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Pore-Scale Modeling of Clogging and Erosion in Porous Media

EMILY DE JONG, Department of Chemical and Biological Engineering, Princeton University, NAVID BIZMARK, Princeton Institute for the Science and Technology of Materials, Princeton University, SUJIT DATTA, Department of Chemical and Biological Engineering, Princeton University — The transport of colloidal particles in porous media plays a key role in applications ranging from groundwater remediation, water filtration, and enhanced oil recovery. However, this process is difficult to model due to diverse processes that may arise, including particle advection through the pore space by fluid flow, adsorption and deposition onto the solid matrix, and erosion or resuspension. Here, we analyze a continuum model to describe these physics for a single straight pore in a computationally-efficient simulation. The model accounts for geometry changes as a result of particle deposition and erosion at the pore walls. We identify the dimensionless hydrodynamic and geometric parameters that govern particle transport, and show how these give rise to two regimes: a deposition-dominated regime in which pores completely close, and a dynamic erosion-deposition regime in which the pore radius decreases and ultimately reaches an equilibrium profile. Our work thus provides a tractable description of the pore-scale physics of colloidal particle transport that can be generalized to more complex porous medium geometries.

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