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A Higher-Order Central-Upwind Scheme for Multiphase Flow in Heterogeneous Porous Media

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One of the most challenging issues in computational poromechanics is the development of numerical schemes capable of capturing in an accurate fashion the effects of spatial variability in the formation properties by handling highly heterogeneous coefficients with complex spatial distributions while preserving local conservation properties. In this work we present a new higher order semi-discrete central-upwind scheme for systems of conservation laws which allows for spatial heterogeneity of the storage coefficient, say, the porosity field. The proposed scheme adopts an inhomogeneous dual mesh with variable cell size ruled by one-sided local propagation speeds, which are used to construct the local Riemann fans and compute numerical fluxes at cell edges as in [1], extending the results of [2] and [3], where the central scheme of [4] was used as basis for simulating multiphase flows in porous media. We also propose the use of the new central-upwind scheme in the composition of a sequential splitting algorithm for simulating incompressible multiphase flow within rigid and compressible porous media, with both permeability and porosity fields heterogeneous. Numerical tests are presented to illustrate the accuracy of the proposed method in problems that simulate immiscible three-phase flow in heterogeneous porous media in two and three space dimensions.

References

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Primary authors: Dr CORREA, Maicon (Univeristy of Campinas); Dr MURAD, Marcio (LNCC - Brazil)

Presenter: Dr CORREA, Maicon (Univeristy of Campinas)

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