

# Sulfur Recovery Unit Feed Forward Analysis

Applied Analytics Application Note No. AN-020



## Application Summary

Analytes: **H<sub>2</sub>S** (hydrogen sulfide), **NH<sub>3</sub>** (ammonia), **CO<sub>2</sub>** (carbon dioxide)

Detector: **OMA-300 Process Analyzer + MicroSpec IR Analysis Module**

Process Stream: **acid feed gas to sulfur recovery unit**

## Introduction

H<sub>2</sub>S is an extremely dangerous chemical which occurs naturally in fossil fuels and is removed through refining processes. The sulfur recovery unit (SRU) of a refinery converts the H<sub>2</sub>S to elemental sulfur which can be stored or sold off. A critical point in this process is the furnace which combusts H<sub>2</sub>S in order to sustain a 2:1 stoichiometric ratio of H<sub>2</sub>S:SO<sub>2</sub> in the subsequent catalytic reaction. The amount of available oxygen in the furnace is carefully controlled to ensure this ratio for the next step. The efficiency of the entire SRU therefore hinges on the ability to continuously measure the required amount of oxygen (i.e. “air demand”) in the furnace.

While tail gas analysis measures the H<sub>2</sub>S:SO<sub>2</sub> ratio after the furnace to calculate air demand correction, a feed forward analysis system measures the H<sub>2</sub>S concentration in the acid feed gas before the furnace to preemptively adjust air demand based on the real-time feed gas H<sub>2</sub>S level. While tail gas analysis provides the most accurate air demand calculation, this measurement occurs after the furnace. Feed forward analysis allows for air demand control with no process lag by immediately detecting sudden changes in acid feed gas composition and preventing any losses in SRU efficiency.

The OMA system continuously measures 0-100% H<sub>2</sub>S concentration in the acid feed gas to provide real-time feed forward control. This system provides the perfect complement to the TLG-837 Tail Gas Analyzer for total SRU air control.

## System Benefits

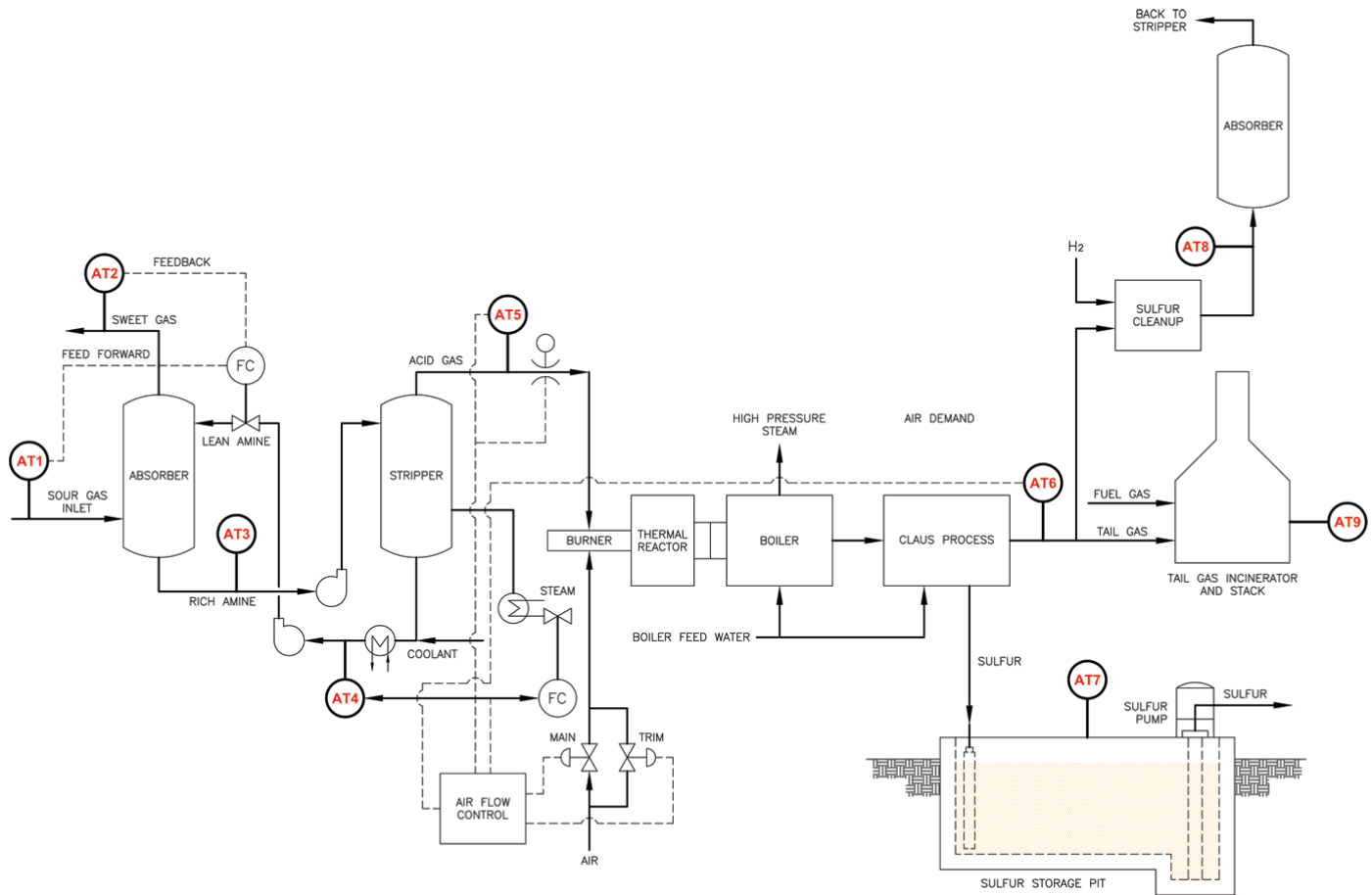
- » Continuously measures H<sub>2</sub>S level in acid feed gas stream using UV-Vis spectrophotometer
- » Totally solid state build with no moving parts — modern design for low maintenance
- » Additional software benches for up to 4 more chemical analytes (e.g. NH<sub>3</sub>)
- » Ultra-safe fiber optic design with no sample gas inside analyzer unit — world’s safest solution for this application

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## Sulfur Recovery Unit Schematic

In the diagram below, the feed forward analysis point is identified by **AT5**.



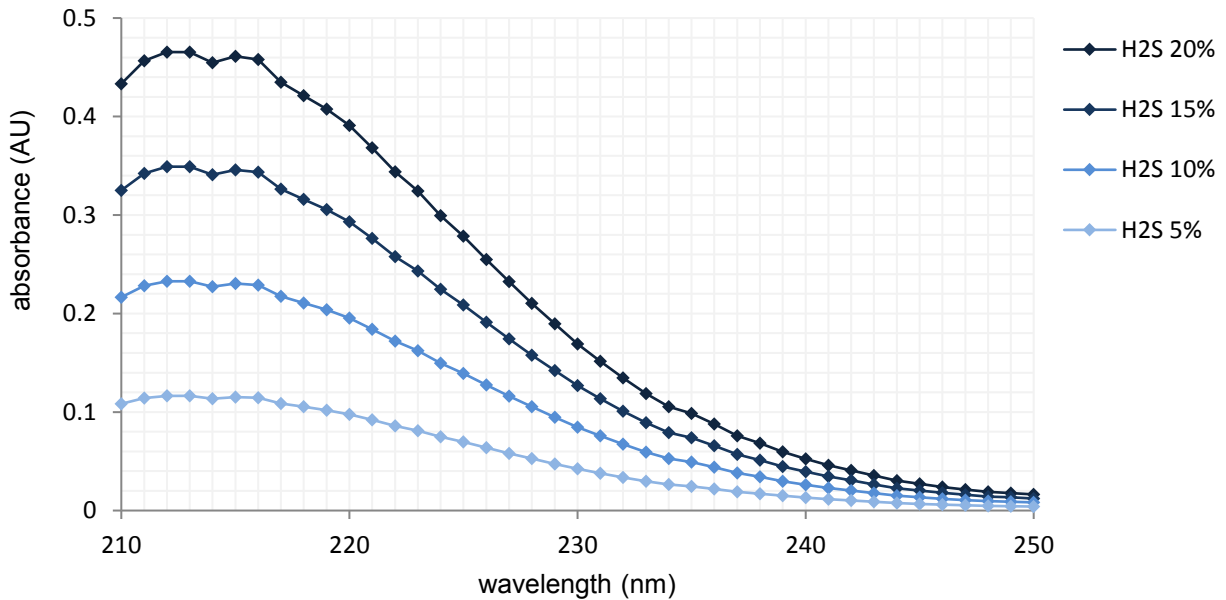
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## H<sub>2</sub>S Absorbance Curve

Any single photodiode measurement is vulnerable to noise, signal saturation, or unexpected interference. This susceptibility to error makes a lone photodiode data point an unreliable indicator of one chemical's absorbance.

As accepted in the lab community for decades, the best way to neutralize this type of error is to use collateral data in the form of 'confirmation wavelengths,' i.e. many data points at many wavelengths instead of a single wavelength:



In the figures above, each diamond represents a single photodiode and data point. After being calibrated on a full spectrum of pure H<sub>2</sub>S, the OMA knows the absorbance-concentration correlation for each measurement wavelength; the system averages the modeled concentration value from each wavelength to completely eradicate the effect of noise at any single photodiode. The OMA visualizes the H<sub>2</sub>S absorbance curve in this manner and knows the expected relation of each data point to the others in terms of the curve's structure.

This curve analysis is critical at the high level H<sub>2</sub>S analysis involved with acid feed gas streams. At very high concentrations, the absorbance will be very high, and a photodiode at a high-absorbance wavelength (e.g. 215 nm) may not register any light at all. Fortunately, the low-absorbance wavelengths (e.g. 240 nm) will be used to validate the curve and reject error.

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## Example Acid Feed Gas Sample Conditioner

The system pictured below was built to monitor 0-100%  $H_2S$  in SRU acid feed gas. Key features for this high level  $H_2S$  application include:

- SS316 fittings & Kalrez gaskets for extreme corrosion resistance
- Heating to 80 C



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The specifications below represent performance of the OMA-300 Process Analyzer with integrated MicroSpec modules in the feed forward SRU application.

For technical details about the OMA-300 Process Analyzer, see the data sheet:

[http://www.a-a-inc.com/documents/AA\\_DS001A\\_OMA300.pdf](http://www.a-a-inc.com/documents/AA_DS001A_OMA300.pdf)

For technical details about the MicroSpec MCP-200 IR Modular Analyzer, see the data sheet:

[http://www.a-a-inc.com/documents/AA\\_DS003A\\_MCP200.pdf](http://www.a-a-inc.com/documents/AA_DS003A_MCP200.pdf)

All performance specifications are subject to the assumption that the sample conditioning system and unit installation are approved by Applied Analytics. For any other arrangement, please inquire directly with Sales.

Subject to modifications. Specified product characteristics and technical data do not serve as guarantee declarations.

Application Data			
Performance Specifications			
	<i>Custom measurement ranges available; example ranges below.</i>		
Accuracy	OMA-300 (UV-Vis)	<b>H<sub>2</sub>S</b>	0-100%: ±1% full scale
		<b>NH<sub>3</sub></b>	0-50%: ±1% full scale
	MCP-200 (NDIR)	<b>CO<sub>2</sub></b>	0-50%: ±2% full scale

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## Further Reading

Subject	Location
OMA-300 H <sub>2</sub> S Analyzer Brochure	<a href="http://www.a-a-inc.com/documents/OMAH2S.pdf">http://www.a-a-inc.com/documents/OMAH2S.pdf</a>
OMA-300 Process Analyzer Data sheet	<a href="http://www.a-a-inc.com/documents/AA_DS001A_OMA300.pdf">http://www.a-a-inc.com/documents/AA_DS001A_OMA300.pdf</a>
TLG-837 Tail Gas Analyzer Data sheet	<a href="http://www.a-a-inc.com/documents/AA_DS004A_TLG837.pdf">http://www.a-a-inc.com/documents/AA_DS004A_TLG837.pdf</a>
Advantage of Collateral Data Technical Note	<a href="http://www.a-a-inc.com/documents/AA_TN-202_CollateralData.pdf">http://www.a-a-inc.com/documents/AA_TN-202_CollateralData.pdf</a>
Multi-Component Analysis Technical Note	<a href="http://www.a-a-inc.com/documents/AA_TN-203_MultiComponentAnalysis.pdf">http://www.a-a-inc.com/documents/AA_TN-203_MultiComponentAnalysis.pdf</a>



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