Measuring Odorants in Natural Gas Pipelines

Applied Analytics Application Note No. AN-011

Application Summary

Analytes: **Odorants** (i.e. mercaptans, thiophenes)

Detector: **OMA-300 Process Analyzer**

Process Stream: **Natural gas**

Zeroing Fluid: **Ultrapure nitrogen**

Calibration Fluid: **Standard mixtures containing sulfides and odorants**

Typical Range: **0-10 ppm or 0.00-2.50 lbs/MMCF**

Response Time: **<15 seconds**

Introduction

Odorants are added artificially to natural gas to allow for human leak detection. Local distribution companies (LDCs) employ numerous "sniffers" who judge odorant level in the natural gas product, while generating data from field reports, customer input, and modeling programs.

However, interstate pipelines span hundreds of miles that cross through various territories. Dispatching "sniffers" across vast distances is both time-consuming and cost-impactive. While "sniff testing" complies and satisfies the minimum criteria set forth in CFR, Title 49, Part 192.625, an on-line process analyzer would provide the same testing functionality with much richer quantitative data (one example: continuous trend data as opposed to discrete data points).

On-line odorant analysis allows the transmission companies to schedule the minimum required visits to perform sniffing, and optimize their odorant distribution system in real-time. Secondary benefits allow them to optimize their pipeline performance by studying lag times, odorizer performance, fading effects, and other odorant issues.

The OMA-300 Process Analyzer is the ideal instrument for monitoring real-time odorant content. "Odorant" is comprised of a blend of different mercaptans and/or thiophenes, all of which show distinct absorbance features in the ultraviolet spectral range. The full-spectrum spectrophotometer is able to recognize these structures in a natural gas background and quantify their real-time concentration inside the pipeline.

Natural Gas Odorization Legislation

Natural gas odorization has occurred since the late 1800's, but did not come into law until the tragic New London School disaster in Texas which left more than 300 people dead. As a consequence, the Code of Federal Regulations, Title 49 Part 192.625 was enacted to ensure that where necessary, all pipelines contain a certain level of odorant. The federal code states that the sum of natural odorant and added odorant be readily detectable by a person with a normal sense of smell in air at one-fifth the lower explosive limit (LEL) of natural gas.

Measuring Odorants with the OMA

The spectra below demonstrate how the OMA visualizes the absorbance curves of various odorizing chemicals in a sample. Each odorant species has its own unique spectral footprint which the analyzer de-convolutes out of the total sample absorbance.

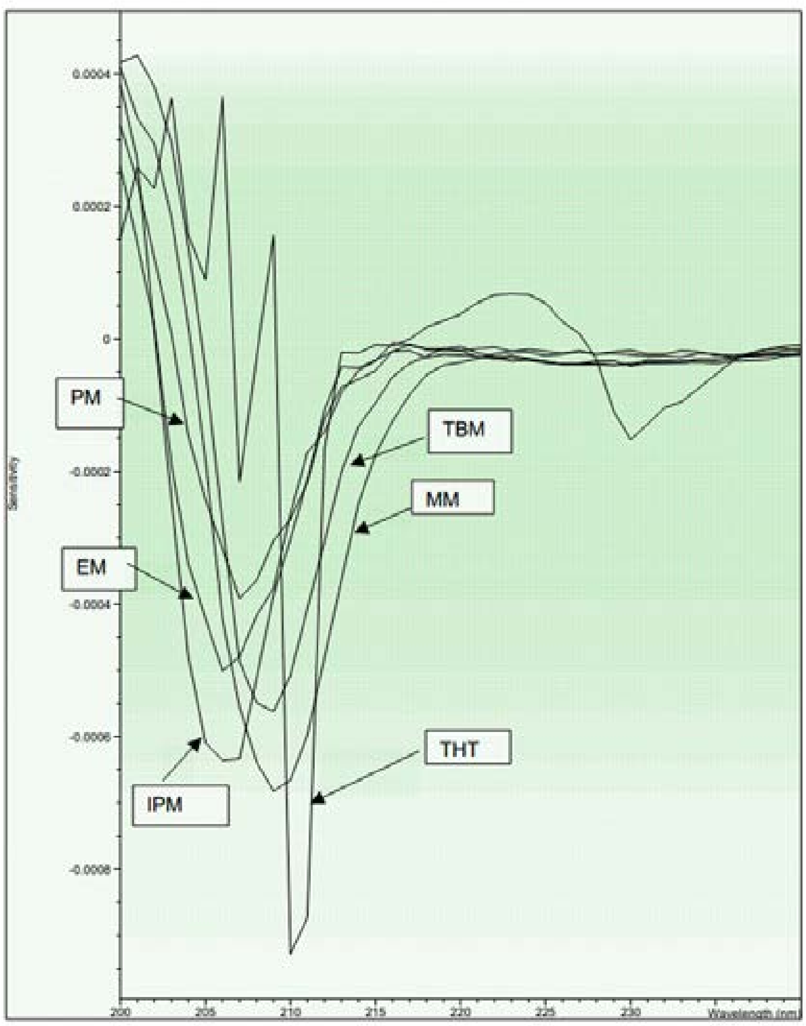

Figure 01: Derivative of absorbance spectra for different odorants in natural gas.

These compounds all have unique absorbance curve structural features, especially in the 200-215 nm range. This makes UV spectroscopy (used by the OMA) the ideal detection technology for odorants.

Critical Advantages of the OMA as Sniffer Supplementation

The OMA offers huge, distinct advantages that are unique to its full-spectrum UV methodology:

» **Rich trend data.** When no one is sniffing, the OMA is still watching the odorant level. This continuous online measurement provides trend graphs that allow the end user to study odorization performance, lag times, fading effects, and other process parameters.

» **Individual concentrations of defined odorants and non-odorant sulfur can be measured by the OMA.** The absorbance of sulfur compounds overlap in the UV spectral region. Standard multi-wavelength photometers might be unable to distinguish between these compounds, and mis-attribute absorbance of H_2S in the stream to the presence of a specific odorant. With high-resolution and full-spectrum analysis in the OMA, each compound's characteristic absorbance structure is de-convoluted out of the total absorbance.

» **Added measurement of H_2S (or other sulfur compounds) for "total sulfur" value.** Natural gas often contains sulfur compound impurities. While this may cause cross-interference for other analyzers (see above point), the OMA can easily distinguish between these compounds and provide separate measurements for each species using a single instrument. For example, the user could define "total sulfur" as odorants + H_2S, and the runtime software would provide separate measurement values for (1) odorants, (2) hydrogen sulfide, and (3) total sulfur. In many jurisdictions, "total sulfur" limit compliance is required.

OMA vs. Gas Chromatograph for Odorant Detection

When supplying an OMA for odorant detection, the system is either a first investment in online odorant analysis, or it is used to replace a GC system. Users prefer the OMA for the following considerations:

» **Price.** The upfront cost of a GC is much higher the OMA; similarly, the typical maintenance spending on the GC far exceeds the OMA cost-of-ownership (see point below).

» **Maintenance and Downtime**. Unlike the GC, the OMA is a solid state system with no malfunctioning moving parts. The OMA also has no analysis downtime aside from the recommended auto-zero regimen, which performs the 60 second auto-zero procedure a few times per day (user-configured frequency).

» **Measurement Speed and Frequency.** The OMA provides dozens of new readings per each single reading of the GC. This allows for tighter control response as well as richer trend graphs with more individual data points.

Conclusion

Sniff testing is required by code, but only shows the operator a picture of their odorant concentration. With the potential for human error and bias and the cost to dispatch a "sniffer" across long distances, pipeline operators need secondary methods to supplement and back up their testing. On-line analysis allows the pipeline operator to (1) continuously monitor the odorant content in their pipeline; (2) identify fade due to new piping, contaminants, or reaction; and (3) troubleshoot odorizer performance for preventive action.

The OMA provides a completely automated and instantaneous measurement to give the pipeline operators deeper insight into their gas quality and operations.

Example Installation

The OMA pictured below measures H_2S and RSH concentrations at a custody transfer station in New York state. The analyzer unit is installed on the external wall of the station, while the sample conditioner and flow cell are installed inside the station. This arrangement maximizes user safety as the analyzer is separated from the sampling point by a wall.

The specifications below represent performance of the OMA-300 Process Analyzer in a typical odorant application.

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

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 Specifcations		
Accuracy	*Example ranges below; custom ranges available. Higher pressure may increase accuracy.*	
	mercaptans/thiols	0-10 ppm: ±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 Process Analyzer	http://www.a-a-inc.com/documents/AA_DS001A_OMA300.pdf
Advantage of Collateral Data	http://www.a-a-inc.com/documents/AA_TN-202_CollateralData.pdf
Multi-Component Analysis	http://www.a-a-inc.com/documents/AA_TN-203_MultiComponentAnalysis.pdf

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