GUIDANT

BS&W Primer and Troubleshooting Techniques

Description

The Invalco BS&W monitor is an electronic instrument designed to measure, display, and transmit the amount of water in an oil stream. A monitoring installation consists of electronic readout unit(s) and a sensing device called a probe.

The reliability of the electronic components meet industry standards and most problems experienced are probe related. However, because the probe is a relatively simple device, by knowing how it functions, the reasons for trouble are easy to understand. This primer will help you on new applications as well as troubleshoot problems with existing installations.

Theory

The probe is an electrical capacitor plain and simple. A capacitor is, by definition, two conductors separated by an insulator. In our probe design, the outer pipe is one conductor and the inner element is the other conductor. The oil flowing through the probe is the insulator.

A capacitor's value is measured in farads, named after Michael Faraday (1791-1867), who did much of the early work on capacitor theory. The value of the capacitance measured by our probe is in much smaller units called pico-farads.

The value of a capacitor is determined by three things:

- The size/area of the conductors.
- The distance between the conductors.
- The dielectric constant (D_k) of the insulator between the conductors.

Dielectric constant is the name given to a particular electrical quality of an insulator that will determine the actual value of the capacitor. Dielectric constants typically vary widely from one material to the next, specifically shown in the following chart:

Air/Gas	1 (actually, a vacuum is 1)
Oils	2±
Water	80

We will now do some simple math so as to show how changes in the D_k will cause the electrical value of the probe to change...but, in order for that to have any meaning, you must first be aware that the monitor interprets any change (in the probes value) of 4.25pF as a 1% change in water content. A D_k change of only .063 will produce the 4.25pF change. The following formula will help you understand what changes occur during the operation of the probe and monitor.

$$C_t = C_a \times D_k$$

Where:

C_t = Total capacitance value.

C_a = Probe base capacitance value in air (empty).

D_k = Dielectric constant of the material in the probe.

The value of C_a is determined by the size of the conductors and the distance between them. The base value of all Invalco probes is 67.5pF.

Let's see what happens when the D_k changes:

Example:

You have an oil with a D_k of 2. What is the capacitance value of the probe when full?

$$C_t = C_a \times D_k$$
$$= 67.5 \times 2$$
$$= 135\text{pF}$$

Now let's assume that the water percentage goes up, or, the treating chemical increases, or, you get some lower API gravity oil mixing with your normal flow. Any of these

circumstances will cause the D_k of the oil to increase. For comparison purposes, we will show that the D_k went up to 2.1. So with this new value, we recalculate the formula with 2.1 instead of 2:

C_t = 67.5 x 2.1
= 141.75pF

The total probe capacitance value increased because the D_k increased.

141.75pF new value
135.00pF old value
6.75pF is the difference

Now since 4.25pF will cause a reading difference of 1%, 6.75 divided by 4.25 equates to 1.59% indicated water increase.

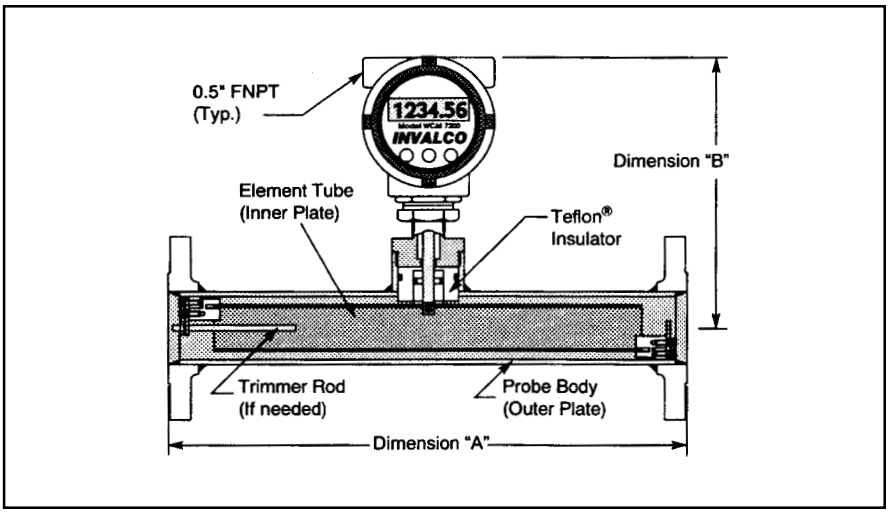
What does this tell us? We have shown that if anything caused the Dk of the oil to increase, the output of the monitor will increase. Normally this is caused by an increase in percent water, but as noted this can also be caused by other factors.

Troubleshooting

As noted above, there are factors other than percent water changes, which will cause the readings of a BS&W monitor to vary. By understanding what causes variations, it will be easier to troubleshoot problems when encountered.

1. An increase in the amount of lower gravity crude in a stream of mixed crudes will cause the monitor readings to increase. This is because the D_k of oils vary inversely with the API gravity. As the gravity goes down, the D_k will go up, indicating more water. If the gravity goes up, the D_k goes down.

Interestingly, the amount of change is not constant with relationship to the gravity deviation due to differences in the crude components. Increases in monitor readings of .1% to .3% per degree of API gravity are not uncommon.



Approach pipelines and receiving terminals with caution and understand that when the oil type ordensity changes, the monitor may need to be recalibrated or the accuracy of the installation may need to be de-rated.

2. An increase in the amount of gas in the oil will cause readings to decrease. This is because the D_k of the gas is close to 1 which is less than that of oil.

Make sure that back pressure is maintained well above the vapor pressure of the fluid.

It is recommended that the probe be installed vertically. Horizontal lines may have water on the bottom of the line, or not be completely full. Either of these will adversely affect the accuracy of the monitor readings.

3. An increase in the amount of chemical in the oil will usually cause the readings to increase. Changing chemicals will often require recalibration of the monitor.

Note that should the chemical plate out on the inside of the flow line, it will also plate out on the inside of the probe, including the teflon insulator. This will cause the readings to drift over time, which could lead to a significant error. Should this happen, the probe must be pulled and cleaned with a solvent. The frequency of cleaning is dependent on the site conditions. Sometimes the insulators will be contaminated so badly they will have to be replaced.

4. A decrease in oil temperature will cause monitor readings to go up. Conversely, an increase in temperature will cause the readings to decrease. Normally, a temperature fluctuation of 10°F in a mid-30° API oil will cause a 0.1% change in monitor readings.

5. Paraffin tends to hold water. Should enough paraffin be present such that it accumulates on the inside of the probe, the probe will "see" the paraffin as water and tend to drift upwards with no apparent increase in centrifuge verification readings.

As with chemical plating above, the probe must be removed and cleaned with solvent or arrangements must be made to circulate heated oil through the probe periodically to prevent buildup.■