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Transport and retention of engineered nanoporous particles in porous media: Effects of concentration and flow dynamics

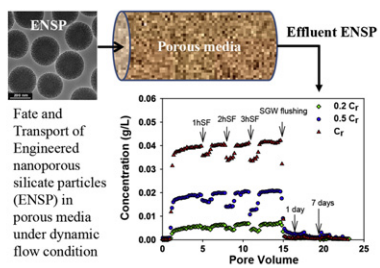
Jianying Shang*, Chongxuan Liu**, Zheming Wang

Pacific Northwest National Laboratory, K8-96, Richland, WA, 99352, USA

HIGHLIGHTS

- ► Dynamic flow condition has a strong effect on the transport of engineered nanoporous particles in porous media.
- ► Flow interruption provides a good way to elucidate the transport mechanism of nano- or colloidal particles.
- ► The transport of engineered nanoporous particles is consistent with the transport of non-porous colloidal particles.
- ► Increasing input concentration enhanced relative engineered nanoporous particle transport in saturated porous media.

GRAPHICAL ABSTRACT



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ABSTRACT

Engineered nanoporous particles are an important class of nano-structured materials that can be functionalized in their internal surfaces for various applications including groundwater contaminant sequestration. This paper reported a study of transport and retention of engineered nanoporous silicate particles (ENSPs) that are designed for treatment and remediation of contaminants such as uranium in groundwater and sediments. The transport and retention of ENSPs were investigated under variable particle concentrations and dynamic flow conditions in a synthetic groundwater that mimics field groundwater chemical composition. The dynamic flow condition was achieved using a flow-interruption (stop-flow) approach with variable stop-flow durations to explore particle retention and release kinetics in saturated porous media. The results showed that the ENSPs transport was strongly affected by the particle concentrations and dynamic flows. The experimental data were used to evaluate the applicability of various kinetic models that were developed for colloidal particle retention and release in describing ENSPs transport. Both experimental and modeling results indicated that dynamic groundwater flow condition is an important parameter to be considered in exploring and modeling engineered particle transport in subsurface porous media.

1. Introduction

Engineered nanoporous silicate particles (ENSPs) that have a large surface area, ordered nano-size pore structure, and controlled particle size have been developed for various applications in biomolecular sensing and labeling, energy storage and fuel cell technology, environmental remediation and protection [1]. A functionalized ENSPs material with its internal pore surfaces covalently

Abbreviations: ENSPs, engineered nanoporous silicate particles; SGW, synthetic ground water; SF, stop flow; FI, flow interruption.

* Corresponding author. Tel.: +1 509 371 7368; fax: +1 509 371 6354.
** Corresponding author. Tel.: +1 509 3716350; fax: +1 509 371 6354.
E-mail addresses: Jianying.Shang@pnnl.gov (J. Shang), Chongxuan.Liu@pnnl.gov (C. Liu).

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