Evaluation of the Potential of Salts and Surfactants in Improved Oil Recovery from Unconventional Liquid Reservoirs

Improving oil recovery from unconventional reservoirs is a major challenge the industry is faced with due to the high initial decline rates. A knowledge of recovery mechanisms and interaction of fracture fluid additives with the rock is fundamental in tackling this problem which could help formulate better performing stimulating fluids. Salts have earlier been examined in carbonate and sandstone for low salinity flooding though the principles of wettability alteration hold true for heterogeneous shale reservoirs. Surfactants have widespread uses in the oil industry such as stabilizing fracture fluid additives, in situ foaming and wettability alteration. This research studies focus on analyzing the effect of various anionic, nonionic and complex surfactants as well as monovalent/divalent salts in altering the behavior of unconventional core samples obtained by sidewall coring a South Texas Reservoir and their effectiveness in improving effective ultimate oil recovery.

Research Activities:

- Investigating the effect of various fluid additives on altering the contact angle and interfacial tension of unconventional core samples
- Analyzing the stability of fracture fluids on rock surfaces by measuring their zeta potential
- Conducting spontaneous imbibition experiments with tested salts and surfactants to measure oil expulsion volumes and hence, recovery as a function of time
- Analyzing the penetration magnitude of fracture fluids into core samples with the help of Computed Tomography (CT)

Wettability is found to be altered from intermediate-wet to water-wet when chemical additives are added. This effect is illustrated in Figure 1 where snapshots of an oil droplet on a rock surface in were taken. The ambient phases were water on the left and a tailored brine on the right. As we can clearly see, the oil drop tends to have less affinity to the rock surface in the brine case as lower surface area of the rock is in contact with oil.

The impact of wettability alteration can be seen in the CT scan images shown here where the high density brine displaces lower density oil from the core during spontaneous imbibition which was ineffective with when water alone was the imbibing fluid. These observations open doors to the examination of wettability and IFT alteration in unconventional reservoirs to improve oil recovery as well as obtain a deeper understanding of the chemistry behind wetting changes that can help formulate much cheaper and effective fracturing/injection fluids.

Figure 1. Oil droplets on shale rock surface in the presence of water (left) and brine (right)

Figure 2. CT scan images showing the penetration of high density brine (yellow-orange) into the core samples thereby displacing the lower density oil (purple)