



Flare control and optimization

A tech brief for flare management

Flare stack optimization boosts safety, improves uptime, and reduces environmental impacts

Oil and gas operational costs depend on the accurate, reliable real-time measurement and control of flare gas, steam and emissions

Operations with flare gas have very specific responsibilities to their communities, environment, and employees. Safely disposing of flare gas must be done within government mandated regulations. In the UK, flaring is regulated by the Department of Trade and Industry (DTI), which develops the government policy for oil and gas fields as well as the UK's territorial waters. In other nations, the ministry responsible for oversight of hydrocarbon resources typically oversees flaring. Additionally, the Emissions Trading Scheme (ETS) has been monitoring the emission levels of 11,000+ plants and facilities across the EU (plus Norway, Liechtenstein and Iceland) since 2005.

In oil and gas operations specifically, accurate and reliable flare optimization is the key for improved safety, increased Return on Investment (ROI), and risk mitigation. Optimization of an operator's flare is also proactive in regard to climate change, staving off the looming issue of harmful emissions coming from incomplete combustion or black smoke and odors that can exacerbate risks and result in brand damage.

The solution? Safe, cost-effective solutions from an experienced and industrial-minded partner with deep, proven expertise in oil and gas operations. Working with Panametrics, a Baker Hughes business, and flare.IQ offers a partnership with a company versed in flare optimization via proactive management and control for all assisted flares.

What exactly is flare optimization?

Flare gas characteristics

Handling gas combustion is a highly regulated practice with myriad safety and health implications. Flare stack pressure, volume flow, and gas composition inherently differ significantly over short periods of time. This introduces specialized requirements to ensure reliable, accurate flare management and control.

Characteristics of a flare that needs to be monitored and optimized downstream oil and gas include:

- Variable flow rates (0.1-400 ft/sec; 0.03 to 120 m/sec), meaning a 4000:1 turndown ratio
- Variable composition (H₂ to C₆+)
- Corrosive and/or wet environments (H₂S, HF, H₂O)
- Low pressure, close to atmospheric conditions
- Wide temperature range (-310°F to 482°F; -190°C to 300°C)

Conventional flow meters

Conventional flow meters (i.e., differential pressure flow meters and thermal mass meters) do not align well with intrinsic characteristics of flare gas operations. They are simply not meant to meet the needs of the characteristics outlined above. There is also limited technology available for these types of meters for such a large turn down range; these meters can't measure both very low and very high flows – something that is characteristic of a flare stack.

To elaborate, a conventional flow meter may fail to meet the bar for the following reasons:

Variable flow rates

They are not engineered for the range of flare gas flow rates. There are limitations regarding maximum flow capacity, that can leave a conventional flow meter unable to adequately help during a flaring emergency event – when it is needed most.

Variable composition

A conventional flow meter is also sensitive to composition changes, which does not allow it to be reliable enough to handle burning variable gas mixtures.

Corrosive

Build-up and corrosion on conventional flow meters can cause significant drifts, thus introducing inaccuracies and requiring frequent physical maintenance and calibrations on traditional flow meters.

Low pressure

Pressure drops may compromise proper flare gas purging.

Wide temperature range

Traditional meters may have lower levels of reliability or accuracy within wide temperature ranges and introduce unnecessary risks.

Ultrasonic technology

Ultrasonic technology uses ultrasound to measure velocity and calculate volume and mass flow. The technology is a superior flare tool in multiple categories and aligns well with intrinsic characteristics of flare gas operations. Ultrasonic technology applies to measurement and optimization.

Flare measurement: Ultrasonic is by far the technology of choice for measurement. No other technology can cope with the inherent challenges of flare measurement. The primary advantage is the huge turnaround ratio and the readability from low end to high end.

Flare optimization: It is equally important to measure and optimize the combustion efficiency at the flare tip to ensure only CO₂ goes into the atmosphere and not CH₄, which are more potent gases from a global warming perspective. Smart imaging cameras can also be used with ultrasonic flare measurement to assess combustion efficiency (CE%). Even a basic camera that just reports the flame image to the control room for manual adjustment is helpful. About 60% of optimization is done through cameras currently.

Ultrasonic technology fits the characteristics of flare optimization in several ways. Related to variable flow rates, ultrasonic has almost zero flow to gas velocities exceeding 400 ft/sec or 120 m/sec.

Ultrasonic technology also uses sound of speed to calculate molecular weight of the flare gas mixture, and the algorithm automates steam usage and composition accordingly. Customized materials can be used to prevent corrosion with ultrasonic meters, and ultrasonic is a next-gen technology that can also handle a wide temperature range. Finally, there are higher levels of reliability and accuracy than are found with traditional flow meters.

The following benefits also accompany a switch to ultrasonic technology:

- No pressure drop in lines
- Accurate measurements of flare gas and mass balance of plant
- Help with optimal mix of O₂ (from steam or air) and gas for complete combustion
- Diagnostics used to check health, performance and accuracy of flow meter

flare.IQ: A key software differentiator

A software solution is key to efficiency and maximized safety. Employing flare-specific algorithms and predictive modeling allows plants and refineries to optimize steam input and minimize steam usage. Introducing flare.IQ software and Digital Verification also helps plants to control flare, and maintain flare meters. Setting the required steam input to optimize and manage emissions, and net heating value, is easier and safer with the right software.

Meter performance checks at regular intervals (selectable) ensuring the measurement stays within acceptable limits without the need of any human intervention.

Why real-time flare optimization is crucial

The ability to monitor and optimize flare equipment in real time is quickly becoming an essential component of the modern assisted flare system. Digital verification and flare control benefit plants in the three Es: Environment, emissions, and efficiency.

Environment

Better flare control and monitoring is better for local and global environments. Methane (CH₄) is 25–35 times more harmful to the environment than CO₂ because of its global warming potential over a 100-year period of time (around 80 times over a 20-year period). There is no “reverse” button. Since CH₄ is emitted when uncombusted gas is vented, plants must take control of their excess methane and be able to respond quickly to leaks.

As of October 2020, the European Commission submitted a plan to reduce methane emissions in the region. According to the Commission, changes will include “the establishment of an international methane emission observatory in partnership with the United Nations Environment Programme, the Climate and Clean Air Coalition and the International Energy Agency.” Additionally, the EU’s Copernicus satellite program will enhance the surveillance of global super-emitters and work to identify major methane leaks.

Both existing and emerging regulatory compliance aimed at limiting environmental impact also make flare optimization vital. Mandatory reporting means there is no getting around accountability for non-compliance. Beginning in 2021, the ETS emissions caps will reach Phase 4. This means an annual

reduction of 2.2% for the allowance of common greenhouse gas emissions.

Failing to meet regulation can result in environmental penalties, while eliminating eligibility for environmental incentive programs. And then there is the brand damage that results from consumers perceiving a company as irresponsible or harmful to their community. Finally, maintaining safer operations mitigates the risk of potential catastrophic environmental consequences including everything from property damage to illness.

Emissions

Emission management and compliance requires precision, which is difficult if not impossible to do with outdated monitoring technology. Precision requires accurate, reliable flare optimization via measurement and real-time control. Steam is expensive, and optimizing the flare emissions while controlling costs related to efficient gas-air mixing is key.

Steam ensures complete burning of flare gas by providing the just required amount of oxygen, and the optimal mix delivers a smokeless operation via flow rate control. Next

gen flare optimization solutions like flare.IQ can deliver 98% destruction efficiency or 96.5% combustion efficiency. Not only is this rate more efficient, but it helps eliminate illegal black smoke and a smell that can create negative brand perceptions within nearby communities.

Efficiency

Reliable, real-time flare monitoring and optimization also reduces fuel usage. Some flares add fuel to increase gas Net Heating Value (NHV) when it is too low, but flare.IQ avoids over fueling. Improved flare management is also more reliable, accurate and has repeatable flare gas measurement and real-time optimization. This enables a complete mass balance of the plant, helping to improve plant efficiency.

flare.IQ by Panametrics delivers:

- High-efficiency flare combustion
- Reduced cost steam and fuel usage
- Improved safety

When is flare control right for your operations?

Refineries, petrochemical and gas operations

Some types of plants (assisted flares) must have flare control to remain compliant and safe. These industries include high stakes manufacturing, oil and gas operations, refineries, and petrochemical plants. Flaring keeps operations safe and saves money for operations that necessarily produce excess gas.

Operations with assisted flares that do not have gas recovery systems

Operations that don't have a gas recovery system can benefit from flare controls due to frequent flaring – as often as daily. Not only is flare measurement a key enabler to plant-wide optimization in this case, but it reduces common risks.

Steam optimization and related costs are intrinsic to operations without a gas recovery system, and it is flare optimization that keeps the costs down. The environmental and brand implications of allowing excess steam to go unoptimized can't be overstated.

These types of operations will also benefit from flare.IQ because it eliminates harmful black smoke from under steaming that remains a perpetual risk.

Flare precision and control also mitigates serious safety risks for operations without a gas recovery system and may help prevent a catastrophic event.

Operations with assisted flares that have gas recovery systems

Operations that have a gas recovery system benefit from flare.IQ and optimized flaring because of their emergency flaring, which occurs several times a year on average. At present, flare management and control processes used by operations with a flare recovery system are often lacking or just meet the bare minimum requirements. This introduces risk and sub-optimized emissions. Without the proper management, emergency flaring may be harmful to people and the environment, especially when operations are in close proximity to communities.

In a world with ever-changing regulations, having more control is always good. Regulations may soon change emission measurement, reporting, and control requirements for emergency flaring. The use of a gas recovery system with a flare gas compressor that uses flare gas as a fuel instead of burning it is the most efficient (and also the most expensive) way to reduce flaring.

What customers tell us

Customers tell us they save big on steam and see methane reductions when they use flare.IQ by Panametrics. See the infographic below to learn more about a success story.

Case Study : Steam Savings

Refinery data from flare.IQ installation in Ohio, USA. Data trend is comparison to refinery flare control scheme vs. flare.IQ flare control scheme

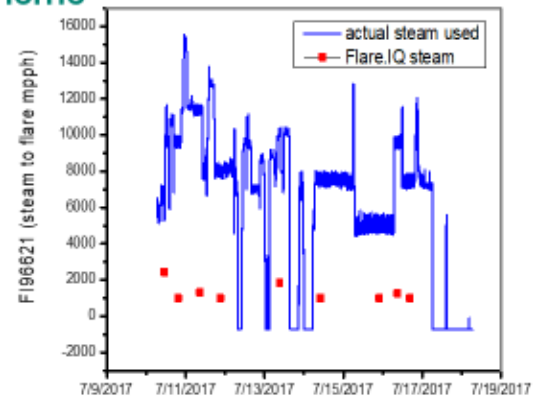
Average Steam Savings		
Hour	Day	Year
6,800 lbs. 3,084 kg	165,000 lbs. 74,842 kg	60,300,000 lbs. 27,351,652 kg
\$30.8	\$748	\$273,516

To generate 1 Lb (0.45 kg) of steam (@300 PSig or 2,068 kPa) with 75°F (23.9°C) of water, it requires 1158 Btu (1,222 kJ). Natural gas heating content of 920 BTU/SCF (34,278 kJ/m³). With a typical boiler heating/combustion efficiency of 85.7%, it requires:

$1158/920/85.7\% = 1.468$ SCF of Natural gas per pound of steam produced
 $1,222/34,278/85.7\% = 0.092$ m³ of NG per kg of steam

Assumes steam costs ~\$10 per metric ton

Resulting Methane Reduction		
Hour	Day	Year
10,000 SCF 268 Nm ³	242,000 SCF 6,432 Nm ³	88,580,895 SCF 2,347,680 Nm ³



Multi-day trend of actual steam consumption vs. calculated flare.IQ steam requirement

Getting started/next steps

Operations that are ready to take their flare control to the next level can turn to flare.IQ. After identifying the need for more optimized flare control is to choose an optimized flare management solution. Flare.IQ by Panametrics, which includes digital verification. A digital verification tool can reduce the logistical and operational costs that are typically associated with things like (but not always including) building scaffolding, getting technician support, and applying for permits to create the infrastructure to verify your flare meter. Digital verification also minimizes the process interruption of operation while the flare meter is digitally verified, and reduces HSE risks associated with sending people to validate the flare meter.

Follow the steps below to get started:

1. Fully assess your entire flare operation
2. Understand the internal and external requirements
3. Estimate the Return on Investment (ROI) of flare optimization
4. Choose a tailored solution like flare.IQ
5. Implement your solution and measure results

Summary

In oil and gas operations, real-time flare optimization has significant and far-reaching consequences. Using ultrasonic flare control solutions makes it possible to improve Return on Investment (ROI) while simultaneously seeing advancements in safety, mitigating risk and reducing potentially negative environmental impact. Reach out to Panametrics to learn more about flare.IQ for advanced flare control and digital verification.

Panametrics, a Baker Hughes Business, provides solutions in the toughest applications and environments for moisture, oxygen, liquid and gas flow measurement. Experts in flare management, Panametrics technology also reduces flare emissions and optimizes performance.

With a reach that extends across the globe, Panametrics' critical measurement solutions and flare emissions management are enabling customers to drive efficiency and achieve carbon reduction targets across critical industries including: Oil & Gas; Energy; Healthcare; Water and Wastewater; Chemical Processing; Food & Beverage and many others.

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