Measuring Hydrogen Sulfide in Biogas & Landfill Gas

Applied Analytics Application Note No. AN-018

Application Summary

Analytes: hydrogen sulfide (H_2S)

Detector: OMA-300 H_2S Analyzer

Process Stream: biogas / landfill gas

Typical Range: 0-1000 ppmv

Introduction

Renewable energy is an area of enormous growth, but harvesting these energy sources comes with its own challenges. The fuel gases generated by biological processes (e.g. anaerobic digestion) can often contain significant levels of H_2S, which is extremely toxic and explosive. In order to responsibly utilize these natural sources of methane-based fuels, the incident H_2S needs to be carefully monitored and removed.

The OMA system is ideal for monitoring H_2S in biogases for several reasons. The excellent dynamic range of dispersive UV-Vis spectrophotometry allows the OMA to accurately monitor H_2S concentration from trace levels to high %. Additionally, the detector has no sensitivity to the typical biogas background components (methane, CO_2, moisture) since these chemicals have no absorbance in the UV wavelength range.

OMA Benefits

- Continuously measures H_2S concentration in gas stream using dispersive UV-Vis absorbance spectrophotometer
- Totally solid state build with no moving parts — modern design for low maintenance
- 5 total software benches allow addition of up to 4 more chemical analytes for future requirements
- Easily reprogram measurement ranges at any time via ECLIPSE software — no 'application lock'

Landfill Gas Analysis

In many parts of the world, our trash is sent to landfills and ultimately decomposed in airtight cells underground. The bacteria that digest the waste release what is known as “landfill gas,” a varying mixture comprising mostly methane and CO_2. Formerly regarded as a flammable/environmental hazard, this gas is increasingly being tapped as a natural energy source.

Landfill operators direct the gas to a common header, filter out large particles, and then use the stream to fuel special generator engines which create electricity that can be sold to the power grid. The problem with this exciting energy source is that the bacteria also produce other compounds such as hydrogen sulfide, an extremely dangerous chemical which must be removed according to the law in most jurisdictions.

The composition of landfill gas, including its H_2S content, varies greatly with the composition of the garbage that we collectively feed to the underground microbes that digest it. The OMA system continuously monitors H_2S concentration in the landfill gas stream before it gets fired in the generator engines.

Providing highly reliable, real-time H_2S measurement, this system allows operators to determine when their landfill gas stream rises above legal H_2S limits and should not be fed to the generators, thus avoiding fines, shutdowns, and socially irresponsible emissions.

Biogas Analysis

The gas produced by anaerobic digestion of organic matter can be used to generate electricity in sewage plants, provide various types of heating, and, if compressed, serve as fuel for combustion engines. Unfortunately, raw un-processed biogas typically contains up to 3% H_2S.

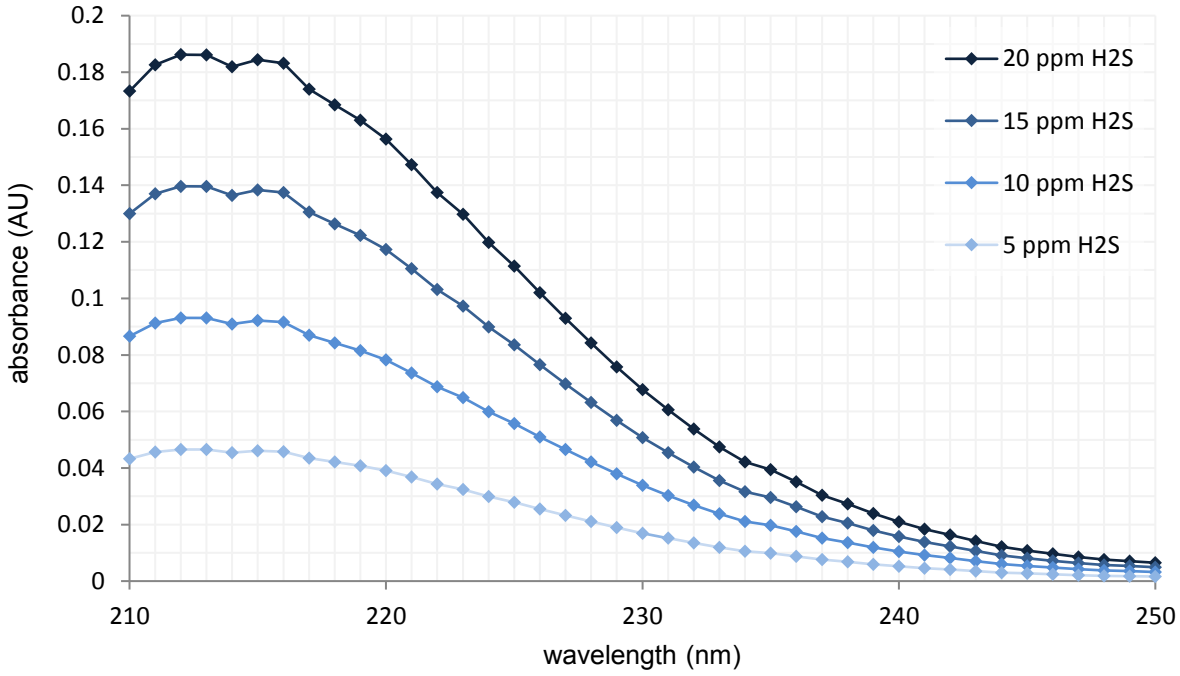
The iron drums used to store biogas are quickly destroyed by corrosion if H_2S content is not regulated. Downstream, corrosion can cause breakdowns of handling equipment and piping.

Accurate H_2S analysis in biogas is absolutely necessary for ensuring safety and protecting equipment through veriying scrubber efficiency and monitoring sales gas quality.

H_2S 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:

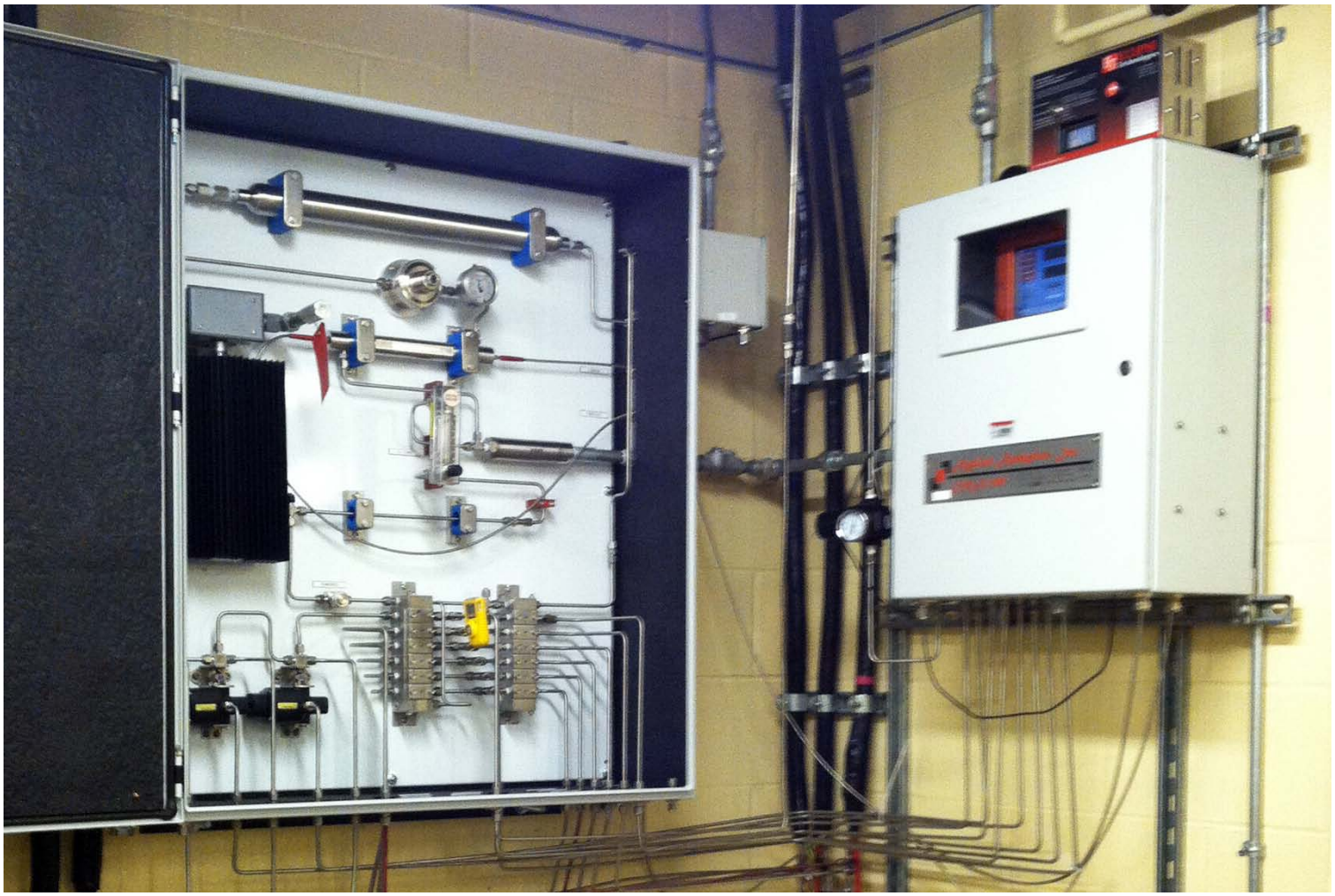


In the figures above, each diamond represents a single photodiode and data point. The nova II registers absorbance at each integer wavelength within the 210-250 nm measurement range and produces an H_2S absorbance curve. After being calibrated on a full spectrum of pure H_2S, the OMA knows the absorbance-concentration correlation for each measurement wavelength; the system can average 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.

Example Installation

The system pictured below was installed to monitor 0-20,000 ppm H_2S in a biogas scrubber at a university:



The specifications below represent performance of the OMA-300 Process Analyzer in a typical biogas 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

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.*	
	H_2S	0-10 ppm (@10 bar): ±0.1 ppm 0-10 ppm (@1 bar): ±1 ppm 0-100 ppm: ±1% full scale or 1 ppm* 0-10,000 ppm: ±1% full scale 0-100%: ±1% full scale
		*Whichever is larger.

Further Reading

Subject	Location
OMA-300 H2S Analyzer Brochure	http://www.a-a-inc.com/documents/OMAH2S.pdf
OMA-300 Process Analyzer Data sheet	http://www.a-a-inc.com/documents/AA_DS001A_OMA300.pdf
Advantage of Collateral Data Technical Note	http://www.a-a-inc.com/documents/AA_TN-202_CollateralData.pdf
Multi-Component Analysis Technical Note	http://www.a-a-inc.com/documents/AA_TN-203_MultiComponentAnalysis.pdf

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