The Role of Oil in Water Testing in Unconventional Oil and Gas Operations

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In the US and Canada, many people view deep shale oil and gas development critical to its energy needs and economic renewal. Others around the world are also eyeing this abundant resource to help diversify their energy supplies. Meanwhile, in some regions including the UK,concerns of the potential negative environmental impact have delayed exploration. France and Tunisia have banned hydraulic fracturing due to environmental and health issues and Quebec, Canada is proposing a moratorium for the next five years in the St. Lawrence River valley.

Public environmental concerns for hydraulic fracturing seem to focus around water—the amount used, especially in arid parts of the world, and potential contamination of ground water. Indirectly, transporting water to and from a well site, as well as materials and other wastes, is also an issue. According to Lynn Helms, director of the North Dakota Department of Mineral Resources, the first year of a new well requires over 2000 truck trips[1]. Trucking is highly visible to the general public with the impact of noise, dust, traffic and road degradation. Reducing incoming and outgoing water to a well site would satisfy both the fear of using up public water supplies as well as truck traffic issues. This makes water recycling and reuse a potential option to improve public perception in addition to a possible economic benefit to the driller.

Cost vs. Regulations

Profit is the driving force of most business procedures. For oil and gas producers, water and wastewater management practices are driven by both cost and regulations. If the cost of fresh water and transport is low, there is little impetus to reclaim the flowback or produced water for reuse. In most regions of the US, reinjection into disposal wells is the lowest cost option for flowback and produced water.

In arid areas where fresh water costs are high and citizens are protesting the depletion of aquifers, the US is beginning to hear talk of regulations supporting water reuse. A March 26, 2013 news release from the Railroad Commission of Texas titled "Railroad Commission Today Adopts New Recycling Rules to Help Enhance Water Conservation by Oil & Gas Operators" [2] shows the trend to support reuse. This particular ruling is not a requirement but an attempt to foster producers' recycling efforts by eliminating the need for a recycling permit if the fluids are to be reused on their site or another operators' site. Legislation for mandatory recycling of flowback and produced water was introduced to the Texas Legislature in March 2013 via House Bill 2992.

Wastewater Management Options

In addition to reinjection, there are a number of other wastewater management options that include removal to an off-site treatment facility, evaporation ponds, reuse for hydrofracking and treatment for surface discharge. Each option has maximum levels of free or dissolved oil that will be accepted making oil removal the first step in wastewater handling. Along with oil removal is the need to test oil in water levels to ensure the required level has been attained.

Arid states in the US that utilise evaporation ponds for wastewater are regulated by the US EPA to have no oil or oil sheen on the ponds. An oil layer also reduces the ponds' evaporative efficiency making oil removal a necessary first step.

Disposal to a public wastewater treatment plant may be an option for some drillers. Initially in the Pennsylvania Marcellus Shale region, wastewater treatment facilities were taking frac water. As the amounts got to be too much for the facilities to handle, many stopped accepting frac water. This opened the door to independent frac water recycling plants for either reuse or treated to clean water levels. Commercial and public treatment facilities have limits of oil for incoming wastewater depending on what their treatment systems can handle.

Wastewater Treatment Options

While the technology exists to treat the wastewater to drinking water standards, the cost is typically not justified. The option to clean the flowback water just to the level acceptable for reuse for fracturing is much more economical. Flowback water is a mix of the fluid used to facture the shale and water from the formation that includes solids, metals, salts, chemical additives -- along with some oil. Once the gas well is producing, naturally occurring water from the shale formation flows to the surface as "produced water". Flowback and produced water have high levels of Total Dissolved Solids (TDS), minerals such as barium, calcium, iron and magnesium that are leached out of the shale along with dissolved hydrocarbons[3].

The amount of treatment the flowback water needs to be cleaned for reuse is dependent on the recipe of chemicals needed for a particular formation. New frac fluid chemistries are rapidly coming to market including formulations that can handle higher levels of TDS. Minimal treatment for reuse typically includes free oil and TSS (total suspended solids) removal, chemicals to remove organics, oxygen and nutrients to prevent bacterial growth that could sour a well, and an oil/grease-TSS polish for further removal. Here again, on-site testing of oil and grease would give the operator immediate feedback that all systems are functioning properly.

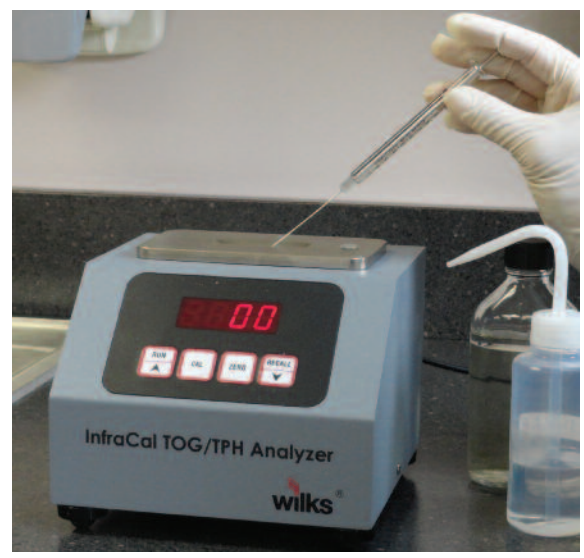

Figure 1: InfraCal TOG/TPH Analyzer

Managing TDS is a more costly step in treatment technology. Depending on the formation and how many times the flowback water has been recycled, TDS levels could become elevated enough to require removal. TDS removal may also be necessary especially if the disposal will be surface discharge. Desalination to lower TDS levels typically employs either membrane or thermal technologies.

With membrane technologies it is critical to remove the oil to prevent fouling of the membrane surfaces. In order to have an immediate alert system, online oil in water analyzers are often employed with a bench top oil in water analyzer to verify and calibrate the online system. Thermal evaporation and crystallization of the brine water are technologies that also benefit from reducing potential fouling agents, such as free and dissolved oil, prior to treatment.

On-site Infrared Oil and Grease Testing

Infrared analysis has been used worldwide for off shore oil in produced water testing for over 50 years. Infrared analysis has the advantage over other technologies in that it can be perfomed by non-technical users and is relatively unaffected by composition changes in the effluent.

Measuring oil and grease levels can be done on-site with portable infrared analyzers. Filter-based infrared oil in water/soil analyzers such as the analyzer in Figure 1, are commonplace at sites where equipment needs to be rugged and reliable. A test can be done on-site in less than 15 minutes without having to incur the cost and delay of off-site laboratory analysis. An added benefit is this simplified technology does not require a skilled laboratory technician to do the analysis.

Another area where an on-site infrared oil measurement is useful is measuring oil levels in drill cuttings. If drill cuttings are to be disposed of via land application or overboard, in the case of offshore platforms, there are limits on hydrocarbon levels depending on the disposal choice.

While water samples typically have hydrocarbon levels in the mg/l range, drill cuttings can be in the 1-10% range. A filter-based infrared analyzer can be configured with different sample stages for different solvents used for extraction or for different oil concentration ranges. For example, a horizontal ATR sample stage using hexane, pentane or cyclohexane as the extraction solvent can be used for oil in water levels from 0.3 to 1000 ppm range. The solvent is evaporated off and the infrared absorbance due to the residual oil film is measured.

The same ATR sample stage can be used for the higher 1-10% range found in drill cuttings. The sample is diluted by using a solvent that does not have an infrared absorbance at the hydrocarbon wavelength such as tetrachloroethylene (perchloroethylene) or S-316 (dimer/trimer of chlorotrifluorethylene) and therefore does not require evaporation. The solvent dilution allows for a high range measurement with the same ATR sample stage used to measure the mg/l level ranges. Infrared analysis can also be used for TPH in soil if a spill or pond leak occurs, to determine the extent of contamination.

The extraction and measurement procedure involves several simple steps allowing an operator with minimal training to do the analysis.

1. The sample is collected in a container.
2. The solvent (hexane, pentane, cyclohexane, perchloroethylene or S-316) is added at a ratio of one part solvent to ten parts sample. For solids testing the ratio is one part solids to one part sample
3. After shaking for 2 minutes the solvent partitions and a portion of the solvent is introduced to the infrared analyser for measurement. With soil, the solids are filtered from the solvent prior to testing.
4. The analysis from sample collection to final result can take less than 15 minutes.

Conclusion

A quick and simple on-site infrared oil and grease measurement gives operators at a well site a useful tool for optimizing frac water treatment procedures, maximizing evaporation pond efficiency, complying with off-site disposal requirements of wastewater and drill cuttings, or for assessing contamination. This is the same field-proven technology that has been used worldwide for both the off-shore and on-shore oil and gas industry and is a reliable testing method that will help reduce public environmental concerns and allow for responsible shale oil and gas development.

References

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[3] Shramko, Andrea; Palmgren, Tor; Gallo, Daniel; Dixit, Rahul; M-I SWCO, Analytical Characterization of Flowback Waters in the Field, 16th Annual Petroleum & Biofuels Environmental Conference (IPEC), Houston, Nov 2009.