



Refinery Turns To Thermal Mass Flow Meter For Safety-Critical Nitrogen Tank Blanketing

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An independent Midwest refiner recently approved a project to improve the safety of its plant and reduce its costs for nitrogen gas used for tank blanketing. The company operates refineries in multiple states with a combined crude oil processing capacity of more than 500,000 barrels per day.

Nitrogen blanketing is a practice commonly used in the chemical and petroleum refining industries to reduce the hazards associated with flammable liquids which improves the safety in the plant and can help increase productivity. Blanketing or padding is a process of applying nitrogen gas to the vapor space of a tank or vessel, which minimizes the possibility of an explosion or fire by reducing the oxygen content or the concentration of flammable and/or explosive vapors in a tank or vessel with inert nitrogen.

Blanketing also helps decrease product evaporation and protects the tank from structural corrosion damage caused by air and moisture. Nitrogen usage varies based on the size of the tanks and vessels used in the production, transfer, transportation and packaging of the product. There are three common types of blanketing: continuous purge, pressure control and concentration control. The continuous purge method employs a constant flow of nitrogen. This approach is simple, but nitrogen consumption is high. The pressure control and concentration control methods are more costly to implement and rely on the pressure in the tank or the concentration of the oxygen to initiate the flow of nitrogen, but these methods improve overall safety and the efficiency of

the process. FCI mass flow meters are used in all three of these types of purging methods (Figure 1).

Problem

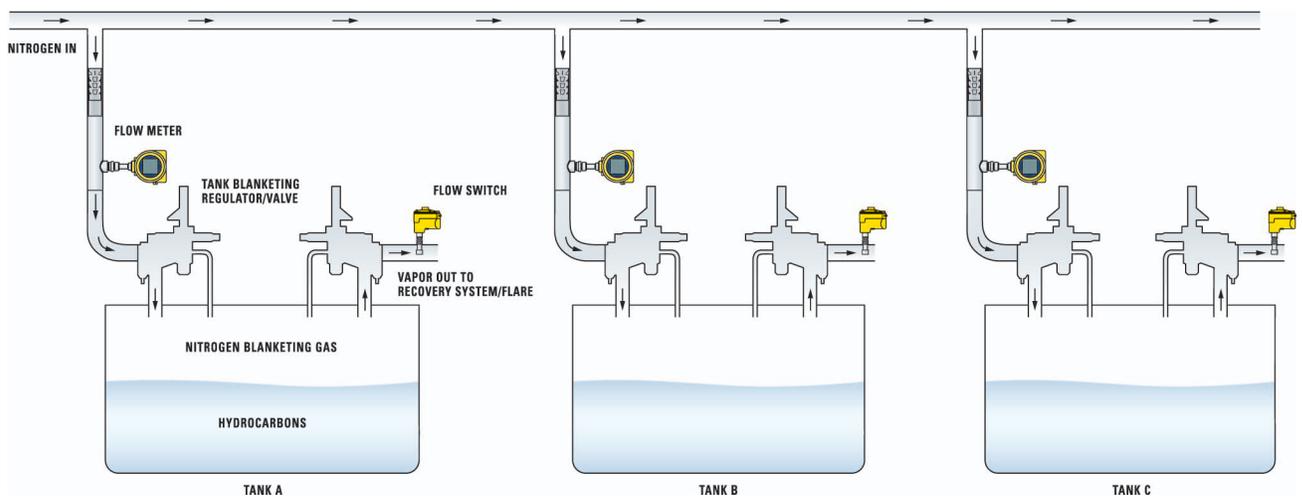
The refiner's plant team needed to measure the flow rate of nitrogen more accurately in its tank blanketing applications. Blanketing is important in these storage applications due to the possibility of static electricity build up, and the nitrogen displaces one leg of the fire triangle. Implementing the pressure control system satisfied the plant team's major concern, which is always safety first.

Nitrogen blanketing, where combustible, flammable or explosive materials are stored, processed or generated prevents these materials from coming into contact with oxygen in the air. The blanket of nitrogen gas creates a nonflammable environment, which prevents the possibility of fire or explosion.

The other reasons the refiner's plant team wanted more accurate flow measurement were to improve efficiency, lowering the plant's nitrogen consumption and costs, and to eliminate any unexpected supply shortages.

The amount of nitrogen pumped into or released out of the tank's vapor space is controlled by a predetermined pressure set point. As product is pumped from the tank, the vapors inside expand and the pressure falls below the set point, more nitrogen is then introduced. As the vessel is filled, the vapors begin to compress and the nitrogen vapors are released and usually sent to a vapor recovery system.

Figure 1: Nitrogen tank blanketing process on refinery tanks



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Figure 2: ST100L FM With Vortab Flow Conditioner

Product falling and rising can create static electricity so the amount of nitrogen in this vapor space is an extremely important safety factor. The refinery needed a flow meter that could provide a mass flow output, measure a low flow rate of 36 SCFH to 600 SCFH [1 NCMH to 17 NCMH] at 158 °F [70 °C] with a pressure maintained at 60 psig [5 bar(g)] in a 1 inch schedule 80 pipe with limited straight-run. With these process requirements, the plant team had many challenges to overcome.

Solution

After consulting with the applications team at Fluid Components International (FCI), the refinery's process engineers selected the Model ST100L thermal dispersion air/gas in-line mass flow meter and the Vortab® flow conditioner with an accuracy of $\pm 0.75\%$ of reading, $\pm 0.5\%$ of full scale. (Figure 2). The Model ST100L is an in-line, spool piece designed gas flow meter that combines best-in-class transmitter/electronics and superior calibration to provide a truly state-of-the-art gas flow meter for industrial process and plant applications.

The Vortab flow conditioner provided a low pressure loss solution for flow profile irregularities produced by elbows, valves, and other disturbances that are commonly present when sufficient straight run is not available to generate the necessary flow profile. Vortab flow conditioners combine proven swirl removal technology with a unique Vortab mixing process to achieve the most thorough and efficient flow conditioning available.

Tabs are located strategically within the conditioner. They promote rapid mixing that creates a uniform flow profile for proper meter flow measurement by eliminating swirl and distortion or any other profile irregularities that could be present through the transitional flow range (Reynolds's number 1000-4000).

The ST100L meter was factory calibrated in FCI's NIST certified laboratory for nitrogen service, but FCI is capable of calibrating in virtually any other process gas. Flow meters calibrated using the actual gas to be measured provides the best accuracy rather than a pre-calculated air equivalent methodology that often fails to transfer accurately in real world installations.

Once installed, the flow meter provided an accurate, repeatable and reliable output necessary for the tank blanketing valve to operate as designed and provide the safety and cost savings expected in this application. Some tank blanketing applications have larger lines and FCI has a solution for this field challenge too. The ST100 insertion style air/gas meter has the same accuracy specifications as the ST100L, but allows the end user the capability to insert the probe directly into the line (Figure 3).

The ST100 Series flow meter comes with many standard and optional features. Up to five calibration groups can be stored to support a broad flow range, differing same gas mixtures, multiple gases, with a range of flow far in excess of 100:1.

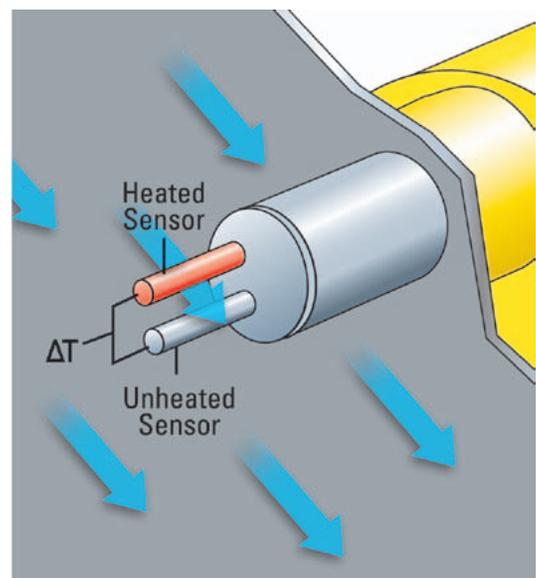


Figure 3: Thermal dispersion principle of operation

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An on-board data logger is included with a removable 2 GB micro-SD memory card to store process flow data.

With its advanced design, the ST100L flow meter offers the industry's widest selection of communication options. Users may select from 4-20 mA analog, frequency/pulse, or certified digital bus communications such as HART, FOUNDATION™ fieldbus, PROFIBUS PA or Modbus RS-485. Should a plant's communication need change in the future, so can the ST100L meter with a simple replacement card that can be installed by technicians in the field.

For ease of local on-site data view, the ST100L flow meter features a graphical, multivariable, backlit LCD display/readout. It provides local information with a continuous display of all process measurements and alarm status, as well as service diagnostics.

Designed for rugged industrial applications, the ST100L flow meter operates at up to 850 °F [454 °C] and is available with both integral and remote (up to 1000 feet [300 meters]) electronics versions. The entire instrument is agency approved for hazardous environments. The enclosure is NEMA 4X/IP67 rated. Approvals include FM, FMc, ATEX, IECEx, InMetro and GOST-R.

Conclusion

Multiple ST100L flow meters have been installed at the Midwest refinery for its nitrogen tank blanketing application. The ST100L provides accurate mass flow measurement with limited straight run, which provides a safe environment in the processing, storing and generating of their flammable and combustible products.

This refiner also has reduced its nitrogen consumption considerably, which in turn reduced its overall operating costs of consumption. According to the plant engineering team, the flow meters are working better than expected. The ST100L was a perfect fit with application conditions because of the installation challenges and process requirements.

The ST100L offers a complete, simple pipe section replacement for new and existing installations. With no moving parts, there is virtually no maintenance. With its long track record of excellent performance at the refinery, FCI and the ST100L meter were the right choice for this safety-critical application. ■