Stimulation

MistFrac™ Service

**New Technology Enables More Effective Fracturing Treatments in Sensitive Reservoirs**

MistFrac™ service uses an ultra-high-quality nitrogen foam fracturing fluid that, compared to conventional foam fracs, provides several advantages:

- Results in less water contact on formations
- Minimizes reservoir sensitivity problems associated with clays, iron minerals, high foamer concentrations, and large volumes of fluid
- Provides improved ability to place proppant in water-sensitive formations compared to straight N₂ or CO₂ fracs
- Provides fast, clean breaks at very low reservoir temperatures
- Cleans up better after treatment for improved conductivity
- Requires less equipment, personnel, fluids and chemicals on a location while reducing fluid disposal costs
- Helps get the well on line quicker.

**New Technologies Enable MistFrac Service**

MistFrac service uses Liquid Sand™, a “liquid proppant” gel system with a new low-temperature breaker activator that allows 20 lb to 24 lb of 20/40 proppant to be suspended in each gallon of fluid.

MistFrac service also uses ReversaFoam™ surfactant, a new pH-dependent foaming agent. The final pH of the stimulation fluid is maintained above 9.0 to achieve a good quality, stable foam. As the foamed fluid enters the formation and is affected by the rock and formation fluids, the pH drops and the foam decreases to moderate or low foam quality prior to flowback. This helps assure good cleanup of MistFrac service treatments.

**Advantages and Challenges in Foam Fracturing**

Foam fracturing is a standard technique used to stimulate low-permeability reservoirs, including shales and coal seams. Foams work well in low-permeability, low-pressured reservoirs that are fluid sensitive. Foams are attractive because the water content of a foamed fluid is very small, reducing the damage potential to sensitive formations. Plus, foams provide the viscosity needed for creating fracture geometry and transporting proppant into the fractures.

In North America, a significant percentage of the stimulated wells are fractured with foamed, proppant-laden fluids. In the foams, the gas portion typically consists of 65 percent to 80 percent nitrogen or carbon dioxide. When the quality of the gas is less than 65 percent, foam viscosity benefits are lost. When the gas percent is above 80 percent, high downhole sand concentrations are limited. This is normally due to equipment limitations at low fluid rates. These issues have been addressed with MistFrac service.

**ReversaFoam™ Surfactant**

In a high-quality foam, achieving adequate foam viscosity using conventional surfactants requires high ratios of foamer to liquid – as high as 20 gal/mgal. New ReversaFoam™ surfactant enables adequate viscosity development with surfactant concentration as little as 8 gal/mgal.
In low-permeability reservoirs, high foamer concentrations can remain in an unbroken state in the tight capillaries, hampering production. This effect has been confirmed by extensive third-party laboratory testing and by field experience. It has proved to be the case in wells treated using conventional foams in the Arkoma Basin, Southern Appalachians and Black Warrior Basin.

Figure 2 shows how new ReversaFoam surfactant works to alleviate this problem. The ReversaFoam surfactant provides excellent foaming capabilities above pH 8 with the foam breaking down below pH 7. As the foamed fluid reaches the pH of the formation, the foam breaks, enabling the fluid to exit the capillaries. This process has already been used successfully on a large number of CBM and Devonian shale wells.

**Case History**

**MistFrac Service Performed With Up to 99.5 Q Foam**

Kentucky – Most Devonian Shale wells are stimulated using straight nitrogen gas fracs with no proppant or water used except for a small amount of hydrochloric acid to help break down the formation. For this operator’s well, Halliburton proposed that better results could be achieved if proppant were used during a gas frac. The treatment began with 500 gal of 7.5 percent Fe Acid® composition being placed into the wellbore. Then, a straight nitrogen gas pad was pumped ahead of the sand-laden fluid stages. The pad was pumped at ± 52,000 scf/min or, equivalently, 78 bpm bottomhole rate. After the pad, the 20 lb/gal sand-laden slurry was pumped into the nitrogen stream to achieve desired downhole sand concentrations. Liquid rates ranged from 0.75 bpm to 5.0 bpm to achieve downhole sand concentrations from 0.1 lb/gal to 1.0 lb/gal. Total bottomhole rate was near 90 bpm during the sand-laden stages and qualities ranged from 99.5 Q – 97 Q.

Total proppant placed in the well was 11,800 lb. This was completed while pumping only 585 gal of clean base fluid which was treated with 6% salt to provide maximum clay stabilization. Total slurried proppant pumped was 1,302 gal. The job was very successful operationally and technically.

Subsequent MistFrac service treatments have achieved downhole sand concentrations of almost 2.0 lb/gal.

For more information about how MistFrac™ service can help make your fracturing treatments more profitable, visit www.Halliburton.com, contact your local Halliburton representative or e-mail stimulation@Halliburton.com.