An Iterative Algorithm for Three-Phase Flow in Porous Media

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ABSTRACT

In this work we present a conservative numerical methodology for simulating immiscible three-phase flow of compressible gas and incompressible water and oil in highly heterogeneous porous media. It is used the fractional approach where the three-phase problem is treated as a total fluid flow, and the individual phases are treated as fractions of the total flow. In this first approach we neglect the capillary effects and the resulting equations lead to a coupled system of partial differential equations, which consists of a nonlinear parabolic equation for the pressure, and a nonlinear hyperbolic system for the saturation of the phases. One of the most challenging issues in computational poro-mechanics 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. Here we propose an iterative algorithm where the pressure and the saturation equations are decoupled in time, so that specific numerical methods can be used for each problem. Numerical simulations of water and gas injection in strongly heterogeneous porous media are presented to illustrate the performance of the proposed computational model in two and three spatial dimensions.