PRODUCTION ENHANCEMENT

TENDEKA

MajiFrac HVFR-5SA

High viscosity friction reducer

A solution for friction reduction and proppant transport.

MajiFrac HVFR-5SA is a premium, medium charge, high molecular weight anionic copolymer suspension. It is intended for use as a proppant transport and suspension fluid system that achieves friction reduction in fresh water and produced water conditions, at ultra low dose rates. Reduction in dose rates results in lower cost and polymer residue damage as compared to the standard emulsion friction reducers.

Standard friction reduction loadings for this product in produced water are 0.25-0.50gpt, with ability to place high loading of proppant away with fluid dosages between 1.0-4.0gpt leading to better proppant suspension and transport. Lab testing is recommended in field water in order to optimize fluid systems prior to use. Tendeka will conduct such fluid optimization.

MajiFrac HVFR-5SA displays superior proppant transport and suspension capability in produced water.

The MajiFrac Solution
A less water intensive way to frac

Features

- Low dosage requirements for friction reduction in fresh water and produced water conditions
- Delivers exceptional friction reduction at loadings as low as 0.25gpt
- Long linear viscoelastic range in produced water

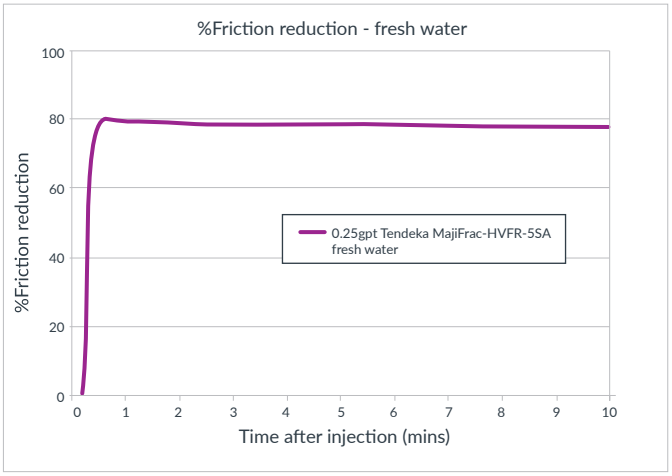
Benefits

- Superior proppant suspension and transport capability in produced water leading to more conductive fractures and optimized production
- Enhanced production due to lower polymer residue in the fracture
- Easy to dilute and pump on the fly
- Reduces volume requirements to place a given amount of proppant, which decreases cost of frac crew and fluid additive requirements
- Reduces overall water and horsepower requirements

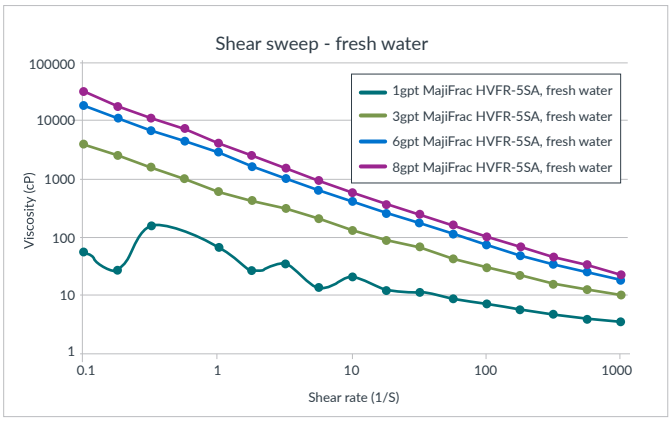
Technical Specification

Appearance	Tan milky liquid
Specific gravity @70°F	0.99 - 1.1284
Density @70°F, lbs/gal	8.26 - 9.41
Slurry visc. (cp) @300rpm @70°F	150 - 254
pH at 5gpt, @70°F	6 - 8
Freeze point	-40°F
Solubility	Soluble
Charge	Anionic, medium charge

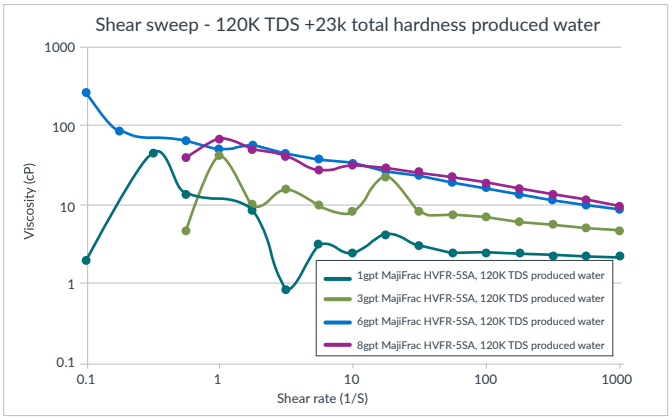
Dose rates as low as 0.25pt provide maximum friction reduction in the ½-inch friction flow loop test at a flow rate of 10gpm.



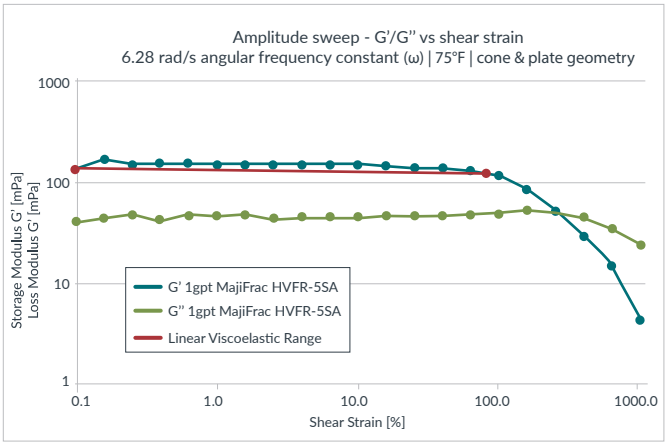
MajiFrac HVFR-5SA displays stabilized viscosity from low to high shear regimes at higher dose rates in fresh water.

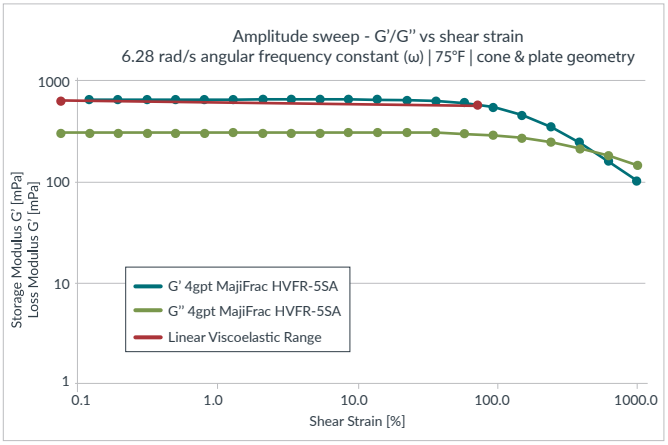


However, the superior proppant carrying capability of MajiFrac HVFR-5SA prepared with produced water does not lend itself to its viscosity behaviours at different shear regimes, but rather its elastic characteristics.



The below graphs are the amplitude sweep test of 1gpt and 4gpt in loading of MajiFrac HVFR-5SA in produced water with 120K TDS and 23k total, which shows a broad range of the linear viscoelastic region (LVE region).



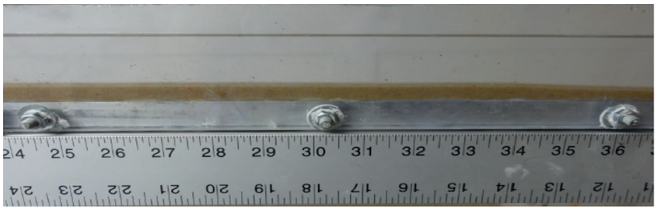


In situations, such as presented above, where G' is greater than G", the polymer has more elastic characteristics than viscous. This means that the interactions between the polymer and proppant is stored as kinetic potential energy rather than dissipating as heat, which is what happens when G'' is less than G'.

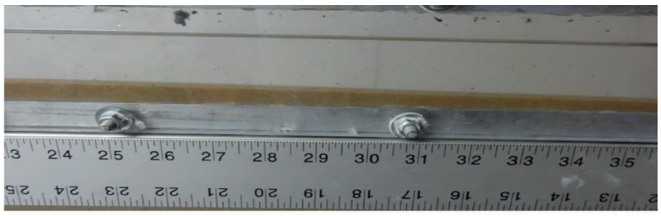
Values of G' elasticity, on the y-axis that are higher, indicate increased elasticity and vice versa regarding G" and viscosity. Polymers that display more elastic effects than viscous (G' > G") over both a broad frequency range and amplitude (y-axis) sweep compared to other polymers of equivalent mass are deemed better proppant carriers.

To evaluate the capability of fluid to carry proppant, both proppant suspension and transport should be considered.

The capability of the MajiFrac-HVFR-5SA to carry high proppant loads, was dynamically evaluated using a slot flow containing a fracture width of ¼-inch. The fluid was pumped at both laminar and turbulent rates.



Turbulent flow

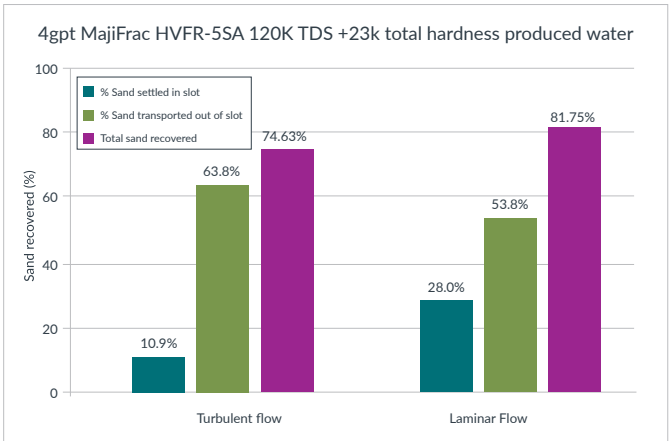


Laminar flow

The distance traveled by the sand prior to settling or "dune" formation was recorded with the height along the slot. At the end of the test, any fluid/sand collected at the slot outlet or remaining in the slot were recovered, dried, and weighed to calculate the percent sand transported. 4gpt loading of the HVFR was tested with produced water and 2ppa 40/70.

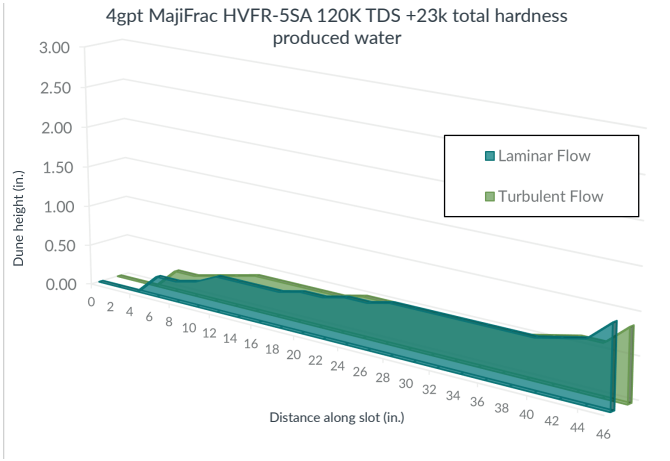
Proppant Suspension Capability is indicated by a high % sand recovered when both in turbulent and laminar flow. However, if a fluid lacks proppant suspension capability, proppant may settle in the inlet reservoir and never enter the slot machine. The higher the overall total sand recovered, means that proppant is not settling as much in the inlet reservoir. There is only a 7.2% difference between total sand recovered in each flow regime, which indicates the HVFR is not relying on turbulence to suspend proppant.

MajiFrac HVFR-5SA has a superior ability to suspend proppant in harsh produced water conditions compared to many other industry HVFRs which were evaluated under similar conditions in SPE paper SPE-195192-MS.

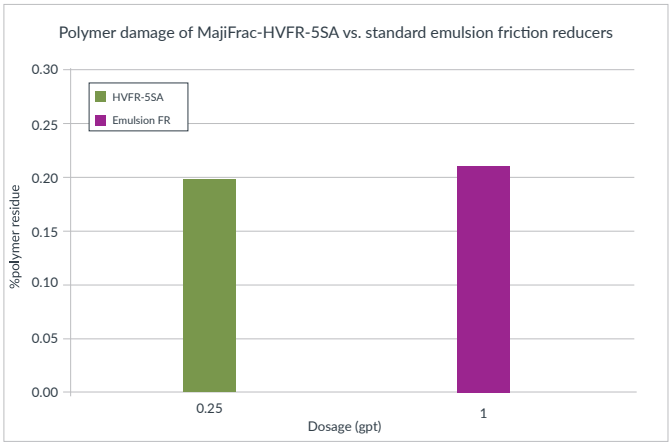


Proppant Transport Capability is determined from the sand traveling the furthest along the slot before settling. The larger the dune height the lower a fluids ability to transport sand. The highest peak in the slot is at the end of the slot.

The minimal dunning effects accompanied with the ability to suspend proppant, results in more uniform proppant placement along the slot flow apparatus.



The polymer residue of MajiFrac HVFR-5SA was determined and compared to both linear guar and a industry leading emulsion FR, which is ran as a friction reduction reducer at 1gpt.



The MajiFrac HVFR is part of the MajiFrac Solution which is the combination of a wide range of high-performance technologies and products designed to reduce water use and pumping time during completion operations in unconventional shale plays in the USA.