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Hydraulic Pumping System

Re-routes Abrasive Frac Fluids to Increase Runtime and Reduce Maintenance

A newly applied technology first implemented in desalinization processes could more than double the useful life of hydraulic fracturing pump components and save service companies millions now spent on repair and maintenance from wear and tear caused by frac sand and other constituents.

Field trials are underway this summer on Energy Recovery Inc.'s VorTeq™ hydraulic pumping system designed to increase pump runtime during frac jobs while reducing repair and maintenance costs on high pressure pumps that force a slurry of sand and other components downhole to unlock oil and gas reserves in shales and other tight formations.

The introduction of the technology to fracturing could be commercialized as soon as next year and is expected to extend the life of the most commonly used reciprocating positive displacement, or PD, pumps mounted to frac trucks. It also could allow service companies to consider other types of pumps that previously failed at higher rates from wear and abrasion.

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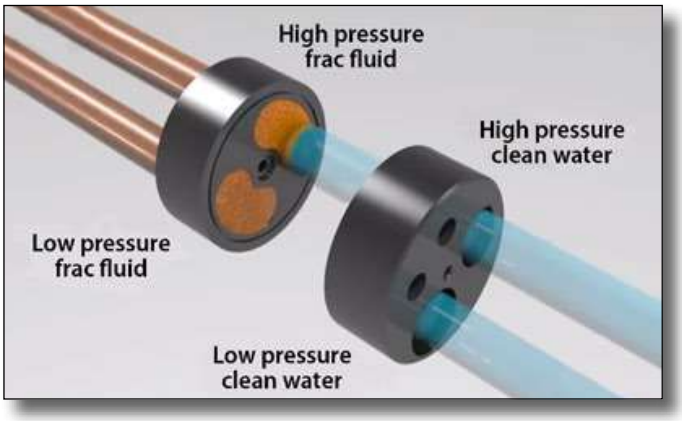
"We believe that VorTeq has the potential to be the most disruptive technology introduced into hydraulic fracturing since horizontal directional drilling," insists Joel Gay, president and chief executive officer at Energy Recovery, based in San Leandro, California.

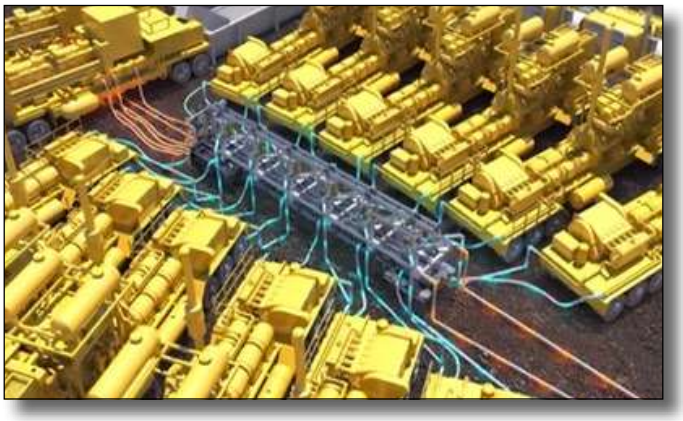
The trailer-mounted VorTeq system replaces the traditional hydraulic fracturing manifold trailer, or "missile." It uses Energy Recovery's revolutionary Pressure Exchanger® (PX) technology in which frac pumps only contact clean water during pumping operations.

In typical hydraulic fracturing systems, slurries of sand, other proppants, and specialty chemicals are mixed in a blender and piped at relatively low pressures to truck-mounted frac pumps that boost the pressure and force the mixture into the manifold and downhole.

But the components, especially sand in increasingly common slickwater fracs, are highly corrosive and can quickly scar and wear down pump components, forcing companies to spend millions annually to repair or replace valves, seats and other pump parts.

In the VorTeq system, sand and other constituents are blended and





piped directly into the Pressure Exchanger at relatively low pressures instead of into frac truck pumps. Simultaneously, the frac pumps are used only to pump high pressure water into the exchanger.

Inside the device, the high pressure water column collides with the column of incoming low pressure slurry for a few milliseconds, transferring the high pressure from the water to the slurry, which exits the exchanger at high pressure that forces the fluid downhole. The water column, with its energy diminished, leaves the device at low pressures and is circulated back to the truck-mounted pumps in a closed-loop system to repeat the process.

The exchanger has only one moving part, a cylinder that resembles a revolver cylinder of sorts that includes a series of tubes that pass through it. The Pressure Exchanger is made from tungsten carbide, which is 1,000 times more abrasion-resistant than steel.

Gay compares the energy transfer inside the Pressure Exchanger to a cue ball in billiards colliding with an eight ball. The energy from the cue ball is transferred to the eight ball, which is knocked toward the pocket, while the cue ball is stilled or perhaps rolls slightly away.

"On one end of the PX, you have a high-pressure column of fluid and on the other end you have a low-pressure column of fluid, and we are in essence ramming the columns of fluid into each other, thereby parting the hydraulic pressure energy from one stream to the next," Gay explains. "We do that about 20,000 times a minute in any given PX. Put another way, imagine a Gatlin gun and you have the columns in a Gatlin gun and it spins at a known RPM. That's what our Pressure Exchanger does. It spins via hydraulic torque, and it exchanges pulses of energy 20,000 to 30,000 times per minute, depending upon speed and the design of the pressure unit."

Inside the Pressure Exchanger, the high pressure water column collides with the column of incoming low pressure slurry for a few milliseconds, transferring the high pressure from the water to the slurry, which exits the exchanger at high pressure that forces the fluid downhole.

Despite the fluid columns touching, mixing is less than 5 percent, which consultants have indicated is minimal, says Gay, adding that Energy Recovery believes mixing can be reduced to 2 percent.

"We have worked with a bevy of consultants and no one is concerned about the mixing," he says. "Given the cost benefits, they are willing to trade a minimal amount of mixing."

The Pressure Exchanger technology already is in use in more than 15,000 desalination installations worldwide, Gay says. Each exchanger can handle up to 110 barrels a minute, with a treating pressure up to 15,000 psi.

There is a Pressure Exchanger for each frac pump, says Ron Gusek, vice president of technology and development for Denver-based Liberty Oilfield Services, a hydraulic fracturing company focusing chiefly on the DJ, Powder River and Williston basins, and Energy Recovery's partner in field trials.

In building its research and engineering staff, Energy Recovery searched for ways to apply the desalinization technology to other industries, a venture empowered by the addition of engineers and scientists with previous experience in hydraulic fracturing technologies at General Electric, Raytheon and other companies, Gay says.

The idea was first broached in 2013 of using the PX as sacrificial barrier between the existing positive displacement pump and viscous multi-phase frac fluid.

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Research and development was initiated later that year. The company unveiled the project in December 2014. Field trials were announced in April.

The VorTeq system and its Pressure Exchanger technology can help resolve a challenge on Gusek's mind since the middle of the last decade of finding alternatives to spending huge sums repairing and maintaining PD pumps.

"The challenge from a pumping services standpoint has grown since slickwater fracturing has become the preferred method in a lot of these unconventional reservoirs," explains Gusek. "When the frac fluid was quite thick, we didn't see a lot of damage as sand passed through the equipment, but at these higher rates with these lower viscosity fluids in slickwater fracs, we have seen significant increases in the wear and tear on the equipment."

"If we don't have to pump corrosive abrasive material through the pumps, we expect the repair and maintenance on the pumps to go down and ultimately expect to have lower repair and maintenance costs and the ability to do more work efficiently."

From the outset, the industry has been aware that standard PD pumps last longer pumping clean water or even corrosive substances such as acid without abrasive materials entrained in the fluid, he says.

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The VorTeq system is expected to reduce non-productive time from less repair work onsite, which increases HSE risks to service company employees performing repairs in proximity to high pressure pumping activities, Gusek says.

Gay insists the VorTeq and its Pressure Exchanger technology offers companies three key aspects of value creation, including reducing repair and maintenance costs to the tune of $1 million annually.

"That's what we expect to manifest as soon as we roll into commercialization," Gay says.

The VorTeq also could allow service companies to redeploy excess capacity that exploration and production companies now require onsite during hydraulic fracturing work to offset fluid washout and ensure maximum availability and capacity utilization, he says.

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For example, a fleet of 10 pump trucks can be required to carry 50 percent excess capacity, which means 15 pump trucks actually are at the jobsite instead of just 10. Savings would come from being able to forgo capital expenditures in the future, and assuming sufficiently high crude oil prices to stimulate drilling, service companies could aggregate new fleets and generate income elsewhere from pump trucks released from standby duty, he says.

"If you could reduce that required excess capacity by, say 15 percent, you are talking anywhere from a $7 million to $9 million benefit to the service provider," Gay says. "If the VorTeq allows the pump to only process clean water, the pumps will actually fail far less frequently than they do today. Therefore the exploration and production companies will be able to witness a new mean time to failure and ultimately require service providers to carry lower levels of excess capacity."

Thirdly, service companies could opt for other types of pumps tried previously that may be more efficient than PD pumps but that are less rugged and fail more frequently because of abrasion and wear from frac sand.

"If service providers no longer had to process frac fluid through their frac pumps, why would they continue to use reciprocating PD pumps?" Gay asks. "The answer is of course they would not."

PD pumps have life of about 6,000 hours. New centrifugal pumps that Energy Recovery could introduce with similar technology could have a life expectancy of 60,000 hours, Gay says. As field work progresses, the industry is keeping watch, Gusek says.

"The industry is intrigued and anxious to see what comes of it and how it works out," he says. "It's exciting to be a part of it."