Gas Chromatography Problem Solving and Troubleshooting

Question:

I switched from a packed column to a capillary column for my blood alcohol analyses. I expected better separation and shorter analysis times; however, the capillary column was not better. Are there instances in which a packed column is superior to a capillary column?

Answer:

For most GC analyses, capillary columns provide better resolution with shorter analysis times. The benefits are most evident with complex samples, especially those with compounds that elute over a wide time range. There are a few types of compound samples for which a packed column may be better than a capillary column.

When a sample contains only a few analytes (such as a typical blood alcohol analysis), a packed column may be better. There are over 100 different packed column stationary phases readily available. Due to the large selection of stationary phases, usually there are several that will separate all the analytes in a very short amount of time. There are only 10–15 unique stationary phases for capillary columns. Sometimes the available phases do not separate all the analytes or require conditions that result in long analysis times. The much higher resolution of capillary columns cannot be exploited if the stationary phase cannot separate the analytes or if the separation is excessive. Many ideal packed column stationary phases cannot be easily coated in capillary columns, and the performance of a capillary column with these phases is very poor. For blood alcohol analyses, there are capillary columns that separate all the analytes. The analysis times for some of these columns are 2–3 times longer than those of a packed column. Some capillary columns have comparable analysis times, but the cost of these capillary columns is often 3–4 times higher than a packed column. For blood alcohol analyses, there are no commercially available capillary columns that supercede a suitable packed column when separation, analysis time, and cost are collectively compared.

One area in which packed columns are usually better than capillary columns is in the analysis of gases or very volatile compounds. Light hydrocarbons, volatile solvents, sulfur gases, various oxides, water, and ammonia are just a few of the types of compounds for which packed columns may be better suited. There are a series of porous polymers that provide excellent separation of these types of compounds; however, many of these polymers are not available in a capillary column or, if available, are quite expensive.

For any situation in which carrier gas flow rates of 30 mL/min or higher are required or desired, a packed column may be better than a capillary column. Depending on the carrier gas, optimal flow rates for capillary columns are 1–10 mL/min and 20–60 mL/min for packed columns. Using excessively high carrier gas flow rates with capillary columns results in severely increased peak widths. The resulting loss of resolution eliminates much of the advantage a capillary column has over a packed column.

One limitation of capillary columns is their low sample capacity. Although diluting a sample is often a possible solution, it is not always desirable or feasible. If one of the analytes is present in a much higher concentration than the others, the limited capacity of the capillary column may become a serious problem. If the sample is diluted, the lower concentration analytes can no longer be detected. Failure to dilute the sample results in an overloaded peak for the high concentration analyte, which often interferes with nearby smaller peaks. A packed column allows the injection of a large enough sample so that the lower level analytes can be detected without any overloading problems for the higher level analytes.

There are analysis situations in which a capillary column is not better than a packed column. Packed columns are often equivalent or better for samples with only a few compounds (especially ones with very similar structures), gaseous samples, samples with large concentration ranges, or conditions requiring high carrier gas flow rates. In some cases, the lower cost of packed columns makes them a better choice.

The purpose of *Chromatography Problem Solving and Troubleshooting* is to have selected experts answer chromatographic questions in any of the various separation fields (GC, GC–MS, HPLC, TLC, SFC, HPTLC, open column, etc.). If you have questions or problems that you would like answered, please forward these to the *Journal* editorial office with all pertinent details: instrument operating conditions, temperatures, pressures, columns, support materials, liquid phases, carrier gas, mobile phases, detectors, example chromatograms, etc. In addition, if you would like to share your expertise or experience in the form of a particular question accompanied by the answer, please forward to JCS Associate Editor, *Chromatography Problem Solving and Troubleshooting,* P.O. Box 48312, Niles, IL 60714. All questions/answers are reviewed to ensure completeness. The *Journal* reserves the right not to publish submitted questions/answers.

Dean Rood
Associate Editor