Advanced flare monitoring

Dario DiMaggio and Robert Morpeth, Kurz Instruments, Inc., USA, outline the challenges and criteria to consider for flow instrumentation in flare gas applications.

The increasing environmental regulation demands of the last decade have stimulated the need for flow instrumentation that provides accuracy and repeatability on all emission related applications. Business and site managers demand cost effective and reliable solutions in order to balance corporate environmental stewardship with fiscal responsibilities. This article attempts to clarify the challenges and criteria to consider for flow instrumentation in flare gas applications.

Local, federal and global environmental strategies are evolving in an attempt to track daily onshore and offshore flared gas applications to better understand emissions containing volatile organic compounds (VOC). The Global Gas Flaring Reduction (GGFR) organisation estimates approximately 150 billion m^3 of natural gas are flared annually, adding 400 million t of CO_2 into the atmosphere. Regulators are working to gain a more complete understanding of these emissions in an effort to set policy that protects the environment without unduly impacting quality of life issues.

Flares and flow measurement

Flares are used in many industries for handling a variety of VOC emissions and to relieve emergency process upsets while maintaining a safe operation. An efficient, burning flare does not produce visible smoke, while black smoke is a good indicator of incomplete combustion. Emissions that result from incomplete combustion add CO, CO_2, and NO_X to the atmosphere. Emissions from processed natural gas can contain hydrogen sulfide (H_2S) and sulfur dioxide (SO_2).

Measuring the flow stream to the flare is a challenge for most instrumentation because of the unstable flow rates, shifting flow profiles, frequently dirty gas composition, typically ultra low flows rates during most of the operation, and potential variations in temperature, pressure, or

Figure 1. Thermal meter used in offshore flare.

Figure 2. Thermal meter in an oilfield pipeline.

composition. Flare gas velocities ranging from 0 - 600 ft/s (approximately 183 m/s) are common.

The instrumentation used in a variety of flare applications must support a large range, with some of the highest flow rates during upset events (up to 600 ft/s) on one end of the performance envelope and with extremely low (less than 1 ft/s) purge flow or regular operation flaring on the other end. Limitations on the output data resolution scaling of the flow instrumentation can indicate a need for additional devices to accommodate the broad low and high flow ranges.

Blockages and obstructions caused by elbows, curves, valves, or reducers can create flow irregularities (turbulent versus laminar flows) within the pipe. Dirt and particulate buildup in the line can also create flow irregularities and impede flow readings. For example, pigging in the oil industry is a device used to clean the particulate buildup inside wall of a pipe.

A major obstacle to reducing global flaring is the poor data that has historically been available, which in part is due to:

- Calculations or assumptions based on constant usage.
- Improper placement of the instrumentation.
- Flow profile and velocity uncertainties.
- Variations between calibration and usage conditions.
- Flawed flow range (low and high capability) accuracy or efficiency.
- Instrumentation drift due to dirt, misalignment, or changing gas composition.

Regulations and standards

The procedures for suggesting flow instrumentation commonly fall to standards organisations such as International Organization for Standardization (ISO), American Gas Association (AGA), or American Petroleum Institute (API). The standards developed by these organisations are frequently generated by engineers or specialists using specific instrument selections in a controlled environment. Although a flow instrumentation manufacturer is not identified as part of the specification, the conclusion is often based on testing a single model and does not necessarily address the full performance capabilities or limitations of the technology. Test conclusions indicate the tested technology as 'certified' or 'approved by' with an implied recommendation. In many cases, such as custody transfer, there is no real certificate of approval, just de facto acceptance.

Flow measurement specialists are able to simplify studies and reports that categorise flow meters into simple technology groups, such as thermal, ultrasonic and differential pressure. A common practice for biasing a specific flow technology for a given application is using a controlled test environment based on a few assumptions. However, this strategy ignores the complexities of real world installations. It is important for site managers to investigate the options for flow instrumentation rather than accept the de facto standard for general flare applications. This can lead to huge money and maintenance savings, while maintaining the accuracy and repeatability that is necessary for these demanding applications.

Flow instrumentation technology

Although a variety of flow instrumentation is readily available on the market, the harshness of flare applications effectively limits technology options to either ultrasonic or thermal flow meters. The manufacturers of these devices are continually stretching the capabilities of the technology.

Ultrasonic technology

Historically, ultrasonic technology gained acceptance because the instrumentation provides noninvasive flow measurement and is not affected by changing gas composition. Ultrasonic technology is also in good standing with a variety of standards organisations. However, there are unique aspects among real world flare applications that make it unlikely that 'one size fits all', and using ultrasonic instrumentation is not always the best or the most cost effective choice. For example, a single path ultrasonic device is sensitive to low flow profiles, easy to install, and has an acceptable purchase price. Based on an assumption that the flow rate has minimal fluctuation, this could be a good choice. However, actual flow rates will likely experience low and high velocities and make a multi path ultrasonic meter the better choice.

Ultrasonic technology operates best above some of the minimal flow thresholds, and dirty processes and pigging operations can foul the instrument, which creates an extensive cleaning process that leads to operation downtime. The readings from ultrasonic devices can become affected by the particulate buildup on the pipe walls, which changes the pulse transit time between transducers.

Thermal technology

Thermal technology in particular has made great advances in recent years and has moved well beyond the limits of when many industry reviews and standards were written in favor of ultrasonic. Thermal flow meters are now frequently viewed as an alternative to ultrasonic devices. However, within thermal technology, the available instrumentation has substantial differences. Constant power thermal devices do not typically perform well in very low flows and require critical flow conditioning. Constant temperature thermal devices provide higher accuracy and repeatability over a larger flow range. Within the constant temperature thermal device category, one of the ways manufacturers differentiate their product offerings is the amount of overheat based on the temperature of the flow stream.

No instrument is completely unaffected in dirty gas stream. However, insertion thermal meters with significant overheat designs remain cleaner for longer and are easy to remove for simple cleaning. In real world environments, insertion thermal flow meters also have an acceptable purchase price, support wide ranging flow profiles, and require almost no maintenance.

Conclusion

The technologies used for flow measurement instrumentation have specific characteristics, performance capabilities, and price ranges that help determine its suitability for an application. The importance of selecting the right flow instrumentation for a specific flare gas installation is vital in accurately monitoring the amount of emissions. Relying on a 'one size' solution, however well reviewed in general, can add significant complications to process measurements.

Figure 3. Kurz flow meter for flare applications.