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Surfactants Synthesis Using Petroleum Fractions and Crude Oil: Application in Microemulsion Formulation

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Surfactant synthesis was realized from Algerian crude oil and petroleum fractions. To predict the composition (wt%) in paraffins, naphtenes, and aromatics, the crude oil and petroleum fractions were first characterized using the n-d-PA empirical method of Robert. The characterization showed a good level in aromatics compounds which give high yield in the sulfonation reaction by oleum. The synthesized surfactants were characterized by spectroscopic techniques (UV, FTIR) and by critical micelle concentration (CMC), Krafft temperature, solubility (in aqueous and in salt solution), molecular weight, and matter actives (%) measurements. The formulation of microemulsion using synthesized surfactant from plat format petroleum fraction showed a Winsor III type system. The effect of salinity demonstrates the existence of an optimal value of NaCl concentration for which the interfacial tension takes the lowered value (10^{-4} mN/m). Viscosity measurements confirm that the formulated microemulsion has a Newtonian behavior.

Keywords Microemulsion, petroleum fraction, physicochemical characterization, sulfonation, surfactant

1. INTRODUCTION

During the oil deposit exploitation, the petroleum recovery can be done according to two principal methods called primary and secondary processes. Under the best operating conditions, a third of oil can be extracted. With the secondary process, the injection of gas or water, and the existence of important capillary forces trap oil in the pores reserve rock. That is why very quickly appeared the need to inject into the deposit energy to increase oil production. Then, several techniques have been developed to improve oil recovery.[1] Among these techniques, the addition of surfactants has been proved to be effective but complex operation because of problems of interface, emulsion formulation, capillary forces, soil permeability; oil deposit temperature, and salinity, which make the task very difficult but not impossible[2,3]

The chemical process, which involves surfactant injection, can be done in the form of aqueous solution containing varying amounts of surfactant and other additives such as alcohol, electrolyte, and polymer to adjust rheological properties of the system; or in the form of mixture in varying proportions of water, surfactant, electrolyte, oil, and alcohol, called microemulsions.[4]

Solubilization of oil by means of microemulsions has become an efficient way to increase the amounts of oil extracted from oil wells. It is one of the enhanced oil recovery (EOR) methods developed to recover residual oil left after water flooding. This technique was been used successfully in many product oil deposits, but their development has encountered the high cost of the chemical materials and the petroleum product.[5,6] In prevision of the oil shortage, the study on enhanced oil recovery (EOR) in many major oil-producing countries is in progress.

Producing ultra-low interfacial tension is one of the most important mechanisms for oil recovery with respect to surfactant flooding. For displacement of oil in the pores and capillaries of petroleum reservoir rock, it would appear that it is necessary to reduce interfacial tension between oil and slug of surfactant-bearing water to ultra-low value. These conditions can be obtained using microemulsions.[7] These complex systems are thermodynamically stable consisting of a hydrophilic and hydrophobic phases stabilized with the use of surfactant.[8]

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