Waters
Lab Highlights
An Internal Communication of Applications and Techniques
LAH 0193 TH 10/84

RADIAL COMPRESSION - A PROVEN TECHNOLOGY FOR LC

PART I OF TWO PART SERIES

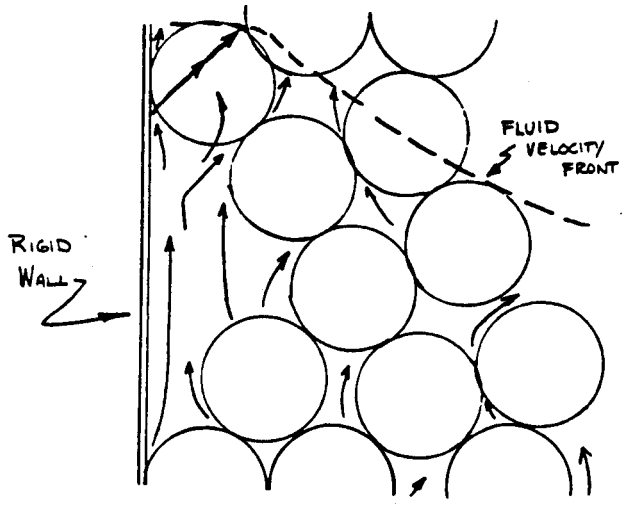
It is a fact that columns packed with materials having the same particle size exhibit higher efficiencies in a radially-compressed cartridge than in a steel tube. This means that radial compression gives higher performance "per micron of particle size" than non-compressed systems. In terms of the benefits it gives chromatographers, the advantages of this radial compression technology were reviewed in a recent report (1). The report states: "It is therefore possible to use a short column with a wider bore, the advantages being reduced backpressures, improved resolution and greater sample capacity. The reduction in backpressure will allow increased flow rates resulting in shorter analysis times. As sample capacity is much increased (up to 20 mg) the system may be used in a preparative mode for the purification and isolation of neuropeptides." The report continues, "It is also our experience that these columns [radially compressed cartridges] have a much longer life than steel columns." This is just one of numerous reports demonstrating that these radially compressed cartridges do produce better separations than steel columns (2-5).

Technical Issues in Packing Rigid-Walled Columns. When packed steel columns are used for chromatography, a major technical problem exists in that the dispersion of the mobile phase near the column wall is greater than that in the center of the column. This phenomenon has been referred to as the "wall effect." It has been claimed that in a steel column of 5mm I.D. containing 20 µm particles, the interstitial volume affected by the "wall effect" may be as large as 40% of the empty column volume (6). In addition to the wall effect, there is also difficulty in producing a uniform packing structure throughout the column. Unfortunately, as particle size is reduced from 20µ to 3µ, nonuniformity in the structure of the packed bed becomes an increasingly significant problem which can lead to channeling or voiding. This results in unstable columns which are prone to loss of resolution after relatively short useful lifetimes.

To understand why this might be the case, one should consider the makeup of the packed bed structure. If one could view a perpendicular cross sectional slice through the column, the permeation of eluent would be through various channels and spaces comparable to those which are present in the cross section of a depth filter. Thus, at different positions in the flow stream, there are different velocities caused by the different local permeabilities through these channels. Due to this local heterogeneity, the travel of the solute band is not uniform in conventional packing structures. This is true in both the axial and radial directions and constitutes a significant source of band broadening for packed chromatographic columns.

Waters
Division of MILLIPORE 34 Maple St. / Milford, MA 01757 / 617-478-2000
Brian Bidlingmeyer

While the ideal column should be a very poor mixer, the actual column rarely is. The packing material in a column will resist, deflect, and disperse the travel and diffusion of solute in the mobile phase. Therefore, a tendency toward differences in the nature of the solute flow through a chromatographic column results. It has been reported that, next to diffusion, the manifestation of flow variations within the column has the second major effect upon the chromatographic separation (3). From another viewpoint, the differences in flow can be attributed to fluid viscosity and frictional drag of the fluid layer which is in contact with the adsorbed solvent layers and fixed structures on the particle surface (7-8). The packed bed structures provide resistance to flow and produce a pressure drop as well as distortion of the solute band.



FLOW THROUGH A STANDARD STEEL COLUMN PRODUCES BROAD SAMPLE BANDS.

Refer to Part II (LH #194) for the benefits offered by Radial Compression.

1. A.I. Smith and J.R. McDermott, J. Chromatogr., 306 (1984) 99.
2. S.P. Assenza and P.R. Brown, J. Liquid Chromatogr., 3 (1980) 41.
3. S.J. Soldin, Clin. Biochem. 2, (1980) 99.
4. S.C. Powell, Z.K. Shihabi, J. Chromatogr. Sci., 270 (1983) 332.
5. J.S. Landy, J.L. Ward, J.G. Dorsey J. Chromatogr. Sci., 21 (1983) 49.
6. J.H. Knox (Editor) High Performance Liquid Chromatography, Edinburgh University, 1978, p.82.
7. J.C. Giddings, Dynamics of Chromatography, Marcel Dekker, New York
8. S.D. Schlichting, Boundary-Layer Theory, McGraw Hill, New York 1968.