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Effect of viscous coupling in multiphase flow in porous media[1]
JUAN C. PADRINO, XIA MA, DUAN Z. ZHANG, Los Alamos National Laboratory — Multiphase flow in porous media has traditionally been modeled by the extension of Darcy's law. This is accomplished by the introduction of the concept of relative permeability, which depends on fluid saturations only. In cases of fluids with significant viscosity difference, additional representation of fluid interactions of viscous nature, not accounted for by Darcy's law, are needed. In this work we report on new approaches to modeling viscous coupling between phases. Our analysis starts with the ensemble phase averaged momentum equation for multiphase flow. The averaged momentum equation leads to an equation system similar to Darcy's law, but with additional force terms representing interaction between fluids. These forces arise from the fact that the less viscous fluid pushes the more viscous one to flow through the porous matrix, as shown in our calculation based on the bundle-of-tubes model [Yang et al., 2009, Int. J. Multiphase Flow, 35, 628]. These forces are therefore proportional to the viscosity of the more viscous fluid and the relative velocity between fluids. Based on the formulation developed from the bundle-of-tubes model, we performed numerical simulations of a laboratory experiment of multiphase flows in a porous matrix. Comparisons with the experimental data and other numerical results are presented and discussed.

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