228 (2023) 211986

Contents lists available at ScienceDirect

Geoenergy Science and Engineering

journal homepage: www.sciencedirect.com/journal/geoenergy-science-and-engineering

Simulation study of polymer flooding performance: Effect of salinity, polymer concentration in the Malay Basin

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ARTICLE INFO

Keywords:
Polymer flooding
TNavigator
Simulation
Adsorption
Salinity
Polymer concentration

ABSTRACT

The major problem of the water flooding development process is the flood process's high mobility and viscous fingering. Previous studies have shown that polymer flooding is viable and can recover bypassed oil. However, the mechanism of the polymer flooding process is still tenuous in literature. Therefore, in this study, a two-dimensional model was used to simulate polymer flooding and forecast the mechanism of the polymer flood in the presence of electrolytes. Likewise, the effect of pH, pressure, and temperature on the polymer flooding process was investigated. Thereafter, the model was validated with an independent set of experimental data from the literature. The results show that the polymer flooding mobility ratio (M) was 0.36 indicating a favorable mobility control, thereby improving oil recovery by 60% of original oil in place (OOIP). In comparison, to water flooding mobility ratio of 3.6, which was greater than 1, thus resulted in viscous fingering, early water breakthrough, and oil recovery of 36% OOIP. Besides, at high salinity concentrations, the polymer adsorption was 3.3 mg/g compared to 2.2 mg/g from the experimental results. This indicates that the simulation results were consistent with the experimental results at the same concentration. Likewise, the simulation and experimental studies suggest high oil recovery was obtained at a higher injected pore volume. Finally, it can be concluded from this study that mechanical trapping and adsorption of the polymer on the pores of the porous media were the dominant mechanisms during the polymer flooding.

1. Introduction

Oil-producing countries have increased oil production from mature oilfields to fulfil global energy demand. An enhanced oil recovery (EOR) approach allows for the recovery of residual oil following natural drive production. However, oil recovery from natural drive mechanisms is still less than 50% original oil in place (OOIP) (Agi et al., 2018). Waterflooding can be used to repressurize water drive reservoirs. However, the major water flooding problem is viscous fingering and early water breakthrough. Nevertheless, chemical EOR (CEOR) is one of the most effective strategies for bypassed oil recovery in terms of sustainability, cost, and implementation simplicity (Pal et al., 2018; Musa et al., 2019). The popular CEOR techniques included surfactant, alkaline, and polymer flooding (Belhaj et al., 2019; Laben et al., 2022). Previous studies have shown that surfactants can overcome capillary forces restricting oil mobilization in porous media (Belhaj et al., 2020a). However, surfactant adsorption and precipitation in harsh reservoir conditions is the major limitation to the surfactant flooding process's successful implementation and economic viability (Belhaj et al., 2021). Hence, the successful application of surfactants at high salinity, high temperature, and pressure reservoir condition has not been achieved (Belhaj et al., 2020b). Recent research and application of various chemical flood injection modes for EOR processes have led to the development of new injection techniques. Foam boosted by surfactants and polymers has recently been examined for mobility control and shown to improve oil recovery (Gbadamosi et al., 2019a).

It has been determined that polymer flooding, a CEOR approach, is one of the most efficient and effective methods for recovering

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https://doi.org/10.1016/j.geoen.2023.211986
Received 6 February 2023; Received in revised form 24 May 2023; Accepted 7 June 2023
Available online 19 June 2023