

On-Site Infrared Measurement of Fats, Oils and Grease Can Help Protect Our Water Resources

Fats, Oils and Grease Impact Water Quality

As the world supply of fresh water decreases and the demand for water exceeds the supply in many parts of the world, protecting the quality of water resources becomes a priority. In 1977, the US established the Clean Water Act that enacted regulations for industrial discharges. More recent updates of the Clean Water Act focus on "non-point source pollution" from diffuse sources rather than from identifiable facilities. This includes clogged sewer lines that cause Sanitary Sewer Overflows (SSOs). In the US, it is estimated that about 30% of SSOs are due to Fats, Oils and Grease (FOG). As a result, industries discharging into sewer lines are faced with limits as low as 100 ppm of oil and grease.

Europe also established initial directives for water quality standards in the 1970's. Since these initial efforts were not effective enough, the Water Framework Directive came into effect in 2000 with a legal framework for the EU to protect and restore water resources. In 2008, the Directive on Integrated Pollution Prevention and Control (IPPC) was adopted to minimise pollutants discharged from large industrial installations. The initial focus of the IPPC is on the 33 worst pollutants which are currently on the "list of priority substances". While it is recognised that oil and grease is a major culprit for SSOs, the EU regulations are not yet as strict as the US. The first step in the Water Framework Directive is to get all the Member States to participate in a monitoring program. As data is gathered on the health of Europe's waters and the sources for the priority substances are identified and controlled, the next phase will most likely lead to SSO's and regulation of FOG sources.

For Thailand in Southeast Asia, the environmental regulations set by the Pollution Control Department already has Industrial Effluent Standards in place that give maximums from 5–100 mg/L depending on where the discharge is going. Other parts of the world are also recognising the importance of measuring FOG discharge levels and have already implemented regulations or are considering doing so.

As water quality concerns around the world force industries of all types to monitor effluent FOG discharge levels, the need increases for an accurate, quick and simple on-site analysis method to ensure pretreatment systems are operating properly. Both regulators and plant operators benefit by being able to conduct on-site analysis of discharge levels. A simplified procedure for FOG analysis based on solvent extraction and infrared absorption which provides accurate measurement results of FOG levels in less than 10 minutes is discussed below.

Infrared Analysis of Fats, Oils and Grease

Infrared analysis of oil and grease has been used in the petroleum industry on highly regulated off- and on-shore oil platforms for over 30 years. EPA Methods 413.2 and 418.1 are infrared methods for oil and grease measurement that called for the now-banned Freon to extract the hydrocarbons from the effluent. In the US, EPA Method 1664 using hexane as the extraction solvent and gravimetric analysis is now the standard method replacing Freon methods. This gravimetric procedure is a time and equipment intensive process that requires a skilled technician and can only be done in a laboratory. To accommodate those that need a quick, portable analysis, the ASTM passed a method (D7066) using a Freon replacement solvent and simplified infrared analysis. There is also a simplified infrared method using hexane extraction and evaporation.

The measurement by infrared absorption makes use of the fact that hydrocarbons, such as fats, oil and grease, can be extracted from water with an appropriate solvent. The extracted hydrocarbons absorb infrared energy at a common infrared wavelength and the amount of infrared energy absorbed is proportional to the concentration of the oil/grease in the solvent. The infrared absorption can be directly calibrated to read ppm or mg/L of oil and grease.

Measurement of FOG using a Hydrocarbon-Free Solvent and Infrared Analysis

For analysis by infrared, FOG is measured at the C-H absorption band at

2930 cm^{-1} or 3.4 micrometers. S-316 (called for in the ASTM method D 7066) and hydrocarbon-free perchloroethylene are good infrared solvents as they totally lack a C-H absorption band. The solvent extract is placed directly in a sample cell (cuvette) and a beam of infrared light goes through the cuvette measuring the hydrocarbon content in the extract (Figure 1). The minimum detection for this method using a portable fixed filter infrared analyser is 2 ppm.

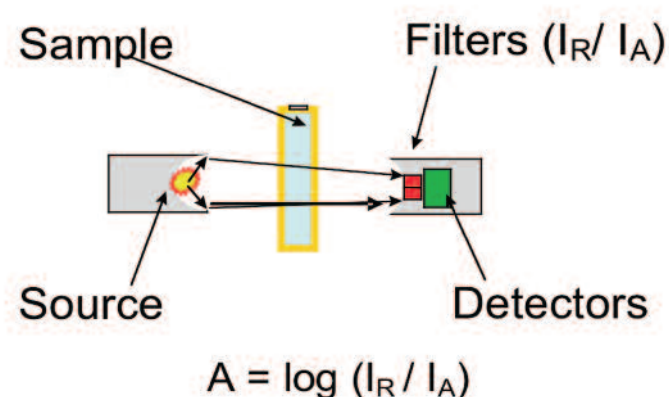


Figure 1: The Measurement of IR Absorption of an Oil Sample with a Cuvette

Measurement of FOG using Hexane Extraction and Infrared Analysis

Hexane is a desirable solvent because it is fairly easy to dispose and it is the solvent used in EPA Method 1664. Because hexane contains hydrocarbons, it must be evaporated off so that it does not interfere with the measurement of oil and grease. This poses a problem for the traditional infrared method of using a cuvette and transmission as described above. To overcome this limitation, an ATR (attenuated total reflection) sample plate (Figure 2) is used as an alternate sample holder to the cuvette. For this analysis, a measured amount of the hexane extract is deposited directly on the exposed ATR crystal. The hexane evaporates and leaves a film of oil and grease on the surface. The infrared beam is internally reflected down the ATR crystal and at each reflection penetrates beyond the edge of the crystal to measure the oil film. The minimum detection for the hexane extraction/infrared method is 8 ppm.

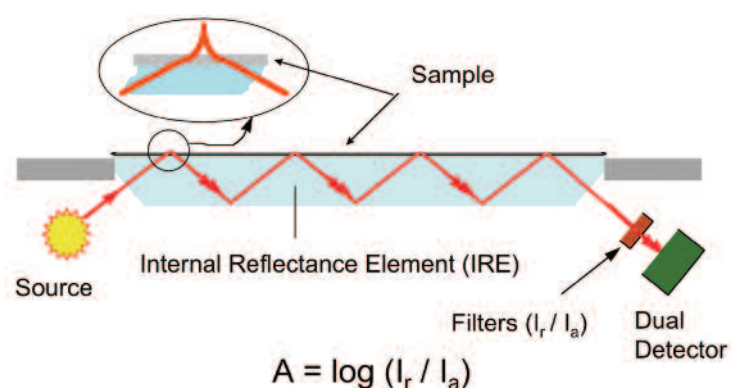


Figure 2: The Measurement of IR Absorption of an Oil Sample with an ATR Sample Plate

Comparing Different Oil and Grease Analysis Methods

Oil and grease is a difficult analysis because it is not a unique chemical entity. The definition of FOG is dependent on the procedure and solvent used. Because different testing methods are looking at different physical properties of oil, there can be differences in the analysis. At 3.4 μm , infrared is primarily counting CH₂ groups so the infrared absorbance goes up with the length of the hydrocarbon chain which correlates with the weight of the hydrocarbon. Therefore, the EPA 1664 Method and infrared analysis typically correlate well with each other. Table 1 shows

two sets of data comparing the hexane/infrared method to the hexane/gravimetric method. One data set is from a meat packing plant and the other from tests done on a grease trap from a restaurant. While taking into account that it is difficult to get two identical grab samples from a waste stream, the two methods correlate very closely.

Meat Packing Plant		
Sample #	Infrared	Gravimetric
1	67 ppm	70 ppm
2	1990	2020
After Grease Trap at a Restaurant		
1	423	415
2	332	300
3	103	130
4	157	170

Table 1: Comparison of the Hexane/infrared Method to the Hexane/gravimetric Method

Infrared Oil and Grease Measurement Procedure

An advantage of infrared analysis over the gravimetric method is the ease of use and the quick analysis time. Portable, relatively inexpensive fixed-filter infrared analysers, such as the Wilks InfraCal TOG/TPH Analyser (photo 1), are currently employed by regulators and industrial pretreatment personnel worldwide for on-site testing. The extraction and measurement procedure involves several simple steps allowing an operator with minimal training to do the analysis.

The sample is collected in a container. The solvent, hexane, perchloroethylene or S-316, is added at a ratio of one part solvent to ten parts sample. After shaking for 2 minutes the hexane, which is lighter than water, will rise to the top carrying dissolved oil and grease with it. The S-316 and perchloroethylene are heavier than water and require an

inverted container such as a separatory funnel or a jar with a septum to remove the solvent.

For the hexane method, the extract is placed on the ATR crystal and after evaporation (about 3 minutes) the result is displayed. For the ASTM method D7066, the cuvette is filled with the S-316 or perchloroethylene extract and placed in the analyser. After 30 seconds, the result is displayed. The analysis from sample collection to final result takes less than 10 minutes.



Photo 1: Wilks InfraCal Analyser

Conclusion

Using portable infrared analysers with a simple and quick infrared procedure enables operators of a pretreatment system to easily assess their system's efficiency and ensure their part in protecting the quality of water resources. On-site analysis gives plant operators the advantage of taking samples before and after treatment to see how a system functions under different operating conditions. Pretreatment system parameters can be immediately adjusted and the results of the changes tested without waiting a week or more for an off-site laboratory result. Regulators also have the advantage of immediately knowing if the FOG levels at an industrial outflow are above the regulatory limits. Most importantly, high FOG levels can be stopped before it stops the flow of the sewer lines and impacts water quality.

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