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Monitoring Siloxane Levels Using Gas Analysis

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Key Words

- Antaris IGS
- Digester Gas
- Landfill Gas
- Methane
- Siloxane

Introduction

Throughout the world, landfills are a significant source of methane, a greenhouse gas. In order to reduce the methane impact, landfill managers initially burned this landfill gas (LFG) in open flares that reduced the gas to CO_2 and water vapor. Progressive landfill operators viewed this gas as a potential fuel for powering electric generators or providing a source of heat. In addition, municipalities began constructing wastewater treatment plants utilizing anaerobic digesters to produce methane-rich gas. This is called Anaerobic Digester Gas, or ADG. The drawback is that, because of its source, biogas (ADG or LFG) contains high moisture content as well as other contaminants that could shorten generator engine life and increase maintenance costs.

Some of the most damaging contaminants in biogas are compounds of silicon. Organic compounds of silicon are known as organosilicons. In particular, the siloxanes are the most significant offenders. Siloxanes are made up of silicon, oxygen, carbon and hydrogen:

sil(icon) + ox(ygen) + (meth)ane

Organosilicons occur in biogas because of the removal of boron (a whitening agent in detergents) and its replacement with silicon-containing compounds. There is also increasing use of siloxanes in other consumer and commercial products such as hair spray, deodorant, and lipstick. When biogas containing siloxanes is burned, a silicon dioxide (SiO_2) deposit is left that can contaminate the engine oil, damage engine parts or clog passages in heat recovery systems or catalysts (Figure 1 and Figure 2). Equipment repair or replacement can be costly both in direct costs as well as lost income caused by equipment downtime.

Figure 1: Piston top coated with SiO_2. *Photo courtesy of Applied Filter Technology.*

Figure 2: Boiler tubes coated with SiO_2. *Photo courtesy of Applied Filter Technology.*

The Solution

The solution to these problems is to remove the siloxanes before the biogas is burned. Several removal techniques exist that use adsorbers like activated carbon and activated graphite. Other techniques use molecular sieves or liquid $C0_2$ scrubbing. These are all proven solutions that are available, robust and relatively simple to implement. The major problem is determining the optimum time to replace or regenerate the removal media. If it is replaced too soon, unused media is thrown away; if it is replaced too late, the siloxanes will not be removed and can cause damage.

Until now, the only method for measuring siloxane was to take a grab sample at the landfill or wastewater treatment plant and send it to an off-site commercial laboratory that uses Gas Chromatography/Mass Spectrometry (GC/MS) instrumentation. The Thermo Scientific Antaris IGS gas analyzer is an alternative solution that offers many advantages over GC/MS including:

- Analysis done at the landfill site
  - *No waiting for results*
  - *No sample collection into sample bags*
- Analysis can be done automatically at pre-set times
- System can work with PLC (Programmable Logic Controller) systems for automatic switching of gas sources
- Simple, work-flow based operation can be set up with password-protected access for different levels of operators
- Multi-level operation with access controlled via passwords
- Analyzer requires minimal training for operation
- Less costly

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Thermo Fisher Scientific has worked with a major landfill operator to develop a system that can monitor the LFG pre- and post- filter, automatically, every 30 minutes at the landfill site. The Antaris IGS gas analyzer uses FT-IR technology combined with a long path length (2 meter) gas sampling cell to measure total siloxane content using an analytical band at 815 cm^{-1} (Figure 3).

By continuously monitoring the siloxane level, the media being used to remove the siloxane can be changed at the optimum time to reduce cost and downtime (Figure 4).

The monitoring system consists of the Antaris™ IGS gas analyzer interfaced to an automated sampling system. The software to control the sampler receives instructions from Thermo Scientific RESULT software used for Antaris IGS control and analysis. Easily housed in the room controlling the gas extraction and filtration, the Antaris IGS can provide measurements down to 7 mg/m^3 of total siloxane with an accuracy of 10%.

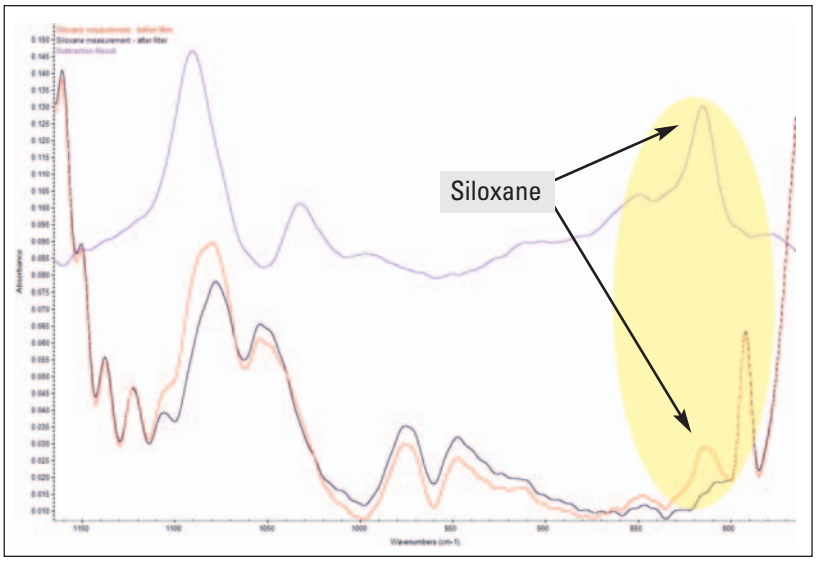

Figure 3

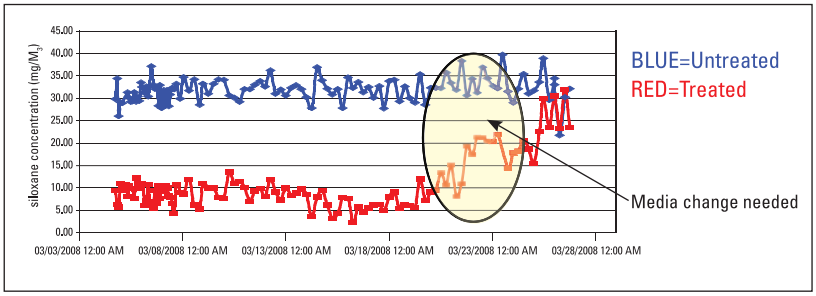

Figure 4

Conclusion

The Antaris IGS offers an alternative to time-consuming "grab sampling" for the monitoring of harmful siloxanes in landfill methane gas in real-time at the landfill site. By implementing the Antaris IGS gas analyzer into the monitoring process, the landfill operator was able to significantly reduce costs and downtime.

Applied Filter Technology manufactures, installs and operates biogas treatment systems for the removal of siloxanes and hydrogen sulfide.

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