Paper Summary

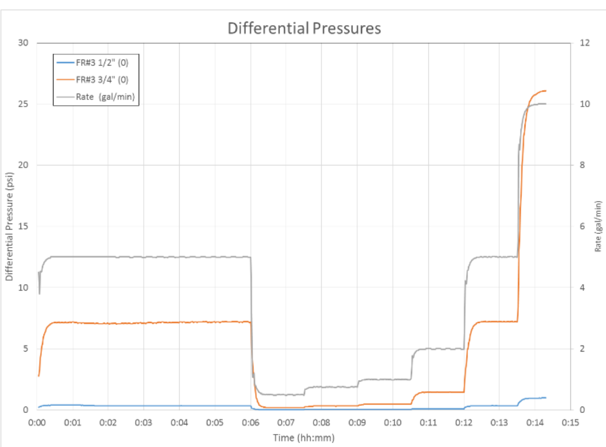
A Slippery Slope for Friction Reducers in Produced Water

"A gem cannot be polished without friction, nor a man perfected without trials", Seneca

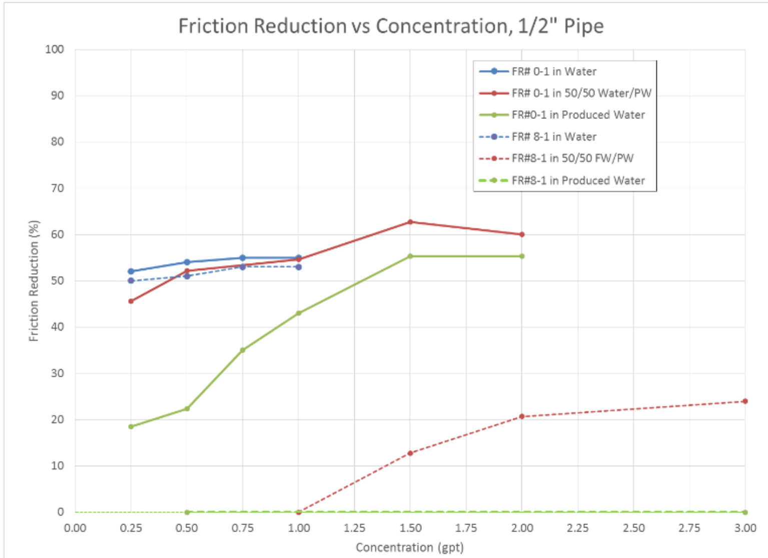
As the shale development progresses, the industry seeks to apply more sustainable practices which includes the recycling of produced water. It is on a slippery slope when evaluating produced water for consideration for effective friction reduction – some Friction Reducers (FRs) cannot handle high salinity in produced water. Liberty evaluated several products that can work with the high-TDS produced water from the Bakken Formation.

Liberty's Williston flowloop helped identify several commercially available FRs to effectively reduce pipe friction in high-TDS produced Bakken water.

From an economic and environmental point of view, reuse of produced water in the Williston Basin is a sustainable practice to conserve water and save on well completion cost. Several technical challenges accompany the application of produced water in well stimulation including stimulation design, execution, and effectiveness. Considerable attention is required regarding fluid chemistry including stimulation additives, guar-based gels, crosslinkers, and friction reducers (FRs) used in slickwater. Effective friction reducers are critical for slickwater jobs that are pumped at high rates of 70 bpm and the early slickwater stages using in hybrid fracs (combination of gel and slickwater). Achieving that high rate is key to effectively divert fluid flow and maintain sufficient rate to transport proppant in a long lateral.



Various experimental and commercial FRs were screened using Liberty's Williston flowloop to determine their individual effectiveness with fresh water and produced water. The plot above shows and example of a typical 15-minute flow loop test at different rates, showing differential pressures and associated friction reduction as compared to water in the 1/2" and 3/4" sections. The efficiency of a few tested FRs was also measured in actual field treatments, so that we were able to conduct a comparison of the frictions measured in field and lab to provide a methodology for proper comparison of the two, enabling a reasonable forecast of frictions measured in the lab to pipe frictions expected under field conditions.



Error! Reference source not found. As an example, the graph above shows friction reduction for sample FR#8-1 (dashed lines) and sample FR#0-1 (solid lines) as a function of FR concentrations in fresh water (blue), 50/50 fresh water/produced water (red) and 100% produced water (green). Both products show similar friction reduction ability in fresh water, with the cheaper FR#8-1 showing about 50% friction reduction versus about 55% for FR#0-1.

Once water and produced water are mixed at 50%-50%, FR#0-1 only partly deteriorates, and only at the lower FR concentrations. At 0.25 gpt it can reduce frictional pressures by 45%, while it maintains 50% friction reduction at 0.50 gpt and friction reduction gets to 60% when concentrations of 1.5 gpt are used. FR#8-1, however, has deteriorated completely, providing no noticeable friction reduction up to concentrations of 1.0 gpt. FR#8-1 can get to about 20% friction reduction for a 50/50 fresh water/produced water mixture when concentrations of 2.0 gpt and higher are used. These observations were further confirmed for 100% water.

The friction measurements in this paper helped to better determine expected surface pressures and maximum injection rates for alternative tubular designs for slickwater treatments, specifically with the use of a frac string.

More information

SPE paper 169497: “Technical Implementation and Benefits of Use of Produced Water in Slickwater and Hybrid Treatments in the Bakken Central Basin”, by Griffin et al.