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Improving Recovery by Altering Wettability from Oil Wet to Surfactant Wet

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Abstract

Surfactants play an important role to alter wettability in any reservoir. Adsorption of surfactants onto reservoir surface will reduce the contact between water and oil which indeed has less impact on Interfacial tension. Oil wet reservoirs are specifically preferred than water wet due to high oil saturation. At the same time extracting oil from oil wet reservoir is difficult due to its wetting nature. The only way to extract oil is by altering wettability from oil wet. The aim of this work is to extract more oil with less adsorption by altering oil wet to surfactant wet. Wettability of sandstone has been chosen to alter from oil wet to surfactant wet. Surfactants of low concentration, which is less than CMC (Critical Micelle Concentration) has been introduced before surfactant flooding during water flooding to make core surfactant wet. The recovery of oil during water flooding is 0.2 Pore Volume (PV). This has been increased to 0.5 pore volume by making it surfactant wet and adsorption has been reduced to 0.5 pore volumes.

Keywords: Adsorption, CMC, Surfactant Wet, Wettability

1. Introduction

Surfactant flooding is one of the most successful operations for altering wettability in cover Chemical Enhanced Oil Recovery. Surfactants carry polar head's and nonpolar tails in the form of hydrocarbon chain. While injecting surfactants the tail part will attach to the surface of reservoir where it is initially oil wet. After that polar heads are exposed at the surface making them water friendly[1]. The oil will be displaced by polar moieties. This process is considered to be altering reservoir from oil to somewhat water wet. During this process there is a great chance of adsorbing surfactants. Normally surfactants were applied in an oil wet reservoir to alter the wettability at the same time to reduce interface energy between oil and water and surface energy between reservoir surface and oil. But, due to adsorption it is difficult to make total interaction between surfactant solution and oil[2]. During surfactant flooding adsorption is a major parameter to be considered. As much surfactant concentration is in contact with reservoir fluids that much great chance is there to reduce Interfacial Tension IFT. Due to adsorption the remaining concentration of surfactants are not enough to reduce IFT[3]. Reservoir being oil wet it could able to attract surfactants more due to its organic tails. The concentration of Surfactants and salinity of brine could be selected by conductivity and emulsion tests. For wettability alteration this concentration should not get absorbed. The objective is to reduce the adsorption of concentration by making reservoir surfactants wet[4].

2. Methodology

2.1 Surfactant Wet

A dry clean core sample was considered to be aged with crude oil for 2 days. After 2 days the core was saturated with oil. Here we considered that core have been wetted

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by oil. In place of flooding with water surfactants SDS with low concentration below CMC level as an aqueous solution was introduced. These aqueous solutions have been adsorbed completely by core making surfactant friendly or wet.

2.2 Conductivity Test

Surfactant concentration is directly related to conductivity inside aqueous medium. Conductivity will rise with concentration of surfactants until the micelle has completely formed[5]. After the micelle has completely formed addition of surfactants will add number of micelles and the conductivity will be constant. The concentration where micelle starts to form is considered to be critical micelle concentration[6]. Micelles are spherical in shape and its radius is equivalent to the tail of surfactants. In aqueous phase heads of micelle will be exposed and for organic phase tails. This concentration is suitable for reducing Interfacial Tension (IFT) to ultra-low.

2.3 Emulsion Test

This test is conducted by considering different proportions of salinity concentrations with CMC from conductivity test. Three phase region is observed in the test indicates the concentration of salinity is matching with reservoir brine salinity as shown in Figure 1. Then surfactants can easily separate water from oil by penetrating into interfacial and oil zone[7].

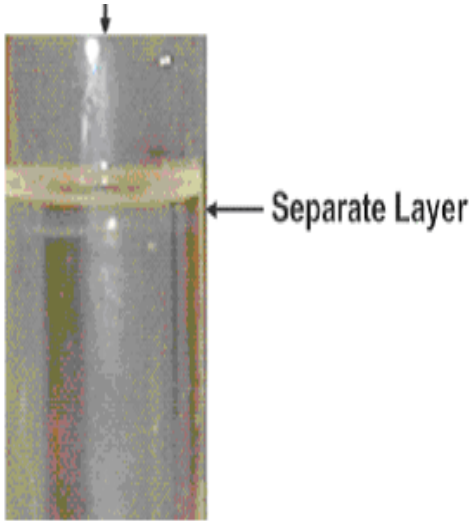

Figure 1. Emulsion test indicating separate region.

3. Results and Observations

Conductivity test have been conducted with seven concentrations of SDS shown in Table 1. CMC of surfactant as 300 ppm have been chosen from Figure 2 where deviation is observed. 300 ppm of SDS was chosen for emulsion test. Three 25 ml tubes of each 300 ppm of surfactants with different salinities as 0.5, 1.0 and 1.5 wt% simultaneously were filled to half upto 12.5 ml and other half by crude. Three phases have been observed at 1.0 wt% salinity.

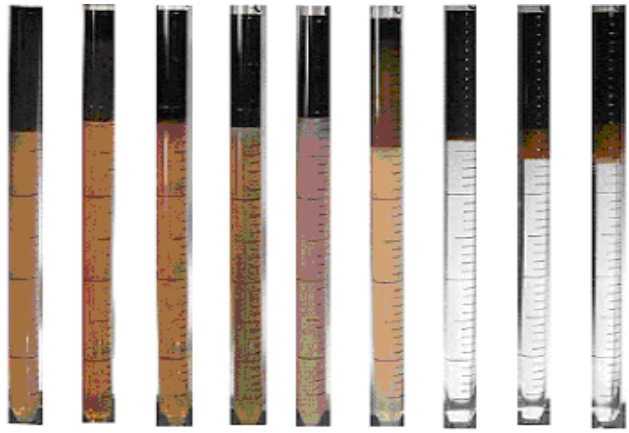

Table 1. SDS concentrations with conductivity

Sample	SDS ppm	Conductivity mS/cm
1	100	5
2	200	12
3	300	18
4	400	20
5	500	21
6	600	21
7	700	22

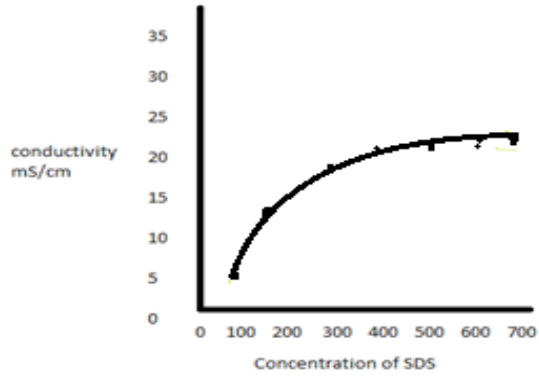

Figure 2. SDS conductivity.

3.1 Core Flooding by Bottle Test

The recovery of oil has been tested by two methods.

1. Recovery by direct injection
2. Recovery by alteration

In first method after aging core with oil, 3 pore volumes of water have been injected. 2.5 pore water has absorbed by core. SDS of 300 ppm with 1.0 wt% salinity was flooded with 1.0 pore volumes. Little amount of oil less than 0.1 pore volume with 0% of surfactants was recovered at outlet. This is due to surfactant adsorption onto the reservoir surface.

In second method surfactants SDS with concentration of 100 ppm which is below CMC have introduced earlier during water injection after oil aging. Injection of surfactants was very slow allowing it to contact everywhere. 2 pore volumes of aqueous surfactants were injected. 0.2 PV of oil has been collected at outlet and aqueous surfactants were adsorbed. We again injected surfactants with configuration of 300 ppm CMC and 1.0 wt% salinity. After four hours 0.5 PV of oil have been collected with 0.5 PV of aqueous surfactant.

4. Conclusion

Surfactants have been introduced successfully into the core during water flooding to make it surfactant wet. Continuous injection of Low concentration surfactants has made oil wet surfactants to mixed surfactant wet. Then, SDS of 300 ppm at CMC has been in applied to improve recovery. Adsorption of surfactants has been successfully reduced by applying surfactants of low concentration during water flooding. By this process, surfactants contact with interfacial region has improved. Adsorption was not reduced completely due to impurities like clay. Carbonate reservoirs are also likely to adsorb surfactants. This process has scope to apply on carbonate reservoirs for further investigations.

5. References

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