Core Flood Modelling of Ion-Exchange during Low Salinity Waterflooding

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Abstract

The present work contains a literature review of the key and latest publications on Low Salinity Waterflooding (LSWF) since its real development in the 1990s to explain the dominant mechanisms, numerical modelling processes and requirements to apply this Enhanced Oil Recovery (EOR) technique. To-date, there is no general agreement of the dominating mechanism that rules the LSWF effectiveness. Currently, wettability alteration to a more water-wet state of the rock as a result of ion exchange and/or double layer expansion mechanism are the two most feasible and supported pore scale mechanisms. However, most of the latest published numerical modeling methods aim to represent the wettability changes only as a result of Multi-Ion Exchange (MIE) processes and geochemical reactions. These publications cross-check their results with observed laboratory data and with the chemical reactions obtained from a recognized geochemical simulator, PHREEQ-C (Kharaka et al., 1988).

The present project is oriented to reproduce experimental results obtained at Heriot Watt University with PHREEQ-C to investigate the effects of concentration changes of the low salinity injection brine on the ion-exchange reactions. Later the experimental results are reproduced using industry standard reservoir simulation software to reproduce the observed data in a 1D single phase system. The reproduction of the experimental results will be used as basis to define correlations between grid size, cation exchange capacity (CEC), selectivity coefficients, and injection rates in a Multi-Ion Exchange modelling process and also as a method to estimate the type of clay present in the system through the intrinsic CEC value. In addition, a 1D two-phase system is also the set up to observe the different oil recoveries as function of the injected pore volume when using different equivalent fractions and aqueous concentrations as relative permeability interpolants.

By using these models and a model that reproduce experimental data, a correlation between the CEC and the oil recovery factor is presented which can help to understand more the modelled MIE process