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Development of EOR Composite Surfactant and Study of Alkali Effect on Foam Properties

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Background: Crude oil has been primary extracted by natural derive mechanism utilizing its natural reservoir energy, however, due to decline in reservoir energy, the production becomes unstainable. Second stage of extraction technology involves injection of water to maintain the pressure, yet water technology face with challenges of viscous fingering. Enhanced Oil Recovery (EOR) techniques are advanced methods to maximize hydrocarbon extraction from oil reservoirs. Foam injection is one of the important techniques that addresses early gas breakthrough and improve oil extraction. However, challenges of foam instability persist at high reservoir temperature. This work intends to create a new composite surfactant formulation to generate stable foam for use in EOR applications.

Methods: The design of formulations involved various combination of different commercial surfactants (Do'zee, Brezee, Daia) at varying concentration range (0.1%-0.5%) using Design Expert software. Foam generation and stability studies were performed by a Ross-miles method, which describes a simple method of foam generation by turbulence mechanism. Surfactant formulations were transferred to a burette and allowed to drip into empty measuring cylinder kept at a fixed distance, as a result, a foam was generated. The foam volume was recorded and subsequently allowed undisturbed to record the half-life (foam stability). Furthermore, effects of temperature, alkali, and crude oil on foam stability were studied. Foam morphology was also investigated using a microscopy to overserve changes in bubble size and distribution.

Results: The results indicates that the optimum foam volume (13.50mL) was found at concentrations of surfactants (Do'zee 0.5%, Brezee 0.1%, Daia 0.3%) and brine (0.2%). At these conditions, the study observed that both alkali and crude contributed to foam instability, however, foam was best stable for about 35 min under alkali conditions. The bubble size and distributions highlights that the foam formed was spherical to polyhedral in shape, with significant bubble size variation in the continuous phase.

Conclusion: It was observed that combination of surfactants can be more effective than single surfactants providing stability benefits over broad scenarios of salinity, crude oil, alkali and temperature. These investigations may lead to breakthroughs in EOR technology, certainly, prolong the life of oil fields.

Keywords: Surfactant, Foam, Stability, Crude oil, Enhanced oil recovery

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