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Companies are being required to work faster and to be able to analyse an increasing number of samples. That is the case for most gas chromatography (GC) routine analyses labs in different fields such as forensics, clinical diagnostic, food safety, environment, and pharma QC. A laboratory equipped with 10 GC systems is expected to acquire 3 new GC-FID in order to increase their throughput by 30%. So how do you accomplish this without buying a new GC system. Below will walk you through how to optimize existing methods using fast gas chromatography analysis. However, be ready to take a few precautions so as not make your GC system too furious!

1. Fast Gas Chromatography Analysis

A column's internal diameter is key, in fact, the smaller the internal diameter of a GC column, the better the efficiency. Therefore, as demonstrated below, using a 0.18 mm ID column compared to a 0.25 mm ID column provides 39% increase in efficiency (See Table 1).

The good news is that efficiency is also proportional to length, so on a 0.18 ID, you can decrease length by 39% and maintain same effect as a 0.25 ID, as well as same resolution. This allows you to reduce column length by 33% and still have an improvement in efficiency but shorter retention times. Therefore, a lab analyzing 100 samples per day (run time 20

min), can analyze 130 samples per day (run time 14 min) just by optimizing the columns dimensions and the method.

Column ID (mm)	Trays / Meter (theoretical)	Trays / Meter (experimental)	% Augmentation N	% Augmentation R
0.10	12,500	7,500	83%	35%
0.18	**6,600**	**5,700**	**39%**	**18%**
0.20	5,940	5,000	22%	10%
0.25	**4,750**	**4,100**	**0%**	**0%**
0.32	3,710	3,350	-18%	-10%
0.53	2,240	1,500	-63%	-40%

Table 1: Plates/meter and relative Efficiency (N) and Resolution (N) for different column inner diameters.

To have similar elution order and chromatogram structure, it is important to maintain what is called the beta ratio, found below:

$$\beta = \frac{ID}{4 \times d_f}$$

Therefore, a 30 m x 0.25 mm x 0.25 µm column needs to be replaced by a 20 m x 0.18 mm x 0.18 µm column of same selectivity. This is what is shown in Figure 1 below with a transfer

of a method for Fatty Acid Methyl Esters from a 30 m column to a 20 m one.

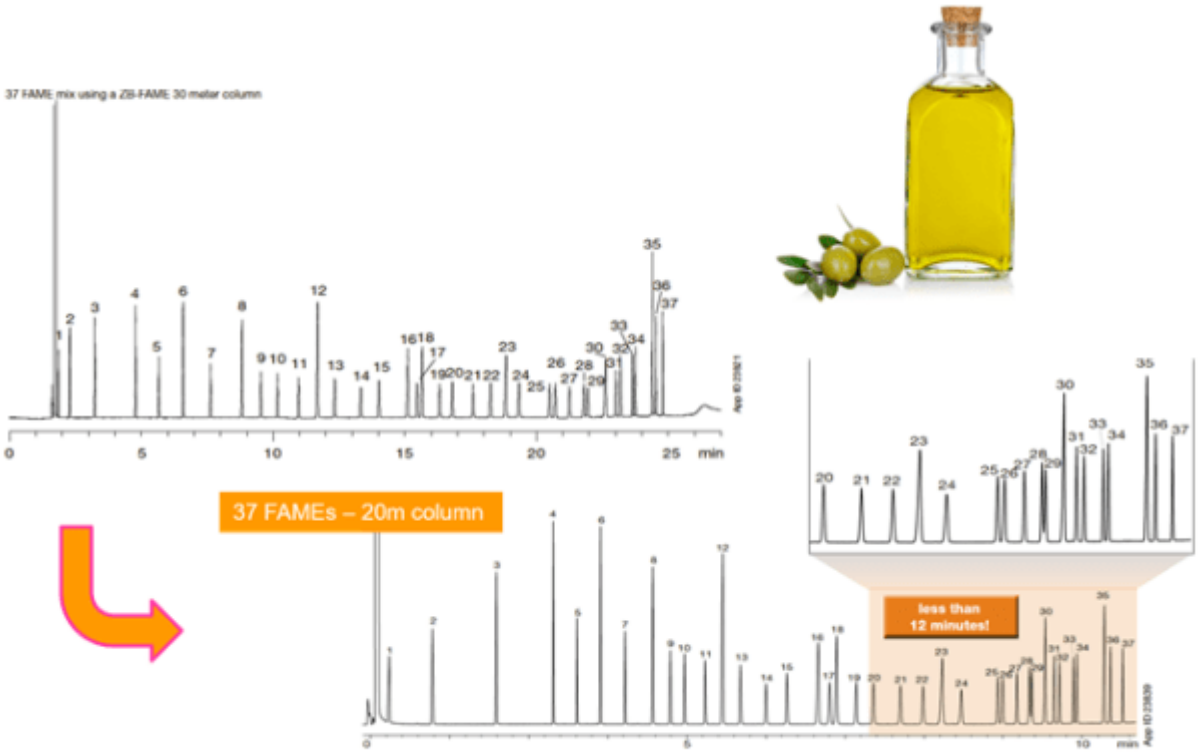

Figure 1: FAMEs analysis method transfer on ZB-FAME

Another advantage is a reduced bleed resulting from the smaller ID and the thinner film, this overall reduces the amount of stationary phase in the column. So, there is less phase loss per unit time as shown in Figure 2.

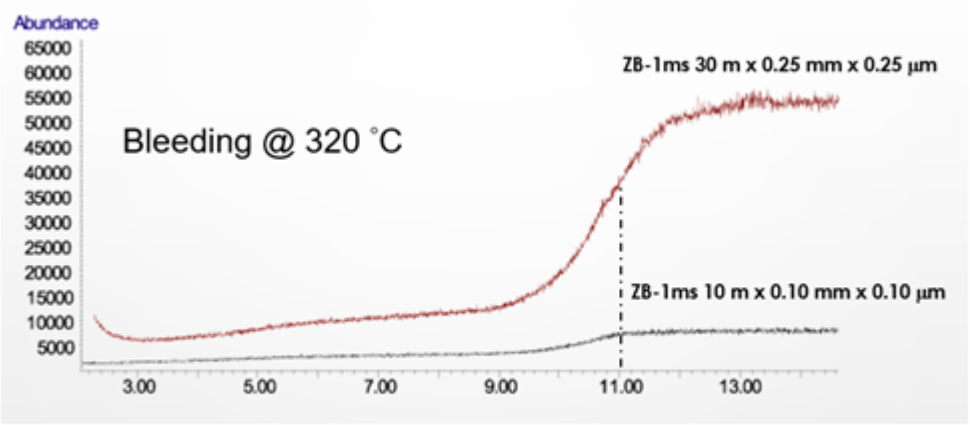

Figure 2: Bleeding level of a ZB-1ms 30mx0.25mmx0.25µm compared to a 20mx0.18mmx0.18µm

2. Furious Gas Chromatography Analysis

Although we see that there isn't any connectivity issues as the outside diameter remains the same (see Figure 3), there are a few aspects that need to be checked carefully so as to not make your GC system furious.

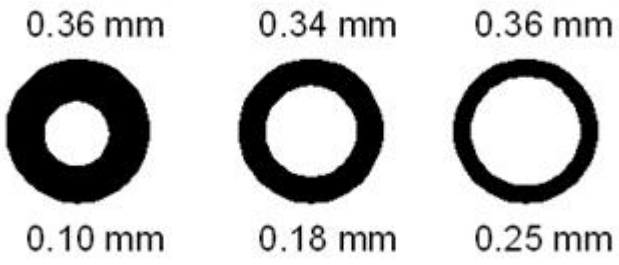

Figure 3: Inner (bottom) versus outer diameter (top) of fast and classical GC columns

You need to check for the impact of fast gas chromatography analysis on Detector Scan

Rates for mass spectrometry systems. Older MS systems have a very slow scan rate of less than 1 Hz as compared to a more advanced TOF-MS, which has a scan rate of 100 Hz. If peak width decreases by factor of 3, then the detector frequency needs to increase the same way to get the same number of data points for every peak (Figure 4). For MS, it might not be possible so you may need to change what it scans, e.g. instead of 25-450, scan 350-450, or run SIM mode (look at specific ions but don't scan).

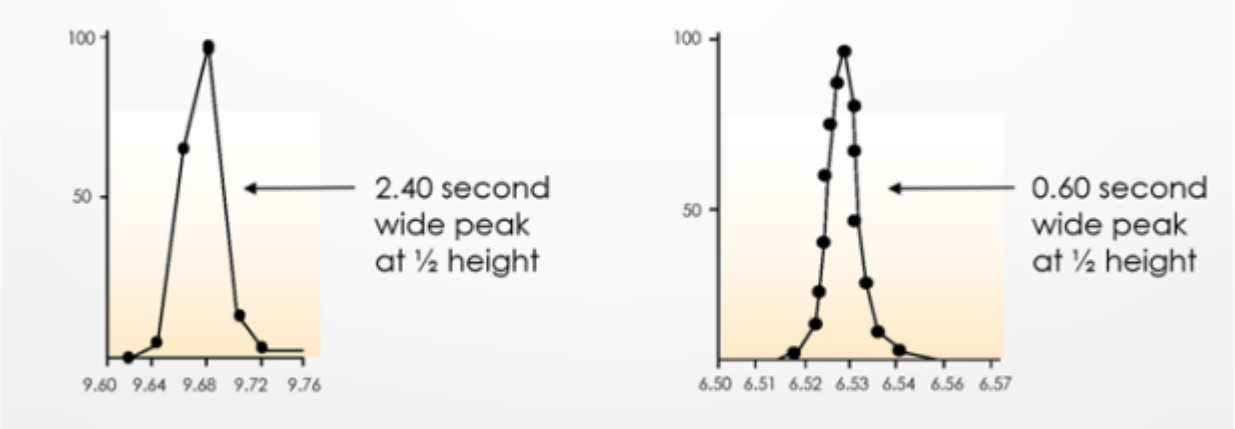

Figure 4: Data acquisition of a sharp Fast GC peak (right) versus a "normal" GC peak.

Next you will need to check loadability. As inner diameter and film thickness are reduced, the loadability will be reduced and that might be an issue for analysis of compounds at trace levels. Some typical on-column concentrations are given in Table 2 below. For ultra-fast separations with 0.10 mm internal IDs, the concentration allowed can be very low and not adapted to trace level analysis.

Column ID	Typical on-Column Concentration
0.10 mm	< 10 ng
0.18 mm	~25 – 50 ng
0.20 mm	~50 – 100 ng
0.25 mm	~50 – 100 ng

Table 2: Typical on-column concentrations versus column ID

New GC column technologies allow to have narrower diameters leading to same chromatographic performances, but in a much shorter time. Therefore, a GC method re-validation on a fast GC column is well-spent time as it will improve the lab throughput by 33%.

Fast GC method transfer is most of the time established from a 30 m x 0.25 mm x 0.25 µm column to a 20 m x 0.18 mm x 0.18 µm but it is even possible to get faster using a 10 m x 0.10 mm x 0.10µm column. In that case, the loadability is even lower and your system should be able to run at high pressures.

If you have any questions regarding the above, or are interested in making your gas chromatography analysis faster and more furious, reach out to our technical experts who are here to help you 24 hours 7 days a week. Live Chat with them today: Technical Expert Live Chat

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