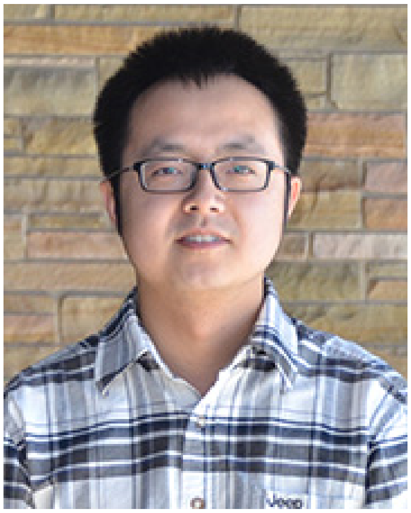

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Lattice Boltzmann method coupled with multi-phase reactive transport modeling for pore-scale mechanistic study of low salinity waterflooding in carbonate reservoir rocks

Abstract

Carbonate reservoir contains a significant amount of oil reserves in the world. It is essential to implement enhanced oil recovery (EOR) techniques to improve the oil recovery after primary and secondary production phases. Depending on the location. The low salinity waterflood technique (LSWF) can be a promising technique for the EOR process regarding the availability, affordability of the injectant, and oil displacement efficiency. The main mechanisms proposed are fluid-fluid interactions, multi-component ions exchange, mineral dissolutions, wettability alteration, and electrical double layer (EDL) expansions.

Despite the numerous experimental investigations published in the literature with mechanisms proposed, only a limited amount of literature focuses on LSWF modeling based upon one or few mechanisms due to the high level of uncertainty behind them. Meanwhile, most modeling studies are based on static modeling approaches, or simplified dynamic modeling methods.

In this study, we proposed and developed a comprehensive pore-scale modeling approach to study the LSWF in carbonate reservoir rocks by coupling the open-sourced fluid flow solver PALABOS, and the geochemical reaction solver PHREEQCRM. The model is validated by benchmark problems regarding basic fluid flow, diffusion to complex coupled reactive transport. And it integrates the surface complexation model (SCM) to simulate the electrokinetic properties between the Crude Oil-Brine-Rock (COBR) interfaces. An advanced Neural Network (NN) based stochastic optimizer was developed for numerical model parameter optimizations.

2D single/two-phase core flood numerical experiments were designed based on a validated model with artificial flow channels and real limestone rock images. A series of low salinity effects from the core flood numerical experiments resulted in the dynamic wettability alteration attributed to multiple mechanisms. The high-resolution pore-scale dynamic wettability alteration is also directly observed during the two-phase core flood simulation.

The comprehensive pore-scale modeling framework illustrated the capability of investigating the pore-scale LSWF processes for EOR optimization purposes, which demonstrated great potentials in simulating complex fluid-fluid and fluid-solid interactions associated with subsurface applications. It is also flexible to incorporate new chemical/physical models for broader applications.

Date:

Monday, Jan 25th, 2021

Time:

Starts @ 9:00AM

Zoom Meeting Details:

HYPERLINK

Meeting ID: 945 5422 4532

Password: 636542

Committee Chair:

Associate Professor Reza Barati