CASE STUDY

Interface Fracturing Fluid Optimization

Primexx reduces chemical cost >50% using Interface Fluidics' fracturing fluid optimization solution

Challenge

- Reduce fracturing fluid costs without sacrificing production.
- Develop a workflow for chemical selection and optimization that addresses pad by pad variability.
- Quantify performance impacts of high TDS brines vs. fresh water for produced water applications.

Solution

- Screen 7 products from 5 vendors in reservoir representative analogues in Interface's laboratory at HPHT using Interface's Fracturing Fluid Optimization service.
- Isolate and quantify variables affecting chemical performance (temperature, pore throat size, brine salinity, and wettability).

Results

- Chemical cost was reduced by >50%.
- Project ROI achieved >10X.
- Chemical loadings were reduced from 1.5 GPT to 0.5 GPT, a reduction of 300%.
- Optimal chemistry for the well in question was identified in <1 month.

Quote from Primexx:

In a sea of surfactant marketing claims, Interface's work has provided me an informed position from which to move forward on field scale trials.

– Michael Mast, Technical Completions Lead

PRIMEXX ENERGY PARTNERS

Abstract

Primexx Energy Partners Ltd. (Primexx), a technology focused oil-and-gas exploration and production company operating in the Southern Delaware Basin of West Texas, approached Interface to ensure they were using the most cost effective and highest performing chemical additives in their fracturing operations. Interface screened seven products from five vendors. Through Interface's screening process, Primexx was able to qualify a new vendor, reduce chemical loadings by 3x from previous wells without impacting initial production, and achieved a chemical cost savings of over 50% compared to their prior well fracturing program.

Closing the gap in fracturing fluid screening

Oil and gas operators have been flooded with new chemical providers making performance claims about their additives and promoting their unique mechanisms for mobilizing trapped oil. Operators are then left to evaluate and verify these claims which can be a costly and time consuming process using typical laboratory methods.

Fracturing fluids are typically evaluated using a combination of laboratory methods such as packed column tests, bottle testing, interfacial tension measurements, Amott cell imbibition testing, core flooding, among others. Each of these methods lack critical experimental parameters required to be representative of a fractured shale system such as high temperature, high pressure, repeatable porous media, and representative nano-confinement. In particular, Core flooding experiments, typically applicable to conventional reservoirs, cannot be effectively used with shale due to the ultra-low permeability and associated long runtime.

Interface adresses the challenges and limitations of traditional testing methods using proprietary reservoir analogues and associated test methodologies. In addition to being able to screen fluids and their interactions quickly, Interface's technology accounts for the unique conditions of each well.

Achieving Sustainability Goals

Primexx is very conscious of the environmental impact of its operations and uses produced water in its fracturing process. Fracturing using produced water is an attractive prospect from a sustainability and environmental impact perspective and can significantly reduce the cost and logistics associated with fresh water fracturing. Produced water and temperature have significant and often unpredictable impacts on chemical performance, especially with the surfactants and polymers required in fracturing operations.

A key Primexx objective with approaching Interface was to find a testing methodology that could qualify new chemicals in a highly saline environment, at reservoir temperature.

Additionally, oil and gas operators have a tremendous opportunity to reduce environmental impact by making informed decisions on chemicals and concentrations. Chemistry employed in the oil and gas industry has major embedded energy costs and associated CO2 emissions. Surfactants for example are produced at a rate of 14 Mt/yr globally, and the production of each tonne results in ~4.7 tonnes of CO2 on average [1]. The volume of chemistry on the well completed with the recommended product corresponds to 35 tonnes of CO2 emissions avoided - the equivalent of taking ~7.5 cars off the road.

Laboratory results predicted field results

After engaging Interface, Primexx met with Interface's team to develop a screening matrix to evaluate a large suite of stimulation additives. A key Primexx objective was to quickly de-risk changes to chemical loadings for an upcoming WolfCamp well (Well B) within a couple of weeks.

Primexx provided Interface with seven chemistries from five vendors and each product was tested at two concentrations, 0.5 Gallons per Thousand (GPT) and 1.5 GPT (Table 1). Testing was run at temperatures of 150o F with connate water at 51,000 TDS and oil from an offset producing well in the Wolfcamp. All tests were conducted at two distinct frac water salinities including 91,000 TDS and fresh water (<1,000 TDS) to evaluate their performance in produced water fracs. A baseline control was run with fresh water and no chemistry.

Laboratory Results

Interface evaluated each chemistry under reservoir conditions. Of the seven chemistries tested, the results showed a clear top performer (P4) in both the 0.5 GPT and 1.5 GPT loadings. The top performing additive performed best at a lower concentration than anticipated, allowing more oil to flow back in a set period of time.

Using these results Primexx decided to switch chemical vendors and completed the Well B using Sample P4 at a loading of 0.5 GPT.

	0.5 GPT Volume of oil flowed back (nL) (% Change)		1.5 GPT Volume of oil flowed back (nL) (% Change)	
Fluid additives	**91,000 TDS**	**Fresh**	**91,000 TDS**	**Fresh**
Control (Brine)	21±5	47±5	21±5	47±5
Sample P1	25±4 (+19%)	-	33 (+57%)	-
Sample P2	28 (+33%)	-	33±4 (+57%)	-
Sample P3	30 (+43%)	55 (+17%)	48 (+129%)	65±12 (+ 38%)
Sample P4	89±13 (+324%)	60±11 (+28%)	74±9 (+252%)	60±6 (+28%)
Sample P5	24±6 (+38%)	38 (-19%)	22 (+5%)	43±10 (-9%)
Sample P6	49 (+133%)	38±7 (-19%)	40 (+90%)	43 (-9%)
Sample P7	32 (+52%)	-	23±2 (+10%)	-

Table 1. Results of Rapid Surfactant Screening, showing Volume of Oil Flowed Back (nL) and Improvement Over Control (%) in high and low salinity cases.

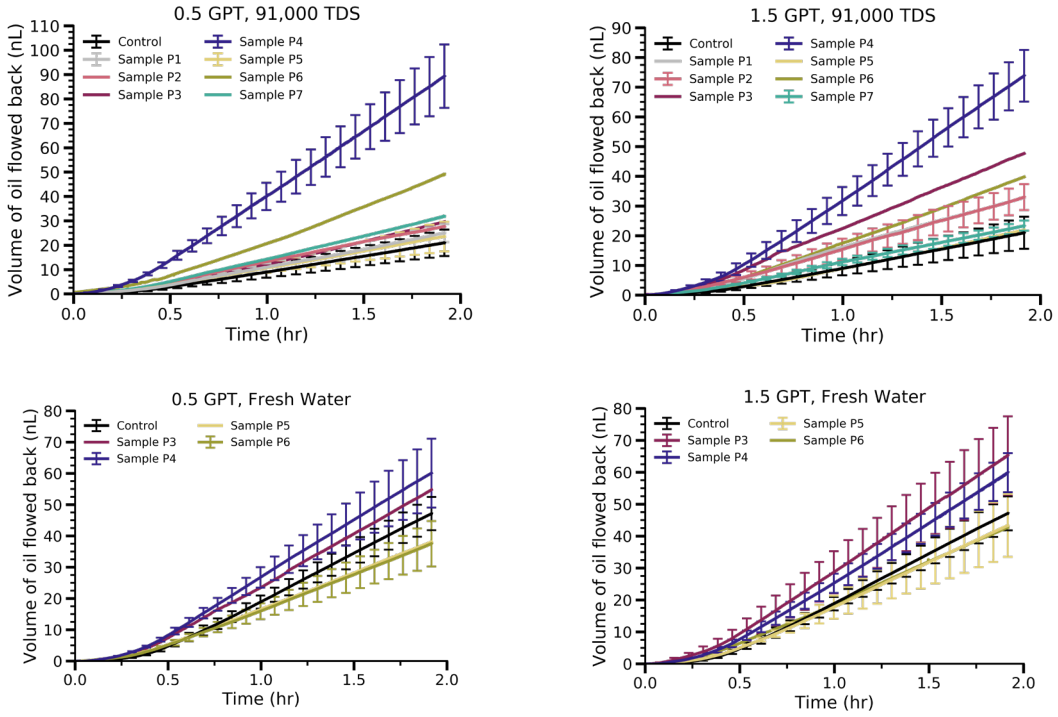

Figure 1. Laboratory Results showing Volume of Oil Flowed Back over Time.

Field Results

Well B was completed with chemical (P4) at a 0.5 GPT loading and compared against an offset well (Well A), which was completed with a different chemical (P5) at a 1.5 GPT loading. Six months of production data was plotted, giving insights into the field performance of the new chemistry compared to the legacy chemistry.

Well A produced 146,000 barrels of oil during its first 180 days on production. Well B produced 156,000 barrels of oil in the same time, a 6.5% increase.

It should be noted that relative changes in cumulative production may be impacted by localized differences in relative reservoir quality and production differences. However, the conclusion can be drawn that the change did not have a negative impact on oil production in Well B, and likely a positive impact.

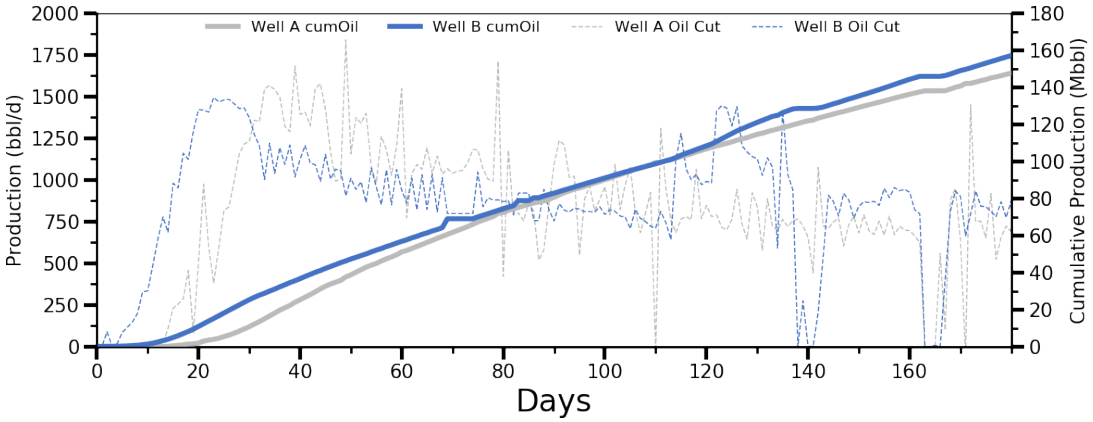

Figure 2. First 180 days of production from Well A (Offset Well) and Well B (Test Well)

Flowback Solution Overview

Interface's Flowback solution uses a reservoir analogue, in place of core, in an experiment similar to core flooding. The reservoir analogue had a porous pattern replicating the inherent geometries of the reservoir rock based on available petrophysical information provided by Primexx.

The heterogeneous dual-porosity dual-permeability reservoir analogue was connected to fluid handling and optical microscopy systems. Prior to testing, the wettability of the reservoir analogue was modified to reflect that of the reservoir. The system was then used to assess the performance of different flowback chemistries under reservoir relevant conditions gathered from the field. The average pore throat diameter, porosity, and permeability were matched at 85 nm, 5.4%, and ~1 µD, respectively. Temperature was set at 150 Fahrenheit and reservoir pressure used was 3,300 psi .

Interface's Flowback solution allows for visualization at the pore scale. This pore scale visualization is key to understanding chemical performance, and is a unique capability of Interface's technology. Proprietary machine vision software ensures standardized analysis that is independent of the experiment operator. As such, Interface's testing provides insights into the mechanism behind chemical performance or damage if present in a controlled environment not possible with other technologies.

Interface's methodology also allows for true repeatability as the entire system, including the porous media, is highly controlled. The only variation in the testing protocol was the stimulation fluid being used. The system required less than 10 mL of oil and test chemistry to run a single test, facilitating easier sample handling and shipment logistics from the field to the laboratory. This repeatability ensures that all future chemistry or testing that Primexx performs is directly comparable, leading to a database of comparable results not achievable with other technologies.

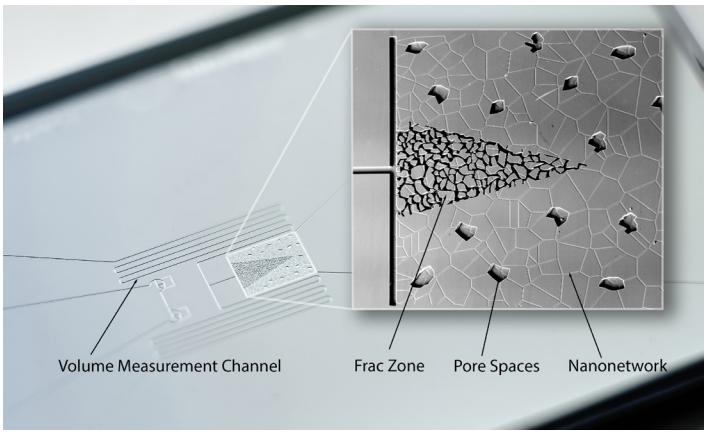

Figure 3. Schematic of the microfluidic reservoir analogue used for Primexx. Left image shows the test system including the volume measurement channel. The volume measurement channel allows for picolitre accurate flowrate measurements when combined with proprietary analysis software.

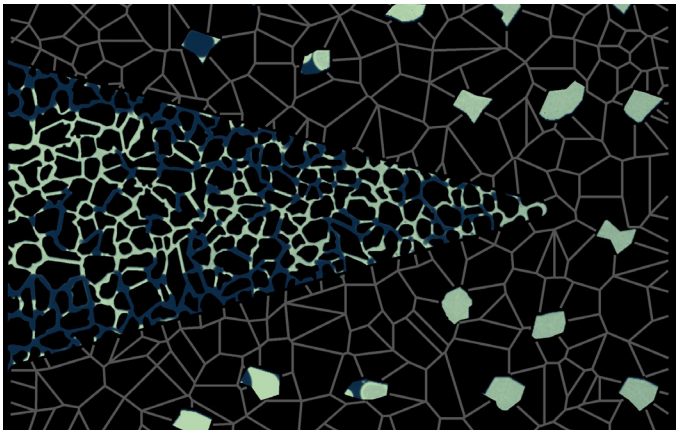

Figure 4. Image of oil flowing through the microfluidic device during flowback. Direction of flow is Right to Left

Conclusion

Interface's Flowback solution enabled Primexx to rapidly evaluate a wide range of stimulation fluids for an upcoming well. Seven stimulation fluids were evaluated, and a clear top performer was identified. In addition to optimal chemical selection Interface's testing also revealed that a decrease in loading from 1.5 GPT to 0.5 GPT improved performance of the additive. Using the information gained from Interface's Flowback Testing, Primexx changed their injected chemistry for an upcoming well and found that the change in chemical did not cause any hinderance to oil recovery, while saving over 50% in chemical costs.

Interface's technology platform enables operators to optimize fluids, prevent reservoir damage, and de-risk operations, through better, data-driven decisions. The result is improved economics, well performance, and overall environmental sustainability.

[1] Patel, M., Theiß, A., & Worrell, E. (1999). Surfactant production and use in Germany: Resource requirements and CO2 emissions. Resources, Conservation and Recycling, 25(1), 61-78. doi:10.1016/s0921-3449(98)00063-9