# Technical Publication

# Flow Switches For Refinery Water / Wastewater Control

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**To ensure quality production of petroleum-based products in oil refineries, including gasoline, diesel, kerosene, heating oil, and byproducts for plastics and a variety of lubricants, operators must establish reliable water monitoring and treatment. There are three refinery process areas that require large amounts of water: cooling water units, desalter units and wastewater treatment plants.**

## Cooling Water

Water is a key process in the refinery because the water is used for the removal of heat from machinery and heated process material. Several processes require cooling water, including the crude distillation columns where the crude is heated and vaporized into a fuel. The fuel fractions are separated by condensing in distillation columns with air cooled exchangers and cooling water heat exchangers. The cooling water from the distillation columns typically is recirculated through a cooling tower. The cooling tower is a process whereby the warm returning water is cooled in evaporative units. The cooling water needs to be treated to prevent build-up of dissolved solids in the system. The cooling tower water is periodically removed through a blowdown event. The blowdown effluent is sent to the wastewater treatment in refineries via a sewer.

## Desalter Units

Crude oil contains inorganic salts which are predominately sodium chloride. The salts in the hydrocarbon liquids are corrosive and foul process equipment, which means they must be removed early in the process. Typically the first operation in a refinery crude oil unit is desalting, in which a hot wash water flush is applied to the crude oil and hydrocarbon liquids. This is an important process because it removes the corrosive effects from the chloride salts. It also prevents plugging and fouling of process equipment downstream. Accumulation of drilling muds mixed in with the crude oil accumulate over time and need to be removed. The removal process includes intermittently increasing the wash water flow to the mud washing nozzles that are located at the bottom of the desalter unit. This cleaning operation further increases the effluent discharges and volatile organic carbons (VOCs). The hot wash water flush in the desalter units creates large amounts of effluent with VOCs that must be treated before it is either recycled or discharged.

## Water Treatment

Water used in cooling units, desalter units, and other water from multiple plant processes results in a large amount of wastewater with VOCs 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. Most refinery wastewater treatment plants utilize primary and secondary oil/water separation followed by biological treatment in aeration basins and digester tanks. They all, however, have one thing in common: liquid flow switches are necessary to monitor and control the flow of water in the wastewater treatment system.

## Liquid Flow Monitoring

Flow switches are commonly used at multiple points in these types of water applications. The flow switch provides pump protection by detecting a no flow condition of the water in the process which prevents damage to the pump, before the line is pumped dry. The flow switch is a low cost and reliable way of protecting a pump.

In the primary process of the wastewater treatment, the desalter water and sour water enters a separation tank to separate the oil and water. The flow switch can monitor the tank drain valves for flow/no flow detection and confirmation.

Valves, not only in tank drain but throughout the plant, can be monitored with flow switches for process leak detection. Detecting a valve leak can save costly process inefficiencies. The monitoring of cooling water throughout the plant enhances plant efficiency while protecting process control equipment.

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In selecting a flow switch for refinery water applications, the first step is choosing the appropriate flow switch technology. Operators can choose from numerous flow switch sensing technologies available from multiple manufacturers. They all have their advantages and disadvantages. Selection is based on required reliability, process fluid type, temperature, pressure, and desired output alarm velocity setpoint.

As an example, thermal flow switches are frequently specified in refinery water applications because they offer exceptional reliability. Thermal flow switches have no moving parts and a mean time between failure (MTBF) rating of 190 years. Beyond flow switch reliability, there are several other factors to consider:

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

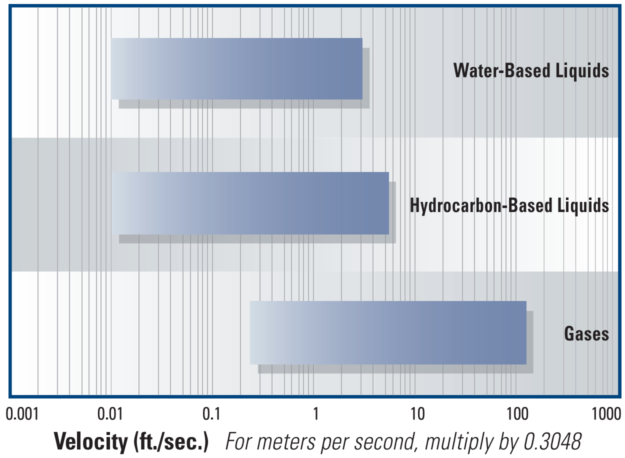


*Figure 1. FCI Thermal Flow Switch Flow Ranges*

## Accuracy and Repeatability

You'll want to determine the accuracy, repeatability and flow range of the flow switch that you choose for your application. For example a typical thermal flow switch, such as FCI's Flow/Level/Temperature FLT93 Switch operates over a liquid flow range from 0.003 MPS to 0.9 MPS [0.01 FPS to 3.0 FPS], with accuracy of + 2.0 percent of the set-point velocity over a + 28 °C [+ 50 °F] temperature range and repeatability of + 0.5 percent of reading (*Figure 1*). FCI also has an optional high velocity liquid flow switch to 3 MPS [10.0 FPS].

## Precise Performance Accuracy

Based on FCI's long term thermal dispersion experience, the unique sensor technology of the FLT93 Series switches, combined with FlexSwitch temperature compensation circuitry, provide performance capabilities such as:

- Exclusive flow accuracy as precise as ± 2% of the setpoint velocity over a ± 28 °C [± 50 °F] temperature range; repeatability of ± 0.5% reading
- Level resolution of ± 2.5 mm [± 0.1 inch]; repeatability of ± 1.3 mm [± 0.05 inch]
- Standard temperature accuracy ± 1 °C [± 2.0 °F]; repeatability ± 0.6 °C [± 1.0 °F]; improved temperature accuracy is available with factory calibration

## Integrated Technologies / Advanced Circuitry

For the switch you're researching, determine its features that impact safety, and ease of use in the field. For example, FCI's fail-safe, dual alarm (SPDT) control circuit provides the user with the security of knowing the instrument will indicate when a component fails on the switch.

The FlexSwitch control circuit also provides the exclusive advantage of one switch that offers the following field-selectable features.

- Dual, independent SPDT relays for these alarm combinations:
  - Flow rate and temperature
  - High flow and low flow
  - Point level and temperature
  - Flow rate and low liquid level
  - Three-phase level interface
  - Fail-safe flow, level, or temperature
- One DPDT relay for single alarm of flow rate, liquid level or temperature is optionally selectable

## Accuracy and Temperature Compensation

Another factor to research when making a purchase is how the instrument manages temperature fluctuations and accuracy. The FLT93 Series switches are "precision temperature compensated" to insure the accuracy of factory and field set alarms when installed in dynamic process applications. Accuracy combined with temperature compensation results in:

- Preventing false alarms or alarm failure
- Maximizing operator and process safety
- Having the option to set alarms within a narrow set point range
- Eliminates having to reset alarm points with seasonal or process temperature changes

The following graphs illustrate how "temperature compensated" flow switches will not experience signal drift during temperature changes. Whereas a "non-temperature compensated" flow switch experiences signal drift (as indicated by the red arrow) causing alarm failure. (*Figures 2 and 3*)

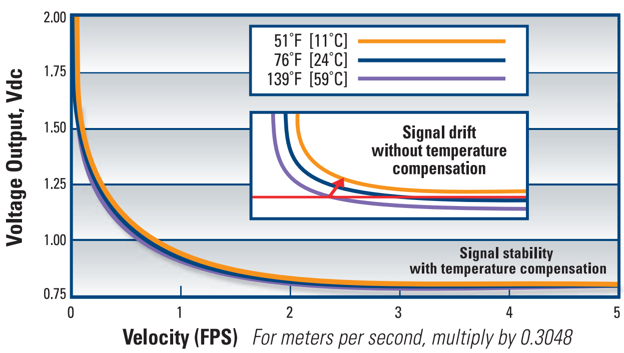


*Figure 2. Temperature Compensated Flow Curves*

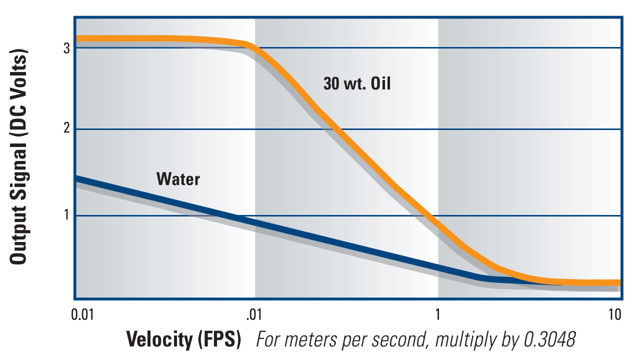


*Figure 3. Typical Liquid Flow Curves*

## 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 designed specifically for ease of installation. Ask if the flow switch can be inserted directly into the process pipe (larger diameter pipes above 3/4 inches) or if it requires an in-line 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.

## Conclusion

When you're upgrading or expanding systems that require water in a refinery plant, determine the type of flow switch technology that will perform best in your application. Consider the flow switch's reliability, accuracy, installation and maintenance requirements, and service life when analyzing switch instrumentation's total lifecycle costs. That way you'll be able to determine the lowest total cost of ownership, and the best value for your money. ■

*Caption*