Selecting a GC Column

Strategic column choices can improve lab productivity by assuring that speed and resolution are optimized. While the number of choices available can be daunting, consideration of the resolution equation variables—selectivity, retention (capacity), and efficiency—simplifies the decision. Selectivity determines which stationary phase is most appropriate, and it can be approximated using retention indices or existing applications. Once the phase has been chosen, physical dimensions (internal diameter, film thickness, length) can be selected based on retention and efficiency. Understanding how selectivity, retention, and efficiency influence separations allows analysts to make effective, informed choices and quickly select the best column for specific separations.

$$R = \frac{1}{4}\sqrt{\underset{\substack{\uparrow \\ \text{Efficiency}}}{\frac{L}{H}}}\ \mathrm{X}\ \underset{\substack{\uparrow \\ \text{Retention}}}{\frac{k}{k+1}}\ \mathrm{X}\ \underset{\substack{\uparrow \\ \text{Selectivity}}}{\frac{\alpha-1}{\alpha}}$$

R = resolution
L = column length
H = HETP
k = capacity factor
α = selectivity

Selectivity, α

The selectivity of the capillary column is directly related to how the analyte molecule interacts with the stationary phase being considered. If the analyte strongly interacts with the stationary phase, it can be said that strong intermolecular forces exist. These intermolecular forces of attraction between the analyte and the stationary phase are a function of the structure of both the analyte molecule and the stationary phase. If these two structures are similar, then the attractive forces are strong. If they are dissimilar, then analyte to stationary phase attraction is weak, and less retention is observed. Therefore, when selecting a stationary phase, knowledge of the structure of the analytes of interest and the stationary phase is crucial. The reference table on page 27 provides the chemical structure of Restek's most common stationary phases.

An example of selectivity can be shown using benzene and butanol (both have nearly the same boiling point) eluting through the 20% diphenyl/80% dimethyl polysiloxane stationary phase (Rtx®-20). The benzene molecule will dissolve into the stationary phase more readily than the butanol based on the concept that "likes dissolve likes". Since benzene solvates more readily with the stationary phase, it has more interactions with the stationary phase as it elutes through the column. Therefore, the elution order of these two compounds on the Rtx®-20 stationary phase will be butanol first and benzene second.

As methyl groups are replaced by different functionalities such as phenyl or cyanopropyl pendant groups, the selectivity of the column shifts towards compounds that will have a better solubility in the stationary phase. For example the Rtx®-200 stationary phase provides high selectivity for analytes containing lone pair electrons, such as halogens, nitrogen, or carbonyl groups. Polyethylene glycol columns, such as the Stabilwax® and Rtx®-Wax columns are highly selective towards polar compounds such as alcohols. Again using the example above, the butanol more readily solvates into the polyethylene glycol stationary phase; therefore, the butanol will have more interaction with the phase and elute after benzene.