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The role of multi-mineral pores in mixed-wet behavior of the Montney tight oil play

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Problem

This paper presents comprehensive rock-fluids experiments to investigate wetting affinity of the Montney tight oil play using reservoir rock and fluids. Wettability characterization is essential for selecting optimum fracturing fluids by completion engineers and for selecting appropriate relative permeability and capillary pressure curves by reservoir engineers. Application of the conventional techniques for wettability evaluation of tight rocks is challenging primarily due to their extremely low permeability and complex pore structure. The objective of this paper is to develop an alternative laboratory protocol for evaluating the wettability of tight oil rocks reliably.

Methodology

First, we conduct comparative spontaneous imbibition tests on twin fresh core samples from two different wells drilled in the Montney formation. Then, we measure brine/oil contact angle for all samples. To characterize the samples, we conduct SEM/EDS analysis. In the second part, we perform counter-current imbibition experiments on partly saturated samples. The objective is to investigate the possible displacement of oil (or brine) by brine (or oil) spontaneously. We visualize the expelled oil (brine) droplets and measure the accumulated produced oil (brine) volume.

Results, Observations, and Conclusions

Both oil and brine spontaneously imbibe into the fresh samples, composed of quartz, carbonates (dolomite/calcite), clay minerals, feldspars, and organic matter. The results indicate that the effective pore network exhibits a mixed-wet behavior. Moreover, brine spontaneously imbibes into and forces the oil out of the oil-saturated samples, while oil cannot imbibe into the brine-saturated samples. This indicates that in the presence of both oil and brine, the rock affinity to brine is higher than that to oil. SEM/EDS results also show that presence of multi-mineral pores may be responsible for mixed-wet behavior of the Montney samples. Pores are surrounded with different minerals. Some minerals including quartz, clay and feldspars tend to be more water-wet while carbonates and organic matter tend to be more oil-wet.

Applications

The experimental data and interpretations presented in this paper leads to an improved understanding of wettability and rock-fluid interactions in the Montney tight oil formations. The results of this paper will help the industry to optimize fracturing fluid formulation and soaking period.