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Pavel Bedrikovetsky, Zhenjiang You, Alexander Badalyan, Yuri Osipov, Liudmila Kuzmina

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Analytical model for straining-dominant large-retention depth filtration

Pavel Bedrikovetsky[a], Zhenjiang You[a*], Alexander Badalyan[a], Yuri Osipov[b], Liudmila Kuzmina[c]

[a] *Australian School of Petroleum, The University of Adelaide, SA 5005, Australia*

[b] *Moscow State University of Civil Engineering, 26 Yaroslavskoe shosse, Moscow, 129337, Russia*

[c] *National Research University Higher School of Economics, 20 Myasnitskaya Ulitsa, Moscow 101000, Russia*

ABSTRACT

A method for determining pore size distribution for a porous medium from long-time straining-dominant mono-sized suspension injection is proposed. The aim is avoiding using multiple-size particle suspensions in short-term challenge tests. We derive an exact solution for long-time non-linear injection of particles with the same size, where the non-linearity is determined by accumulation of strained particles and alternation of porous medium properties. The exact downscaling procedure, determining the evolution of pore size distribution from an exact solution of large-scale equations is developed. It shows the preferential plugging of large pores during mono-sized particle transport, explaining well-posed formulation of pore-size distribution tuning from breakthrough concentrations and retention profiles. The laboratory tests on long-term mono-sized injections, where straining dominance has been monitored by DLVO-repulsion between particles and porous media, have been performed. High quality match of the breakthrough concentrations by the analytical model has been observed. The tuned-model-based prediction of the retained profiles also shows close agreement with the experimental data, which validates the proposed method.

Keywords: colloidal-suspension transport; straining; pore size distribution; exact solution; downscaling; porous media

1. Introduction

Straining and size exclusion are significant particle capture mechanisms during deep bed filtration in microfiltration and ultrafiltration membranes, contaminant propagation during disposal of industrial wastes in aquifers, industrial filtering, water production by artesian wells, storage of low salinity water in subterranean basins, hot water storage in geothermal reservoirs, propagation of viruses and bacteria in

* Corresponding Author: Zhenjiang You, e-mail: zhenjiang.you@adelaide.edu.au

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