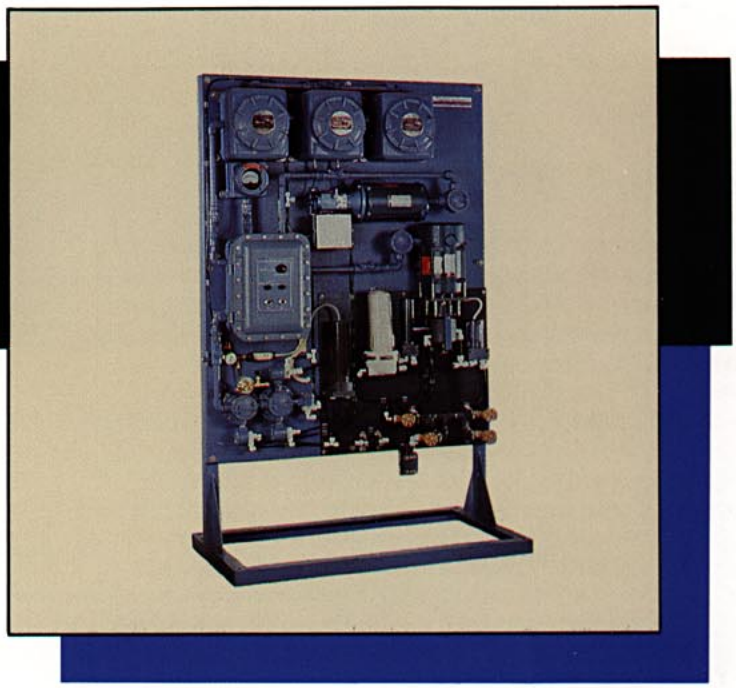
Model 660

Oil-in-Water Analyzer System



- **Rack or Cabinet Mounted**
- **General Purpose or Explosion-Proof**

The Model 660 Oil-in-Water analysis systems developed by Teledyne Brown Engineering utilize the ultraviolet absorption principle to detect and continuously measure oil concentration in water. Reproducibility of the on-line system exceeds standard laboratory techniques. Typical industrial applications include the monitoring of boiler return condensate, recycled cooling tower water, refinery and offshore drilling effluents, and on-shore deballasting discharges.

Teledyne's automated analysis system includes a single-beam dual-wavelength UV photometric analyzer that compensates for sediment, turbidity, algae, cell window coatings and other extraneous optical attenuation. A unique conditioning system delivers to the analyzer a sample which is representative of the true oil content of the stream. A continuous high-speed homogenizer disperses all suspended oil droplets and oil adsorbed onto foreign matter so that the sample, to the analyzer, appears to be uniform and in true solution.

Oil Detection and Analysis

The detection of oil by means of an ultraviolet analyzer is a practical application of Beer's Law. The law mathematically relates the concentration of oil to the amount of energy which the oil in the sample absorbs in a cell of fixed length.

The simplest and least expensive UV analyzer offered by some manufacturers for oil detection is the single wavelength photometer, i.e., a "go/no-go" instrument without a sample conditioning system. TBE, however feels that single wavelength analyzers lack the degree of instrumentation sophistication necessary to perform reliable oil detection monitoring. Among their drawbacks is the fact that attenuation of energy transmission by turbidity and cell window deposits cannot be distinguished from absorption due to oil. Secondly, without sample conditioning and automatic zeroing, these simple analyzers cannot produce a truly representative solution for analysis nor compensate for "background" absorption found in most oil-in-water applications. Moreover, go/no-go analyzers can be deceptive by indicating the presence of oil in non-oil solutions.

TBE's Dual Wavelength Analyzer

Recognizing the importance of eliminating the effects of turbidity and inherent electro-optical interferences, **TBE** has developed a single sample cell, chopped beam, dual-wavelength photometric analyzer unmatched in reliability and accuracy. This instrument utilizes optical filters to isolate and make energy measurements at two specific wavelength bands. The UV **measuring** band (centered at 254 nanometers) is extremely narrow to avoid sideband interferences which could cause erroneous results. A **reference** signal is generated at a selected wavelength region where oils do not absorb significantly. This reference signal is affected primarily by turbidity and electro-optical interferences. The measuring signal is affected by the aforementioned interferences **as well as by absorption due to the presence of oil.**

Since both the measuring and reference wavelengths are generated at the end of the transmission system, electro-optical interferences (cell window coating, variations in source lamp, ageing of detector and other electronics, etc.) affect each signal equally. The output signal is obtained by electronically generating the logarithm of the ratio of the measuring signal to the reference signal.

Thus, the output signal, linear with absorption because Beer's Law is an exponential function, shows little or no effect from turbidity. Additionally, electro-optical stability is enhanced by the dual wavelength design of the photometer. Factors associated with undissolved oil and background absorption are eliminated by sample conditioning incorporated into the analysis system (see Figure 1).

Sample Conditioning

The **TBE** system incorporates conditioning components that prepare the sample so that both undissolved and dissolved oils are detected and measured. A high-speed,

high-shear homogenizer mechanically disperses the oil droplets suspended in the sample to a minimum size so they can be measured by the analyzer (see Figure 2). Any oil absorbed onto particulate matter contained in the sample is also dispersed by the homogenizer. Since the response of particulate matter as a possible attenuator is automatically neutralized by the optical system and ratioed to zero by the electronics of the photometer, the characteristic absorption of the total oil can be measured. The output signal or meter readout is linearly proportional with total oil concentration. The system is calibrated accordingly, using representative samples.

Compensation for Background

Many applications require compensation for background absorption, i.e., non-oil compounds commonly present will be "read" as oil, leading to inaccurate measurements.

A large number of compounds other than oil, both organic and inorganic, also absorb UV energy. Some of these compounds, perhaps many, may be present in the sample. If so, their concentrations will likely fluctuate with time. Applications have been encountered where absorption due to the non-oil compounds exceeded by several times the absorption due to the normal quantity of oil present.

In order to obtain an analysis that is specific to oil, the background absorption contributed by these non-oil compounds must be "zeroed out" of the analysis, with periodic updating to account for fluctuations.

Automatic Zero Mode

TBE Models 660/661 oil-in-water systems offer a completely automatic zeroing feature, permitting a continuous analysis, specific for oil, without any interference. The zeroing mode is accomplished by the automatic preparation (filtering, sparging, storing) and periodic analysis of an oil-free fluid which still contains the compounds contributing to background absorption. When this fluid is analyzed, the background absorption is measured and then zeroed out. The cycle is automatically repeated once each hour to update the oil analysis by correcting for fluctuations in background.

The components contributing to total absorption in a typical water effluent sample are shown in Figure 3. With turbidity and electro-optical interferences removed by analyzer design, and non-oil background zeroed out, the homogenized dissolved/undissolved oil fraction can be detected and quantitatively measured.

Analytical accuracy of the Models 660/661 oil-in-water analysis systems is better than ±2% when the analyzer is calibrated with an oil identical to that being measured. Furthermore, the reproducibility of system analysis (better than ±1%) exceeds the normal reproducibility of any other laboratory or analytical method known. When calibrated in a range of 0-10 ppm, changes as little as 0.1 ppm are detected (1% sensitivity). Optional sample coolers facilitate the analysis of hot water samples.

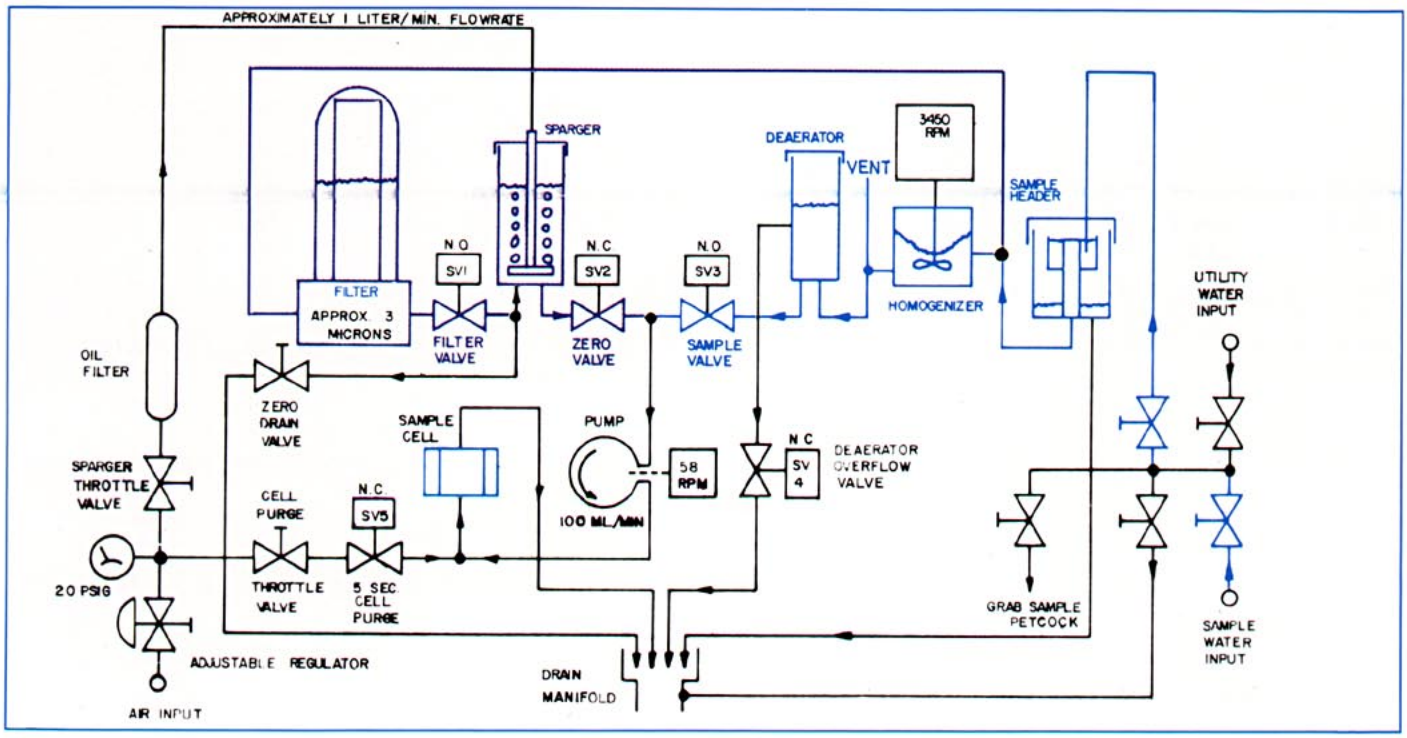


FIGURE 1 — Sample conditioning system

A sample is fed into both sides of the conditioning system. A high-speed, high-shear homogenizer disperses any oil in the sample including small and large oil droplets and oil absorbed into foreign particles. A portion of the stream is conditioned to remove all oil, both dissolved and undissolved, without altering the "background" (boiler additives or other inorganic or organic non-oil compounds). When this portion is delivered to the analyzer, the analyzer subtracts the background from the total and reads out total oil only. The analyzer is calibrated with a known standard on 2 one-time basis.

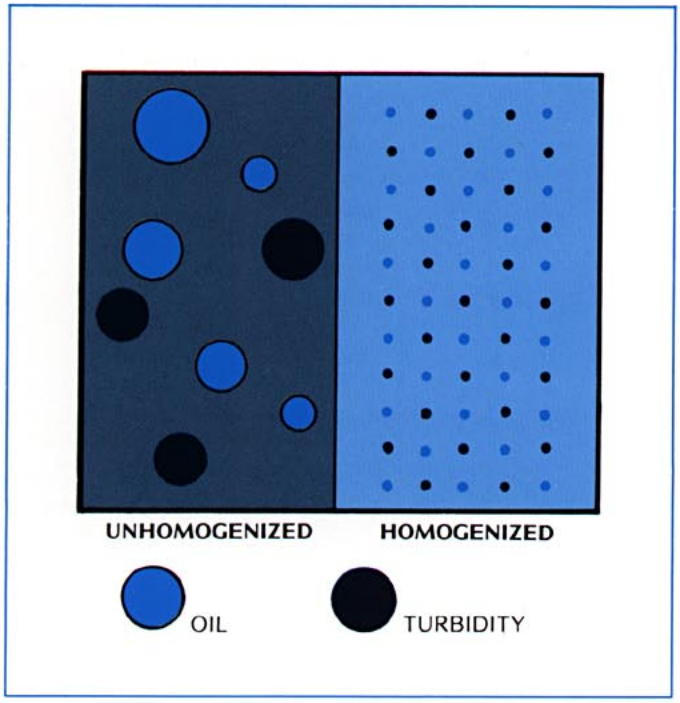


FIGURE 2 — Homogenizer function

The effect of homogenization on the sample is demonstrated pictorially. Both the particulate oil and the compounds representing turbidity are of random size. Homogenization causes the oil droplets to be dispersed to such a particle size that, to the analyzer, they appear to be in true solution. Oil adsorbed upon, or contained within the portion represented by turbidity is also placed into solutiuon along with the particulate oil. Turbidity has no characteristic absorption and is ratioed to zero by the analyzer.

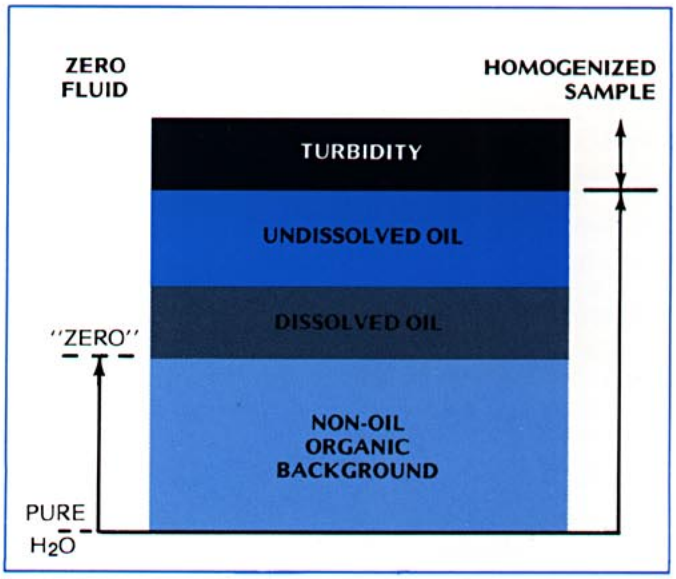


FIGURE 3 — Fractions contributing to total absorption in typical water effluent

The homogenized sample contains all components of the effluent stream. The UV analyzer will measure the stream fractions as non-oil organic background, dissolved oil and undissolved oil. Turbidity will be ratioed out and give no reading. The analyzer will measure the zero fluid as the non-oil organic fraction.

Turbidity and oil have been removed from the zero fluid by filtering and sparging. Filtering removes the undissolved oil. Sparging (bubbling air through a filtered sample) removes the lighter dissolved oils. During the zero cycle, the analyzer is automatically adjusted to read zero. The non-oil UV absorbing background is subtracted from the total UV reading.

Applications

Teledyne oil-in-water analysis systems are currently in use throughout the world. Systems have been furnished for all of the following applications.

- Pollution abatement programs involving effluent from refineries, chemical/petrochemical plants, oil fields, steel mills, automotive production, food processing and other industries
- Offshore drilling platforms
- Monitoring of airport runoff
- Boiler return condensate or process cooling water
- Process stream monitoring
- On-shore deballasting discharges and ballast treatment facilities
- Municipal water treatment plants
- Waste water and sewage treatment plants
- Oil field water flooding or steam injection operations

Features

- Specificity to oil
- Unsurpassed reliability and stability
- Ratio measurement
- Cancels out effects of dirt and other suspended solids
- Readout is linearly proportional to oil concentration
- Continuous measurement
- Electronic automatic zero
- Integral alarms
- Automatic cell cleanout
- Minimum maintenance required
- Automatic turbidity compensation
- High accuracy and reproducibility
- Analysis correlates with laboratory results

Models

661 R: Rack mounted, general purpose
661 C: Free-standing enclosure, general purpose
660 R: Rack mounted, explosion proof housings
660 C: Free-standing enclosure, explosion proof housings

*Specifications/Features: vary with application; are established and validated during design; are not to be construed as test criteria for every product manufactured; and subject to change without notice.

Specifications *

Ranges:
0-10 ppm to 0-200 ppm oil no-water

Noise:
Less than 1% of full scale

Zero Drift and Diurnal:
Corrected by automatic zero

Accuracy:
Dependent upon variability of oil composition; ± 2% of full scale when calibrated against same oil as being analyzed

Reproducibility:
± 1% of full scale

Linearity:
± 1% or better (A few rare oils have non-linear characteristics.)

Power Requirements:
Standard: 115 VAC, 50/60 Hz, approx. 1 KW (other voltages available, i.e., 230 VAC, etc. specify requirement)

Sample Temperature:
32°F to 140°F (0°C to 60°C), normal (higher temperatures with integral sample cooler)

Elec. Classification:
Models 661R, 661C — general purpose
Models 660R, 660C — explosion-proof

Ambient Temperature:
Models 661R, 660R — 32°F to + 122°F (0° to 50°C)
Models 661C, 660C — may be heated or cooled, as required, to operate in other temperature ranges

Output Signal:
Linear. Customer specified mVDC standard. Current or voltage output signal available

Alarms:
Single or double relays available

Readout:
Local meter

Shipping Weight: (approx.)

Model Number	Pounds (lb)	Kilograms (kg)
661R	400	182
661C	770	350
660R	500	227
660C	970	441

Overall Dimensions: (approx.)

661R, 660R	Height: 70″ (1778 mm) Width: 44″ (1118 mm) Depth: 26″ (660 mm)
661C, 660C	Height: 72″ (1828 mm) Width: 48″ (1219 mm) Depth: 16″ (406 mm)

TELEDYNE BROWN ENGINEERING
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