

A Guide to Oil in Water Monitoring for Environmental Compliance

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Intent of this Guide

This guide focuses on oil in water for environmental compliance. However, much of the content can be applied to process applications as well. Since most environmental concern is directed to petroleum based oils, there is a focus in this guide toward these types of oils.

Section 1 provides a background to oil in water monitoring. Topics will guide you through the definitions of oils, issues to the environment, resulting regulations, techniques to measure and help comply with the regulations, and accessory considerations of instruments.

Section 2 reviews the solutions that Arjay products can offer to oil and water related applications. Special attention is given to the fluorescence technique used in the HydroSense series which are the most popular models in the Arjay line-up for environmental compliance monitoring.

Section 1: An Introduction to Oil in Water Monitoring

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Short instructional videos are available at www.arjayeng.com

1. Overview

Applications for industrial oil in water monitoring can vary greatly.

In upstream and midstream oil and gas production applications, monitoring separation efficiencies is key to optimize production rates, preventative maintenance, chemical use, flow, and environmental compliance. Separated water from the oil is called *produced water* and it must be cleaned of oil before disposal or re-injection.

In downstream applications and for end-users of fuels and oils, environmental compliance becomes key for stormwater management and spill protection. Refineries, power stations, airports, steel plants, pulp and paper, and basically any industry or facility that could have oil contamination in their stormwater run-off would also have an interest to monitor for trace oil in water contamination in their effluents.

Where water is used in heat exchanger applications, monitoring for oils is important to warn of impending water contamination through pin-holes leaks or other breaches into the cooling water.

Shipboard applications of ballast and bilge water discharges to open waters must be monitored for compliance.

De-salination and water purification plants need to monitor for possible oils in their raw water sources due to the detrimental affects of oil to Reverse Osmosis (RO) and other filtration media.

These are just a few of the many applications for oil in water monitoring. Anywhere oil is being separated from water or where oil can come into contact with water, there could be monitoring needs for efficiency or compliance.

Trace Oil in Water Discharges

Trace oil in water typically refers to ppm and mg/l concentrations of oil in water. While ppm and mg/l do not correlate directly, industry has generally accepted the two as equals for discussion purposes.

When water is released back into the environment or to a treatment facility, allowable concentration levels are usually regulated by an environmental authority. Allowable discharge concentrations vary by country and region. Typically, 30 mg/l (29 mg/l in Gulf of Mexico) is a guideline for produced water in open bodies of seawater. Land based applications for water discharge tend to be about 15 mg/l. The shipping industry regulates ballast and bilge water discharge concentrations at 15 ppm as guided by the IMO (International Maritime Organization) and some countries adopt inland water ship discharges as low as 5 mg/l.

Re-injection or effluents headed to a treatment facility may allow higher concentrations.

Oil Spill Containment

Industrial applications that store fuel or use oils in transformers, heat exchangers and manufacturing may not have trace oil in water concerns. Sumps and separators are a common approach to contain water effluents as a final catch for any gradual accumulation of oils or spills.

In these applications, the oil is contained and not monitored as trace contamination in the effluent water. Alarms and monitors are available to alert operators of a spill situation or when the oil accumulation has reached a defined amount that requires action for disposal.

Oil/Water Interface

In process operations such as oil production and recycling facilities, oil is intentionally separated from water by mechanical or chemical means. Alarms and monitors are used to track the oil/water interface levels and rag (emulsion) layers and provide valuable data to the operators for process control decisions.

This paper addresses **Trace Oil in Water Discharges**. Application and technologies for **Oil Spill Containment** and **Oil/Water Interface** can be further reviewed at arjayeng.com

2. Hydrocarbons Revealed

Oils can be animal, vegetable, synthetic or petroleum based. The following discusses petroleum based oils. Hydrocarbons (petroleum oils) are a common and natural occurrence in the environment and varying concentrations in stormwater and effluent water are not unusual. Hydrocarbons in water can be found as free floating, emulsified, dissolved, or adsorbed to suspended solids.

A hydrocarbon, by definition, is one of a group of chemical compounds composed only of hydrogen and carbon. Typically, hydrocarbons are broken down into three main classes; aliphatic, alicyclic, and aromatics. Further sub-classes can also be defined. Simply stated though, hydrocarbons are organic compounds made up of hydrogen and carbon.

Microbes in the soils and water have a natural ability to breakdown many of these compounds. Light hydrocarbons, in particular, are quite volatile and will dissipate when exposed to air. Also, reactions such as photochemistry, can transform the hydrocarbon and further enhance the hydrocarbon decomposition.

Industrial processes and human induced activities often result in the increased loading of hydrocarbons in water. The natural abilities within the water to decompose the hydrocarbons become overwhelmed and the resulting affect on the environment can include:

- oils can affect respiration of fish by adhering to the gills
- oils adhere to and destroy algae and plankton
- feeding and reproduction of water life (plant, insect, and fish) is affected
- aesthetics is affected by sheens
- micro-organisms needed for plant nutrition is redirected to oil degradation

Typical sources of man induced hydrocarbons include the production and refining processes of crude oil into gasoline, lubricating oils, kerosenes, etc.. The resulting commercial products find their way into the environment through stormwater run-off and spills from road asphalts, fueling depots (ie. airports, maintenance facilities), transportation and haulage, oil production and refining, cooling water systems, manufacturing facilities such as automotive, plastics and steel production, and wood distillation industries.

Hydrocarbons Defined

As mentioned above, a hydrocarbon is a compound of hydrogen and carbon. Of course, the chemistry involved can be a lot more complicated than this. In fact, there could be well over 10,000 individual organic compounds in one sample of conventional or synthetic crude oil. And of these, hundreds could be of a hydrocarbon nature.

There are many acronyms used in reference to hydrocarbon contamination in water to become familiar with. Here are just a few.

PAH's (polycyclic aromatic hydrocarbons)

This will be described in more detail later but is of special interest because PAHs are considered carcinogenic. Aromatics will readily dissolve in water and are difficult to separate from water by mechanical means so they are of particular interest to monitor.

BTEX (benzene, ethylbenzene, toluene, xylene)

These are low carbon chain hydrocarbons and very volatile. As such, they are often excused from monitoring or reporting because of their volatility and low concentrations. Lab tests will typically report these as separate compounds.

TPH (total petroleum hydrocarbons)

Usually refers to a sample test requirement of only petroleum oils, not animal and vegetable fats and oils.

FOG (fats, oils and grease)

All oils; animal, vegetable and petroleum. Typically a measurement in the municipal wastewater industry but could apply to all industries.

TOG (total oil and grease)

Same as FOG but used more in the industrial world, not as much in municipal.

ppm (parts per million)

A ratio measurement of contamination, such as 5 parts oil per million parts water. For environmental oil in water contamination, measurements are usually in the 0-100 ppm range with discharge limits around 15 to 30 ppm.

mg/l (milligrams per liter)

Similar to ppm and often interchanged but not exactly the same. Mg/l is a measurement of weight per volume of liquid such as 30 mg of oil per liter of water (30 mg/l). You could have two samples of 30 ppm oil in water, but if the densities of the oils in each are different, the mg/l measurement will differ.

API Gravity (American Petroleum Institute gravity)

API is common term to define the heaviness of oil relative to water. API > 10 floats on water, < 10 sinks. API is used throughout the world to grade oils.

A hydrocarbon concentration in water of 30 mg/l could contain any number of different compounds to make up the 30 milligrams, including compounds found in jet fuels, diesels, lubricating oils, etc.. In other words, the source of the hydrocarbon and the specific compound is not particularly targeted. It is the overall total of hydrocarbon compounds that is typically of interest.

There are many approaches to classifying hydrocarbons. Here are three main classes of hydrocarbons based on the physical structure.

1. Aliphatics are open chain compounds, bonded in a linear fashion, and are saturated or unsaturated. Saturated (single bond) aliphatics are often referred to as paraffins or alkanes. Unsaturated aliphatics are known as olefins or alkenes (double bond), acetylenes or alkynes (triple bonds), diolefins or alkadienes (two double bonds), and alkatrienes and alkeynes (multiple double or triple bonds). Typical aliphatics include ethane, acetylene, and 1,2-butadiene, and the most popular; methane.



Fig. 1 Aliphatic Compound example: note the linear bond fashion that leaves the molecules open ended. This particular triple bond compound shown is named acetylene.

2. Alicyclics, as indicated by their name, contain rings of carbon atoms in their structure. The ring size and number can vary which increases the number and classes of this compound. Multiple ring compounds are referred to as polycyclic alicyclic compounds. Examples of alicyclics include cyclopropane and cyclopentane.

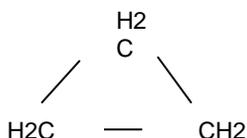


Fig. 2 Alicyclic compound example: note the circular (cyclic) bond fashion that leaves the molecules close ended. This particular compound shown is named cyclopropane.

3. Aromatics contain at least one 6-membered benzene ring in their make-up. Poly aromatic hydrocarbons (PAHs) contain multiple benzene rings. As the name infers, these compounds typically possess a fragrance. Examples of aromatics include ethylbenzene, vinylbenzene (styrene), toluene, xylene. The most basic PAH compound is two benzene rings called Naphthalene.

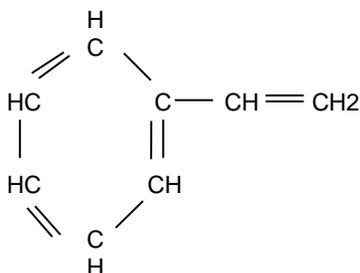


Fig 3. Aromatic compound example: note that a benzene ring (on the left) is in the make up of the compound. This particular compound shown is named vinylbenzene (styrene).

Most unrefined crude oil does not contain high concentrations of aromatic hydrocarbons. The aromatic hydrocarbons are typically the result of the refining process and are produced during the distillation (cracking) operations of a facility. Aromatics are

therefore commonly associated with gasoline, jet fuels, diesel, kerosene, lubricating oils, and transformer oils.

Aromatics are often the target of monitoring instruments to verify distillation efficiency, filtration and separation effectiveness, and environmental contamination.

In terms of a physical description of oil, here are some more definitions. Different industries and applications will have different definitions. The following are generally accepted definitions for oil in water separation and environmental interests.

Dissolved Oil

Oil and water don't readily mix. However, in the oil industry, process chemicals and reactions can entrain small hydrocarbon molecules into the water and the oil behaves as if it is soluble. This is referred to as dissolved oil. Light aromatics are more prone to this although any oils can be 'dissolved'. This will normally only happen in very low concentrations. Once the oil in the water reaches a saturation point, oils no longer dissolve into water. Dissolved oil compounds are usually very small (< 2 micron) and are difficult to separate out of water.

Dispersed Oil

Dispersed oils are a gray area by definition. In general terms, these are oils that are evenly dispersed throughout a medium, such as water. Dissolved oils would be dispersed. Floating oils such as sheens would not be dispersed. However, under some regulatory guidelines, such as OSPAR in Europe, dispersed oil is defined by a method of extraction and analysis. It is the sum of the compounds extractable by n-pentane that are between C7 and C40 carbons, excluding TEX (toluene, ethylenebenzene and xylene) and measured by a GIC-FID according to the ISO 9377-2 Modified Method.

Emulsified Oil

These are oils that are suspended in water by chemical or mechanical means such as surfactants or soaps. These are typically difficult to separate without the aid of additional chemicals such as dispersants, dissolved air flotation techniques, filtration or heat.

Free Oil

Oils that are buoyant enough to freely separate from the water without chemical or mechanical means. First stage separators will typically allow free oils to separate before a second stage uses more costly chemical or mechanical means. There is no size definition as oil physical characteristics may differ, but generally 2 micron and larger are considered free oils.

3. Regulation

Environmental interest groups, government bodies, regulatory agencies, private industry and of course, the general public, all have legitimate concerns with regards to oil in water.

Regulation is usually one of the first introductions an industry has to the oil in water monitoring world but it doesn't have to be a stressful one. Regulation constantly evolves as industry intensifies and environmental knowledge and instrumentation advances. Ecosystems differ all over the world and as new regions are explored and different oil retrieval techniques are introduced, regulation needs may change.

Regulatory Authorities

Various countries or groups of countries throughout the world have their own regulatory authorities. These authorities will be your source for discharge limits and analytical methods for testing.

Most authorities rely on the guidance and recommendations of non-enforcing organizations. The United States has the authority of the USEPA to enforce regulations through various channels such as the Clean Water Act and its NPDES (National Pollutant Discharge Elimination System).

Canada's National Energy Board enacts federal legislation to give regional authority to bodies such as the Canada-Newfoundland Labrador Oil Petroleum Board (C-NLOPB).

In the North Sea area, the OSPAR Commission is responsible for encouraging responsible environmental activity by setting standards and guidelines for its member countries; which include Norway, the UK and the Netherlands. These activities include matters pertaining to the concentration of oil discharge in produced water. In the UK the Department of Energy and Climate Change enforce the OSPAR recommendations. In Norway, the KLIF is the enforcing body.

Discharge regulations could be enforced at the federal, provincial, state or municipal levels.

Standards and Guidelines

To help enforce guidelines, standard measurement methods are used so that similar industries reporting to an authority are on an equal playing field.

Various organizations around the world can be approached to write a standard. Usually, an unbiased organization that is recognized with a high degree of integrity and experience is approached by an interested committee, but in reality, anyone can write a standard. However, without solid third party support, it would be difficult to convince a local authority to adopt an unsupported standard. A change to an approved method can take many years and due to the costs involved, it usually meets with resistance.

Oil in water monitoring practices in the North Sea follow standards that have been developed through the International Standards Organization. Specifically, ISO 9377-2 has been adopted. In other regions of the world, other standards may be referenced. For instance, in the USA, the USEPA refers to ASTM D7066 for TPH in wastewater and the EPA 1664 Rev A for oil and grease. ASTM (originally the American Society for Testing and Materials) is an organization focused on verifying and writing standards.

Neither ISO or ASTM write the laws or enforce the standards and methods for testing oil in water. They only help to develop and document them. There is a shift toward international harmonization of standards but it is slow. Country needs and attitudes are unique and even if a base harmonized standard is accepted, each country or region will usually add a few twists that will localize the standard.

Third Party Organizations

In any industry, there can be many private and public interest groups that provide third party input, verification and certification to standards, practices, and products. Here are just a few that you may come across in the oil-in-water monitoring industry. Most do many more functions beyond the notes below.

ISO (International Standards Organization) Sources and writes standards that can apply to almost any industry for quality, inter-connectivity, and methodology. International suppliers of oil monitors should be certified to ISO 9001 quality standards to acknowledge to the end-user that the product meets the high quality standards of design, manufacture, and safety. ISO also writes an analytical methodology (ISO-9377-2) that is used in several countries for oil in water, particularly the North Sea area.

SCC (Standards Council of Canada)

Central body in Canada that recognizes and authorizes laboratories for testing and reporting and certification of standards.

NRTL (Nationally Recognized Testing Laboratory)

USA national recognition that authorizes laboratories for testing and reporting and certification of standards.

ASTM (American Society of Testing Materials)

Agency that researches, performs and writes standards, including lab test methods for oil in water and flange ratings for pressure.

NACE National Association of Corrosion Engineers

Agency that researches, performs and writes standards. MR1075 is a standard by NACE that addresses corrosion issues of sour (H₂S) gas in the oil industry.

IMO (International Maritime Organization)

Agency that researches and writes standards with a focus on marine based industries such as shipping and FPSOs. IMO standard MEPC.107(49) regulates ship water discharges at 15ppm.

CSA (Canadian Standards Association) Writes standards and also tests to standards. Mostly safety related for electrical and hazardous location equipment.

UL (Underwriters Laboratories)

Writes standards and also tests to standards. Mostly safety related for electrical and hazardous location equipment.

FM (Factory Mutual)

Writes standards and also tests to standards. Mostly safety related for electrical and hazardous location equipment.

ATEX (Atmospheres Explosive)

European standard for equipment being installed in Hazardous Locations.

Inmetro

Brazilian certification authority for equipment being installed in Hazardous Locations.

CE (Conformite Europeenne/European Conformity)

A manufacturers declaration that the applicable regulations and certifications have been met to sell products in Europe.

IEC (International Electrical Commission)

Writes various standards applicable to the electrical safety of instruments.

IECEX (International Electrical Commission - Explosives)

Writes various standards applicable to the electrical safety of instruments for use in hazardous classified areas.

DNV (Det Norske Veritas)

Inspection and Classification agency.

BV (Bureau Veritas)

Inspection and Classification agency.

ABS (American Bureau of Shipping)

Inspection and Classification agency.

NFPA (National Fire Protection Agency)

Writes standards pertaining to safety. References purging solutions for hazardous locations.

USEPA (US Environmental Protection Agency)

Government body that regulates and enforces standards applicable to environmental protection

4. Monitoring Technologies

There are several different techniques available to determine hydrocarbon levels in water and multiple manufacturers offering products. Most authorities will require a third party accredited lab to perform sample testing if ppm or mg/l levels are to be reported on a regular basis by law. Oil production facilities or sites that send oil cleaned wastewater to a stream or ocean often have to report, by law, oil in water concentrations on a daily, weekly or monthly basis. Strict fines and even imprisonment can be enforced for infractions.

Due to the thousands of oils and compound structures being released from multitudes of sources, it is difficult for an agency to define specifically what oils are to be reported. To combat this, oil in water measurement definitions are Method Dependent. This means that an Analytical Method is decided as the reporting method and whatever oil is in the water sample being presented to that Method that causes a response is to be reported.

Historically, two reportable analytical methods have been predominant for oil in water; infrared absorption and gravimetric. Both used Freon solvents to extract the oils out of the water prior to analysis which provided a common method to pre-qualify the oils to be measured.

The gravimetric approach heats a solvent extracted sample to evaporate the solvent and weighs the residual oil. The infrared approach extracts the oil using solvent and measures the amount of infrared absorption of the oil after solvent evaporation at a targeted wavelength and correlates this to a pre-calibrated curve of absorption vs. ppm (mg/l). Due to the Montreal Protocol restrictions on the production of freons in the late 90's, alternative solvents for infrared methods were introduced and the playing field became less clear as new methods were introduced and others superseded. The USEPA eliminated it's Freon extraction Method 413.1 in favour of Method 1664, which uses Hexane as the extraction solvent.

Around 2003, in the North Sea area, the OSPAR Commission adopted a technique called GC-FID (Gas Chromatograph - Flame Ionization Detection). The standard for this testing method for oil in water was issued by the International Standards Organization as ISO 9377-2. This method uses a pentane solvent extraction for the preliminary sample qualification. The OSPAR guideline modified this standard slightly to eliminate some of the very light aromatics.

In the USA, the gravimetric approach is most popular for the oil industry under the USEPA 1664 Rev A Method, which uses a hexane solvent extraction.

In many other countries of the world, the ISO 9377-2 method is becoming the method of choice for petroleum based applications. The infrared approach is still accepted as a reportable method in some countries.

Industrial environments, precise analytical measurements, and hazardous solvent use tends to restrict the gravimetric and GC-FID methods to controlled laboratory use. These methods may provide reportable data for authorities, but are not very conducive

to field use. Where fast process control decisions are desirable to optimize production or environmental response, correlation instruments are often used in the field.

These field instruments are calibrated against a laboratory analyzed sample which correlates them to an approved analytical method. These instruments typically cannot be used for regulatory reporting purposes. They provide valuable on-site data but samples will still be routinely sent to a lab as a requirement for regulatory reporting.

Non-reportable field instruments allow users to select an instrument that is more suited to their site and personnel conditions. This, in turn, results in a greater acceptability of the instrument and respect for the valuable data it can offer.

Measurement techniques can be categorized as discrete sample or continuous on-line instruments. Typical techniques for monitoring include:

- **Gravimetric** **lab only**
- **Colorimetric** **lab only**
- **Infrared** **lab and limited on-line**
- **UV Absorption**
- **Light scatter**
- **Fluorescence**
- **Fluid Imaging**
- **Ultrasonic**

Gravimetric: This technique of hydrocarbon determination was first described under the EPA Method 413.1 which uses an extraction additive. Freon-113 was added to a water sample and a subsequent boiling off of the water and Freon leaves the oil and grease which can then be weighed. EPA Method 1664 replaced 413.1 and uses n-hexane to extract the oil and grease to be weighed. This method allows the total oil and grease to be measured in mg/l. A sample must be drawn from the process and taken to a lab to perform the procedures. This is not conducive to field use because of the sensitive equipment necessary.

Colorimetric: A catalyst is added to an solvent extracted sample which initiates a color transformation. The resulting color can be compared to a color chart or analyzed using a spectrophotometer.

This method provides a more direct approach than weighing (gravimetric) which makes it more practical in the field. However, a data base of standards of colours must be collected for each different hydrocarbon and application. Most colorimeters are qualitative and threshold based, meaning the resulting reading is determined as above or below a certain value. The absolute reading value cannot be relied upon or correlated to an actual ppm value.

Infrared: Historically, this has been a widely used method of measuring for hydrocarbons in water. This technique measures the energy absorption as a function of the total number of hydrogen and carbon bonds and, through a pre-determined calibration input, provides a ppm indication of the total hydrocarbons.

Typical units are transportable and require a discrete sample input. On-line devices are also in practice that will provide a near continuous indication of hydrocarbons. Infrared employs the use of energy absorption. Hydrocarbons absorb energy at a specific wavelength (3.4 micrometers) and the amount of energy absorbed is proportional to the amount of hydrocarbons. Since other materials also absorb energy in this range (including water), the oil must first be removed from the interfering background. A solvent extraction is typically used for discrete samples.

On-line devices may automate the extraction function or may incorporate a submerged and specially coated fiber cable that draws the hydrocarbons from the water and onto the fiber for analysis. The fiber is then mechanically cleaned off prior to the next reading.

UV Absorption/Transmission: This is similar in approach to the infrared, however the hydrocarbons do not need to be extracted from the water. This makes the unit applicable to laboratory and on-line applications. Different compounds absorb UV light at different wavelengths. By emitting UV light at a specific wavelength into the water, the hydrocarbon level can be determined by measuring the amount of light absorbed (the inverse of the amount that is transmitted through).

While this technique targets hydrocarbons, there are organics such as bacteria and algae, as well as suspended particles, that will interfere with the light transmission (and hence, absorption) measurement. Compensation, filtering, or frequent zeroing is therefore required in many applications.

Nephelometry/Light Scatter: This technique uses light intensity measurements through the water to indicate ppm levels of oil in water.

Oil in water can cause the light to refract (scatter) in a predictable manner that can be monitored. As the oil concentration increases, the intensity of scattered light at the receiving sensor increases.

This technique provides a cost effective in-line measurement. The sample must be stable with regards to any other sources of interference to the light path. These interferences can include suspended solids, other chemical compounds, and color additives that may cause the light to scatter and result in a false hydrocarbon reading. Compensation and filtering techniques are often used to help offset interference.

Light Scatter techniques are not selective to petroleum hydrocarbons and will respond to all oils such synthetic, animal and vegetable. The oils must be great than about 2 micron to induce scattering. These are typically referred to as Free Oils. Dissolved oils will not typically induce a scatter response.

Fluid Imaging: Basically, this is a high speed microscopic camera that takes pictures of the passing stream and compares the shapes and sizes of particles and oil droplets in the photo against a library of previously identified components. The processor then counts the various components in the snapshot to provide a breakdown of

concentrations. This technique can identify more than just oil such as sand particle size and distribution.

Changes to the oil make-up or non-oil components that have similar features and photographic effects can distort the readings and affect accuracy.

Ultrasonic Pulses are directed into the passing stream and signature sound waves returned to the sensors. These signatures are identified and concentrations determined. As with the fluid imaging, signatures not previously identified or components with similar features can confuse the instrument which results in accuracy issues.

Fluorescence: This technique uses a UV light source. The actual absorption is not measured but rather, the fluorescing characteristics of specific compounds is monitored. Fluorescence is a phenomenon whereby a portion of the absorbed wavelength in the targeted compound is re-emitted at a higher wavelength.

When the water is excited at a specific wavelength of UV light, certain compounds, including hydrocarbons, will absorb energy. Even fewer compounds will re-emit this light at a higher wavelength. Hydrocarbon compounds will re-emit at a wavelength range that is unique to them. By measuring the fluorescence intensity at this wavelength, the concentration of hydrocarbons can be determined. This approach makes the instrument very selective to petroleum hydrocarbons.

For benchtop units, an extraction of oil from the water can be used to provide accurate results similar to regulatory standards. Straight water samples can also be inserted, making the unit an ideal screening tool to determine that hydrocarbons are present.

Fluorescence relies on the aromatics in the hydrocarbons to fluoresce. The ratio of aromatics to total oil must be consistent to give constant results.

5. Sample Taking Techniques

On-line

On-line instruments are available with the sensor mounted directly in the process stream (in-situ) or the sample may be tapped off the process or pumped to the instrument (slip-stream). For in-situ instruments, the installation requirements will be dictated by the manufacturer. For slip-stream, industry standards for sample draw techniques are available from organizations such as ISO and ISA.

Flow patterns in the pipe may force contaminants and solids toward the pipe walls. Avoid drawing a sample directly from a coupling on the pipe wall as this may contain higher than normal solids. The important point is to get a representative sample to your monitor. A typical approach is use a quill (pitot tube) in the process pipe. A shut-off valve at the process pipe is a good idea for future maintenance requirements.

The tube from the process to the monitor should be at least 12mm (1/2") to reduce the risk of clogging. This will also provide adequate flow to the monitor. Minimize the distance and number of elbows as these will reduce the pressure. Avoid using plastic tubing. Plastics can draw out oils.

Adjacent to the instrument, a manual sample take-off should be installed. This will be used for calibration of the instrument. This take-off port should also be used for routine lab analysis if the results are to be compared with the monitor.

Manual

When taking a manual (grab) sample for a benchtop instrument or third party lab, there are several precautions. Consistency is Key and this will be your most important ally. The rest is common sense.

- take samples from the same location each time so your results can be compared historically for trending
- know the process conditions and if there are certain times of day to avoid that could skew your sample, such as backwashing or chemical treatments.
- ensure the sample is fresh by allowing the spigot to run a bit first to a drain or a separate container
- use a quill so the sample is representative in the pipe stream
- use an appropriately sized container and fill completely so there is no air space
- use glass or Teflon lined bottles, plastics can skew samples by contaminating or drawing out oils
- follow the lab's recommended procedures and check if additives are required prior to transport
- keep the sample cool to minimize degradation and vapourization
- thoroughly clean or use fresh bottles each time
- record as much information on the label as possible (where, when, who)
- Be Consistent → Minimize Variables

Sample taking does not require detailed measuring or fine science and since a third party lab will be doing the testing, the above is not difficult once the routine is put into place.

6. Hazardous Area Installations

Most on-line oil in water monitors are taking readings of the water every few seconds, 24 hours a day. Some degree of maintenance will be required on any monitor.

If the instrument is in a difficult location to access, it will be ignored. This will lead to maintenance issues and eventual failure. In-situ instruments should be mounted with this consideration. Slip-stream instruments can be installed in accessible and protected locations, ideally in a room or shelter with heat and cooling as needed.

Benchtop instruments are typically used in non-hazardous locations in controlled ambient conditions such as a site lab or weather shielded shelter.

On-line instruments are not afforded the same location luxury and will be installed at or near the process sample location. In non oil & gas sites such as power plants, steel mills, and water plants, the mounting location of the instrument will usually be in a general purpose non-hazardous area.

Where there is a continuous or intermittent presence of hazardous fuels such as at an oil platform, refinery, or fuel storage facility, there will likely be Hazardous Area Classifications to contend with.

There are two main approaches used around the world to describe and designate hazardous locations; Divisions and Zones. Both are in use at the present time although there is a global shift toward the Zone system. Europe and a few other countries use the Zone approach exclusively. In other regions of the world, both the Division and the Zone approach are still in use, although, as new sites get classified, the Zone approach is more typical.

Zones and Divisions first classify locations based on the following conditions.

Zone 0 / Division 1	explosive vapor is present continuously Example: Vapor space inside a fuel storage tank
Zone 1 / Division 1	explosive vapor is present intermittently Example: Area immediately outside of tank where spurious gas concentrations may occur regularly when filling or maintaining a tank or process
Zone 2 / Division 2	Explosive vapor is not normally present Example: Area close to the tank where vapors are not normally present but could be under abnormal or upset conditions

It is important to note that the Zone and Division approval standards are not interchangeable. For instance, a Division 1 approved instrument cannot automatically be considered acceptable for a Zone 1 classified area. The end-user or engineer involved will determine suitability.

Most on-line oil in water instruments use a sample take-off approach that streams a sample through the instrument off the main process line. This is often referred to as on-line slip-stream. This has a few advantages. It allows the sample to be conditioned prior to analyzing for solids removal, de-gassing and cooling if required. It also allows the instrument to be mounted away from the Zone 0, Zone 1/Div 1 location and into a Div 2 /Zone 2 or General Purpose Location. This often allows instruments to be calibrated and maintained without powering down and de-classifying the area. In Zone 0 and Zone 1 locations, live circuits are not allowed to be exposed to the ambient conditions without costly and time consuming de-classification procedures.

There are multiple methods used to make an instrument approved for use in a Hazardous Classified Location. The most popular are explosion proof housings, intrinsically safe electronics, non-incendive electronics, and purging/pressurizing a standard housing.

Explosion proof enclosures can be cumbersome, difficult to physically access and the power must off before opening. The advantage is that it allows installation in Zone 1/Div 1 areas.

Intrinsically Safe (I.S.) electronics may also allow installation into Zone 0, Zone 1/Div 1 areas. Intrinsically Safe circuits must be of low power and current and are not applied to most of the technologies used for oil in water monitoring.

Non-Incendive designs allow for installation in Zone 2 and Div 2 locations only. The circuits are tested for arcing and surface temperatures of components. The advantage is that the electronics can be in a standard Type 4/IP56 style housing that can be accessed without powering down the electronics.

Purging/Pressurization applies a positive pressure inside the housing of the electronics. This de-classifies the internals of the housing to General Purpose, and therefore non-hazardous rated electronics can be put inside. If used in Zone 1/Div 1 area, the power must be off and a cool down period lapsed before opening the housing. If used in Zone 2/Div 2 areas, the power can often remain on when the box is opened. Check for site policies before assuming.

Added benefits of a purge include a clean dry source of air surrounding the electronics, which eliminates the affects of harsh or humid environmental conditions. As well, the continuous air flow will purge the sensing chamber of humidity caused by the open flow of the sample stream.

The disadvantage is the added cost of the Purge System and requirement of a continuous flow of clean compressed air.

7. Filtering the Sample

Sample streams that have changing concentrations of suspended solids and turbidity can influence readings. In optical devices, the light paths can be affected which will in turn, affect the strength of light reaching the sensors. This can give false positive or negative results. In ultrasonic and imaging devices, the signatures can become confused and result in false positive or negative readings.

Should stream filtering be necessary due to a high volume of particles, algae, or debris, there are a number of mechanical methods available to filter or separate particulates prior to entry into the chamber. Use caution when considering these since they may also remove oil, resulting in a sample being measured that is not indicative of actual process conditions.

Some oil in water instruments will provide internal conditioning features that will minimize or divert the effects of suspended solids..

Hydrocyclone: This forces particulates to separate from the water by a centrifugal force as water is funneled in a swirling action down a specially designed tube. The heavy particles separate out while the light and emulsified contaminants remain.

These are available for use with the pressure and flow available from the process or electric models are available.

Routine maintenance is not generally required. Use caution when selecting a cyclone to only remove solids since cyclones are also used to remove oil.

Screen or Bag Filters: These are economical and easily installed in-line. Models are available that have automatic backwash systems to periodically clean out the filter. Otherwise, a periodic maintenance program will need to be put in place to clean the filter.

As the filter traps debris, it will also start to trap oil. If this occurs, the clean-out frequency should be increased.

Separators: A flow through separator relies on the natural separating properties of the sample to remove solids. The continuous flow enters a vessel of a size that will cause the sample flow to slow down considerably. Baffles will generally direct the flow up and down as it moves through the unit. This retention time spent in the separator allows heavy particles to fall and become trapped in the separator. Contaminants that are lighter than water will surface and also become trapped in the separator.

Any non-emulsified or free-oils will have a tendency to separate during this retention time. The separator design may allow these back into stream rather than retaining them.

8. Pumps

A continuous pressurized sample stream from the process to the monitor is great but not always available. The source may not be under enough pressure to ensure an adequate flow rate to the unit or it may be from a pit, pond, or stream. In-line options such as coolers and flowmeters as well as long distances will increase the pressure needed to provide an adequate flowrate.

In order to maintain a good representative sample to the monitor, it is best to minimize any mechanical interference within the sample stream.

When pumps are employed, use careful consideration in the type and its installation. To choose a pump, you will need to know the height from the source to the pump inlet, the horizontal distances, the tubing size, the flow rate desired, and the operating voltage. Make sure the pump components are designed for water and the contaminants you may have in your water. Discuss any suspended solids and grit that may be in the sample. Confirm if the pump location is in a Hazardous Classified area.

Progressive Cavity: These pumps provide a strong positive pressure and flow. A stream by-pass is required at the monitor to divert any flow greater than the monitor can accept. Otherwise, a pressure will continue to build in the line between the pump and the monitor. Alternatively, a speed control can be used to run the pump at the desired flowrate. These pumps are generally of good industrial quality and wear well under a continuous run operation. If the pump runs dry, the stator can heat up and wear quickly which will incur downtime and replacement parts. Dry Pump Alarms can be installed in-line. The pump will usually require a prime prior to start-up. The action of the rotor through the stator can cause a shearing of the sample. This can change the make-up of the water and its contaminants. It can reduce the size of the oil droplets, which in turn will affect the reading of an analyzing unit. If using a PC pump, be sure to take grab samples for testing downstream of the pump at the analyzer so that the lab samples and analyzer samples are representative to each other.

Peristaltic: This is a common pump style for intermittent use in water monitoring samplers and laboratory use. The sample stream does not come in contact with any components other than the inside wall of the tubing, which minimizes cross contamination. In wastewater applications, the continuous wear on the tubing requires frequent changing, particularly when there is grit in the water. Since the mechanical action is a pushing of the sample through the line, there is minimal physical affect to the water make-up.

Air Diaphragm: These pumps are known for being very robust. They are typically self-priming and can run dry without damage. The sample is not substantially altered since the sample is moved through the pump in a pulsing fashion. A dampener may be necessary or an extended length of flexible tubing to absorb the pulse action prior to the sample entering the analyzer. A continuous air source or air compressor is necessary for operation. The sample flowrate can easily be controlled by adjusting the air pressure to the pump. The pump is not dramatically affected by suspended solids and grit.

Magnetic Drive Pump: This offers strong suction lift and good chemical resistance. The magnetic drive minimizes component contact with the liquid. The unit can accommodate most suspended solids. If any contaminants in the water are tacky, the pump may require cleaning prior to use after being stopped. This is due to the non-contacting magnetics that drive the impeller. A fluid by-pass is often available directly on the pump to minimize any high pressure build-up in the outlet tubing.

Metering Pump: This pump provides an adjustable flow rate directly on the pump. The output flow is steady and controlled. It does require a prime which is done quickly and easily at the pump. Excessive grit can hamper the piston stroke of the unit, although typical suspended solids found in wastewater streams are easily handled.

9. Section Closing Comment

While the chemistry definition of a hydrocarbon may be clear, the definition of a hydrocarbon contamination in water is not so clear.

The type of hydrocarbon and the ability to reliably monitor for it within practical means plays an important role in this definition.

Reportable measurements should be made within an industry standard to provide a common ground for comparison and discussion. On site monitoring is the prerogative of the user for what best suits their needs for process optimization and environmental compliance.

The user must consider the benefits of a benchtop device providing spot checks of multiple sample points verses the on-line benefits of trending and immediate indication of a trending upset.

The user must also consider the technology used and the cost of ownership verses data received. The decision will be based on a number of variables and each application will be unique. There are several technologies on the market and with each, there are various designs and methods to present and read the sample.

Easily accessible parts for routine cleaning is a prerequisite. And of course, inexpensive and field replaceable consumables are also important.

For field instrument use, simple is typically better. Installation ease and accessibility is an important factor. A comfort level is required between the operator and the instrument. Without this, the unit will not be maintained properly, the data will become questionable, and the instrument will be abandoned.

----- SECTION 2 -----

10. Arjay Oil/Water Product Overview

Oil and water applications can be categorized into oil **IN** water and oil **ON** water. The following is a quick overview of the various Arjay products applicable to both categories.

Following this overview will be a more detailed review of fluoresce as applied to the HydroSense 2410 and the FluoroCheck. These are the most typical models used for environmental compliance monitoring applications.

Oil **ON** water

This refers to monitoring separated oil that has accumulated in oil/water separators, free water knock-out (FWKO) vessels, sumps, lagoons, etc. These are not concentration monitors. Instruments for these applications monitor the interface level between the oil and water to determine the amount of oil accumulation.

Basic models are available to alarm when the interface reaches a pre-determined level of oil. The alarm can be used to close effluent valves, power off pumps, alert automation systems or simply provide an audio visual alarm for an operator.

The following models are typical for alarm applications:

2852-OWS and 2880-OWS

Used in oil/water separators and sumps, a tip sensitive probe is installed vertically or horizontally into the vessel. As the oil accumulates and the interface crosses the probe tip, an alarm indicates. The 2880 has the electronics directly on the probe and the 2852 has the electronics remote from the probe. Typically used where accumulation is acceptable and an alarm is required when it is time to remove the accumulated oil.

2852-HCF

A floating sensor rides the changing water level in sumps and containments. The unit will alarm when there is about 2-6 mm of oil accumulated on the water surface. This model is typical where an accumulation of oil is not normal and should indicate an alarm that a leak or spill has occurred.

2852-IFA

A probe inserted into a vessel or pipe is tuned to the oil or the water phase. When the phase changes, the unit will alarm. This unit is typically used in process pipes, tank drain systems, storage tanks, etc.

2852-ILA and 2852-LPS

A sensor is installed in the berm around tanks or in the interstitial (annular) space of double-wall tanks to alert of a spill. A liquid intrusion into the normally dry condition indicates the alarm.

For applications where it is desirable to track the oil/water interface level or amount of oil accumulation, interface transmitters are available:

2852-OWI and 2880-OWI

A probe inserted into a vessel will provide a proportional output to the calibrated interface range. The output can be used for general trending or process control applications. The 2880 has the electronics directly on the probe and the 2852 has the electronics remote from the probe.

4100-OWS

Designed specifically for oil/water separator applications, this will monitor the separated oil on water layer and provide an indication and alarm of the oil thickness. This model is used where the overall liquid level remains static, such as gravity flow separators.

4100-HCF

In vessels and containments where the overall level changes, the 4100-HCF sensor will ride the changing liquid level and indicate the oil thickness layer. Two sensor models are available for applications up to 25mm of oil or up to 300mm.

4100-PRO

For applications in oil water separation where a profiling of the emulsion (rag layer) interface level and thickness is required, the 4100-PRO is available. Multiple probes staggered into a vessel will each monitor a specific region for oil/water concentration. The overall data of all the probes provides a profile of the emulsion layer.

Level Monitors

In addition to the above products, Arjay offers a full line of level controls for monitoring and alarm of liquids in tanks and containments.

Oil *IN* Water

The focus of Section was oil *in* water monitoring for environmental compliance. Arjay offers several models to target ppm and mg/l oil in water. The HydroSense series provides models for on-line concentration monitoring of oil in water. The FluoroCheck series is a benchtop fluorescence monitor for discrete sample testing.

HydroSense 4420

The HydroSense 4420 uses a light scatter technology that monitors for trace oil in water. Oil droplets in water will scatter light in a predictable manner. By directing light into a passing sample and monitoring the intensity of scattered light, the ppm (mg/l) can be determined.

Light scattering is ideal for any oil type and can monitor for animal/vegetable, synthetic and petroleum oils. The oil droplet size must be greater than about 2 micron to induce the scattering, which are loosely defined as free oils. The background water must be free of turbidity or other contaminants that could also scatter light and cause false positive readings. As such, typical applications for this model are clean filtered water applications or closed loop cooling water where the background water is very clean and stable.

HydroSense 2410, 4410-LMP and 4410-OCM

These models use a UV Fluorescence technology to monitor for trace petroleum oil in water. By filtering the directed light to the specific excitation and emission wavelengths that are indicative of hydrocarbons, the sensor is able to selectively target petroleum oils. This eliminates the background affects of non-petroleum oils and other contaminants in the water.

Fluorescence will excite both the free and dissolved oil in water.

The Hydrosense 4410-OCM is closed loop flow through device with a range of 0-250 ppm. The closed loop is limited to clean water applications such as filtered water for purification and de-salination applications.

The HydroSense 2410 and 4410-LMP incorporate unique designs specifically for industrial environmental compliance applications. The pre-conditioning sample chamber, non-contacting optics and flow-plate design enhance and improve accuracy over an extended range while minimizing maintenance. These two models are physically the same. The 2410 carries IMP MEPC 107(49) certification and North American Div 2 Approvals. Both models can be purged for further Zone 2/ Div 2 application.

FluoroCheck

The FluoroCheck is a benchtop fluorescence monitor working on the same principle as the HydroSense 4410 and 2410 models. The unit allows for both quick direct water samples for pre-screening and also solvent-extracted samples for high accuracy results. The solvent approach extracts only the oils from water that are to be tested following the EPA and ISO extraction procedures. This makes the FluoroCheck an ideal correlation instrument.

11. Fluorescence and What it Detects

The HydroSense and FluoroCheck technique to determine hydrocarbon concentration in water is called Ultra-Violet (UV) Fluorescence. The premise of fluorescence is that targeting light at a specific wavelength into a sample and simultaneously measuring the intensity of the resulting emitted light at a specific and higher wavelength will provide a proportional indication of the amount oil in the sample.

Many common, and not so common, compounds have the ability to fluoresce light when excited by light at one or more specific wavelengths. The Arjay fluorescence monitors operate the filtered UV lamp at a wavelength which will provide a strong peak of response from hydrocarbons.

When water and any contaminants in the liquid are excited at this wavelength, certain compounds will respond by re-emitting this light at a variety of different wavelengths. This re-emitted light from the discrete sample or water stream is then filtered again to only allow the wavelength through for which hydrocarbons are responsible. While most applications have a fairly stable background water make-up, interfering fluorescing contaminants can exist. These would be compounds that fluoresce in the same wavelength range as the hydrocarbons. During calibration, the background fluorescence is zeroed out. If there are background fluorescent changes, the readings may display nuisance positive or negative results. An example could be that fluorescent soaps are being used during an upstream cleaning exercise.

The hydrocarbons that fluoresce to the prescribed wavelengths are generally within the aromatic class. Typically, these hydrocarbons will include one or more benzene rings in their make-up (Poly Aromatic Hydrocarbons (PAHs)). Further, these are usually found with a carbon chain length of about C-6 to C-36 and include BTEX, crude oil, refined oils such as lubricants and grease, gasoline, diesel, Jet A, etc..

Synthetic oils, vegetable oils, mineral oils, and animal fats inherently do not fluoresce at the targeted wavelength since they do not contain an aromatic hydrogen and carbon molecule. However, they may carry a dye or additive that does fluoresce in the same wavelength. In these cases, this interferent may be considered a tracer and could be used to monitor water contamination.

The energy intensity of a hydrocarbon emission (quantum yield) may vary according to its structure. For example, 10 ppm of crude may fluoresce at a different intensity than 10 ppm of diesel. As well, there are many different structures of crude, each with its own characteristic and fluorescing ability. For this reason, a site calibration is necessary to accurately tune the instrument measurement of light to an accurate site specific ppm reading and output.

12. Interferences and Affects to Accuracy

The UV fluorescence technique monitors the intensity of light emitted from the passing stream at a selected wavelength band.

This technique can be quite selective by eliminating the light affect of compounds in the water that do not share the same fluorescence characteristics of hydrocarbon.

1. When chemical compounds in the water are excited with light energy, only certain compounds will emit the light back out of the water at a higher wavelength than excited with. These are referred to as fluorescing compounds. The HydroSense does not respond to most chemicals because it only responds to fluorescing compounds, of which aromatic hydrocarbons are included.
2. The light used to excite the compounds is filtered to a specific wavelength. Of all the fluorescing compounds, only certain ones will respond to this wavelength. Some respond to higher and some to lower wavelengths. The light filter further narrows the HydroSense response to only those that fluoresce at the prescribed wavelength.

The limited number of compounds that do fluoresce may emit light at any number of wavelengths such as 290nm, 310 nm, 350 nm 480nm, etc. By filtering the light sensor from all light except the signature emission wavelength of oil, only the hydrocarbon fluorescence is picked up by the receiver.

3. Oil and Grease in water may be made up of hundreds or thousands of different hydrocarbon compound structures. The aromatic compounds tend to be the fluorescing compounds. The proportion of aromatics within the total hydrocarbons is generally consistent in a product or process. The aromatics are therefore used as a tag to correlate the monitor to total hydrocarbons in water.

Changing Oil Types and Sources

Different oils have a different make-up of compounds and the fluorescing strength may vary between oil types. For instance, diesel fuel may fluoresce much stronger than transformer oil. If the HydroSense is calibrated using 100 ppm of diesel, 100 ppm of transformer oil may only give a display reading of 95 ppm.

Crude oil may vary from one well to another, lubricating oils from different manufacturers may vary in their make-up, oils may be dissolved or free, and so on.

The calibration is therefore site selective and should be done using actual process water or with samples of oil that are to be targeted by the monitor.

The calibrated accuracy relies on the oil type and conditions being consistent. The HydroSense will respond positively to aromatic hydrocarbons but the accuracy may be affected by variations in the types and sources of these hydrocarbons.

Other Chemicals in the Water

The light sensor is selective to compounds in the water at specific wavelengths. If there is a background chemical in the water that fluoresces at these wavelengths, the Hydrosense will respond to them.

If this background chemical concentration is consistent, this interference will be zeroed out during calibration. Calibration is recommended using process water so that any background interferents are zeroed out.

If an interfering background chemical changes in concentration, the HydroSense will sense this change. Consideration to this affect is important for alarms and recording. Filtering of the water, changes to chemical use, or special light filtering may be required to provide more stable readings.

The periodic introduction of fluorescing chemicals into the water may also affect the reading. During these conditions, operators and alarms should be acknowledged that nuisance alarms may occur. Soap manufacturers will often include fluorescing dyes in the product for appearance and identification. Green dyes are typical in industrial degreasers and commercial soaps. Fluorescing chemicals are often included in detergents to enhance the visual affect of a cleaned product such as clothes.

Not all of these commercial dyes will affect the wavelengths of the HydroSense, however, green dyes have proven to be a common interferent.

Suspended Solids and Turbidity

The unit is calibrated to a passing stream of water. The amount of light fluoresced by the aromatic hydrocarbons determines the calibration parameters. The light received by a hydrocarbon and then sent back to the receiver is based on a stable light path through the water. If suspended solids or turbidity block the light getting to the hydrocarbon, light cannot be fluoresced back to the sensor. Readings can be dampened by an increase in solids or turbidity. When process water is used during the calibration, the offset affect of solids is taken into account and zeroed out.

The design of the large surface sensing area of fluid verses the small sensing depth minimizes the affect of turbidity in the HydroSense. In effect, the hydrocarbons have little place to hide behind solids. The HydroSense includes a solids divert chamber to drop out many of the heavier solids in the water. In circumstances of dramatic changes in turbidity, sample conditioning techniques prior to the HydroSense should be considered.

13. HydroSense 2410 Design Considerations

A common concern of field instruments is the routine maintenance and cleaning of wetted components. One of the favorable characteristics of fluorescence is that the UV light source and the receiving module do not need to be in direct contact with the liquid.

The Hydrosense series takes advantage of this non-contacting ability and hovers the UV light source in front of the passing sample without actually touching it. Also, since a fluorescence sensor looks for light re-emitted back out of the water from the hydrocarbon compounds, the sensor is also installed to hover in front of the passing sample. On the Arjay Hydrosense, there is no water contact with any of the optical surfaces.

For non-contacting systems, the incoming sample stream is under pressure but the sample becomes open to atmospheric pressure in the detection chamber. As such, the instrument cannot return the water to the process under the incoming process pressure. The sample stream outfalls to drain or can be collected and returned to the process by pump or other discrete method. If the installation permits, the monitor can be installed above the separator or process to allow the water to free fall back into the process.

Since the optical devices are hovering in front of the sample, further advantages are realized in the pre-conditioning and delivery of the sample through the chamber.

In the HydroSense 2410, the sample flow is slowed as it passes through a vertical flowing pre-conditioning chamber. This allows heavier solids and particulate to fall out of the sample and by-pass the sensor path. The reduced turbidity in the sample improves stability and accuracy. The sample then passes over the weir which releases any bubbles that may be entrained in the sample.

A flow-plate then sheens the conditioned sample down a vertical path. This thins the sample out so any any turbidity or particles cannot hide the light from targeting the oil molecules. The wide sheening path provides a large representative viewing area for the receiver to monitor the "big picture" and not just a segmented portion of directed light. With the light pulsing at the passing stream 50 times per second, all the oil molecules are accounted for.

The sensor response to hydrocarbons is instantaneous, allowing operators and controls to respond to real-time changes and upsets. The continuous monitoring allows logging of data over extended periods for valuable trending and maintenance scheduling.

These unique features to the delivery of the sample though the HydroSense 2410 allow the benefits of a laboratory fluorescence technology to be brought to the field and provide a robust instrument applicable for continuous on-line field use.

14. HydroSense 2410 Installation and Maintenance Considerations

Any analytical instrument that is expected to operate 24/7 and provide stable, reliable results will need some degree of routine calibration and maintenance. The HydroSense 2410 is designed to make this as simple and fast as possible.

In addition to the internal design considerations, the instrument location plays a strong role to ensure the operator pays attention to periodic maintenance

Hazardous Location Rating

The HydroSense is designed for Div 2/Zone 2 or General Purpose locations. This will allow the operator to work on the unit under normal conditions without having to de-classify or power down the instrument.

During calibration, instruments need to be powered On and it is important that the operator have full access to the unit and sample stream. To ensure this, the slip-stream design allows the instrument to be mounted outside of Zone 0 and Zone 1 locations.

It is also important for routine maintenance and cleaning that the unit be accessible in a quick manner without having to power down the unit and access components through restrictive explosion proof housings.

The HydroSense comes standard with a CSA Div 2 rating. Should ATEX or IECEx be required, ATEX/IECEx purge systems can readily be installed on to the unit.

Sample Flow

The Sample Chamber receives the flow sample from the process and outputs it to drain. The chamber should be wall mounted on a vertical plane to allow a proper flow through the sensing unit. A bubble level is included inside the chamber to assist in mounting the unit correctly.

The Sample Chamber should be located close to the process to reduce the lag time of the sample to the unit. This will offer more instantaneous readings and real time recording.

The outlet gravity flows to drain, and consideration to the close proximity for this effluent is important. Also, mount the unit where it is readily accessible for maintenance and periodic testing.

If the process is not under a flow pressure, the chamber could be mounted below the process level so the sample can free flow down and through the unit. A pump may be required. The minimum input pressure at the instrument is 2 psi but higher pressures may be required if coolers or other accessories are used. Regulators should be used to keep inlet pressure below 100 psi for safety reasons.

The minimum flowrate input is 1 l/m. However, to make full use of the solids by-pass feature a flowrate of 5 l/m should be available.

The inlet connection to the unit is a 3/8" female thread. A barb connection may be threaded to this when flexible inlet tubing is used.

A three-way valve is provided on the inlet to the instrument. This sample port can be used to take manual grab samples for routine lab testing and calibration.

An on/off valve at the process tank or pipe is recommended to shut down the system for maintenance and/or sample tube replacement. An on/off valve is included within the unit for throttling flow. This can be used to turn off flow for internal maintenance.

The sample gravity flows out of the Sample Chamber. The outlet tube **must** only be installed in a downward vertical or downward graded horizontal direction. Any upward direction will cause the sample to back up and flood the sample chamber.

The outlet fitting is a 2" female thread. Pipe or tubing of 2" sizing is recommended. A restricted outfall can result in a back up into the chamber.

The outlet of the drain pipe should be open to air, **not** submerged in water or a process which could cause a back pressure. This would result in the sample chamber flooding.

Electronics Considerations

The monitor is used for display and calibration and should be mounted where it can be readily accessed and is easily visible.

The monitor provides LED indication of relay status for Lamp Replacement (Relay 4), and alarm levels (Relay 1 & 2). Relays are included for these controls for remote annunciation. The relays are dry contacts and will accept AC or DC inputs.

A 4-20 mA dc output signal proportional to the PPM levels is provided. This is a non-isolated signal capable of driving 1000 ohms. A modbus RS-485 communication is also provided. Remote indicators, receiving devices and their distances should be considered when choosing a location for the Arjay Controller.

Shielded wiring is recommended for the output alarms and signals to avoid EMI and RFI interference from other equipment near the sample unit.

The Monitor is housed in a Type 4X (IP 65) stainless steel enclosure. Extremes in temperature and humidity should be avoided. Indoor installation or a heated instrument shelter for outdoor use is recommended or may be required.

Routine Cleaning Program

The HydroSense relies on a constant flow of water across the sensing plate. Excessive particulates and algae in the water can build up on the glass flow plate. This will eventually affect the performance of the unit and require cleaning.

Setting up a Routine Cleaning Program is important to the successful performance of any unit.

Each application will vary in the frequency of cleaning. Some may require daily wipes and some may require monthly cleaning. A basic wipe down of the glass can be done without having to shut down the stream or power. The wipe procedure will take 2 to 3 minutes.

To set up a schedule, it is recommended to program a daily wipe of the flowplate using a clean paper towel. After one week of daily cleaning and observation, change to every two days to determine if this may be adequate. If so, set this program in place for another week. Slowly extend the frequency between cleanings until an adequate program frequency is determined for your individual site conditions.

There are no mechanical movements, small diameter tubes, or flow restricting devices used in the HydroSense. The flow plate is used to sheen the water across a wide surface area with a depth of only a few millimeters. Routinely check that the water sheening evenly down the plate.

15. Customer Application Worksheet

HydroSense Application Data Sheet

Please fill in as much information as possible. Some information is required to determine the suitability of the instrument. Other information will help us understand your application better. We may be able to provide some further installation and monitoring guidance.

1. **Agent/Representative** _____
2. Prepared by _____ date _____

3. End User Information

Name: _____

Address: _____

Site: _____

Contact _____

Tel: _____

4. **Application Description** (brief overview of process and reason for monitoring the water for hydrocarbons)

5. Water Source Description

sump pit process tank process pipe vessel ditch open channel
 separator well offshore platform cooling water pipe
other _____

6. Water Type

storm water waste water treated water process water cooling
water condensate drinking water sewer ground water sea water
 distilled water produced water
other _____

7. **Compound to be monitored** (describe the contaminant, chemical name, structure, source etc.)

minimum ppm to be measured_____, maximum ppm to be measured_____

8. Are there other contaminants or products in the water ? _____
Describe _____
Do they vary in their concentrations ? _____
9. Is there any colour in the water? _____ Describe _____
10. Are there any suspended solids (turbidity) in the water ? _____
What range? _____
Describe _____

Process Information

11. Is there a continuous sample flow available to the HydroSense? _____
12. What is the flow range ? _____
13. What is the pressure in the process ? _____
14. What is the pressure in the stream line to the HydroSense? _____
15. Can the sample stream outfall from the HydroSense go to an open drain or containment? _____
16. Is the sample stream pumped from the process source to the HydroSense? _____
If yes, what type of pump ? _____
17. What is the process stream temperature range _____
18. What is the HydroSense enclosure location temperature range _____
19. Area Classification of HydroSense installation:
General Purpose Type 12____Type 4____
Hazardous Zone 2 (Div 2)_____
20. What is the input power available? __24 vdc __110 vac __220 vac
21. Are the relays being used?
Describe _____
22. Is the 4-20 mA output being used?
Describe _____
21. Do you presently have grab samples tested? __laboratory on site __send to outside lab. What technique and compounds are measured ?
-
23. Does the process ppm concentration vary on a regular basis ? _____
24. Do you have the ability to force a change or make up a ppm in water sample for calibration purposes ? _____
25. Is the monitoring intent to determine an upset condition or to record and evaluate actual ppm levels?
Describe _____

Make a quick sketch of the process overview and HydroSense Location

17. Engineering Specification

The ppm Oil in Water Monitor shall be a continuous flow through type using a fluorescent technology that is selective to hydrocarbons in water. The operating range shall be user defined and selectable at site from 0 to 10 ppm up to 0 to 5000 ppm. The continuous sample flow will tap off the main effluent line and feed to the monitor under process pressure and flow rates. In cases where pressure and flow is not adequate, an approved pump is acceptable. The sample stream gravity outfalls from the monitor to a drain or return sump.

The sensor shall be a non-contacting type with no mechanical or pneumatic devices necessary to maintain a continuous on-line operation. The flow shall be directed across a sensing plate that has been treated to negate background interference due to any normal operational coatings on the glass. Suspended solids up to 400 mg/l shall have no interference with the output signal.

The controller shall provide a 4-line LCD display of ppm concentration and bar graph simultaneously. The display will also advise of diagnostic and control functions. An isolated 4-20 mA output signal will be standard and its range selectable through the keypad. An RS-485 Modbus communication shall be standard. Four 10 amp SPDT relays shall be available; two relays for alarm setpoints, each with full differential to eliminate control chattering and allow a concentrated stream to adequately clear prior to reset; one relay to alarm on a negative offset drift, and one relay to alarm on a maintenance requirement or fault condition. Relay time delay and output signal filtering shall be standard and selectable via the keypad.

For maintenance purposes, the lamp and any components requiring routine cleaning shall be readily accessible without tools and without having to shut off the flow or power to the unit. The relays can be manually disabled and re-enabled via the keypad during operational checks and other routine sump and pump interventions. The 4-20 mA output can be simulated through the keypad to set up and verify remote interconnected devices. Continuous self diagnostics will warn of a signal failure, negative offset drift, over-range, lamp failure, or calibration failure.

Calibration shall be done on-line and under normal process flow and power conditions. Unknown calibration values can be corrected to an outside laboratory result by a simple keypad entry.

The controller and chamber shall be housed in a Type 4X 316 SS housing.

The system shall be as the HydroSense Model 2410 from Arjay Engineering Ltd. if CSA Div 2 Certification is required. For General Purpose Locations or purged applications, the HydroSense 4410-LMP shall be used.