Leaving Produced Water Management to the Experts

Operators need guidance on water management to ensure compliance and to cut costs.

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Contributing Editor

Although it constitutes most of the total volume of liquids produced by the oil industry worldwide, operators have traditionally dedicated few resources to managing produced water. In the face of increased regulatory pressure and the extreme costs of produced water transportation, treatment and disposal, operators have been turning to water experts and full-service water management companies to fill voids in their engineering staffs. The increase in consultants and services within the upstream industry is testimony to the fact that efficient water management is a critical and complex operator function that is better left to the experts.

“Water treatment is as complicated as oil refining,” said Schlumberger produced water product manager, Dan Shannon. “Most operators focus on the oil side and their expertise on the water side can be limited. The whole idea is to involve the water treatment experts who know the right questions to ask in order to determine the best solution.”

Cleaning waste
Formation liquids usually consist of hydrocarbons mixed with a significant fraction of water. The water fraction of this mixture usually increases over time and, without intervention, most formations will eventually deliver much more water per day than oil. The composition of produced water is as varied as the formations from which they flow but typically contain inorganic and organic compounds and some residue of chemicals introduced into the reservoir by stimulation and other EOR operations.

Regulatory-directed produced water purity requirements also vary widely around the world and depend on, among other things, final disposition of the water. Water intended for discharge overboard in the Gulf of Mexico, for example, has certain limitations on the contaminant levels of entrained oil found in the water that is to be discharged. In other areas of the world, no liquids at all may be discharged into the ocean. In the North Sea, regulators require operators to dispose of all produced water through injection into non-producing formations.

To properly choose and size treatment equipment, experts use basic input that includes flow rates, influent water quality and desired effluent water quality. As the first two of these are easily known, best water management practices demand use of only quality assured produced water samples.

“What causes less than optimal performance is the water quality data not being identified correctly,” Shannon said, referring to operator-taken water samples. “For instance, if crude oil gravity was taken on a sample with diesel in it allowing it to flow better, we need to know that. If the water quality is highly variant due to events in the formation, ongoing field development work or chemical additives—these variations need to be known as well.”
After analyzing produced water samples, experts design water treatment solutions by establishing the quality window within which a treatment strategy is to perform. Because the quality of produced water changes as wells are produced, the solution must be able to accommodate a wide range of variables that might change over time. For this reason, optimal equipment is selected and then installed based on the quality requirements that evolve over the life of the field.

Depending on the operating environment, final water quality targets and budget, water management strategies might consist of a single treatment or of numerous increasingly refined treatments. The former solution, say some experts, is a prescription for less than optimal results and, because of its lack of flexibility, may not be able to deliver desired final water quality as the makeup of the produced water changes over time. In addition, when engineers specify a specific piece of water treating equipment, they may force experts into devising a best single-widget solution that is less effective than a solution that considers use of other options.

Integrated water service engineers possess expert knowledge of reservoirs and water treatment technology. They also understand the regulations that govern the industry and know what water quality must be achieved to accommodate operator plans. While large oil companies have regulatory staffs, because water use regulations vary significantly across relatively small geographical distances, most operators rely on water management experts to act as de facto regulatory advisors.

“Typically, customers reach out to us when facing challenges with the water they are producing. They basically say, ‘we have water that needs to be treated for a particular use,’” Shannon said. “In other words, they are looking for a solution that treats the water from the current quality to the required effluent quality. During this discussion, our process design experts acquire the right information to ensure an optimal solution is modeled.”

For example, Schlumberger’s Shannon pointed out that traditional treatments for waterflood effluent containing polymers is to oxidize the water to destroy remaining polymers and then add polymers back to get the system to requisite viscosity levels before it is...
pumped back downhole. But, he said, Schlumberger’s secondary treatment system can save the extra cost by treating the returned water without removing the polymer.

“When the water returns from subsurface, it still contains some valuable polymer,” Shannon explained. “The traditional way to treat it is to use chemicals that completely destroy the remaining polymer. The inability to re-use this polymer later in operations can be a costly expense to the customer.”

In the current oil price environment, trimming operating costs is a compelling driver of best water management practices, particularly in the booming shale plays.

**Shale, water and trucks**

In 2014, according to the U.S. Geological Survey, the mining and oil and gas industries accounted for just 1% of all the water used in the U.S. per industry. It would seem a relatively small amount but for the fact that oil and gas exploration and production operations, particularly in shale plays, often take place in water-strapped locales. Consequently, in the rush to exploit unconventional resources, the interests of business and corporate citizenship converge to drive operational efficiencies.

According to Schlumberger’s Jess Lee, well services chemistry portfolio manager, water accounts for about 35%, or about $7.3 billion, of total costs of hydraulic fracturing.

That figure arises from the cost to complete the full water cycle of transporting water to location, adding chemistry for fracturing fluid, performing the fracture, flowing the well back and transportation to a treatment or disposal site. Transportation in the form of trucks moving fresh and produced water between source, treatment and disposal sites accounts for more than half of the water costs. Large numbers of heavy water haulers also significantly impact nearby infrastructure and pose environmental risks associated with moving large volumes of contaminated water through public areas.

Traditionally, because the chemicals in water produced from fractured wells pose a threat to equipment, flowlines and the formation, operators have long had little practical choice but to pump it down disposal wells or recondition it for agricultural or industrial use. Seeking ways to minimize overall costs of hydraulic fracturing operations, operators have begun to turn to water recycling produced water, including water used to create fracturing fluids, which returns to the surface after all stages of a well have been fractured and the well opened to flow.

Based on their analysis, they then design a system to condition the water to be compatible with the fracture fluid to be used on the next well and with the formation to be treated. Because multiple wells are drilled and stimulated from a single location or pad, this method not only reduces the need for a continuing source of freshwater but because the treatment systems are deployed on location, it eliminates much of the transportation and storage portion of the water cycle.

Taking flowback and produced water use to the next level, engineers and scientists at Schlumberger have expanded the concept by approaching...
WATER MANAGEMENT: BEST PRACTICES

Water recycling from a different direction. Instead of conditioning available water to be compatible with the formation and fracture fluid, the company provides a service that allows produced water-based fracturing fluid formulas that use untreated produced water.

The new offering from Schlumberger is called the xWATER integrated water-flexible fracture fluid delivery service. The design of the fracture fluids, explained Max Nikolaev, stimulation technologies production champion, allows operators to use water that has gone through little or no treatment to build fracture fluids. “The ultimate goal,” he said, “is to be able to build a fluid based on any available water source.”

The theory behind the practice is reminiscent of the quality window concept, which accounts for water quality variance. In this case, however, the concept of flexibility in backflow water quality refers to ranges of salinity levels, temperatures, pH, sulfates and metals. Using the xWATER service, fracture fluids can be built that are compatible with water having a wide range of salt levels and other characteristics of the target formation.

The process begins with produced water analysis. Fracture fluid designs built on those analyses are then modeled and tested at every stage of the water cycle from pumping to flowback.

The service allows operators to build fracturing fluids using most types of available water sources such as brackish groundwater or seawater. The flexibility to use multiple water source types with minimal or no treatment to provide a crosslinked gel system, significantly cuts costly steps from the full water cycle by reducing or eliminating the cost and pressure on area roads arising from transporting water over long distances.

In the Williston Basin of North Dakota, the xWATER service was used to hydraulically fracture a two-lateral well using filtered but otherwise untreated produced water. The operations used 7 million gallons of water, including 2.2 million gallons that were crosslinked, to place proppant in the Bakken and Three Forks formations.

The fluid used standard oilfield chemical practices and equipment and is based on an industry standard, widely available and inexpensive polysaccharide gelling agent. During the operation, engineers observed treating pressures that indicated better near wellbore proppant transport than is typically seen in the area.

The operation eliminated the need for freshwater and disposal of produced water, which Schlumberger calculates took 600 trucks off the road. Production from the treated formations is reported to equal or exceed of offset wells of similar design.

**Conclusion**

Within the traditional business model, water treatment companies acted essentially as manufacturers who built and installed equipment according to client specification. Their involvement after the equipment was online was confined to maintenance as needed. But with increasingly stringent regulations on contaminants and the growing economic importance of water supply and demand in the economics of North American unconventional resource production, operators are coming to view water treatment in a different light.

“Today, we merge responsibility for performance with inherent expertise,” said Schlumberger’s Shannon. “Clients often install various water treatment solutions but refrain from utilizing the solution experts when operating them. So, the approach now is to take ownership and utilize our water treatment expertise to not only communicate to the operator what these solutions do but also ensure they perform as expected.”