The Effect of Dissolved CO2 on Oil Wettability Measured at High Pressures and Temperatures

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9.29.2020 - 10.1.2020 – AAPG Annual Convention and Exhibition 2020, Online/Virtual

Abstract

One of the primary goals of enhanced oil recovery (EOR) techniques is to reduce the wettability of oil in the reservoir to improve mobility and increase recovery. Wettability is commonly quantified using contact angle measurements between an oil drop and a representative solid surface in the laboratory. However, these measurements are frequently performed at atmospheric pressure and temperature as opposed to pressures and temperature representative of the reservoir. Contact angles and interfacial tension are heavily affected by pressure and temperature, and therefore it is crucial to replicate these conditions in the laboratory when researching EOR methods. In this presentation, contact angles of an oil drop surrounded by brine with and without dissolved CO2 were measured with an optical tensiometer incorporating a high pressure chamber. The measurement chamber was filled with 60 ml of 3.5 wt% NaCl and an n-dodecane solution was sonicated and injected into the chamber to form a 3 µl drop. An automatic pump injected CO2 into the chamber until a pressure of 15 bar was reached. Contact angles were then measured at temperatures of 30 °C, 70 °C, 90 °C, 120 °C, 150 °C and 180 °C, and at pressures between 10 and 350 bar. The effect of dissolved CO2 on the contact angles exhibits different trends above and below 90 °C. Below 90 °C, the addition of CO2 increased contact angles compared to no dissolved CO2, while above 90 °C the addition of CO2 decreased contact angles. With and without dissolved CO2, increasing pressure caused a decrease in contact angles, while increasing temperature tended to increase contact angles. The results demonstrate that CO2 addition can be effective at reducing oil wettability at lower temperatures, but the effectiveness of CO2 diminishes at higher

temperatures. As temperature increased, the effect of pressure was also magnified. At temperatures below 70 °C, increasing pressure had a marginal effect on the contact angles, while at 180 °C the contact angles dropped more than 10° over the measured pressure range up to 350 bar. This study provides new insight into the effect of dissolved CO2 on oil wettability at pressures and temperatures representative of reservoir conditions, and provides guidelines for future study of carbonated water EOR methods.

AAPG Datapages/Search and Discovery Article # 91200 © 2020 AAPG Annual Convention & Exhibition Online, Sept. 29- Oct. 1.