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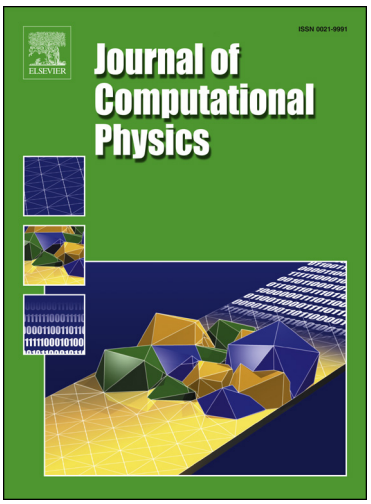

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Modified Sequential Fully Implicit Scheme for Compositional Flow Simulation

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Abstract

The fully implicit (FI) method is widely used for numerical modeling of multiphase flow and transport in porous media. The FI method is unconditionally stable, but that comes at the cost of a low-order approximation and high computational cost. The FI method entails iterative linearization and solution of fully-coupled linear systems with mixed elliptic/hyperbolic character. However, in methods that treat the near-elliptic (flow) and hyperbolic (transport) separately, such as multiscale formulations, sequential solution strategies are used to couple the flow (pressures and velocities) and the transport (saturations/compositions). The most common sequential schemes are: the implicit pressure explicit saturation (IMPES), and the sequential fully implicit (SFI) schemes. Problems of practical interest often involve tightly coupled nonlinear interactions between the multiphase flow and the multicomponent transport. For such problems, the IMPES approach usually suffers from prohibitively small timesteps in order to obtain stable numerical solutions. The SFI method, on the other hand, does not suffer from a temporal stability limit, but the convergence rate can be extremely slow. This slow convergence rate of SFI can offset the gains obtained from separate and specialized treatments of the flow and transport problems. In this paper, we analyze the nonlinear coupling between flow and transport for compressible, compositional systems with complex interphase mass transfer. We isolate the nonlinear effects related to transmissibility and compressibility from those due to interphase mass transfer, and we propose a modified SFI (m-SFI) method. The new scheme involves enriching the 'standard' pressure equa-

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