Panametrics
a Baker Hughes business

Case study

Sentinel LNG Flowmeter In Extreme Conditions

At A Glance

Problem
Accurate measurement of flow during LNG transport, backflow of BOG, and flare at an LNG facility in the Arctic Circle.

Solution
Panametrics's Sentinel LNG, gas and flare gas flowmeters

Outcome

- Successful tracking of flow in a sub-optimal environment using 26 Sentinel flowmeters
- Accuracy to ±0.25%
- Ensured against pressure drops in backflow of BOG
- Certification for all hazardous area standards

Background

With an expanse nearly equivalent to the area of Russia and an average depth of 3,400 feet, the Arctic Ocean is the smallest and shallowest of the world's oceans. Centering on the North Pole, it is also the coldest. Dotting and jutting into those frigid waters are hundreds of near permanently frozen landmasses. Greenland, Norway, Sweden, Russia and other country states lay claim to these tundra. These locations contain some of the largest untapped sources of natural gas and dozens of liquid natural gas processing facilities.

In 2000, the US Geological Survey (USGS) stated that nearly 1/3 of the earth's undiscovered oil and gas resources were in the Arctic. Exploration boomed. The technology to extract and process natural gas in these regions also rapidly advanced. These are wild, remote locations where temperatures regularly drop as low as -50°C. The environment is so harsh and dynamic that to ensure stability, processing plants are built atop steel piles to account for rapid shifts in permafrost and ground stability—these are engineering marvels. The extreme ambient conditions also compound a significant challenge associated with liquid natural gas production, flow measurement.

It's no secret that natural gas is compressed 600 times in volume to facilitate easier transport as liquid natural gas. Under the best conditions, measurement is a challenge since volume is a function of pressure and temperature, factors that can create havoc in metrology. So, when one regional producer was planning to add new liquefaction trains as part of its expansion adjacent to its existing LNG facility, it reached out to Panametrics for assistance.

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Application Challenges

Before natural gas can be supplied to national distribution networks, it needs to be liquefied for transport. Terminals like this LNG facility are faced with receiving the gas for processing and moving the gas within its facility, storing and ultimately transferring the now liquid product to vessels that will bring it to market. Natural gas changes physical form within the infrastructure that handles these operations as temperature and pressure conditions vary. For instance, liquefied natural gas is stored at pressures very close to its boiling point within cryogenic double-walled tanks. Within these tanks, it is mostly stable. However, once LNG starts moving through a pipeline, there is a risk of it changing to a two-phase flow if there are hot spots along the path or if the pressure drop transforms some of the liquid into gas with a much higher volume. Accurate measurement is essential to minimize lost and unaccounted for product.

Within the new LNG facility, Panametrics engineers worked with the customer to identify situations with the greatest potential for product loss and the greatest need for flow measurement. Needs centered around the transport of LNG, backflow of boil-off gas (BOG), and flare.

The LNG facility was built to withstand the harsh environment using a [Photo suggestion: LNG Facility ground level showing piles] a modular design. This approach saved nearly 30% in construction costs but created a compact infrastructure devoid of sufficiently long straight runs, a requirement for accurately measuring flow with ultrasonic meters. Getting accurate measurements was one of the top priorities for the customer to export LNG efficiently.

The temperamental nature of LNG demands that it be handled at a very low temperature (around -150°C or lower). Every time LNG moves from a vessel to the processing facility, some BOG needs to be flown in the opposite direction to maintain the delicate pressure equilibrium to prevent the rapid release of LNG vapors, known as “rollover”. Here again, there was a need for precise measurement.

The third area requiring careful measurement is the handling of excess gas. Due to the liquefaction process, excess gas (mainly methane) is vented through a flare stack where, as a safety protocol, it is combusted. Depending on where it is released, the excess gas going to the flare can have a vast flow rate range – from 0.03 m/s up to 100+ m/s - and temperature – from -160°C up to +300°C – making the measurement a big challenge.

Solving the Challenges

With the challenges identified, Panametrics' experience with similar LNG projects took over. Immediately, the company set to work on a technical analysis that included a review of isometric engineering drawings and computational fluid dynamics to model the environment mathematically. This work resulted in a plan that was custom-tailored to the needs of this particular LNG facility and which relied heavily on Panametrics's Sentinel LNG flowmeter, the latest addition to its series of advanced ultrasonic flow meters for LNG measurement. The BOG and flare measurements both used the legacy gas and flare meters with several thousands of these in operation worldwide. The plan and Panametrics's industry-leading expertise in LNG created a trustful environment with the engineering, procurement, construction firm, and the customer.

Valves, elbows, control valves, and other piping components limit the number of straight runs in an LNG facility and can cause flow disturbances. The tight configuration of this facility had more than the usual amount of these to fit within the footprint of its gravity-based structures.

To address the woefully insufficient straight runs which create measurement errors due to non-fully-developed flow profiles, Panametrics selected its 4-path meter Sentinel LNG, which reacts to changes in flow rate with incredible speed and accuracy. Sentinel LNG extends the use of ultrasonic technology into cryogenic applications for measuring liquefied natural gas (LNG) with unbeatable performance, reliability, and safety and can be calibrated down to ±0.25% of reading. In all, 26 Sentinel units were installed.

Panametrics has a proven track record for BOG measurement in similar LNG projects. For this project, the company recommended its XGM868i, which handles low pressure and cryogenic conditions exceptionally well using ultrasonic technology. Choosing this meter ensured against pressure drops and the maintenance of necessary equilibrium pressure.

The harsh environment of the region also demanded special consideration for handling flare. To ensure that its product was up for the task besides using their XGF868i flare electronics, Panametrics conducted extensive testing of its transducers to expose them to extreme temperature cycles. Creating artificial environments using liquid nitrogen and specialized ovens, the company first tested the units at -190°C and then at +300°C. The transducers performed at both extremes enabling certification for all hazardous area standards while ensuring reliable operations.

Panametrics, a Baker Hughes business, develops solutions for measuring and analyzing moisture, oxygen, liquid, steam, and gas flow with proven technologies that are well-known and widely deployed across many industries, including oil and gas.

For more than 50 years, we've been constantly evolving our product line to deliver the most effective moisture and gas measurement systems on the planet. Today, the culmination of decades of expertise, insight, and innovation is expressed in our Sentinel portfolio of high-accuracy liquid flow meters that cover a range of operating temperatures and applications.

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