Waste Management Corner

New for 2020, *EM* is expanding its content coverage of waste management issues with a special section of waste-themed articles in every issue, called *Waste Management Corner*. In this month’s article, Pete Roos and Ben Losby describe a new landfill methane-monitoring technology.

Drones Save Landfill Operators
Time and Money with Advanced Emissions Measurements

Landfill gas emissions are a known cause of odor nuisance and are known to be a principal source of methane emissions, a potent greenhouse gas. The U.S. Environmental Protection Agency (EPA) regulates landfill gas (LFG) emissions, including a requirement for monitoring methane emissions from landfills. Until recently, both the technology and costs associated with detecting and quantifying methane emissions have been viewed by many landfill operators as less than optimal. This article describes a new landfill methane-monitoring technology intended to make landfill methane measurements more comprehensive, more accurate, and less costly.
Landfill Methane Emissions

Landfill emissions have an impact on both a local and global scale. At the local level, while methane itself is odorless, it is often accompanied by other gases emitted by landfills that are odorous. As a result, landfill owners and operators can find and mitigate odor sources by locating methane “hot spots” with surface emissions monitoring (SEM) technology. SEM is required by EPA for controlled landfills that have LFG collection and control systems installed. Currently, SEM is performed at landfills using expensive and time-consuming foot patrols equipped with handheld sensors. These foot patrols cost landfill operators an EPA-estimated US$10,400 per year on average.1 Anecdotal industry information, such as for a 53-acre Kansas landfill incurring a cost of around US$12,000 per year, support this estimate.2

On a global scale, methane is a potent greenhouse gas. Landfills are a significant emitter of methane. Accordingly, EPA also regulates whole-landfill emissions (i.e., the amount of methane emitted from an entire landfill over time).3 In these cases, if modeled emissions of methane from a landfill exceed EPAs applicable threshold, then EPA requires a LFG collection system. However, whole-landfill emissions are currently only estimated based on mathematical models rather than measured empirically. Unfortunately, the model inputs, such as waste material composition and age, moisture content, soil content, landfill topology, temperature, and other conditions, are notoriously difficult to accurately determine and the models’ predictive capabilities are often poor.4 A recent study found that “the models consistently overestimated annual methane emissions by a factor ranging from 4−31.”5 As a result, many landfill owners unnecessarily pay for remediation based on incorrectly high regulatory tiers.

Gas Mapping LiDAR

Recent advances in light detection and ranging (LiDAR) are transforming the way methane emissions are detected, quantified, and managed. Over the past four years, a small company in Bozeman, Montana, Bridger Photonics, Inc., has developed an advanced airborne remote sensor technology called Gas Mapping Lidar™ (GML) that images and quantifies methane emissions. While GML was initially developed for the oil and gas industry to detect, locate, and quantify methane leaks throughout the entire natural gas value chain, Bridger has recently investigated applying the technology to the solid waste industry. GML determines gas concentration by measuring the amount of laser light absorbed by methane gas. The laser beam is rapidly scanned over the landscape to generate sensitive gas concentration maps that are geo-registered using GPS and a whole host of other sensors, and then overlaid onto satellite imagery.

Figure 1 shows an example GML data product for the oil and gas industry where multiple simultaneous methane leaks are imaged. Bridger’s technology applies advanced analytics to the plume imagery to identify the source of the leak (to equipment-level precision) and to quantify the emissions rate (gas flux), among other data products. With this information, oil and gas operators know precisely where the leak sources are and how much gas is being lost by each leak so they can deploy their mitigation resources most efficiently.

For landfills, the emissions sources may be spatially distributed area sources rather than point sources, but similar principles apply. Figure 2 shows imagery from a landfill fly-over using a helicopter-mounted GML sensor. The light blue swaths represent the areas interrogated by the sensor’s laser, the white lines represent the aircraft flight path, and the color map represents the methane concentration map. “Hot spots” of methane emissions may be determined from the concentration map (and signified by red dots in the image). Landfill owners may choose to focus odor remediation efforts on these regions. Importantly, by scanning the entire landfill, and applying advanced analytics, the whole-landfill methane emissions can be determined. However, challenges remain, and the process is long, to secure EPA approval for using GML to replace existing approved methods. Nevertheless, the technology already provides needed information in a more efficient manner.

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Successful Tests

Bridger’s GML technology has been tested in blind field tests for methane detection on oil well pads at the Methane Emissions Test and Evaluation Center (METEC) in Colorado, using both mast-mounted and drone versions of the sensor. METEC is an undertaking of The Energy Institute at Colorado State University, and the testing was conducted on behalf of the oil and gas industry. During Round 1 of testing, GML detected 17 of 17 leaks (plus one null); it located all leak sources to within a three-foot radius; and it quantified the flow rates of all leaks to within 50% of the METEC uncertainty, as shown in Figure 3. While the blind testing was performed under ideal and controlled scenarios, it validates the fundamental principles of the GML technology.

Current Status

In early 2019, Bridger’s GML was commercially deployed surveying oil and gas assets in both the United States and Canada. In just its first year of deployment, Bridger surveyed tens of thousands of oil and gas well sites and natural gas pipeline miles. As a result of these surveys, operators have been able to repair thousands of leaks, significantly reducing their emissions profiles. GML was recently (in October 2019) recognized by R&D World magazine as one of the top 100 innovations worldwide.

Bridger received funding from the Environmental Research and Education Foundation (EREF), a consortium of waste management industry leaders, to demonstrate the capabilities of GML for both SEM and whole landfill emissions determination. Those studies are ongoing, and results will be available through EREF. Bridger is currently capable of deploying GML commercially to scan landfills via helicopter to identify hot spots and is seeking a waste management service provider partner in the longer-term for drone deployment.

Whether capturing methane emissions at your landfill is the highlight of your day professionally, or the bane of your professional existence, it is an increasingly important part of landfill management. The first step in addressing methane emissions is knowing where a facility stands. To do that, managers need auditable coverage to know that their landfill

Bridger has developed GML sensors suitable for both manned aircraft and drone deployment (see graphic on first page of this article). Airborne deployment can achieve significant time and cost savings relative to foot patrols. Bridger’s drone-based sensor can scan an average landfill (50 acres) in less than two hours, compared to more than three days using conventional foot patrols. With a helicopter, the time to scan the same landfill is reduced to less than 10 minutes because the helicopter can cover so much more ground so much faster. Due to line-of-site restrictions currently placed on the operation of drones by the U.S. Federal Aviation Administration (FAA), both manned and drone deployment requires a human operator or observer. As a result, the economics of drone versus manned aircraft are heavily dependent on several factors, including the size and location of the landfill.

Figure 1. GML results for the oil and gas industry showing emissions quantification (1 lpm = 2.08 scfh).

Copyright: Bridger Photonics, Inc. Figure 1 was enabled by funding and site access provided by the Alberta Upstream Petroleum Research Fund. Measurements were acquired in collaboration with Lidar Services International and Z-Air.

Figure 2. GML imagery from a landfill fly-over.

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facility, in its entirety, has been inventoried for its LFG emissions. With that comprehensive LFG emissions data in hand, landfill managers can make informed decisions regarding methane emissions-reduction requirements. In many cases, having a full picture of a site’s emission profile will result in a significant savings in landfill operational costs via a reduction in the regulatory tier under which the facility falls, thus eliminating the requirement for LFG control. Significant savings in landfill operating costs can also result because new technology reduces the cost of surface emissions monitoring for LFG emissions. As methane emissions continue to be a dominant topic of conversation in relation to climate impacts, landfill managers have the opportunity now to be proactive in their emission reduction efforts. New and exciting technology is making it easier to get ahead of the curve.

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References