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Chemically enhancing post-fracturing oil recovery in the Duvernay Formation of Alberta

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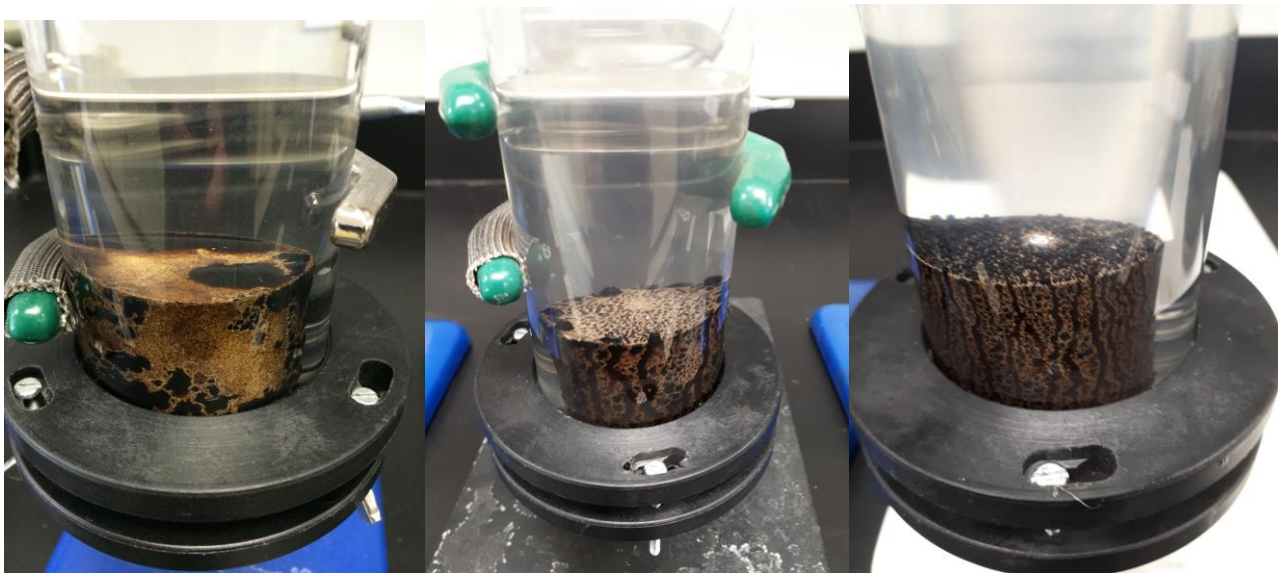
Abstract

The Duvernay Formation is characterized as a Devonian carbonate-siliceous tight source rock in the Western Canadian Sedimentary Basin. In the southern Duvernay Shale Basin, tight limestone beds are interbedded with laminated organic-rich shales, which show maturity ranging from early oil to condensate window. The nature of these deposits requires hydraulic fracturing to increase stimulated rock volume and access large reservoir volumes. General completion programs involve >50 plug 'n' perf of slickwater or hybrid fluids (~40-50,000 m3) with >4000 t of proppant per well, which often exceed 2000 m in lateral length. The large water volume pumped will inevitably interact directly with the rock surface in the stimulated area and cause both oil-water and rock-water interactions including imbibition.

Here we present some laboratory investigations to identify the effect of imbition of the fluids with oil-saturated Duvernay rock material to identify and estimate oil-recovery. For the experiment, we utilized Duvernay shale sample material and oil produced within the vicinity of the well. Several critical aspects had to be addressed including identifying optimal surfactant loadings and thus fluid-fluid interactions. The data was used to produce an optimal surfactants for the hydrocarbons in place. Rock samples were saturated with oil, placed in Amott-cells at room temperature, and filled with various fluids to initiate the spontaneous imbibition experiment. The results presented illustrate that an innovative nanomolecule surfactant plays a critical role in changing the interfacial tension and enhances oil-recovery from these samples. We present data and illustrations to explain potential mechanisms behind the interaction.

The data illustrate the importance of testing surfactants and rock-fluid interactions to optimize oil recovery in both the short and long-term range. We believe that with rigorous pre-stimulation testing, spontaneous imbibition in unconventional rocks can be artificially manipulated to enhance forces that expel or release liquid hydrocarbons. Critically to this approach is the assurance of demulsification of the fluids with both condensates and oils.



Area of oil drainage increased in core sample when exposed to different surfactants: Blank (Left), synthetic sulfonate (middle) and nano-molecule surfactant (right)