Nano-Bubble Retention in Saturated Porous Media under Different Solution Chemistry

*Shoichiro Hamamoto[1], Takuya Sugimoto[1], Takato Takemura[2], Taku Nishimura[1], Scott A Bradford[3]

1. Department of Biological and Environmental Engineering, The University of Tokyo, 2. College of Humanities and Sciences, Nihon University, 3. U. S. Salinity Laboratory

An understanding of nano-bubble (NB) migration in porous media is needed for potential environmental applications. This research investigates factors that control the transport, retention, and release of air NBs in repacked glass beads. One-dimensional column transport studies with air NBs were conducted under different solution IS, ionic composition, and pH conditions. Collected data were simulated using a mathematical model that considered advective and dispersive transport, first-order kinetic retention, and transient release. Results were interpreted with the aid of interaction energy calculations that considered electric double layer, van der Waals, and Lewis acid-base interactions on surfaces with different amounts of nanoscale roughness. NB concentrations in the effluent were reduced with an increase in ionic strength (IS) or a decrease in pH due to a reduction in the repulsive force between the glass surface and NBs, especially when the solution contained Ca^{2+} as compared to Na^{+} and for larger NBs. NB retention on the surface was explained by ubiquitous nanoscale roughness on the glass beads that significantly lowered the energy barrier, and localized attractive charge heterogeneity and/or hydrophobic interactions.

Keywords: Nano bubble, Transport, Porous media, Solution chemistry

