Effect of Initial Wettability on the Performance of Low Salinity Waterflooding for Carbonate Reservoirs

Kholood Al-Nofli

Abstract

In the following years, recovery of hydrocarbon fluids from the current oil fields must improve willing to keep up the worldwide developing demand of fossil powers. Carbonate reservoirs represent more than half of the world hydrocarbon reserves. The application of conventional water flooding methods for these reservoirs results in low oil recovery as a consequence of their oil-wet nature. Recently, exceptional considerations have been coordinated on modifying the chemistry of the injected brine which is represented by "smart water flooding" as an enhanced oil recovery technique (EOR). It is broadly trusted that ultimate oil recovery of a reservoir under smart water flooding is controlled by wettability alteration of the rock surface to a more water-wet condition. However, the main mechanism of low salinity flooding (LSF) in carbonate is not well understood and it is still debatable.

The purpose of this study is to investigate the effect of initial wettability of carbonate reservoirs on the performance of low salinity water flooding. Different analytical tools such as contact angle measurements, pH measurements, and EDS were used to provide inclusive analyses about wettability alteration of rock surfaces. Five initial wettability ranges were provided by aging calcite surfaces in brines or crude oil to mimic oil wet, intermediate wet, and water wet conditions. Four different low saline and smart brines were prepared by adjusting salinity and ion concentration to study their effect on wettability alteration. Our experiments showed that the aging time in oil affects initial wettability of carbonate rocks. Low salinity brine and designed smart brines are not suitable to be used for EOR and wettability alteration for samples initially strong water wet. Also, High salinity brine had no ability to alter wettability of samples which are initially oil-wet, and cannot be considered as a good choice for EOR in carbonate reservoirs. Brine with high magnesium ion concentration was slower in wettability alteration process for oil-wet samples than the brine containing both high magnesium and sulfate ions concentration. This was related to the catalytic role of sulfate ion compared to magnesium ion. Finally the results proved that the initial wettability of the reservoir affects the type of waterflooding method planned to be applied.