SAFETY OF SHIPBOARD DIESEL-LNG DUAL-FUEL ENGINES RELIES ON VENTILATION FLOW ASSURANCE SWITCH

The maritime industry's worldwide role in the release of the greenhouse gases (GHGs) that cause global warming has been estimated as equivalent to the levels of an industrialised nation. For this reason, global organisations including the United Nations (UN), the European Union (EU) and the International Maritime Organisation (IMO) are now working hard on the problem.

GHGs emitted by diesel powered ships (Fig. 1), the electric energy required to run port facilities and the land-based fossil fuel vehicles that service them all contribute to the marine industry's carbon footprint. GHGs also have been identified as a major contributor to the acidification of the world's oceans, which is harming sea life, contributing to species extinction rates and threatening an important global food source.

The IMO, for example, has adopted mandatory measures to reduce emissions of greenhouse gases from international shipping. It has set a series of baseline levels for the amount of fuel each type of ship burns for a certain cargo capacity. By 2025, for example, all new ships built will be 30 percent more energy efficient than those built in 2014. Longer term goals are even more ambitious with the desire stated to eliminate the issue in the future.

The Problem

In response to these and other emerging global standards and regulations, some ship builders and operators are now converting their fleets to more green-friendly dual-fuel engines. These new dual-fuel engines run heavier-duty diesel fuel at sea where engine power is a must and then changeover to less polluting LNG fuel while in port to provide electrical service and other functions. The result is a reduction in GHG emissions.

LNG, while a lower polluting fuel than diesel, can be highly combustible under the right conditions and poses a safety hazard to crew, other nearby ships and port personnel. For this reason, engine ventilation systems are critical. Failing to sense the lack of ventilation air and issue a warning alarm could be disastrous and result in an explosion and/or fire aboard the ship, endangering the lives of the crew and causing extensive, costly physical damages.

The challenge for ship designers and builders alike is to find a highly sensitive air flow sensor capable of detecting very low air flows, alarming when air flow is disrupted and warning the ship's crew of the danger. The design and construction of the air flow sensor must be reliable and rugged enough to withstand marine shipboard environments while meeting HazEx agency approvals for installation in potentially explosive LNG environments.

Fig 1. Cargo Ship at Sea (Photo)

The Solution

The system design engineers at a leading global manufacturer of dual-fuel marine engines recently contacted Fluid Components International (FCI) regarding their need to assure ventilation air flow for safety purposes in a dual-fuel engine system. The manufacturer relies on a double-wall pipe ventilation system to prevent ignition of LNG in the event of a leak.

The manufacturer's system design requires the ship operators to be signaled if the vent's flow is in any way restricted or disrupted. The challenge was to find a highly sensitive flow sensor capable of detecting very low flows with a continuously reliable and rugged design to withstand marine/shipboard applications and with agency approvals for installation in a potentially explosive gas environment.

The manufacturer's design team provided the applications team at FCI with the following specification requirements:

- Pipe Diameter: 2-inch SCH40, or double wall pipe, 4 -inch SCH80 or 6-inch SCH80
- Media Type: air with flow range: 0.3 ft/sec to 120 ft/sec (0,1 m/sec to 37 m/sec)
- Flow Alarm Level/Trip Point: Primary set at ≤ 1 ft/sec (≤ 0,3 m/sec) to signal critical low flow condition; an optional second

Fig 2. FLT93 Flow Switch (Photo)

alarm set at 6.6 ft/sec (2 m/sec) to warn of decreasing flow condition

• Relay Status: Normally energised when flow above trip point

After studying these requirements, the FCI application team recommended the company's versatile thermal FLT93 Switch (Fig. 2). It is designed with a fail-safe, dual alarm (SPDT) control circuit and provides multiple field-selectable parameters such as monitoring flow rate and temperature, or high flow and low flow, or point level and temperature, or flow rate and low liquid level, or three-phase level interface, or fail-safe flow, level, or temperature

The FLT93 Switch met all the manufacturer's requirements: It detects very low air flows from 0.3 to 120 ft/sec (0,1 to 37 m/sec) when installed on the 2-inch (Schedule 40) piping or double wall 4- or 6-inch (Schedule 80) piping typically required in this application. For example, the primary flow alarm level trip point was set at 1 ft/sec (0,3 m/sec) to signal low flow conditions. The optional second alarm was set at 6.6 ft/sec (2m/sec) to warn of decreasing air flow.

Either a single FLT93 Switch, or if the design requires redundancy, a second FLT93 Switch can be inserted into a spool piece pipe section for integration into the engine fuel system. This switch met the engine fuel requirements for low flow sensitivity, provides dual-relays for both the low and no flow alarm trip points, carries global agency approvals for Div 1/Zone 1 use in hazardous areas.

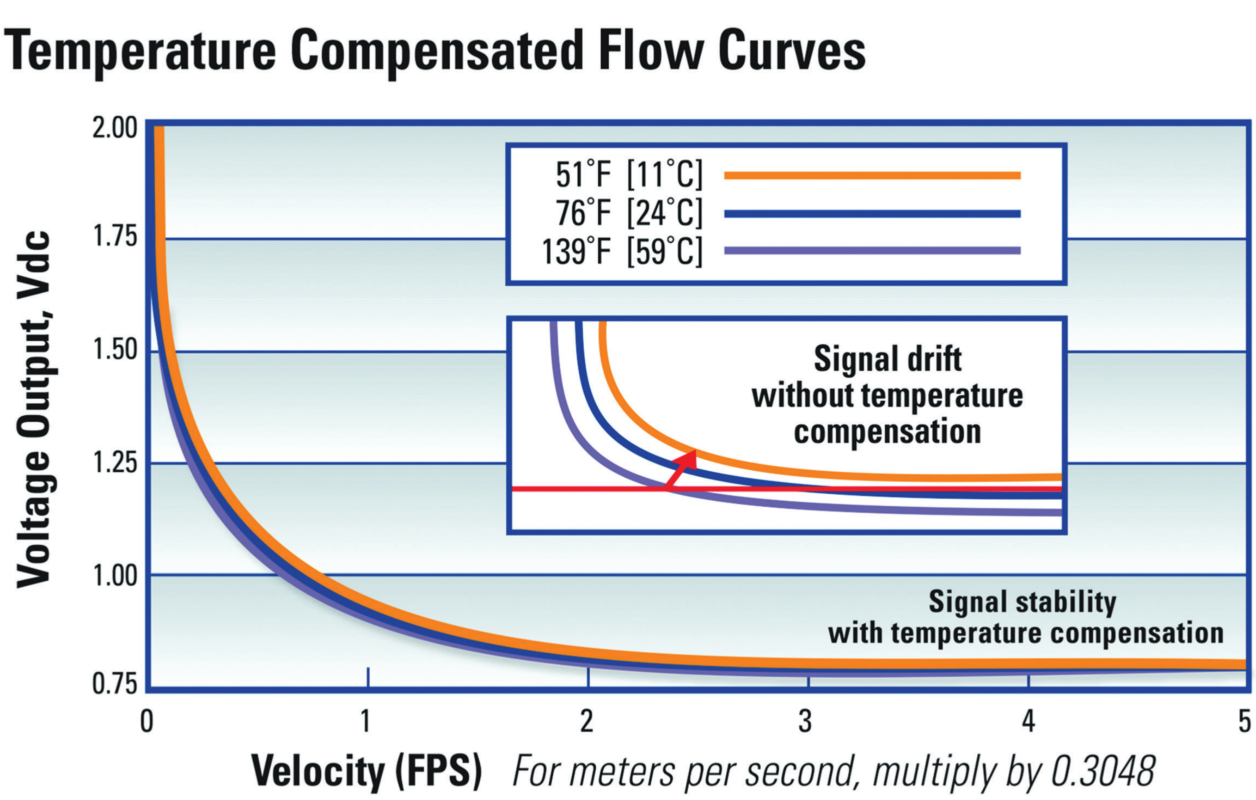

Fig 3. Temperature Compensated Flow Accuracy (Graph)

The highly reliable FLT93 Switch has a 180-year mean time between failure (MBTF) rating. An optional stainless steel enclosure provides superior corrosion resistance in marine environments. .It is also rated as a SIL-2 device for safety instrumented systems (SIS). It was independently evaluated by industry expert exida for compliance. FCI is committed to safety in the hazardous industries and complying with IEC 61508 and 61511.

The design team appreciated the simplicity of the switch's installation into the piping spool piece through a threaded tap in the pipe. The FLT93's hazardous area approval ratings also helped the manufacturer save on wire and installation costs. With its robust no-moving parts flow circuit design and the ultra-rugged enclosure, the switch offers long, worry-free service. Its no-moving parts design also eliminates the expense of routine maintenance checks.

The rugged FLT93 Switch is hydrostatically proof pressure tested to 3500 psig [240 bar (g)] at 70°F (21°C). De-rated with temperature, the maximum operation service recommended is 2350 psig [162 bar (g)] at 500°F (260°C). Higher ratings are available with special construction and test certification. When required, the FLT93 Switch beats the heat too and is temperature compensated for dependable accuracy (Fig. 3). Depending on the model and materials chosen, it withstands temperatures up to 850°F (454°C).

Conclusions

After installation by the engine manufacturer, the first FLT93 Switch has been in operation for over two years and there have been no problems reported. The manufacturer continues to use this switch in its dual-fuel engine designs.

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