Recovering Hydrocarbons from Fracking Wastewater

OILSKIMMERS, INC.
OSI ENVIRONMENTAL

Organizations treating and disposing hydraulic fracturing wastewater generate new revenue and improve operations with cost-effective, reliable oil skimming technology.

WHITE PAPER

Throughout the past few years, organizations involved in the oil and gas industry's hydraulic fracturing wastewater business have learned that employing efficient, low-maintenance oil skimming technology can bring sustained improvements to the bottom line.

Facilities treating hydraulic fracturing wastewater for permanent disposal into underground injection wells have found that oil skimming can be a highly reliable and cost-effective solution for recovering oil found in the wastewater. In recent examples, within 2 to 3 months of using oil skimming technology, wastewater disposal companies in Texas, West Virginia and Ohio, have added monthly profits of $3,000 to $18,000 by selling the recovered oil, generating an excellent return on investment (ROI).

Oil skimming has a long, trusted history serving the oil and gas industry. It reduces operational costs, generates new revenue streams and delivers a terrific ROI and a fast payback.

This white paper offers a brief overview of hydraulic fracturing, outlines opportunities for hydrocarbon recovery from hydraulic fracturing wastewater, and examines oil skimming as a beneficial solution for wastewater disposal facilities.

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The Hydraulic Fracturing Boom

Hydraulic fracturing, also known as "fracturing" or "fracking," is defined by the oil and gas industry as the process of injecting fluids to create underground fractures in shale rock formations containing deposits of hydrocarbons. Hydraulic fracturing was first introduced to the petroleum industry in the 1940's to stimulate shale formations, and in doing so, release trapped oil or gas located in underground shale reservoirs.

Coupled with more recent technological breakthroughs in horizontal drilling, hydraulic fracturing has dramatically increased potential US energy production of oil and gas. Horizontal drilling is a drilling technique in which wells are first drilled vertically, then horizontally. Horizontal well sections can extend 1,000- to 12,000-feet from the well.[2] Together, horizontal drilling and hydraulic fracturing have increased access to potential energy resources within shale formations that were previously inaccessible.

According to a 2009 report by the Groundwater Protection Council (GWPC) and ALL Consulting, natural gas, coal and oil supply approximately 85 percent of the nation's energy, with natural gas consisting of 22 percent.[3] Additionally, estimates from the U.S. EIA released in June 2012, state that natural gas production is projected to increase by nearly 30 percent throughout the next 25 years.[4]

The Technique: It's a Water-Based Process

Hydraulic fracturing begins after a well is drilled as part of the "completion process," the process that makes a well ready for production. It involves pumping "fracking fluid" into the well at a high pressure, sometimes exceeding 9,000 pounds per square inch. Fracking fluid is a solution comprised primarily of water, along with sand and chemicals.[5] The pressure created causes the shale formation to crack or "fracture" and the sand in the fracking fluid serves as a "propping agent" to "prop" open the fractures allowing the hydrocarbon to escape. GWPC's 2009 report states that the amount of water needed to drill and fracture a horizontal shale gas well ranges from 2 million to 4 million gallons per well, depending on the basin and formation characteristics. According to other industry data, in Pennsylvania's Marcellus shale, water usage can average 4.5 million gallons per well and in various Texas shale plays, it can total more than 6 million gallons per well.[6]

When fracturing is complete and pressure is released, a portion of the fracking fluid begins to flow to the surface. Depending on how much of the fracking fluid is absorbed, anywhere from 20 to 80 percent of the injected water can return to the surface as "flowback water" throughout a period of a few days to a few weeks.[7]

Subsequently, throughout the hydrocarbon extraction or "production" process, water that is naturally present within the reservoir may also rise to the surface. This water is known as "produced water" and can consist of natural formation water and other naturally occurring substances underground. The Colorado Oil and Gas Association notes that roughly 50 percent of all produced water released from drilling and rock stimulation surfaces within one week,[8] although, water can continue to flow throughout the life of the well, depending on the quantity of water in the formation.

"Drill Rig" Tim Hurst http://www.flickr.com/photos/ecopoly/6458342385

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Wastewater: A Key Piece of the Puzzle

Water and wastewater management are extremely important components of hydraulic fracturing – from monitoring the amount of water used to executing the appropriate treatment on the flowback and produced water that results.

Hydraulic fracturing wastewater, also known as "brine water," often consists of a large amount of total dissolved solids (TDS) – up to three times that of seawater, acid-producing bacteria, naturally occurring radioactive materials and scaling materials like barium, calcium, iron, magnesium, strontium and more.[9] These constituents can have potentially harmful impacts on both the environment and society so wastewater must be properly managed per federal and state regulation.

There are three wastewater management options, each subject to government regulation:

1 **Permanent Disposal** via deep-well underground injection

Permanent disposal via underground injection is a permitted and monitored process that is regulated under the federal Safe Drinking Water Act (SDWA), Underground Injection Control (UIC) program.

2 **Reuse** in current or future fracturing operations

Hydraulic fracturing wastewater that is to be reused for fracturing is not subject to federal regulation, according to the Natural Resources Defense Council, but is state regulated.

3 **Recycling** for alternative uses, such as other water supply areas

Recycling wastewater for use in irrigation, dust control on unpaved roads, de-icing roads or for other wastewater discharges is subject to strict U.S. Environmental Protection Agency (EPA) standards under the Clean Water Act (CWA).

Wastewater Treatment

The process for treating hydraulic fracturing wastewater varies depending on whether the water is to be permanently disposed of, reused in fracturing operations, or used in other water supply areas.

For example, depending on the amount and type of constituents in the wastewater, treatment for re-use or permanent disposal may simply include the blending of freshwater to bring TDS levels and other constituents to an acceptable range.[10] Without some type of treatment, these materials could potentially clog the well if returned to the gas reservoir. Wastewater could also be statically charged to allow waste particles to separate.[11] In the case of full recycling, the process is generally more intricate as the objective is to remove all TDS.[12] Depending on contamination levels, wastewater may not be applicable for recycling.

In addition to improving quality, treating hydraulic fracturing wastewater also presents a unique opportunity. Hydraulic fracturing wastewater often contains traces of oil that can be collected and sold for added profits.

Oil in Wastewater

Due to the differences in porosity and permeability of each hydrocarbon reservoir, "dispersed oil" may emerge with the hydraulic fracturing wastewater. In fact, oil and metals are two of the most common naturally occurring substances found in a reservoir's formation water. Oil-containing water may lie underneath or within the same "zone" as a formation's oil or natural gas hydrocarbons. The amount of dispersed oil that surfaces depends on geologic composition and shale play variances. For example, oil may be present in a natural gas reserve and may surface in varying quantities, or not at all.

According to an interview with an Ohio-based permanent disposal facility, due to the differences in geologic composition throughout Ohio, hydraulic fracturing wastewater containing oil hydrocarbons is currently found more often in the southern half of the state than the northern half. In any case, the amount of dispersed oil present in hydraulic fracturing wastewater is relatively small – however, it is a profitable revenue source.

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Wastewater and Dispersed Oil Recovery

Recovering oil present within hydraulic fracturing wastewater can occur at various points throughout the wastewater path using an array of recovery methods. For example, recovery could occur initially on the well site through a heated three-phase gravity separation process. It could also occur at a wastewater treatment facility by means of centrifugal separation or air flotation devices. Still another scenario for recovery might entail the use of gravity separation and oil skimmers at a wastewater disposal facility.

Wastewater and the Oilfield

One of the first opportunities to collect dispersed oil is within flowback water. As mentioned above, flowback water begins to emerge from the wellhead when fracking is complete and well pressure is released. The collection of flowback water is considered to be one of the final phases of the well completion process and each oilfield operation has its own method for collection.

In a study led by the Center for Energy and Environmental Resources, University of Texas at Austin, the process for collecting flowback water included the initial flow from the well to an open or vented tank, as well as initial flow from the well to a separator, or multiple separators, and then to a flowback tank. With the latter process, oil, gas and wastewater were separated prior to the wastewater entering a flowback tank and collected oil was sent to a separate holding tank.[13]

According to an educational video series from Chesapeake Energy Corporation, Chesapeake pipes flowback water directly to above ground double-walled steel tanks, sealed for temporary holding, where it is later filtered and recycled.[14] In this case, any oil present is likely recovered at the off site treatment or disposal facility.

When the primary hydrocarbon stream begins flowing from the well, the return of flowback water slows and transitions to produced water. At this time, a well moves from completion to production.

According to Chesapeake's video series, when production begins, the fluids and hydrocarbons emerging from the well are sent through the following process:

1. Fluids first travel through a system of baffles within a separator or "production unit" to initially separate the gas, oil and water.

2. In natural gas wells, the gas may then travel to a secondary separation unit before it is measured and transported for sale. Additional processing or compression may be completed at a facility known as a Central Delivery Point (CDP), where dehydrators or other separator technologies may be used to remove remaining fluids.

3. The remaining oil and water is sent to a heated three-phase gravity separator or "heater treater" unit where heat is applied to increase the efficiency of separation.

4. Once separated, the recovered oil and wastewater are sent to onsite stock tanks for temporary storage. The oil is later transported for sale and the wastewater is sent to a disposal facility, re-used or recycled.

5. The process for oil wells is similar to that of natural gas wells. Following initial separation via a production unit, oil either travels to a secondary location prior to sale or to onsite storage tanks, where it is later removed by tanker truck. In the case CDP facilities for oil wells, oil enters the tank battery, which is a group of connected tanks designed to receive a well's crude oil production, then through a set of filters. The oil's integrity is tested and if it doesn't meet proper requirements, it is processed through the heater treater again before entering the high-pressure pipeline for sale.

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As outlined, dispersed oil found in hydraulic fracturing wastewater is often initially recovered on the oilfield site using various separation technologies; however, full recovery doesn't always occur. Flowback and produced water that is temporarily held in onsite stock tanks, even after processing, often still contains residual amounts of oil and solids, presenting a unique opportunity for hydrocarbon recovery for those in the permanent or saltwater disposal business.

Opportunities for Hydrocarbon Recovery in Permanent Disposal

While treatment of hydraulic fracturing wastewater for reuse and recycling is gaining momentum, wastewater disposal continues to be one of the highest growth areas within the hydraulic fracturing market. In many U.S. regions, permanent disposal into Class II deep injection wells is the most common method of disposing of wastewater fluids or other substances from shale extraction operations. The EPA estimates that there are approximately 144,000 Class II wells in operation in the U.S. and that roughly 20 percent are disposal wells for brine and other fluids from oil and natural gas production.[15]

In many cases, permanent disposal of hydraulic fracturing wastewater into deep injection wells is more cost-effective than reusing or recycling the water. In Texas, operators estimate it costs as little as 25 cents a barrel to dispose of wastewater using an injection well.[16]

Permanent disposal facilities operating Class II deep injection wells often receive hydraulic fracturing wastewater on a daily basis. Upon arrival, wastewater is commonly transferred to a holding or gravity separation tank or pit. It is within this pit or tank that oil hydrocarbons are typically recovered. Once recovered, the oil is often sent to a secondary tank or container for sale and distribution and the wastewater continues throughout the treatment process. The treated water is then permanently disposed of in an injection well.

West Virginia-based Tech Service Center uses a Model 6V Brill™ Oil Skimming Station from Ohio-based Oil Skimmers, Inc. to recover oil from its hydraulic fracturing wastewater holding pit prior to treatment and permanent disposal of the wastewater into the company's Class II injection well.

Ohio-based K.D.A. uses a Model 6V Brill™ oil skimmers, which resides in an enclosed hydraulic fracturing wastewater holding tank. The skimmer recovers oil from fracking wastewater that is transported to the facility from numerous drilling sites throughout Ohio and Pennsylvania.

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Remove and Sell: Oil Brings Revenue

Newfound Success

A company operating natural gas wells and a Class II disposal well for oil and gas production in West Virginia says it receives hydraulic fracturing wastewater every day. The wastewater, which often contains brine, oil and other substances, is delivered via truck, unloaded into the company's fracturing water holding pond and is then treated for permanent disposal. However, before the wastewater leaves the holding pond, the revenue-generating oil is recovered.

Using a closed-loop, tube-based oil skimmer, the company has found an easy and cost-effective way to skim the oil from the wastewater, increasing its daily profit margins. Prior to using oil skimming technology, the company's previous method for separating oil from fracturing wastewater required the use of multiple company resources, including two employees and one vacuum truck.

Time-trusted Solution

Although more wastewater disposal facilities have recently realized the advantages of oil skimming technology, it's not a new concept. Oil skimming is a trusted solution that has been used for many years in the oil and gas industry. In Hawley, Texas, a company that has been in the saltwater disposal business since 1936 has used Oil Skimmers, Inc. tube-based oil skimming solutions to successfully recover oil from wastewater for more than 30 years.

Benefits of Tube-Based Oil Skimming

Due to size, mobility, maneuverability and more, Oil Skimmers, Inc. tube-based oil skimmers are ideal for hydraulic fracturing wastewater permanent disposal applications. Stationed near the wastewater holding unit, tube-type skimmers are designed to attract floating oil to the outside of the tube, which floats on the surface even as the wastewater level fluctuates. As the tube is driven across the surface of the fluid and through a set of scrapers, the oil is removed and gravity-drained into a collection tank.

Since using tube-based oil skimmers, the company has enhanced efficiencies, improved operations and increased revenue by more than $18,000 per month.

Why Skim?

Skimming oil in any industry brings added revenue. Often, oil recovered by skimming holds significant dollar value as showcased in the above wastewater disposal facility examples. Additionally, Oil Skimmers, Inc. skimmers are designed for continual operation, to consistently remove oil, which helps address environmental concerns regarding oil-related contaminations, while simultaneously helping meet established environmental standards.

With regard to wastewater treatment, skimming brings value to the entire process. Skimming often leads to reductions in the amount of chemicals required for water treatment and also aids in meeting government regulations, such as those associated with the permanent disposal of hydraulic fracturing wastewater.

However, not all oil skimmers are created equal. It is important to select an oil skimmer that has the ability to easily maneuver around debris, such as a floating tube skimmer. This is essential in the wastewater disposal business due to the amount of brine and debris often present in hydraulic fracturing wastewater. Additionally, the skimmer's design and construction should allow for minimal or essentially no supervision or maintenance. In the case of some belt-type oil skimmers, parts can be located below the surface of the wastewater causing undesirable operational and maintenance issues.

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Why the Tube?

For optimal results, those in the permanent disposal business often select a floating tube-based oil skimmer such as Oil Skimmers, Inc.'s patented Brill™ oil skimming system to recover oil from hydraulic fracturing wastewater.

Closed-loop floating tube-based oil skimming technology was invented by Eugene L. Brill, who founded Oil Skimmers, Inc in 1969.

With a floating tube skimmer, there is no fixed path as there is with stationary disk skimmers, overflow weir skimmers and drum skimmers and all working parts are out of the water for safe, easy access, minimizing maintenance issues.

The tube floats freely around debris and easily adjusts to fluctuating water levels. Tube skimmers also cover more surface area than any other skimming technologies, by allowing the tube to be on the surface to collect oil at all times. And, with the continuous movement of the floating tube, more oil is attracted to the tube for faster, more complete oil removal.

Why Oil Skimmers, Inc.?

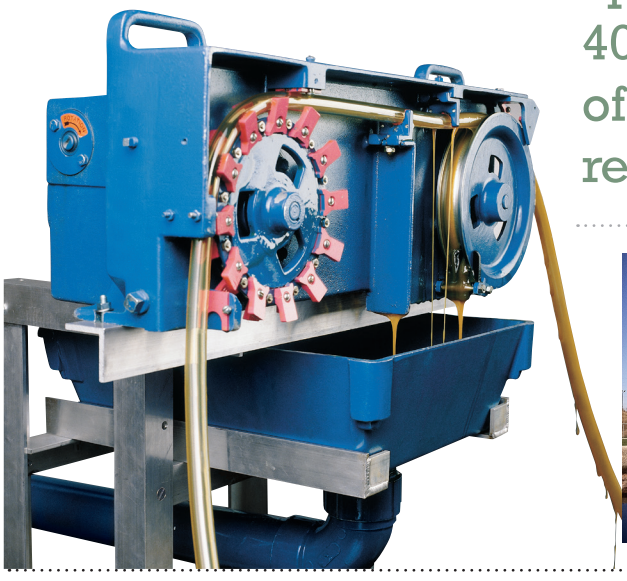
Tube-based skimmers from Oil Skimmers Inc. feature a unique, simple design and an extremely rugged construction that encompasses a cast aluminum housing, wear-resistant ceramics, internal gearing and high-strength steel and bronze for a dependable skimming solution, 24/7.

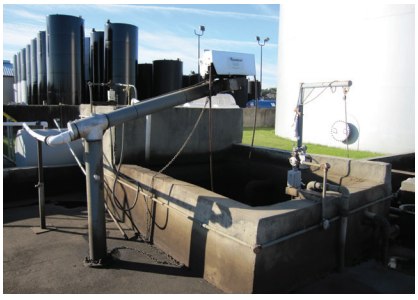
> Using oil skimming technology, the company has recovered up to 25 barrels of oil a day from its saltwater disposal pit, with profits from the skimmed oil comprising approximately 40 percent of its overall revenue.

The quality components used throughout the manufacturing process provide an edge over other equipment. It is not uncommon for Oil Skimmer's Inc. floating tube skimmers to remain in operation for decades, delivering a level of quality and reliability that is unmatched in the industry, and proven to withstand the test of time and weather in the toughest environments.

Oil Skimmers, Inc.'s solutions offer easy and economic installation with custom and pre-fabricated mounting systems and are extremely versatile. Their skimmers are available in a variety of configurations and are customizable to every wastewater disposal facility's needs.

Depending on the size of the application, an Oil Skimmers, Inc. floating tube-type oil skimmer can be accompanied by a "balanced boom system" to extend overall reach as far as 16-feet, which is especially beneficial for those storing hydraulic fracturing wastewater in larger open pits or ponds.





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Growth and Opportunity: What's Next

There are more than 1 million fracked wells throughout the U.S. and roughly 80 percent of natural gas wells drilled in the next decade will rely on the hydraulic fracturing technique, states the American Petroleum Institute (API).[17]

Hydraulic fracturing has become an extremely important facet of the future of the U.S. energy industry as technological innovations, coupled with abundant shale plays have left the U.S. rich with natural gas and oil. This natural gas has been said to be a "bridge fuel" that will transition the country to a more low-carbon energy economy, and energy analysts like the U.S. EIA predict the nation to become increasingly reliant on it.[18]

Water is a vital element to the hydraulic fracturing technique and proper treatment for disposal, reuse and recycling of hydraulic fracturing wastewater is imperative. Oil removal solutions from Oil Skimmers, Inc. have proven to be reliable, valuable and cost-effective methods for hydrocarbon recovery from hydraulic fracturing wastewater.

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