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Experimental Study of Sodium Carbonate and Dodecyltrimethylammonium Bromide Surfactant Effects for Enhanced Oil Recovery in Asmari Oil Reservoir

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INTRODUCTION

Application of chemicals such as surfactants, alkaline materials and polymers is among the most common and sophisticated methods in enhancing oil recovery [1]. The major aim of all methods used for enhancing oil recovery is increasing the volumetric sweep efficiency and improving the displacement efficiency compared to normal water flooding [2]. Surfactants are amphipathic molecules, meaning they are hydrophobic at one head and hydrophilic at the other. By acting as an interface, the surfactant molecules reduce the surface tension between water and oil phases, thus enhancing oil recovery [3].

Alkaline materials prevent deposition of surfactants by giving a base state to the bed and increasing the negative charge on the rock surface. At the proximity of surfactants, alkali causes an increase in the efficiency and effectiveness of surfactant on reducing surface tension and change in rock wettability [4].

Since our main source of income is oil, enhancing oil recovery is highly significant. Therefore, study on methods of enhancing oil recovery is valuable. Considering that most of oil reservoirs of the country have past the primary and secondary phases of oil recovery, investigating and studying the tertiary methods of enhanced oil recovery is of interest.

The present research investigates the addition of alkaline material to surfactant solution and its effect on the mechanisms which affects the enhanced oil recovery from Asmari reservoir. Accordingly, different parameters such as the presence of surfactant on variability of rock wettability in reservoirs and the effect of an alkaline material at the proximity of surfactant on increased hydrophilicity of the reservoir rock were studied.

EXPERIMENTAL PROCEDURES

The carbonate cores of Asmari reservoir were placed inside an immersed beaker in the crude oil in oven at a temperature of 65˚C. The oil-wetted sections were put inside the solutions provided from surfactant and alkaline, and by considering their retention time inside solution, they were brought out of the solution after 1, 3, 5, and 7 days.

RESULTS AND DISCUSSIONS

Firstly, the contact angle between water and oil-wetted reservoir rock was measured that was 110 degrees. By placement of rock samples inside surfactant solutions, it was observed that by increase in weight percent of surfactant, the contact angle with water decreases, which indicates the shift in wettability of the rock towards hydrophilicity.

Next, by adding different weight percent of sodium carbonate as an alkaline material, the effect of adding it to surfactant in reduction of rock contact angle was studied. For this purpose, sodium carbonate with 0.5, 1, 1.5, 2, and 2.5 wt.% was added to the cation surfactants, then the rock was left for 1 day inside the prepared solution. As shown from test results in Fig. 1, the presence of sodium carbonate in surfactant solution of dodecyltrimethylammonium bromide has caused reduction in contact angle, thus increasing the hydrophilicity of the reservoir rock. By increase in hydrophilicity of the reservoir rock, the oil recovery would be enhanced. In surfactant solution of dodecyltrimethylammonium bromide, the optimum rates of sodium carbonate at concentrations of 0.05, 0.1, 0.3 and 0.5 wt% of surfactant solution was obtained at 2, 2, 1, and 1 wt% of sodium carbonate respectively, where there is seen the minimum rate of contact angle.

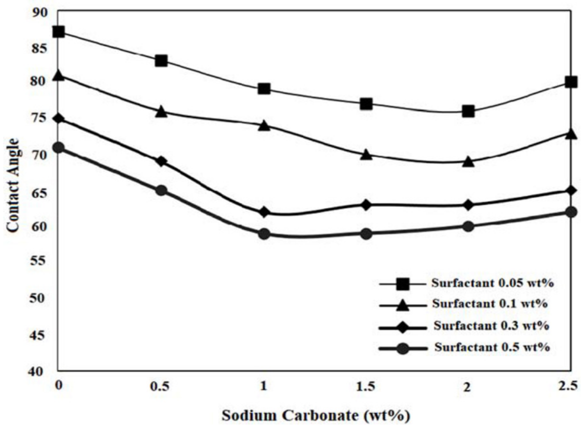

Figure 1: The effect of adding sodium carbonate to the surfactant solution of dodecyltrimethylammonium bromide.

Pursuant to the rocks placement for 1 day in the solution with 0.5 wt.% of surfactant at the presence of sodium carbonate with the concentration optimum of 1 wt%, the minimum contact angle was measured and 59 was obtained.

The test results show that with increase in retention time of the rock in the surfactant solution of dodecyltrimethylammonium bromide at the presence of and absence of sodium carbonate, the contact angle decreases. However, as indicated, the maximum reduction rate in contact angle happened in the first day and afterwards the efficiency of surfactant in decreasing the contact angle was not significant. The contact angles after one day, three days and seven days of retention in surfactant solution of dodecyltrimethylammonium bromide with concentration of 0.5 wt.% at the presence of sodium carbonate at the optimum concentration of 1 wt.% are shown in Fig. 2.

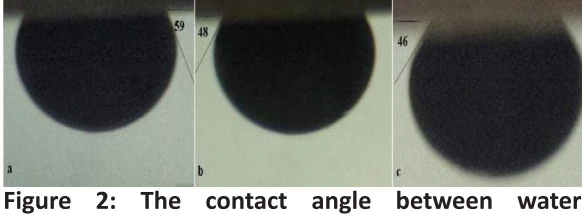

Figure 2: The contact angle between water and the reservoir rock a) after 1-day b) after 3 days c) after 1 week inside surfactant solution of dodecyltrimethylammonium bromide at a concentration of 0.5 wt.% at the presence of sodium carbonate at an optimum concentration of 1 wt.%.

CONCLUSION

By increasing the concentration of surfactant solution of dodecyltrimethylammonium bromide in the test range up to 0.5% wt.% and by wetting the reservoir rock for one day, the contact angle between reservoir rock and water shifted from 110 degrees to 71 degrees. Adding the sodium carbonate alkaline to the surfactant solution and water led to further decrease in contact angle. Also, in any weight percent of surfactant, an optimum concentration for sodium carbonate was obtained, where the maximum rate of decrease in contact angle was obtained. By increase of retention time of rock in the solution, the shift in wettability of the rock towards hydrophilicity is observed. The presence of surfactant in water causes a decrease in surface tension between water and oil, where in the critical micelle concentration of surfactant, the minimum surface tension was generated. With an increase in sodium carbonate weight percent in surfactant solution and water, the surface tension is highly increased. Moreover, the rate of oil recovery for water injection is 53 percent. Next, by injection of surfactant-alkaline solution, oil recovery is further enhanced by 18%, with the final recovery reaching to 71 percent.

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