

The Summer Undergraduate Research Fellowship (SURF) Symposium

6 August 2015

Purdue University, West Lafayette, Indiana, USA

Oil Recovery in Low Temperature and Salinity Reservoir Rock Using Anionic and Anionic/Cationic Surfactant Formulations

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Abstract

As oil reserves are being depleted in the United States, there is an increasing need to recover the trapped oil in the reservoir rock which accounts for up to 60% of the total oil available. This oil may be recovered using chemical enhanced oil recovery (EOR) techniques. In our case study, we investigated viable EOR surfactant/polymer formulations for conditions conducive to high efficiency oil recovery in ultra-low salinity, low temperature, and high hardness reservoirs. Formulations were screened for Winsor Phase I (microemulsions) or Winsor Phase III (bicontinuous emulsions), both of which are conducive to high efficiency oil recovery. Strong emulsion phase behavior at low salinities was observed in binary surfactant mixtures of anionic alkyl-alkoxy sulfates (at > 16,000 ppm). Using a novel anionic/cationic formulation, emulsion phase behavior was observed at the ultra-low reservoir salinity of 10,000 ppm. These formulations demonstrate industrially viable surfactant/polymer formulations that can be used for high efficiency EOR in low temperature-salinity and high hardness reservoirs within the continental United States and abroad.

Keywords

Enhanced Oil Recovery, Polymer, Phase Behavior, Anionic Surfactant, Cationic Surfactant, Low-Salinity Reservoir, Low-Temperature Reservoir, High-Hardness Reservoir