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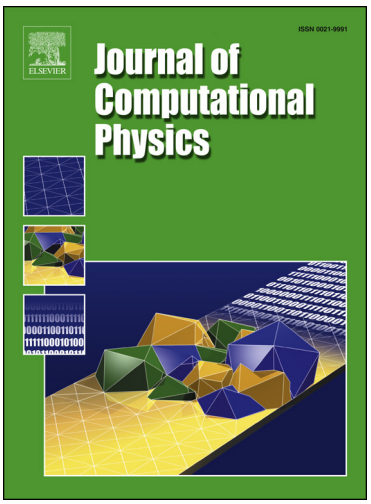

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Modeling and Simulation of Surfactant-Polymer Flooding using a New Hybrid Method

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Abstract

Chemical enhanced oil recovery by surfactant-polymer (SP) flooding has been studied in two space dimensions. A new global pressure for incompressible, immiscible, multicomponent two-phase porous media flow has been derived in the context of SP flooding. This has been used to formulate a system of flow equations that incorporates the effect of capillary pressure and also the effect of polymer and surfactant on viscosity, interfacial tension and relative permeabilities of the two phases. The coupled system of equations for pressure, water saturation, polymer concentration and surfactant concentration has been solved using a new hybrid method in which the elliptic global pressure equation is solved using a discontinuous finite element method and the transport equations for water saturation and concentrations of the components are solved by a Modified Method Of Characteristics (MMOC) in the multicomponent setting. Numerical simulations have been performed to validate the method, both qualitatively and quantitatively, and to evaluate the relative performance of the various flooding schemes for several different heterogeneous reservoirs.

Keywords: surfactant-polymer flooding, global pressure, capillary pressure, finite element method, method of characteristics, numerical simulations, heterogeneous permeability

1 Introduction

One of the effective methods of tertiary oil recovery is Surfactant-Polymer (SP) flooding which involves injection of polymer and surfactant laden aqueous phase in oil reservoirs. Polymer in the displacing fluid improves oil recovery by inhibiting the growth rate of the fingering instability and by increasing the water saturation level behind the displacing front. See Daripa *et al.* [1] for a study of these phenomena during polymer flooding which in general is a less effective method of tertiary oil recovery than the SP flooding, a subject of present study. In the SP flooding, the use of surfactant further improves oil recovery by reducing the capillary pressure between the aqueous and the oil phases and by reducing the residual saturation limits of the rock matrix. ASP flooding in which Alkali is also used in the SP-laden aqueous phase, is supposed to be even more effective since the alkali produces surfactant in-situ thereby replenishing surfactant lost due to adsorption by the porous matrix during the transport of these chemical components by the flow through the porous matrix. In recent years, surfactant-polymer flooding has been shown to be preferable to even ASP flooding in highly heterogeneous reservoirs as the elimination of alkali removes undesirable inorganic scale

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