Theory and computation of multiphase, multicomponent flows in porous media

A fast and efficient approach for solving a coupled system of elliptic and parabolic equations arising in the context of multiphase flows in porous media will be presented. Such flows are found in many different physical applications which include enhanced oil recovery processes, subsurface flows and bio-fluid flows. A new global pressure function for incompressible, multicomponent, immiscible two-phase flows will be introduced. One of the key features is that the system of equations using the global pressure model is not as strongly coupled as the models which use the phase pressures as primary variables. This system is numerically solved using a modern, hybrid method based on a combination of a non-traditional discontinuous finite element formulation and a time-implicit finite difference scheme based on the modified method of characteristics. L^2 error estimates obtained from a convergence analysis will be verified with an exact solution and also with realistic flooding simulations. Results from qualitative validation studies with existing literature will be presented. We will conclude with a discussion of the effect of various chemical components and of the heterogeneity of the domain properties on the spontaneous formation of finger patterns and other complex flow characteristics. This work was supported by the U.S. National Science Foundation grant DMS-1522782

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