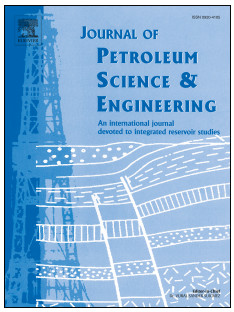
Accepted Manuscript



Pore-scale investigation of some effective parameters on immiscible displacement efficiency using Free Energy model of Lattice Boltzmann method

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PII: S0920-4105(17)30542-9

DOI: 10.1016/j.petrol.2017.06.052

Reference: PETROL 4064

To appear in: *Journal of Petroleum Science and Engineering*

Received Date: 2 March 2017

Revised Date: 9 June 2017

Accepted Date: 18 June 2017

Please cite this article as: Ansarinasab, J., Jamialahmadi, M., Pore-scale investigation of some effective parameters on immiscible displacement efficiency using Free Energy model of Lattice Boltzmann method, *Journal of Petroleum Science and Engineering* (2017), doi: 10.1016/j.petrol.2017.06.052.

Pore-scale investigation of some effective parameters on immiscible displacement efficiency using Free Energy model of Lattice Boltzmann method

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Abstract:

The effects of capillary number, viscosity ratio, wettability and interfacial tension on immiscible displacement efficiency in porous media were numerically investigated. These parameters greatly affect the efficiency of flooding processes which are carried out in order to enhance oil recovery after the primary stage of oil production. Cahn-Hilliard type Free Energy model of Lattice Boltzmann method was used which we believe it is the first time use of this model to conduct such study. Constant velocity boundary condition was developed for this model to simulate injection of displacing liquid in different injection rates through heterogeneous porous medium. The model has been validated by three benchmark tests which confirm the ability of the model in simulating contact angles, velocity profile inside a pore and determination of capillary pressure. Our results show that areal sweep efficiency, ultimate recovery factor and breakthrough time improve with a decrease in capillary number by reducing injection rate. Decreasing viscosity ratio by increasing displacing phase viscosity shows improvement of flow stability and enhancement of displacement recovery. Wettability alteration from displaced-phase-wet to displacing-phase-wet, leads to remarkable increase of sweep efficiency and ultimate recovery. Finally, increasing interfacial tension slightly enhances displacement efficiency in forced imbibition process, when interfacial tension is high enough that miscibility does not occur between phases. Comparison of our results with previous experimental and numerical results in literature shows consistency in some cases and contradiction in others.

Keywords: Lattice Boltzmann Method, Capillary number, Viscosity ratio, Wettability, Interfacial tension, immiscible displacement, Porous media

1. Introduction:

Study of multiphase fluid flow through porous media is the subject of many researches in petroleum engineering fields such as determining relative permeability and capillary pressure in special core analysis (SCAL) and investigation of effective parameters on enhanced oil recovery (EOR) processes. In chemical flooding and mobility-control techniques of EOR processes, water

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