC is a better technique for dicarboxylic acids. Figure 11 shows a separation of organic acids on an Ultra Aqueous C18 HPLC column. A GC analysis of short-chain free fatty acids is shown in Figure 12.

Figure 7

Glass cleaner on an Rtx®-VMS column.

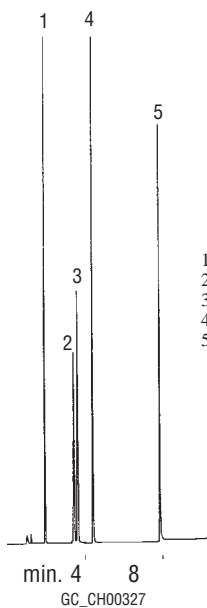


1. iso-propanol
2. butyl Cellosolve®

Rtx®-VMS, 60m, 0.25mm ID, 1.4µm (cat.# 19916)
Sample: Approx. 5% sample in methanol
Inj.: 1.0µL split injection (100:1),
4mm inlet liner (cat.# 20814)
Inj. temp.: 250°C
Carrier gas: hydrogen, constant flow
Flow rate: 1.5 mL/min.
Oven temp.: 60°C (1 min. hold) to 138°C @
4°C/min. to 145°C @ 2°C/min. to
210°C @ 15°C/min. to 230°C
@ 5°C/min.
Det.: FID @ 250°C

Figure 8

Glycols and alcohols on an ultra-low-bleed column.

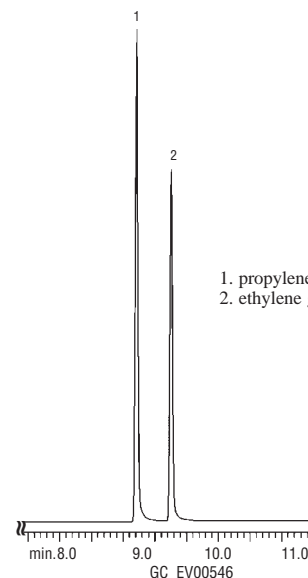


1. n-butyl alcohol
2. ethylene glycol
3. propylene glycol
4. butyl Cellosolve®
5. butyl carbitol

XTI®-5, 30m, 0.53mm ID, 1.0µm (cat.# 12255)
Inj.: 1.0µL direct injection of glycols
and alcohols, 100ppm each
Oven temp.: 40°C to 185°C @ 15°C/min.
(hold 5 min.)
Inj. / det. temp.: 150°C / 200°C
Carrier gas: helium
Linear velocity: 40cm/sec. (flow rate: 5cc/min.)
FID sensitivity: 8 x 10⁻¹¹ AFS

Figure 9

Glycols on a Stabilwax® column.

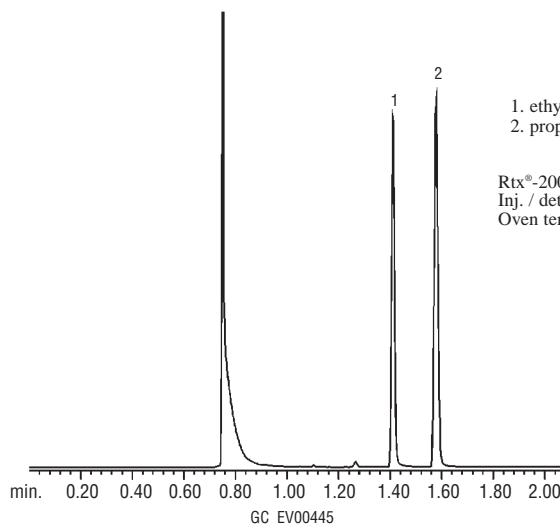


1. propylene glycol
2. ethylene glycol

Stabilwax®, 30m, 0.53mm ID, 1.0µm (cat.# 10655)
Inj.: 1.0µL direct injection of ethylene
glycol and propylene glycol,
100 ppm each, in water. Open-top
Uniliner® direct injection liner
without wool (cat.# 20843-205).
Septum purge: 5.0cc/min.
Oven temp.: 80°C (hold 1 min.) to 200°C @
8°C/min. (hold 5 min.)
Inj./det. temp.: 225°C/250°C
Carrier gas: helium
Linear velocity: 50cm/sec.
Detector: FID

Figure 10

Glycols on a uniquely selective trifluoropropyl phase column.

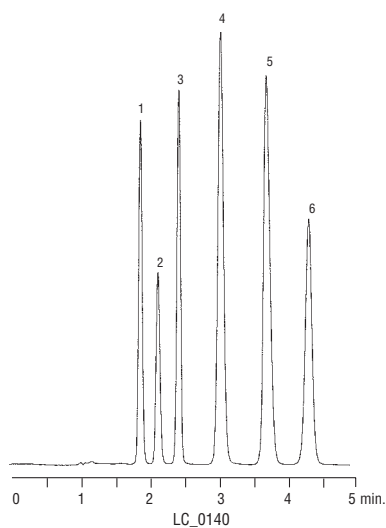


1. ethylene glycol
2. propylene glycol

Rtx®-200, 30m, 0.53mm ID, 1.0µm (cat.# 15055)
Inj. / det. temp.: 220°C / 270°C
Oven temp.: 80°C (hold 1 min.) to 200°C
@ 8°C/min. (hold 3 min.)
10psi pressure

Figure 11

Organic acids on an Ultra Aqueous C18 HPLC column.



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:

Solvent: HPLC-grade water
Inj.: 10µL

Column: Ultra Aqueous C18

Catalog #: 9178565
Dimensions: 150 x 4.6mm
Particle size: 5µm
Pore size: 100Å

Conditions:

Mobile phase: 50mM potassium phosphate, pH 2.5; acetonitrile (99:1)

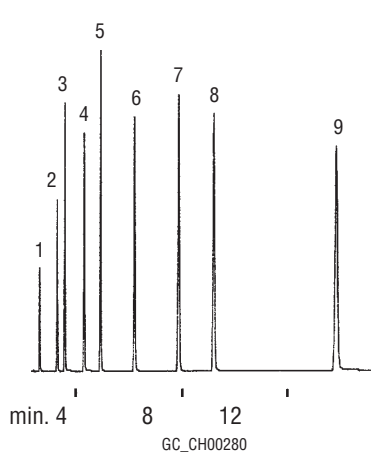
Flow: 1.5mL/min.
Temp.: 25°C
Det.: UV @ 210nm

HOT tech tip

The Ultra Aqueous C18 column is an excellent choice when using highly aqueous mobile phases. Embedded polar groups prevent collapse of the alkyl chains—even in 100% aqueous environments. See page 12 for more information.

Figure 12

Organic Acids on a Stabilwax®-DA column.



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

Stabilwax®-DA, 30m, 0.25mm ID, 0.25µm (cat.# 11023)

Inj.: 1.0µL split injection (50:1) of a free acid standard, approximately 10 to 20ng/µL each analyte

Oven temp.: 145°C
Inj. & det. temp.: 250°C
Carrier gas: hydrogen
Linear velocity: 40cm/sec.
FID sensitivity: 2 x 10¹¹ AFS

Alkalis

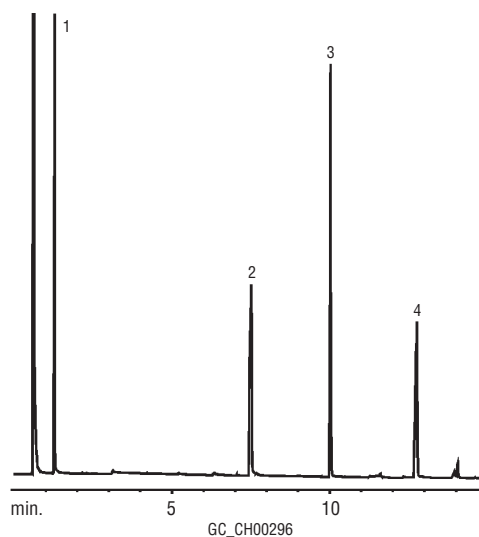
Products with higher pH are useful for dissolving fatty or oily soils. Alkalis, or bases, are used to neutralize acidic ingredients, or to raise the pH. Suitable alkalis include ethanolamines, ammonium hydroxide, and sodium silicate. The more basic compounds, such as ethanolamines, can be analyzed by GC, but a base-deactivated column should be used. Ethanolamines analysis on an Rtx®-5 Amine capillary GC column is shown in Figure 13.

Antimicrobial Agents

Antimicrobial agents are included in soaps, detergents, health and skincare products, and household cleaners. By controlling microbial growth, they control disease and odor. More than 300 active ingredients currently are used to control microorganisms.³ These agents can be categorized as sterilizers, disinfectants, sanitizers, or antiseptics/germicides. Sterilizers are used to eliminate fungi, viruses, and bacteria; disinfectants, to destroy or control fungi and bacteria, but not necessarily their spores; sanitizers, to reduce microorganisms on surfaces. Antiseptics or germicides are used on living people and animals. In the United States, a product used in or on the body, or in processed food, is regu-

Figure 13

Ethanolamines on a base-deactivated column.



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

Rtx®-5 Amine, 15m, 0.25mm ID, 0.50µm (cat.# 12335)

Inj.: 1.0µL split injection (58:1) of ethanolamines in methanol; on-column conc. 34ng each analyte

Oven temp.: 50°C (hold 2 min.) to 180°C @ 10°C/min. (hold 2 min.)

Inj. & det. temp.: 280°C / 300°C
Carrier gas: hydrogen
Linear velocity: 43cm/sec. set @ 50°C
FID sensitivity: 6.4 x 10¹¹ AFS



lated by the Food and Drug Administration (FDA). Other products fall under the guidelines of the US Environmental Protection Agency (EPA). Examples of antimicrobial agents are: quaternary ammonium compounds, sodium hypochlorite, organic acids, alcohols, iodine, Triclosan, and 4-chloro-3,5-dimethylphenol (*para*-chloro-*meta*-xylanol/PCMX). A PCMX assay by HPLC is shown in Figure 14; Figure 15 demonstrates the separation of benzoic and sorbic acids on an Ultra Phenyl HPLC column.

Preservatives

Preservatives are used to extend product shelf life. Examples of preservatives used in cleaning and personal care products are BHT (3,5-di-*tert*-butyl-4-hydroxytoluene), BHA (2- & 3- *tert*-butyl-4-hydroxyanisole), EDTA (ethylenediamine tetraacetic acid), and glutaraldehyde. BHT and BHA are phenolic antioxidants that can be very effective, even at low concentrations. These compounds can be analyzed either by GC (Figure 16) or by HPLC (Figure 17).

Figure 14

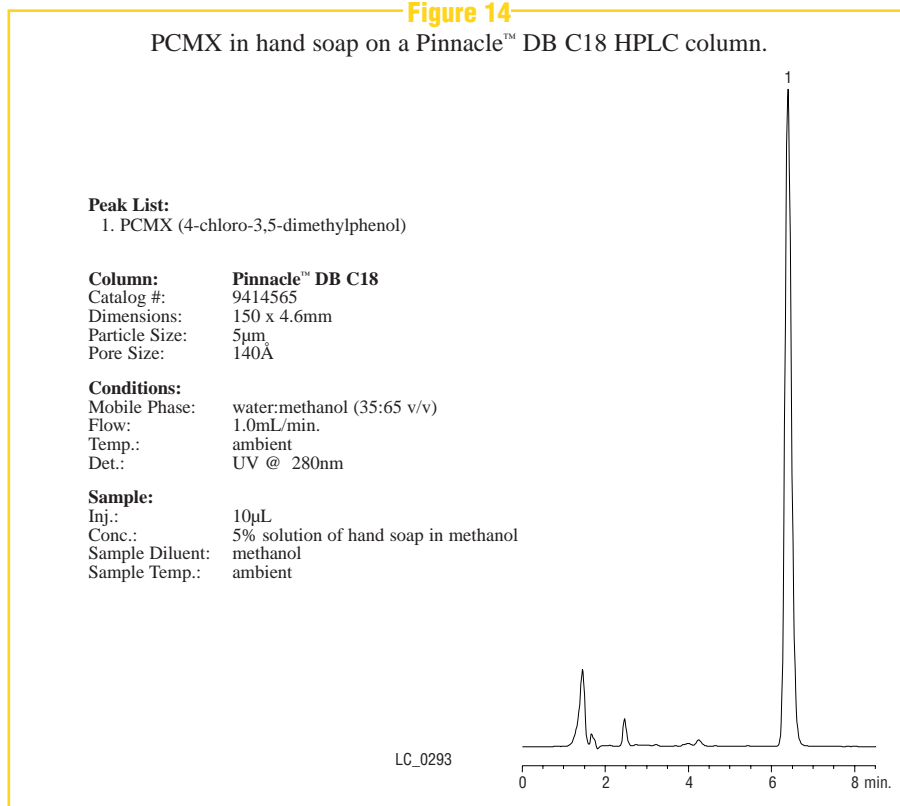


Figure 15

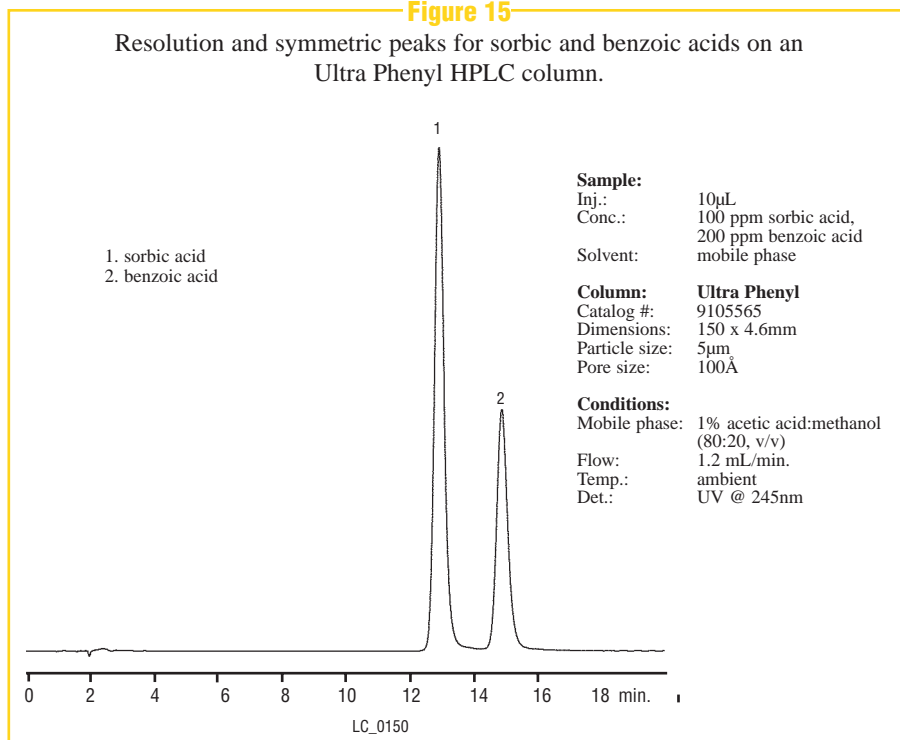


Figure 16

Preservatives BHA and BHT on an Rtx®-50 intermediate polarity column.

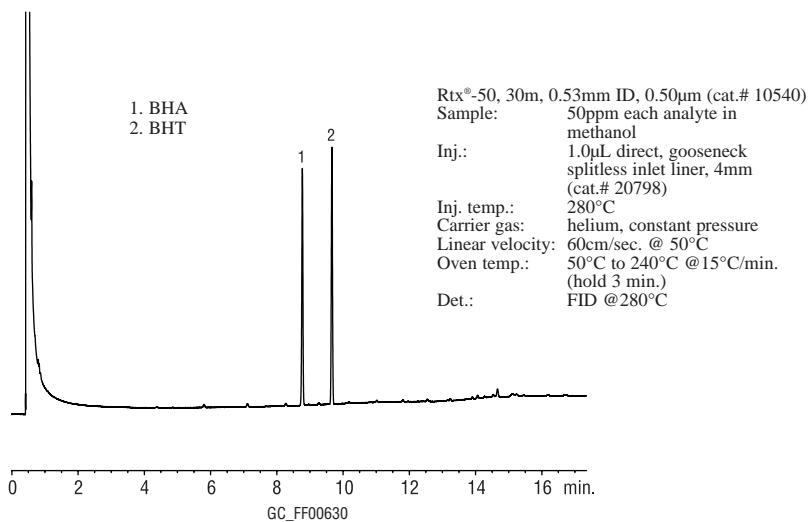
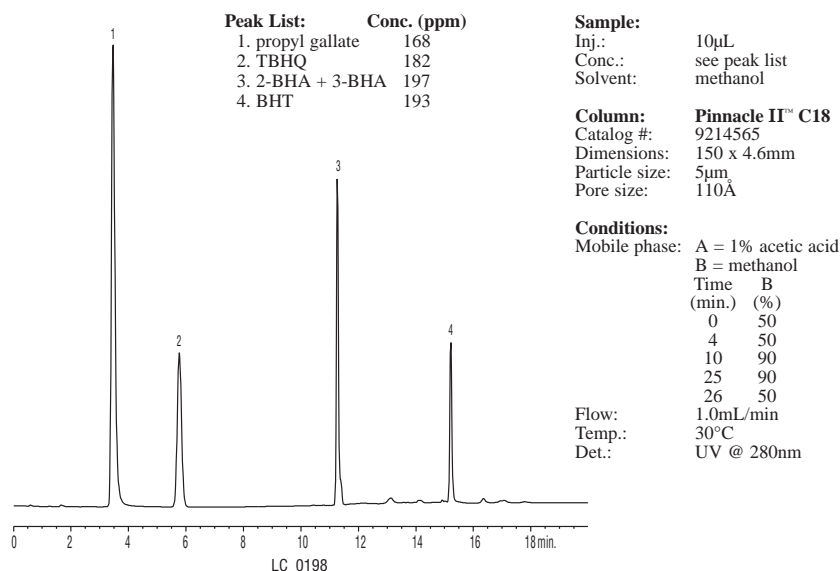


Figure 17

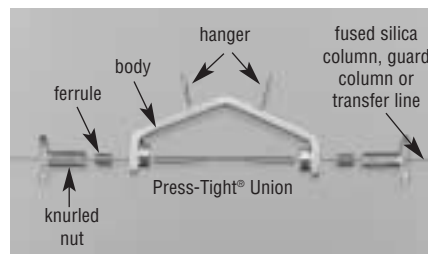
Phenolic preservatives, including BHA and BHT, on a Pinnacle II™ C18 HPLC column.



Secure, Reliable Column-to Column Connections

Use a Vu2 Union™ connector when you:

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Kits include: Vu2 Union™ body, 2 knurled nuts, 2 Press-Tight® unions, and 4 ferrules

Fits Column ID	qty.	cat.#
0.15–0.25mm	kit	21105
0.28/0.32mm	kit	21106
0.45/0.50 & 0.53mm	kit	21107
Knurled nut	2-pk.	21108



Questions?

Contact Restek's Technical Service Team! We have answers to your toughest analytical questions. Call 800-356-1688 or 814-353-1300, ext. 4, email us at support@restekcorp.com or contact your local Restek representative.

Fragrances & Colorants

Fragrances and colorants give a unique look or scent to a product. Blue dyes or pigments—bluing agents—absorb in the yellow region of the spectrum, masking age- and use-associated yellowing of clothing and bedding, and making these articles look brighter. Colorants also make a product “seen” in use, as in toilet bowl cleaners and floor sanitizers. Fragrances disguise odors from soils, or from the product itself, as well as provide the desired scent. In general, GC is effective for monitoring or identifying fragrance components. Examples of fragrance assays by GC are shown in Figures 18–20.

Figure 18

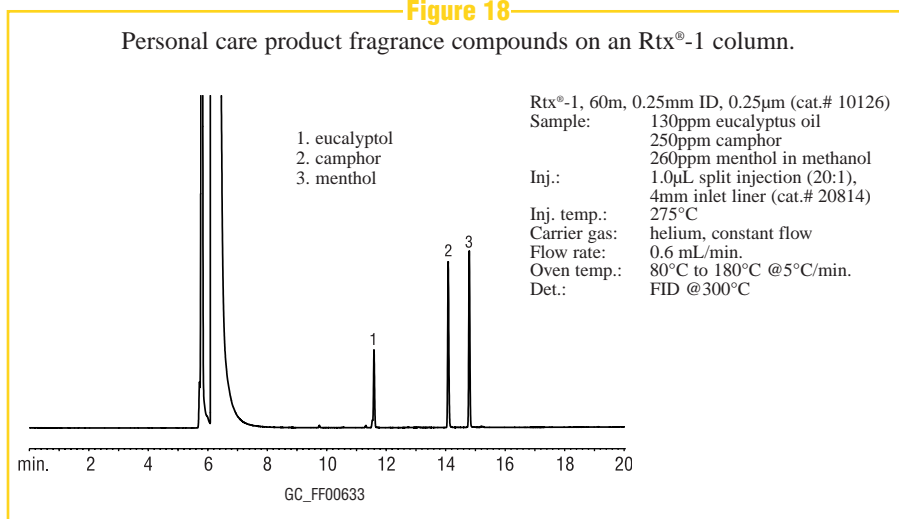
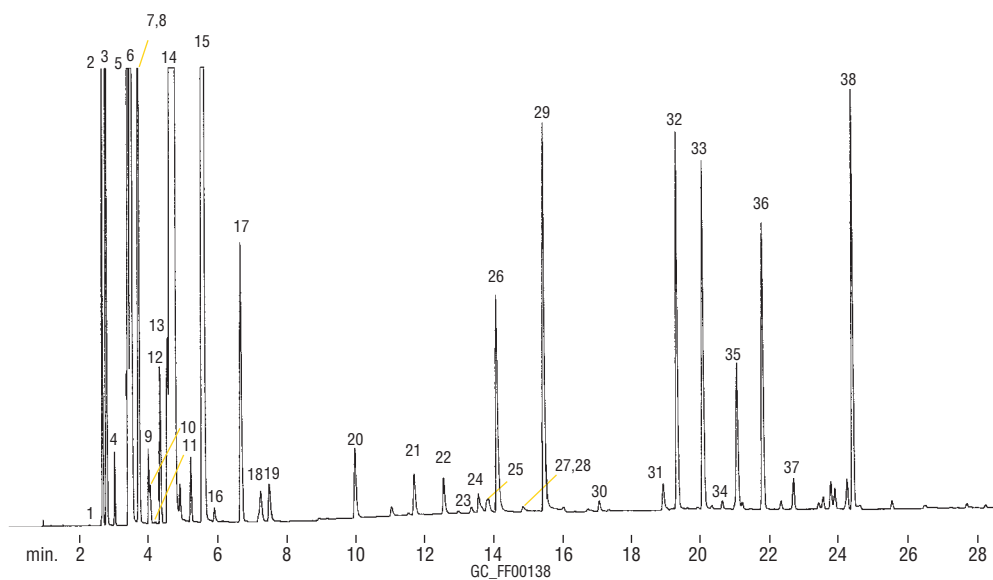


Figure 19

A complex fragrance, lemon oil, resolved on an Rtx®-5 column.



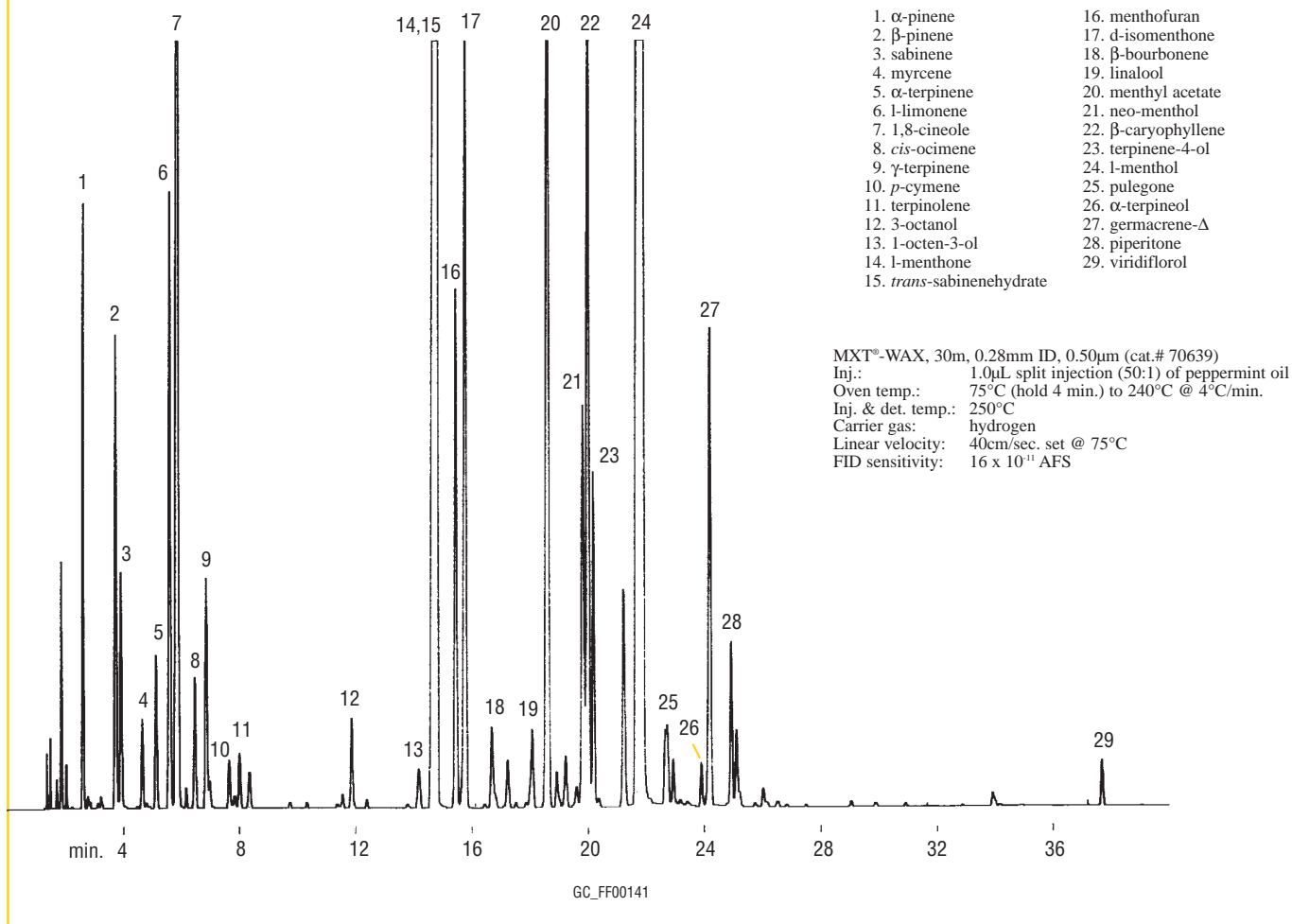
1. heptanol
2. α-thujene
3. α-pinene
4. camphene
5. sabinene
6. β-pinene
7. 6-methyl-5-hepten-2-one
8. myrcene
9. octanal
10. α-phellandrene
11. 3-carene
12. α-terpinene
13. p-cymene
14. limonene
15. γ-terpinene
16. octanol
17. terpinolene
18. linalool
19. nonanal
20. citronellal
21. terpinene-4-ol
22. 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

Rtx®-5, 30m, 0.32mm ID, 0.25µm (cat.# 10224)
Inj.: wet needle split injection (100:1) of 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



Figure 20

Peppermint oil components resolved on an MXT®-WAX column.



Miscellaneous Ingredients

Other ingredients used in cleaning, sanitizing, and personal care products include abrasives, such as quartz or sand; anti-redeposition agents, such as carboxymethylcellulose, that prevent soils from resettling on cleaned surfaces; bleach (e.g., sodium hypochlorite), for whitening and stain removal; enzymes, for removing specific soils, such as proteins; and fabric softeners, such as quaternary ammonium compounds.

Summary

A wide and disparate list of ingredients is used in cleaning and personal care products, to solubilize soils, wet surfaces, mask odors, or perform a variety of other functions. Gas chromatography and liquid chromatography are used to

monitor specific components, to ensure product quality. Restek chromatographic columns and supplies ensure peak performance of these chromatographic assays. For assistance with your specific applications, please call Restek's Technical Service Team at 800-356-1688 or 814-353-1300, ext. 4, or email us at support@restekcorp.com. We will be happy to work with you.

References

1. Branna, Tom *The I&I Market* in *Happi*, Nov. 2000.
2. The Soap and Detergent Association. www.sdahq.org
3. US Environmental Protection Agency. www.epa.gov/pesticides/citizens/antimic.htm



HPLC Columns

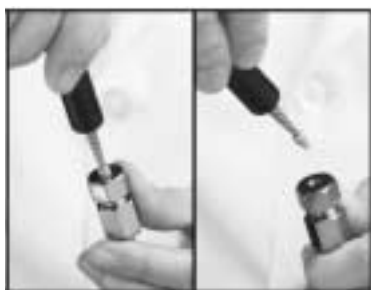


For a complete listing of our HPLC columns and accessories, request our HPLC catalog (lit. cat.# 59241A), or visit our website.

PEEK® Fitting Extractor

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

cat.# 25325, (ea.)



Sonic Debubbler

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

cat.# 20444, (ea.)



Ultra Phenyl 5µm Columns (USP L11)

Physical Characteristics:

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

Chromatographic Properties:

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

	1.0mm ID	2.1mm ID	3.2mm ID	4.6mm ID
Length	cat.#	cat.#	cat.#	cat.#
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

Ultra Aqueous C18 5µm Columns (USP L1)

Physical Characteristics:

particle: 5µm spherical not end-capped pore size: 100Å
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.

	1.0mm ID	2.1mm ID	3.2mm ID	4.6mm ID
Length	cat.#	cat.#	cat.#	cat.#
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

Pinnacle II™ C18 5µm Columns (USP L1)

Physical Characteristics:

particle: 5µm spherical fully end-capped pore size: 110Å
pH range: 2.5 to 7.5 carbon load: 13% 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.

	1.0mm ID	2.1mm ID	3.2mm ID	4.0mm ID	4.6mm ID
Length	cat.#	cat.#	cat.#	cat.#	cat.#
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

Pinnacle™ DB C18 5µm Columns (USP L1)

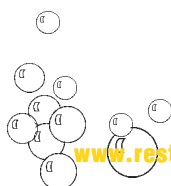
Physical Characteristics:

particle: 5µm spherical endcap: yes pore size: 140Å
pH range: 2.5 - 7.5 carbon load: 11% temperature limit: 80°C

Chromatographic Properties:

Highly base-deactivated spherical silica manufactured by Restek Corp. Monomeric C18 bonding. Hydrophobic C18 phase suitable for analyses of a wide range of compounds, from acidic through slightly basic. Replaces Hypersil® BDS C18.

	1.0mm ID	2.1mm ID	3.2mm ID	4.6mm ID
Length	cat.#	cat.#	cat.#	cat.#
30mm	9414531	9414532	9414533	9414535
50mm	9414551	9414552	9414553	9414555
100mm	9414511	9414512	9414513	9414515
150mm	9414561	9414562	9414563	9414565
200mm	9414521	9414522	9414523	9414525
250mm	9414571	9414572	9414573	9414575





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 be easily 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 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, and order the appropriate XG-XF male fitting.

Description	qty.	cat.#
XG-XF Fitting for 1cm Guard Cartridge	ea.	25026
XG-XF Fitting for 2cm 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

Trident™ Direct

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

Description	qty.	cat.#
High-pressure filter	ea.	25082
1cm guard cartridge holder without filter	ea.	25083
1cm guard cartridge holder with filter	ea.	25084
2cm guard cartridge holder without filter	ea.	25085
2cm guard cartridge holder with filter	ea.	25086
Connection tip for Waters®-style end fittings	ea.	25088
PEEK® tip standard fittings	ea.	25087

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)
Pinnacle II™ C18	921450212	921450210	921450222	921450220
Pinnacle™ DB C18	941450212	941450210	941450222	941450220
Ultra Aqueous C18	917850212	917850210	917850222	917850220
Ultra Phenyl	910550212	910550210	910550222	910550220

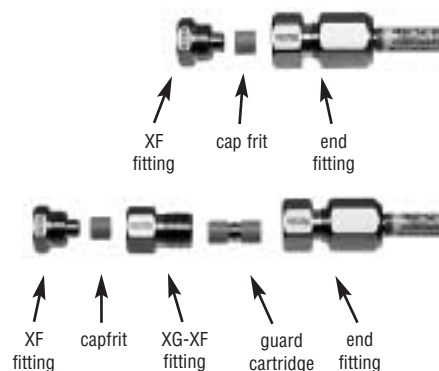
Trident™ HPLC In-Line Guard Cartridge Holders

A Trident™ in-line guard cartridge holder can be used with almost any HPLC column by connecting it with a short piece of 1/16" tubing, appropriate nuts and ferrules, or finger-tight fittings. The system can be used with Restek columns or columns from other manufacturers. Holders are available for either 1 or 2cm guard cartridges. Either size can be purchased with or without a prefilter, which provides added protection against the particles that can shorten the lifetime of the guard cartridge.

Description	qty.	cat.#
Holder for 1cm guard cartridge	ea.	25021
Holder with filter for 1cm guard cartridge	ea.	25040
Holder for 2cm guard cartridge	ea.	25061
Holder with filter for 2cm guard cartridge	ea.	25060
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, the tip must be replaced with cat.# 25088.

Guard Column Systems



Trident™ Direct provides three levels of protection



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



Trident™ Direct 1cm guard cartridge holder with filter
Protection against particulate matter and moderate protection against irreversibly adsorbed compounds.



Trident™ Direct 2cm guard cartridge holder with filter
Protection against particulate matter and maximum protection against irreversibly adsorbed compounds.



Holder for 1cm guard cartridge



Holder with filter for 1cm guard cartridge



Holder for 2cm guard cartridge



Holder with filter for 2cm guard cartridge

GC Columns



For a complete listing of our GC columns, request our annual Chromatography Products Guide (lit. cat.# 59473), or visit our website.

Rtx[®]-1 Columns

(Crossbond[®] 100% dimethyl polysiloxane)
temp. limits: -60 to 330/350°C

length	ID (mm)	df (µm)	cat.#
30m	0.25	0.25	10123
30m	0.32	0.25	10124
60m	0.25	0.25	10126
60m	0.32	0.25	10127

Rtx[®]-5 Columns

(Crossbond[®] 5% diphenyl/95% dimethyl polysiloxane)
temp. limits: -60 to 320/340°C

length	ID (mm)	df (µm)	cat.#
30m	0.25	0.25	10223
30m	0.32	0.25	10224
30m	0.25	0.50	10238
30m	0.32	0.50	10239

XTI[®]-5 Columns

(Crossbond[®] 5% phenyl - extended temp. and inertness)
temp. limits: -60 to 330/350°C

length	ID (mm)	df (µm)	cat.#
30m	0.25	0.50	12238
30m	0.32	0.50	12239
30m	0.53	0.50	12240*
30m	0.53	1.0	12255**

* temp. limits: -60 to 330/360°C
** temp. limits: -60 to 325/350°C

Rtx[®]-5 Amine Columns

(Crossbond[®] 5% diphenyl/95% dimethylpolysiloxane)
temp. limits: -60 to 300/315°C

length	ID (mm)	df (µm)	cat.#
15m	0.25	0.50	12335
30m	0.25	0.50	12338
15m	0.25	1.0	12350
30m	0.25	1.0	12353

Rtx[®]-50 Columns

(Crossbond[®] 50% methyl/50% phenyl polysiloxane)
temp. limits: 0 to 300/320°C

length	ID (mm)	df (µm)	cat.#
30m	0.25	0.50	10538
30m	0.32	0.50	10539
30m	0.53	0.50	10540*

*temp. limits: 0 to 270/290°C

Rtx[®]-200 Columns

(Crossbond[®] trifluoropropylmethyl polysiloxane)
temp. limits: -20 to 290/310°C

length	ID (mm)	df (µm)	cat.#
30m	0.25	1.0	15053
30m	0.32	1.0	15054
30m	0.53	1.0	15055*

*temp. limits: 0 to 270/290°C

Stabilwax[®] Columns

(Crossbond[®] Carbowax[®] - provides oxidation resistance)
temp. limits: 40 to 250°C

length	ID (mm)	df (µm)	cat.#
30m	0.25	0.25	10623
30m	0.32	0.25	10624
30m	0.53	0.25	10625
30m	0.32	1.0	10654*
30m	0.53	1.0	10655*

*temp. limits: 40 to 240/250°C

Rtx[®]-WAX Columns

(Crossbond[®] polyethylene glycol)
temp. limits: 20 to 250°C

length	ID (mm)	df (µm)	cat.#
30m	0.25	0.25	12423
30m	0.32	0.25	12424
30m	0.25	0.50	12438
30m	0.32	0.50	12439

Stabilwax[®]-DA Columns

(Crossbond[®] Carbowax[®] for acidic samples)
temp. limits: 40 to 250°C

length	ID (mm)	df (µm)	cat.#
30m	0.25	0.25	11023
30m	0.32	0.25	11024
30m	0.53	0.25	11025
30m	0.25	0.50	11038
30m	0.32	0.50	11039
30m	0.53	0.50	11040

Rtx[®]-VMS Columns

temp. limits: -40 to 240/260°C

length	ID (mm)	df (µm)	cat.#
30m	0.25	1.4	19915
30m	0.32	1.8	19919
30m	0.53	3.0	19985
60m	0.25	1.4	19916
60m	0.32	1.8	19920
75m	0.53	3.0	19974

MXT[®]-1 Columns

Silcosteel[®]-treated metal column
(Crossbond[®] 100% dimethyl polysiloxane)
temp. limits: -60 to 360°C

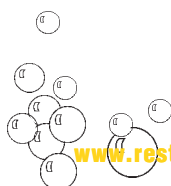
length	ID (mm)	df (µm)	cat.#
15m	0.28	0.1	70106
30m	0.28	0.1	70109
15m	0.28	0.25	70121
30m	0.28	0.25	70124

MXT[®]-WAX Columns

Silcosteel[®]-treated metal column
(Crossbond[®] polyethylene glycol)
temp. limits: 20 to 250°C

length	ID (mm)	df (µm)	cat.#
30m	0.28	0.25	70624
30m	0.28	0.50	70639
30m	0.28	1.0	70654*

*temp limits: 40 to 240°C





Fragrance Materials Association Test Mix

Use this mix in essential oils analysis, to aid in the detection of inlet problems, stationary phase degradation, loss of resolution, changes in sensitivity, and the presence of reactive sites in the sample pathway. The required 5% test solution can be conveniently made by diluting the entire 0.5mL of neat mixture to 10mL with acetone.

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

Neat, 0.5mL in an amber ampul

Each	5-pk.	10-pk.
31807	31807-510	—

AOCS #1 Mix

Chain Compound	%
16:0 methyl palmitate	6.0
18:0 methyl stearate	3.0
18:1 methyl oleate	35.0
18:2 methyl linoleate	50.0
18:3 methyl linolenate	3.0
20:0 methyl arachidate	3.0

Composition listed as a weight/weight % basis.

Each
35022

FAME #15 Mix

Chain Compound	%
16:0 methyl palmitate	10.0
18:0 methyl stearate	3.0
18:1 methyl oleate	50.0
18:2 methyl linoleate	30.0
20:0 methyl arachidate	1.5
20:1 methyl eicosenoate	1.5
22:0 methyl behenate	3.0
24:0 methyl lignocerate	1.0

Composition listed as a weight/weight % basis.

Each
35036

Ethylene Oxide Standard

ethylene oxide

500µg/mL in dimethylsulfoxide, 1mL/ampul

Each	10-pk.
36005	36105

USP 467 Calibration Mixture #4

Meets guidelines in USP25/NF20, effective January 2002.

benzene	2µg/mL
chloroform	60
1,4-dioxane	380
methylene chloride	600
trichloroethene	80

Prepared in methanol, 1mL/ampul

Each	10-pk.
36006	36106

ASTM D6042-96 Calibration Mix

This mixture contains the common antioxidants and slips listed in American Society for Testing and Materials (ASTM International) Method D6042-96.

BHT	Irganox® 3114
erucamide slip	Irganox® 1010
vitamin E	Irganox® 1076
Irgafos® 168	

50µg/mL each in isopropanol, 1mL/ampul

Each	5-pk.	10-pk.
31628	31628-510	31728

ASTM D6042-96 Internal Standard Mix

Tinuvin® P

51.8µg/mL in isopropanol, 1mL/ampul

Each	5-pk.	10-pk.
31629	31629-510	31729

Analytical Reference Materials



Fruit Juice Organic Acid Standard

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

In water, 1mL/ampul

Each	5-pk.	10-pk.
35080	35080-510	—
w/data pack		
35080-500	35080-520	35180

In water, 5mL/ampul

Each	5-pk.	10-pk.
35081	35081-510	—
w/data pack		
35081-500	35081-520	35181



Restek will create the right solution for you!

“The Company Chromatographers Trust”

- ✓ Quotations supplied quickly.
- ✓ Mixtures made to your EXACT specifications.
- ✓ Most reference materials shipped within 5-7 days after receipt of your order.*

Restek should be your first choice for custom-made reference materials. Our inventory of over 3,000 pure, characterized, neat compounds ensures you of maximum convenience, maximum value, and minimum time spent blending mixtures in your lab. For our online custom reference material request form, visit <http://www.restekcorp.com/stdreq.htm>

*Availability of raw materials and final product testing required may affect delivery of some mixtures. International orders require additional shipping time.



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Bellefonte, PA 16823

Monday–Friday, 8:00 a.m.–6:00 p.m. EST

www.restekcorp.com

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