Oil monitoring by infrared surface scanning

According to the national and international environmental laws concerning water
“every person is liable for taking the necessary precautions, according to the specific conditions, to prevent oil pollution of water”
It is very important that water of industrial plants never introduces oil into the process or into the environment.
For this reason, a continuous monitoring of water is necessary at the outlet of those plants, where oil emissions are possible in case of operational malfunctions.
The problem is, that produced water carries typically a considerable load of contaminations, e.g. sand, mud, algae or salts. Operation conditions such as temperature, speed of flow or water level are not constant. These changing process properties make it very difficult to get reliable oil monitoring results.
The measurement of the absolute oil amount in mg/l or ppm is not really possible by using the known inline & online measuring systems. The reasoning for this statement is, that oil is not homogeneous distributed in the water. The systems capture only a fraction of the total water quantity for analysis.
The biggest quantity of the water is not measured, at installations in open channel, basin, tank or large pipes. Taking a representative sample with average oil content is virtually impossible, because the distribution of the oil fluctuates unpredictably within the water. The distribution is affected by parameters like water depth, temperature, speed of flow and oil type. As an example, very often you will find no oil in a water depth of 30cm, but there is an oil film on the water surface. Almost all types of oil or at least their components are lighter than water and therefore they float. Due to this property we can expect to get the highest oil concentration at the surface or in the upper region of large pipelines. The oil monitor model IRmat uses the floating characteristic of oil to ensure maximum sensitivity

Review of different measuring Methods

Various methods are used to detect oil in water:

- **Infrared surface scan**
- **UV- stimulated fluorescence**
- **Ultrasonic reflection**
- **Light scattering turbidimetry**
- **Conductivity measurements at the water surface**
- **Capacitive measurements**
- **Transfer of oil in a solvent for hydrocarbons & spectroscopic analysis of the solvent**
- **Absorption photometry**
- **Transfer oil hydrocarbons to gas phase (e.g. stripping with air) and their detection into the gas phase (e.g. with a FID)**

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Most applications concern water that contains contaminants as like sand, salts, algae, mud, etc. beside the oil. These particles can considerably falsity the measurements. Methods requiring contact with the fluid, e.g. flow cells or dipping electrodes in the fluid, may be disturbed in their function by the following influences:

- **Floating dirt**
- **Growth of algae**
- **Variations of the surface e.g. waves, position, etc.)**
- **Oil coating at the sight glasses**
- **Contamination of flow cells**
- **etc.**

Much maintenance is needed, to ensure the reliability of such instruments. Measurements based on sampling of the fluid have problems with oil and dirt covering. Due to the difficulties with these measuring methods, it was sense full developing a non contact monitoring method. Since the oil usually floats we developed the idea of a sensor positioned above the water level. The detection should be done by using a suitable radiation method. Such a method is the surface detection by IR-surface scan. Thin oil films on a water surface result in interference pattern easily recognized by the human eye. The infrared method is more sensitive as the human eye and allows to detect oil layers of less than 5-10µm. The model IRmat uses this method and provides highly sensitive and reproducible monitoring results paired with low maintenance.

The IR- Reflection Method

- **Infrared rays are emitted to the water surface (large area 2000mm²).**
- **optical interferences at the oil/water borderline will be detected**

Even this method can be affected by:

- **Ambient light with extreme high intensity**
- **Strong movement of the surface (waves, variations in water level, etc.)**
- **Swimming debris at the water surface**

Electronic compensation circuits and a well chosen measuring location minimize those influences.

General

An oil film on the water surface causes a very good visibility to the human eye. This is due to the optical interferences caused by floating oil layers. The oil monitor model IRmat uses this effect and scans the water surface with modulated infrared light. The instrument allows detecting oil films starting at about 5-10 microns thickness. The detection of this thin layer is even more sensitive than the visibility by the human eye. The sensor was developed for non- contact real time detection of oil in water and is free of maintenance. The detection of the optical interferences at the oil/water borderline allows the monitoring of very low amounts of oil. The modulation of the projected IR- light ensures for a nearly 100% DC-light compensation, so that ambient light does not affect the measured values.