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Surface Tension, Interfacial Tension and Phase Behavior: Interactions of Surfactant/Polymer Solutions with Crude Oil

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ABSTRACT

Advanced oil recovery techniques, beyond primary and secondary recovery, are required in order to produce additional oil in existing reservoir rock. Here, we evaluated a combination of polymer and surfactant aqueous solutions, in order to generate a working fluid capable of achieving high-performance enhanced oil recovery (EOR). In this recovery process, surfactant is added to the water flooding mixture in order to lower the interfacial tension between the oil and the water. If the interfacial tension can be decreased by ~1,000-fold, then the aqueous solution can mobilize and displace the oil. Moreover, a polymer is added to the aqueous solution in order to increase the viscosity of the working fluid. Aqueous solutions with a viscosity higher than the oil viscosity can produce a stable flow of oil. However, the exact combination and concentration needed for these two key components to be effective is dependent on each oil reservoir and requires several experiments and specific tuning in order to yield an effective design. In order to determine the optimal combination, the effects of the average molecular weight of the polymers, the surfactant chemistry, and their combinations in salt solutions (at varying salt concentrations) were investigated. Specifically, the surface tension of aqueous solutions against air and the interfacial tension against oil and the phase behavior of the polymer-surfactant systems were evaluated with a model hydrocarbon, dodecane, and with crude oil. By varying the molecular properties of the surfactant and the polymer, we found a technically promising surfactant-polymer combination for potential EOR application.

KEYWORDS

EOR, surfactant, polymer, oil, salinity, phase, surface tension, interfacial tension