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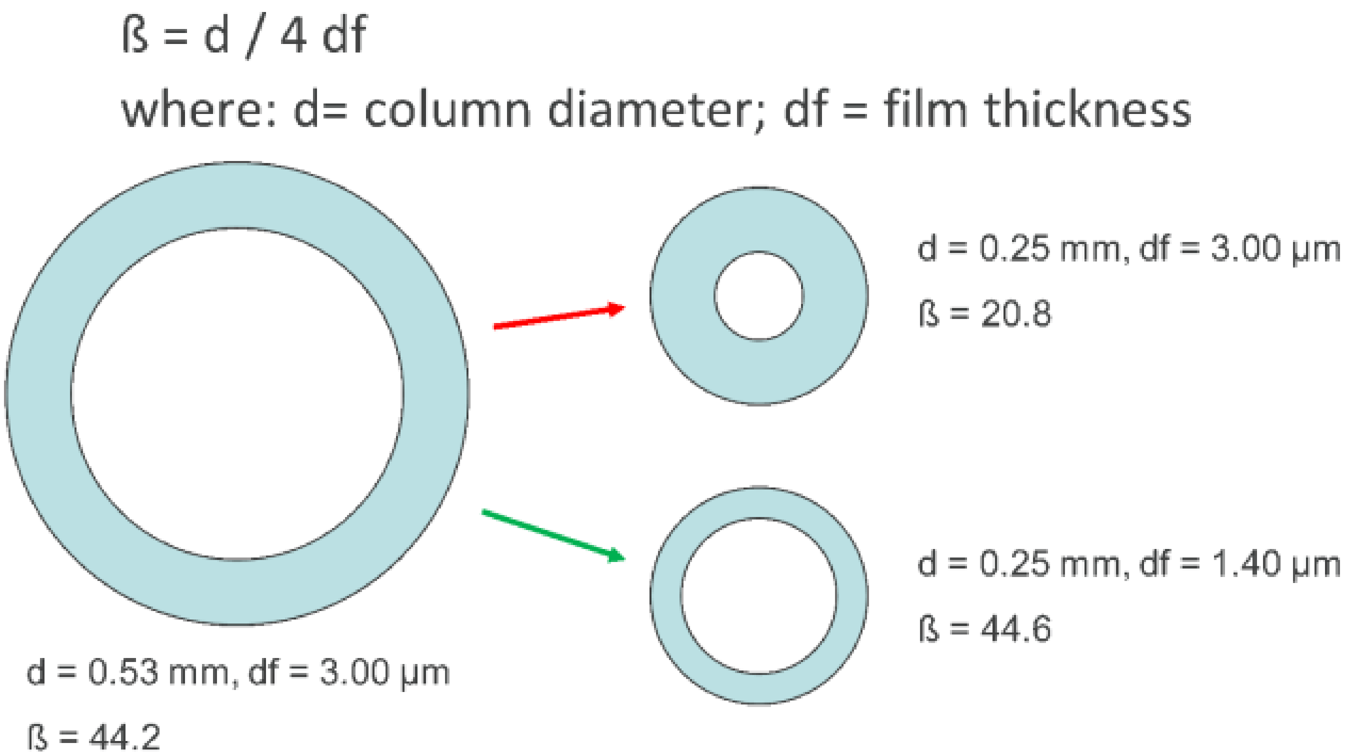
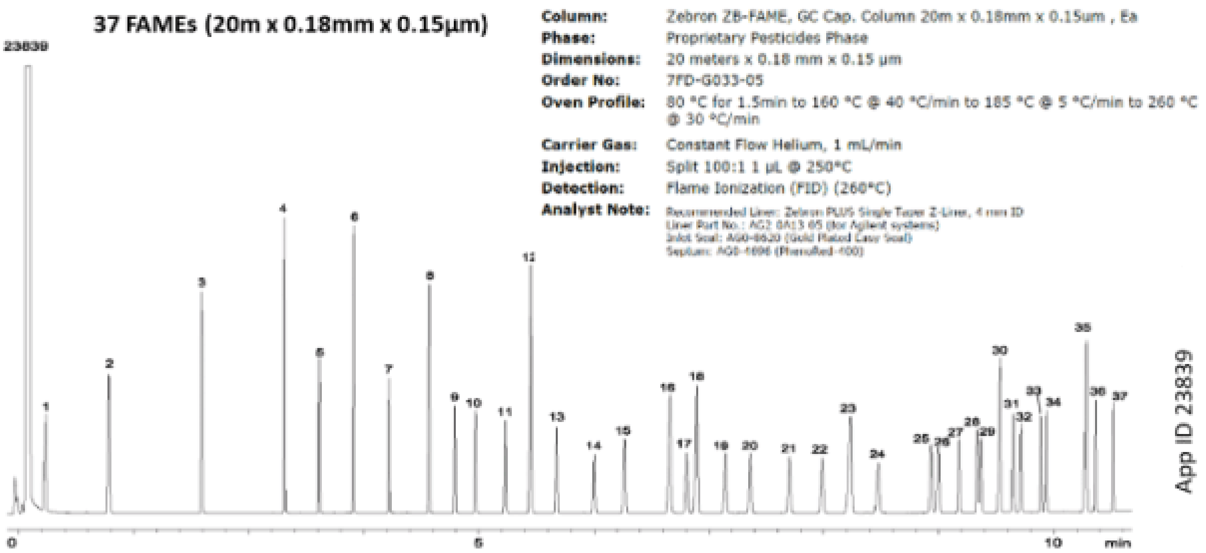
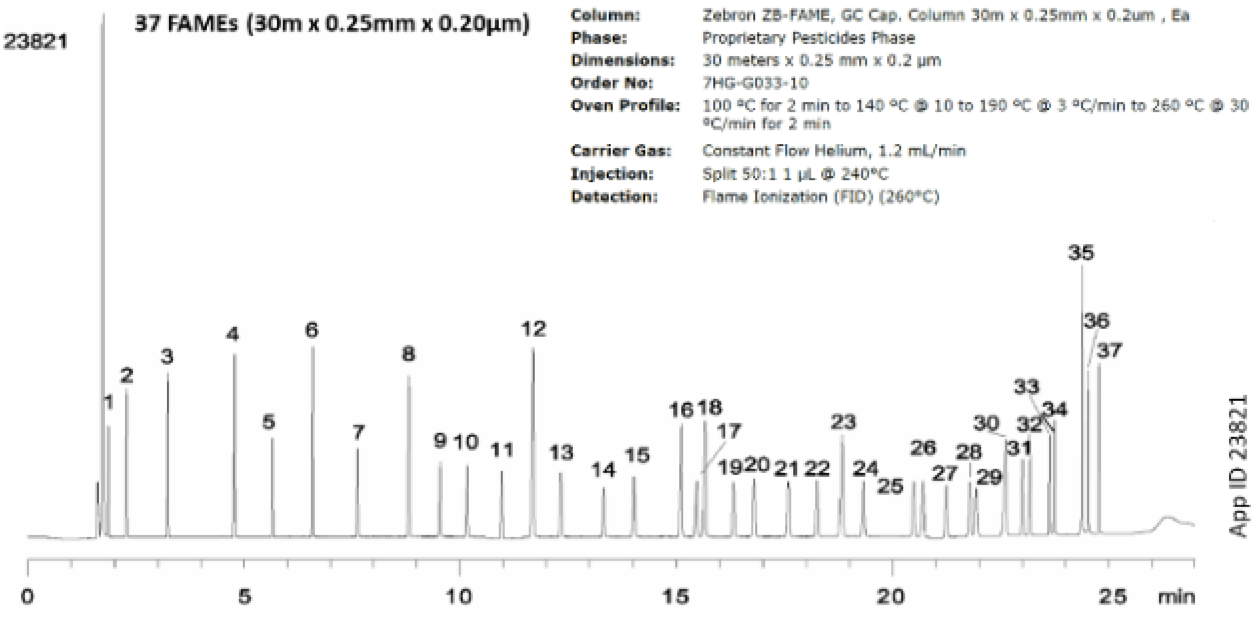
Gas chromatography columns offer a range of stationary-phase by which to optimize the selectivity of your analysis to assure that analytes are suitably separated from one another, or resolved. Once you have established resolution, you may find yourself encumbered with a long run-time, and worry that any changes to the column length will compromise your hard earned resolution. Fear not, as you may preserve your resolution and shorten your run-time through an awareness of your GC column's phase ratio.



Phase ratio represents the dynamic between the internal diameter of a GC column and the stationary-phase film that coats the interior wall of the column. You may select a shorter length for your column and preserve your resolution so long as you maintain the phase ratio of the column used for your initial method. This is demonstrated in the analysis of 37 fatty acid methyl esters (Fames) using two ZB-FAME columns. The column with dimensions 30m x 0.25mm x 0.20µm has a phase ratio of β = 312.5, while the 20m x 0.18mm x 0.15µm has a very similar β value of 300. The oven temperature programs will need to be adjusted to account for the smaller column dimensions. A review of chromatography fundamentals will demonstrate how phase ratio preserves the integrity of a separation.





Phase ratio preserves the "efficiency," "selectivity," and "retention" terms within the resolution equation. An ideal application of phase ratio when selecting a shorter column will not change the values for these term, the mathematics of which will be presented at a later time (they're not as daunting as they appear). A conceptual walk-thru is more than enough for now.

Generally, the internal diameter (ID) and film thickness are adjusted proportionally to one another when maintaining phase ratio. The ID will affect the frequency of interactions between an analyte and the stationary phase film, while the film thickness affects the rate of mass-transfer as an analyte partitions into and out of the stationary-phase. The use of a smaller film thickness compensates for a narrower ID by expediting the mass transfer of analytes as the number of frequencies increase. This ultimately leads to a higher column efficiency, justifying the use of a shorter column to return to the efficiency needed.

$$R_s = \underbrace{\frac{\sqrt{N}}{4}}_{\text{Efficiency Term}} \cdot \underbrace{\left[\frac{\alpha - 1}{\alpha}\right]}_{\text{Selectivity Term}} \cdot \underbrace{\left[\frac{k}{1+k}\right]}_{\text{Retention Term}}$$

"Efficiency" represents the sharpness of a peak, and is reflected by the number of plates (N) that a column and method offer. A shorter column will lower the "enhanced" efficiency above by lowering the number of theoretical plates available. "Selectivity" refers to the order and relative retention of analytes during a method. Analytes will certainly elute closer to one another with a shorter and narrower column, but the relative retention of analytes remains constant, particularly when accounting for the smaller void volume of the shorter and narrower column. The "retention" term refers to the retention of individual analytes, and is corrected for the void volume of the column. The proportionality of phase ratio conservation preserves the values for selectivity and retention within the resolution equation.

There are some limitations to consider when making column adjustments that preserve phase ratio. The primary concern is the capacity of the column. A smaller column ID will require a smaller concentration of analytes, in addition to either a higher split ratio and possibly a smaller injection volume. The narrower ID will force an analytical band to occupy more length of the column. A smaller amount of analyte on the column will consolidate the sample band to generate a sharp peak. Another consideration is to lower the "mL/min" flow-rate of carrier gas through a column with narrower ID, so as to preserve the linear velocity of your method in terms of cm/sec. Lastly, consider increasing the rate of temperature gradients, while decreasing the duration of any.

We will delve into the technical nuances of the relationship between phase ratio and resolution in a later post. For now, use phase ratio as a means of preserving the resolution and relative retention of your method when converting your method to a shorter column for faster run-times.

If you have any questions regarding the above information, please reach out through Chat Now, to talk with one of our Technical Specialist through a live texting form found on our website. You can start chatting at www.phenomenex.com/chat. You might even get to talk with Zach himself!

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