# Initial deposition rate of colloidal silica in unsaturated sand column

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The transport of colloidal particles in porous media is an important subject in industrial and environmental engineering such as filtration and colloid facilitated transport. The transport behaviour of colloidal particles in the packed bed of collector beads depends on the deposition of the particles onto the collector beads, and the deposition kinetics is influenced by electrical, van der Waals, and hydrodynamic interactions. For water-saturated porous media, the initial kinetics of deposition is well described by a so-called colloid filtration theory, which considers the deposition of a colloid particle onto the solid-water interface (SWI) between solution and the collector surface [1]. However, less studies have been carried out for the initial deposition in unsaturated porous media; the appearance of air-water interface (AWI) affects the transport of colloidal particles in unsaturated porous media [2]. Therefore, we conducted column experiments on the initial deposition stage in both water saturated and unsaturated conditions to improve our understanding of colloid transport in porous media.

We used the packed bed of Toyoura sand collectors as porous media. Colloidal particles used were negatively charged colloidal silica and positively charged amine-modified silica. The ionic strength was controlled by the addition of NaCl, and the solution pHs were adjusted 6.8 and 5 for negatively and positively charged silica cases. Our results on the breakthrough curve of silica showed that the concentration of negatively charged silica at the outlet of the column decreased with increasing NaCl concentration. The effluent concentration of the positively charged silica weakly depended on the NaCl concentration. Decreasing the water content of the sand column reduced the outlet silica concentration. By fitting the solution of an advection-dispersion equation including the colloid deposition rate with experimental breakthrough curves, we obtained the deposition rate constants of AWI and SWI (Fig. 1). The deposition rate constants demonstrate that the AWI acts as an additional site for the colloid deposition. The rate is controlled by the salt concentration and the sign of particle charge through the change in particle-AWI and particle-SWI interactions.

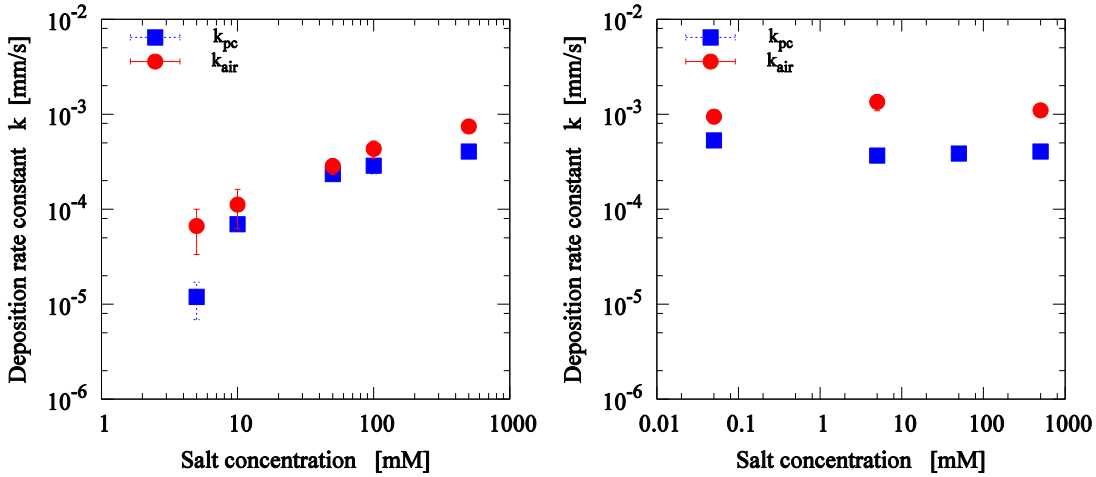


Figure 1 Deposition rate constants of air-water interface ($k_{air}$) and solid-water interfaces ($k_{pc}$), left: negatively charged silica, and right: positively charged amine-modified silica.

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[1] M. Kobayashi, H. Nanaumi, and Y. Muto, *Colloids Surf. A.*, 2009, **347**, 2.
[2] Y. Fujita and M. Kobayashi, *Chemosphere*, 2016, **154**, 179.