Effect of Salinity on Waterflooding of Petroleum Reservoirs

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Abstract

Exploration and production companies are always looking for new methods to improve hydrocarbon recovery with maximum economic benefits. Waterflooding has been used for many decades to maintain the reservoir pressure and increase the oil recovery from petroleum reservoirs.

This paper presents a literature review and an experimental study carried out at the Technical University of Denmark (DTU), in which the crude oil/brine/rock interactions were studied with reference to the modified brine composition. Series of brines with different ionic compositions were used also known as Smartwaters. Crude oil and brine interaction were studied through interfacial tension (IFT) experiments. Contact angle measurements were carried out to understand and relate the wettability alterations associated with the ionic compositions. Smartwatercoreflooding experiments on StevnsKlint outcrop chalk samples were carried out to correlate the wettability alteration with improved oil recovery.

The experimental results indicated that the interfacial tension decreased with increasing brine salinity. The decreasing trend was not only dependent on the salinity, but also on the ionic composition. The change in interfacial tension was not large enough to explain the improved oil recovery observed during the coreflooding experiments. Although with decreasing IFT in almost all cases, contact angle measurements indicated that the ionic composition of aqueous phase had different effects on wettability. Brines with higher concentration of calciumand magnesium tend to make carbonates more water wet. On the contrary presence of sulphate tends to make carbonates less water wet. Coreflooding experiments revealed that seawater, seawater with three times additional sulphate ions and ten times diluted seawater all resulted in improved oil recovery after injection of formation water. Modified Brines either with additional sulphate or diluted by deionized water can improve oil recovery from carbonate reservoirs at high temperature.