AMETEK®
PROCESS INSTRUMENTS

APPLICATION NOTE

MEASUREMENT OF SULFUR IN REFINERY FLARE GAS STREAMS

Tunable diode laser absorption spectroscopy (TDLAS) based analysis for compliance with the United States EPA Subpart J(A) regulatory requirement

US EPA regulation NSPS Subpart J(A) has placed an extra investment and operational burden on petroleum refineries to meet the regulatory requirement. AMETEK Process Instruments offers an economical solution to meet the challenge of the measurement of high-range and low-range hydrogen sulfide (H_2S) in refinery flare gas streams, with an emphasis on lower capital and operating cost along with improved reliability.

The EPA regulation summary

- Routinely combusted flare gases cannot exceed 162 parts per million (ppm) H_2S on a three-hour rolling average
- Refineries shall continuously measure flare gas lines and record H_2S on a low-range scale of 0-300 ppm
- Total reduced sulfur (TRS), which is defined as H_2S + carbonyl sulfide (COS) + carbon disulfide (CS_2), shall be continuously measured at a high range with a minimum scale of 0 to 5,000 ppm or 1.3 times the maximum expected concentration of H_2S (site-specific). In practice the high-range scale tends to be in 0 to 40% H_2S and higher
- In addition to the H_2S (low-range) and TRS (high-range) analysis, both flow and British thermal unit (BTU) must be measured. This application bulletin does not address these measurements

METHODS OF MEASURING THE HIGH-RANGE TRS

The low-range (0 to 300 ppm) is defined as H_2S only. For the high range the requirement is to measure TRS. The EPA document describes various choices in terms of the high range measurement, to comply with the Subpart J(A) requirement the most practical being:

1) Measure just the H_2S at the high range (not the COS, CS_2) and establish a correlation of the ratio of CS_2, COS to the H_2S value by grab sample and lab analysis
2) Measure total reduced sulfur as H_2S + COS + CS_2 (using EPA method 15 as a basis)
3) Measure total reduced sulfur by oxidizing the sample to sulfur dioxide (SO_2) and measure as SO_2 (using EPA ref method 15a as a basis)

The AMETEK solution utilizes the first technique described above; direct measure of H_2S (only) for the high range utilizing TDLAS. The TDLAS technique is highly specific to H_2S, fast-reacting and immune to contamination from high concentrations of H_2S span gas or high H_2S event. The reasons for not measuring the COS and CS_2 are the limitation of the spectroscopy to measure COS and CS_2 at the required ranges.

Unlike other technologies, TDLAS is non-contact and resistant to process upsets. It's also virtually maintenance-free. Operational savings over a GC are significant, as shown in Figures 1 and 2. Based on customer input operation savings related to usage of instrument air, carrier gas, calibration gases, electricity, consumable parts and labor can be $10-20,000 per year. As with any compliance analyzer, reliability and availability is paramount. TDLAS non-contact technology is resilient against common issues that plague other analytical analyzers like contamination of liquids, exposure to process upsets, etc.

Limitations with other analytical techniques

- Utilizing a single GC for both the low (H_2S) and the high-range TRS measurements can be compromised by high-concentration H_2S daily cylinder gas audits or a high-concentration H_2S process event
- Utilizing an oxidizing technique, followed by dilution and pulsed fluorescence spectroscopy, has the associated complications of dilution orifices being fouled and introduction of an open flame for the oxidizer
- Both GC and oxidizing (dilution orifice) techniques are subject to damage from the ingress of liquids, which can be a common occurrence due to failure of liquid seals, addition of steam to the flare line, and the presence of entrained liquid hydrocarbon

Advantages of TDLAS

- TDLAS is a direct, continuous measure and non-contact technique
- The AMETEK 5100HD has a H_2S reference cell, this ensures line-lock at low concentrations as H_2S approaches zero. The technique is continuous direct measure – no scrubbing or switching required
- The 5100HD is rated IP65 for installation in a free ventilated building or three-sided shelter, eliminating the need for a temperature-controlled analyzer house and the associated infrastructure in many environments
- An additional safety benefit of installing the analyzer in a free ventilated building or three-sided shelter, is the reduced risk of exposure to H_2S from the daily (high) concentration H_2S cylinder gas audits
- Low-maintenance – no carrier gas, no flame, no columns, no dilution, no switching

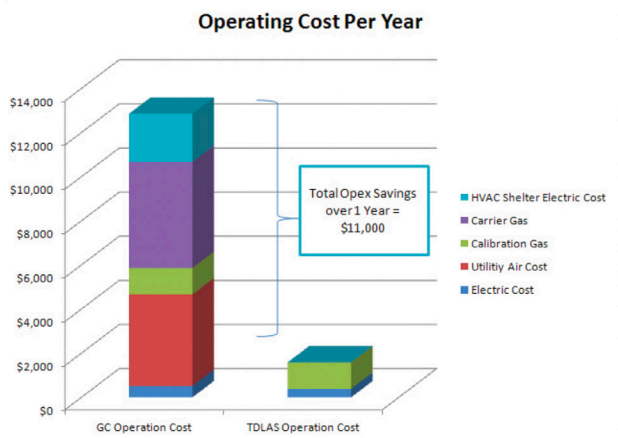

Figure 1. Operation cost of TDLAS versus a process GC

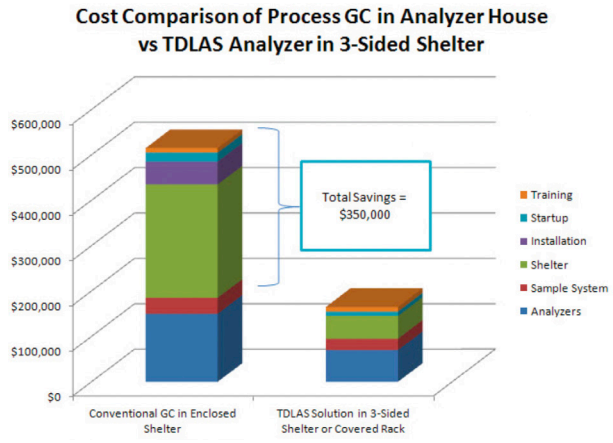

Figure 2. Capital cost of a TDLAS versus a process GC

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