3D Fluid Flow And Thermal Diffusion In Porous Media

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Abstract

Macroscopic modeling of fluid flow and thermal diffusion in porous media relies on the accurate estimation of equivalent properties such as permeability and effective thermal conductivity. These properties are strongly influenced by the complex 3D topology of the microstructure and the nature of the flow regime at the pore scale. In this work, a detailed three-dimensional analysis of microscopic transport phenomena is realized by importing realistic microstructures into representative elementary volumes (REV). After numerical validation, particular attention is given to the transition between different flow regimes (e.g., Darcy, transitional, or inertial). The study compares complete 3D simulations with simplified 2D representations to assess the relevance and limitations of dimensional reduction. A wide range of operating conditions (statistical analysis) is explored to identify the influence of microstructural anisotropy and pore connectivity.

Figures used in the abstract

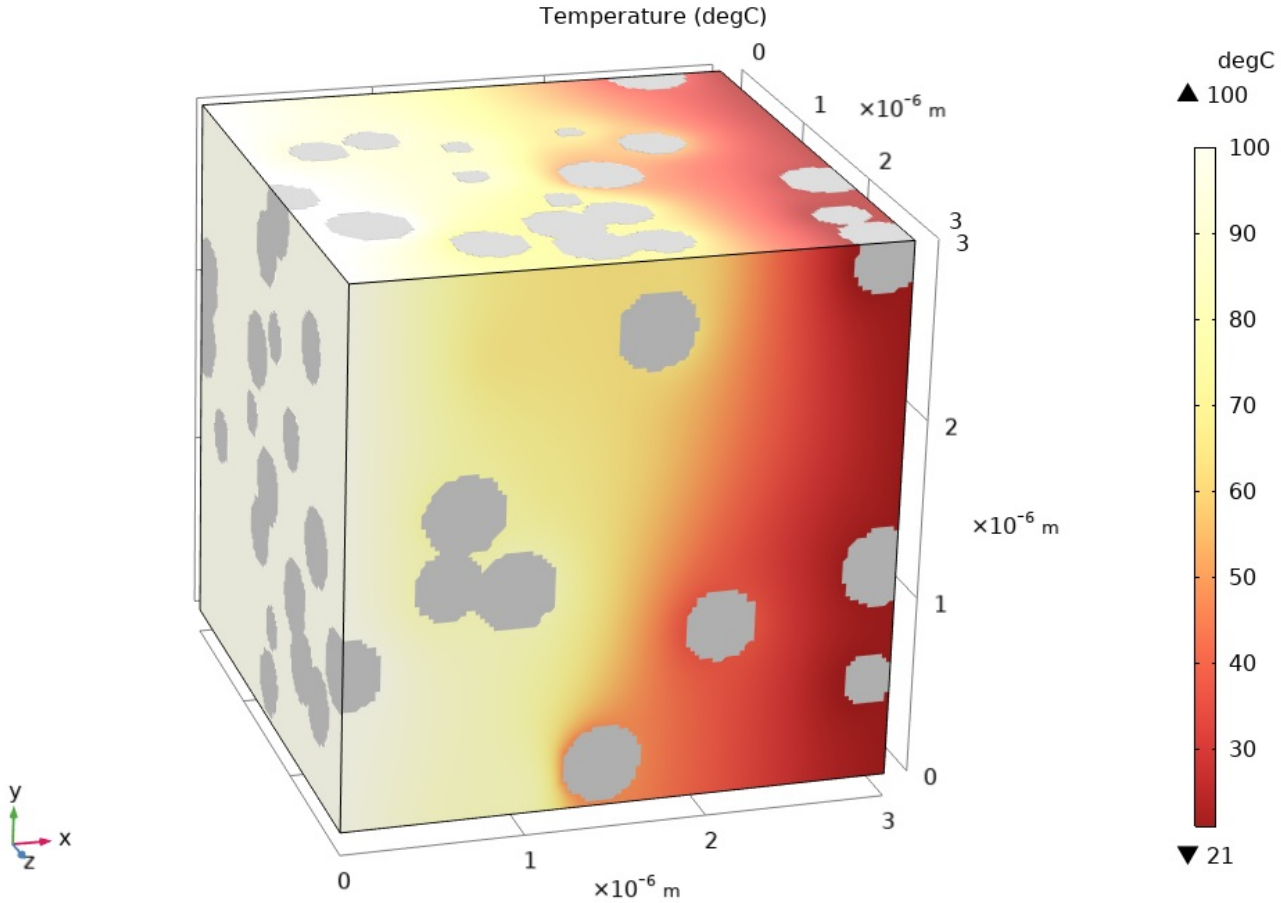

Figure 1