Reiterated Homogenization of Flows in Deforming Double Porosity Media

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Abstract

The double porosity materials consist of two very distinct porous systems so that their interaction has a strong influence on the fluid transfer and other mechanical properties. In general, the "primary" and the "dual" porosities can be distinguished. These two systems characterized by very different pore sizes are arranged hierarchically, one is embedded in the other. In the present study, we consider the fluid-structure interaction problem in the double porosity medium. To respect the skeleton poroelasticity, we extend the model of the hierarchical flow in a rigid double porosity medium described in [3]. The two-level homogenization by the periodic unfolding method was applied to upscale the Stokes flow in a rigid micro-porosity and, consequently, to upscale the Darcy-Stokes system relevant to the mesoscopic medium. The macroscopic flow was described by a Darcy-Brinkman system of equations governing macroscopic fields of pressure and flow velocity. The model derived in this conference paper follows also the hierarchic upscaling procedure described in [1], where a static problem was considered. In [2] we modified the model of a hierarchical poroelastic material by including the Darcy flow in the microporosity. Here we consider the reiterated homogenization of the Stokes flow problem with a strong contrast in the fluid viscosity between the micro- and meso-pores. The 1st level homogenization leads to the Biot model associated with the microporosity. The 2nd level upscaling of the mesoscopic fractured medium then follows: the mesoscopic model is constituted by the Biot model governing the microporosity and by the Stokes flow model of the fractures. Modified Saffman interface conditions are obtained after the 1st level upscaling. In the paper we present the local problems for characteristic responses; using their solutions the homogenized coefficients of the meso- and macro-models are computed. Moreover, we explain reconstruction of the three-scale fields at the two levels of the heterogeneous porous structure. We discus influence of the relative size between the micropores and the fractures and also the influence of the mesoscopic interface condition possibly modified to control the slip velocity on the mesoscopic interfaces.

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References

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