Landfill Gas BTU Determination

Introduction

Landfill gas is generated during the natural process of bacterial decomposition of organic materials contained in municipal solid waste (MSW) landfills. According to the Environmental Protection Agency (EPA) estimates, approximately 64 percent of all municipal solid waste (MSW) generated in the United States is currently being disposed of in roughly 1,800 operational MSW landfills. Landfills are the second largest single human source of methane emissions in the United States, accounting for nearly 23 percent of all methane sources. More than 400 MSW landfills in the United States recover and combust landfill gas to generate heat or electricity.

ATEX-version ProMaxion for use in hazardous location applications.

The ProLine comes complete with multiport automatic valve switching, inlet manifold, and turbomolecular pumping package.

Composition of Landfill Gas

By volume, landfill gas is about 50 percent methane and 45 percent carbon dioxide and water vapor. It also contains small amounts of nitrogen, oxygen, and hydrogen, less than 1 percent non-methane organic compound (NMOC), and trace amounts of inorganic compounds. A number of factors influence the quantity of gas that a MSW landfill generates and the composition of that gas. These factors include, but are not limited to, the types and age of the waste buried in the landfill, the quantity and types of organic compounds in the waste, and the moisture content and temperature of the waste.

Landfill Gas and BTU Values

Advances in landfill gas energy technologies have encouraged the combustion of landfill gas to benefit human health, safety, and the environment, as well as provide economic opportunities. Landfill gas can be an asset when it is used as a source of energy to create electricity or heat. It is classified as a medium-BTU gas with a heating value of 350 to 600 BTU per cubic foot, approximately one-half that of natural gas. Landfill gas can often be used in place of conventional fossil fuels in certain applications.

Some landfill operators can further “clean” the landfill gas using Pressure Swing Absorbers (PSA) or membranes to generate what is called “high methane, high BTU value” gas, thus increasing the methane content to about 80-90 percent that can easily be incorporated into existing energy gas pipelines.

Landfill Gas Quality

By quality of landfill gas, it is meant the percent amount of methane that is present that can be use as fuel. As previously stated, landfill gas normally has about 50 percent methane and can be increased to between 80-90 percent through a “cleaning” process. Operators of landfill gas plants have to continuously determine the percent amount of methane in their product as this determines the end use and the pricing. This quality is either determined by measuring the actual methane content or by determining the BTU values. In landfill plants, they can use dedicated BTU analyzers to determine the heating value or gas chromatograph (GC) to determine the percent methane or the BTU value. However, these methods of BTU values determination are cumbersome and time consuming and offer no real-time information. Since the environment (i.e. physical conditions like temperature and moisture content), as well as the make up of the waste materials can determine the level of methane, operations in a landfill gas plant requires analyzers that can give fast, accurate and real-time information that helps to determine what conditions are present and which feed stock should be used to achieve higher methane levels. A mass spectrometer is an ideal analyzer for such a task. More and more landfill operators are turning to the mass spectrometer for its speed, sensitivity to changing conditions both environmental and chemical, real-time monitoring capability, and multiple sampling features.

Dycor Process Mass Spectrometers

The Dycor process analyzers are quadrupole mass spectrometers that offer high performance without the high price; they provide features and a level of performance associated with more expensive mass spectrometric

systems. It is a fast and accurate precision analyzer with excellent detection limits. The reliability and automatic calibration and verification capability help maintain the performance of the analyzer and allow it to quantify the amount of gas species in multi-component samples without the need of a separate separation stage. Real-time monitoring of up to 32 components is straightforward with these analyzers. The Dycor process mass spectrometers, among others, include the Proline and ProMaxion. They both offer on-line monitoring of not just the methane content, but also other components in the landfill gas so that operators know exactly what is in the gas stream. Sampling port ranges from 8 to 80, thus making it possible to sample more than one process line. Low ppm level measurement capabilities enable the identification of trace components in the gas stream.

Evaluation of a Dycor Proline in a Landfill Gas Plant

A landfill plant evaluated the Dycor Proline in their facility. The purpose of the test was to compare the mass spectrometric BTU analyzer reading to those obtained from an existing dedicated BTU analyzer. In addition to the BTU value determination, the concentrations of the major components were also determined, especially that of methane that has a direct correlation to the BTU values. A calibration gas cylinder containing the major gas components of a landfill gas was obtained and used to calibrate the instrument. These components were methane, oxygen, nitrogen, and carbon dioxide. After the calibration was performed, sampling of the landfill gas was carried out for three weeks.

Results and Conclusion

At the conclusion of the test period, the following results were obtained and conclusion drawn. The figures show a plot of the real-time BTU reading (Fig. 1) and the real-time concentration reading of the major components that were of interest to the landfill operator. While this is not the entire set of results obtained during the three weeks that the test was carried out, it is an accurate representation of the process taking place within the site. The first conclusion that can be drawn from this result is that the concentration of methane at above 50 percent is consistent with what was expected, and the BTU value that was above 500 BTU/ft3 is also consistent with what was expected. This also reveals that their landfill gas is of higher quality even before cleaning. The almost straight parallel lines of the trend show how consistent the methane production of that particular landfill was at the time of the test. Perhaps, the biggest advantage of the Proline was that it was recording and displaying the result in real-time. While the “other” dedicated analyzer was able to return similar BTU value, it was at a slow pace and often further calculations had to be carried out manually to determine the BTU values. The operators of this plant saw the benefit of an online analyzer that gives real-time results.

As evident by this plot, any changes to the composition or heating value of the landfill gas are instantly recorded by the Dycor mass spectrometer with real-time compositional analysis and BTU value.

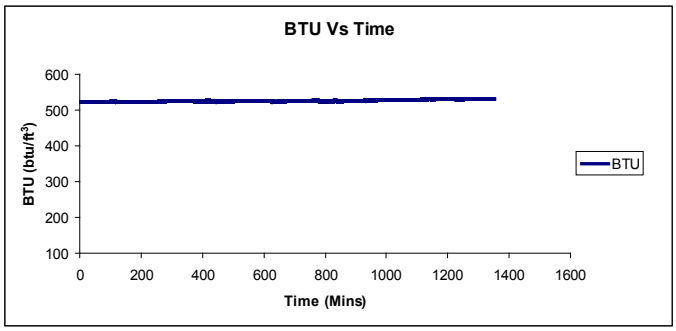

Figure 1. A plot of the real-time BTU values that was measured

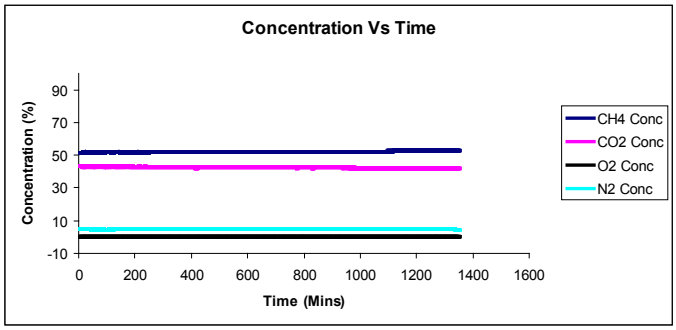

Figure 2. A plot of the concentration values of the major component of interest to the landfill management

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