Produced Water: Importance of Treatment and Reuse

By Brittany Davis

Oklahoma produced about 153 million barrels of crude oil and 2,468 billion cubic feet of natural gas in 2016.[1] Along with this oil and gas, about 755 million barrels (1 barrel=42 gallons) of water were produced throughout the state![2]

This water, most commonly called "produced water," is the water naturally present in oil- and gas-bearing geologic formations combined with any flowback of water pumped into the ground in order to fracture or flood the rock containing oil and gas. Unfortunately, when this water surfaces, it contains pollutants making it unsafe for use without major treatment.

Oklahoma's produced water is either reused in the oil field or disposed of through reinjection, meaning it is pumped back into the ground. This disposal process has been linked to an increase in seismic activity.[3] Reinjection of flowback water also removes water from the natural water cycle. Concerns of increasing earthquakes and increasing water needs are compelling professionals around the world to develop effective treatment methods.

Researchers, including several at Oklahoma State University, are exploring treatment options, including membrane filtration, reverse osmosis, thermal distillation, and evaporation. Unfortunately, none of these treatment methods is able to single-handedly treat the various impurities in produced water, which may include salts, hydrocarbons, toxic metals, and even radioactive compounds.

While it is important to treat for all of these impurities, salts are the biggest challenge.[5] Produced water can be 1-30% salt by weight (compare that to seawater at 0.3%)![6] At such high salinity levels, standard wastewater treatment methods cannot be used.[7] Existing methods of desalination, the process of removing salt from the water, are very costly and require a lot of energy. Current research is pursuing a solution to this matter.

Produced water storage tank[4]

One promising treatment method for removing salts from the water, as well as other impurities like hydrocarbons, is membrane filtration. Similar to a small mesh, membranes allow water molecules to pass through while preventing passage of larger substances, including salts, oils, greases, and particles. However, these oils, greases and other hydrocarbons can buildup on the membranes and severely decrease their performance. Therefore, much of the research at OSU on produced water treatment revolves around hydrocarbon removal.

Membrane research in a laboratory

Drs. Seok-Jhin Kim and Clint Aichele, Assistant Professors in Chemical Engineering, and Dr. David Lampert, Assistant Professor in Civil & Environmental Engineering, are focused on developing inorganic membranes that are more stable and less likely to foul than organic membranes. Dr. Pankaj Sarin, Assistant Professor in Materials Science & Engineering, is using inexpensive ceramic materials to develop low-cost inorganic membranes, which will be stronger, can be operated at high pressures, are chemically stable, and will perform better than polymer-based membranes.

Taking a different approach, Dr. Babu Fathepure, Associate Professor in Microbiology & Molecular Genetics, is researching microbial removal of hydrocarbons rather than physical removal. He works to reduce the salinity of produced water by blending it with other types of wastewater to create an environment that will enable the microorganisms to break down hydrocarbons. This will allow microbial remediation of both the produced water and wastewater.

No matter the treatment method used, there is an urgency to create a solution to handle the large volume of produced water before oil prices increase. Recent U.S. sanctions imposed on Iran have potential to drive up the price of oil.[8] This would likely cause an increase in production by American energy companies that could result in an exceptional amount of produced water.

Future treatment technologies are promising. Renewable energy, like solar and wind, could provide inexpensive energy for treatment plants. Recovering valuable elements during the treatment process could add a monetary return, making it more appealing to companies. Other future technologies will also include the improvement and advancement of current methods.

Oklahoma State University researchers have an advantage in produced water research, given their access to produced water—a resource not easily available to many other research universities around the world. With this advantage comes an important role in furthering research and technical knowledge. New research will one day provide the opportunity to reuse produced water, signifying an increase in available water and the overall improvement of the world's environment.

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[3] "Induced Earthquakes." U.S. Geological Survey. Accessed November 01, 2018. https://earthquake.usgs.gov/research/induced/myths.php.
[4]@lemonid, Jean-Philippe MIOT. "Conception Metallique Petroliere Etudes et Assistance." CMPEA Vertical Tanks Comments. Accessed October 31, 2018. http://www.cmpea.fr/en/realisations/reservoirs-verticaux/.
[5]Dr. David Lampert, environmental engineering professor at OSU, personal communication
[6] Dr. Seok-Jhin Kim, chemical engineering professor at OSU, personal communication
[7]Dr. Babu Fathepure, microbiology and molecular genetics professor at OSU, personal communication
[8]Meredith, Sam. "US Sanctions on Iran Are Set to Keep Oil Prices Elevated, Analysts Say." CNBC. August 07, 2018. Accessed October 23, 2018. https://www.cnbc.com/2018/08/06/us-sanctions-on-iran-could-push-oil-prices-above-90-a-barrel-by-year-.html.