Technical Publication

Reliable Thermal Switch Ensures Safe Operation of Loading Arms at Marine Terminal To Prevent Spills

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A leading European-based marine terminal operator with locations on every major continent is responsible for the managing, handling, storing and distribution of large quantities of oil and gas, as well as refined petrochemicals, which serve industries and consumers around the globe. The company's thousands of employees are highly trained and are focused on the safe, reliable and efficient storage of large quantities of bulk products at each of its locations.

Much of the world's oil/gas production is produced offshore and/or transported over the ocean to marine storage terminals prior to refining or stored as refined product prior to industrial distribution. Marine terminals are complex hives of activity as bulk fuels or refined petrochemical products are loaded or unloaded from ships and then stored in massive, dense tank complexes prior to pipeline or other modes of delivery to the eventual end-users.

For this reason, safety is always the primary concern at marine terminals because these bulk fuels and refined petrochemicals can be highly combustible and flammable (and toxic too) and spills have major environmental effects. Transferring them from ship to shore or vice versa requires highly specialized equipment and trained operators. As the fluids are moved from tanker ships into the terminal and to storage tank areas, two of the major concerns are always loading/unloading spills and tank overfills.

When these incidents occur, there is a high potential for explosions and fires that can quickly engulf the rest of the terminal. The results can be catastrophic if the equipment isn't used properly and if precautions are not taken to ensure safe, efficient operations. In addition, cargo ships and marine facilities have been tasked by governments and other regulatory bodies around the world with significantly reducing marine pollution — especially because spills of petroleum products are so harmful to sea life, birds and shore animals.

The Problem

Large loading arms *(Figure 1)* connect shore installations to vessels delivering or transporting petrochemical products that include crude oil, diesel, petrol, bitumen products and many different types of specialized chemicals. These loading arms are highly engineered pieces of equipment that in marine environments must adjust themselves to the constant motion of tankers responding to windy weather and the ocean tide patterns.

Figure 1: Oil product tanker loading from shore terminal

These loading arms have flexible joints allowing them to connect the shore installations to the various sizes of vessel so the fluid or gas product can either be pumped in or out of these vessels. They have to reach across relatively long distances and they have counter weights installed to balance the weight of the product being pumped.

In their rest position the arms often catch a lot of high winds and become easily unbalanced if the point of gravity is not at the bottom where the counter weight is located. For this reason, it is absolutely vital that these arms are totally empty when retracted into their folded rest position. To allow the arms to fold properly, any remaining residual product fluid leftover in the arms after finishing the loading or unloading process must then be returned to a slob tank.

Making sure the arm is entirely empty after loading/unloading requires the operators to keep the pump running somewhat longer to transport the remaining fluid into the slob tank. There is, however, another second potential spill process hazard if the connection from the arm to slob tank is not entirely open. If the arm is in a partially closed state, this prevents the arm from fully draining and so product stays behind in the loading arm.

When the arm is not fully drained, incidents have occurred in stormy high wind conditions when the loading arms have actually tipped over because of the weight of the product left in the arm. Such incidents create potentially hazardous consequences in terminal operations because of the highly combustible nature of petrochemical products and could endanger workers, damage vessels or affect other onshore terminal equipment.

The Solution

The marine terminal's operating team, which wanted to prevent this type of loading arm accident, contacted the applications team at Fluid Components International (FCI) to discuss ways to improve operational safety. The FCI applications group listened to the terminal team's concerns and recognized that its thermal flow sensing technology and flow switch expertise could be of value in solving the problem.

After the discussions, FCI recommended installing its FLT flow switch *(Figure 2)* at the bottom of the loading arm to solve the problem. Now when the terminal operator leaves the pump running to drain any excess fluid back into the slob tank, the FLT switch confirms the flow has stopped and the loading arm is empty. The FLT switch is set so that Alarm 1 detects when the loading arm is empty, generating a relay contact closure signal indicating a "green" safe status and showing that the loading arm is ready-to-retract on the screen of the operator's distributed control system.

In addition to solving the initial problem, the dual-alarm FLT switch's Alarm 2 is also now set to detect when fluid is flowing through the loading arm in both directions: The switch indicates when when fluid is flowing for either loading or unloading vessels, making maximal use of the switch to ensure safe operation of the loading arm under all operating conditions.

In another marine terminal application of the FLT switch, it is helping the terminal supervisors determine that its workers have opened the correct valve and/or turned on the correct pump to send the correct fluid to the intended tank or vessel during unloading/loading operations. Sending the wrong fluid to the wrong location can cause a number of problems including overfills and spills, as well as cross-contaminating products.

Figure 2: FCI FLT93F and FLT93S flow switch

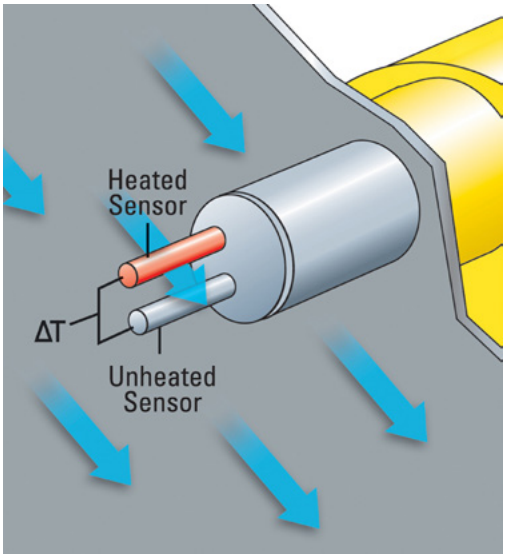

Figure 3: Thermal dispersion technology

Flow Switch Technology

FLT switches from FCI feature advanced thermal dispersion sensing technology in which the temperature difference is greatest in a no-flow condition and decreases as flow increases, cooling the flow sensor's heated resistance temperature detector (RTD). Changes in flow velocity directly affect the extent to which heat dissipates and, in turn, the magnitude of the temperature difference between the RTDs *(Figure 3)*.

An electronic control circuit converts the RTD temperature difference into a conditioned DC voltage signal. These signals are used to drive adjustable set point alarm circuits and outputs. Depending on the switch configuration, alarms are field configurable for flow, temperature, high or low, hysteresis, time delay and more.

FCI has designed a broad range of flow switch sensors to meet a wide variety of fluid, gas, accuracy and application requirements. These versatile flow switches are rugged, reliable and dependable to ensure continuous operation and the longest service life in industrial applications. An extensive selection of flow element materials, process connections and enclosures assure dependability, easy installation, low maintenance and long life.

The terminal operations team appreciated the fact that the flow switch sensor is free of any moving parts and is robust enough for heavy industry applications and demanding plant environments such as those conditions where the loading arms are in operation. The flow sensor is designed with all-welded construction using 316L stainless steel or other materials such as Hastelloy C, Monel or titanium where corrosion is a concern.

This FLT switch's sensing and switching capability is achieved by combining a precision, all-welded sensing element with an advanced, user-friendly control circuit. Two standard sensing element configurations are available: The "S" element was chosen by the terminal operations team and is designed for use in standard heavy industrial applications and in applications with high velocity liquid setpoint requirements. The switch's "F" element configuration is designed for fast response gas applications.

Flow accuracy is as precise as ± 2% of the setpoint velocity over a ± 28 °C [± 50 °F] temperature range; repeatability is ± 0.5% reading. Both sensing elements can be supplied in either standard (-40 °F to 350 °F [-40 °C to 177 °C]) or medium (-100 °F to 500 °F [-73 °C to 260 °C]) temperature configurations. The "S" element is also available in an optional high temperature (-100 °F to 850 °F [-73 °C to 454 °C]) configuration.

The FLT switch's standard electronics package is integrally mounted in an IP67 rated enclosure, either epoxy coated Aluminum or for close-to-shore installations in an all stainless steel enclosure, which was chosen by the terminal's operations team. Remote mounting of the electronics up to 150 meters away is available to meet safety requirements.

The operations team at the terminal found the switch was easy to set by utilizing the available analog output signals. Technicians can easily view the status of the switch via its built-in display and do routine checks without removing the switch from the loading arm, switching to simulation mode and reading voltage settings is all they need to do.

A choice of process connections is available: NPT, BSP or ANSI and DIN flanged or even a retractable version is available for hot tap requirements. While the switch relies on an insertion configuration type of sensor, its outer diameter is only a maximum of only 22 mm and the resulting pressure drop is less than 1 milliBar — so there is no loss of pumping energy or risk of blockages because of the sensor.

The FLT switch is certified as SIL 2 compliant. It is also available with multiple hazardous area approvals, including: FM, CSA, IEcEx, ATEX and GOST. The terminal's operation team recognized the importance of the certified SIL 2 compliance and that the multiple safety approvals supported its overall regulatory compliance requirements.

Conclusions

The FLT switch has been successfully installed and operating without incident in the terminal operator's loading arms for more than a year. In addition, the terminal operator has installed additional switches in its process due to the excellent performance of the switches in the loading arms application. ■