

# Solving inefficiencies of fracturing fluid delivery

New structured fracturing fluid delivery system brings order to a cluttered work environment.

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Originating from the pumping of cement from the cement pump trucks to the wellbore, the conventional pipe work used to deliver the frack fluid from the pump trucks to the frack tree might have reached its limits in unconventional applications. Increased proppant volumes and flow rates impact the life cycle of conventional pipe work or “frack iron.”

The continued use of this traditional technology can no longer be considered the best solution. The emergence of multiwell pad drilling brought to light not only inefficiencies in fracturing operations but also safety issues. Derived from a mindset that there must be a better way, a new technology is raising the flag as an innovative solution to today’s high-volume frack operations.

## Shortcomings of conventional frack iron

With the use of frack iron, the myriad flowlines between frack trees and manifolds depend on not-very-sturdy connections. When technicians must work among the flowlines, they are subjected to hazardous working conditions, especially on multiwell pads with zipper frack operations.

Traditionally, conventional frack iron has a 3-in. inner diameter and is configured with straight pipe segments for distance and swivel joints for alignment. The joints are then connected to the frack head (which sits on top of the frack stack). All components are connected together using hammer unions. When looking at the frack stack from a distance, it looks like an octopus as the frack head serves as the body and the flowlines are the tentacles, giving it the name of “fracktopus.”

This method has notable shortcomings:

- the integrity of the connection must be secured by a sledge hammer;
- the number of individual connections creates *in situ* leak paths, which can become failure points;
- it is costly from an ownership and asset management standpoint;
- it is time-consuming to install; and
- it creates a cluttered work environment.

## Making a new connection

A factor in the evolution to multiwell pad drilling and batch completions is the increased time that stimulation crews are spending on the well site. Not long ago service providers often spent five to seven days fracking a single well with 20 stages per well on average. Nowadays pressure pumping service crews are spending 20 to 30 days on a multiwell pad and are fracking more than 50 stages per well.

Meanwhile, operators push lateral lengths and the number of frack stages and drill wells more closely together while greatly increasing proppant and frack fluid volumes. Doing all of this requires sustained use of pressure pumping equipment at high-performance thresholds, prompting faster wear and tear on frack service equipment.

One of the standard responses to these conditions has been to put more fluid through the conventional frack iron. But that only adds to an already tangled maze of lines at the well site. Cameron’s answer is the patented Monoline Frac Fluid Delivery System. It is a single-line frack fluid delivery system that adheres to the American Petroleum Institute’s 6A standards and uses bolted connections to promote a higher level of system integrity and safety.

The system’s flanged connection enables components (straight high-pressure [HP] pipe, 90-degree elbows and swivel flanges) to be bolted together. The hammer unions are replaced by measurable torqued flanged connections with metal sealing gaskets. This configuration allows the full range needed for alignment from the pump truck to the frack manifold and to the frack tree.

It eliminates the risk to mismatch equipment while minimizing leak paths and failure points, critical to safety and the environment. It simplifies the rigup procedure by arriving on location pre-assembled. When compared to conventional pipe work, the Monoline reduces installation time by more than 60%, with rigup requiring only two hours as opposed to 12 hours for the conventional frack iron method. It also eliminates more than 70 hammer-union connections. Overall, the system offers a larger diameter for increased flow rate, mitigating erosive fluid velocities; a simplistic design to ease installation and reduce the bends in the flow path; and a safer connection that reduces failure points.

## Studying linkage

A study was conducted to observe and quantify the erosion due to hydraulic fracturing through the 5-in. bore 10,000-psi Monoline system consisting of two legs, each with a 7-in. 10,000-psi zipper manifold throughout a multiwell continuous fracturing operation. The goal was to quantify erosion characteristics of equipment exposed to fracturing operations and to verify that the two-leg 5-in. 10,000-psi system is fit for service conditions up to 10,000 psi at 80 bbl/min.

The system showed minimal erosion at key indicator points through the duration of the test. The test equipment was subjected to an average pressure of 7,200 psi, transferring an average of 5,500 tons of sand per well at an average rate of 63 bbl/min during the 42-stage frack program. With maximum pressures more than 9,000 psi and maximum flow rates above 75 bbl/min, the pipe sections, elbows, crosses and zipper manifold were observed to be well within their operational capabilities.

Additionally, studies were commissioned to assess erosion characteristics of typical components due to high-velocity, HP flow of abrasive frack slurries. The objective of the study that took place on a 69-stage frack program in the Haynesville Shale was to observe and quantify erosion due to hydraulic fracturing through a skid-mounted 5-in. 15,000-psi manifold consisting of three legs, each with a 5-in. 15,000-psi tee and two 5-in. 15,000-psi Cameron FLS-R gate valves throughout a multiwell fracturing operation. The study was conducted to verify if gate valves and tees used in Cameron frack manifolds are fit for service conditions up to 15,000 psi at 80 bbl/min.

The 5-in. 15,000-psi manifold showed minimal erosion at all key indicator points through the duration of the test. Test equipment was subjected to an average pressure of 11,500 psi, transferring an average of 2,000 tons of sand per stage at an average rate of 65 bbl/min during the 69-stage frack program. With maximum pressures more than 13,000 psi and maximum flow rates above 75 bbl/min, the 5-in. 15,000-psi gate valves were observed to be well within their operational capabilities.

Ring groove inspection on elbows found no visible defects.

**The system replaces the need for multiple connections between the frack tree and the manifold. (Source: Cameron)**

Field trials that included a frack and inspection program were undertaken to observe and analyze performance in actual frack conditions to optimize the life cycle. Operators employing the system have reported an increase in daily frack completions rate and a reduction in transition time between frack stages.

## Eagle Ford field trial

During field application of this new technology in the Eagle Ford Shale, the system was shown to reduce potential leak paths, eliminate mismatched connections, remove temporary pipe work and resist erosion during an operation that saw 23 frack stages per leg. Cameron installed and operated the 5-in. 10,000-psi system on two wells with a flow rate of 80 bbl/min max pumping 4-lb/gal max slurry density.

Following a simulation of the placement concept for a two-leg one-well pad, the system was installed at the actual well site. A four-person crew used a crane to install the pre-assembled system in 2.5 hours per leg and to remove the system in 2 hours per leg. The system performed to expectations, directing a 4-lb/gal max slurry density at a flow rate of 80 bbl/min max for 23 frack stages per leg. **ESP**

