

Apparatus for Determining Distribution Coefficients of Nitrogen Heterocycles on Nanoparticles and Colloids

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Prediction of solute-particle interactions of nitrogen heterocycles (in particular, drugs, drug metabolites, explosive, and pesticides) with soils, sediments and colloids using traditional K_{OW} methods does not adequately describe the observed behavior. Indeed, recent studies demonstrate these compounds persistent in soils and sediments above predicted concentrations. We hypothesize that clay minerals and mineral colloids provide significant transport for both water soluble and hydrophobic contaminants within this group. To date, measurements to quantify binding interactions and fundamentally thermodynamic properties between submicron particles and colloids have been difficult. A technique is presented that measures individual solute interaction with particles (and colloids) that are < 1 μ m, typically between 25 to 100 nm. The technique is based on capillary hydrodynamic chromatography principles, and builds on techniques that characterized colloids and micelle-solute interactions. The system exploits the differences in diffusion coefficients; small molecules diffuse rapidly forming Gaussian shaped peaks, while the larger colloids are asymmetric in nature. Small molecules that interact with the colloids (through partitioning or electrostatic interactions) assume the flow profile of the larger colloid (or nanoparticle). By probing the system at multiple UV wavelengths or wavelengths where the colloid adsorption is negligible, the molecule concentration in each phase (solution or adsorbed) can be determined. Binding isotherms of the system can then be determined by varying molecule concentration facilitating distribution constant (K_D) determinations.