SEQUENTIAL UPSCALING OF MULTIPHASE DISPERSION IN POROUS MEDIA

Jianwei Guo and Farid Laouafa and Michel Quintard

Keywords: Active dispersion, Darcy-scale heterogeneity, non-equilibrium model.

In this paper we consider the transport of a chemical species in a two phase system with exchange of matter at the interface (so-called active dispersion). The boundary conditions at the interface between the two phases existing within the pore space are either of thermodynamic equilibrium or of reactive type. Saturation changes with the exchange of matter at the interface. The medium itself is characterized by different levels of heterogeneity starting from the pore-scale. In this work, problems related to pore-scale to Darcy-scale upscaling and then to Darcy-scale to Large-scale upscaling are considered.

The first upscaling [1] leads to different problems depending on the boundary conditions and various assumptions, in particular the role of the total mass exchange rate, non-standard terms, etc. The role of geometry, reaction rate on dispersion and tortuosity is investigated for simple 1D/2D/3D unit cells.

The second upscaling is only considered for the case of a local non-equilibrium Darcy-scale model in the case of small variations of density and viscosity with concentration. It leads to a complex coupled problem between Darcy-scale deviations and large-scale averaged values. In particular, the solution exhibits memory and history effects. An algorithm is proposed to solve for the case of small Damköhler numbers (the Diffusive Damköler for low Péclet numbers or the convective Damköhler for high Péclet numbers). The resulting large-scale model is of the non-equilibrium type. The algorithm allows for the calculation of large-scale effective properties such as large-scale relative permeability, large-scale mass exchange coefficients as a function of the large-scale phase saturation.

References

[1] J. Guo, M. Quintard and F. Laouafa, *Dispersion in Porous Media with Heterogeneous Nonlinear Reactions*, Transport in Porous Media, 109, pp. 541-570, 2015.

J Guo
Southwest Jiaotong University, P.R. China/
jianweiguo@home.swjtu.edu.cn

F. Laouafa
INERIS, France.
Farid.LAOUAFA@ineris.fr

M. Quintard
IMFT, France.
michel.quintard@toulouse-inp.fr