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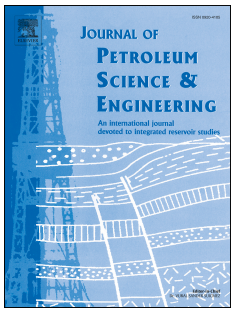

Direct pore-scale visualization of interactions between different crude oils and low salinity brine

Pedram Mahzari, Mehran Sohrabi, Alexander J. Cooke, Andrew Carnegie

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Direct pore-scale visualization of interactions between different crude oils and low salinity brine

Pedram Mahzari[1], Mehran Sohrabi[1], Alexander J Cooke[1], and Andrew Carnegie[2]
[1] Centre for EOR and CO_2 Solutions, Heriot-Watt University
[2] Woodside Energies Ltd

Abstract

Direct pore-scale visualizations using micromodels for low salinity water injection (LSWI) have revealed that the contact between low salinity water and crude oil can provoke formation of water-in-oil micro-dispersions. This experimental work, using a number of different crude oils, aims to visually study the link between micro-dispersion formation and pore surface wettability alteration by low salinity water injection. The effect of aging time on wettability alteration by LSWI was investigated. It was observed that mixed-wet conditions established with a moderate aging time would increase low salinity ability controlled by the oil characteristics. Moreover, under tertiary LSWI, the trapped oil was mobilized if the crude oils exhibited capabilities of forming micro-dispersions. Interestingly, when a crude oil with little or no propensity to form micro-dispersions was used, low salinity effects such as wettability alteration and improved oil recovery were absent. Also, micromodel experiments could enable the investigation of LSWI for waxy crude oil, which is difficult to do with other approaches. To demonstrate the impact of micro-dispersion formation on polar components of the oils, infrared analyses were performed indicating the importance of oil polar agents enriched in aromatics and sulfoxides on controlling the formation of the micro-dispersions. After using various crude oils, it was concluded that the effectiveness of LSWI as the method to increase oil recovery is predominantly controlled by two factors; (i) initial degree of wettability of pore surfaces and (ii) the propensity of crude oil to form micro-dispersions.

1. Introduction

One of the main challenges of oil recovery by low salinity water injection (LSWI) is the conflicting insights reported for pore-scale mechanisms identified from various experimental information [(Sheng, 2014), (Al-Shalabi, et al., 2014)]. As a result, it is currently difficult to reliably identify whether low salinity water injection would lead to additional oil recovery under conditions of a specific oil reservoir or not [(Robertson, 2007), (Skrettingland, et al., 2011)]. It is generally accepted that the wettability alteration towards a more water-wet state would result in the reduction of residual oil saturation. Judging wettability states from core-scale experiments is not a straightforward task due to indirect nature of interpreting coreflood