Membrane Technology Plays Key Role in Flowback and Produced-Water Treatment

APATEQ's new mobile OilPaq system is cost effective and requires no chemicals in the process.

BY DIRK MARTIN

Most of the fracing flowback and produced water from oil and gas production today is discharged into disposal wells. However, various factors, such as economic considerations, freshwater shortage and regulation, put the focus more and more on treating and reusing wastewater, which accumulates in large quantities. As current treatment solutions are either costly or energy intensive and often require different types of individual unit processes used in a series, clean-tech venture APATEQ developed a cost-effective, green process technology. It is based on long-lasting membranes that efficiently separate hydrocarbons from frac flowback and produced water without using chemicals in the treatment process. The portable OilPaq covers almost the entire treatment chain as a single device, reducing free and emulsified oil from 500-2,000 ppm (parts per million) down to 1-2 ppm, suspended solids from 500-1,000 ppm to 1-2 ppm.

◀ The ultrafiltration is equipped redundantly to avoid any breakdowns of the system.

with oil and gas production. And we are not talking about water with an oil layer floating on the surface, but dissolved hydrocarbon particles in the smallest sizes, free and emulsified oil, suspended solids, and numerous salt and mineral contaminants in the water. Depending on the well location and depth, other toxic substances, such as heavy metals and natural radioactive materials (NORM), may also be present. Today more than 90 percent of this water from onshore production is dumped into disposal wells.

THE IMPORTANCE OF FINDING ALTERNATIVES TO DISPOSAL WELLS

Handling produced water and fracing flowback has become more and more a significant factor for various reasons. Increasing price pressure forces oil-and-gas pad operators to reduce costs in order to remain competitive. Truck traffic related to hauling the water to the nearest disposal well represents a major issue for municipalities in oil-and-gas extracting regions and may cause a negative environmental impact. Not only public resistance and ecological factors, but also economic considerations raise the question of how sensible hauling produced water is. Water hauling represents more than two-thirds of the U.S. onshore water-management market. We are talking about more than $35 billion a year, which would be saved if the water were treated onsite.

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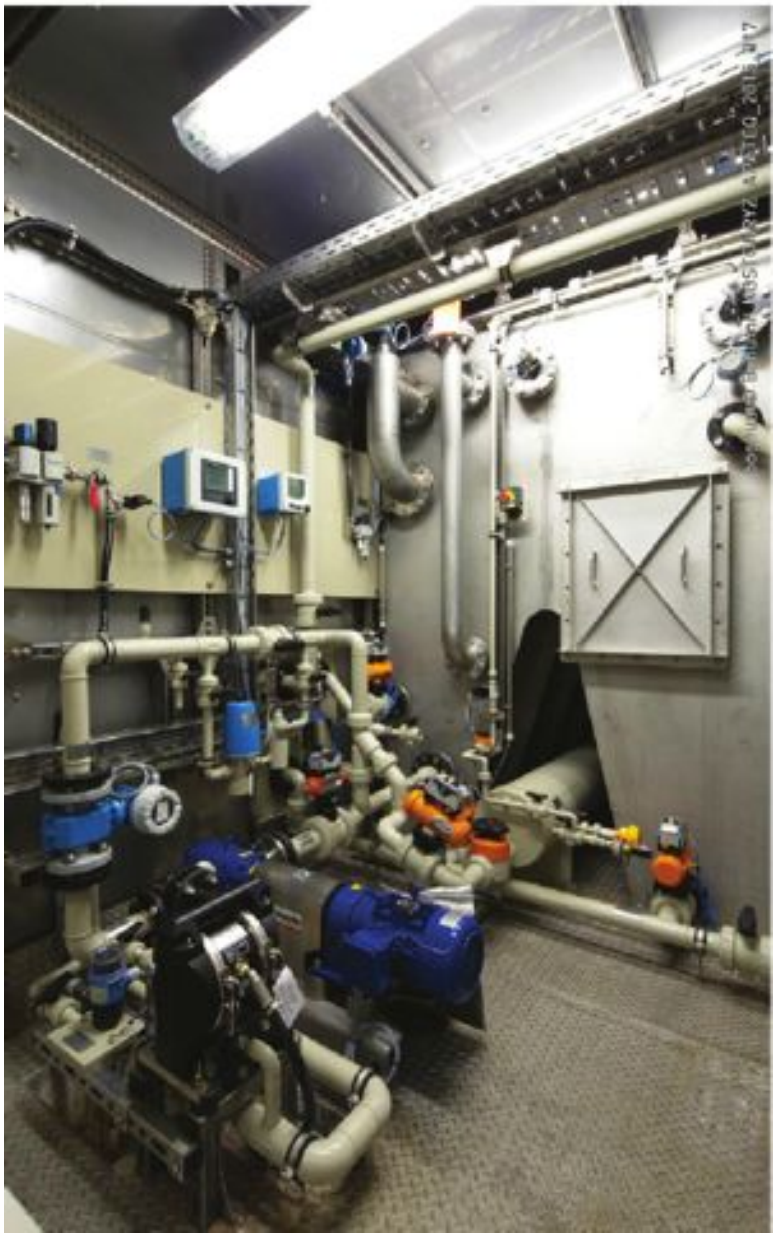
On average, three to five barrels of water are produced with every barrel of oil. This means that more than 21 billion barrels per year of produced water and fracing flowback are generated in the United States alone. Worldwide this figure exceeds 77 billion barrels per year. Fracing flowback and produced water are by far the largest waste streams associated

By dumping the water in disposal wells, oil particles left in it are wasted. Produced-water streams strongly vary in their composition. The total oil content in produced water can



The containerized primary treatment module of the OilPaq

range by a wide margin, from 40 to 2,000 ppm or more. While that may not sound like much oil, it can add up quickly. A small oil pad with eight to 10 producing wells can easily produce 10,000 BWPD (barrels of water per day) or more. One thousand ppm of oil in the water is the equivalent of 10 barrels of oil. Besides this lost revenue, it needs to be considered that the hydrocarbons, along with sand, other solid particles and bacteria, accumulate within the pores of the disposal well's formation surface and thus increase its operation costs by forcing the operators to apply bleaching or other chemical well treatments to avoid clogging. Therefore, treating the produced water before pumping it into a disposal well makes sense from an economical and ecological point of view.

The impact of droughts is unpredictable, but has increased over the years. This affects several oil-and-gas extracting regions in North America. The huge amount of fracing flowback and produced water generated, on the other hand, stands in contrast to the increasing shortage of fresh water and related rising freshwater costs. Treating produced water to an effluent quality that is reusable, e.g., suitable for reinjection into the borehole for enhanced oil recovery (EOR) instead of dumping it into a disposal well, saves freshwater resources that can influence the economic limit of a well.

And finally, saltwater disposal (SWD) wells are forbidden in some U.S. states, causing additional costs for water hauling to the nearest state where SWD wells are permitted.

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EVALUATING DIFFERENT PRODUCED-WATER TREATMENT SYSTEMS

Because the concentration of contaminants varies significantly from region to region or even from well to well and the requirements for disposal or reuse are largely varying, too, there is a wide range of produced-water treatment equipment available on the market. Most often, an effective treatment

◀ Office container including control cabinet and storage

system will consist of many different types of individual process units used in a series to remove a wide suite of contaminants that may not be removed with a single process. Organic and particulate removal, desalination and disinfection are the major classifications of produced-water treatment technologies. Organic and particulate removal is mostly required as a pretreatment step when desalination technologies must be used to treat produced water. These technologies include biological aerated filters, hydrocyclones, dissolved air flotation, adsorption, media filtration, oxidation, settling ponds, air stripping, ultraviolet (UV) disinfection, and ceramic and polymeric micro- and ultrafiltration (UF). Desalination technologies are necessary to lower the total dissolved solids concentration and the concentration of ions that are too high for the desired beneficial use of the treated water.

Membrane technology could represent the most effective technology in the oil and gas industry for eliminating suspended solids, recovering oil, and recycling flowback and produced water for reuse. However, due to minute oil particles and light-density solids adhering to the membrane surfaces, clogging the membrane pores, previous large-scale attempts to apply this technology in the oil and gas industry have failed.

APATEQ GOES GREEN WITH OILPAQ

APATEQ made its OilPaq system green by using membrane technology in an innovative way so that no chemicals are required for the treatment process. The system's membranes have a lifetime of greater than five years without clogging and fouling. There are long intervals in between automated CIPs (clean in place), resulting in low operation expenses. With virtually no consumables besides the typical wear-and-tear components and electricity consumption of 0.2–0.4 kWh per barrel, the TCO (total cost of ownership) of the OilPaq is estimated at 50 cents to less than $1 per barrel, depending on the throughput of the installation.

The OilPaq consists of three modules: primary treatment, ultrafiltration, and an office with a control center and storage. Available in various capacities, it is portable, built either in standard shipping containers or rack mounted. It works with salinity levels as high as 300,000 ppm and eliminates bacteria such as SRB (sulphur-reducing bacteria) and APB (acid-reducing bacteria) because bacteria cannot pass the membrane surface that holds back particles larger than 40 nanometer. The fully automated system is controlled by a touch-screen panel that is integrated into the plant, or it can be controlled remotely. Thus, one service technician can simultaneously supervise, operate and maintain several OilPaq sites. OilPaq's primary treatment and membrane-filtration technology complement each other. The primary treatment already eliminates free and emulsified oil particles down to 50-200 ppm, and the subsequent ultrafiltration reduces the value to 1–2 ppm. The primary treatment collects the oil that has been held back by the membranes, as oil and concentrate from the ultrafiltration is cycled in front of the primary treatment stage to be reprocessed. Taking it one step further again, the membrane filtration then removes the particles that the primary treatment is not capable of eliminating. The primary treatment of the OilPaq combines dissolved-gas flotation with a settling process that uses alternating hydrophilic and hydrophobic surfaces, in which no energy and chemicals are used. The ceramic ultrafiltration membranes are conditioned to exhibit strong hydrophilic characteristics that reject free oil drops, emulsified oil droplets and other hydrophobic substances. This conditioning prevents membrane pores from clogging by free oil, other hydrophobic substances and low-gravity suspended solids. While the ultrafiltration concentrate is cycled back to the primary treatment, the permeate represents the final effluent water.

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Exterior view of two OilPaq modules in shippable container format

OILPAQ'S SAFETY FEATURES

Meeting the highest international standards for effluent and build quality, the OilPaq is designed to operate safely in potentially hazardous areas and explosive environments. Its safety features include blanketing the entire water surface within the tanks with nitrogen to suppress explosive gases. Continuously monitoring environmental gases, sensors for light and heavy gases, H_2S and oxygen are installed in the plant. If gas levels inside the OilPaq approach hazardous levels, the plant immediately shuts down all systems automatically. Remote monitoring and operation is a given while safety and operational alarms inform the operator in case there is an unscheduled event. The OilPaq's critical operational sub-systems are redundant to avoid processing disruptions. In the unlikely event that a critical sub-system fails, the OilPaq's software is programmed to take immediate action by switching from the defective device to its backup device.

In early 2014, APATEQ delivered a pilot OilPaq to one of the largest oil and gas producers in Europe. With only process-control parameter adjustments and no hardware changes, the pilot OilPaq was capable of continuously treating alternating produced waters resulting from 30 different wells in a Northern European gas field. APATEQ is currently running a program of on-demand, onsite produced-water treatment in the U.S. and Canada with the same pilot plant. In addition to the existing North American clientele, the program is open to new participants by a no-engagement subscription. By the end of 2015, APATEQ will establish its first subsidiary in the Houston, Texas region to directly serve the North American market. ◻

About the Author:

Dirk Martin has more than 20 years of professional international sales, procurement and logistics experience throughout Europe, North America, South America, Asia and Africa. He holds a business-administration degree and has specialized in developing startup companies in various industrial sectors, with an emphasis on commercialization of new technologies and the creation of new strategic business alliances. Mr. Martin has sold wastewater-treatment systems to customers in North America, France, Germany, Italy and Luxembourg.