REDEFINING SHALE FRACTURING FLUIDS

FRICITION REDUCERS DRIVE PERFORMANCE EFFICIENCIES

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Introduction

One of the most important aspects in the development of hydraulic fracturing processes over the past 70 years has been the evolution of highly effective fracturing fluids. Today, a range of fluids exists to cover varying operator requirements. Choosing the most appropriate fracturing treatment to maximize effectiveness can be critical to the success of your project.

**THE THREE REQUIREMENTS OF FRAC TURING FLUIDS**

**SURFACE EFFICIENCIES**
This includes the ability to be able to mix and pump the fluids easily, with or without the use of specialized, onsite equipment. A low friction pressure is also important for ease of pumping and, because hydraulic fracturing involves the use of significant amounts of water, the fluid must be compatible with different water sources on the surface.

**FLUID EFFICIENCIES**
Temperatures in a reservoir can vary significantly, from ambient to extreme, so the fluid must be able to remain stable at the required temperatures for as long as necessary. Also, because the fluid can be required to be pumped at high rates, it has to be able to deliver shearing stability. Finally, the ability to maintain fluid loss control to ensure it remains inside the fracture and does not enter the porous media of the fractured rock is critical.

**FRAC TURE OPTIMIZATION**
Effective proppant and fluid transport with control of the fracture geometry is essential. Once the proppant is in place in the fracture, the viscosity must be broken down to allow maximum clean up through a highly permeable fracture that enables fluid escape. The degree of fluid egress impacts significantly on the permeability of the fracture and on conductivity.

**FRAC TURING FLUIDS - THEN AND NOW**
The history of fracturing fluid mirrors the history of the oil and gas industry's expansion from conventional to unconventional hydrocarbon sources, and the changes in requirements this has brought about.

The first commercial fracturing treatment was performed in 1949 using gelled oil as the fluid. However, cost and flammability meant gelled oil's popularity was short-lived and the industry soon moved on to water-based systems with more economical borate-crosslinked guar as the gelling agent. From 1970 to 1990 saw the development first of guar-based derivatives, then gas-enhanced foamed fluids for low pressure reservoirs followed by expensive viscoelastic surfactants (VES). Throughout this period, the focus was on conventional reservoirs, good proppant transport, temperature stability and improved fracture connectivity – particularly important for foamed fluids and VES.

Technological developments in this century and the growth of multistage fracturing have enabled a shift towards unconventional reservoirs. This has brought a greater focus on well/reservoir economics and the development of first generation friction reducers followed by specialty friction reducers.
Friction Reducers for Unconventional Reservoirs

Aside from the benefits implied in their name, in an increasingly cost-conscious industry, friction reducers offer significant advantages over all other fracturing fluids. They can come in various forms and can deliver high viscosity, rapid dissolvability in water, high levels of friction reduction and overall enhanced process efficiency. Also, the active concentration of the fluids plays a role in their effectiveness.

**FRICTION REDUCER TYPES AND FORMS**

Specialty friction reducers represent the latest development in this field. Their high molecular weight allows improved proppant transport at higher loading during fracturing and greater reduction in pipe friction at lower loading.

Using one fluid system across the entire fracturing process instead of several can lower project costs, reduce water requirements, and use fewer chemicals and less equipment on location and provide greater flexibility for a rapid design change. It also enables enhanced proppant loading with added productivity.
ThinFrac™ Friction Reducers

Responding to client needs for enhanced efficiencies, BJ Services has developed a broad portfolio of rigorously tested, water-based friction reducers that can provide specific fluid properties in a broad range of applications.

FAMILY OF FRICTION REDUCERS FROM BJ SERVICES

**ThinFrac MP**
Effective anionic friction reducer for enhanced proppant transport with precise breakability for fresh water, brines, and low pH fluids

**ThinFrac HV**
High-viscosity, anionic friction reducer for fresh water and brines

**ThinFrac PW**
Effective anionic friction reducer when using produced waters

**ThinFrac Plus**
Cationic friction reducer for high salinity waters

**ThinFrac D**
Dry anionic friction reducer for simplified logistics

**ThinFrac E**
Economical anionic friction reducer for fresh water

To ensure the best product portfolio available, we screened 70 select products from 17 different suppliers. We tested the products in varying water qualities from fresh water up to 275,000 total dissolved solids (TDS). We then conducted over 600 hours of testing to determine the performance characteristics of each product based on proppant settling, rheology, viscosity, and more. Based on this rigorous testing, we selected only the best products to provide a full friction reducer portfolio.

In addition, we identified gaps within the current offering, and developed and patented our flagship, proprietary ThinFrac MP friction reducer.
Our Flagship Enhanced Friction Reducer

ThinFrac MP provides superior friction reduction, improves permeability, enhances operational efficiency and improves production. The key attributes and the benefits of this visionary polymer are wide ranging.

**RAPID HYDRATION FOR SUPERIOR FRICTION REDUCTION**

The synthetic polymer provides rapid hydration in 8-10 seconds in cold water, developing instantaneous viscosity in slickwater fracturing operations and delivers the proppant to the fractures. Rapid hydration reduces pipe friction pressure, which has been proven to lower hydraulic horsepower and surface equipment requirements.

**ENHANCED PROPPANT TRANSPORT FOR ADDED PRODUCTIVITY**

This enhanced friction reducer provides a greater reduction in pipe friction at lower loading because of its high molecular weight, providing improved proppant transport at higher loading during fracturing.

It also simplifies the standard of reducing friction with a single-fluid solution. The use of friction reducers together with linear or crosslinked guar has traditionally introduced increased treatment cost and operational complexity. Using a one-fluid system can lower costs and require less onsite equipment while achieving both friction reduction and superior proppant transport.

**PRECISE BREAKABILITY FOR IMPROVED PERMEABILITY**

The oxidizable linkages along the polymer’s backbone are a key feature. All current friction reducers are polymers with carbon-carbon backbones. Difficult to break, even in the presence of an oxidizer breaker, these conventional reducers can cause formation damage.

However, the molecular structure of our enhanced friction reducer allows a clean, efficient break with little or no formation or proppant pack damage, and provides enhanced proppant transport over conventional friction reducers. No residue polymer or polymer fragments will be deposited on the fracture surface or in the proppant pack to impact the hydrocarbon production.
Increased Production

The use of ThinFrac MP in North America has significantly increased production and lowered operational costs by up to 30 percent.

CASE STUDY

THINFRACT MP IN THE PERMIAN BASIN

An operator in the Spraberry/Wolfcamp shale play in the Permian Basin was looking to maximize hydrocarbon recovery. Eight multistage wells were chosen with similar depths of approximately 10,265 ft (3,100 m) and the average treated interval was 1,500 ft (460 m) in length.

Four wells were treated with ThinFrac MP and four offset wells were treated with conventional linear and crosslinked gel fracturing fluids. Over a 12-month period, the wells treated with ThinFrac MP saw a 46% higher average cumulative production rate when compared to the offset wells.

CASE STUDY

HIGHEST PRODUCING WELL USING THINFRACT MP IN THE MARCELLUS SHALE PLAY

A major operator wanted to maximize hydrocarbon recovery from wells with longer laterals. To achieve the increased production and ensure success of the completion program, the operator worked with BJ Services to perform a fracture stimulation program on a well with a 10,500-foot lateral using ThinFrac MP friction reducer.

After six days, the well treated with ThinFrac MP became the operator’s highest-rated operated well in the play. In addition, the operator is having to redesign the surface facilities to support the increased production. Over the next 6-month period, the operator plans to continue to enhance completion designs in as many as 40 more wells that are set to come on production, including several less productive wells in the field.

CASE STUDY

BREAKABILITY BENEFITS OF THINFRACT MP IN WESTERN CANADA

An operator pumping an unconventional reservoir in the Viking formation saw higher surface treating pressures than expected. BJ Services engineers recommended using ThinFrac MP as an effective alternative to conventional friction reducers. 50 m3 of the enhanced friction reducer was pumped at 1.5 L/m3, which reduced friction and surface treating pressure by 15 MPa at a 17 m3/min pump rate.

By replacing the conventional friction reducers with ThinFrac™ MP, the operator saw a decrease in total completion time by several days and an estimated cost savings of $600,000.
Webcast Questions and Answers

Recently, BJ participated in the World Oil ShaleTech™ Hydraulic Fracturing Forum webcast. We received great questions from the attendees and wanted to share the answers.

**Q: ARE BREAKERS RECOMMENDED FOR THINFRACT MP FRICTION REDUCERS OR FOR FRICTION REDUCERS IN GENERAL, SUCH AS EMULSIONS, SLURRIES AND DRY REDUCERS?**

A: Breakers are recommended when pumping friction reducers. As I mentioned during my presentation, friction reducers are more difficult to break because of the stronger bonds. This is the reason we incorporated weaker linkages along the backbone of ThinFrac MP polymer. These linkages allow easy breakdown of high-molecular-weight polymers into smaller molecules. Physical forms such as emulsions, slurries or solid, do not impact the breakability of friction reducers as they are related to surface delivery.

**Q: ANY DISCUSSION FOR FUTURE OF FOAM SYSTEMS-N2, CO2-TO REDUCE PROBLEMS WITH WATER CONTAMINATION/RESERVOIR DAMAGE AND REDUCE VOLUME OF WATER USE OVERALL?**

A: Widespread adoption of foam systems by the shale industry is not foreseen in the near future. Yes, use of foam will certainly reduce the water usage as well as formation damage; however, foamed fluid reduces the hydrostatic pressure, requiring more horsepower to pump at the same rate. Therefore, complexity, cost and inefficiency associated with pumping foamed fluid make it prohibitive.

**Q: ANY CONCERN ABOUT CHANGES IN THE RESERVOIR WETTABILTY WHEN USING THE FRICTION REDUCER AS PROPPANT CARRYING FLUID?**

A: Wettability change with friction reducers are currently not a concern. One reason is that most friction reducers used today are anionic which is believed to have less interaction with the reservoir rock. The other reason is perhaps related to extremely low permeability of the rock such that friction reducers will not penetrate the rock matrix to impact the rock surface.

**Q: WHERE HAS THE THINFRACT MP ENHANCED FRICTION REDUCER BEEN APPLIED AND IS THERE A LIMITATION?**

A: The enhanced friction reducer has been applied in all major basins in the US and Canada including Midland, Delaware, DJ, Appalachian, Williston, Anadarko, Powder River, Western Gulf, Wind river, Piceance and Western Canada Sedimentary Basin (WCSB). We have seen a tremendous uptake of the technology since its introduction late last year as more and more clients start to adopt the product. As for the limitation, the enhanced friction reducer works best under 50K in TDS. However, our R&D team is in the process of developing a next generation product to extend the TDS range.

Friction Reducers of the Future

We expect the need for high viscosity friction reducers that deliver good proppant transport capabilities across a range of water sources to continue for the foreseeable future.

We may also see a greater deployment of friction reducers in more conventional plays in some parts of the world. Whatever the specifics may be, one thing is for certain: friction reduction is going to remain a major driver in hydraulic fracturing for years to come and BJ Services will continue to lead their development.