Filtration in Porous Media
Influential Parameters and Comparison with Experiments

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Filtration in Porous Media: Influential Parameters and Comparison with Experiments

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Introduction

There is a considerable and ongoing effort aimed at understanding the transport and the deposition of suspended particles in porous media, especially non-Fickian transport and non-exponential deposition of particles [1-6]. In this work, the influential parameters in filtration models are studied to understand their effects on the non-Fickian transport and the non-exponential deposition. The filtration models are validated by the comparisons between the modelling results and the experimental data.

Modeling non-Fickian transport

\[ \frac{\partial c}{\partial t} + v \frac{\partial c}{\partial x} = -\left( \lambda_0 + \lambda_d \right) c + \lambda_s s + \lambda_{sw} s_m; \]

\[ \frac{\partial s}{\partial t} + v \frac{\partial s}{\partial x} = \lambda_c c - \lambda_{sw} s_m - \lambda_{sw} s_m; \]

\[ \frac{\partial s_m}{\partial t} = \lambda_{sw} s_m + \lambda_c c - \lambda_{sw} s_m; \]

Temporal dispersion term for non-Fickian transport

Heterogeneous particle-grain interactions

\[ p(\lambda) = \frac{1}{\lambda_0 \sigma \sqrt{2\pi}} \exp \left( \frac{-(\ln \lambda - \mu)^2}{2\sigma^2} \right) \]

Log-normal, power-law and other distribution types are applied to describe heterogeneous particle-medium interactions, such as heterogeneous surface charges, energy minima, distributed particle sizes via size exclusion [3,6].

Released and migratory deposition

A third equation is applied to describe the released and migratory particles. The third particle population may be the surface-associated particles or the released large aggregates. The boundary condition for the third population is zero at the injection side [5].

Conclusions

1. The elliptic equation can be applied to model the non-Fickian transport. It results more dispersed breakthrough curves and hyperexponential deposition.
2. The consideration of a third migratory particle population may result in non-monotonic deposition and long tails after the end of injection in the breakthrough curves.
3. Distributed filtration coefficients can be applied to model heterogeneous particle-medium interactions. The modelling results can match the hyperexponential deposition in experiments.
4. The elliptic equation and the CTRW equation expressed in Laplace space can both catch the non-Fickian transport of tracers in heterogeneous porous media, while the advection dispersion equation cannot.

References