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Potential-based Reduced Newton Algorithm for Nonlinear Multiphase Flow in Porous Media FELIX KWOK, ICME, Stanford University, HAMDI TCHELEPI, ERE, Stanford University — We present a phase-based potential ordering for the finite volume discretization of the multiphase porous media flow equations. This ordering is an extension of the Cascade ordering introduced by Appleyard and Cheshire. The extension is valid for both two-phase and three-phase flow, and it can handle countercurrent flow due to gravity and/or capillarity. We show how this ordering can be used to reduce the nonlinear algebraic system that arises from the fully-implicit method (FIM) into one with only pressure dependence. The potential-based reduced Newton algorithm is then obtained by applying Newton's method to this reduced-order system. Numerical evidence shows that our potential-based reduced Newton solver is able to converge for time steps that are much larger than what the standard Newton's method can handle. In addition, when standard Newton does converge, the reduced Newton algorithm also converges, and often at a faster rate than standard Newton. Applications of the potential ordering to linear preconditioning will also be discussed.

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