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IFT and emulsification properties of oil-brine mixtures in the presence of calcium carbonate nanoparticles

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The effect of modified salinity brine on enhanced oil recovery methods are still a matter of active investigations. The rock-fluid-fluid interactions that take place during displacement in the reservoir govern the recovery processes and efficiency and in order to describe these effect it is necessary to understand the interfacial behaviour of the fluids and solid phases involved.[1] This study presents a series of measurements of the interfacial tension (IFT) between a Danish North Sea crude oil and brines of varying salinity and the pressure and temperature dependence of the IFT. The IFT has been measured for high salinity formation water and sea water salinity brines and as well as several dilution levels of sea water in the presence of a 0.5 TAN crude oil. It is seen that while pressure plays a minor role in condensed phases, the temperature dependence of the interfacial tension varies with brine salinity and not in a straightforward manner. These results indicate that certain intermediate salinities lower the IFT to the highest degree rather the lowest salinity tested. In addition, the same crude oil and series of brine compositions were mixed with nanoparticles of chalk to investigate the emulsification properties of ultrafine particles that might be naturally present in the reservoir. A hypothesis about the modified salinity recovery mechanism relates to the formation of microemulsions in the presence of fines, and the emulsification properties are determined by amongst other things the particle size and the IFT between the fluid phases. We present a series of vortexed batch experiments combining the three phases, and the results indicate that the maximum emulsion formation generally takes place at intermediate dilution levels of sea water in the presence of particles less than 100 nm in size. The results are discussed in the context of recovery mechanisms in carbonate reservoirs.

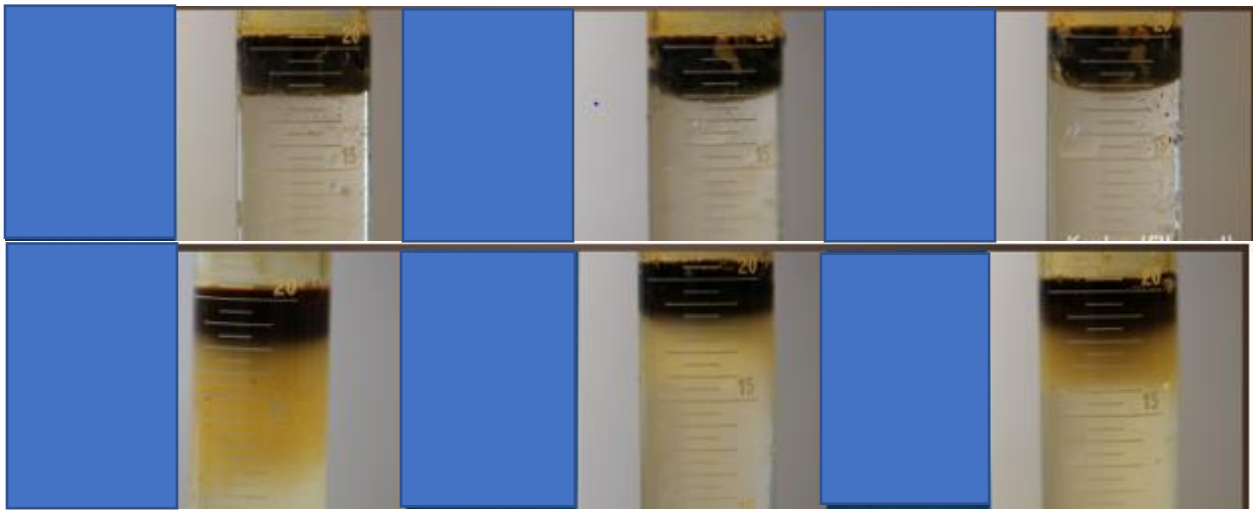

Figure 1. Varying emulsification properties of a Danish North Sea Crude Oil in the presence of chalk nanoparticles ranging from 5 nm to 500 nm and in varying salinity brines. From top left the Salinity varies from high salinity formation water to diluted sea water at bottom right.

1. Mokhtari, R. & Ayatollahi, S. Dissociation of polar oil components in low salinity water and its impact on crude oil–brine interfacial interactions and physical properties. *Pet. Sci.* **16**, 328–343 (2019).

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