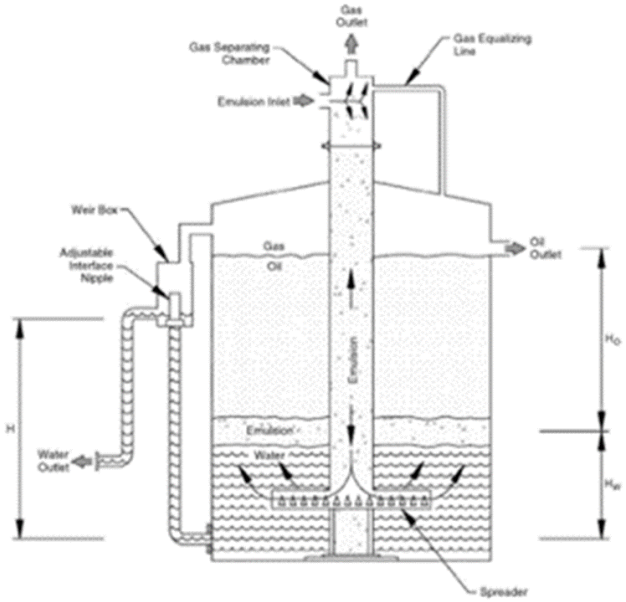
Validation of Saltwater Disposal Well Treatment Plants with Oil in Water Sample Analyzer

Saltwater Disposal (SWD) well operators often dispose a substantial volume of oil inadvertently when injecting salt water, thereby losing the opportunity to sell the oil on the market and potentially reducing the ability to inject water in the well. Injection facilities are typically operated with minimal instrumentation or system optimization, which means the operators don't know how much, or when, oil is being disposed.

A typical oil field tank battery for oil/water treatment consists of a collection tank, a gun barrel tank, and storage tanks for water and oil. The purpose of these tanks is to produce clean oil and water and remove solids in the process. The reality, however, is that often the water has a significant amount of oil and solids that do not separate. Some of the oil is emulsified, and some is coating the solids, sinking to the bottom of the tanks.

The capacity of a typical gun barrel tank is between 750 and 1000 barrels and can treat up to 10,000 barrels per day. At that rate water is retained in the tank for about 2.4 hours, allowing the oil to separate and be skimmed.



Typical gun barrel tank

At a truck unloading facility, the water flow rate can vary wildly as trucks dump water at irregular intervals. In pipeline fed facilities, the flow rate can be more stable, but can still have quick changes.

A typical oil/water separation system is a relatively simple system with no, or minimal, moving parts and is designed for a set of conditions (flow rate, oil concentration, oil gravity, pH, solids content, etc.). When the process is operating within the design parameters, the water quality will be good, the injection well will operate with low maintenance costs, and most of the available oil will be collected. However, in processes that fluctuate greatly, it is common for the conditions to be outside the design

parameters. Also, as these SWD facilities grow with increased water volumes, the treatment systems will be even more challenged by upset conditions.

Surveys and Pilot Demonstrations

Before approving a facility improvement project, the owners of a SWD well facility must have some data on current process conditions and performance. Usually a pilot, or demonstration, plant is tested before a full-scale facility is built. Before and after flow rate and oil concentration data should be collected from these systems to verify the design is correct and the capital expenditure can be approved.

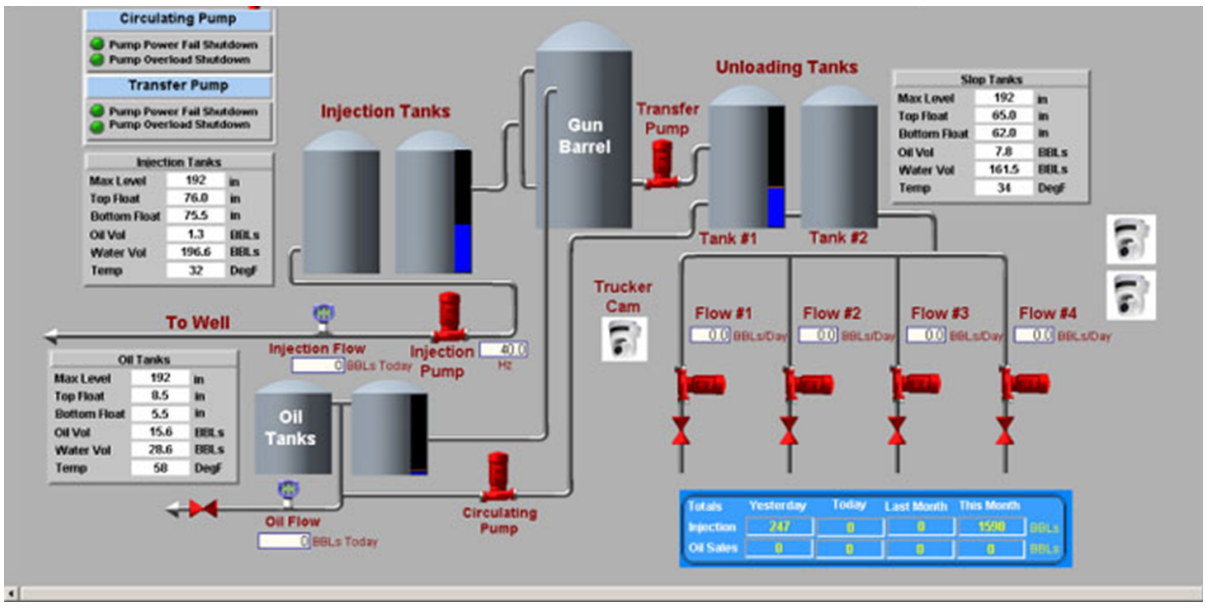
Ideally, a continuous online monitor would be used for collecting data to determine upset frequencies, duration and normal conditions. Many of the SWD facilities and demonstration plants do not have a budget that allows for continuous monitoring. However, high frequency sample analysis can be performed on site, using a portable analyzer. Easy to use, low cost field analyzers, such as the TD-500D, TD-550 and TD-560 are essential for optimizing the effectiveness of treatment systems during pilot studies and meeting a budget that includes frequent measurements.

Two Blackwall Process Studies

In a recent Blackwall Process demonstration, preliminary data reported that the SWD facility treated 4,600 barrels of water per, and that the gun barrel tanks skimmed an average of 380 barrels of oil per month. Oil in water measurements averaged 2,753 parts per million (ppm).

Backwall Process installed its water treatment system for a 2-week trial. During this trial the system treated 2,000 barrels of water per day and 570 barrels of oil were skimmed. To compare this to the original flow rate, approximately 2,622 barrels of oil would have been skimmed per month. This skim volume shows that the water averaged 20,357 ppm oil content. It also proves that the original treatment system was only removing about 10 percent of the oil, with the remainder being lost in the disposal well. This data also illustrates that the disposal well probably had significant maintenance costs due to the high oil concentration.

This demonstration facility showed significant oil removal, but was not able to collect frequent enough data during the trial to analyze upset frequencies or upset magnitude.



Blackwall Process conducted a second demonstration at a pipeline-fed facility. It used a fluorescent sample analyzer to analyze 30 samples per day for a high frequency, thorough survey of the process. The samples were collected in the water intake lines, after the unloading tanks and the gun barrel tanks.

The data collected before the demonstration showed that the inlet water oil concentration fluctuated between 2,777 ppm and 11,772 ppm, with a 6,421 ppm mean. The unloading tanks removed some oil, especially when the concentration was high. At low oil concentrations, the unloading tanks did not remove much oil. The gun barrel tanks were effective, with a discharge concentration between 1,292 ppm and 2,095 ppm. However, the plant operators did not report any oil skimmed during this period.

The Blackwall Process treatment system was then added to the process. For 2 weeks 30 samples per day were collected and analyzed on site, using a TDHI sample analyzer to verify the demonstration plant's performance.

Water Treatment System — Before and After	
Pipeline Inlet • High — 11,772 ppm • Low — 2,777 ppm • Mean — 6,421 ppm	Pipeline Inlet • High — 12,672 ppm • Low — 1, 484 ppm • Mean — 6, 139 ppm
Transfer Pump to Gun Barrel • High — 5,561 ppm • Low — 2,109 ppm • Mean — 3,365 ppm	Transfer Pump to Gun Barrel • High — 4,822 ppm • Low — 1,870 ppm • Mean — 3,108 ppm
Clean Tank • High — 2,095 ppm • Low — 1,292 ppm • Mean — 1,570 ppm	Clean Tank • High — 500 ppm • Low — 456 ppm • Mean — 472 ppm
0 barrels oil skimmed prior to treatment install	68 barrels oil skimmed in 10 days

The data collected during the demonstration showed that the water inlet concentration and oil removal by the unloading tanks was similar to the period before the demonstration. The Blackwall Process produced much cleaner water with a stable concentration during the demonstration. The plant operators were able to skim 68 barrels during this period proving the Blackwall Process was effective.

There is a market for the skimmed oil to be sold, which will offset the cost of treatment, and is not included in this study. Although there is no data to show the reduced maintenance cost of the disposal well, at 66–80 percent less oil injection, it is easy to determine that maintenance costs will be significantly lower.

Oil in Water Analyzer Performance

Turner Designs Hydrocarbon Instruments (TDHI) offers proven, easy to use, accurate field analyzers that correlate well with all commonly used laboratory methods. For example, a chemical company used a TDHI sample analyzer and the gravimetric method, 1664A, on the same water samples. Their primary test was to see if changing water chemicals would improve oil concentration in the water. The two analytical methods were used to verify the chemical's effectiveness. Because the Gravimetric method can take many hours to complete, and often days, the chemical company wanted a method that would be faster.

For this study, the analyzer was calibrated with the target oil to show the volumetric concentration. The analyzer measurement correlated well with the gravimetric method in this study, allowing the chemical company to determine the effectiveness of the two different chemicals by using either method. Because TDHI sample analyzers can measure an oil in water sample in less than 5 minutes, future tests of the two different chemicals will be completed quickly.

To perform onsite sample analysis, the first step is to collect a 100 ml water sample from the process and add 10 ml of an extraction solvent to the bottle. This solvent is commonly hexane, though any solvent can be used.

The water sample and hexane are shaken in the bottle for 2 minutes. The oil in the water sample is dissolved into the hexane and extracted from the water. Once the bottle has settled for 2 minutes a small sample of the oil rich solvent can be collected. The solvent is added to a sample cuvette, filling it approximately ¾ full.

The cuvette is placed in an adapter, then into the sample analyzer for a reading. The sample analyzer takes 5-6 seconds for a measurement. The displayed result is the oil concentration in the original water sample.

In comparison, when an off-site laboratory is used, the common analytical method can take at least 6 hours to perform and cost about $100 per sample. In reality, the samples can take days to weeks to be analyzed because of transportation time to a laboratory and sample analysis scheduling.

NOTE: The TD-500D oil in water meter is no longer in production. Although still supported by Turner Designs Hydrocarbon Instruments, it has been replaced by the TD-550 and TD-560 oil in water analyzers.

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