thermoscientific

What you need to know about flare gas emissions, compliance and monitoring

ThermoFisher SCIENTIFIC

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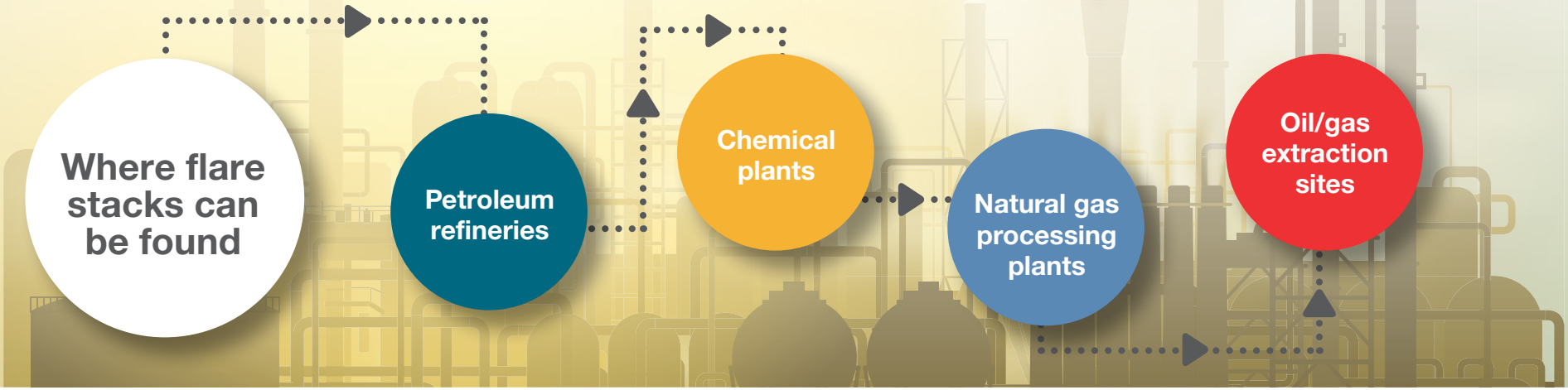
Overview

What are flare stack emissions?

Flare stacks emit excess hydrocarbon gases that cannot be recovered or recycled. These gases combined with steam and/or air are burnt off in the flare system to produce water vapor and carbon dioxide. Flaring can occur during start-up, shut-down and during unplanned operational interruptions such as, power outages. National and local government bodies are requiring processing companies to monitor the various emissions from their plant stacks and flares to reduce the amount of pollution entering the atmosphere.



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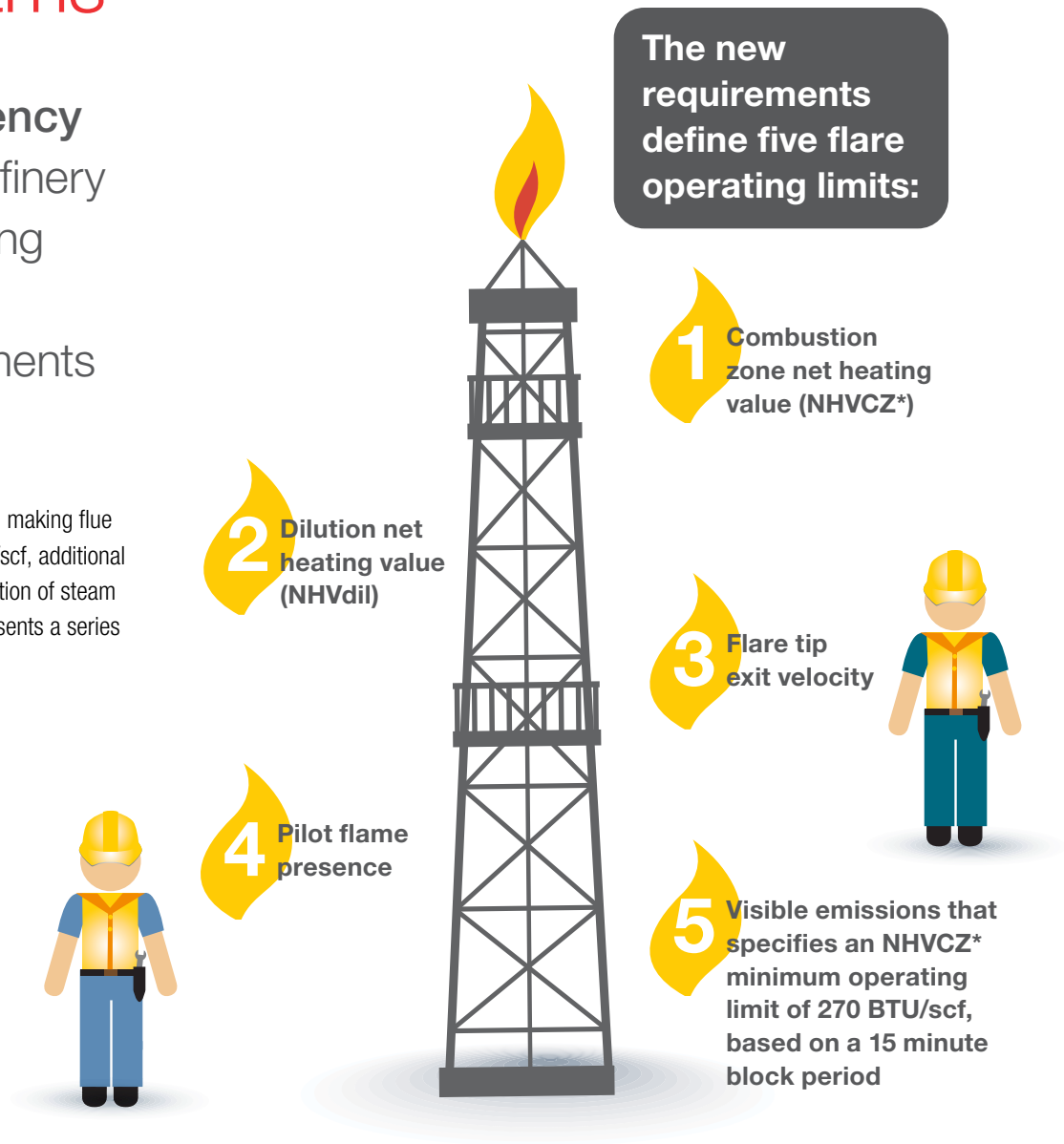
Compliance

Compliance: Flare streams

The **US Environmental Protection Agency (EPA)** has published amendments to Refinery Sector Rule RSR 40 CFR Part 63 affecting flares; refineries must bring flares into compliance with new §63.670 'Requirements for Flare Control Devices'.

*NHVCZ can be calculated by measuring the net heating value of the vent gas (NHVVG), making flue gas analysis a vital part of any compliance strategy. If the NHVCZ approaches 270 BTU/scf, additional fuel gas such as propane or natural gas must be added. This may then require the addition of steam to the flare, to avoid the production of visible emissions. The analysis of flare gases presents a series of challenges to the processing industries.



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Compliance: Total sulfur

Regulators are interested in values for hydrogen sulfide (H_2S) and Total Reduced Sulfur (TRS); however, there is some divergence on what constitutes TRS. In some cases it is defined as H_2S together with carbonyl sulfide (COS) and carbon disulfide (CS_2). It can also be defined as a mixture of compounds, which contain a sulfur component in the reduced form, most commonly H_2S, methanethiol (methyl mercaptan, CH_3SH), dimethyl sulfide (DMS, $(CH_3)_2S$) and dimethyl disulfide (DMDS, $CH_3S_2CH_3$).

40 CFR* 60 Subpart J/a:

- Analyzers must be able to measure 10-30% higher than highest expected sulfur level
- All flares modified after May 14, 2007 must comply
- Existing SCAQMD and BAAQMD compliant systems must meet requirements of 40 CFR 60 Subpart J/a
- If compliance limits are exceeded, root cause analysis must be performed

*Code of federal regulations

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Monitoring technology

Measuring flare gas streams with process mass spectrometers

Although many regulations require just the total heating value, total sulfur, or total hydrocarbon values to be recorded, measuring the concentrations of individual components helps identify the source of the emission, locating the problem to a specific part of the plant. Root cause fault analysis is therefore greatly facilitated, by comparing the detailed composition data from the flare gas stream with that of the various process streams. The analysis speed is crucial as the heating value of the flare can quickly change. Analysis times measured in minutes increase the risk of failing to meet emission standards.

- Accurate
- Fast
- Multicomponent analysis
- Monitor more than one flare
- Measure process and flare streams

Magnetic Sector Mass Spectrometer

Key advantages of magnetic sector analyzers include:

- Improved precision—2 and 10 times better than a quadrupole analyzer
- Greater accuracy
- Long intervals between calibrations
- Resistance to contamination

Rapid Multistream Sampling (RMS)

Key advantages of RMS include:

- Fast, reliable means of switching between streams
- Sample selection from 1 of 32 or 1 of 64 streams
- Maintenance interval ~10 million cycles
- Not a rotary valve

Click here to download the application note: Fast online monitoring of flare gases

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Measuring total sulfur with process mass spectrometers

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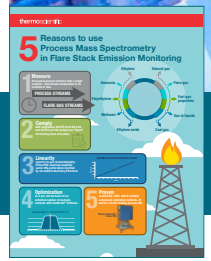
Improperly operated flares may emit methane, sulfur dioxide and other sulfur compounds

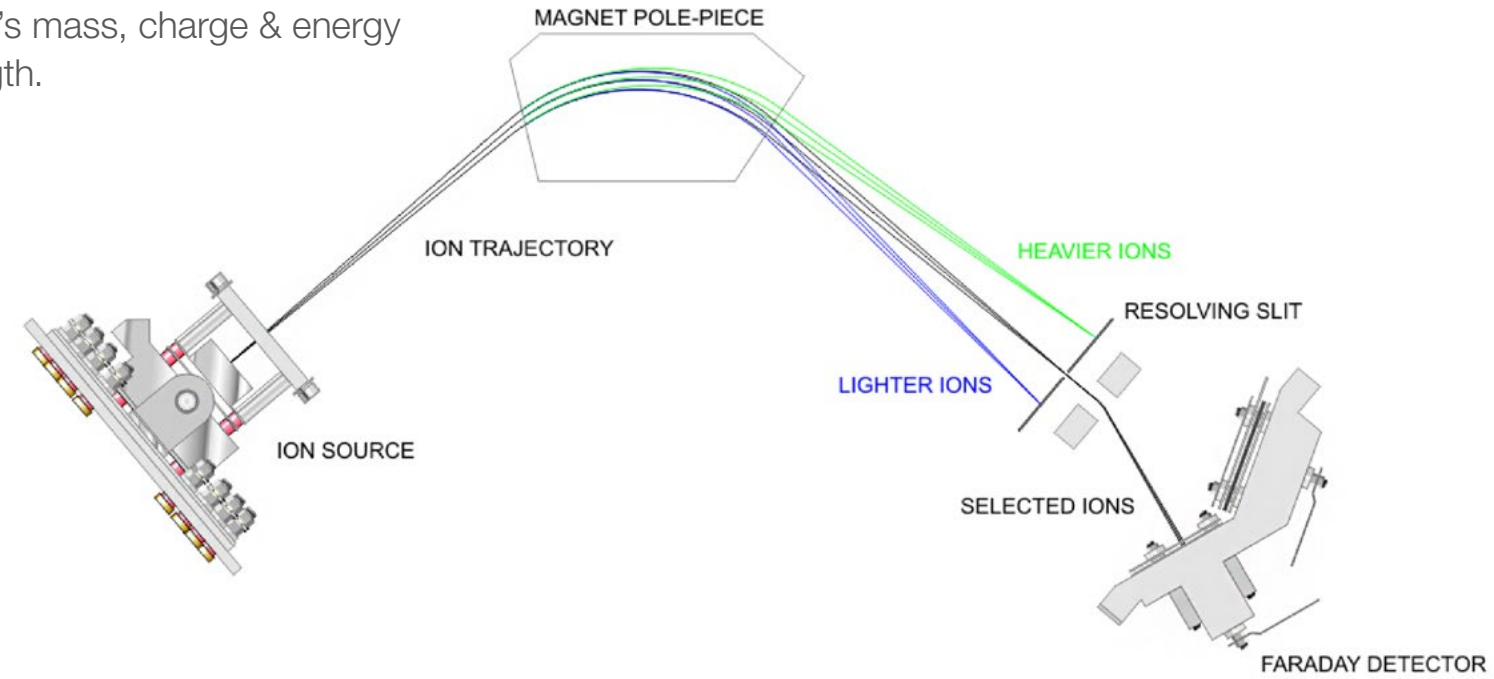
Process mass spectrometers can measure a number of sulfur compounds from percentage of concentrations down to ppm levels. Analysis time is less than 30 seconds, including stream switching time. They calculate and report heating values according to ISO 6976 (ASTM D 3588). They can also calculate average molecular weight and density.



Click here to download the infographic: 5 Reasons to Use Process Mass Spectrometry in Flare Stack Emission Monitoring

Overview of how process mass spectrometers works

- Sample gas (here, N_2 and O_2) enters ion source and is converted to positive ions by collision with high energy electrons from filament.
- N ionized to N+, 28AMU, O ionized to O+, 32AMU. 2222.
- Ions are accelerated into variable magnetic field and move in circular path.
- Radius depends on ion's mass, charge & energy and magnet field strength.
- Vary magnet field strength—bring ions sequentially onto a single detector.
- Peak height is directly proportional to concentration.
- Magnetic sector analyzer produces characteristic flat top peak—don't need to measure dead centre of peak.



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Measuring total sulfur with process analyzers

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Total sulfur process analyzers provide continuous and accurate determination of total sulfur in flare gas streams. They use PUVF (pulsed ultra–violet fluorescence) spectrometry to determine total sulfur.

What is PUVF technology?

To determine the total sulfur content of hydrocarbon samples by PUVF, all organically bound sulfur is converted to sulfur dioxide (SO_2) by sample combustion. Irradiation of SO_2 with ultraviolet light at a specific wavelength forms an excited form of SO_2. The excited SO_2 relaxes to its ground state by the emission of light or fluorescence. The intensity of the emitted light is directly proportional to the SO_2 concentration and thus the flare stack's total sulfur concentration.

The PUVF detector uses a variable PMT (photomultiplier tube) power supply to set the detector sensitivity over the entire range from 10ppm to 100%. Dual sample injection valves, with a 100: 1 dilution ratio, are used to introduce the sample into the zero grade air carrier/ combustion gas.

Click here to download Sulfur Online Analyzer product specification.

Measuring total sulfur with process analyzers

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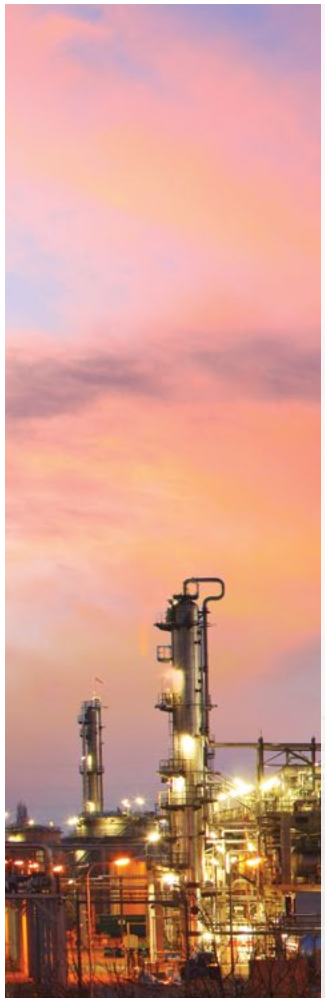

Flare gas and condensable vapors

A dynamic measuring range from 10 ppm to 100% S by volume with fast high-to-low response time, enabling reliable flare stack sulfur emission reporting.

Clean fuels

- Enables refiners to make timely process adjustments to enhance the economic efficiency of desulfurization and fuel blending operations.

Multi-calibration/Multi-stream

Enables multiple streams of different sulfur concentrations (i.e., batch processing, inlet/outlet of reactors, etc.) to be measured by a single analyzer.

Benefits of the SOLA iQ Flare

- Vapor samples up to 100% total sulfur
- Low range set to 1% of high range
- Linear over the entire measuring range
- Configured specifically for high dew point vapor samples

Click here to download SOLA iQ FAQ

Equipment

In process control and measurement equipment

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Prima PRO Process Mass Spectrometer

Accurate analysis of hydrogen over a wide dynamic range is critical because of its high combustion potential. Thermo Scientific™ Prima PRO's magnetic sector analyzer has been independently evaluated by Effectech UK, an independent specialist company providing accredited calibration and testing services to the energy and power industries.

GasWorks® MS Analysis Software

The Thermo Scientific™ GasWorks software provides an intuitive, information rich and flexible window into the operation of the Prima PRO, Prima BT and Sentinel PRO. GasWorks is designed for rapid installation and to facilitate ongoing operation while providing a secure, stable platform for process analytics.

Click here to watch the video: Flare Gas Monitoring by Prima PRO

In process control and measurement equipment

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SOLA iQ On-line Sulfur Analyzer

The highly accurate Thermo Scientific™ SOLA iQ Flare analyzer features a dynamic measuring range from 10 ppm to 100% S by volume with fast high-to-low response time, enabling reliable flare stack sulfur emission reporting.

An accurate measurement of total sulfur in a range of liquid and vapor fluids, correlating to;

- ASTM Method D5453 for liquid phase samples
- ISO Method 20846 for petroleum products

AutoCONFIG Software

Thermo Scientific™ AutoCONFIG Software's intuitive, heavy duty front panel mounted 7" color touchscreen user interface. The software runs from a local networked PC for security protected access.

1. SOLA iQ to SOLA II comparison
2. Prima PRO specification sheet
3. Refining and petrochemical industry monitoring solutions brochure

Additional resources

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For additional information or to request a quote, please click below.

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