Transport of Colloidal Particles in Saturated Toyoura Sand: Effects of Flow Rate on Importance of Electrostatic Repulsion

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There are substantial colloidal particles such as clay minerals and metal oxides in soil environments. Such colloidal particles have been considered as a potential carrier of contaminants in vadose zone and aquifer, due to their surface charges and high specific surface area. Therefore, understanding the transport mechanisms of colloidal particles in soils is essential to predict the fate of the contaminants in the environments. In this study, we analyze deposition rate coefficients of polystyrene latex particles with a diameter of 1 μm in a column packed with Toyoura sand with an average diameter of 0.274 mm as a function of NaCl concentration at three different flow rates. The concentration of the colloids in the effluent was quantified using a spectrometer photometer. The experimental results showed that the deposition rate coefficients of the colloids increased with increasing NaCl concentrations and reached a plateau above a certain NaCl concentration, called the critical deposition concentration (CDC). The CDCs shifts to higher salt concentrations with increasing injected flow rates. We show that this experimental trend can be captured by a simplified model including physico-chemical interactions based on the DLVO theory.

Keywords: Colloidal particles, Transport, Porous media, Ionic strength, Flow rate

