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On the Effects of Salinity, Asphaltenes and Resins on Interfacial Tension: Applications to Low Salinity Water Injection

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Summary

In this study, it has been tried to investigate the effects of asphaltenes, resins and NaCl salinity on IFT value between oil/water. Most importantly, it was revealed that low salinity water injection could only be effective for IFT reduction within a specific range. Therefore, it is recommended to optimize water salinity instead of just decreasing it. It was shown that Asphaltenes could reduce IFT value, but their effects are dependent on Resins.

Introduction

As the energy demand of the world is increasing, the interest toward more oil production is also increasing. Naturally, reservoirs produce hydrocarbons to a maximum 20 % of total oil in place. This means that further production will only be possible through an Enhanced Oil Recovery (EOR) strategy. Water flooding has been recognized as the most popular technique to increase oil recovery. Economically, what actually matters is the salinity of injection water (Hussain et al., 2013; Moghadasi & Moghadasi, 2017). Low salinity water (LSW) injection has been introduced about 25 years ago as a new method of oil recovery, when first Jadhunandan (1990) found that oil recovery depends on water composition (Jadhunandan, 1990). Since then, extensive investigations have been conducted to detail the underlying mechanisms, thus designing the most optimized process (Sheng, 2014). One of the proposed mechanisms for LSW deals with fluid/fluid interactions (IFT). Previous studies have shown that modifying water salinity toward LSW could decrease oil/water IFT; thereby, increasing oil recovery. However, most of works have ignored the sole effects of polar components of crude oil.

This study tries to experimentally investigate the effects of NaCl salinity with respect to the existence of polar components known as asphaltenes and resins. A set of IFT tests were conducted to investigate these effects. Results show that an optimization of salinity should be implemented instead of only decreasing salinity for an improved oil recovery by LSW.

Method and/or Theory

In this study, first a sample of Iranian crude oil was used for resins and asphaltenes extraction. The method of extraction was based on API recommendation. Then, synthetic crude oils were prepared by adding desire amounts of asphaltenes (3, 5, 8 % wt) and resins (5, 10 % wt) to the toluene. The preparation method was also based on API recommendation. Water phase was prepared by adding predetermined amounts of NaCl (0, 1, 2, and 3 5 wt) to double distilled water. Using a pendent drop IFT apparatus, the IFTs between different solutions of synthetics oil and brine were measured.

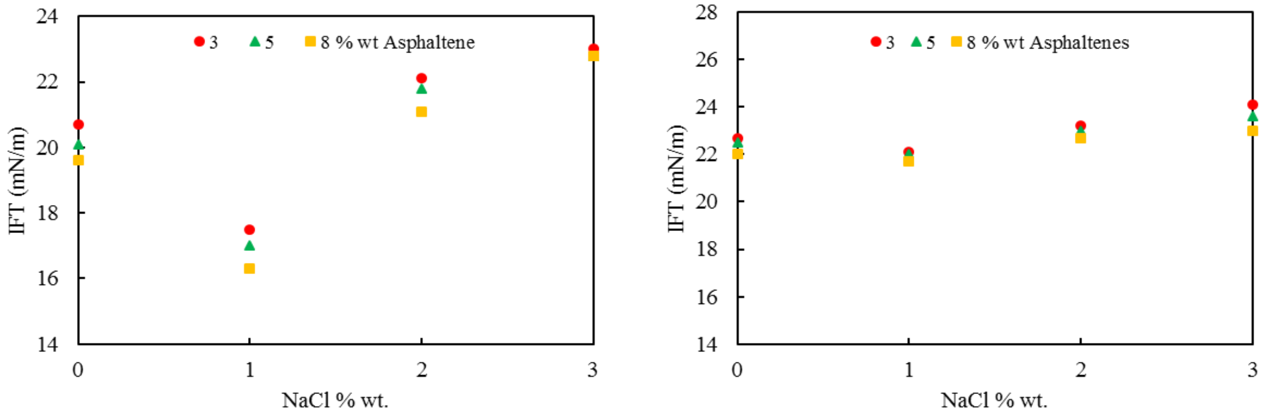
Conclusions

Results of our experiments are shown in Fig. 1(a-b). As shown in both of these figures, increasing the concentration of asphaltenes has caused the IFT to be reduced. This is due to asphaltenes polar nature. Due to their structures, which contain polar functional groups, they have affinity towards both polar and non-polar mediums. Thus, they could migrate from the bulk to the interface of oil/water, making bonds with water molecules. As a result, a rigid film of absorbed asphaltenes is made at the interface leading to decreased IFT value. A microscopic view of oil/water interface used in this study confirms the creation of rigid film at the interface (Fig. 2). By a comparison between Figs. 1(a) and (b), it is revealed that increasing resins concentration causes the IFT value to be increased. For instance, for the case of 3 % wt asphaltene and 0 % wt NaCl, the IFT value has increased from 20.7 to 22.7 as resins concentration changes from 5 to 10 % wt. It is also obvious that asphaltene concentration effect is not very significant in the solution of 10 % wt of resins. This is due to peptizing role of resins. As resins concentration is increased, higher proportions of asphaltenes are stabilized within the bulk. Thus, less proportion of asphaltenes would migrate toward the interface.

Regardless of asphaltenes and resins concentrations, decreasing NaCl concentration from 3 to 1 % wt has caused the IFT to be reduced. However, further decrease from 1 to 0 % wt, resulted in an increase in IFT value. This implies that LSW can assist oil recovery by reducing the IFT value between water/oil, but it is only effective within a specific range. For instance, considering Fig. 1(a), for the case of 8 % wt asphaltenes, the IFT has reduced from 22.8 to 21.1, and to 16.3 then has increased to 19.6 as NaCl concentration changes from 3 to 2, 1 and 0 % wt, respectively.
Based on these observations, results could be summarized as follows:

- Asphaltenes act as natural surfactants. They could be absorbed to the oil/water interface, thus reducing the IFT value. Although this may reduce interfacial forces between oil/water, which results in higher oil recoveries, but it is controlled by other factors like resins concentration.

- Decreasing water salinity toward low salinity water can result in higher oil recoveries by reducing IFT value. However, the IFT is only reduced within a specific range of salinity. Therefore, optimization of salinity manipulation should be implemented instead of only decreasing water salinity.



(a) (b)

Fig. 1. *IFT between synthetic oil-brine at atmospheric pressure and temperature of 25 °C: effects of brine salinity, asphaltenes and resins concentration: a) 5 % wt resin, b) 10 % wt resin.*

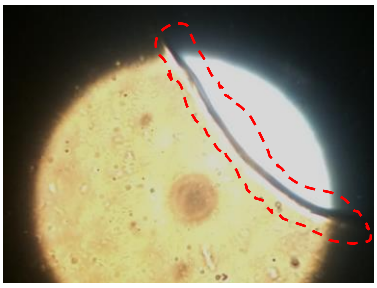


Fig. 2. *Microscopic view of oil/water interface*

Acknowledgements

We respectfully acknowledge supports given by the research centre in Petroleum University of Technology, Ahwaz, Iran.

References

Hussain, F., Zeinijahromi, A., Bedrikovetsky, P., Badalyan, A., Carageorgos, T., & Cinar, Y. (2013). An experimental study of improved oil recovery through fines-assisted waterflooding. *Journal of Petroleum Science and Engineering, 109*, 187-197.

Jadhunandan, P. P. (1990). *Effects of brine composition, crude oil, and aging conditions on wettability and oil recovery*. Department of Petroleum Engineering, New Mexico Institute of Mining & Technology.

Moghadasi, R., & Moghadasi, J. (2017). *Experimental Investion of Formation Damage Caused During Low Salinity Water Injection and Effects of Nano Particles*: 79th EAGE Conference and Exhibition 2017.

Sheng, J. (2014). Critical review of low-salinity waterflooding. *Journal of Petroleum Science and Engineering*, *120*, 216-224.