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Review

Implementations of two-dimensional liquid chromatography

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Abstract

Today scientists must deal with complex samples that either cannot be adequately separated using one-dimensional chromatography or that require an inordinate amount of time for separation. For these cases we need two-dimensional chromatography because it takes far less time to generate a peak capacity n_c twice in a row than to generate a peak capacity n_c^2 once. Liquid chromatography has been carried out successfully on thin layers of adsorbents and along tubes filled with various adsorbents. The first type of separation sorts out the sample components in a physical separation space that is the layer of packing material. The analysis time is the same for all the components of the sample while their migration distance increases with decreasing retention. The resolution between two components having a certain separation factor (α) increases with increasing migration distance, i.e., from the strongly to the weakly retained compounds. In the second type of separation, the sample components are eluted from the column and separated in the time space, their migration distances are all the same while their retention times increase from the unretained to the strongly retained compounds. Separation efficiency varies little with retention, as long as the components are eluted from the column. We call these two types of separation the chromatographic separations in space (LC^x) and the chromatographic separations in time (LC^t), respectively. In principle, there are four ways to combine these two modes and do two-dimensional chromatographic separations, $LC^t \times LC^t$, $LC^x \times LC^t$, $LC^t \times LC^x$, and $LC^x \times LC^x$. We review, discuss and compare the potential performance of these combinations, their advantages, drawbacks, problems, perspectives and results. Currently, column-based combinations ($LC^t \times LC^t$) are the most actively pursued. We suggest that the combination $LC^x \times LC^t$ shows exceptional promise because it permits the simultaneous second-dimension separations of all the fractions separated in the first-dimension, thus providing remarkable time saving.

Keywords: Band interference; Peak capacity; Separation efficiency; Separations in space; Separations in time; Three-dimensional chromatography; Two-dimensional chromatography; Two-dimensional thin-layer chromatography; Thin layer chromatography; One-dimensional chromatography

Contents

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