Effective Benzene Solubility in Water Increases When Biomass Present

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A current project sponsored by DOE's Environmental Management Science Program (EMSP) collects fundamental partitioning data for a variety of sparingly soluble subsurface contaminants (e.g., benzene, toluene, TCE, etc.). Understanding how contaminants migrate from phase to another (e.g., DNAPL to aqueous phase to vapor) is critical for predicting the spread of underground plumes, as well as for designing better methods for their removal. This work has shown that pollutants in underground matrices that contain substantial quantities of biomass and biomass components (high humic material, soil bacteria, etc) partition much differently than would be expected based on classic data conducted under ideal conditions (pure water). In tests using the abovementioned pollutants, the presence of biomass (in the form of whole yeast cells) strongly increases both the maximum effective solubility and liquid phase partitioning--in some instances, by more than a factor of ten. For example, benzene's air/liquid partition constant (Henry's law constant) decreased from 2.9 atm L mol^{-1} to less than 0.1 atm L mol^{-1} when biomass was added to systems containing this pollutant. This represented a 33X solubility factor increase over ideal, water-based thermodynamics. These data will make a wide range of environmental predictive models more accurate by providing better estimates of critical parameters, which should also be applicable to above-ground bioreactors and bioprocesses.