Lean Amine / Rich Amine Analysis

Applied Analytics Application Note No. AN-025

Application Summary

Analytes: H_2S (hydrogen sulfide), CO_2 (carbon dioxide)

Detection Technology: OMA-300 H_2S Analyzer (UV-Vis spectrophotometer) + MicroSpec module (IR analyzer)

Process Stream: amine solution

Introduction

Amine gas treating is used to remove H_2S and CO_2 from sour gas for environmental reasons. In the absorber unit, an amine solution absorbs H_2S and CO_2 molecules from the feed gas in order to "sweeten" the upflowing gas stream.

Gradually, the amine becomes "rich" (i.e. saturated) with absorbed H_2S/CO_2 and loses scrubbing efficiency. The rich amine must be sent to a regenator unit (typically comprised of a stripper with a reboiler) to be converted back into fresh "lean" amine for recycling into the absorber unit.

In order to minimize energy costs of the operation, the use of the heated regenerator must be carefully controlled. The amine should only be sent to the regenerator when fully saturated to prevent unnecessary regenerator activity. This circulation can be optimized by implementing a system to monitor H_2S/CO_2 loading in the rich amine and determine current saturation level.

Additionally, the lean amine produced by the regenerator should be validated by a continuous H_2S/CO_2 loading measurement to ensure there are no problems with the stripper. Watching breakthrough levels in the lean amine allow for prompt response to regenerator problems and prevent treating efficiency losses from sending ineffective amines to the absorber.

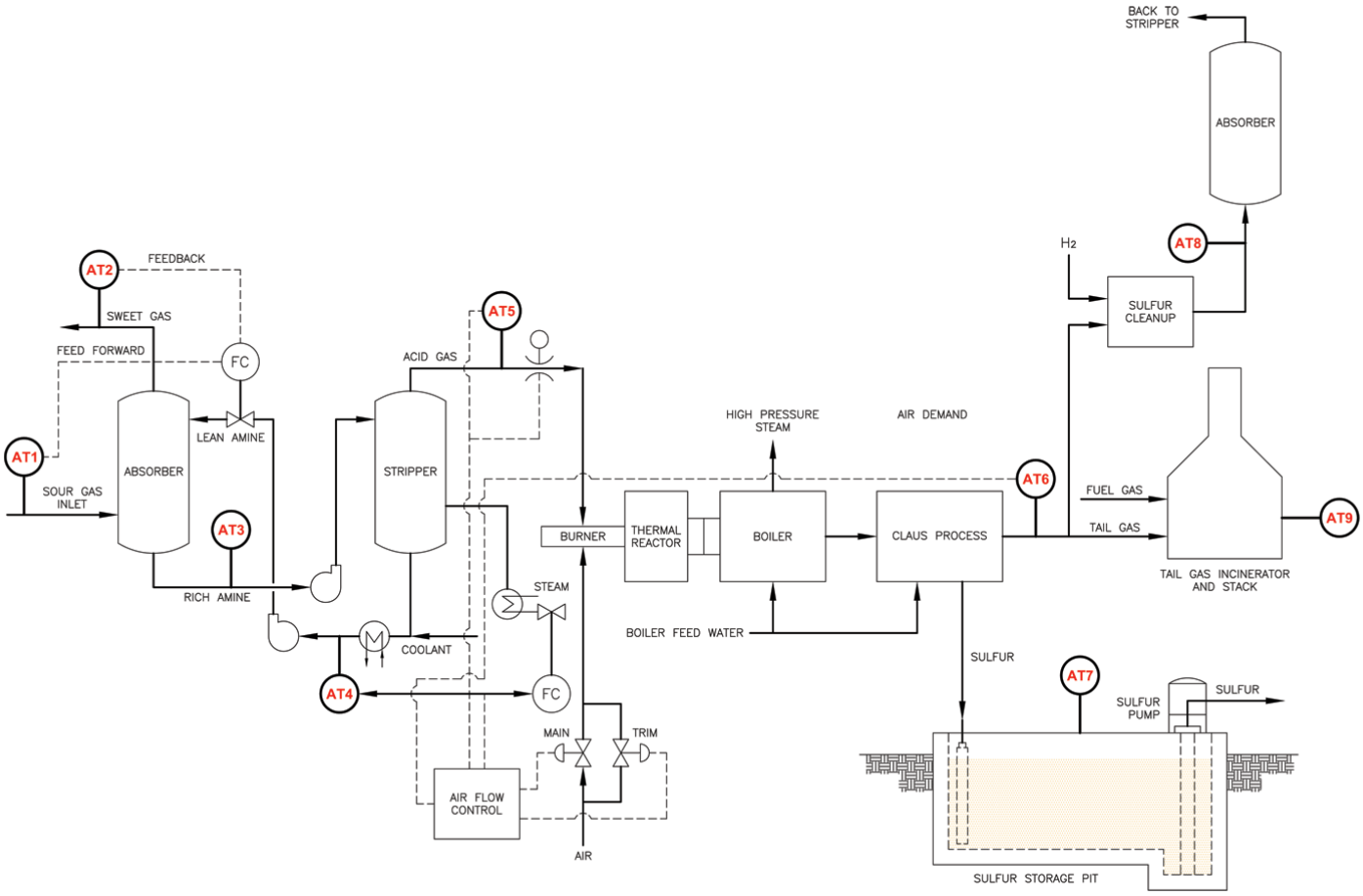
The OMA +MicroSpec Solution

Continuously monitoring H_2S and CO_2 levels in the amine solution, the OMA +MicroSpec system provides the solid state solution with total automation. The system uses a dispersive UV-Vis spectrophotometer to measure H_2S absorbance and a integrated MicroSpec IR module to measure CO_2 absorbance.

Auto Zero functionality ensures highly sustainable accuracy with no human involvement. The OMA +MicroSpec system is the ideal solution for lean/rich amine analysis in terms of proven reliability, ease of use, and inherent operator safety by virtue of the fiber optic flow cell design.

Sulfur Recovery Unit Schematic

In the diagram below, the amine analysis applications are identified by **AT3** (RICH AMINE) and **AT4** (LEAN AMINE).



Direct Analysis vs. Headspace Analysis

Depending on the characteristics of the amine solution used by the process, Applied Analytics will implement either direct analysis or headpsace analysis.

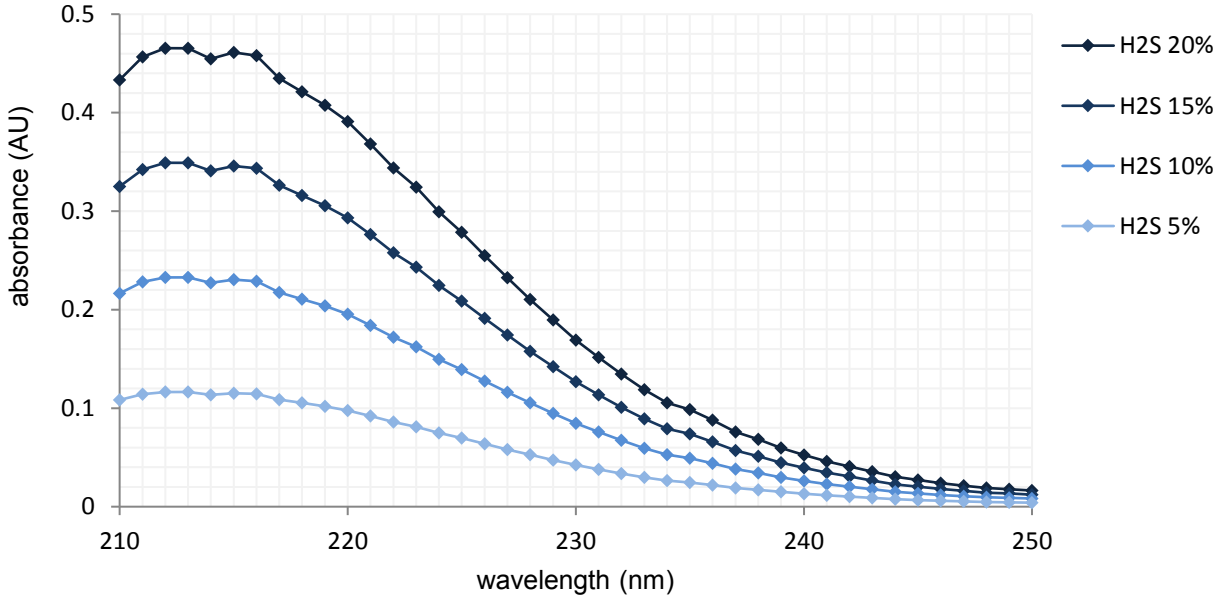
In **direct analysis**, the system performs Auto Zero using lean amine to normalize the spectrophotometer for the zero-loading absorbance background, thus compensating for any unpredictable changes in the amine solution composition. The analysis is performed with the liquid amine solution running through the flow cell.

In **headspace analysis**, the system uses Henry's Law to analyze a vapor-phase sample produced by heating the amine liquid to a controlled temperature where the partial pressures of H_2S and CO_2 are known. The vapor phase concentrations are easily correlated to the concentrations in the liquid solution. This design is especially useful when amine composition varies widely with high-absorbance interfering agents.

H_2S Absorbance Curve and the Power of Collateral Data

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 spectra above, each diamond represents a single photodiode and data point. The spectrophotometer measures absorbance at each integer wavelength within the 200-800 nm UV-Vis range and produces an H_2S absorbance curve.

After being calibrated on a full spectrum of pure H_2S, 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_2S 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 enables the OMA to automatically detect erroneous results at specific wavelengths, such as when a single photodiode is saturated with light. The normal photometer, with a single data point, is completely incapable of internally verifying its measurement.

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The specifications below represent performance of the OMA-300 Process Analyzer with integrated MicroSpec modules in a typical amine analysis 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

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

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.

Application Data			
Performance Specifications			
Accuracy	*Custom measurement ranges available; example ranges below.*		
	direct analysis	**H_2S**	0 to 0.5 mol H_2S/mol amine: ±1% full scale
	headspace analysis*	**H_2S**	±1% full scale
		CO_2	±2% full scale
	*Note: Accuracy specifications for headspace analysis represent headspace gas sample analysis validated with span gas.		

Further Reading

Subject	Location
OMA-300 H_2S Analyzer Brochure	http://www.a-a-inc.com/documents/OMAH2S.pdf
OMA-300 H_2S Analyzer Data sheet	http://www.a-a-inc.com/documents/AA_DS001B_OMA300H2S.pdf
MicroSpec MCP-200 Analyzer Data sheet	http://www.a-a-inc.com/documents/AA_DS003A_MCP200.pdf
Headspace Sampling System Brochure	http://www.a-a-inc.com/documents/headspace.pdf
Advantage of Collateral Data Technical Note	http://www.a-a-inc.com/documents/AA_TN-202_CollateralData.pdf

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