Re-Purposing Produced Water: Helping Solve Industry Water Problems

Customer Need

The large volumes of water required for various completion strategies in Unconventional Reservoirs create challenges in regions where fresh / low-salinity water resources are scarce. The use of Produced Water is gaining traction amongst operators as a means of reducing the fresh water footprint of these hydrocarbon production practices.

The focus is on the effects the production water has on the reservoir, including the rock matrix and the liquids. Once the interactions between injected fluids and the reservoir are understood, then strategies for optimizing the water treatment procedures can be developed. A primary goal is to improve reservoir performance by tailoring the water treatment practices to minimize damage created by scaling and microbial processes.

Methods and Materials

A project like this extends across disciplines thus requiring different skillsets and collaboration between several groups, including water and rock analysis, treatment efficacy of biocides (to minimize microbial activity over short to long-term time periods), and fluid compatibility tests between oil and water phases. Samples of water and rock are collected under industry-standard protocols and analyzed with a combination of API/ASTM methods and advanced core analysis techniques developed at Premier. Special emphasis is placed on field-site measurement of pH and HCO_3 - that provides a baseline for work done later in the laboratory. Major and minor elements found in the Produced Water are analyzed with conventional ICP-OES instruments, while anionic species are captured by titration and HPLC methods.

Identification of the formation's mineralogy is critical in identifying sensitive phases that would react to the introduction of Produced Water. Premier's combination of XRF-based elemental analysis and XRD-based mineralogy provides sufficient quantification of the formation's matrix composition. Standard CST and Roller Oven tests help identify which water chemistries create greater changes in the formation's compatibility. Bench-top tests to evaluate the effectiveness of emulsion breakers are complemented with analytical techniques to measure various aspects of wettability, such as contact angle, surface, and interfacial tensions.

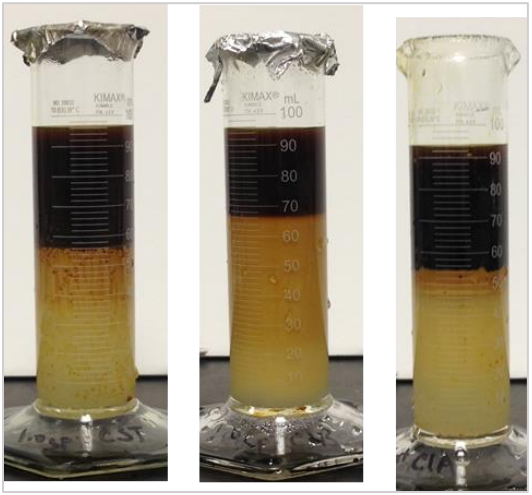

Figure 1: Benchtop Emulsion Testing to study the efficacy of emulsion breakers

Microbiologists evaluate the effectiveness of various biocides on the specific microbiota associated with a particular reservoir interval. Since micro-organisms can be introduced at

various stages of the water injection process, ranging from the original source water, additives to drilling and injection fluids, or those residing in the reservoir, a complete analysis program must be developed to handle biocide requirements through the life of the program.

Initial screening tests on the formation rocks can be accomplished with well cuttings, though as the questions and concerns become more focused, the need for intact core plugs for testing becomes more critical.

Results of the Analysis

Produced Water chemistry is provided in a searchable database along with the basic measurements of mineralogy and rock chemistry. The fluid-rock sensitivity tests, CST, Roller Oven, are typically reported just as single (discrete) numbers, but often there is value in reviewing the raw data from these tests. The effectiveness of the emulsion breakers is often best observed in images of the sample bottles, though quantitative measurements of the fluid separation are also useful. Spontaneous imbibition tests that determine the interactions between rock, water and oil, are best analyzed by the time-dependent production of oil in the cell. These results are then converted to a dimensionless time basis that allows for direct comparison of imbibition rates and effectiveness by removing contributions of the different samples' petrophysical properties.

The evaluation of the effectiveness of different biocides is placed into the context of Quick Kill to Long-Term Protection strategies. Possible interactions between these biocides and the mineral matrix are considered to be critical given the fine-grain nature of most of these reservoirs.

Discussion

The use of Produced Water as the frac fluid will decrease water usage, the need for disposal wells, and improve public relations. Re-purposed produced water will not only add value by reducing costs for the operator, but will also help solve associated water problems in the industry.

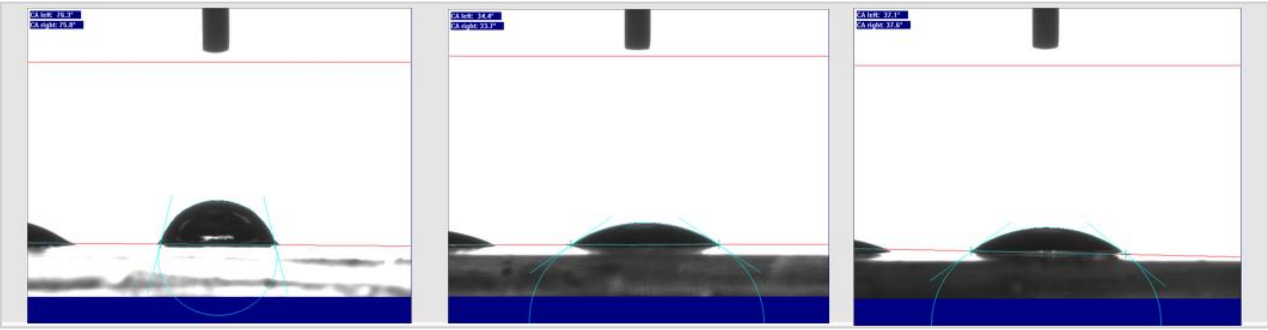

Figure 2: Image of Contact angle experiments showing preferential water-wetness (left) and preferential oil-wetness (right)