Development and Validation of a New Transport Model for Co-injection of Nonionic Polymers and Nanoparticles in Porous Media

Hamed Mohammadnejad, Bonnie Marion, Kurt Pennell, and Linda Abriola,

The development of mathematical models capable of reliably predicting nanoparticle (NP) transport in subsurface systems is crucial to assess their environmental fate and to improve NP delivery methods. To enhance the stability of NP suspensions, NP production often involves the use of nonionic polymers as stabilizing agents, many of which have been shown to affect NP transport in porous media. Thus, the influence of secondary stabilizing constituents on NP deposition must be incorporated in NP transport models. This will require development and validation of a model for nonionic polymer transport and sorption in porous media.

Based upon a number of experimental studies that have reported bilayer sorption of nonionic polymers, this work presents a multi-constituent nanoparticle transport model that incorporates two-stage kinetic co-polymer sorption and competitive sorption/attachment. The sorption module was validated and parameterized using data from a series of column experiments. These scenarios involve injection of two different nonionic polymers (Gum Arabic and Witconol 2722) into sand columns packed with several size fractions of Ottawa sand (OS) and crushed Berea sandstone (CSS) as well as various flow rates and influent concentrations. Following validation, the two-stage sorption model was implemented in a one-dimensional subsurface flow and transport simulator, employing a revised version of the multi-constituent site-blocking model (MCB) framework first introduced by Becker, *et.al.* (2015). The enhanced model was then applied to simulate a series of column experiments in which Gum Arabic was co-injected with magnetic nanoparticles (nMag) in several size fractions of OS and CSS. Comparisons of experimental observations and model predictions are used to highlight the utility of the two-stage kinetic modeling approach in conjunction with the MCB model.

Hamed Mohammadnejad, Tufts University, Medford, MA, 02155, United States, Tel: 617-961-2779, hamed.mohammadnejad@tufts.edu

Bonnie Marion, Air Liquide, San Francisco, CA, bonnie.a.marion@gmail.com

Kurt Pennell, Brown University, Providence, RI, 02912, United States, kurt_pennell@brown.edu

Linda Abriola, Tufts University, Medford, MA, 02155, United States, linda.abriola@tufts.edu