Sulfur Recovery and Tail Gas Treating Unit Process Analyzer Applications

The Claus sulfur recovery unit (SRU) and associated tail gas treating unit (TGTU) have eight (8) possible analyzer tags (see Figure 2, Simplified Process Flow Diagram). The H₂S / SO₂ TGTU tail gas analyzer (AT4) is the one constant – every SRU will employ this critical analytical measurement. If the SRU is followed by a TGTU, there is at least one and possibly two additional analyzers located at sample point locations AT5, AT6, and/or AT7. The feed gas/acid gas analyzer (AT1) becomes more prevalent as recent developments provide real time full composition analysis to mitigate hydrocarbon (HC) upsets. In addition to measuring H₂S and total HC, the feed gas analyzer can quantify the acid gas contaminants (BTX, Methanol CO₂).

There are two other process measurements: The measurement of O₂ at the outlet of the waste heat boiler (AT2) for start-up and shutdown purposes, and the sulfur pit gas analyzer (AT3).

Finally, the emissions analyzer, in its simplest form, reports the SO₂ emission but can also be used as a process optimization tool if the emission is expressed in mass basis terms.

Figure 1. Field Data / HC Process Upset.

Figure 4. COS Upset Data from TGTU Absorber.
AT2 – Oxygen Analyzer

(Control of air:natural gas ratio at Start-up and Shut-down)
O₂ (CO)

Model 5100 TDLAS Analyzer

A fixed gas analyzer alternative to a portable unit for start-up (shut-down) when natural gas is introduced, and remaining online as the SRU transitions to (from) acid gas mode.

Benefits of Oxygen Analyzer include:
- The driving force is operator safety and catalyst protection.
- Based on tunable diode laser absorption spectroscopy (TDLAS), a non-contact type of analyzer.

AT3 – Sulfur Pit Gas Analyzer

(Lower Explosive Limit)
H₂S / SO₂

Model 888 / 930 Pit Gas Analyzer

Liquid sulfur contains ~350 ppm of dissolved H₂S and spontaneous degassing results in accumulation in the head space. If the sweep gas is interrupted, H₂S can reach the lower explosive limit (LEL) (~3.25 %). See Figure 3. Benefits of Pit Gas Analyzer include:
- CFD modeling confirms localized H₂S concentrations can be 16 times the mean value, indicating values of ~2,000 ppm H₂S may constitute an imminent hazard.
- SO₂ is monitored to alarm for a smoldering pyrophoric sulfur fire.

AT4 – Tail Gas Analyzer

Model 888 / 900 Tail Gas Analyzer

Measurement of H₂S / SO₂ in SRU tail gas for feedback (trim) control of the process air. Reliability has evolved to where the analyzer anticipates and reacts to adverse process conditions. With an installed operating base in excess of 2,000 units, AMETEK offers two types of tail gas analyzers:
- Benefits of Tail Gas Analyzer include:
  - Close-coupled (no sample line): mounts directly on the pipe, does not require climate controlled shelter; rated for 60 °C (140 °F) without external cooling; and automatic flow control.
  - Extractive (sample line) – For installation in an analyzer house in extreme climates, or if the sample point location is compromised due to piping design, or for measurement of COS and CS₂.
  - Sample handling is close-coupled but external to the process, at a safe and accessible distance.
  - Optional double block isolation from the process.

Figure 2. Simplified Process Flow Diagram Showing Eight Process Analyzer Tags (AT#).

Figure 3. Sulfur Pit High H₂S and SO₂ Values (just prior to an incident).