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Wettability behavior of preserved core material compared to dry stored core plugs during a low salinity water core-flooding investigation

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Low salinity water-flooding is an EOR method that potentially modifies the equilibrium of the crude oil/brine/rock (COBR) system to a condition that allows additional oil to be mobilized in the porous media. The uncertainties associated with this EOR method, which has been demonstrated extensively in sandstones and some carbonates, are greater when dealing with a realistic crude oil containing polar components and a rock with highly reactive surfaces. Amongst carbonates, chalk reservoirs are particularly challenging due to their low matrix permeability, high porosity, high degree of heterogeneity, and a high tendency for surface reactions with both crude oil and brine. In the literature, experiments on outcrop chalk cores have been extensively reported, however, there is still a lack of data for reservoir chalk material, and further, there are no results on preserved core material showing how differently they might behave compared to dry stored reservoir core plugs. Preserved core plugs have been stored in a sealed condition with the fluid retained inside the core, while dry stored core plugs have been left open to drying and evaporation of all but the heaviest oil components. There is thus a question of how the wetting condition of the reservoir is represented by the two types of samples. Therefore, besides investigating the role of brine salinity on oil recovery, this work aims to evaluate the effect of using preserved core material on the results through a series of systematic core-flooding experiments on cleaned and dry stored cores and preserved reservoir material. For this purpose, using computed tomography results, reservoir chalk core samples (dry and preserved) without any open fractures were selected. These cores were saturated with reservoir fluids and aged at reservoir conditions for three weeks. Several synthetic brines were introduced through different injection scenarios into the aged cores at reservoir conditions. Insights into the role of brine chemistry were obtained through effluent analyses performed using ion chromatography. Furthermore, the COBR interactions were investigated through post-flooding NMR relaxation time measurements.

Results showed that diluted seawater, compared to normal seawater, has a significant effect on oil recovery when injected at the secondary stage. It is worth mentioning that formation water showed almost the same recovery potential as diluted seawater. Calcite dissolution, deposition of a magnesium-containing phase and the release of sulfate ion were observed at these experimental conditions during DSW injection, even though brines were equilibrated with calcite at room temperature. NMR relaxation experiments reveal that the rock surface for the preserved core is more oil-wet still after the first core flooding experiment, and changes to a more water-wet state after the second experiment on the same core. This means that although a preserved core sample may mimic the reservoir condition better, core flooding results on the same core may not be directly comparable.

Effluent brine analyses and NMR relaxation provide a large body of data that elucidate rock-brine-oil interactions during core-flooding. This work complements low-salinity recovery data in the literature that, at this point, is completely lacking in information from Danish chalk reservoirs.

Time Block Preference

Time Block A (09:00-12:00 CET)

References

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