

Hans-Gerd Janssen, Ph.D., Unilever Food and Health Research Institute



Numerous articles have been published in the scientific literature regarding faster methods for gas chromatography (GC), yet confusion remains on how best to speed up separations. A significant source of this confusion is the fact that authors often neglect to define the terms "analysis speed" and "analysis time". Does the analysis time include sample preparation time? Or is it just the run time between injection and last time point on the chromatogram? Does it include reconditioning, paperwork, or interpretation? Is it the instrument time or the operator time? Numerous questions often are left unanswered and it is these questions that are to blame for the chaos in fast GC. Here I will try to clarify this confusion.

A chromatographic analysis consists of four steps: sample preparation, chromatographic separation, detection, and data interpretation. Clearly these steps are related and can not be considered in isolation. Changes in the sample preparation might affect the performance of the separation, and more sensitive and selective detectors may allow simpler sample preparation. It is these very strong interactions among the four steps that make it very difficult to describe the consequence of a change somewhere in the procedure on the total analysis time. The next problem to consider is the fact that the term "total analysis time" also is not very well defined. Is it the time-to-result for a sample, or is it the total operator time for the analysis of 100 samples divided by 100? Because of all this confusion, information from the literature on how to speed up GC analyses should be interpreted and used with great care. It is the author's sincere belief that these undefined terms have been, and still are, major obstacles, to the success of faster GC. People have tried solutions towards faster GC that too often did not work. This made people lose their confidence in fast GC. However, we should not forget there are almost 20 methods for speeding up a GC separation!<sup>1</sup> If one selects the wrong route, all too often the conclusion is that fast GC does not work, rather than that the analyst was wrong in his or her selection. Fast GC works if—and only if—the correct route is selected. Doing that is much simpler than one might expect. Simple guidelines can be followed to select the best option, if we restrict ourselves to the chromatographic separation itself.

The selection of the best route to speed up a separation starts with an understanding of why a chromatographic separation takes time. The total time a chromatogram takes is the sum of all empty baseline segments plus the sum of the width of all baseline peaks. How can we minimize the total time? Very simple: Get rid of the baseline, only separate those peaks that need to be separated and make the peaks as narrow as possible. This sentence summarizes the three main routes to faster GC. In correct scientific terms, and in the correct order of implementation, one would describe them as 1) minimize resolution to a value just sufficient, 2) maximize the selectivity of the chromatographic system, and 3) implement a method that reduces analysis time while holding resolution constant.

If your chromatogram contains baseline or over-resolved peaks, the first step in making the separation faster is to eliminate this over-resolution. The options to do this include:

- shortening the column.
- working at an above optimum carrier gas velocity.
- increasing the initial temperature or the temperature programming rate.
- converting an isothermal separation to a programmed method.
- using flow programming.
- using a thinner film.

Only after having eliminated all baseline and situations of over-resolution should one continue to step 2. But more importantly, if one does not have baseline or over-resolved peaks, do not even consider using these options! Faster temperature programming has been described as a universal solution for faster GC. But if your chromatogram is full of peaks all just separated without any excess resolution, faster programming will ruin your

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**Erratum:**In Advantage 2008.02, Figure 1 on page 19 was incorrect. The corrected figure can be seen at [www.restek.com/aoi\\_fff\\_A016.asp](http://www.restek.com/aoi_fff_A016.asp)

## Achieving Faster GC

Continued from page 2

separation (and another disappointed user is born!). Please also bear in mind that the above options will reduce all baseline segments in your chromatogram to the same extent. So, if you have over-resolution throughout your chromatogram except for one critical peak pair that is just barely resolved, forget about these options. In general however, all of the above options are low-risk options that could be tried before moving on to the more elaborate steps discussed below.

Now that you have eliminated all the empty parts of the baseline you can move to step 2, maximizing the selectivity of the system. Selectivity is the ability to distinguish between compounds. This can be done through the separation or through detection (once the method for sample preparation has been selected). Options for improving selectivity include:

- using a more selective stationary phase or coupled columns.
- using conventional 2-dimensional or comprehensive 2-dimensional GC.
- using selective detection, with mass spectrometry (MS) being particularly attractive.
- backflushing.

Because the above options are all rather expensive and require special instruments and expertise, the only really widely used option is the use of MS detection. Indeed MS is a marvellous way to get selectivity in an easy and quick way.

You have now gone through the two initial steps of speeding up your method. You have selected a system that offers you the required resolution, yet not more resolution than really needed. If the analysis time in this "minimum acceptable resolution" situation still exceeds the desired or permitted time, options that reduce the analysis time at constant resolution should be exploited. Possibilities include:

- reducing the column inner diameter.
- using hydrogen as the carrier gas.
- applying vacuum-outlet conditions.
- using turbulent flow conditions.

Of these options the first two always work; however, vacuum operation only works if you have a separation on a short wide-bore column, and turbulent flow operation in practice is of little use.

*Mea culpa*, with more than 20 papers published on fast GC, I have also contributed to the chaos in faster GC. I hope the above discussion helps resolve at least part of the confusion. Faster GC is possible, it is always possible, and the need for it is actually still increasing as a result of recent trends in process control and high-throughput experimenting.

L. P. Korytár, H.-G. Janssen, E. Matisová, U.A.Th. Brinkman, Trends in Analytical Chemistry 21 (2002) 558-572.

**Hans-Gerd Janssen** received his Ph.D. in analytical chemistry from Eindhoven University in 1991. After having worked at Eindhoven as an associate professor for eight years, he joined Unilever Research to work as the group leader for chromatography and mass spectrometry. In 2004, Hans-Gerd was appointed part-time professor at the University of Amsterdam, focusing on biomacromolecular separations.

## Restek On-the-Road

### Tradeshaw Schedule

#### October, 2008

Show: **2008 NIH Research Festival Exhibit**  
Date: Oct. 16-17  
Location: National Institutes of Health, Bethesda, MD

Show: **Society of Forensic Toxicologists (SOFT)**  
Date: Oct. 27-31  
Location: Arizona Grand Hotel, Phoenix, AZ

Show: **COLACRO XII**  
Date: Oct. 28-30  
Location: Florianopolis Convention Center, Florianopolis, Brazil

#### November, 2008

Show: **2008 AAPS Annual Meeting & Expo**  
Date: Nov. 16-20  
Location: Georgia World Congress Center, Atlanta, GA

Show: **Eastern Analytical Symposium (EAS)**  
Date: Nov. 17-20  
Location: Garden State Convention Center, Somerset, NJ

Show: **Symposium on Air Quality Methods & Technology**  
Date: Nov. 3-6  
Location: Chapel Hill, NC

Show: **LC/MS Montreux Symposium**  
Date: Nov. 12-14  
Location: Montreux Convention Center, Montreux, Switzerland

#### January, 2009

Show: **Gulf Coast Conference**  
Date: Jan. 20-21  
Location: Moody Gardens Convention Center, Galveston, TX

### Seminar Schedule

Date	Cat. #	City	State
<b>Petrochemical Seminar</b>			
10/27	65746	Corpus Christi	TX
10/29	65747	Houston	TX
10/31	65748	Oklahoma City	OK
<b>Comprehensive HPLC</b>			
11/3	65749	Seattle	WA
11/5	65750	San Francisco	CA
11/7	65751	San Jose	CA



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