APPLICATION NOTE

Continuous flare stack emission monitoring

Thermo Scientific SOLA iQ Flare Analyzer

Author: Daniel Merriman, Thermo Fisher Scientific, United Kingdom

Keywords
- 40 CFR 60 Subpart J/a
- Refinery flare emissions
- Total sulfur
- Pulsed Ultra Violet Fluorescence (PUVF)
- Compliance
- Validation

Introduction

In September 2012 the US Environmental Protection Agency (EPA) promulgated a final ruling that all refinery flares that were installed or modified after May 2007 must be equipped with a monitoring system for emissions of sulfur. The maximum permitted sulfur emissions were set at 500lb (on an annual basis) in a 24-hour period. If compliance limits are exceeded root cause analysis must be performed. This ruling requires those existing flares to be equipped with a monitoring system by November 2015, the rule still applies.

In anticipation of the potentially high concentrations of sulfur in refinery flares, the requirement is to measure very high concentrations of sulfur and indeed the EPA further ruled that the installed monitoring system must be able to report up to 30% higher than the expected sulfur levels.

The Thermo Scientific™ SOLA iQ Flare analyzer is a reliable and effective solution for rapid determination of total sulfur at concentrations from 10ppm to 100% sulfur. This dual auto-ranging analyzer returns continuous sulfur measurements to operating units, ensuring efficient and reliable compliance to the EPA rules. The SOLA iQ Flare analyzer requires very infrequent user intervention for

maintenance and with no costly utilities offers extremely low cost of ownership.

Each measurement range is independently calibrated and can be validated at user defined intervals to meet the requirements of the EPA rule.

To achieve the two independent measuring ranges and to maintain the ±1% of full-scale linearity and repeatability for each range, a unique analytical arrangement is utilized. The PUVF detector uses a Programmable Photomultiplier Tube (PMT) power supply to set the detector sensitivity. Dual sample injection valves, with a 100:1 dilution ratio, are used to introduce the sample into the zero-grade air carrier/combustion gas. The software will automatically choose the appropriate measuring range (PMT setting and sample injection valve) based upon the sulfur level

	Low Range 1	High Range 2
Total Sulfur	0-3000 ppmv	3000-300,000 ppmv
Repeatability & Linearity	+/- 1% of 3000 ppmv or better	+/- 1% of 300,000 ppmv or better
Valve Type	10 port rotary valve	6 port rotary valve
Sample Injection Volume	100 ul	1 ul
Range Switching Points	Low to high range at 3,000 ppmv	High to low range at 10% 2700 ppmv
Response During Flare Event	2-4 min to fully achieve high response	5-8 min to achieve recovery after a high sulfur flaring event

Figure 1 Typical SOLA iQ Flare analyzer range configuration for a 30% measuring range

output in real-time. The transitions from low to high and high to low range are programmable to optimize performance; Figure 1 shows how a 30% high range may be setup, in this example when the sulfur content in the sample increases above the low range threshold the SOLA iQ Flare analyzer automatically switches to the high range, when the sulfur level falls to 90% of the low range full scale the analyser returns to low range.

Utilizing two injection valves ensures that approximately the same amount of sulfur passes to the detector when operating at the high end of both measuring ranges. This arrangement allows the SOLA iQ Flare analyzer to achieve an unmatched recovery time after a flaring event with high sulfur content. The recovery time is five to eight minutes from percent levels down to low ppm levels.

The excellent recovery time is important while measuring flaring events, but is also critical for the required daily validations. Every 24-hour period, a high sulfur standard must be applied to the analyzer that is within 80-100% of the high measuring range. Daily validation time needs to be minimized – each validation gas is required to be analyzed for ten minutes. Depending upon the validation sequence selected, two to three standards are required to achieve the four validation runs required for two measuring ranges.

Principle of operation

The SOLA iQ Flare analyzer is based on the same field-proven SOLA II Flare online sulfur analyzer that employs PUVF spectrometry for determination of total sulfur. To determine the 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.

Sample introduction and combustion

A sample conditioning system is used to provide sample filtration and to regulate sample pressure, temperature and flow rate as required. The sample is then injected every 30 seconds by one of the two injection valves by an air carrier gas.

Additional air is added upstream of the mixing chamber, this mixing chamber ensures a thorough mixing of the hydrocarbons and air. The pyrolizer, operating at 1100 ^{0}C ensures that all sample components are combusted to CO_2, H_2O and SO_2 in the pyrolizer. The combusted sample is transported to the PUVF detector for measurement of the SO_2. Thorough studies have proven that at this temperature all sulfur species are converted to SO_2, this is supported by several ASTM standard methods.

For ease of maintenance the pyrolizer is mounted to the inside of the oven door, providing full access to the rugged ceramic furnace tube & heater components, which can be removed for replacement in just a few minutes without removing the pyrolizer.

For the SOLA iQ Flare analyzer the sample line enters the oven directly and the injection valve is always located within the oven to enable the appropriate temperature to be maintained.

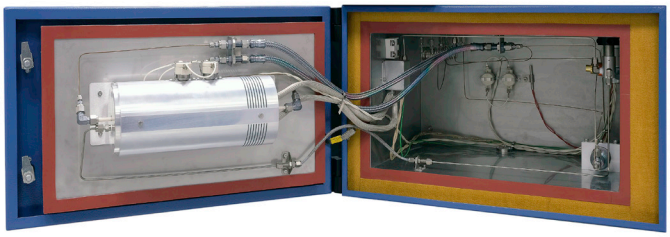

Figure 2 SOLA iQ Flare analyzer oven and pyrolizer assembly

The inclusion of a photodetector within the optical chamber of the analyzer enables the software to monitor light intensity and regulate the lamp voltage, ensuring very

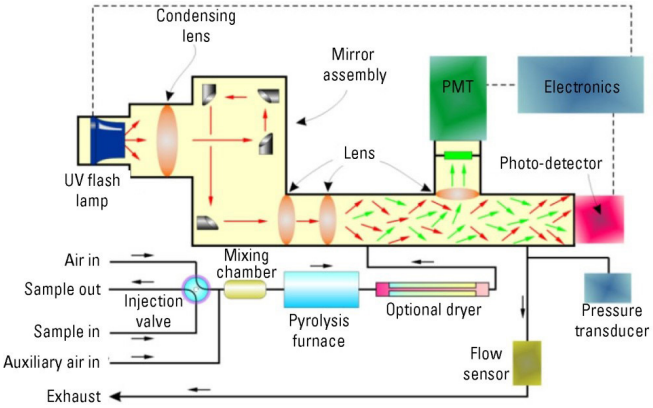

Figure 3 SOLA iQ Flare analyzer detector schematic

stable operation. This also provides a valuable feedback loop where the rate of lamp voltage change is used to diagnose potential lamp failure and even partial failure of the combustion process facilitating early intervention to prevent analyzer contamination.

The PUVF detector is highly accessible as the whole of the analytical bench folds out of the cabinet on a secure hinge; from here the pulsed UV lamp, photo detector, Photo Multiplier Tube and other critical components are within reach. The UV lamp is quick to replace and because it is not a conventional continuous UV lamp, the lifetime is typically two times longer, further reducing the cost of ownership for the SOLA iQ Flare.

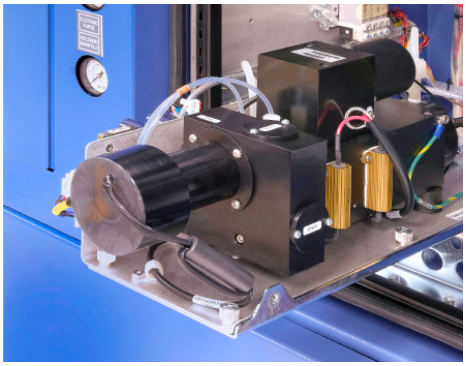

Figure 4 SOLA iQ Flare analyzer UV fluorescence bench

Graphical User Interface

Essential analyzer functions are easily accessed via the intuitive Graphical User Interface (GUI) mounted conveniently on the front panel of the SOLA iQ Flare analyzer. Suitable for installation in Zone 1 and Div 1 hazardous areas, this ultra-responsive touch panel displays total sulfur readings as well as diagnostic information including oven & furnace temperatures, PMT and lamp voltages, detector flow rate and many more.

Critical analyzer configuration settings are security protected to prevent improper use, invoke a validation or run calibration routines with just a few simple clicks, or examine stored data in graphical form.

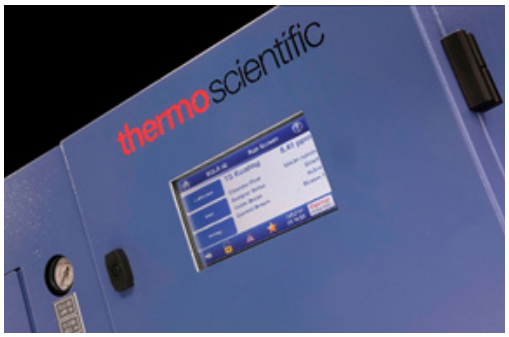

Figure 5 SOLA iQ Flare analyzer front panel Graphical User Interface

Connect securely from a remote location on your PC or mobile device to access all the same front panel display functions. Approved users can also access all analyzer setup and configuration parameters and all process and diagnostic data. Connect via a standard PC across your Local Area Network. Download 30,000 data records (process and analyzer functions), typically up to 24 hours of records via Thermo Scientific™ AutoCONFIG software.

AutoCONFIG Software

The AutoCONFIG software is a very powerful and flexible tool that can be used to create configurable pages permitting such functions as, but not limited to, viewing and changing the analyzer setup, viewing alarm logs, collecting and downloading historical data, and initiating calibration. A set of specific pages have been pre-configured to perform SOLA iQ analyzer related operational and diagnostic functions. Run AutoCONFIG on a PC connected to the SOLA iQ Flare analyzer via a standard network connection.

Driving performance

Thermo Fisher Scientific provides vital support to your product's lifecycle. These solutions are created to minimize cost of ownership, increase uptime and maintain regulatory compliance to meet your business needs. Our Global Service Team is focused on solving your equipment issues, providing you world-class training and technical support.

- Spare parts & kits
- Field service
- Technical support
- Technical training

thermo scientific

Figure 6 SOLA iQ Flare analyzer

Summary

The installation of a reliable and continuous total sulfur analyzer for flare gas monitoring enables plant operators to maintain compliance to EPA rules. The SOLA iQ Flare analyzer combines the most proven technology for total sulfur measurement with a host of new features to enhance the user experience, reduce maintenance and control total cost of ownership.

USA
27 Forge Parkway
Franklin, MA 02038
Ph: (713) 272-0404
Fax: (713) 272-2273
orders.process.us@thermofisher.com

India
C/327, TTC Industrial Area
MIDC Pawane
New Mumbai 400 705, India
Ph: +91 22 4157 8800
india@thermofisher.com

China
8/F Bldg C of Global Trade Ctr,
No.36, North 3rd Ring Road,
Dong Cheng District
Beijing, China 100013
Ph: +86 10 84193588
info.eid.china@thermofisher.com

Europe
Ion Path, Road Three,
Winsford, Cheshire CW73GA UK
Ph: +44 1606 548700
Fax: +44 1606 548711
sales.epm.uk@thermofisher.com

Find out more at **thermofisher.com/flaregases**

ThermoFisher SCIENTIFIC

© 2020 Thermo Fisher Scientific Inc. All rights reserved. All trademarks are the property of Thermo Fisher Scientific and its subsidiaries unless otherwise specified. TS_SOLAiQ_0720