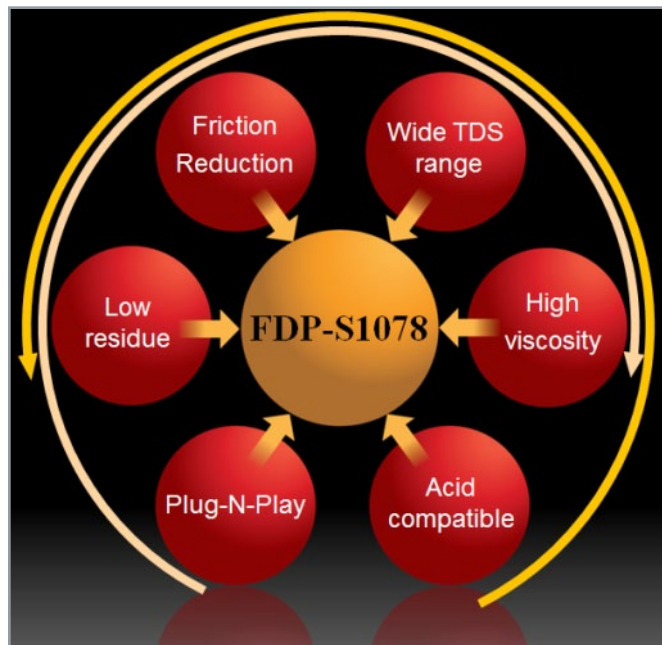


## PERMVIS™ VFR-10 Friction Reducer

A robust friction reducer which enables the use of flowback and produced waters for hydraulic fracturing

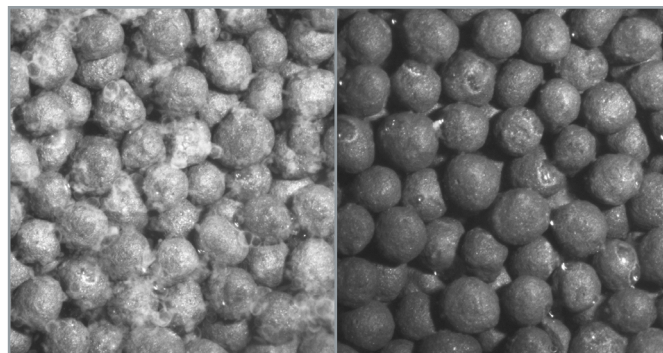


Halliburton's PERMVIS VFR-10 agent is a novel Plug-N-Play friction reducer that enables the use of a wide range of TDS waters, from fresh to flowback/produced waters, for hydraulic fracturing applications. It consists of an oil-external emulsion that is easy to invert and disperse in aqueous fluids. PERMVIS VFR-10 unique polymer exhibiting chemistry enables it to be very effective in high TDS waters at low concentrations.

The advantages of using PERMVIS VFR-10 friction reducer include the following:

- High tolerance of a variety of ions in water as compared to other leading friction reducers
- Superior performance at low concentrations in fresh water, in flowback and in produced water in comparison to other leading friction reducers
- Less residue than conventional friction reducers on the market (Figure 1)
- Exhibits unique properties that provide superior conductivity and cleanup compared to other friction reducer chemistries.
- Yields higher viscosity than conventional friction reducers to enable placement of higher proppant concentration slurries for liquids rich reservoirs

PERMVIS™ VFR-10 friction reducer can effectively perform in waters with a variety of ions (sodium, calcium, sulfates, strontium, magnesium, iron, chlorides). Effective friction reduction has been demonstrated in waters of TDS levels up to 300,000 ppm. Figure 2 demonstrates the superior friction reduction performance of PERMVIS VFR-10 agent in a wide range of TDS compared to a conventional friction reducer. The case study shows PERMVIS VFR-10 agent reduces the treating pressure significantly with 100,000 ppm TDS water.



*Figure 1. Photos of proppant pack treated with commercially available friction reducer (left) and PERMVIS™ VFR-10 friction reducer (right) illustrates the lower level of residue accumulated in the proppant pack.*

### Advanced Properties

#### Viscosification:

By adding slightly higher concentrations, PERMVIS VFR-10 friction reducer can achieve viscosities similar to guar, assisting in proppant transportation. (Figure 3)

#### Unique Breaking Performance:

A clean technology has been deployed. The viscosity of PERMVIS VFR-10 agent can decrease to water-like levels at high temperatures, as shown in Figure 4. The higher the formation temperature, the faster PERMVIS VFR-10 agent viscosity decreases, and in combination with a breaker enables good cleanup as well as good conductivity.

#### Acidizing:

PERMVIS VFR-10 friction reducer is very effective in low pH fluids, such as 20% hydrochloride acid.

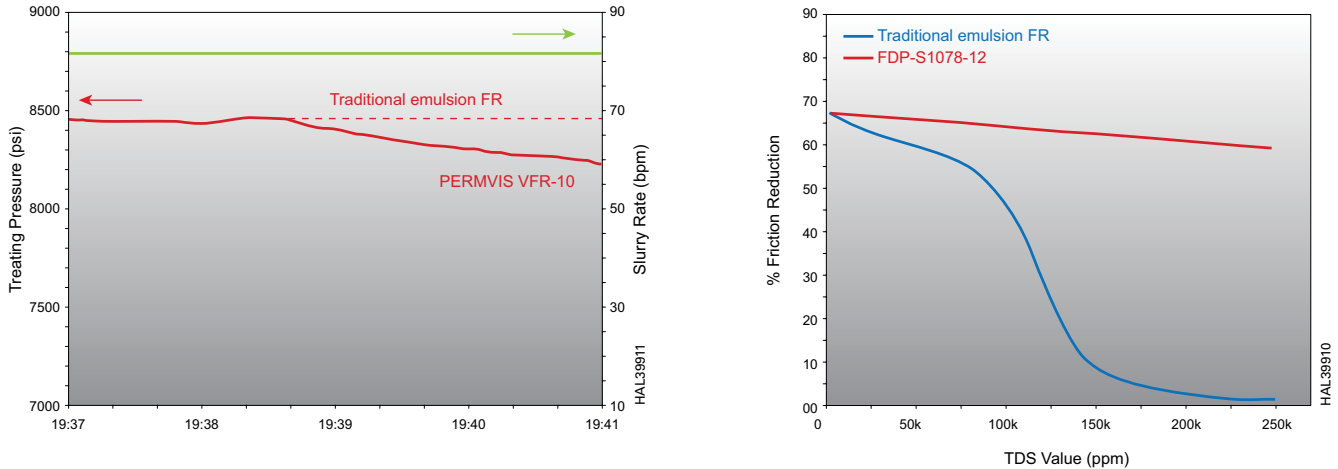


Figure 2. Comparison of friction reduction performance of PERMVIS VFR-10 friction reducer and a commercially available friction reducer: a case study in 100,000 ppm TDS water (left) and laboratory data with a wide range of TDS levels (right). PERMVIS VFR-10 friction reducer shows a superior margin in friction reduction performance.

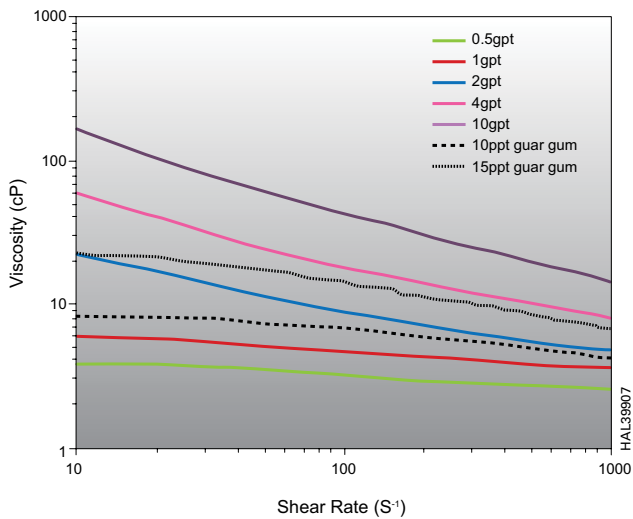


Figure 3. By employing slightly higher treating rate concentrations, PERMVIS VFR-10 friction reducer exhibits viscosities similar to and higher than linear guar gum at 10 lbm/1,000 gallons. This enhanced viscosity capability allows improved proppant transport.

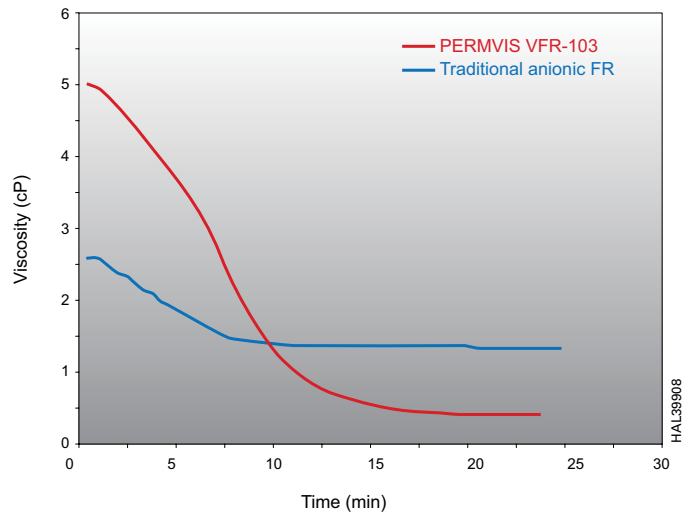


Figure 4. Example of the breaking profiles in fresh water at 150°F for PERMVIS VFR-10 friction reducer and a commercially available anionic friction reducer without breakers. The viscosity of PERMVIS VFR-10 decreases to water-like levels, contributing to the advanced breaking performance of this clean friction reducer technology for improved proppant conductivity.

**For more information on PERMVIS™ VFR-10 Friction Reducer, please call your local Halliburton representative or email us at [stimulation@halliburton.com](mailto:stimulation@halliburton.com).**