CASE STUDY

Interface FLUIDICS

Interface Fluidics Regain Conductivity

Interface and Ovintiv commercialize a rapid regain conductivity alternative

Challenge

- Develop a method for friction reducer selection and optimization that is repeatable, fast, and cost-effective
- Quantify the relative performance of friction reducers in a highly repeatable porous media at least as accurately as traditional methods
- Validate a new method against conventional proppant pack style testing

Solution

- Replace high-variability proppant packs with Interface's microfluidic technology
- Isolate and quantify variables affecting friction reducer performance (concentration, temperature, brine salinity, and breaker)

Results

- Reduced cost of measurement by >50%
- Reduced time per measurement by >75%
- Chemical performance was clearly differentiated between products, especially in top performing friction reducers
- Demonstrated a highly repeatable method against traditional proppant pack screening

Quote from Ovintiv:

Interface's Regain Conductivity solution provides us with a novel tool to make better decisions for our completions. We are faced each day with new and innovative products that could have major impacts on our economics, and this method gives us another platform to guide our decisions more confidently.

- Ashley Kalenchuk, Completions Advisor

Ovintiv

The Objective

Ovintiv is a leading North American energy producer keen on driving innovation within industry. Quantifying friction reducer performance is a necessary part of Ovintiv's workflow, playing an essential role in reducing formation damage and optimizing flowback. Together, Ovintiv and Interface recognized an opportunity to address the technical challenges, such as high variability, and the inefficiencies associated with proppant pack testing using Interface's microfluidic technology. A solution was found that reduced cost and time while increasing run-to-run repeatability, realizing a step change in how friction reducers are evaluated, with the potential to revolutionize the formation damage measurement industry.

Tackling Proppant Pack Variability

Operators and chemical suppliers rely on industry standard proppant pack testing to provide insights into friction reducer damage. Proppant packs consist of sand packed between two core platens. Results are heavily dependent on the packing of the cell, which can vary by as much as 80% between laboratories and ±20% between operators[1]. Issues with fluid bypassing, filtration, and defects in the platens also contribute to high variability. Proppant pack testing is also arduous, taking multiple days of preparation and runtime, resulting in high costs.

Interface's Regain Conductivity solution addresses this challenge using proprietary reservoir analogues that replicate the proppant pack. Interface designed a "proppant pack on a chip" with a permeability of 1050 mD and porosity of 21.8%. The parameters of the analogue were chosen based on a series of evaluations of a range of permeabilities and reservoir analogue designs. The selected design enabled a clear differentiation of the chemistries in the analogue, while demonstrating similar trends observed in 40/70 mesh proppant packs. The analogues are fabricated in-house using a silica-based substrate, representative of many conventional proppant pack materials. The reservoir analogues are identical, ensuring high repeatability between runs while eliminating the effects of bypassing or channeling common to proppant pack systems. Interface's Regain Conductivity alternative is an ideal platform for rapidly evaluating fluid-fluid interactions, such as the effectiveness of breaker and impact of brine salinity, providing a more complete picture before going to the field.

Additionally, Interface's Flowback Solution can take the results from Regain Conductivity and build on them to evaluate matrix interactions and impacts on oil flowback.

Regain Conductivity Solution Overview

What makes Interface's Regain Conductivity solution so successful? Interface's proppant pack analogue has a permeability that is fixed at 1 Darcy, with variability of less than 1% between analogues. This tighter, repeatable pack 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.

The heterogeneous dual-depth microfluidic device was connected to microfluidic pumps and high-accuracy flow-through pressure sensors. Prior to testing, the differential pressure of brine across the porous media was measured. The system was then used to assess the performance of different chemistries by injecting the selected friction reducer through the system until the system stabilized. Following the polymer injection, a 2% KCl brine was injected until stable differential pressures were observed. Using the differential pressure measurements, a Damage Factor can be calculated for each polymer. The Damage Factor of the friction reducer was calculated by dividing the final pressure drop of brine over its initial pressure drop through the system. The Damage Factor is then converted to a relative regain conductivity (%) value showing FR performance over time.

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

Interface's methodology allows for true repeatability as the entire system, including the porous media, is highly controlled. The only variation in the testing protocol is the stimulation fluid being used and the testing parameters, as was specified by Ovintiv. The system required less than 10 mL of friction reducer to run a single evaluation, compared to liters of fluid in traditional testing. Ultimately, this facilitates easier sample handling and shipment logistics from the field to the laboratory. The platform's repeatability ensures that all future friction reducer evaluations that Ovintiv performs are directly comparable, leading to a database of comparable results not achievable with other technologies.

Interface Results Demonstrate Comparable Trends to Conventional Data

Ovintiv provided eight products from five vendors for a blind validation of Interface's technology platform. At the end of the validation, results were compared to conventional proppant pack data. The results obtained using Interface's Regain Conductivity methodology agreed with the proppant pack data, identifying the best and worst performers in the same ranking.

To validate the new method, Interface duplicated the analysis of the FRs. The results were highly repeatable, with an average relative percent difference of 4.3%. The repeatability of Interface's Regain Conductivity method is considerably better than proppant pack testing, which can vary by up to 80%[1]. The high repeatability provides a greater confidence in FR selection, enabling operators and chemical providers to further refine their FR selection processes. Differentiation

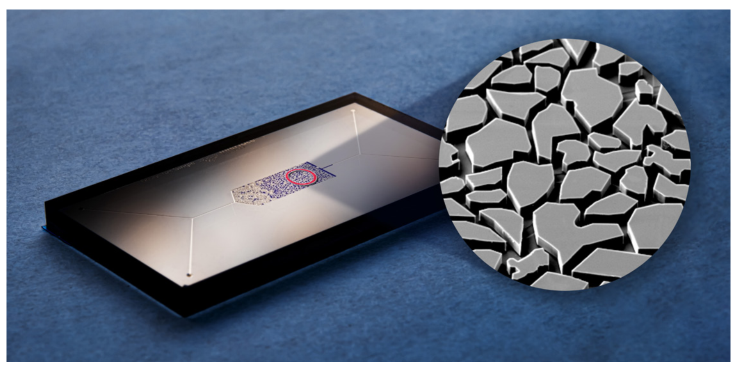

Figure 1. Microfluidic reservoir analogue used for Regain Conductivity screening. Left image shows the microfluidic device. The right image shows an SEM image of the porous media, representative of a 1 Darcy proppant pack.

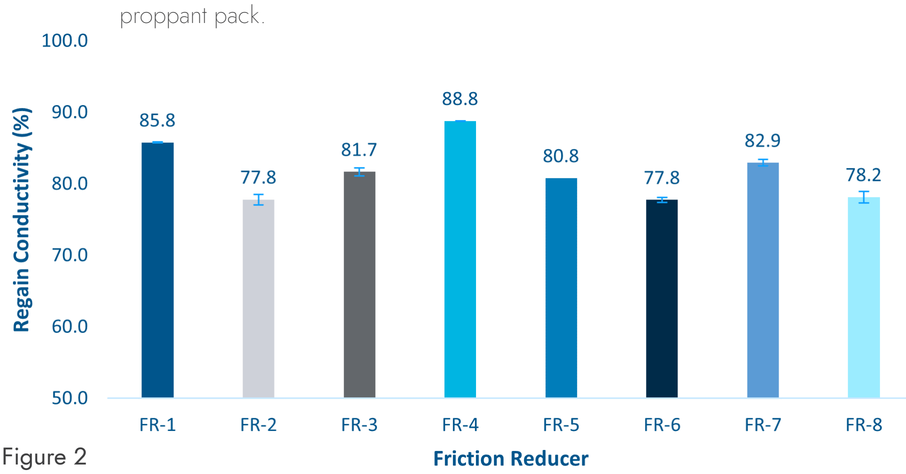

Figure 2

in chemical performance can be attributed to factors such as breaker addition, salinity, and temperature — instead of that information getting lost amongst noisy data.

Of the eight products supplied by Ovintiv, three freshwater chemistries and five brine chemistries were evaluated. In both the freshwater and brine cases, Interface's results clearly identified the lowest performers as FR-2, FR-6, and FR-8, in line with proppant pack data. The proppant pack results identified two top-performing chemistries in the freshwater study, FR-1 and FR-7. While Interface identified both as excellent performers, the reservoir analogue enabled a clear differentiation between them, identifying FR-1 as the optimal choice, shown through the high repeatability of the testing.

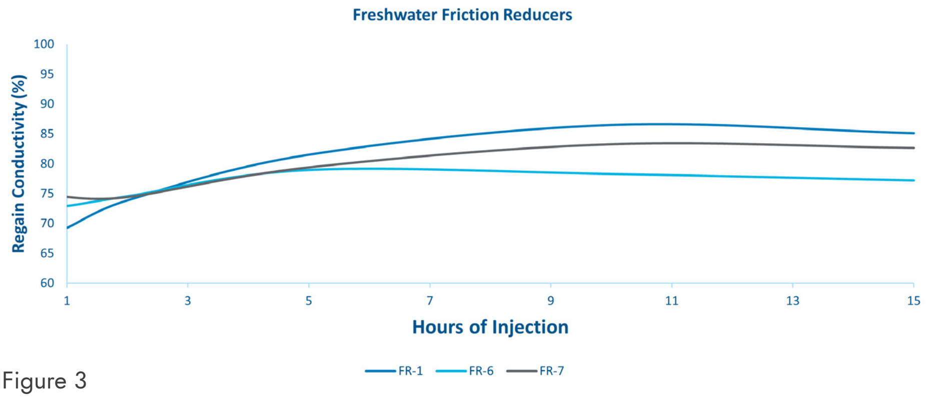

Figure 3

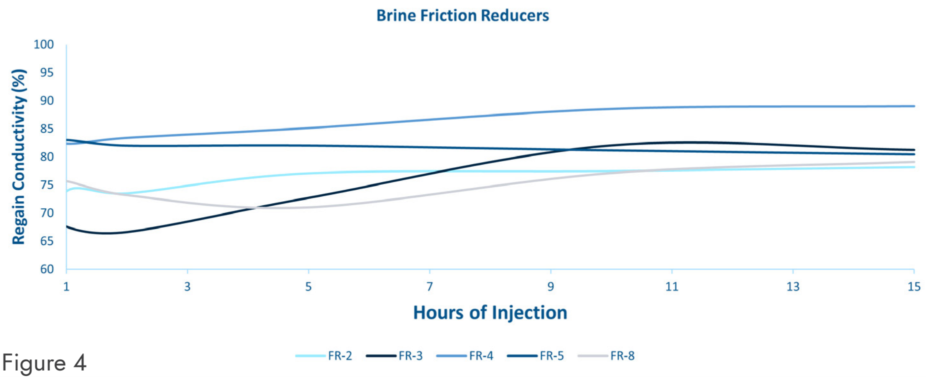

Figure 4

In some cases, the stabilized Regain Conductivity value does not tell the whole story. All freshwater FRs followed a similar trend, with FR-1 outperforming FR-6 and FR-7. FR-1 and FR-7 stabilized after 10 hours of brine injection, whereas FR-6 stabilized after just 5 hours of injection — yet was more damaging overall.

When comparing the high salinity FRs, FR-3 and FR-5 resulted in a comparable final Regain Conductivity value. However, FR-3 took 10 hours longer to stabilize and was considerably more damaging in the first half of brine injection compared to FR-5.

The ability to quickly identify potential challenges like FR solubility, injectivity problems, and long-term performance helps operators when selecting the right chemistry for their application. Interface's Regain Conductivity method enables higher resolution of performance data, giving more confidence to friction reducer selection.

Conclusion

Interface's Regain Conductivity solution allowed Ovintiv to rapidly evaluate a wide range of stimulation fluids and identify a new technique for friction reducer damage and fluid compatibility. The new methodology demonstrates high repeatability in comparison to traditional proppant pack testing while reducing the run time per measurement by more than 75%. Because of the rapid turnaround time, Interface Fluidics can deliver a quantification of friction reducer damage for less than half the cost of traditional labs.

Interface's technology platform enables operators to optimize fluids, prevent reservoir damage, and de-risk operations through better, data-driven decisions. Working with Ovintiv, Interface accomplished the goal of developing an alternative method to screening friction reducer damage. The result is improved economics and well performance for a fraction of the time and cost of conventional testing.

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

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