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Numerical modeling and simulation of two-phase flow problems in heterogeneous porous media with gravity and dynamic capillary pressure

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Numerical simulations of immiscible two-phase flow in porous media with dynamic capillary pressure and gravity interactions in heterogeneous porous media are presented with a novel computational method based on ideas introduced in [1]. We formulate and test numerically a new two-dimensional fully coupled and implicit procedure for numericaly solving two-phase transport problems of pseudo-parabolic nature, see [1,2,3]. For the parameter range considered, immiscible viscous fingers are found to undergo interaction with dynamic capillary pressure and gravity effects for typical flow path situations in porous media transport problems. The dominant feature for these flows is the saturation overshoot under non-equilibrium effects in the capillarity pressure [2,3]. Our numerical experiments demonstrate the viability of the proposed procedure for multiscale problems in heterogeneous high contrast media.

[1] E. Abreu and J. Vieira, Computing numerical solutions of the pseudo-parabolic Buckley-Leverett equation with dynamic capillary pressure. Mathematics and Computers in Simulation 137 (2017) 29-48.

[2] C.J.van Duijn, K. Mitra and I.S.Pop, Travelling wave solutions for the Richards equation incorporating non-equilibrium effects in the capillarity pressure, Nonlinear Analysis: Real World Applications 41 (2018) 232-268.

[3] S.M. Hassanizadeh and W.G. Gray, Thermodynamic basis of capillary pressure in porous media, Water Resour. Res., 29(10) (1993) 3389-3405.

References

[1] E. Abreu and J. Vieira, Computing numerical solutions of the pseudo-parabolic Buckley-Leverett equation with dynamic capillary pressure. Mathematics and Computers in Simulation 137 (2017) 29-48.

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[3] S.M. Hassanizadeh and W.G. Gray, Thermodynamic basis of capillary pressure in porous media, Water Resour. Res., 29(10) (1993) 3389-3405.

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