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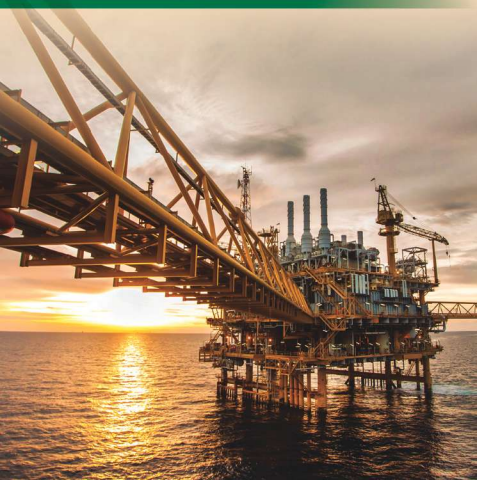
Special Section:
Shale Technology Showcase

Regional Report:
EAST AFRICA



Scratching the SUBSURFACE

Technologies reveal shale's secrets

Upstream water management continues to evolve

More affordable and effective solutions are being developed for water management processes.

Compiled by **Ariana Hurtado**, Associate Managing Editor

Operators can be faced with a variety of water challenges, such as reducing and recycling produced water, minimizing freshwater use, reducing unwanted water production, treating produced water, and finding and transporting water for disposal and reuse.

"The ability to reduce and recycle produced water and minimize freshwater use can improve operator profitability and contribute to water conservation," Halliburton stated on its website. "Globally, oil wells produce about 220 million BWPD [barrels of water per day]—roughly three barrels of water for every barrel of oil. In older fields, the water cut, or ratio of water-to-oil, can be 95% or higher. Managing this produced water is a great challenge for operators."

The goal remains to optimize the use of natural resources, minimize waste and use water efficiently.

"Water is both a waste and a valuable commodity that is critical to all human activities," Mark Wolf, director of onshore facilities at National Oilwell Varco, told *E&P*. "The future for water management in oil and gas will be finding ways to economically recycle water from waste back to something useful."

The following is a sampling of some of the new technologies and products available for companies in the water management space. ■

Editor's note: *The copy herein is contributed from service companies and does not reflect the opinions of Hart Energy.*

The water management market for upstream oil and gas operations in the U.S. was worth an estimated $33.6 billion in 2018 and projected to grow at a 3.9% compound average growth rate through 2023, according to IHS' December 2018 "WaterIQ" report. (Source: somsak nitimongkolchai/*Shutterstock.com*)

ADDRESSING SHALE WATER MANAGEMENT CHALLENGES

Three to seven barrels of water are produced for each barrel of oil in unconventional oil and gas assets. As a result, water management in the oil and gas industry is a significant expense and serious environmental concern. Recycling produced water for use as frac fluid reduces freshwater aquifer drawdown and lowers operator costs. With the most productive wells often tens of miles from infrastructure, onsite mobile services give operators the security of knowing that a total solution is available anywhere they need it. As a field-ready onsite sodium hypochlorite generation system, the De Nora Neptune mobile treatment unit produces oxidant or biocide at the lowest cost, without using or producing hazardous chemicals. This gives operators a completely safe solution for frac water disinfection and produced water recycling. *denora.com* ■

MULTIPHASE WELLHEAD AND WELLSTREAM DESANDERS

Exterran Water Solution's new Separon multiphase wellhead and wellstream desanders are economic, highly efficient alternatives for high-pressure environments. The technology is a complete solution that is compact, lightweight and meets all standards up to 20,000 psi, removing solids from wellhead and wellstream applications at a lower cost than other products and made for multiphase and gas applications. Exterran provides a full range of treatment solutions for removing oil and suspended solids from produced water with primary, secondary and tertiary treatment. Exterran designs, builds and commissions systems that quickly, efficiently and cost-effectively treat produced water ranging in volumes from 100 to more than 1 MMbbl/d of water for oil and gas production facilities and has treated more than 5 Bbbl to date. *exterran.com/solutions/watersolutions* ■

SELF-CONTAINED MOBILE WATER TREATMENT PLATFORM

Fountain Quail Water Management's genesis of SCOUT grew out of collaboration with the industry. E&P operators were asking for a call-out type service and a reliable system that generates clean brine from flowback water with minimal setup time and labor. SCOUT offers a minimum 10,000 bbl/d of water clean brine capacity. The self-contained mobile system can be hooked up in hours and offers proven performance in demanding environments. Developed jointly with Filtra-Systems, each SCOUT only requires 480 V power and three connections: Feed IN, Treated OUT and Backwash. The backwash volume is typically less than 1% of feed. *fountainquail.com* ■

One of the 14 mobile SCOUT units operated in the Permian Basin in May. (Source: Fountain Quail Water Management)

OXIDATION SYSTEM FOR PRODUCED WATER TREATMENT/REUSE

Hydrozonix has released its HYDRO$_3$CIDE, a fully automated oxidation system for the treatment and reuse of produced water. This system generates ozone on demand, significantly reducing the cost of recycling produced water as a completion fluid. Produced water is typically managed in disposal/injection wells, which has been the lowest cost option. Induced seismicity concerns have the potential to significantly restrict permitted capacity of disposal/injection wells, leaving recycling as a viable alternative. Oxidation of produced water for bacteria, iron and sulfide control is a critically important step in the recycling process and has been primarily completed using a liquid chemical oxidizer. HYDRO$_3$CIDE reduces the cost of oxidation by up to 90% finally allowing recycling to become the lowest cost option for the management of produced water. *hydrozonix.com* ■

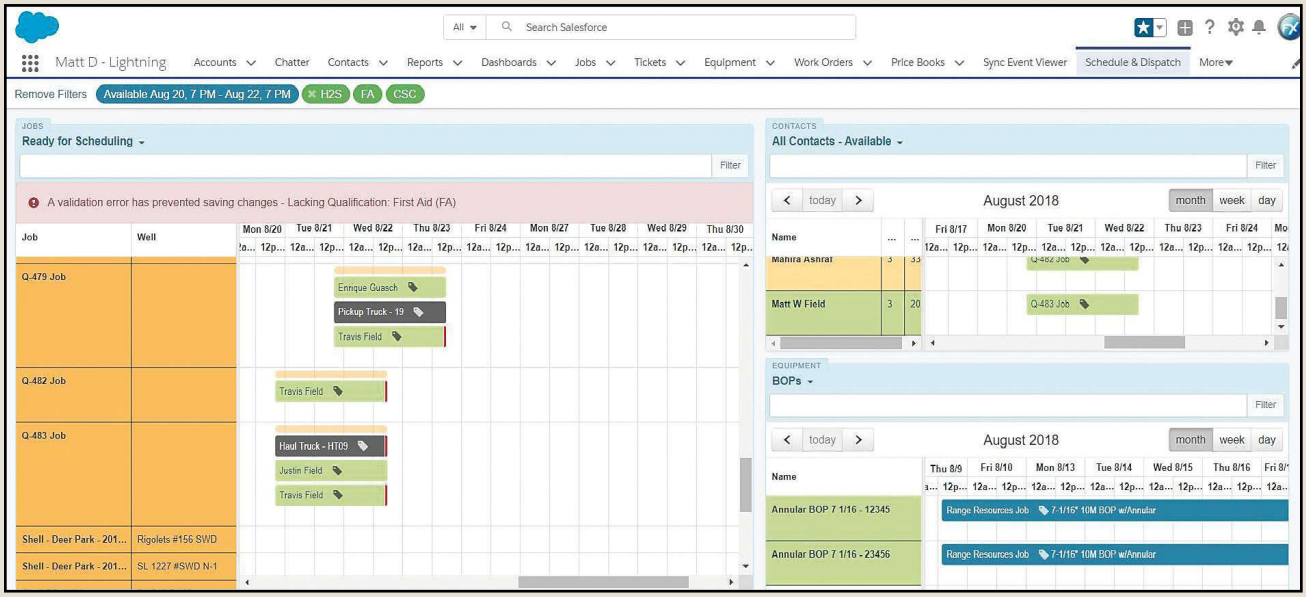
The HYDRO$_3$CIDE automated oxidation system is shown at a produced water recycle facility. (Source: Hydrozonix)

EXTRACTING VALUABLE MINERALS, METALS FROM PRODUCED WATER

Kaizen Fluid Systems has announced the newest innovation to its proprietary technology in treating high total dissolved solids and chlorides found in produced and flowback water. The technology is designed to increase revenue streams to the operator's income by extracting the valuable minerals and metals found in produced water. Kaizen has consistently extracted valuable commercial grade metals and minerals, such as vanadium, lithium and cobalt, which has proven more valuable than oil or gas. It is important that the produced water is cleaned to potable standards to extract a commercial grade product. If the produced water is not cleaned to potable standards, all contaminants entrained in the water will be trapped within the minerals or metals reducing the value significantly. *kaizenfluidsystems.com* ■

MODULE STREAMLINES JOB MANAGEMENT PROCESS

Water logistics dispatchers are challenged with finding available drivers with the right certifications in the best possible locations for each job. LiquidFrameworks' recently redesigned FX Schedule & Dispatch module has streamlined the dispatcher's job for service companies in the water management space by updating, storing and managing all of the pertinent job, personnel and equipment information in one convenient place. Dashboards can be customized with dynamic drag-and-drop functionality, and personnel can be sorted by role, schedule and qualifications. *liquidframeworks.com* ■



FX Schedule & Dispatch keeps companies informed of all job-related data and gives users the ability to track all of their resources, including personnel, equipment and materials, so they'll never dispatch duplicate jobs or unavailable equipment. (Source: LiquidFrameworks)

GREEN FLOCCULANT USED FOR COST-EFFECTIVE WATER RECYCLING

Monarch Separators' H_2O Floc green flocculant is used to reduce the environmental impact of oil and gas operations through cost-effective produced and flowback water recycling while also improving oil recovery. The green alginate flocculant's primary treatment objectives are removal of oil, grease and total suspended solids and when used in conjunction with an oxidant, metals, H_2S and bacteria. Through multiple pilot scale produced and flowback water treatment tests in the Permian, Denver-Julesburg and Powder River basins, H_2O Floc chemistry was able to reduce turbidities from greater than 650 nephelometric turbidity units (NTU) to 1 NTU, oil removal to less than 2 mg/L, and iron and manganese to less than 1 mg/L, while being dosed at a much lower rate than current market flocculants. *monarchseparators.com* ■

This blended produced and flowback water comparison shows water before (far left) and after treatments (middle and far right) with Monarch Separators' H_2O Floc and filtration. (Source: Monarch Separators)

A SIMPLE WAY TO SEE OIL REMOVAL PERFORMANCE OF WATER HANDLING SYSTEMS

National Oilwell Varco (NOV) has released a new Oil-in-Water Monitoring Service, which offers oil producers and saltwater disposal operators a simple and more effective way to see the oil removal performance of their water handling systems. An online monitoring device linked to NOV's GoConnect digital platform provides continuous, real-time oil-in-water concentration data and trending analyses. NOV's comprehensive remote monitoring service eliminates the need to purchase costly, sophisticated equipment or perform time-consuming maintenance and calibration steps. Placing this valuable information at the user's fingertips enables operators to better evaluate and understand facility process performance, resulting in increased oil recovery, improved profitability and prevention of injection well damage. *nov.com* ■

DISSOLVED AIR FLOATATION UNIT TREATS 40,000 BBL/D PRODUCED WATER

Orion Water Solutions has released its new, double-capacity dissolved air floatation (DAF) unit, which is designed to treat large quantities of produced water for fracturing use in shale plays. Orion's DAF, including its operating system, was designed from the ground up specifically to treat produced water for fracturing. This separates it from most currently available DAFs built for other industries. The DAF solves the bacteria issue for operators storing produced water in ponds. By removing iron and total suspended solids, it leaves water without the food that airborne bacteria need to survive, keeping ponds fresh longer and saving on chemical cost. Its capacity of 40,000 bbl/d and 12,000 gpm enables operators to treat on the fly in support of fracturing operations. *orionwatersolutions.com* ■

Orion Water Solutions' 40,000-bbl/d DAF units provide on-the-fly treatment for fracturing jobs using produced water. (Source: Orion Water Solutions)

MANAGEMENT OF SOURCE WATER

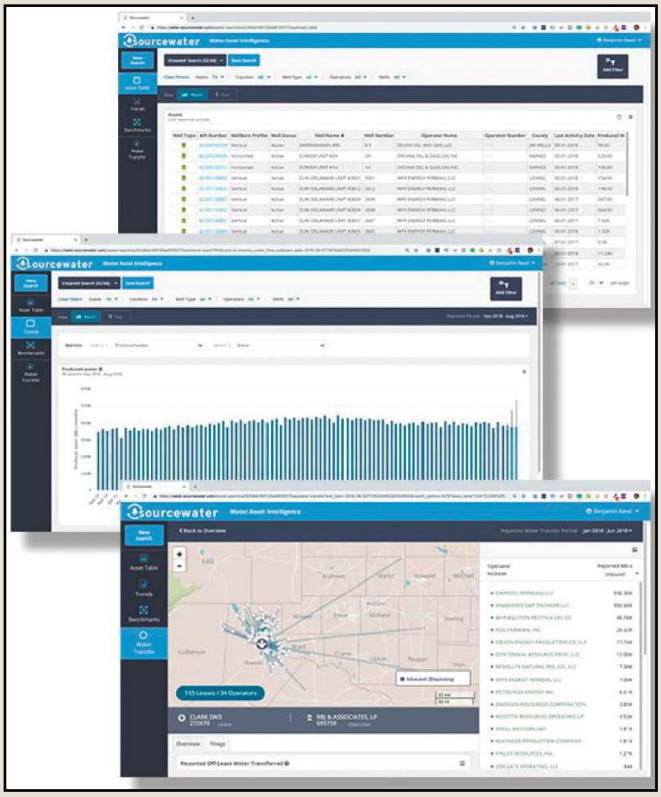
From an operations and accounting standpoint, managing source water required for shale play fracturing and drilling jobs can be a juggling act. Upstream operators have to keep track of source water well ownership and volumes, monitor water pit levels, track movement to jobs and on a monthly basis account for what they owe their water providers. A new offering from P2 Energy Solutions eases the burdens of managing complex midstream water systems. P2 Source Water Management eliminates spreadsheets, allowing companies to accurately track and manage pit water available for jobs and invoice providers and, in so doing, reduce overpayments or underpayments. *p2energysolutions.com* ■

OILFIELD WATER INTELLIGENCE PLATFORM

The *Sourcewater.com* oilfield water intelligence platform helps companies find water-related business opportunities and see oilfield water and disposal prices, utilizations and market trends ahead of their competition.

Sourcewater gathers, analyzes and maps water, disposal, oil and gas permits, capacity, production and pricing data from its exclusive water and disposal marketplace as well as from Sourcewater's satellite imagery analytics, government records and from continuous market research to show users where every barrel of water is located and where it comes from and goes in Texas, New Mexico, North Dakota and Pennsylvania.

The new dirt work detection technology scans weekly satellite imagery of the Permian Basin to predict drilling permit and rig activity six months ahead of permit filings. *sourcewater.com* ■



Sourcewater's Water Asset Intelligence shows users where every drop of produced water comes from and goes in Texas, New Mexico, North Dakota and Pennsylvania. (Source: Sourcewater)

LOW-COST PER BARREL WATER MANAGEMENT

Shale operations are dealing with higher water management costs and more environmental and operational risks than ever before, both of which are becoming an increasingly larger part of operators' costs. Sourcing freshwater and increasing volumes of sand flowback and produced water, which are often trucked out and disposed, are the primary cause. Addressing these challenges in an environmentally responsible way frequently requires adding more services and personnel at each site. TETRA Technologies' water management solution delivers innovative and differentiating offerings for produced water transfer, de-sanding and on-the-fly water treatment and recycling. By integrating and automating the company's offerings, efficiency is maximized through job planning and crew optimization, helping reduce manpower for a typical fully integrated completion operation by more than 30%. The step change in efficiency is delivered through fully automated technology that provides greater transparency and quality control throughout the transfer, flowback and recycling of produced water, all while simultaneously improving environmental considerations. *tetratec.com* ■

TRANSPORTABLE SYSTEM FOR WATER REUSE

ShaleFlow is a transportable, modular system for produced water treatment. (Source: Veolia Water Technologies)

ShaleFlow is a cost-effective transportable solution for reuse of produced water and flowback water from hydraulic fracturing operations. This compact, modular system utilizes technologies designed to enable reuse with the flexibility to be moved as the field is developed. It treats up to 10,000 bbl/d (300 gpm) of produced water with a simple drop-and-go approach. ShaleFlow tolerates a wide range of influent water quality containing up to 300,000 ppm of total dissolved solids. It can remove up to 98% of particulates such as suspended solids, oil and grease and scale formers. The treated water is suitable for reuse in fracturing and completion operations. *veoliawatertech.com* ■

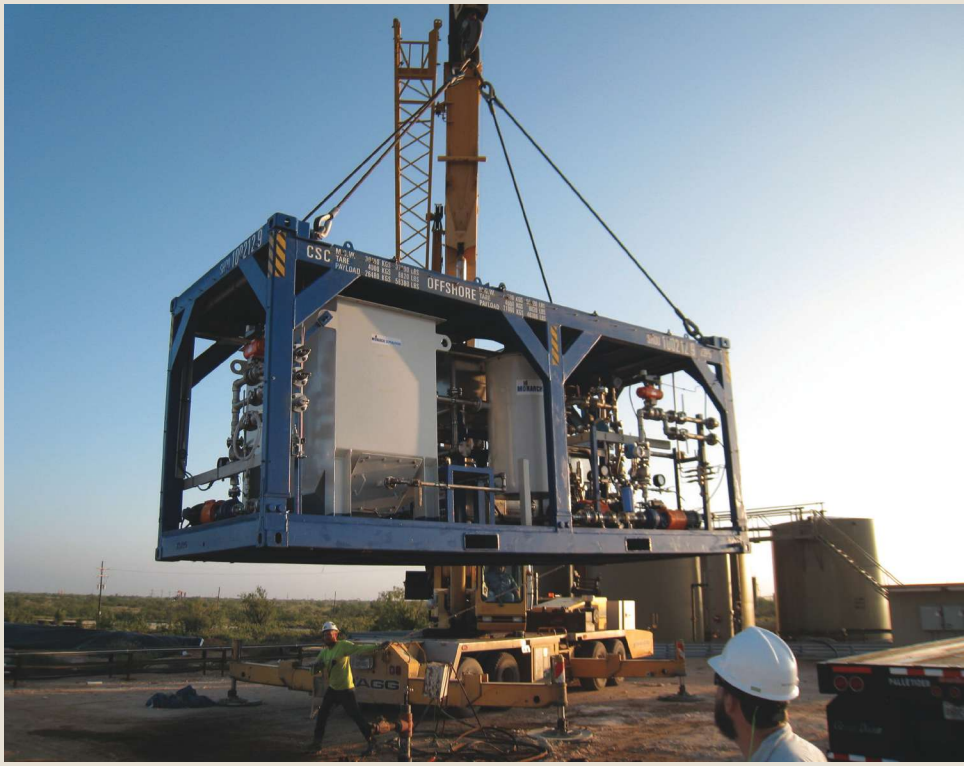
CHARACTERIZING WATER DATA FOR QUICK DECISION-MAKING

Proper characterization of the composition of various waters throughout the upstream oil and gas industry is critical to understanding how that water should be handled and treated. Dissolved minerals dramatically impact the performance of friction reducers, scale inhibitors, corrosion inhibitors, biocides and other chemical additives that are critical to the performance of a hydraulic fracturing operations, waterfloods and production chemical programs. Water Lens has developed a fast, lab-quality water testing system that can be run by anyone, anywhere in the world. It is specifically designed to correct for the numerous interferences found in oilfield waters and can be operated by any oilfield worker in any field environment. This allows operators and service companies to ensure they have the correct chemicals for a given water and are using the correct dosage, which saves money and damage to the formation and associated equipment. *waterlensusa.com* ■

A water treatment company uses the Water Lens testing system on a job in Midland, Texas. (Source: Water Lens)

WATER TREATMENT SYSTEMS ENABLE REUSE OR SURFACE DISCHARGE

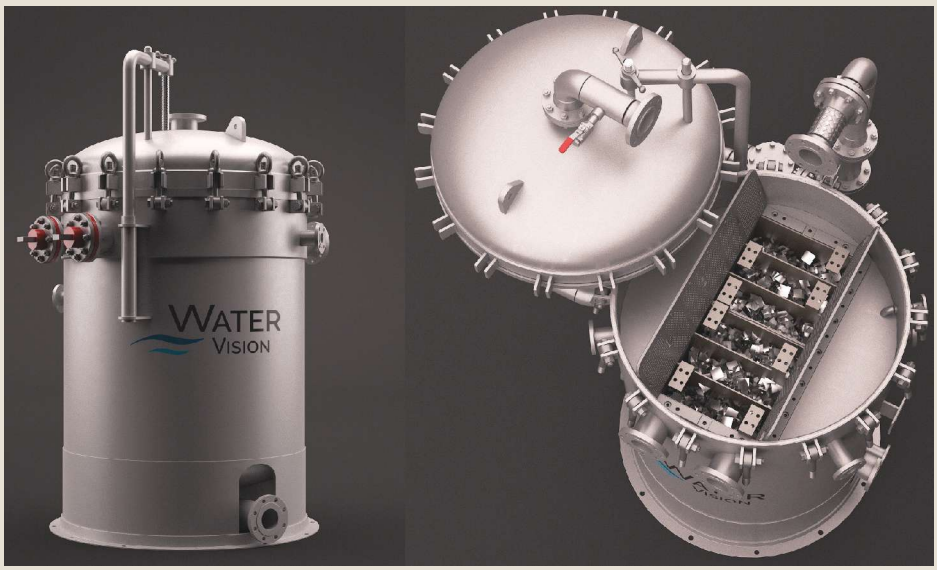
Water Standard has developed its compact and modular H2O Spectrum platform after successfully executing demonstration programs in the Permian, Denver-Julesburg and Powder River basins for treatment of produced and flowback water where cost and operability were key drivers. The H2O Spectrum platform offers the ability to treat water for reuse and recycle, or advanced treatment for safe surface discharge back into the water cycle, demonstrating the stewardship of this water as the most valuable resource. The general constituents targeted for removal in reuse applications include oil and grease, suspended solids, bacteria and iron, while treatment for surface discharge extends to the removal of salt, ammonia and dissolved organics. *waterstandard.com* ■



Water Standard's H2O Spectrum mobile system is being delivered in the Permian Basin. (Source: Water Standard)

ELECTROCHEMICAL WATER TREATMENT ADDS EFFICIENCY

The Thincell direct contact electrochemical treatment technology is providing the oil and gas industry with an *in-situ* method to cost effectively treat flowback fluids from shale produced wells. Thincell has been proven to surpass electrocoagulation and other similar treatment methods. It reduces soluble and insoluble hydrocarbons, heavy metals, suspended solids and bacteria with an efficiency exceeding 99%. The technology replaces traditional electrocoagulation methods, which are plagued with passivation, the early failure of electrodes due to scaling and corrosion. Instead, Thincell's cathodes, anodes, sacrificial electrodes and fluidized bed combine to provide multiple treatment reactions in a compact, single treatment chamber. The result is low maintenance, increased uptime, reduced operating costs, higher efficiency and improved personnel safety. *watervisioninc.com* E&P



The new vessel for Thincell is shown. (Source: Water Vision Inc.)