



Centered on Wastewater Treatment

Optimizing wastewater management for shale oil & gas production

By Jeff Easton

The number of hydraulic fracturing (fracking) shale oil and gas wells in the U.S. and worldwide continues to increase. Within the Bakken Shale formation in North Dakota and Montana alone, 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 due to advances in horizontal drilling and fracking technologies, which have enabled access to oil and gas in shale formations, such as the Bakken.

But as more fracking wells come into operation, so does more stress on surface water and groundwater supplies due to the withdrawal of large volumes of water for use in the process, which requires up to 1 million gal (almost 24,000 barrels) of freshwater per wellhead to complete the fracking process alone. Equally important is the growing volume of wastewater generated from fracking wells, which requires disposal or recycling. Up to 60% of the water injected into a wellhead (potentially 600,000 gal) during the fracking process will discharge back out of the well shortly thereafter as flowback. For the life of the wellhead, 100,000 gal per day of produced wastewater will be discharged. This wastewater needs to be captured and disposed of, or recycled in an environmentally safe manner.

Water Management Challenges

Because water is the base fluid and primary component in hydraulic fracturing, 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 the process. Freshwater and wastewater operating procedures that 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.

One solution that promises a comprehensive approach to integrating all aspects of freshwater and wastewater management in shale oil and gas production, while also optimizing the utilization of water resources throughout the entire life-cycle of well production, is a centralized approach to the treatment and reuse of wastewater. Centralization not only provides treatment and reuse of flowback from a large number of wellheads when the wells are fracked, but it also provides treatment and reuse of

produced wastewater for the full life-cycle of the wells—which represent the vast majority of wastewater flowing from wellheads. Further, a centralized system can more easily access and utilize alternative water sources—such as municipal wastewater facilities—which otherwise would not be accessible.

Inherently, wellheads providing shale oil and gas production have long life-cycles, typically exceeding 20 years, but conventional solutions in play for handling freshwater resources and wastewater are geared toward the short term. Impounding wastewater for evaporation in surface ponds, trucking water over long distances to deep well injection sites, and treating flowback for reuse at the wellhead are all short-term options that do not address critical long-term issues impacting of the industry—such as diminished water sources, increasing regulation limiting wastewater disposal, and growing safety and environmental concerns from governments and the public.

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 either up and producing, or in development.

Diminishing Options for Water Sourcing

Freshwater supplies for use in hydraulic fracturing are becoming more expensive and harder to obtain. The U.S. Army Corps of Engineers recently mandated against the longstanding policy of water acquisition from the Missouri River watershed for use in shale oil and gas fracturing. This forced fracking operators to purchase pond and well water at higher rates from local landowners. Now these landowners are running out of water. Total 2013 water usage in Bakken formation fracking wells is expected to reach 6 billion gal. Today, water sourcing is the main fracking challenge in the Bakken.

In Texas, where hydraulic fracturing 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 freshwater. As in North Dakota, water sourcing is the main fracking challenge in Texas. In both of these areas, an indefinite supply of water for expansion of hydraulic fracturing operations does not exist.

Even in Pennsylvania, and throughout the Marcellus and Utica shale formations, where water is more accessible, the increase in well sites is causing water sourcing to become more tightly

controlled. According to the Susquehanna River Basin Commission (SRBC), hydraulic fracturing a horizontal Marcellus well may use 4 to 8 million gal of water within about one week. The commission stated, however, that some Marcellus wells may need to be fractured several times over their productive life (typically five to 20 years or more). These large water withdrawals may come from streams, rivers, privately owned lakes and ponds, or groundwater, and could affect availability of nearby drinking water sources, increasing the potential for conflicts between water users.

Wastewater Disposal Limitations

States and some local governments have primary responsibility for adopting and implementing programs to ensure proper management of hydraulic fracturing wastewater. Many fracturing wells operating in the Bakken formation in North Dakota and Montana, and in the Eagle Ford, Barnett Shale and Permian Basin formations in Texas, use surface ponds to store hydraulic fracturing fluids (flowback and produced wastewater) for evaporation, or until arrangements are made for disposal. Almost 50% of the wastewater generated from hydraulic fracturing in these states is diverted and stored in surface ponds. Pennsylvania, however, within the past 24 months, has completely eliminated the use of surface ponds for wastewater storage.

But the future use of surface ponds is likely to be more regulated. EPA currently is 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 the disposal of fracking fluids and other substances from shale oil and gas extraction operations. Pennsylvania outlawed the use of deep well injection within the state. Fracking companies operating in Pennsylvania that want to deep well inject their wastewater must have it trucked to Ohio for deposition.

This opens up 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 have on residents. Another concern is the impact of fleets of heavy trucks traveling on these 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 away wastewater for deep well injection range between \$3 and \$7 per barrel. For a newly fracked well, the cost could reach \$100,000 for transporting more than 14,000 barrels of flowback—water levels produced from each basin, and even each wellhead, can vary. Additionally, a well can produce a potential 3,400 barrels of wastewater each day, costing \$20,000 per day to transport. It was estimated to cost \$160 million (including trucking, water disposal and labor costs) to haul water offsite for



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disposal over the 20-year life of a hydraulic fracturing well project.

Surface ponds and deep well injection have served the wastewater needs of shale oil and gas production for well over a decade. From a short-term view, these methods have provided a cost-effective solution. But, as well operators are progressively beset with the need to better manage their water resources, it is necessary to be truly cost-effective from a longer-term perspective, one that approximates the longer-term investment into wells and more closely aligns with the tightening restrictions being imposed on the industry.

Wellhead Wastewater Treatment

Wastewater associated with shale oil and gas extraction can contain high levels of total dissolved solids, fracturing fluid additives, total suspended solids, hardness compounds, metals, oil and gas, 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 ft and deeper), which facilitates fracking by modifying the water chemistry to increase viscosity, carry more sand and improve conductivity. Effectively, the fracking process pushes the water down into the rock formation, trying to wedge the rock cracks open. The sand fills in between the cracks that the hydraulic fluid has propped open. Once the fracking is done, much of the water comes back up the well as flowback. Along with it come bacteria and constituents 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 and/or supplement freshwater in formulating fracturing fluid for a future well or re-fracturing the same well. Reuse of shale oil and gas wastewater is, in part, dependent on the levels of pollutants in the wastewater and the proximity of other fracturing sites that might reuse it. 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 in surface ponds on site, or for trucking it for disposal at offsite deep well injection locations. The recycled wastewater is treated specifically for a different well site based on its geology.

The drawback of wellhead mobile solutions is that they do not provide continuous processing to handle produced wastewater, which the well will continue to generate for up to 20 years following fracking. Because produced wastewater represents 95% or more of the wastewater generated during the life-cycle of a well, mobile processing systems do not provide an adequate solution to solving the long-term problems of diminished water sourcing and tightening wastewater disposal limitations.

Centralized Water Management

Centralized treatment facilities handle both the flowback and produced wastewater from oil and gas wells within a region, at a

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radius of 40 to 50 miles. Pipeline connects 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, then it is processed to meet that usage. Once processed, the wastewater is then piped directly to the targeted well site.

Centralized wastewater treatment facilities are in a better position to provide a broader scope of treatment options than what would be available otherwise, such as with mobile wellhead treatment plants. They can provide just-in-time processing capability, whether it is for a slickwater application in a well, or 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 wide 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; and
- Sludge management for dewatering collected solids.

Such centralized plants can be integrated with alternative sources of water to supplement freshwater 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 SRBC and its Department of Environmental Protection, which emphasize that 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 hydraulic fracturing 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.

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 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 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. **IWWD**

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