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Technology Forum

Managing produced water is one of the controversial environmental issues facing the oil and natural gas industry. This prototype of Wescorp Energy's Total Fluids Solution oil/water separation unit was installed adjacent to storage tanks that are part of the operator's treating facility. Photo courtesy of Wescorp Energy.

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Produced water management: controversy vs. opportunity

One of the most controversial areas of oil and gas production operations today is the handling, treatment, and disposal of produced water.

The oil and gas producing industry generates tens of billions of barrels of produced water every year along with the hydrocarbons it recovers, and with that practice comes mounting concerns about waste and contamination of water.

"The world's population has insatiable demands for two equally precious commodities, potable water and fossil fuels," notes Doug Biles, president and CEO of Wescorp Energy Inc. "Unfortunately, the pursuit of one always seems to be at odds with the pursuit of the other. The perception exists that the demand for fossil fuels comes at the expense of the supplies of potable water in particular and the overall environment in general.

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Contamination concerns

Halina Caravello, Baker Hughes vice-president, health, safety, and environment, notes that "while oil spills are the headline grabbers, release of produced water is, in aggregate, the largest liquid discharge from E&P operations, and perhaps, more difficult to manage effectively."

Recent data indicate that worldwide 9 tons of oil were released via produced water for every million tons of produced hydrocarbons, she notes.

"While improper management can lead to detrimental environmental consequences, such as contamination of aquifers, or harm to plant and animal life, managing this stream effectively can have positive environmental impacts." Caravello says.

"Recent activity to increase oil production in new and existing fields has created a more difficult produced water challenge, namely 'high oil-in-water load emulsions,' she notes. "Instead of treating production primarily to remove water from the oil, these fluids must be primarily treated to recover oil from the water. This requires the use of a whole new class of chemicals not used in oil production before—ultra-long-chain polymer flocculants requiring much higher levels of skill and care to apply effectively. This new generation of treatments must be delivered emulsified or dispersed in oil or brine, or diluted in gelatinous solutions."

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"...Due to higher commodity prices, wells that would have otherwise been shut in are now proving to be commercially viable and are remaining in production for longer periods of time. The maturation of these older wells results in higher than initially forecasted water cuts—thus the produced water treatment system being in an overcapacity situation."

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One particularly difficult class of contaminants to manage in produced water are water-soluble organics, which are insoluble under the acidic conditions in which oil-in-water is measured, Caravello points out.

"New treatment regimes, which employ 'activated hydrophilic acids,' alone or in combination with anionic polymers, reduce the concentrations of these contaminants to acceptably low levels," she notes.

As clean water becomes a scarcer vital resource, the treatment of produced water to allow other uses, such as recycling back to the reservoir as water or steam to enhance production and prevent subsidence, or using for irrigation, washing, or even drinking, may become more important than oil, Caravello adds: 'At ever more wellheads, the most effective approach is 'treat the water first.'"

Because regulators are increasing their requirements on petroleum companies across the globe—a trend that is likely to continue—"the industry must recycle produced water and use it again and again and again, much like how an automatic car wash recycles water," says Biles.

"When hydrocarbons are present in the produced water, other existing technologies—desalinization, desanding, etc.—won't work," he points out. "Today, in the Canadian tar sands area, tailing ponds are so huge they can seen from space with the naked eye.

"If this water treatment issue is not solved, it has the potential of negatively impacting new exploration and production in the United States and Canada."

Biles estimates that it takes 4–20 bbl of water to produce 1 bbl of oil in today's unconventional drilling.

"This water needs to be cleaned so it can be recycled," he adds. "Preserving and remediating water reduces trucking and disposal costs and increases potable water sources."

Michael R. Robicheaux, general manager, oil and gas division, Siemens Water Technologies Corp., concurs that the worldwide E&P sector is currently experiencing several challenging issues pertaining to produced water treatment and discharge criteria. "First, due to higher commodity prices, wells that would have otherwise been shut in are now proving to be commercially viable and are remaining in production for longer periods of time," he points out. "The maturation of these older wells results in higher than initially forecasted water cuts—thus the produced water treatment system being in an overcapacity situation.

"Second, both domestic and international operators of new production platforms are demanding smaller equipment footprint and weight reductions while still maintaining the capability to properly treat high volumes of produced water to be discharged while ensuring compliance.

"Third, water-soluble organics (WSOs) are posing a significant challenge to the industry, and economical treatment alternatives have not yet been identified. Overall, the most difficult challenge centers around ever-increasing volumes of produced water requiring treatment, whether on land or offshore."

Robicheaux thinks that dealing with WSOs and mercury contamination loom as the major environmental challenges ahead for industry's efforts centered on managing produced water.

He contends that industry efforts should be focused on three main areas:

- Ultimate compliance with the local, regional or international discharge criteria.
- Reduction in operational cost even at the expense of higher initial capital outlay.
- Point source treatment alternatives.

Cost-effectiveness

The most cost-effective approaches to managing produced water offshore is primary and secondary separation and treatment, followed by discharge into receiving waters within criteria limits and/or reinjection, Robicheaux says.

"Onshore, the most promising beneficial reuse approaches to managing produced water include water reinjection for reservoir/pressure maintenance, reuse of treated water for agricultural purposes (i.e., irrigation), and for miscellaneous applications such as subsequent hydraulic fracturing projects, surface hole drilling, roadway dust suppressant, etc.," he notes.

New technologies

Among new technologies that offer great promise for handling and treating produced water is the dissolved gas flotation (DGF) system patented by Monosep.

Monosep describes the system as follows:

The DGF pump works by using a dual-sided impeller that pulls both water and gas into the pump volute. The backside of the impeller has a "subatmospheric" zone that pulls vapor from the blanket gas source or other means and allows mixing

with the incoming fluid. As this occurs the vapor is dissolved into the water, creating microfine bubbles that break out of solution once a pressure drop is experienced. This pressure drop occurs once the fluids and dissolved gas are flowed across a globe valve prior to entrance into the flotation vessel. Due to the close tolerance between the back vanes of the impeller and the back plate of the DGF pump, the vapor is sheared into microfine bubbles piped into a vessel or tank, allowing the fine gas bubbles to attach to the oil droplets. As the gas bubble attaches to the oil droplet, the droplet floats to the surface at an accelerated rate. The DGF technology can produce bubbles that range from 1 micron and greater, according to Monosep.

Robicheaux cites the emergence of subsea separation systems, "a new technology, although not proven on large-scale projects, and there are minimal installations."

Wescorp offers a system it dubs "Total Fluids Solutions."

In the Wescorp system, a unique patented aeration system creates micron-sized gas bubbles that supersaturate the produced water. As the solids are cleaned of hydrocarbons, the heavy solids fall, and the lighter suspended solids rise and are encapsulated in the recovered oil. An innovative tank configuration removes the oil and a slight amount of water from the primary tank. This oil-water mixture flows through the remainder of the system, achieving virtually total separation of the oil and produced water. The recovered oil flows into an oil collection tank and the water, free of oil and solids, is pumped down a disposal well back into the reservoir. Through this process, the hydrocarbon content in the injected water is reduced from the typical 5,000–30,000 ppm to less than 50 ppm.

Biles cites the economic advantages of his company's Total Fluids Solution as:

- Reducing the frequency of expensive remedial work on injection wells.
- Recovering additional reserves from the reservoir.
- Decreasing the amount of surface treating facilities, in some cases.

"These advantages will make a significant difference in the operating costs of an oil field," Biles contends. "This new technology has the ability to significantly help with water shortages in a number of oil and gas producing areas, including the Barnett shale production areas in the US."]