Petroleum and Chemical Engineering Department-College of Engineering-Sultan Qaboos University

Effect of Smart Water shock on the oil recovery from carbonate reservoirs

Balqees Yahya Al-Kharusi

Abstract

In the coming years, hydrocarbon liquid production from the existing oil fields should increase in order to meet the global growing demand of fossil fuels. Carbonate reservoirs account for more than 50% of the World hydrocarbon reserves. Conventional water flooding application in these reservoirs leads to low oil production as a result of their oil-wet nature. Special attention has been recently directed on changing the chemistry of the injected water which is referred to smart water flooding as an enhanced oil recovery method (EOR). It is widely believed that ultimate recovery governed by smart water flooding is mainly related to wettability alteration of the rock surface to preferentially more water-wet state. However, the underlying mechanism of wettability alteration is not fully understood.

This effort aimed to design a smart water for an Omani carbonate field by studying the impact of salinity and the influence of the most wettability modifier agents (SO42- and Mg2+) on the wetting properties of oil-wet carbonate surfaces through contact angle measurements. Some analytical methods were utilized including pH, brine analysis, SEM-EDS, and zeta potential measurements to provide comprehensive analyses about the surface wettability alteration mechanisms. The results verified that diluting the base water resulted in little changes on the surface wettability towards water wetness. A comparison of diluted base water spiked with sulfate ions to that spiked with magnesium ions indicated that SO_4^{2-} ions played a catalytic role during wettability alteration process more efficiently. However, increasing the concentration of both ions in the diluted base water turned the oil-wet carbonate surface to a completely water-wet surface, hence, this brine was selected as the optimized smart water for this field. Based on the obtained results, salting-in effect may contributed on wettability alteration of aged carbonate in the presence of the designed smart waters (LS).Carbonate dissolution and multi ion exchange (MIE) were proved to be the main mechanisms on changing the wettability in the presence of LS brines. The interfacial tension (IFT) of the LS and crude oil showed insignificant IFT drop. A new sequence of the smart water injection was examined in this study. Core flooding experiment proved the efficiency of injecting the selected optimized smart water in a short period and as a shock in a tertiary recovery mode as it increased the recovery by 4.3 %.