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Optimizing every drop from unconventional shale formations

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The mission to drill and complete new wells in US unconventional shale plays has shifted dramatically in recent years. From deploying cookie-cutter and 'pump-and-pray' fracturing treatments to a sector driven by economics, advanced technology and greater consideration for the environment. Therefore, increasing recovery factors and improving operational efficiency is paramount in today's fluctuating oil and gas market.

Roughly 70% of wells currently being drilled in the Eagle Ford are infill wells, as are 50% of those wells drilled in the Permian.[1] Infill drilling brings with it a high level of risk of damage to the parent wells from frac driven interactions, where clean outs may be needed, and reduced production may be inevitable. The infill, or child well, is more than likely to underperform compared to the production of the parent well. As the industry recognizes the inevitability of avoiding frac-driven interactions, particularly if missed reserves from previous field development are going to be produced, the demand to design and implement better fracturing treatments, with leaner expenditures, will no doubt continue to grow.

Decreasing fluid costs and volumes, pump down times, fracturing treatment time, horsepower requirements, and plug mill out times, are just some of the ways that operational efficiency can be achieved alongside stage cost reduction. Advanced chemistries that can access the nano-network around the fracture and increase the recovery of oil flowback, is yet another way to drive efficiencies.

Increasing recovery in new and existing completions

In April 2019, the US Department of Energy estimated that crude oil production from shale and other tight formations accounted for about 60% - 7.4 million barrels a day - of US output.[2] While unconventional wells produce approximately 35% less wastewater per unit of gas than conventional wells, the sheer number of wells and amount of oil and gas being produced means that water use has increased by as much as 500% in some areas.[3]

During a fracturing treatment, it is not uncommon to pump tens of millions of gallons of fluid into a single well. This procedure can result in escalating cost and risk associated with not only handling the water but also managing the energy required to pump the fluids from surface far into the formation. Furthermore, production potential is often compromised as inaccessible oil remains trapped in the unfractured nanonetwork surrounding the fracture

To increase production and tackle the intensive fracturing water and pumping requirements of shale formations and the challenges associated with using produced water in fracturing treatments, independent global completions service company, Tendeka has developed the MajiFrac Plus Solution, a combined suite of environmentally-responsible technologies.

The strategically sourced portfolio of high-performance tools and chemical systems aims to reduce water use and pumping time during completion operations. The overall result is less pump time, lower cost, reduced water consumption and enhanced production.

The components of the solution can be used individually or sequentially to optimize fluid distribution across the interval. This can lead to more contact area with the formation resulting in increased production. The package includes the company's acid resistant FracRight fully composite frac plug, a wireline-friendly modified spearhead acid system, ShaleModifier, and a range of high viscosity friction reducers.

- **FracRight Fully Composite Frac Plug**

  Comprised of high performance, proprietary, composite material, FracRight plugs can be milled quickly and easily. Rated to 10,000psi at 350°F are available in a full range of sizes, the tool incorporates a pump down feature to minimize fluid bypass reducing the amount of water required to place the plug at setting depth and allows for placement of particular fluid spacers behind the plug. The fast mill out time also reduces operational schedules with small remaining debris that can be readily produced back to surface.

- **Modified spearhead acid system**

  Enviro-Syn-HCR-7000-WL is applied in a combination of spotting the spearhead acid with the frac plug and perforating guns. This modified spearhead acid system boasts superior ultra-long-term corrosion protection compared to hydrochloric acid (HCl) or urea-based acids. It can be prepared in produced water, utilized and exposed to

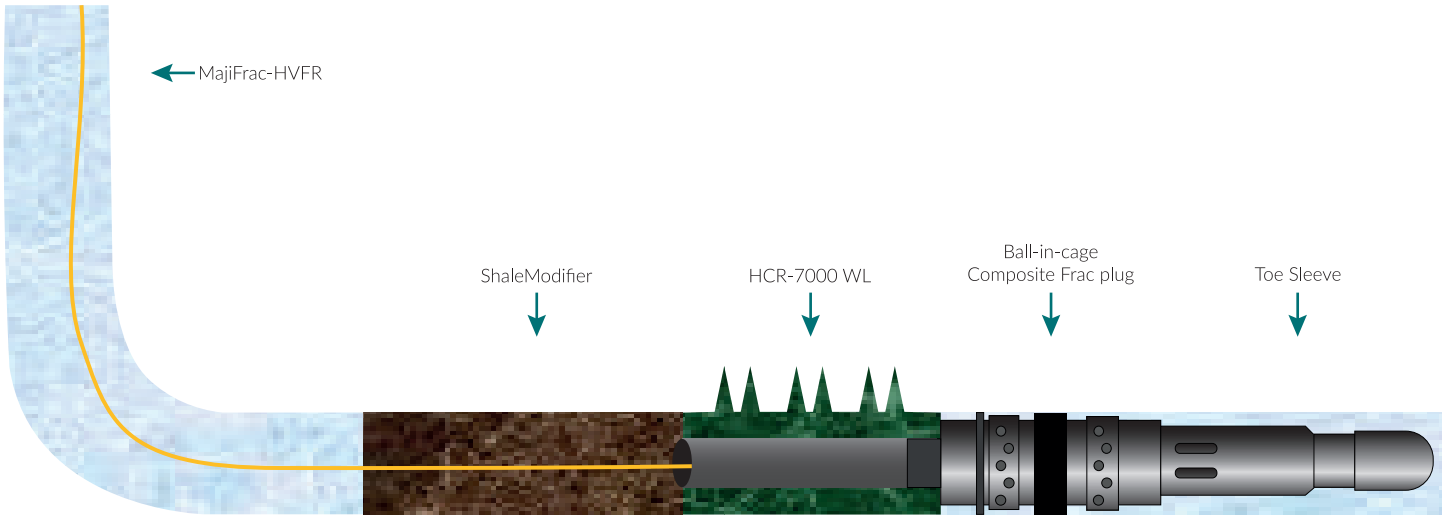

Figure 2: The MajiFrac Plus Solution includes an acid-resistant FracRight fully composite frac plug, a wireline-friendly modified spearhead acid system, ShaleModifier and a range of HVFRs.

perforating tools and wireline at high temperatures over long periods with minimal effect. It allows operators to pump acid with the perforating guns and plug, reducing time per stage and saving considerable water per stage (a hole-volume per stage) where applicable.

Harmless to the skin, it minimizes unsafe exposure levels and effluent rates, as well as costly transport and storage. Not only is superior breakdown possible with the system, perforations are created resulting in more efficient perforation cleaning helping to more uniformly place the fracturing treatment and access energy.

- **ShaleModifier**

Behind the acid there is a hydrophobic oil-based surface modifier that is synthesized with an organometallic binder that adheres to exposed silicone oxide sites, changing the surface energy of the rock. Optimized using nanofluidic reservoir analogues, this fluid has superior injection displacement efficiency in oil wet nanostructures as small as 100nm, and binds to the walls of the nanonetwork structure, creating a permanent pathway free of high capillary pressures, allowing for oil to be recovered from the nanomatrix.

It is pumped as a pre-pad stage to the main fracturing treatment and can increase oil flow recovery from shale formations during initial completions and remedial treatments.

The ShaleModifier has potential for use in Huff-and-Puff treatments to help inject more gas faster, thereby decreasing soaking times, and increasing the overall amount of oil recovered.

- **High viscosity friction reducers (HVFR)**

The MajiFrac-HVFR-5SA is a superior HVFR designed for tough produced water conditions. It can carry proppant at higher loadings in produced water, due to its elasticity properties, which are enhanced in produced water. Designed and manufactured in-house by the company's production enhancement team, this gives improved drag reduction, without the need for a booster, at ultra-low dosages. The performance of the MajiFrac-HVFR-5SA at the ultra-low dosages, means that operators who are pumping emulsion HVFR can expect to see friction reduction stage cost savings by as much as 58%.

Credible, complete and customized solutions

With increased pressure to restrict expenditure, many operators in the sector have already eradicated many conventional additives, such as surfactants as flowback agents, that were once a staple of the fracturing fluid system. Nonetheless, the appetite for disruptive advanced completion technology and production enhancement solutions with the potential to increase low recovery factors still exists. This is on the proviso that performance can be demonstrated, and acceptable production results achieved at economical rates.

Likewise, enhanced oil recovery (EOR) treatments from legacy shale wells is also on an upward trend to capture and extract additional reserves from within the complex nanonetwork matrix of fracture wells.

Ultimately, to maximize return on investment, reducing the time and cost to complete wells in unconventional shale plays is critical, particularly given the increasing trend to pump more proppant per thousand feet as well as the associated increase in volumes of fracturing fluids.

Bringing a credible, combined and economic package of hydraulic fracturing solutions closer to the operator, which can be tailored to meet specific water quality and demands, is a leap forward from the fragmented, 'fingers crossed' approach in the shale plays of old.

References

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