



Transport and Retention of Stabilized Silver Nanoparticles in Water-Saturated Porous Media

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Water-saturated column experiments were conducted to investigate the transport and retention of surfactant stabilized silver nanoparticles (AgNPs) in quartz sand. The mobility of AgNPs was enhanced with an increase in water velocity, sand grain size, and AgNP input concentration (C_o), and a decrease in solution ionic strength (IS). Retention profiles (RPs) for AgNPs exhibited uniform, nonmonotonic, or hyperexponential shapes depending on physicochemical conditions. The experimental breakthrough curves (BTCs) and RPs were described using a numerical model that considers time/concentration- and depth-dependent retention. The simulated maximum retained concentration on the solid phase (S_{max}) and the retention rate coefficient (k_1) increased with IS and as the grain size and/or C_o decreased. The RPs were more hyperexponential in finer textured sand and at lower C_o , were nonmonotonic or uniform at higher C_o and in coarser sand, and tended to exhibit higher peak concentrations in the RPs at lower velocities and at higher solution IS. These observations indicate that uniform and nonmonotonic RPs occurred under conditions when S_{max} was approaching filled conditions. The sensitivity of the nonmonotonic RPs to IS and velocity in coarser textured sand indicates that AgNPs were partially interacting in a secondary minimum and largely irreversibly interacting in a primary minimum associated with microscopic heterogeneity. The competitive retention of AgNPs and surfactants close to the column inlet was observed when additional surfactants were added into the system. Nonmonotonic RPs had peak concentrations at a greater distance in the presence of larger amount of surfactant. This implies that the existence of natural occurring organic matter will likely facilitate NP transport deeper into the subsurface environment and increase the risk potential of ground water contamination.

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