Saudi Aramco Uses Kurz to Help Monitor Flare Emissions

Saudi Aramco developed its Environmental Control and Remediation Technology (EC&RT) team to ensure that the company is a regional leader in the use, adaptation, and development of new and innovative approaches to environmental management, such as air quality. It is well-known that the volatile organic compound off-gases generated with petroleum extraction and petrochemicals production processes must be piped to a flare during production, maintenance, and emergency procedures. The off-gases are mixed with fuel to reduce/eliminate any harmful gases and particulates from being released into the atmosphere.

Kurz Instruments began working with Saudi Aramco more than 13 years ago using Kurz single-point and multipoint thermal flow meters throughout platforms and facilities in the Berri, Hawiyah, Marjan, Safaniyah, Tanajib, and Zuluf oil fields. Applications range from combustion air to gas flow for the flare stack pilot flame.

The current project involves replacing flare instrumentation – going from ultrasonic flow meters and low-quality thermal meters to high-quality thermal flow meters – on platforms in the Safaniya Oil Field in the Persian Gulf and in facilities within Saudi Arabia.

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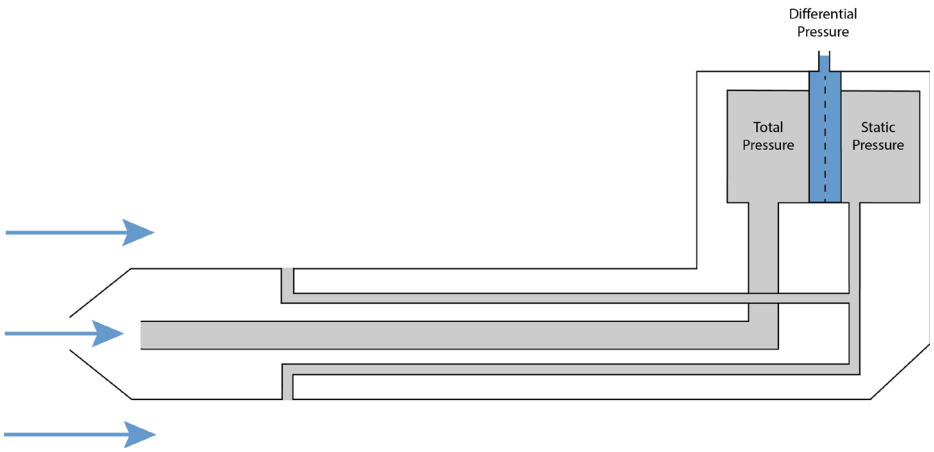
A Brief Review of Flare Gas Monitoring Devices

Flare systems are designed to support two modes of operation – typical low flows containing small quantities of hydrocarbon gases that are not economical to recover and sporadic high flows resulting from emergencies such as process upsets, de-inventorying gases, or power failures. Additionally, the waste gas composition has a significant impact on the accuracy of the flow measurement technology. A purge gas of typically natural gas or fuel gas is maintained at the flare header at all times. The requirements of these flare systems for low, ambient pressure, 1000:1 turndown ratio, and large pipe size limit the flow measurement technologies to pitot tubes (differential pressure), ultrasonic, and thermal mass.

Pitot Tubes

Pitot tubes, a common flow differential pressure alternative for flare gas applications, measure impact velocity using an opening that is in-line with the oncoming flow stream. An analysis of pitot tubes capabilities concludes:

- Pitot tubes are subject to clogging and require regular attention to ensure no particulates interfere with any openings.
- Pitot tubes have a relatively narrow turndown ratio.
- Pitot tubes have limited capability measuring low flows in large diameter pipes.
- Pitot tubes are prone to a natural frequency vibration caused by the force created as vortices are shed by the pitot tube. At a critical point (a function of probe geometry, probe material, and the velocity of the flowing fluid), a destructive natural frequency vibration occurs that can lead to probe failure. A second mounting support can improve the probe's resistance to vibration.
- Pitot tubes require lengthy upstream and downstream straight runs for minimum reliability (8- to 10- times pipe diameter for upstream and 4- to 5-times pipe diameter for downstream).



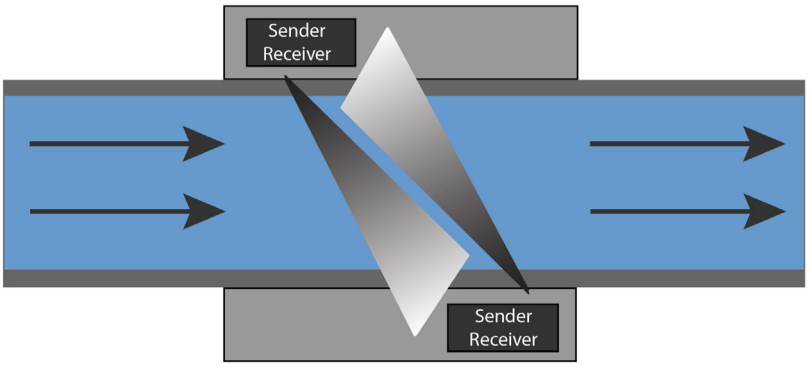
Ultrasonic Devices

Ultrasonic meters for flare gas applications are typically permanently installed. Ultrasonic flow meters measure the flight time of ultrasonic pulses across a liquid or gas stream. The time of flight is evenly averaged across the entire duct or pipe, with the result providing the average velocity.

They provide high accuracy and precision for flare gas applications, supporting low sensitivity to changing gas composition and variable gas correction capability. However, ultrasonic devices are affected by the temperature, density, and viscosity of the flow.

- Particulates in a gas stream must be uniform and non-interfering.
- Severe vibrations must be dampened to eliminate errors.
- Very long straight runs (20 x D) are required to ensure no noise levels interfere in the wave length range.
- Accuracy can decline at very low flow rates and very high flow rates, due to low sound levels and high sound levels, respectively.

Multiple measuring points (additional devices) are frequently required, and the mounting requirements often mean building extra platforms for accessing vertical duct locations.



Thermal Mass Devices

Constant temperature thermal mass technology uses two sensors – one as a reference and one as a process temperature measurement. The reference sensor is maintained at a constant, process temperature. The process sensor maintains an elevated temperature relative to the process temperature, and gas flow passing the process sensor pulls heat away from the sensor. The energy used to maintain the temperature difference between the reference and process sensors corresponds directly to the mass flow rate of gas in the pipe.

Kurz thermal mass flow meters support zero flow as an actual flow rate and can accurately go up to 24,000 SFPM (18,000 SCFM). Kurz offers thermal flow meters with the highest turndown ratio available in the market and the only thermal meters capable of accurately monitoring up to 100,000 FPM (500 NMPS).

Kurz Offers Solutions

The single-pass ultrasonic flow instrumentation was failing to perform. It was incapable of accurately reading the low flows and frequently showed zero flow when there was evidence of gas flaring. Ultrasonic meters are better suited for clean and ultra-pure flows, and it is typical that flare lines contain particulates that can affect accuracy. Ultrasonic meters also become less dependable when flow rates drop below 2 ft/s and are historically limited to a 100:1 turndown. A reduction in flaring resulted in flare lines that commonly have very low flow rates – from as low as 10 standard feet per minute (SFPM) up to 400 SFPM.

The low-quality thermal meters Aramco had been using had a slow response time that impeded the ability to effectively monitor the flare gas flow rate. This issue, combined with the low signal-to-noise ratio, gave the engineers little confidence in the monitoring data. Engineers tried multiple tactics to use the equipment they had already purchased but discovered the limitations of calibrating the low-quality thermal instrumentation in the field. Rather than continuing in that direction, the engineers looked at the instrumentation used in other applications around the company.

Saudi Aramco contacted Bandariyah International Company (BIC), a major engineering and procurement group in the Middle East specializing in the oil and gas industry, to get an idea about the types of instrumentation that would perform accurately with the flow ranges in their flare application. BIC has been representing Kurz Instruments in the Middle East for more than 10 years and suggested that the high turndown, high sensitivity, and fast response time made Kurz thermal flow meters a viable option.

Saudi Aramco was already aware that Kurz flow meters are reliable and durable due to existing Kurz flow meters employed in combustion applications. The Kurz meters are also known for their flow range capabilities and insensitivity to particulates in the flow stream.

In particular, Kurz flow meters are capable of accurately measuring from zero up to 24,000 SFPM because of the unique, patented design. Kurz flow meters are frequently used in stack and flare applications, so Saudi Aramco ordered a K-BAR multipoint insertion flow meter to test with their flare system.

Kurz Engineering Support went to the Saudi Aramco platforms in the Safaniya Oil Field to help improve the measurement precision by analyzing the flow patterns in the pipe leading to the flare. To maintain safety while minimizing flaring, the lowest-possible velocity of gases must go through the flare pipe to eliminate the possibility of oxygen entering from the reverse direction. In some cases, nitrogen or carbon dioxide gas are used to maintain the minimum required positive flow. Any oxygen in the flare line allows the potential for an explosive mixture.

The Saudi Aramco engineers were initially skeptical that the Kurz flow meter would behave any differently than the other thermal and ultrasonic flow meters they had attempted to use. It is a common misconception that all thermal flow meters are the same, but the axiom "you get what you pay for" also applies to the world of thermal mass flow meters. In this instance, the lower-quality flow meter could neither support the flow range nor provide the necessary sensitivity to the low flow.

Once Kurz Engineering Support entered the new site-specific information into the Kurz flow meter, the Saudi Aramco engineers could easily see the difference using quality instrumentation. They also recognize that Kurz thermal flow meters provide an alternative to ultrasonic instrumentation for flare applications.

About Saudi Aramco

The Saudi Arabian Oil Company, better known as Saudi Aramco, is headquartered in Dhahran Saudi Arabia. The company is a fully integrated, global petroleum enterprise and a world leader in exploration and producing, refining, distribution, shipping, marketing and petrochemicals manufacturing. Saudi Aramco manages proven reserves of 261 billion barrels of conventional crude oil, and the fourth-largest gas reserves in the world, 294 trillion cubic feet, and produced 3.5 billion barrels in 2014. In addition to its headquarters in Saudi Arabia, Saudi Aramco, through its affiliates, has joint ventures and subsidiary offices in China, Japan, India, the Netherlands, the Republic of Korea, Singapore, the United Arab Emirates, the United Kingdom, and the United States.

The company's history began in the 1920s with support from Standard Oil of California. After many more years of exploration, investment, and shareholder changes, the Saudi Arabian government acquired a 25% stake in 1973 and finally 100% ownership in 1980. By royal decree in 1988, the company changed its name from Arabian American Oil Company to Saudi Arabian Oil Company.

The largest offshore oil field, the Safaniya Oil Field, was discovered in 1951, and the largest onshore oil field, the Ghawar Field, was discovered in 1957. In overall oil production, Aramco provides about one in every eight barrels throughout the world.

Saudi Aramco is one of the leaders for reducing sulfur emissions, CO2, and flaring in the Middle East. The company's pioneering environmental programs started in 1963, and these programs continue expanding to reflect the latest in environmental responsibilities, developments, and challenges. Aramco's Environmental Protection Department (EPD) administers programs that include clean fuels, carbon management, air and water quality, and waste management. In addition, each facility undergoes an Environmental Performance Assessment (EPA), a comprehensive operation and maintenance inspection to ensure it meets environmental standards.

The EPD's directive and a component of the company's Environmental Master Plan include:

- Protecting and promoting the well-being of workers and community residents
- Encouraging environmental education and advancing environmental awareness Kingdom-wide
- Minimizing the company's environmental impact by maximizing its environmental performance
- Ensuring compliance with the Kingdom's environmental regulation and standards
- Protecting the Kingdom's natural resources
- Advocating the company's point of view in designing international environmental policies and regulations

Conclusion

Accurately monitoring flare gas flows provides information that can be used in conjunction with other data to identify potential problems and support solutions. A flow meter that supports a wide flow range and provides a fast response time can indicate an obstruction in the line, impending overpressure, or a failing high-pressure connection. A thermal meter with these qualities provides a cost-effective alternative to several other flow technologies and should be considered as part of the investment in any flaring application. Saudi Aramco embraces its global commitment to environmental protection and human safety as a sound economic choice and good business practice. Kurz is honored to be a part of Saudi Aramco's environmental efforts and initiatives.