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CHARACTERISTICS OF REAGENTS TO INCREASE OIL RECOVERY

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Abstract

During the application of enhanced oil recovery (EOR) processes, complex operational issues, such as the deposition of organic compounds (i.e., wax, resins, and asphaltenes, among others), reservoir formation damage, rock wettability alteration, and high fluids viscosity negatively affect oil recovery. Presents an experimental evaluation of the multifunctional properties of two recently developed new chemical agents: a zwitterionic surfactant (ZS) and a supramolecular complex (here named AMESUS) for chemical EOR applications. The effectiveness of new multifunctional agents and mechanisms for organic scale removal/control, oil recovery, asphaltene inhibition and dispersion activity, heavy crude oil viscosity reduction, rock wettability modification, and relative permeability are discussed. chapter.

Keywords

chemical enhanced oil recovery, viscosity reduction, multifunctional surfactants, asphaltenes, formation damage.

Introduction

On average, only one-third of the original oil in place (OOIP) is economically recoverable after the application of primary and secondary oil recovery (SOR) methods. The implementation of enhanced oil recovery (EOR) processes is increasing due to the decline in the discovery of new oil fields during the last decades [1-3]. EOR is defined as a process to reduce oil saturation below the residual oil saturation [4], and it refers to the injection of any fluid (i.e., steam, polymer solution, solvents, etc.) into the reservoir to change and/or to modify the existing rock/oil/brine. interactions. It has been reported that for light and medium oil reservoirs, the residual oil saturation ranges from 50 to 60% of the

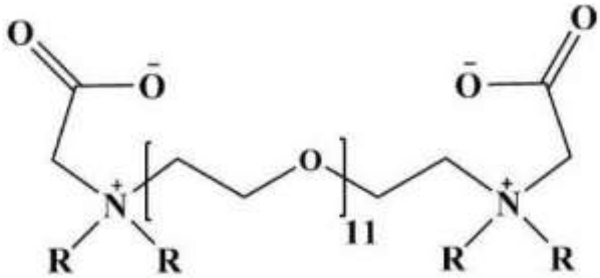
OOIP, whereas for heavy crude oil reservoirs, it could range from 80 to 95% [1, 5]. Several EOR methods have been reported such as the use of chemical products (polymers and surfactants), thermal methods (steam stimulation, in-situ combustion, electrical heating, vibrational methods etc.), miscible gas injection, and microbial EOR, among others [4]. However, the application of EOR technologies can modify in an adverse way the flow and phase behavior of the reservoir fluids as well as the formation rock (FR) properties that can promote oil productivity decline. Some of these issues include organic compounds deposition leading to formation damage, plugging of the formation rock (within the reservoir and at the wellbore), as well as flow restrictions in tubing, flow lines, and production facilities.

Chemical flooding using surfactants is a method that has been widely studied over several decades; it is considered an efficient process to achieve incremental recovery of residual oil with great potential as an EOR process for the petroleum industry. Although the mechanisms involved in the interactions of the surfactants with oil and brine within the porous media are complex, interfacial-tension reduction and formation rock wettability alteration are the most accepted mechanisms responsible for recovering residual oil saturation.

Surfactants that are composed of two hydrophilic and two hydrophobic groups have been the subject of significant research interest since the early 1990s. These surfactants are called Gemini" because their chemical structures can be perceived as two classic surfactant molecules chemically connected at or near the head groups. Their chemical arrangement provides a rich array of aggregate morphologies and solution properties that are dependent upon the nature and size of the linking group and/or head groups. These types of surfactants with unsymmetrical geometry have interesting characteristics in terms of self-assembly into aggregates and packing at interfaces.

Zwitterionic surfactants (ZSs) are considered among the surfactant molecules that can be applied in EOR with molecular structures made up by two hydrocarbon chains, a bridge, and two polar groups of zwitterionic type that can be a cation and an anion in different atoms of the same molecule. ZSs are electrically neutral, and they can behave as bases or acids (acceptor or donor) according to the properties of the medium where they are found. Therefore, zwitterionic surfactants can play a role as smart wettability modifiers that react efficiently according to the characteristics and properties of the specific medium.

Figure 1 displays the general chemical structure of zwitterionic surfactants (ZSs), which corresponds to a recently developed alkyl betaine zwitterionic gemini surfactant with polyethylene spacers [4]. This molecule was designed as a wettability modifier of rock surfaces such as limestone, dolomite, sand, quartz or heterogeneous lithology in the presence of brines with high content of divalent ions (i.e., calcium, magnesium, barium, and strontium), high temperature, and high pressure for EOR applications.



Supramolecular technology has been used for EOR applications. For instance, supramolecular assemblies, such as micellar structures, have been developed for applications in wettability alteration where it is beneficial to modify the rock formation wettability from oil-wet to preferentially water-wet to enhance oil recovery [4]. It has also been reported that supramolecular agents can interact with crude oil fractions within the reservoir to reduce their viscosity promoting additional recovery of residual oil. The supramolecular complex, AMESUS, is a surfactant developed from the interactions among cocamidopropyl hydroxysultaine (CAHS), sodium dodecyl alpha-olefin sulfonate, and sodium dodecyl hydroxyl sulfonate. AMESUS offers multifunctional features including foaming, corrosion-inhibition, and wettability-alteration properties. AMESUS can be used in high salinity brines at reservoir conditions without alteration of its molecular structure.

Figure 2 shows the characteristic chemical structure of a supramolecular structure.

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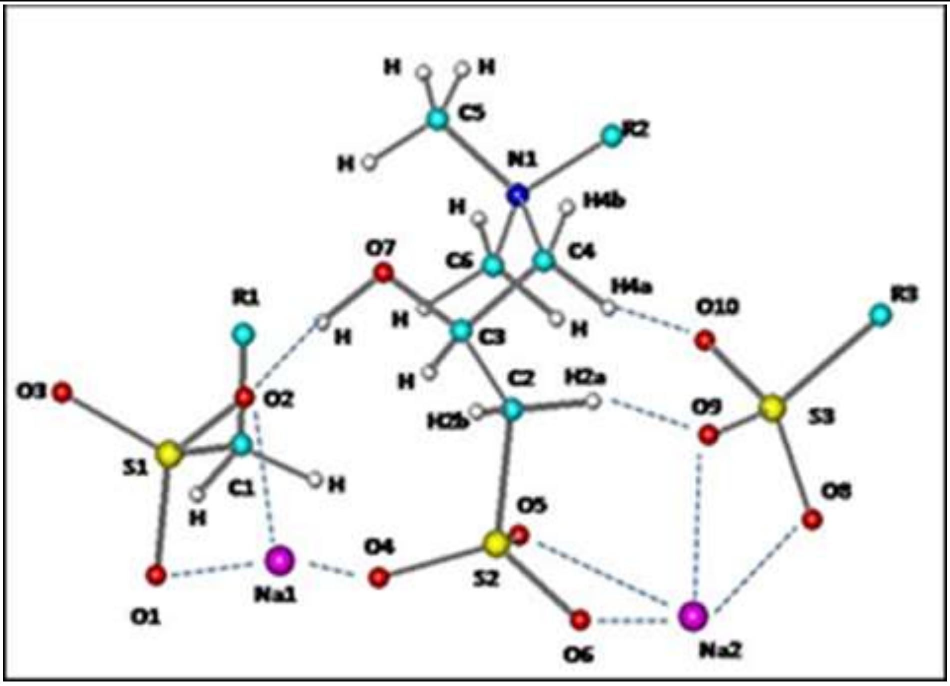

Figure 2. Characteristic chemical structure of the supramolecular complex, wherein R1, R2, and R3 are alkyl, alkenyl linear, or branched chains, whose length ranges from 1 to 30 carbon atoms.

Evaluation of the multifunctional properties. The dominant oil recovery mechanisms during surfactant flooding are interfacial tension (IFT) reduction and wettability alteration . The mobilization of residual oil requires threduction in the interfacial tension at the oil-brine interfaces to ultralow values to overcome the capillary forces responsible for trapping residual oil at the pore scale [5]. Therefore, IFT reduction mechanism depends on the surfactant effectiveness in reducing the oil-water IFT by four to six orders of magnitude. Figure 3 shows the interfacial tension as a function of surfactant concentration and surfactant type (AMESUS and a ZS) obtained from a light crude oil (31API)—high-salinity brine (2.6 wt.% NaCl) system.

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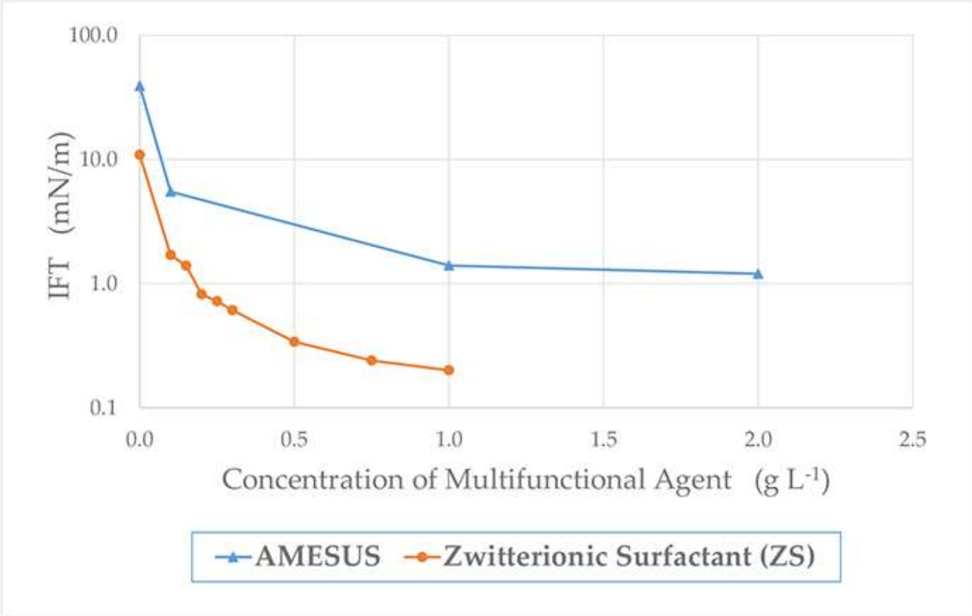

Figure 3. Interfacial tension (mN/m) as a function of surfactant concentration and surfactant type.

As expected, multifunctional agents (surfactants) decrease the interfacial tension as the concentration of surfactant increases until the critical micelle concentration is reached. According to the data presented in Figure 3, "ultra-low" IFT values were not obtained for this system with these surfactants. However, it is important to realize that oil recovery is not only influenced by IFT reduction, there are other several factors affecting the mobilization of oil at pore scale such as rock wettability (contact angle), capillary and viscous forces, and fluid properties, among others [5]. Wettability determines the adhering tendency of a fluid toward a solid surface in the presence of other immiscible fluids, and it is a function of the interfacial chemistry of the phases present in the system. Contact angle is the point at which the oil or water interface meet at the solid (i.e., rock) surface; therefore, it indicates the affinity of the solid surface for any of the fluids present in the system. Contact angle determination is commonly used to establish wettability changes of solid surfaces. In this regard, reliable wettability alteration measurement tools are necessary for the accurate evaluation and monitoring of wettability alteration treatments.

Conclusions. These chemical agents demonstrate suitable performance during surfactant flooding at reservoir conditions (i.e., temperature and pressure) and high salinity brine concentration. These chemical agents are effective as asphaltenes aggregation inhibitors. Similarly, they are suitable asphaltenes dispersants. Therefore, these agents are applicable for the removal and prevention of asphaltenes deposition and/or adsorption onto the rock surface. Furthermore, these multifunctional agents can significantly decrease the viscosity of heavy oil through the breaking and dispersion of asphaltenes and resin aggregates within the bulk oil phase.

LITERATURE

1. Abeysinghe KP, Fjelde I, Lohne A. Acceleration of Oil Production in Mixed-Wet Reservoirs by Alteration of Relative Permeability Curves Using Surfactants. Society of Petroleum Engineers EOR Conference at Oil and Gas West Asia, Muscat, Oman, April 16−18, 2012;
2. Ayirala SC, Rao DN. Multiphase Flow and Wettability Effects of Surfactants in Porous Media. Colloids and Surfaces A: Physicochemical and Engineering Aspects. 2004;
3. Torabi F, Mosavat N, Zarivnyy O. Predicting Heavy Oil/Water Relative Permeability using Modified Corey-Based Correlations. Fuel. 2016;
4. Salikhova O.A, Shodmonova S.G., Kodirov O.Sh. Study of the process of obtaining a catalyst for the synthesis of benzene based on ethylene for the production of cyclohexane. American journal of applied science and technology. volume 02, issue 05, may. -2022.
5. Salikhova O.A., Khamdamov O.O., Kodirov O. Sh. Development of a catalyst for the synthesis of butadiene-1,3 based on butylenes – secondary products of sgcc. European international journal of multidisciplinary research and management studies. volume 02. issue 04. april -2022.