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Effect of retention sites toward silver nanoparticles immobilization in porous media

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Column tests are a widely use experimental tool to investigate particle transport in porous media. However, different experiments can produce similar breakthrough curves, which make these data insufficient in order to understand the governing processes that control particle transport under different conditions. Profile analysis of the deposited particles provides information about the particle distribution in the packed column, but this method involves the destruction of the column and it is subject to many uncertainties during the sample extraction. A novel non-invasive technique, based on x-ray tomography, is proposed for the study of silver nanoparticles (n-Ag) distribution in uniform porous media (glass bead packed column) under both saturated and unsaturated conditions.

Column experiments were performed using a model porous medium of glass beads through which colloidal silver particles were transported under conditions of varying water content. X-ray microtomography was subsequently employed as a non-destructive imaging technique to obtain information on i) the presence and distribution of the different retention sites contributing toward particle immobilization, ii) retention-site specific profiles of immobilized colloids, iii) morphological characteristics of the deposited colloidal aggregates, and iv) channel widths of pore-water network representations.

Therefore, we provide a statistical evaluation of the significance of colloid retention by attachment to the liquid-solid, gas-liquid, gas-solid interfaces, and by straining. Additionally, an effective-pore structure characteristic is proposed to improve predictions of mass removal by straining under various water saturations. The novel procedure leads to the understanding of the pore-scale sites that are responsible for particle retention and their specific contribution to the total filtration process, also allowing revision and strengthening of the mechanistic models describing fate and transport of particles in porous media.

References

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