CASE STUDY

Interface Fluidics Regain Conductivity

Select Chemistry and Interface introduce a new tool to prevent damage and reduce customer costs

Challenge

- Reduce the cost and time of optimizing friction reducer (FR) selection.
- Quantify performance impacts of high TDS brines vs. standard 2% KCl brine for produced water applications.
- Minimize the uncertainty of FR selection associated with traditional methods.

Solution

- Tested a comprehensive suite of FRs to capture variables impacting performance.
- Isolated and quantified variables affecting friction reducer performance such as concentration, temperature, brine salinity, and breaker.
- Applied Interface's regain conductivity method to provide repeatable and reliable results.

Results

- Ran 20 regain conductivity tests in 12 days, saving two months in laboratory time and more than 50% in costs compared to conventional methods.
- Quantified the impact of breaker addition, FR type (powder vs. slurry), and brine salinity.
- Demonstrated a method with less than 5% variability, providing more reliability and differentiation between products compared to traditional methods of up to 80% variability[1].

SELECT CHEMISTRY

The Objective

Select Chemistry, a chemical and logistics solutions provider in the United States, has a unique understanding of the specialized needs of its clients. The company offers a wide range of products for well completion and stimulation, with targeted research and expertise to ensure the best product reaches the market. Part of the evaluation that goes into launching a new product – or optimizing an existing one – is to quantify and mitigate friction reducer damage.

Select recognized an opportunity to leverage Interface's microfluidic platform for rapid and repeatable screening of friction reducers and the many variables that impact well-specific performance. The ability to screen nine friction reducers at varying loadings, breaker concentrations, temperatures, and salinities enabled Select to gain key insights into specific FR performance in a fraction of the time and cost of conventional proppant pack testing. Interface's rapid and repeatable proppant pack alternative offers a unique platform to optimize their chemical offerings – and meet client needs in an efficient and cost-effective way.

"Interface's Regain Conductivity solution will be our preferred screening tool going forward, helping us quickly screen for damage potential and determine fluid compatibility."

Brian Price, VP of Technology & Strategic Optimism at Select Chemistry

Optimizing the Friction Reducer Suite

Operators and chemical suppliers rely on the industry standard of proppant pack testing to provide insights into friction reducer damage. However, proppant pack testing is known to have high variability, up to 20% between operators and 80% between labs[1], adding a caveat to many of the results. Additionally, high costs and slow turnaround times prevent proppant packs from being an ideal screening tool for optimizing the friction reducer package.

Interface's regain conductivity solution is an ideal platform for rapidly evaluating fluid-fluid interactions, due to the system control, high repeatability, and low sample volume requirements. With the capacity for scalability, multiple regain conductivity tests can be run per day, reducing the time per run from days to mere hours. Because of this, Interface's platform is an ideal tool for not only measuring friction reducer damage, but also quantifying the effectiveness of breaker, the impact of brine salinity, variance in chemical loadings, and temperature screening – not to mention delivery methods like liquid vs. powder. The result is a customized FR suite with the right parameters to meet client-specific problems.

Regain Conductivity Design 2.0

Select approached Interface with a seemingly simple challenge: to make regain conductivity testing faster. To meet this challenge, Interface designed a Regain Conductivity 2.0 analogue. The new design features two independent porous media per analogue, which can be run in parallel – doubling the laboratory throughput per bench. The permeability is fixed at 1 Darcy and the analogues are identical. This highly repeatable proppant pack alternative enables differentiation between chemistries that were not capable of being resolved in traditional systems, due to low repeatability, high permeability, and fluid by-passing effects.

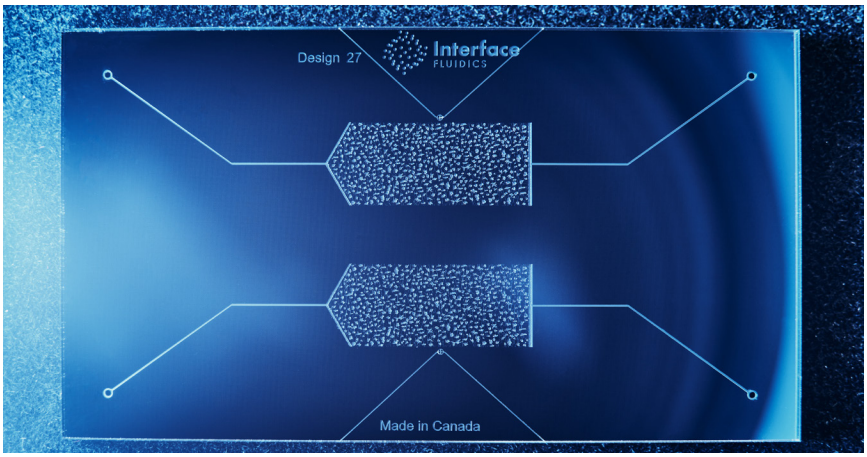


Figure 1 Microfluidic reservoir analogue used for regain conductivity screening, featuring a dual porous media design.

The Results

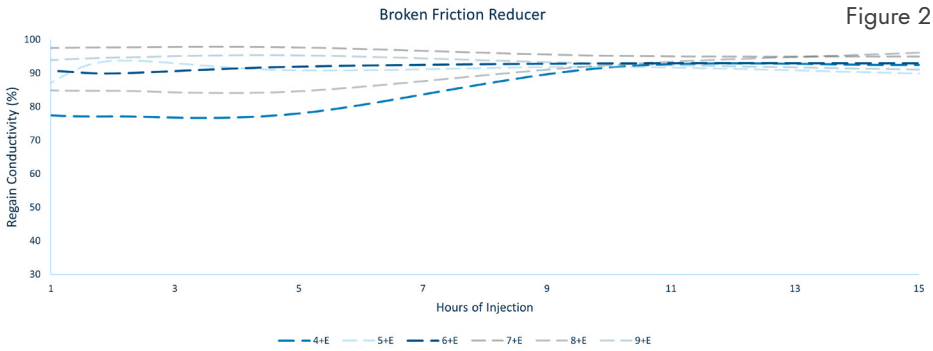
To show the advantages of its testing, Interface evaluated each chemistry in a standard proppant pack analogue of 1050 mD. The damage factor was calculated and converted into a relative regain conductivity (%) trend over time.

$$\textbf{Damage Factor} = \left(\frac{\Delta P \text{ brine final}}{\Delta P \text{ brine initial}}\right)$$

Select screened six unique friction reducers, with and without breaker. An additional three FRs were selected to further investigate the impact of a higher salinity API brine, in addition to breaker. The results of the initial six FRs are shown in below in Figure 2 and Figure 3. The results demonstrated that in all cases, broken friction reducer produced less damage than unbroken friction reducer. However, the end state regain conductivity does not tell the whole story. By comparing their performance over time, certain FRs clearly stand out from others.

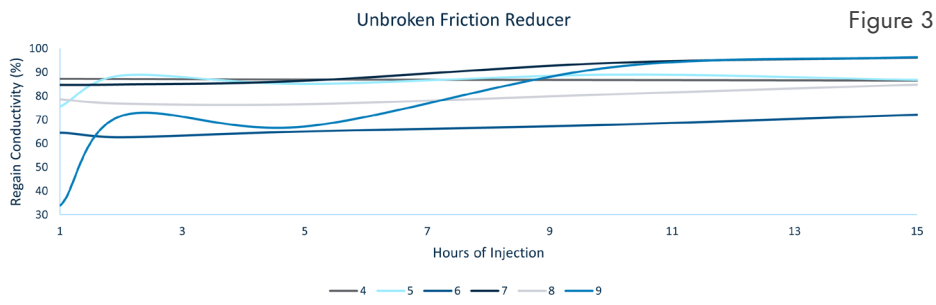
For example, FR4+E and FR6+E resulted in the same final regain conductivity value after 15 hours of 2% KCl brine injection, shown in Figure 2. However, FR6+E achieved a 90% regain conductivity after the first hour of injection, compared to ten hours of injection for FR4+E. In the case of unbroken friction reducer, shown in Figure 3, FR7 and FR9 resulted in the same final value.

Figure 2



Although both FRs produced a low amount of damage in the reservoir analogue, FR9 demonstrated high plugging tendencies and solubility challenges over the first half of injection. Key insights are gained from evaluating FR performance in a highly controlled system from solubility of the FRs, injectivity problems, and long-term performance.

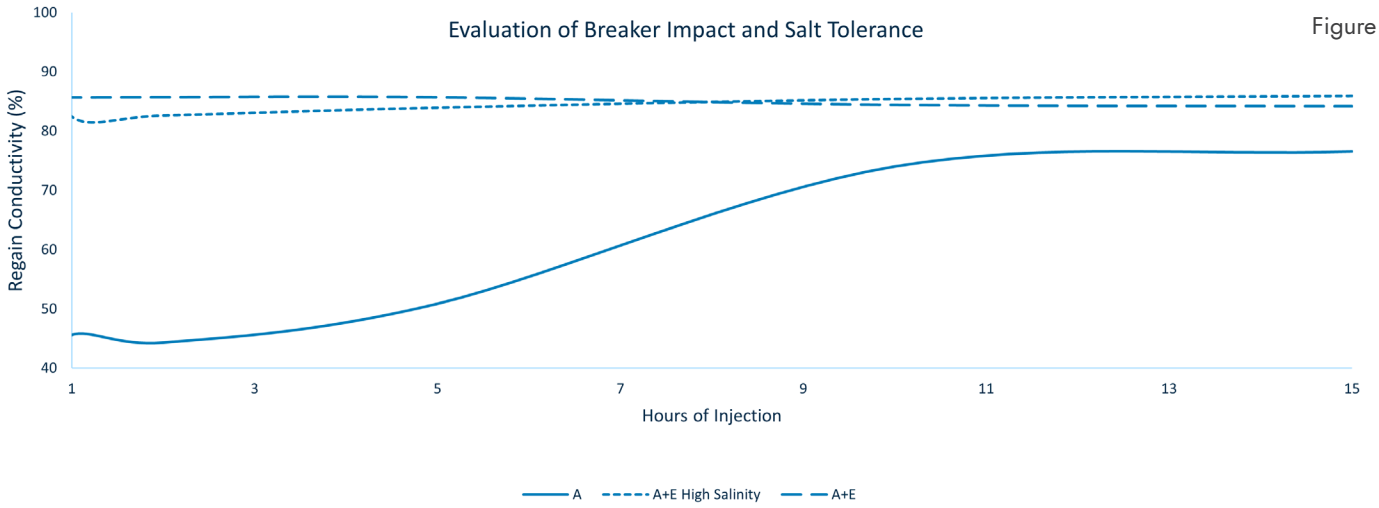
Figure 3



Further analysis of impacts of a higher salinity API brine are shown in Figure 4.

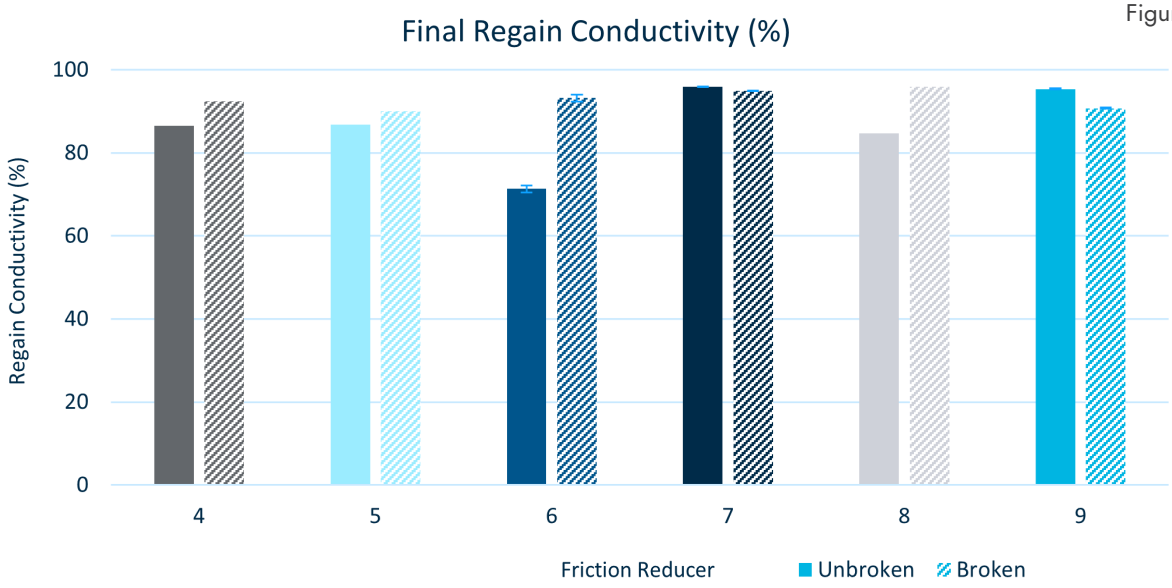
To quantify the impact of salinity, three of the nine FRs were screened in a high salinity brine. FRA is shown in Figure 4 to demonstrate the results in high salinity. Initially, FRA was screened with and without the addition of breaker. The results clearly showed that FRA performed better with breaker. Unbroken FRA took longer to stabilize and resulted in a lower final regain conductivity value. As such, the better performing, broken FR was then prepared in an API brine consisting of 8.5% NaCl and 2.5% CaCl2. Demonstrating a good salt tolerance, the broken FR showed minimal differentiation in API brine compared to the standard 2% KCl brine. Interface's platform enables further analysis of factors like varying brine salinity, the impact of iron, temperature effects, and breaker loading, giving valuable insight into specific FR performance. As a result, custom FR packages can be designed to overcome well-specific needs.

Figure 4



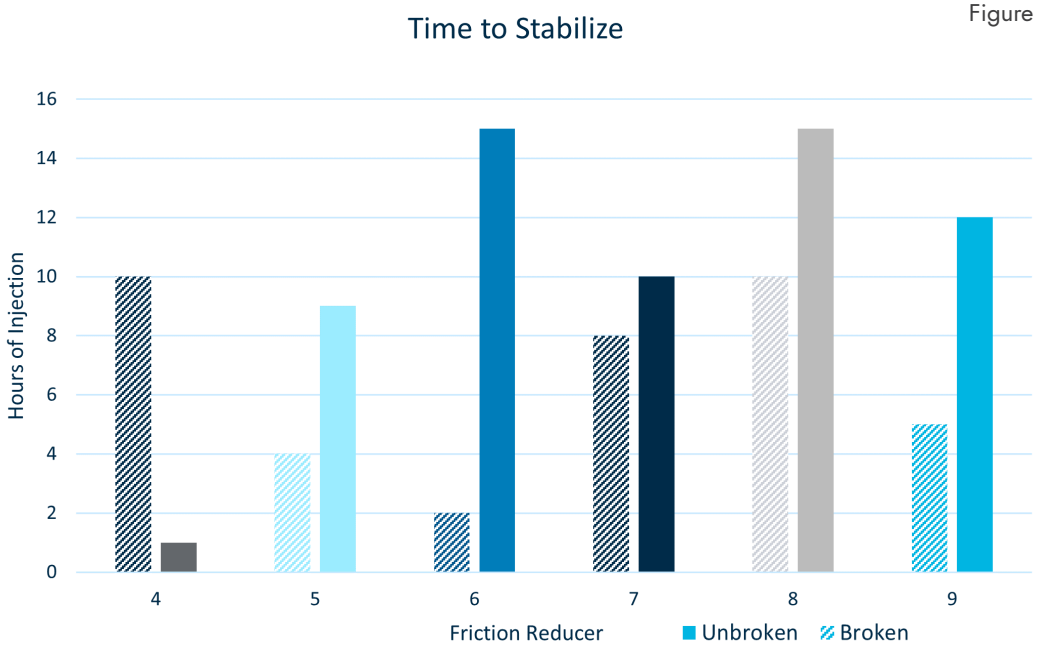
While the final relative regain conductivity value may not tell the whole story, ultimately, the damage caused by an FR is a determining factor on whether it will be used in the field. Figure 5 provides a ranking of the FRs from highest to lowest final regain conductivity. In general, the broken FRs ranked higher than unbroken FRs. FR7 without breaker performed similarly to broken FR7. In cases where broken and unbroken FR result in a similar amount of damage, the addition of breaker may only increase the cost, but not the performance of the chemistry. However, some FRs clearly benefit from adding breaker. For example, FR6 without breaker performed the worst, but with the addition of breaker made its way to the middle ranks. Interface's regain conductivity screen tool can be used to not only determine whether or not a breaker should be used, but also to understand how much breaker is needed for optimal loadings.

Figure 5



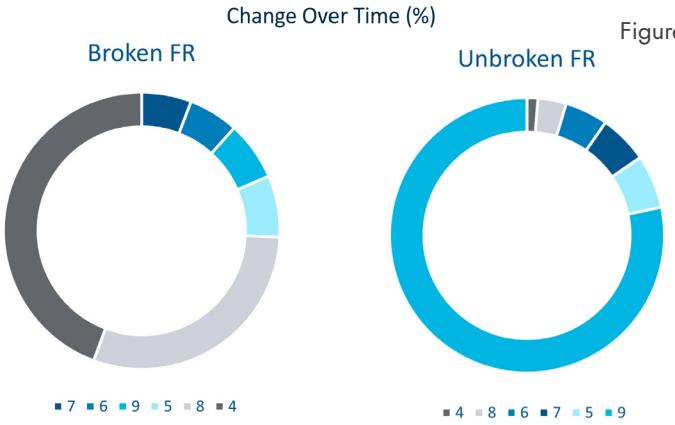
Evaluating the performance of friction reducers over time provides additional insights beyond reservoir damage. The bar plot, Figure 6, shows the time required for each FR to reach a stable regain conductivity value. In all cases, except FR4, unbroken FR took longer to reach stability than broken FR. Figure 7 shows the relative change in regain conductivity over the course of injection. Looking at unbroken FR9, it took over 12 hours to reach a stable regain conductivity (%) and demonstrated the highest relative change in regain conductivity (%) during injection. This behaviour may indicate unfavourable solubility challenges associated with the unbroken FR or injectivity problems.

Figure 6



In comparison, FR5 exhibited the same relative change in regain conductivity throughout the test for both broken and unbroken FR. However, unbroken FR5 took approximately twice as long to stabilize. Interface's highly repeatable testing allows for a consistent determination of regain conductivity (%), as well as the behaviour of FRs over time – helping to answer questions about FR performance unseen in other methods.

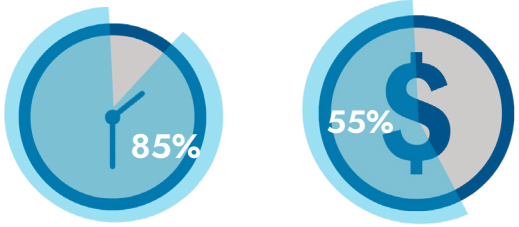
Figure 7



Conclusion

Interface's regain conductivity solution enabled Select to rapidly evaluate a wide range of stimulation fluids and quantify the impact of breaker and brine salinity – and the methodology proved to be an ideal screening tool for friction reducer selection and optimization. Select required quicker turnaround on FR data, inspiring Interface to design a dual proppant pack analogue, doubling throughput, and further reducing turnaround time. Interface's rapid turnaround and high repeatability allows for trusted results 8 times faster than proppant pack testing.

The technology platform created by Interface Fluidics enables the oil and gas industry to evaluate new chemistries and optimize existing products, ensuring their client receives a customized completions solution. Working with Select, Interface accomplished the goal of using its regain conductivity alternative as a tool for mitigating damage and optimizing fluid compatibility. The results provide highly customized products for completions and stimulation, for a fraction of the time and cost of conventional testing.



Interface's test saves 85% of the time and 55% of the cost compared to proppant pack testing.

[1] *Ref: Anderson, R. (2013). Performance of Fracturing Products. Chandler: US SILICA*