Fe-Bearing Clay Minerals and Festr Reduction Implications on Oil Adsorption

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Abstract

The nature of the rock/oil/water interface exerts a significant influence on enhanced oil recovery (EOR), as it is the controlling factor for more incremental oil to be released. Low-salinity water flooding is an enhanced oil recovery method with potential to contribute towards further oil production during secondary and/or tertiary recovery of a matured conventional oil reservoir. The main intervention of this EOR method is to expel the residual oil by reducing the salinity of the injected water into the reservoir. As such, the equilibrium in the rock/oil/brine system will be changed. The main mechanisms that are proposed to explain this process are multi-ion exchange, pH increase and interfacial tension reduction, clay swelling and double layer expansion. One factor that has hitherto been little examined is how structural iron (Fe) in clay minerals can affect their wettability in relation to the reduction-oxidation state of the reservoir. The reservoir initially will invariably be in a reduced state, until flooded and any different water injected can potentially turn this to an oxidizing state. According to the literature, less oil adsorption after reduction of Fe3+str, in core plug experiments. A key question is how Fe reduction and the net negative surface charges created affects the different cation affinity on the clay sheet surface with respect to its hydration energy and consequently the oil adsorption onto these surfaces. By describing better how clay minerals behave both in oxidized and reduced conditions, in terms of swelling, cations exchange and oil adsorption, a better comparison, and understanding of the underpinning mechanism(s) during low-salinity water flooding will be achieved. Experiments Ferruginous clay minerals are supplied, and three studies have been conducted to examine the following: (a) Contact angle measurements on clay films, using crude oil, under oxidised and

reduced conditions. (b) Cation exchange isotherms under reduced conditions. (c) Infrared Spectroscopy (FTIR) studies of hydration (wetting) under oxidised and reduced conditions. For the first set of experiments, untreated clay minerals are used to produce clay films under oxidised conditions and contact angle measurements are taken. While for the reduced conditions, oxidised clay films are reduced in sodium dithionite solution and then used for the same kind of measurements. For the second set of experiments, sodium pre-saturated clay minerals are used to establish the cation selectivity between Na to Ca and Na to K. And for the third set, after the hydration degree of the different cations is established under oxidised and reduced conditions, the adsorption of acidic oil compounds (carboxylates) is studied along with the different hydration of each cation present.