Thermal Flow Switches For Water Treatment In Oil Refineries

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Reliable monitoring and treatment of water in oil refineries is essential for the production of petroleum-based products, including gasoline, diesel, kerosene, heating oil, and byproducts for plastics and a variety of lubricants (Figure 1). There are three process areas within refineries that require large amounts of water: cooling units, desalter units and wastewater treatment.

Figure 1. Typical Oil Refinery Operation

Cooling Units

An important refinery process that uses water involves the removal of heat from machinery and heated process material. This equipment and material produces a tremendous amount of heat that must be reduced with heat exchangers and cooling towers. The cooling towers are evaporative units that are used for cooling the circulating water throughout the plant. All the cooling water running through these processes results in wastewater that must be treated to avoid environmental damage.

Desalter Units

Hydrocarbon liquids such as Benzene, Toluene and Xylene contain salts and aromatics. The salts in the hydrocarbon liquids are corrosive and foul process equipment, which means they must be removed early in the process. In order to remove the salts and aromatics, a hot water flush is applied to the hydrocarbon liquids in a refinery desalter unit. This process generates wastewater with volatile organic carbons (VOC's).

Water Treatment

The water used in the cooling units, the desalter units, and other water from throughout the plant creates a large amount of wastewater with VOC's that must be treated before it is recycled or discharged. There are many different types and choices of systems, chemicals, filters, membranes, screens, etc., that can be used in refinery wastewater treatment. They all, however, have one thing in common: liquid flow switches are necessary to monitor and control the flow of water and chemical additives throughout the wastewater treatment system.

Liquid Flow Monitoring

Flow switches are used at multiple points in water applications that range from pump protection to valve leak detection. In selecting a flow switch for refinery water applications, the first step is choosing the appropriate flow switch technology.

There are numerous flow switch sensing technologies available from multiple manufacturers. They all have their advantages and disadvantages, including the required accuracy, reliability, process media (clean liquids, dirty liquids, slurries) and your application's flow rate requirements.

Thermal Flow Technology

Thermal flow switches, for example, are a popular choice in refinery water applications because they offer exceptional reliability with no moving parts and a mean time between failure (MTBF) rating of 190 years. The typical thermal flow switch sensing element contains two thermowell-protected platinum resistance temperature detectors *(Figure 2)*. One RTD is heated and the other RTD senses the process temperature. The temperature difference between the two RTD's is related to the process flow, level or interface medium. Higher flow rates or denser media cause increased cooling of the heated RTD and a reduction in the RTD temperature difference. In addition to measuring flow rate, thermal type switches also can measure temperature and level.

Thermal dispersion technology provides a flow switching solution that is accurate, highly responsive to changing flow conditions, easy to install and virtually maintenance-free, which results in a low lifecycle cost over a long instrument life. It features a no-moving parts design with no parts to break and no orifices to plug or foul.

Beyond flow switch reliability, there are several other factors to consider:

- Accuracy and repeatability
- Plant and process environment
- Installation and maintenance

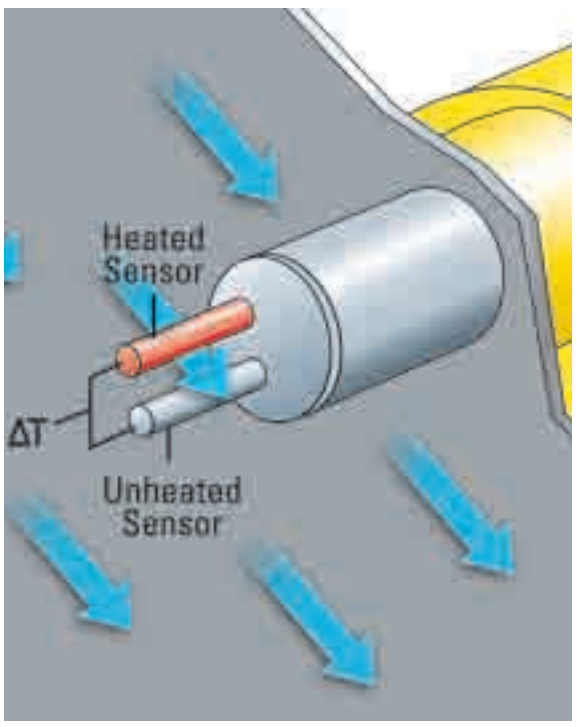

Figure 2. Thermal Dispersion Theory of Operation

Accuracy and Repeatability

You'll need to know the accuracy, repeatability and flow range of the flow switch that you plan to use. For example a typical thermal flow switch, such as FCI's Flow/Level/Temperature FLT93 Switch operates over a liquid flow range from 0.01 to 3.0 FPS (0.003 to 0.9 MPS), with accuracy of +2.0 percent of the set-point velocity over a +50°F (+28°C) temperature range and repeatability of +0.5 percent of reading *(Figure 3)*. FCI also has an optional high velocity liquid flow switch to 10.0 FPS (3 MPS).

The FLT flow switch is a dual-function instrument that indicates both flow and temperature, and/or level sensing in a single device. It can be specified in either insertion or in-line styles for pipe or tube installation. With the FLT, a single switch monitors both key variables necessary to protect pumps, measuring liquid flow and temperature simultaneously with excellent accuracy and reliability. Dual 6A relay outputs are standard and are assignable to flow, level or temperature.

Figure 3. FCI Thermal Flow Switch

Temperature Compensation

Thermal flow switches are precision temperature compensated to ensure the accuracy of factory pre-set and field set alarms when installed in dynamic process applications, such as those found in oil/gas refineries. The addition of temperature compensation circuitry helps prevent false alarms or alarm failure, maximises operator and process safety, and provides an option to set alarms within a narrow set-point range. The flow curves provided in Figure 4 illustrate how temperature compensated flow switches will not experience signal drift during temperature changes caused by changing process conditions or seasonal environmental swings in temperature. This prevents false alarms due to signal drift as shown with the red arrow in *Figure 4*.

Plant and Process Environment

By considering your plant's environmental factors, such as climate, process temperatures, humidity levels, process pressure, etc., you'll find that some flow monitoring technologies are better in extreme environments. Look for a flow switch with a metal enclosure that is NEMA/IP rated for rugged outdoor applications. Thermal flow switches, for example, are rated NEMA4X and EExd.

Installation and Maintenance

Some flow switches are easier to install. Ask if the flow switch can be inserted directly into the process pipe (larger diameter pipes above 1.5 inches) or if it requires an inline configuration (smaller diameter pipes 1 inch and below) that will require you to cut and splice your pipes in multiple places. The thermal flow switch is inserted (or with spool piece for smaller line sizes) into the line using a threaded or flanged process connection. Check the maintenance schedules too: they will differ depending on the flow technology.

Calibration

Flow switches must be calibrated and tested for accuracy and repeatability. Depending on the manufacturer, the calibration process may be limited to water or air and then rely on un-validated theoretical equivalencies for other fluids. The use of 'equivalencies' may result in calibration errors that can be detrimental to measurement accuracy after flow switch installation in your process. It also can be important to be sure that the flow switch is calibrated under the actual temperature and other process conditions of your application. FCI, for example, maintains its own Calibration Laboratory with NIST traceable equipment that meets stringent global standards.

Conclusion

When you're upgrading or expanding systems that require water in a refinery, petrochemical plant, or any industrial plant, think ahead about the type of flow switches that you'll need. Consider the switch's reliability, accuracy, installation and maintenance requirements, and service life when analysing switch total lifecycle costs to determine the lowest cost of ownership.

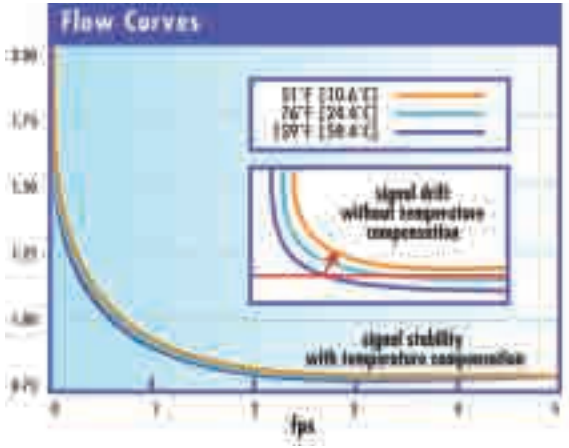

Figure 4. Temperature Compensation Flow Curves