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The Challenges and Solutions of Flare Gas Metering

By Wayne Shannon

Flare gas is the surplus or waste gas produced in industrial processes. Flare gas systems are utilized all over the world as a safety mechanism to burn flammable gas rather than releasing it into the atmosphere. These systems protect people, equipment, and the environment and are used in oil refineries, oil and gas production, petrochemical processing plants, natural gas plants, wastewater treatment facilities, and landfills.

At one time, there were no incentives to minimize the amount of gas flared, nor were there significant environmental emission concerns. Accordingly, a combustion device known as the gas flare or flare stack was commonly used to consume vast quantities of flare gas. Since climate change is an increasingly pressing concern, and there is an increasing need for energy, capturing and reprocessing flare gas, rather than burning it has become more important than ever.

With an increasing need for energy, capturing and reprocessing flare gas is more important than ever.

Application Challenges and Solutions

To select the proper flow meter for any flare gas use, operation and system engineers need to understand the inherent challenges associated with the gas.

Gas Composition

Flare gas lines at refineries contain a mixture of hydrocarbon gases. While the continuous sweep gas is usually methane, other gases are released into the system from various process units, creating a mixture of gases with varying proportions.

Since thermal mass flow meters rely on the thermal properties of the gas (or mixture) in which the meter is calibrated, variations in composition affect accuracy. Therefore, thermal mass flow meters are unsuitable for emission reporting or determining mass balance at refineries; however, they are suitable for use in the lateral lines to measure sweep gas as well as detecting undesired gas leakage into the flare system.

Low Gas Velocity

Many flowmeters do not have the sensitivity to measure the very low velocity (flow) of sweep gas during normal operation.

Thermal mass flow meters have excellent low-flow sensitivity and can measure velocities much lower than other flowmeters.

Rangeability

It is critical to measure a broad range of flow rates, given that there is particularly low flow during normal operation and extremely high flow during an upset condition.

Thermal mass flowmeters have a rangeability of 1000:1, making the technology suitable for flare gas flow applications.

Pressure Drop

The pressure in the header system may be very low. The flowmeter must not restrict the gas flow.

Thermal mass flow meter sensors provide little blockage and virtually no pressure drop.

Oil and Gas Industry – Upstream

The oil and gas industry faces rigorous EPA, state, and local regulations involving flare gas. To maintain compliance, flare emissions at refineries require the measurement and reporting of the volume of gas flared or vented.

In a flare gas system, gas flows to the flare when the following conditions occur:

- Continuous sweep gas flow provides a positive pressure to prevent the buildup of combustible gas in flare headers
- If gas is released from a pressure-relief valve due to an over-pressurization of plant process equipment
- During operational upsets, interruptions or emergency situations that create the need to depressurize equipment quickly to avoid damage
- Venting of equipment, such as analyzers and gas seals, and incidental leaks

Flare gas recovery and combustion

In response to the EPA's restrictions on flare emissions, many refineries install flare gas recovery systems upstream of the flare. During normal operation, all flare gas is recovered. This gas is compressed, treated if necessary, and combined with other plant fuel gas to power facility combustion devices.

While thermal mass flow meters are not suitable to measure flare gas for emissions reporting or mass balance, the technology is excellent for locating flare gas leakage and releases.

Problem: *Fugitive emissions in the flare collection line may indicate there is a loss of raw material, which can be time-consuming and expensive to locate.*

At refineries, thermal mass flow meters can quickly identify the area(s) of a flare system that releases even minor amounts of flare gas. For these purposes, meters are installed in the flare collection line coming from each process unit. Because of the thermal mass flow meter's excellent low-flow sensitivity, the meter detects the

Thermal mass flow meters are an ideal fit for several applications within oil and gas production.

minimal movement of sweep gas, establishing a baseline flow from each process unit. The presence of fugitive emissions, those undesired minor gas releases, and leaks not attributed to an upset condition, is detected by a change in flow rate. For this application, variation in composition is not as important as repeatability. The flow rate change identifies which process unit is the source of the leak, saving considerable time and expense in investigating the source of the leaks.

Oil and Gas Production – Downstream

Natural gas is a natural byproduct of oil production. While the oil may be stored and later transported, the recovery of natural gas requires the presence of a gas pipeline. In many cases, the infrastructure is not in place to transport the natural gas, and it is flared. Even when a gas pipeline exists, the flare is used if the pipeline backs up or there is equipment shutdown.

Flaring natural gas wastes energy and emits greenhouse gases. There is a global initiative to reduce the amount of natural gas flared. Each state or local district has different rules and requirements on flaring at oil and gas production areas.

Thermal mass flowmeters are ideal for measuring the natural gas flow to the flare or vent for emission reporting purposes, to identify loss of product, or simply to account for the natural gas going to the flare. The thermal mass flow meter provides:

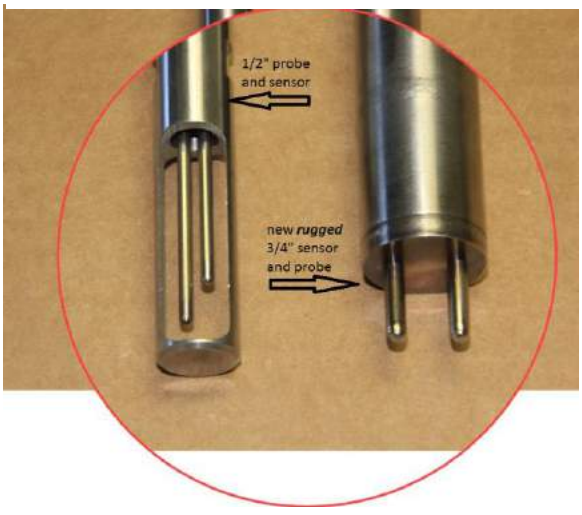
- Mass flow measurement without the need for pressure and temperature correction
- High turndown capabilities, which may be required depending on production rates. Some operators are replacing orifice meters with thermal mass flow meters to achieve a wider range of gas volume measurement.
- Low-pressure drop
- Rugged construction and high reliability meet demanding requirements of the oil field

Problem: *One major oil and gas producer experienced recurrent damage to the thermal mass flow meter's insertion probe and sensor during high-flow conditions.*

An oil and gas producer was using a competitor's thermal mass flow meter to measure natural gas flow in a flare line. They were experiencing frequent failure and breakage of the probe.

The producer suspected that high-velocity flow conditions bent the probe and damaged the sensor, making removal of the probe difficult. The natural gas coming from the well was wet, and because of the large pressure drop, ice particles formed. These ice particles would hit and break the probe. After repeated failures, the client approached Sage Metering to solve

Sage Metering solved the client's problems with its rugged thermal mass flow meter design and Insight communication software.



the problem. Sage's solution was to develop a new larger, heavy-duty probe and sensor that could withstand the challenging conditions. Also, the customer requested advanced communication protocols to communicate with each flowmeter. Sage Metering solved the client's problems with its rugged thermal mass flow meter design and Insight communication software.

Parting Shots

When faced with the substantial challenges presented with measuring flare gas, only a few technologies are left standing, one of which is thermal mass flow measurement. In addition to flow measurement of natural gas in oil and gas production, the thermal mass flow meter may provide monitoring at various flare laterals to assist with locating minor flare gas releases within oil refineries for leak detection. The extraordinary rangeability, ease-of-installation, and low cost make the thermal mass flow meter a notable contender for measuring and monitoring flare gas for the oil and gas industry.

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About the Author

Wayne Shannon is product marketing manager for Sage Metering. Wayne has over 20 years' experience with applications, product marketing, and sales of thermal dispersion mass flow meters. He has been directly involved with recommending and applying thermal mass flowmeters in a wide variety of industries. Wayne has a bachelor's degree in Chemical Engineering and an MBA in Marketing.