WATERLOO | ENGINEERING

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Modeling Colloidal Transport in Saturated and Unsaturated Porous Media Using OpenPNM

Colloidal transport is observed in a wide variety of areas involving both human and ecological health. Some of the beneficial uses of colloidal transport include Enhanced Oil Recovery, removal of pathogens from drinking water, and carrying therapeutical drugs in the human body. Colloids can also be harmful as distribution of contaminants such as viruses, bacteria, and microplastics through soils, sediments, and aquifers can be harmful to the ecosystem. Therefore, being able to predict the transport of colloids is critically important. Most models predicting colloidal transport are on the continuum scale. However, this thesis aims to predict colloidal transport on the pore scale by modeling the pore network using OpenPNM.

In saturated porous media, the effect the colloid size has on the dispersion of colloid particles is predicted. This is done by treating the colloids as a solvent and adjusting the diffusion coefficient and the velocity using two different mechanisms. The first mechanism is “Hindered diffusion” where the diffusion coefficient of a colloidal particle is reduced by two correction factors. These correction factors account for the interaction the particle has with the pore wall. The second mechanism is “Size Exclusion” where a particle traveling in a pore will observe a higher velocity and a lower Taylor dispersion coefficient than a solvent would. This is because the colloidal particle will not observe the entire Poiseuille velocity profile.

In partially saturated oil-water media, colloidal particles can be transported through the water and adsorb onto the surface of the oil. Using existing models that predict the adsorption kinetics, the coverage of colloids on the surface of oil blobs can be predicted after a slug of colloids is injected into the porous media.

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