Optimizing Frack Wastewater Management

Centralized wastewater treatment is emerging as a viable solution for long-term efficiency in managing water sourcing and wastewater treatment from hydraulic fracturing.

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The number of hydraulic fracturing (fracking) shale oil and gas wells in the United States and worldwide continues to increase. Within the Bakken Shale formation alone, in North Dakota and Montana, upwards of 15,000 wellheads are in operation, with another 20,000 wells planned.

The U.S. has vast reserves of oil and natural gas that are commercially reachable as a result of advances in horizontal drilling and fracking technologies, which have enabled improved access to oil and gas in shale formations, such as the Bakken. But as more of these wells come into operation, so does stress on surface water and ground water supplies from the withdrawal of large volumes of H_2O used in the process – needing up to one million gallons (almost 24,000 barrels) of fresh water per wellhead to complete the fracking process.

Equally important is the growing volume of wastewater generated from fracking wells, requiring disposal or recycling. Up to 60 percent of water injected into a wellhead (potentially 600,000 gallons) during the fracking process will discharge back out of the well shortly thereafter. Thereafter, and for the life of the wellhead, it will discharge up to 100,000 gallons per day of produced wastewater. This wastewater needs to be captured, and disposed or recycled.

Because water is the base fluid and biggest component used in fracking, its importance remains a critical factor in the operation and economics of shale oil and gas production. But significant and growing water management challenges are impacting fracking. Fresh water and wastewater operating procedures, which have been in place since the late 1990s, are experiencing increasingly stiffer governmental regulations on water availability and disposal limitations. These factors are prompting oil and gas executives to reassess their current water utilization activities regarding fracking, and adopt a more unified, and longer-range perspective on their water life-cycle management.

A comprehensive approach to integrating all aspects of fresh water and wastewater management in shale oil and gas production, while optimizing the utilization of water resources throughout the entire lifecycle of well production, is a centralized approach to the treatment and reuse of wastewater. Centralization not only provides treatment and reuse of flowback wastewater from a large number of wellheads when the wells are fracked, but also provides treatment and reuse of produced wastewaters for the long-term, full lifecycle of the wells – which represent the vast majority

A centralized wastewater treatment system such as the one shown above can greatly improve the economy of treating fracking wastewater for reuse or release.

of wastewater flowing from wellheads. Further, a centralized system can more easily access and utilize alternative water sources, such as from municipal wastewater facilities.

Inherently, wellheads providing shale oil and gas production are long-term processes, typically exceeding 20-year terms, but conventional solutions in play for handling fresh water resources and wastewater are geared towards the short-term. Impounding wastewater for evaporation in surface ponds, trucking water over long distances to deep-well injection sites, and treating flowback wastewater for reuse at the wellhead are all short-term wastewater handling options, which do not address critical long-term issues impacting of the industry – such as diminished water sources, increasing regulations limiting wastewater disposal, and growing safety and environmental concerns from government and the public.

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The centralized wastewater management concept is gaining momentum. In North America, well over a dozen centralized wastewater treatment facilities servicing shale oil and gas drilling are now active or in development.

Diminishing Options for Water Sourcing

Fresh water supplies for use in fracking are becoming more expensive and more unobtainable. Recently, the Army Corps of Engineers mandated against the long-standing policy of acquisition of water from the Missouri River watershed for use in shale oil and gas fracking. This diverted fracking operators to purchase pond and well water at higher rates from local landowners. Now these landowners are running out of water. 2013 water usage in Bakken formation fracking wells is expected to reach 6 billion gallons.

In Texas, where fracking wells work the Eagle Ford, Barnett Shale or Permian Basin formations and deal with the constant threat of drought, fracking operators compete with farmers and ranchers for their share of fresh water. As with North Dakota, water sourcing is the main fracking challenge in Texas. In these areas, an indefinite supply of water for expansion of fracking operations does not exist.

Even in Pennsylvania where water availability is more abundant, water sourcing is becoming more tightly controlled due to an increase in the number of fracking wells. Fracking a horizontal well may use 4 to 8 million gallons of water in a typical one-week period. Some wells may need to be fractured several times over their productive life (typically five to twenty years, or more).

Wastewater Disposal Limitations

States and some local governments have primary responsibility for adopting and implementing programs to ensure proper management of fracking wastewater. Many fracking wells use surface ponds to store fracking fluids (flowback and produced wastewater) for evaporation, or until arrangements are made for disposal. Almost 50 percent of the wastewater generated from fracking is diverted and stored in surface ponds. However, in the past 24 months Pennslvania has eliminated the use of surface ponds for wastewater storage.

But the future use of surface ponds is surely to become more regulated. The EPA is currently evaluating industry practices and state requirements and is considering the need for technical guidance on the design, operation, maintenance and closure of surface ponds under the Resource Conservation and Recovery Act in order to minimize potential environmental impacts.

In many regions of the U.S., including Texas, North Dakota and Montana, deep-well underground injection is a popular method for disposing fracking fluids and other substances from shale oil and gas extraction operations. Pennsylvania, some time ago, outlawed the use of deep-well injection within the state. Fracking companies operating in Pennsylvania, desiring to deep-well inject their wastewater, must have it trucked to Ohio for deposition.

This opens another set of potential issues relating to transporting large volumes of wastewater. Municipalities are concerned about the safety of high numbers of trucks traveling on rural roads and through small towns, and the safety impact this may be having on residents. Another is the impact of fleets of heavy trucks traveling on the roads. To help offset this issue, some local governments in Pennsylvania require fracking companies to post bonds to cover road repair and maintenance. Issues with trucking wastewater from fracking wells to deep-well injection sites are not isolated to Pennsylvania.

The costs for hauling wastewater for deep-well injection ranges between $3 and $7 per barrel. For a newly fracked well, the cost could reach $100,000 for transporting over 14,000 barrels of flowback – water levels produced from each basin, and indeed, each wellhead can vary. Plus, an additional potential 3,400 barrels each day of transported produced wastewater, at $20,000 per day. To haul water off-site for disposal over the 20 year life of a fracking well project, it was estimated to cost $160 million (includes trucking costs, water disposal costs and labor).

Wellhead Wastewater Treatment

Wastewater associated with shale oil and gas extraction can contain high levels of total dissolved solids, fracking fluid additives, total suspended solids, hardness compounds, metals, oil and gas, bacteria and bacteria disinfection agents, and naturally occurring radioactive materials. These contaminants are partially a combination of chemicals and agents inserted deep into the well (9,000 feet and deeper), which facilitate fracking by modifying the water chemistry to

increase viscosity, carry more sand and improve conductivity.

Effectively, the fracking process is pushing the water down into the rock formation, trying to wedge the rock cracks open. The sand fills in the cracks the hydraulic fluid has propped open. Once the fracking is done, much of the water comes back up the well. Along with it come bacteria and characteristics of the geologic formation, including minerals, radioactive materials and oil and gas.

Some drilling operators elect to reuse a portion of the wastewater to replace or supplement fresh water in formulating fracking fluid for a future well or re-fracking the same well. Reusing shale oil and gas wastewater is, in part, dependent on the levels of pollutants in the wastewater and the proximity of other fracking sites that might reuse wastewater. This practice has the potential to reduce discharges to surface ponds, minimize underground injection of wastewater, and conserve and reuse water resources.

Mobile solutions to treat wastewater at the wellhead enable recycling and reuse of flowback without the need for storing wastewater onsite in surface ponds, or for trucking flowback wastewater for disposal at offsite deep-well injection locations. The recycled wastewater is treated specifically for a different well site frack. The treatment is customized for the geology of that specified well site.

The drawback of wellhead mobile solutions is that they do not provide continuous processing to handle produced wastewaters, which would need to be processed for potentially 20 years following fracking. Since produced wastewater represents 95 percent, or more, of the wastewater generated during the lifecycle of a well, mobile processing systems do not provide a solution adequate to solving the long-term problems of diminished water sourcing and tightening wastewater disposal limitations.

Centralized Water Management

Centralized treatment of wastewater is emerging as a viable solution for long-term efficiency in managing water sourcing and wastewater treatment in fracking. Centralized treatment facilities handle the flowback wastewater and produced wastewater from oil and gas wells within a region, at a radius of 40 to 50 miles. Pipelines connect all wellheads directly with the central treatment plant.

Wastewater received by the plant is identified as originating from a specific well. The targeted usage requirements for that wastewater are specified, and the wastewater is then processed to meet that usage. Once processed, the wastewater is then piped directly to the targeted well site.

Central wastewater treatment facilities are in a better position to provide a broader scope of treatment options than what would otherwise be available, such as mobile wellhead treatment plants. They can provide a just-in-time processing capability, whether it is for a slick-water application in a well, or suitable for discharge to a watercourse. These processes can include:

- Primary three-phase separation to remove dissolved natural gas, floating gel, oil, sand and suspended solids, followed by storage for equalization of chemical composition and flow.
- Secondary separation utilizing dissolved air or gas flotation for removal of a variety of contaminants including polymers, oils and suspended solids. Bactericide is added to control bacterial growth.
- Removal of metals by precipitation, and removal of salts by reverse osmosis;
- Sludge management for dewatering collected solids.

Such centralized plants can be integrated with alternative sources of water to supplement fresh water needs for fracking, such as from abandoned mines, storm water control basins, municipal treatment plant effluent, and power plant cooling water. These initiatives are in alignment with mandates from Pennsylvania's Susquehanna River Basin Commission and its Department of Environmental Protection, which emphasize future trends in water use for oil and gas drilling should represent more reuse of water for fracking, and more use of other waters, such as treated wastewater and acidic mine drainage, in the fracking process.

The development of an integrated infrastructure for water management in shale oil and gas production has lagged behind improvements in drilling technology, which have been successful in spearheading this industry into recent national prominence.

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In the face of increasingly constricting traditional water sourcing options and tightening wastewater treatment regulations, the need for an industry initiative to develop this infrastructure network to deal with these water related issues is of critical importance if oil and gas producers are to effectively manage their frack well operations and maximize profits.

Centralized water management allows wastewater processing to be implemented on an economy of scale that has not before been realized in the shale oil and gas production industry. Reduced capital costs for treatment and distribution systems, lower operating costs, and a more favorable position to garner public and governmental acceptance are the key benefits of this centralized approach to water management.

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