

# Analyzing Alcoholic Beverages by Gas Chromatography



## *Inside:*

*Analysis of alcohols and aldehydes in alcoholic beverages*

*Flavor compounds in distilled liquor products*

*Determining trace sulfur compounds in beer*

*Useful products*

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## HOT tech tip

### Fusel Alcohols

Fusel alcohols are higher-order (i.e., secondary or tertiary) alcohols, traces of which usually are present in all beers. They are produced through a pathway very similar to the pathway for ethanol, the preferred alcohol of beer. Fusel alcohols contribute a hot, spicy, solvent-like flavor and an alcohol "burn". Small amounts of these components can be desirable in a strong ale or barley wine, but they can be offensive, and therefore are unwanted, in a Pilsner or other lager. In addition to their influence on flavor, they usually cause low carbonation and poor head retention in bottle-conditioned beers, because they are deadly to yeast. Higher fermentation temperatures can produce excessively rapid yeast growth, and yeast mutations, which, in turn, stimulate the formation of these components.

## Introduction

The volatile component profiles of alcoholic beverage products consist of a wide range of compounds, including acids, alcohols, aldehydes, and other trace level flavor compounds. Analysts trained in the sensory evaluation of distilled liquors, wines, or beers tell us no two products are exactly alike. The unique sensory properties of different types and brands of distilled liquor products often are due to minor differences among the volatile components present. By using instrumental methods for qualitatively or quantitatively evaluating these differences, in addition to sensory techniques, quality assurance analysts can obtain a wealth of information about their products.

In addition to alcohols and flavor compounds, impurities such as sulfur gases occasionally are present, and might lead to off odors or flavors in the product. Because even parts per billion (ppb) levels of sulfur compounds can impact product quality, a sensitive and selective method of analysis is needed to detect these impurities. The majority of these contaminants are present in the gas phase, necessitating a gas phase sampling and analysis system. Because sulfur compounds also can be very reactive, an inert analysis system is highly desirable.

Gas chromatography (GC) is a powerful tool in the analysis of alcoholic beverage products. Minimal sample preparation, in general, is required, since the samples are in the liquid state in an alcohol or alcohol/water matrix. The flavor compounds tend to be volatile in nature, which fulfills one of the main requirements of GC. General detectors, such as the flame ionization detector (FID), or more information-rich detectors, such as the mass selective detector (MSD), can be used. Additionally, the ability to automate the analysis makes GC a very practical tool in a QA/QC environment. In this guide, we will discuss how GC can be used to (1) monitor alcohol content in alcoholic beverages, (2) determine the volatile profile of a product, and (3) detect trace level impurities.

## Analysis of Alcohols and Aldehydes in Alcoholic Beverages

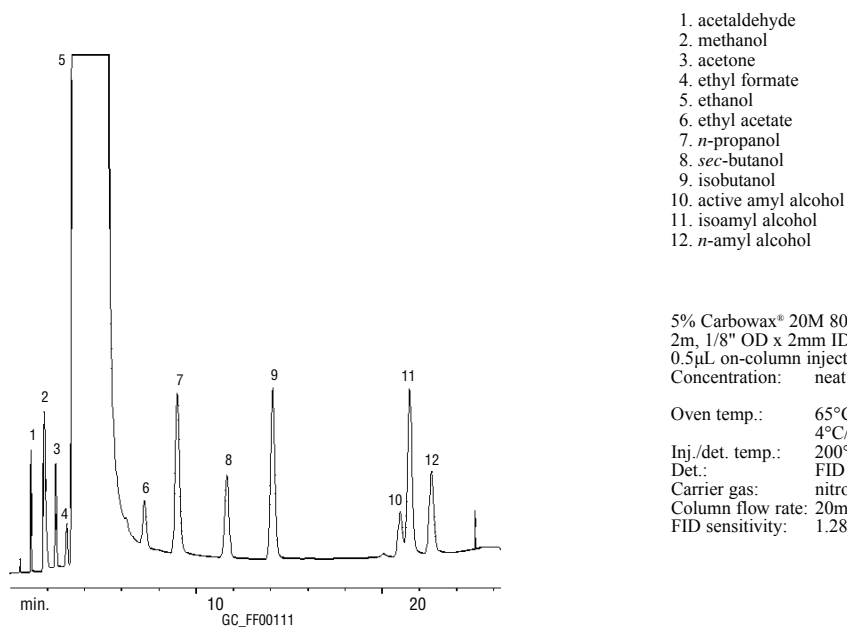
Alcoholic beverages contain a wide range of volatile compounds, including alcohols and short-chain aldehydes. Gas chromatography can be used to analyze these compounds without preliminary extractions. For example, AOAC International has published methods for the analysis of fusel oils, methanol, ethanol, and higher alcohols by GC.<sup>1</sup> Traditionally, packed columns prepared from glass tubing have been used for alcoholic beverage analysis, but these are prone to breakage and can adsorb some of the more reactive compounds. Restek's Silcosteel®-treated CarboBlack™ columns are made from stainless steel which has been treated to provide it with a deactivated silica surface. This conditioning significantly improves inertness and flexibility, relative to traditional glass packed columns.

CarboBlack™ packed columns can be used to quantify the various alcohols in alcoholic beverages. For example, ethanol can be monitored to determine the proof value of the beverage, while methanol and isopropanol can be quantified to determine the levels of denaturants present.<sup>2</sup> While poor methanol peak shapes often are associated with columns of limited sample capacity, a CarboBlack™ B packed column with 5% Carbowax® 20M provides an excellent peak shape for methanol, and completely resolves methanol from ethanol, as shown in Figure 1. In addition, the two predominant fusel oils, active amyl alcohol and isoamyl alcohol, can be resolved and monitored by using this column.

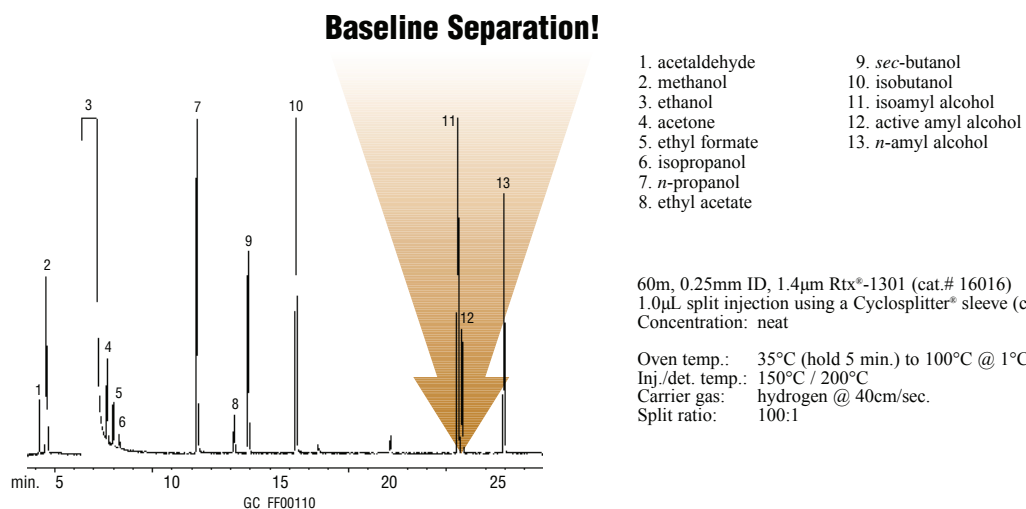
Alcohols and aldehydes in alcoholic beverages also can be monitored by capillary GC. Since capillary columns offer efficient separations, capillary GC is especially useful in analyses of structurally similar compounds, such as the fusel alcohols. The unique polarity of the Rtx®-1301 stationary phase ensures excellent resolution of a range of alcohols and fusel oils. An example of a rum analysis is shown in Figure 2.

**Figure 1**

Difficult-to-monitor alcoholic beverage components methanol, active amyl alcohol, and isoamyl alcohol can be quantified from a packed column analysis, using 5% Carbowax® on CarboBlack™ B.

**Figure 2**

An Rtx®-1301 capillary column offers excellent resolution of alcohols and fusel oils.



## Additional Restek Literature

**Performance information on six polyethylene glycol (PEG) columns—free on request.**



**Lit. Cat. #59890**

## Flavor Compounds in Distilled Liquor Products

Distilled liquor products contain a wide range of volatile and non-volatile compounds in an ethanol/water matrix. The most abundant fusel alcohols and esters can be determined by simple split injection, which also minimizes the amount of matrix ethanol and water transferred to the column. However, many trace-level fatty acids and their esters, which often are used to indicate product quality in alcoholic beverages such as whiskey and rum, cannot be determined by this approach. Capillary gas chromatography is a powerful tool for the analysis of these compounds, but the large ranges in volatilities and acidities can make it difficult to quantify all of the components in a single chromatographic separation. In addition, because the concentrations can vary widely, a splitless injection technique with some type of preconcentration step often is necessary. One example of this is large volume injection (LVI) with a venting step, which can be optimized to remove most of the matrix ethanol and water. Since some water will enter the chromatographic column, a stabilized phase, such as the Stabilwax®-DA phase, should be used.

By using a bonded polyethylene glycol (PEG) capillary column, flavor compounds in distilled liquor products can be quantified in a single splitless injection. A Stabilwax®-DA column was selected for this application, to improve peak shape and reproducibility for acidic components. An acidic functionality added to the PEG stationary phase reduces adsorption of acidic components and significantly reduces peak tailing. An optimized configuration of 30m, 0.18mm ID, and 0.18µm film thickness minimizes analysis times.

To optimize the chromatographic conditions for this analysis, we used a test mixture containing acids, esters, and flavor compounds typically found in alcoholic beverages (Figure 3). A computer modeling program, ezGC™, was used to optimize the column configuration, temperature program, and inlet flow for this system.

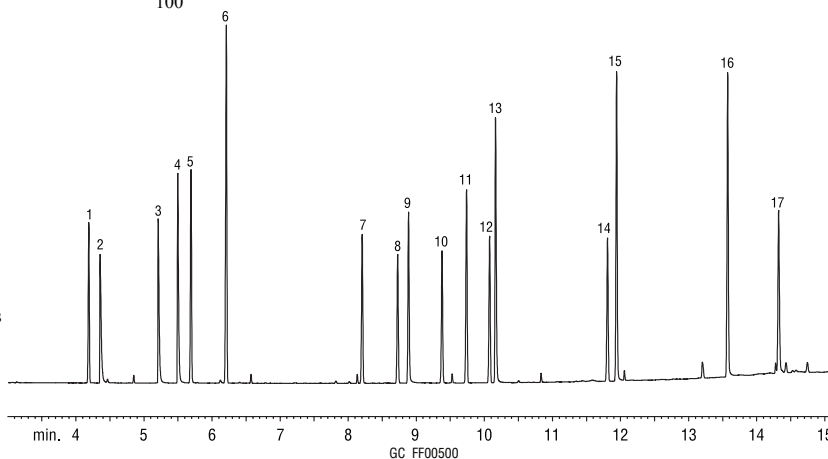
To test the applicability of this column in these dimensions, the critical pair of caproic acid and ethyl laurate was studied. These components can be very difficult to resolve on standard Carbowax®-type columns, especially if peak tailing or broadening occurs, or if one component is present at a significantly higher concentration. The Stabilwax®-DA column achieves baseline resolution of these two compounds in a reasonable analysis time (Figure 4).

**Figure 3**

Acids, esters, and flavor compounds typically found in alcoholic beverages are well resolved on a Stabilwax®-DA column.

| Peak List                 | Conc. (ppm) |                     |     |
|---------------------------|-------------|---------------------|-----|
| 1. ethyl octanoate        | 100         | 14. ethyl palmitate | 50  |
| 2. acetic acid            | 100         | 15. decanoic acid   | 100 |
| 3. propionic acid         | 100         | 16. dodecanoic acid | 100 |
| 4. isobutyric acid        | 100         | 17. vanillin        | 100 |
| 5. decanol 3              | 50          |                     |     |
| 6. ethyl decanoate        | 50          |                     |     |
| 7. ethyl laurate          | 50          |                     |     |
| 8. <i>cis</i> -lactone    | 100         |                     |     |
| 9. 2-phenylethanol        | 50          |                     |     |
| 10. <i>trans</i> -lactone | 100         |                     |     |
| 11. methyl myristate      | 50          |                     |     |
| 12. ethyl myristate       | 50          |                     |     |
| 13. octanoic acid         | 100         |                     |     |

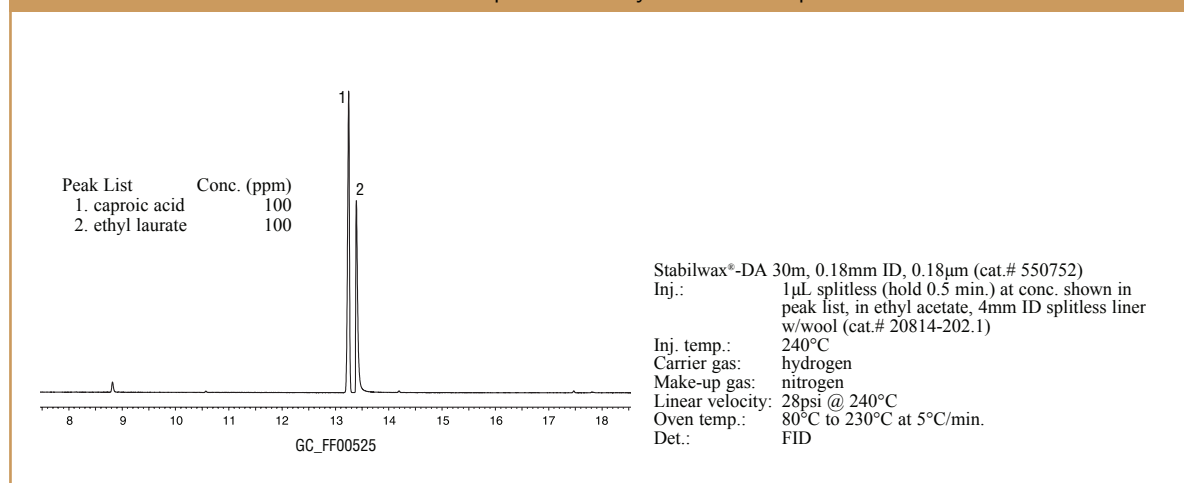
Stabilwax®-DA 30m, 0.18mm ID, 0.18µm (cat.# 550752)  
 Inj.: 1µL splitless (hold 0.5 min.) at conc. shown in peak list, in ethyl acetate, 4mm ID splitless liner w/wool (cat.# 20814-202.1)  
 Inj. temp.: 240°C  
 Carrier gas: hydrogen  
 Make-up gas: nitrogen  
 Linear velocity: 28psi @ 240°C  
 Oven temp.: 70°C to 240°C at 12°C/min. (hold 3 min.)  
 Det.: FID



Because alcoholic beverage samples often are injected via splitless mode, it was important to ascertain the stability of the Stabilwax®-DA column when exposed to aqueous injections. We verified stability by performing a splitless injection of the alcoholic beverage test mix, followed by five 1µL injections of water. We repeated this process 10 times, then made a final injection of the test mix. The chromatogram for the final test mix injection is shown in Figure 5. Even after repeated splitless injections of 100% water, there is very little degradation in the peak shapes for the test mix components. Over the course of the study, the variation in the peak retention times was 0.08-0.22% RSD. These data include retention times for the polar free fatty acids, which can be difficult to analyze under ideal conditions. The excellent stability of this stationary phase is demonstrated by the reproducibility of the retention times.

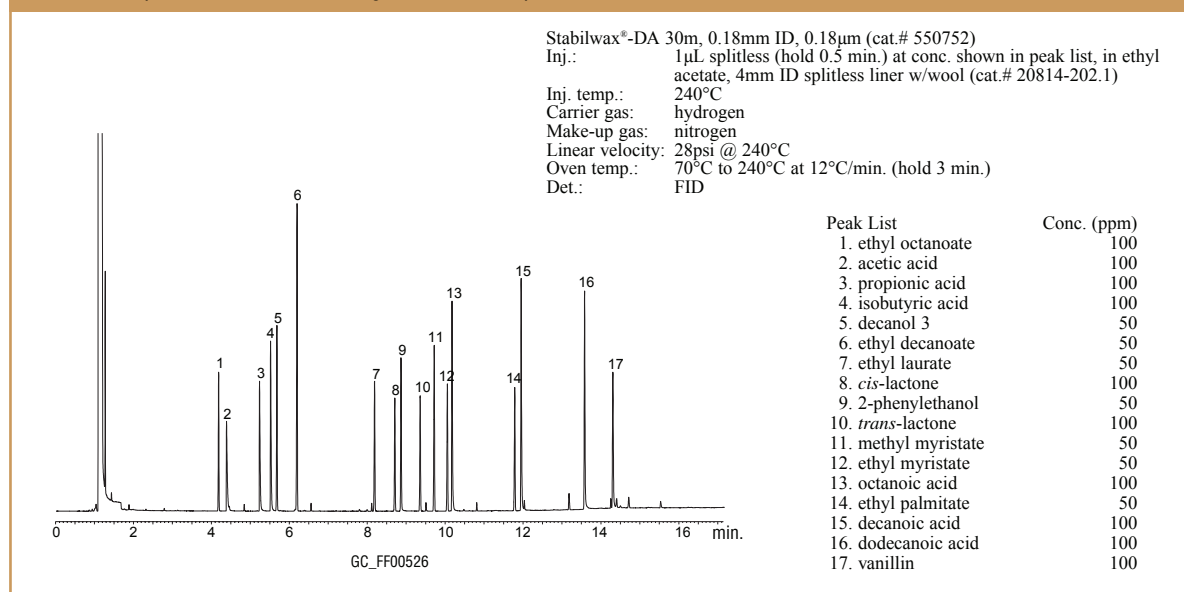
**Figure 4**

A Stabilwax®-DA column resolves the caproic acid / ethyl laurate critical pair to baseline.



**Figure 5**

Stabilwax®-DA columns are well named: repeated injections of water produce very little degradation in the peak shapes for alcoholic beverage test mix components.

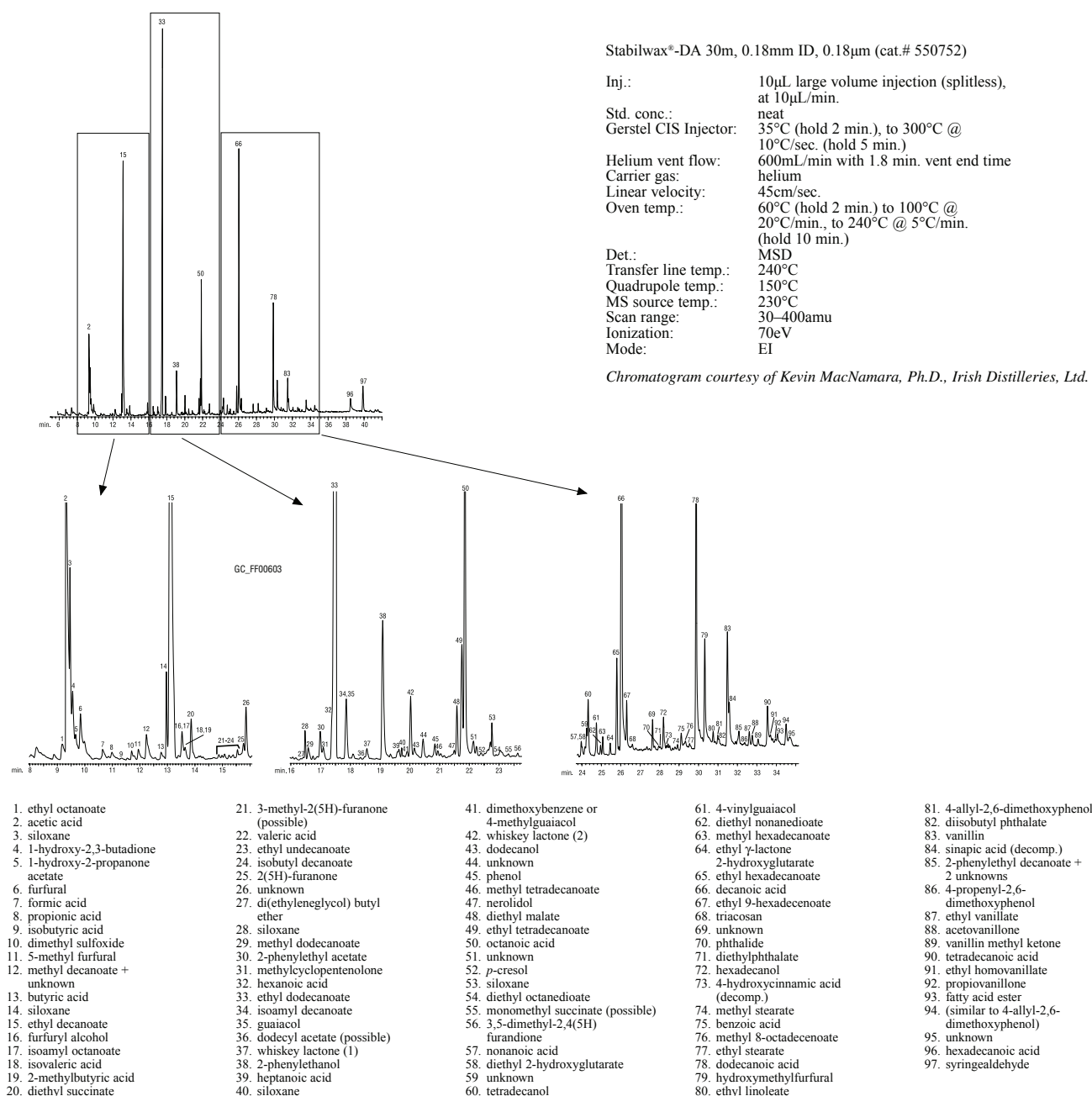




Large volume injections (LVI) can be used to determine flavor compounds in alcoholic beverages such as malt whiskeys and grappas. Whiskey is distilled from a fermented mash of grain, such as corn, rye, barley, or wheat. The whiskey is aged in barrels or casks, and it is during the aging process that whiskey obtains its characteristic color, flavor, and aroma. Factors that influence the flavor of the final product include the characteristics of the grain, the recipe, and how the whiskey is distilled. The flavor profiles of whiskeys contain hundreds of compounds, including fatty acids, esters, alcohols, and aldehydes, in a wide range of concentrations. An example of a malt whiskey profile, determined by GC/MS, is shown in Figure 6.

**Figure 6**

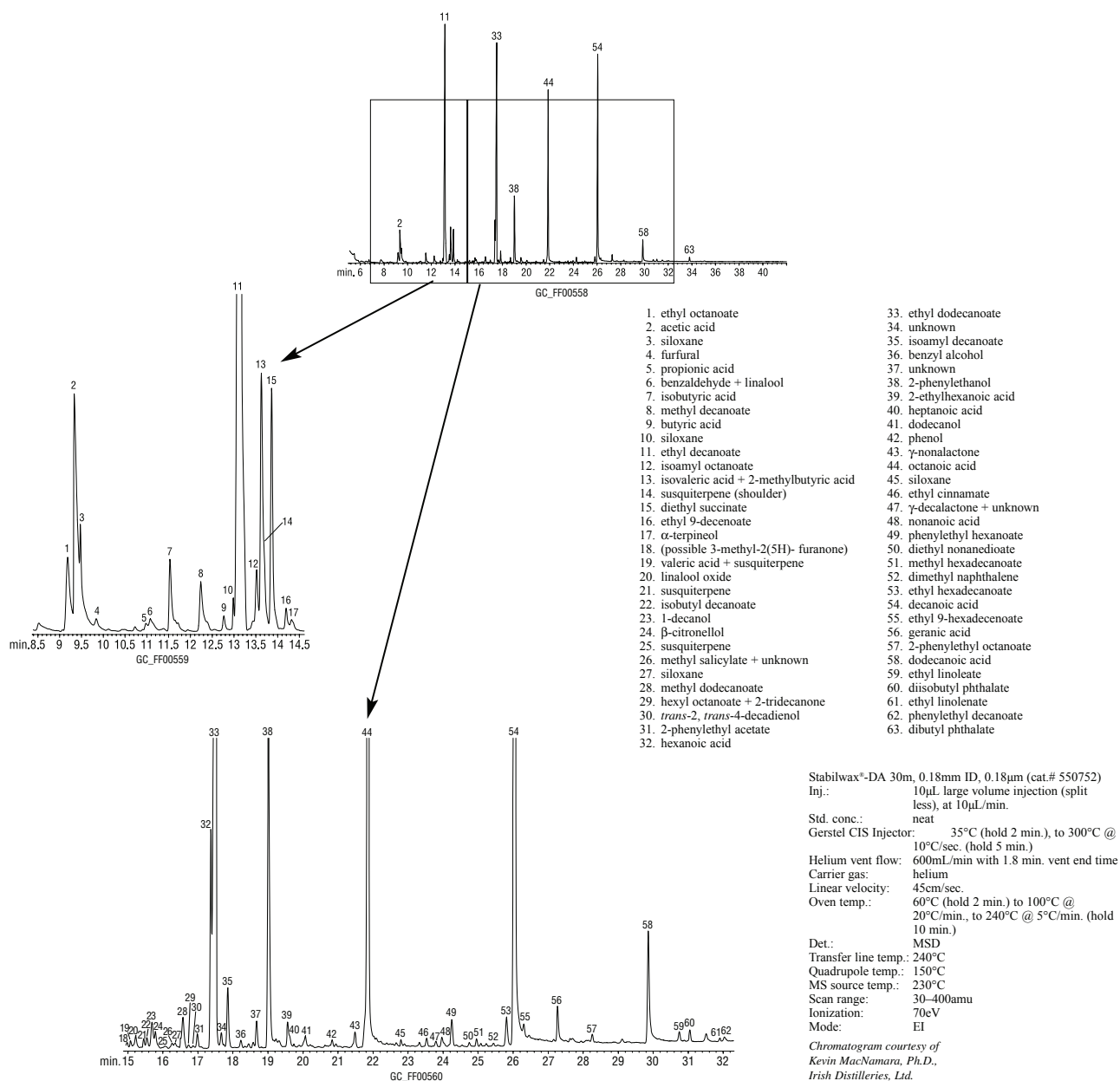
Malt whiskey profile, determined by GC/MS, using a Stabilwax®-DA column and a large volume injection technique.



Grappa is the spirit produced from grape marc, or the skins of the grapes after they have been pressed during wine production. Grape marc is fermented and distilled either directly or by water vapor. Grappas generally do not require the same amount of aging as other alcoholic beverages, although, for example, Italian law requires at least six months of aging. Flavored grappas can be produced by adding ingredients such as herbs and fruits. Flavor profiles of grappas contain hundreds of compounds at a wide range of concentrations. The chromatographic profile of an example grappa is shown in Figure 7.

**Figure 7**

Grappa profile, determined by GC/MS, using a Stabilwax®-DA column and a large volume injection.



## HOT tech tip

### Sample, Transfer, and Analyze Sulfur Compounds at Parts-per-Billion Levels

Our exclusive Sulfinert™ process is the next generation of metals passivation treatments, developed specifically for deactivating metal surfaces that contact organo-sulfur compounds. Untreated stainless steel adsorbs or reacts with hydrogen sulfide, mercaptans, and other active sulfur-containing compounds. Applied to a stainless steel surface, a Sulfinert™ layer prevents these compounds, and other active compounds (e.g., amines), from contacting the reactive metal surface. Combine custom-deactivated sample storage and transfer components with stock Sulfinert™-treated parts to passivate your entire system, and obtain highly accurate information about sulfur compounds in your samples.

### Additional Important Features

Durable and flexible - will not crack or flake.  
Stable to 400°C.  
No memory effects, as seen with polymeric surfaces.

## Determining Trace Sulfur Compounds In Beer

Trace sulfur compounds that are generated during the fermentation process can affect the taste and aroma of malted products such as beers. Several common volatile sulfur compounds might be present in beer at ppb or ppm levels (Table 1).

**Table 1**

Volatile sulfur-containing compounds found in beer at ppm to ppb levels.

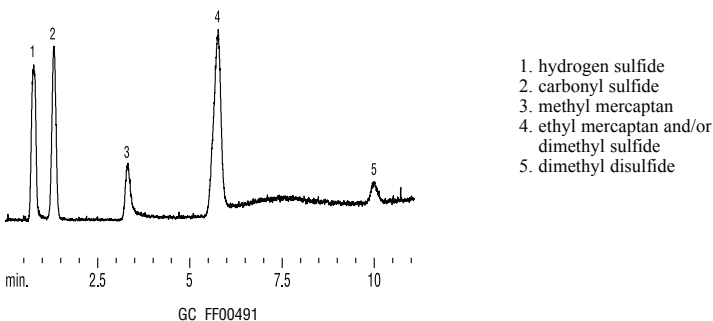
|                      |                     |                    |
|----------------------|---------------------|--------------------|
| hydrogen sulfide     | ethyl mercaptan     | dimethyl disulfide |
| isopropyl mercaptan  | t-butyl mercaptan   | isobutyl mercaptan |
| carbonyl sulfide     | sulfur dioxide      | carbon disulfide   |
| methyl ethyl sulfide | sec-butyl mercaptan | n-butyl mercaptan  |
| methyl mercaptan     | dimethyl sulfide    | t-amyl mercaptan   |
| n-propyl mercaptan   | diethyl sulfide     |                    |

Accurate measurement of reactive sulfur compounds at these levels requires a highly inert chromatographic system. Restek's Rt-XLSulfur™ micropacked column contains a modified divinyl benzene polymer packed into Sulfinert™ tubing, and is specifically designed for monitoring ppb levels of active sulfur compounds. The Rt-XLSulfur™ column exhibits low bleed and thermal stability to 300°C. This column provides excellent resolution of hydrogen sulfide, carbonyl sulfide and sulfur dioxide.

Sample introduction into the column is a critical step in obtaining accurate analytical results for sulfur compounds. In this application, a beer headspace sample was introduced onto the column using a Valco six-port sampling valve fitted with a 1mL sample loop. The valve, sample loop, and all other surfaces in the sample pathway were deactivated using our Sulfinert™ deactivation process. The use of Sulfinert™-treated hardware is critical to achieving a 20ppb detection level for sulfur dioxide and the other target sulfur compounds (Figure 8).

**Figure 8**

Low levels of reactive sulfur compounds in CO<sub>2</sub> (i.e., 20ppb) easily can be detected using an Rt-XLSulfur™ micropacked column and a Sulfinert™ treated sample pathway.



1. hydrogen sulfide
2. carbonyl sulfide
3. methyl mercaptan
4. ethyl mercaptan and/or dimethyl sulfide
5. dimethyl disulfide

1m, 0.75mm ID Sulfinert™ tubing  
Rt-XLSulfur™ 100/120 mesh (cat.# 19806)  
Conc.: sulfur standard @ 20ppb each in CO<sub>2</sub>  
Inj.: 1cc sample loop, 6-port Valco® valve  
Carrier gas: helium  
Flow rate: 10mL/min. @ ambient temp.  
Oven temp.: 60°C to 260°C @ 15°C/min. (hold 5 min.)  
Det. sensitivity: SCD, attn. x 1  
Det. temp.: 800°C

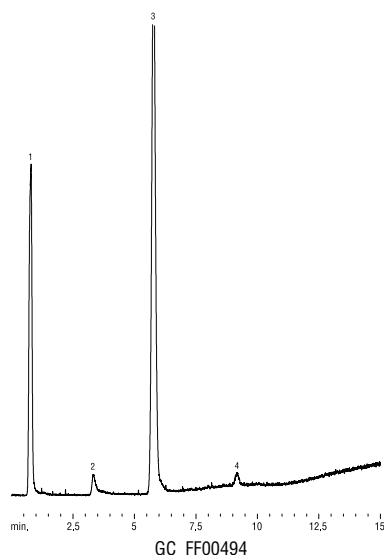


We evaluated the effectiveness of the Rt-XLSulfur™ column by measuring trace sulfur compounds in one domestic (US) and two imported brands of beer. The results from headspace sampling of these products demonstrate the capability of the RT-XLSulfur™ column and the Sulfinert™ deactivated GC system to easily detect sulfur compounds at the 20ppb level (Figure 9).

**Figure 9**

ppb levels of hydrogen sulfide, dimethyl sulfide, and/or ethyl mercaptan and methyl mercaptan in beer.

### Domestic Beer

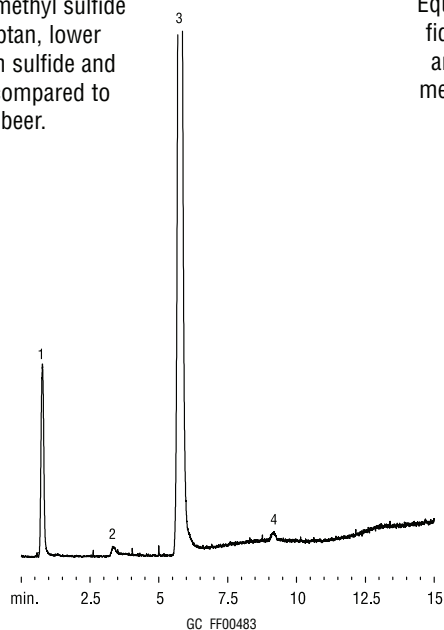


1. hydrogen sulfide
2. methyl mercaptan
3. dimethyl sulfide and/or ethyl mercaptan
4. unknown

1m, 0.75mm ID Sulfinert™ tubing  
 Rt-XLSulfur™ 100/120 mesh (cat.# 19806)  
 Conc.: headspace of a domestic (US) or imported beer sample  
 Inj.: 1cc sample loop, 6-port Valco® valve  
 Carrier gas: helium  
 Flow rate: 10mL/min. @ ambient temp.  
 Oven temp.: 60°C to 260°C @ 15°C/min. (hold 5 min.)  
 Det. sensitivity: SCD, attn. x 1  
 Det. temp.: 800°C

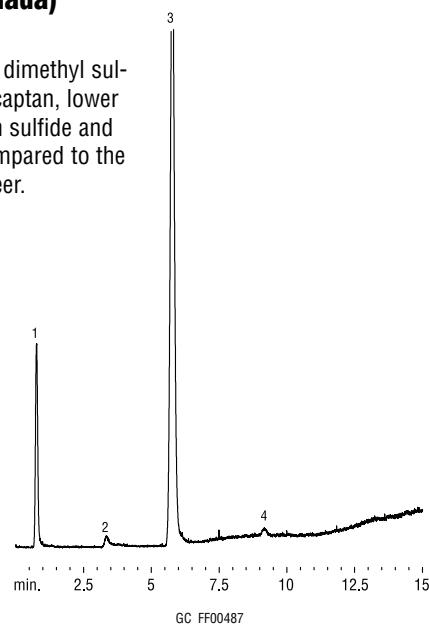
### Imported Beer (Mexico)

Higher amounts of dimethyl sulfide and/or ethyl mercaptan, lower amounts of hydrogen sulfide and methyl mercaptan, compared to the domestic beer.



### Imported Beer (Canada)

Equivalent amounts of dimethyl sulfide and/or ethyl mercaptan, lower amounts of hydrogen sulfide and methyl mercaptan, compared to the domestic beer.



## Summary

Gas chromatography is a simple, sensitive way to characterize the volatile compounds in alcoholic beverage products. Alcohols and aldehydes in alcoholic beverages can be analyzed by packed column GC or capillary GC, depending on the target analytes and their concentrations. Capillary GC provides very efficient separations, thereby resolving closely-related compounds, but the higher capacity of packed column GC systems sometimes makes it easier to detect trace levels of alcohols and short-chain aldehydes in the presence of high levels of ethanol. Ultimately, the choice of technique will depend on the needs of the analyst and the equipment available.

A Stabilwax®-DA capillary column is an excellent choice for analyses of acids, esters, and other flavor components in alcoholic beverage products. This highly stable column has been optimized for analyses of acidic compounds, making it possible to analyze a wide range of compounds. Large volume injection (LVI) techniques accommodate a wide range of concentrations in a single run. As shown in this guide, analytes at higher concentrations, such as alcohols and esters, and trace level flavor compounds can be analyzed simultaneously. The venting step during the large volume injection can be optimized to remove most of the ethanol/water matrix.

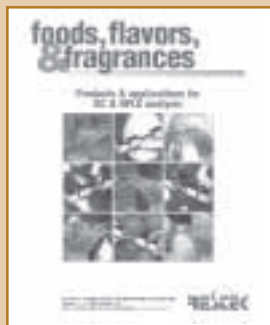
Low levels of reactive sulfur compounds in malted beverages also can be monitored reliably by gas chromatography. The combination of an Rt-XLSulfur™ micropacked column and a Sulfinert™ deactivated sample introduction system provides a state-of-the-art, robust, sampling and analysis approach for monitoring trace levels of volatile sulfur compounds in beer. This system also can be used to detect sulfur compounds in carbon dioxide used for artificial carbonation of carbonated beverages, such as soda waters and soft drinks. For information about this application, and example chromatograms, visit the following page on our website: [www.restekcorp.com/advntage/d01four.htm](http://www.restekcorp.com/advntage/d01four.htm)

## References

1. AOAC *Official Methods of Analysis* (2000), 17th edition, AOAC International.
2. Deman, *Principles of Food Chemistry* (1990), 2nd edition, Van Nostrand Reinhold, New York.

## Additional Restek Literature

### Foods Flavors Fragrances minicatalog



Lit. Cat. #59260

### Preservatives by HPLC



Lit. Cat. #59398

### Genuine Restek Replacement Parts



Lit. Cat. #59627C

### Flavor Volatiles in Alcoholic Beverages



Lit. Cat. #59579

## Capillary Columns for Alcoholic Beverage Analysis

### Ordering Information | Rtx®-1301 (G43) Capillary GC Columns (Fused Silica)

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

| ID     | df (µm) | temp. limits* | 15-Meter | 30-Meter | 60-Meter |
|--------|---------|---------------|----------|----------|----------|
| 0.25mm | 0.10    | -20 to 280°C  | 16005    | 16008    | 16011    |
|        | 0.25    | -20 to 280°C  | 16020    | 16023    | 16026    |
|        | 0.50    | -20 to 270°C  | 16035    | 16038    | 16041    |
|        | 1.00    | -20 to 260°C  | 16050    | 16053    | 16056    |
| 0.32mm | 1.40    | -20 to 240°C  |          |          | 16016    |
|        | 0.10    | -20 to 280°C  | 16006    | 16009    | 16012    |
|        | 0.25    | -20 to 280°C  | 16021    | 16024    | 16027    |
|        | 0.50    | -20 to 270°C  | 16036    | 16039    | 16042    |
| 0.53mm | 1.00    | -20 to 260°C  | 16051    | 16054    | 16057    |
|        | 1.50    | -20 to 250°C  | 16066    | 16069    | 16072    |
|        | 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    |

### Ordering Information | Stabilwax®-DA Capillary GC Columns (Fused Silica)

(Crossbond® Carbowax® for acidic compounds)

| ID     | df (µm) | temp. limits    | 15-Meter | 30-Meter | 60-Meter |
|--------|---------|-----------------|----------|----------|----------|
| 0.18mm | 0.18    | 40 to 250°C     |          | 550752   |          |
| 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    |

## CarboBlack™ Solid Supports

Graphitized carbon black offers unique selectivity and very little adsorption for alcohol analyses. Two CarboBlack supports are available, CarboBlack™ B and CarboBlack™ C. CarboBlack™ B support, with its higher surface area, can support 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.

### Ordering Information | CarboBlack™ Packed Columns

| On CarboBlack™ B   | Mesh   | Stainless Steel Tubing |          |         |        | SilcoSmooth™ Tubing |          |         |        |
|--------------------|--------|------------------------|----------|---------|--------|---------------------|----------|---------|--------|
|                    |        | 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- |

\* Please include configuration suffix number when ordering.

## Leak Detective™ II Leak Detector\*

- Affordable thermal conductivity leak detector—every analyst can have one.
- Compact, ergonomic design is easy to hold and operate with one hand.
- Helium, hydrogen, and nitrogen can be detected at  $1 \times 10^{-4}$  cc/sec. or at an absolute concentration as low as 100ppm.\*\*
- Fast results—responds in less than 2 seconds to trace leaks of gases with thermal conductivities different than air.
- Micro-chip design improves sensitivity and response timover previous models.
- Auto zeroing with the touch of a button.
- Battery-operated for increased portability (one 9-volt).



| Description                      | qty. | cat.# |
|----------------------------------|------|-------|
| Leak Detective™ II Leak Detector | ea.  | 20413 |

\*Never use liquid leak detectors on a capillary system because liquids can be drawn into the system.

\*\*Caution: NOT designed for determining leaks of combustible gases. A combustible gas detector should be used for determining combustible gas leaks in possibly hazardous conditions.

## Configurations

|  |   |
|--|---|
|  | General Configuration<br>Suffix -800                                  |
|  | Agilent<br>5880, 5890,<br>5987, 6890:<br>Suffix -810                  |
|  | Varian 3700,<br>Vista Series, FID:<br>Suffix -820                     |
|  | PE 900-3920<br>Sigma 1,2,3:<br>Suffix -830                            |
|  | PE Auto System<br>8300, 8400, 8700<br>(Not On-Column):<br>Suffix -840 |

See our catalog for custom configurations

[www.restek.com](http://www.restek.com)

## Micropacked Columns

- Higher efficiency than packed columns.
- Higher capacity than capillary columns.
- Made from inert, flexible Silcosteel® tubing.

Micropacked columns are inexpensive, rugged, and easy to install and to operate. With our inert Silcosteel® treatment, micropacked columns are a powerful tool for solving many difficult application problems. Because the Silcosteel® coating is thin, the column can be flexed and coiled without any fear of damage to the inert surface.

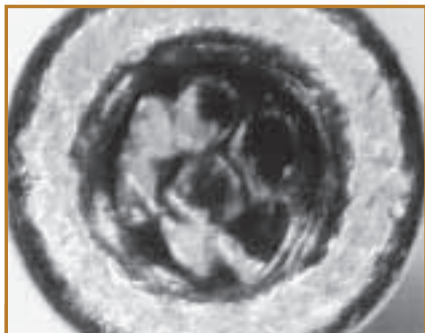
Micropacked columns fit packed or capillary injection systems. 1mm ID, (1/16-inch OD) micropacked columns improve efficiency of packed column instruments, without the expense of converting to a capillary injection system. 0.75mm ID (0.95mm OD) micropacked columns install easily into a capillary injector, using slightly larger ferrules. Micropacked columns operate at flows exceeding 10cc/min., for trouble-free operation. Packed with 100/120 mesh particles.

### Ordering Information | Rt-XLSulfur™ Micropacked Columns

*Purchase installation kit separately.*

| OD     | ID (mm) | 1-Meter | 2-Meter |
|--------|---------|---------|---------|
| 1/16"  | 1.0mm   | 19804   | 19805   |
| 0.95mm | 0.75mm  | 19806   | 19807   |

## HOT tech tip



A common problem with micropacked columns is the integrity of the end plug. Glass wool is difficult to insert into an opening less than 1mm wide and can be dislodged easily by carrier gas pressure surges that occur during valve switching. Restek's chemists insert braided wire into the column bore, then make a small crimp near the column outlet. End plugs are Silcosteel®-treated to ensure that the sample contacts only inert surfaces.

### Ordering Information | Micropacked Columns Installation Kits

|                        | for 0.75mm ID col. | for 1mm ID col. | for 2mm ID col. |
|------------------------|--------------------|-----------------|-----------------|
| For valve applications | 21062              | 21065           | 21067           |
| For split applications | 21063              | —               | —               |
| For all Agilent GCs    | 21064              | —               | —               |
| For direct injections  | —                  | 21066           | —               |

## Headspace Vials



6.0mL Headspace Vial



Silver Seal with  
PTFE/Gray Butyl  
Rubber Septum

### Headspace Autosampler Vials

| Description                     | 100-pk. | 1000-pk. |
|---------------------------------|---------|----------|
| 6mL Clear Vial                  | 21166   | 21167    |
| 10mL Clear Vial, Flat Bottom    | 24683   | 24684    |
| 10mL Clear Vial, Rounded Bottom | 21164   | 21165    |
| 20mL Clear Vial, Flat Bottom    | 24685   | 24686    |
| 20mL Clear Vial, Rounded Bottom | 21162   | 21163    |
| 27mL Clear Vial                 | 21160   | 21161    |

### 20mm Aluminum Seals w/Septa, Assembled

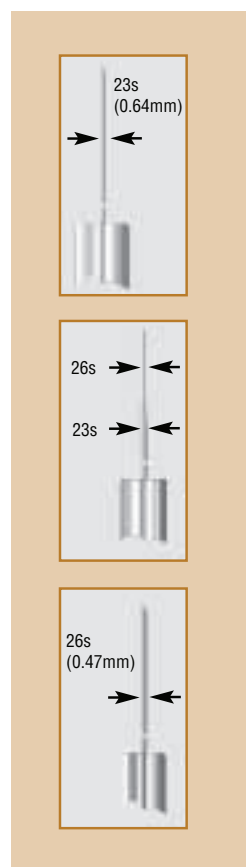
| Description  | 100-pk. | 1000-pk. |
|--|---------|----------|
| Silver Seal w/ PTFE/Gray Butyl Rubber                                | 21761   | 21762    |
| Silver Seal w/ PTFE/Silicone   | 21763   | 21764    |
| Pressure Release Silver Seal w/ PTFE/Gray Butyl Rubber Septum <125°C | 21765   | 21766    |
| Pressure Release Silver Seal w/ PTFE/Silicone Septum >125°C          | 21767   | 21768    |

## Syringes

Restek offers complementing lines of syringes from Hamilton & SGE.

- Hamilton: The historical leader in precision fluid measuring devices for over 40 years, with a commitment to precision, quality, and accuracy.
- SGE: Over 25 years of providing a comprehensive range of analytical syringes unsurpassed in design, quality, and performance.

## Needle Gauge for Agilent 7673 Syringes



### 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.

*SuperfleX™ Flexible Plunger Syringe*

*Agilent 7673 Syringe*

*Gas-Tight Luer-lock Syringe*

### 23s-26s—Dual Gauge (tapered) Needle

- Durability of a 23s gauge needle.
- Ability of a 26s gauge needle to perform split/splitless and on-column injections.

*SGE Removable Needle for Agilent 7673 Autosampler*

### 26s—Single Gauge Needle

- On-column injection ports.
- Split/splitless injection ports.

*Hamilton 10μL, Autosampler Cemented Needle for Agilent 7673 Autosampler*

*Drawings reproduced with permission from Hamilton.*

## Hamilton Syringes

| Volume | Needle Term. | Needle Gauge | Needle Length | Point Style | Hamilton |         | Restek |       |
|--------|--------------|--------------|---------------|-------------|----------|---------|--------|-------|
|        |              |              |               |             | Model    | cat.#   | qty.   | 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 |

\* Autosampler cemented needle.

\*\* Designated by Agilent as #80397.

## SGE Syringes

| Volume | Needle Term. | Needle Gauge | Needle Length | Point Style | SGE                 |        | Restek |       |
|--------|--------------|--------------|---------------|-------------|---------------------|--------|--------|-------|
|        |              |              |               |             | Model               | cat.#  | qty.   | 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-.063/0.47 | 002822 | 6-pk.  | 21215 |

\* Fixed needle.

## Siltek™ Deactivation—The Next Generation

- Maximizes the inertness of the sample pathway.
- Minimizes breakdown.
- Low bleed.
- Thermally stable.
- “Clean and green”—manufactured without the use of harmful organic solvents.

Restek offers the next generation of deactivation. The Siltek™ deactivation process (patent pending) produces a highly-inert glass surface, which features high temperature stability, extreme durability, and low bleed. Try Siltek™ liners, guard columns, wool, and connectors for better recovery of sample analytes.

**For Siltek™ inlet liners, add the corresponding suffix number to your liner catalog number.**


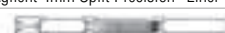




### Siltek™ Inlet Liners

| qty.   | Siltek™ | Siltek™ with<br>Siltek™ wool | Siltek™ with<br>CarboFrit™ |
|--------|---------|------------------------------|----------------------------|
| each   | -214.1  | -213.1                       | -216.1                     |
| 5-pk.  | -214.5  | -213.5                       | -216.5                     |
| 25-pk. | -214.25 | -213.25                      | -216.25                    |




### Benefits of wool-packed Precision™ Liners

- Wool minimizes vaporization and helps wipe the needle during injection.
- No guessing where the wool should be placed; easy to change wool.
- Wool stays in position during pressure pulses in the inlet during an injection.
- 100% deactivation ensures inertness.\*

\* Not Siltek™ deactivation.

| Precision™ Liners  | ID**/OD &<br>Length (mm) | ea.   | 5-pk. | 25-pk. |
|--|--------------------------|-------|-------|--------|
| <br>Agilent 4mm Split Precision™ Liner          | 4.0 ID<br>6.3 OD x 78.5  | 21022 | 21023 | 20979  |
| <br>Varian 1078/1079 Split Precision™ Liner     | 3.4 ID<br>5.0 OD x 54    | 21024 | 21025 |        |
| <br>Shimadzu 17A Split Precision™ Liner         | 3.5 ID<br>5.0 OD x 95    | 21020 | 21021 |        |
| <br>Varian 1075/1077 Split Precision™ Liner     | 4.0 ID<br>6.3 OD x 72    | 21030 | 21031 |        |
| <br>Thermo Finnigan 5mm Split Precision™ Liner  | 5.0 ID<br>8.0 OD x 105   | 21028 | 21029 |        |
| <br>PerkinElmer Auto SYS Split Precision™ Liner | 4.0 ID<br>6.2 OD x 92.1  | 21026 | 21027 |        |

### Inlet Liners for APEX ProSep™ 800 & ProSep™ 800 Plus GCs

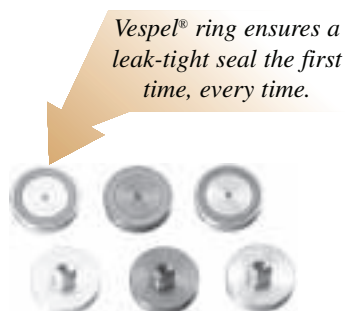
|  | Benefits/Uses:    | ID**/OD &<br>Length (mm) | Similar to<br>APEX part # | cat.#<br>ea. |
|--|-------------------|--------------------------|---------------------------|--------------|
| <br><b>Mega IV (4.0mm ID)</b> | injections <125µL | 4.0 ID<br>6.0 OD x 243   | L-00410                   | 21075        |
| <br><b>Micro I (1.0mm ID)</b> | injections <5µL   | 1.0 ID<br>6.0 OD x 243   | L-00110                   | 21073        |
| <br><b>MIDI II (2.0mm ID)</b> | injections <25µL  | 2.0 ID<br>6.0 OD x 243   | L-00210                   | 21074        |

\*\*Nominal ID at syringe needle expulsion point.



## Vespel® Ring Inlet Seals for Agilent 5890/6890 and 6850 GCs

- Easy-to-use, patent-pending design saves time.
- Vespel® material seals the first time, every time.
- Very little torque is required to make a seal—reduces operator variability.
- Lower leak rate versus OEM metal inlet seals—reduces detector noise.
- Increases column lifetime by preventing oxygen from leaking into the carrier gas.
- Soft sealing area reduces wear on the critical seal of the injection port base.



| <b>0.8mm ID Vespel® Ring Inlet Seal</b> | <b>2-pk.</b> | <b>10-pk.</b> |
|---|--------------|---------------|
| Gold-Plated                             | 21562        | 21563         |
| Silcosteel®                             | 21564        | 21565         |
| Stainless Steel                         | 21560        | 21561         |
| <b>1.2mm ID Vespel® Ring Inlet Seal</b> | <b>2-pk.</b> | <b>10-pk.</b> |
| Gold-Plated                             | 21568        | 21569         |
| Silcosteel®                             | 21570        | 21571         |
| Stainless Steel                         | 21566        | 21567         |

Washers included.

## Replacement Inlet Seals for Agilent 5890/6890/6850 Split/Splitless Injection Ports

- Special grade of stainless steel that is softer and deforms more easily, ensuring a completely leak-tight seal.
- Increases column lifetime because oxygen cannot leak into the carrier gas.
- Reduced noise benefits high-sensitivity detectors (e.g., ECDs, MSDs).
- Silcosteel® seal offers the inertness of glass.



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

\*0.8mm ID stainless steel inlet seal is equivalent to Agilent part #18740-20880.

0.8mm ID gold-plated inlet seal is equivalent to Agilent part #18740-20885.

Note: All seals include washers.

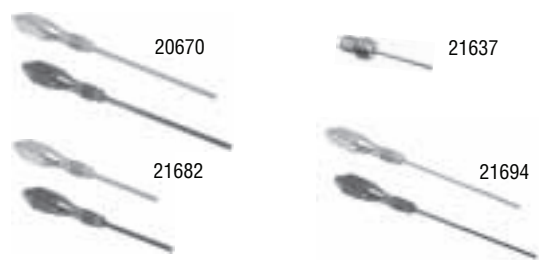
## Replacement FID Jets

- Standard Version: Engineered with a fluted tip to guide the capillary column into the jet.
- High-Performance Version: Identical to the standard version, except that it has been Silcosteel®-treated. Extremely inert, use with active compounds.

### Capillary Adaptable FID Jet for Agilent 5890/6890/6850 GCs (0.011-inch ID tip)

(Similar to Agilent part # 19244-80560.)

| Description                  | qty. | cat.# | qty.  | cat.# |
|------------------------------|------|-------|-------|-------|
| Standard                     | ea.  | 20670 | 3-pk. | 20671 |
| High-Performance Silcosteel® | ea.  | 20672 | 3-pk. | 20673 |



### Capillary Dedicated FID Jet for Agilent 6890/6850 GCs

(Similar to Agilent part # G1531-80560.)

| Description                  | qty. | cat.# | qty.  | cat.# |
|------------------------------|------|-------|-------|-------|
| Standard                     | ea.  | 21621 | 3-pk. | 21682 |
| High-Performance Silcosteel® | ea.  | 21620 | 3-pk. | 21683 |

### Capillary FID Jet for Agilent 5880 GCs

(Similar to Agilent part # 19301-80500.)

| Description | qty. | cat.# |
|-------------|------|-------|
| Standard    | ea.  | 21637 |
|             | ea.  | 21638 |

### Packed Column FID Jets for Agilent 5890/6890/6850 GCs

#### 0.018-Inch ID

(Similar to Agilent part # 18710-20119.)

|          | qty. | cat.# | qty.  | cat.# |
|----------|------|-------|-------|-------|
| Standard | ea.  | 21694 | 3-pk. | 21695 |
|          | ea.  | 21696 | 3-pk. | 21697 |

#### 0.030-Inch ID

(Similar to Agilent part # 18789-80070.)

|          | qty. | cat.# | qty.  | cat.# |
|----------|------|-------|-------|-------|
| Standard | ea.  | 21688 | 3-pk. | 21689 |
|          | ea.  | 21686 | 3-pk. | 21687 |

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