

ZERO LENGTH COLUMN CHROMATOGRAPHY: A POWERFUL TOOL FOR STUDYING GAS PHASE MASS TRANSFER PHENOMENA IN NANOPOROUS MATERIALS

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ABSTRACT

The transport processes in nanoporous systems are considerably more complex than diffusion in homogeneous phases or in macroporous systems. The pathways in nanoporous systems are, by design, similar to the dimensions of the diffusing species. Adsorbate-adsorbate and adsorbate-adsorbent interactions are enhanced. Simple extensions of homogeneous theories are inadequate, as the specific interactions need to be included. As a consequence of the above mentioned complexities no single theoretical model was developed to predict diffusivities in nanoporous materials. Experimental measurement of transport properties in these materials is the only way to obtain reliable kinetics data. A wide range of different experimental techniques, including both micro- and macro-scopic techniques, have been employed for studying gas phase diffusion in nanoporous solids. Among the macroscopic methods, a specific chromatographic method called Zero Length Column (ZLC) method has been widely used since its introduction in late 1980's. The main advantage of this method, over standard chromatographic method with packed or coated columns, is elimination of the uncertainty due to axial dispersion, which causes major difficulty in the analysis of standard chromatographic data. The ZLC tests are quick and easy to perform, which makes this technique relatively simple to automate, thus providing means of rapid screening of samples regarding both kinetic and equilibrium properties. Another advantage of the ZLC method is that the validity of the basic assumptions, related to the ZLC theory, can be easily verified directly by a series of simple and quick experimental tests. The original ZLC method was designed to measure gas (vapor) diffusion in individual particles, e.g., zeolite crystals. However, since its introduction the method was extended for the measurements of binary mixtures, equilibria, surface barrier resistance, diffusion path (pore connectivity) and diffusion in liquid phase systems.