Agilent J&W High-Efficiency Capillary Columns: Productivity-Enhancing Tools for Fast GC Applications

Technical Overview

Introduction

Separation efficiency is related to the number of theoretical plates (N) available on a column. Theoretical plate count increases linearly with decreasing column internal diameter (id). For column comparison purposes, the number of theoretical plate per meter (N/m) is often used. A column with higher N/m is considered to be more efficient.

As a convention, the term high-efficiency capillary GC column or high-efficiency GC column is used to refer to 0.18-mm-id columns. These columns typically produce 6,660 theoretical plates per meter, whereas 0.25- and 0.32-mm-id columns produce 4,630 and 3,760 theoretical plates per meter, respectively.

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Internal diameter (mm)	Film thickness (µm)	Column length (m)	Theoretical plates	Theoretical plates per meter N/m*
0.18	0.18	20	133200	6660
0.25	0.25	30	138900	4630
0.32	0.32	30	112800	3760

*Measured with a k = 5

High-efficiency GC columns offer more plates per meter than their corresponding 0.25-mm-id standard-bore capillary GC columns. The efficiency improvement for the 0.18-mm-id columns allows for better signal-to-noise ratios and similar column performance even with a smaller sample capacity.

High-efficiency GC columns can be very useful in developing fast GC separations. The reduction of column id leads to a proportional decrease of minimum plate height. Consequently, the column length can be decreased while keeping similar theoretical plates. As shown in the table above, a 20 m × 0.18-mm-id column has almost the same theoretical plates as that for a 30 m × 0.25-mm-id column. Therefore, a combination of shorter column length and higher plate number per meter enables high-efficiency columns to deliver faster analysis and higher sample throughput without compromising resolution.

Important Design Features

Carrier Gas Consideration

High-efficiency capillary GC columns are fully compatible with standard-pressure (100 psi or less) gas chromatograph instruments using either helium or hydrogen carrier gas. The chromatographer has the option to stay with a helium carrier rather than switching to a hydrogen carrier often required for 0.10-mm and smaller id columns. Staying with a helium carrier helps simplify the method development process. Alternatively, these columns can be used when a hydrogen carrier is available and/or desired for still faster analyses.

Although it is possible to use 0.10-mm-id columns with standard-pressure-rated GCs and a helium carrier, both achievable linear flow velocities and temperature ranges are severely limited for practical use. The higher operating pressures required for helium carrier operation of 0.1-mm or smaller id columns can lead to poor injector reproducibility as a result of sample blowback. In order to use 0.1-mm or smaller id columns, high-pressure-rated GCs and gas-tight syringes are advisable.

Phase Ratio Equivalence

In order to simplify method translation from standard-bore 0.25-mm format to high-efficiency GC columns, it is recommended to keep phase ratios constant when possible. Phase ratio (ß) is defined as $ß = r/(2 \times d_f)$ where r is the column radius (mm) and d_f is the column film thickness (µm). The most common film thickness on the standard-bore column is 0.25 µm, yielding a phase ratio of 250:1. Film thickness of 0.18 µm on a 0.18-mm-id high-efficiency column yields the same phase ratio of 250:1. Method translation can also be used when different phase ratios are necessary or desired. However, it is important to verify peak elution order on the translated method as changes in elution order are possible due to changes in column selectivity.

Method Translation

Agilent's method translation software simplifies conversion from established laboratory GC methods to parallel sets of conditions suitable for high-efficiency GC columns. Chromatographic conditions are entered into a menu-driven table within the software for an existing method along with the new column dimensions for a high-efficiency GC column. The software calculates the chromatographic set points for the translated method. The resulting software-generated conditions are often all that is required to successfully translate a method.

There are three modes of method translation available in the method translation software: translate only, best efficiency, and fast analysis. The "translate only" mode produces a set of conditions that most closely resemble the original method in terms of linear velocity. The "best efficiency" mode generates a set of conditions where column efficiency is prioritized. "Fast analysis" mode generates a set of conditions where analysis speed is prioritized. By using the various modes available, a translated method specific to an application can be developed quickly with a few keystrokes and iterative passes through the software.

Flow programming is not addressed in the method translation software and may require minor adjustments to flow rate parameters to achieve desired results. When translating flow-programmed methods, initial or intermediate flow rates can be entered into method translation software user interface to visualize the effect on the other parameters. The operator can then collect data at several different flow rates and select the best set of conditions for the application.

The software is also useful in porting a method from the use

of one carrier gas to another. Translation from the existing method using a helium carrier to a hydrogen carrier is calculated in a similar manner. For additional information on Agilent's method translation software please follow this link: www.agilent.com/chem/myGCcolumns.

Column Use

Conditioning high-efficiency GC columns on initial installation is the same as that recommended for the equivalent stationary phase in standard-bore format. Ensure that all system leaks have been eliminated. Flushing the column with high-purity carrier gas to remove oxygen and other potential atmospheric contamination prior to conditioning is essential. After conditioning and initial use, the column can be stored with septa-capped ends in the original box under normal ambient conditions for future use.

Operating temperature parameters are usually the same for these columns as the equivalent stationary phase standard-bore column. Verification of the exact temperature ranges for each column by inspection of the quality control report supplied with each column is highly recommended.

High-efficiency GC columns can be used with the same sample matrix as their standard-bore counterparts. However, column trimming may be required more frequently to remove nonvolatile matrix contaminants deposited at the head of the column. This is due to the slightly lower sample capacity inherent to these columns. For use with particularly dirty sample matrices, the use of retention gaps or guard columns are strongly recommended for both high-efficiency GC and standard-bore GC columns.

High-Efficiency Capillary GC Column Feature Summary

Feature	Benefit
Smaller column id and shorter column length	Improved productivity, faster sample analysis without loss of resolution
Standard pressure operation	Compatible with standard GC and GC/MS instrument
Lower flows	Reduction in carrier gas usage and more instrument up time
Phase ratio correspondence	Straightforward method development
Operates with helium or hydrogen carrier	Flexible carrier gas selection

References

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Column Ordering Guide for High-Efficiency Capillary GC Columns

For more information about Agilent J&W high-efficiency GC columns, visit our Web site at www.agilent.com/chem/HEcolumns.

For More Information

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