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Optimization of Low Concentration Bacillus subtilis Strain Biosurfactant towards Microbial Enhanced Oil Recovery

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Abstract

This study investigates the ability of lipopeptidebiosurfactant produced from Bacillus subtilisstrain isolated from oil contaminated Omani oil field soil samples to recover the residual oil at reduced concentration. The biosurfactant reduced the interfacial tension to 1.8 mN/m and also altered the wettability to more neutral wettability. The biosurfactant is stable over wide range of pH and temperatures.The minimum biosurfactant concentration required to make the process economically feasible was determined by performing core-flood experiments at various critical micelle dilutions using 200-300 md Berea sandstone cores with porosity of 22%.

The fluids used in the work are 32o API crude oil, and brine with 7-9% salinity collected from the field of interest. Experiments were conducted at the reservoir temperature, 60oC. It was found that biosurfactant can maintain an extra recovery of 14% of residual oil after water flooding even after 20 times dilution. These results revealed that the biosurfactant is still effective even at concentration as low as the CMC value (0.1 g/L). Furthermore, the performance of 20 times diluted biosurfactant was improved by mixing it with commercial chemical surfactant to the ratios of 50%biosurfactant:50%chemical surfactant and 25%biosurfactant:

75%chemical surfactant, and, resulted in extra recovery of 28% and 27% of residual oil after water flooding respectively. Salinity studies show that this biosurfactant maintained a relatively low interfacial tension values over wide range of salinities. Biosurfactant maintained extra recovery of about 20% till a salinity of 20%. When the salinity was increased to 10%, the biosurfactant was still successful in reducing the water flooding residual oil saturation by 12% even when diluted by 10 times.

Economical evaluation showed that using this biosurfactant at low concentration would produce appreciable amount of trapped oil with minimum cost.