A Look at Fugitive GHG Emissions Reporting and the Effects on Regulated Facilities

A&WMA's 109th Annual Conference & Exhibition
New Orleans, Louisiana
June 20-23, 2016

Extended Abstract # 1089

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INTRODUCTION

While much of the discussion and regulation of greenhouse gas (GHG) emissions has focused on mobile and point source emissions related to the combustion of fossil fuels, fugitive GHG emission sources have not been overlooked. Fugitive GHG sources, such as municipal solid waste (MSW) landfills and petroleum and natural gas systems, and have been included in federal and state regulations as well as emission inventories. While fossil fuel emissions make up the majority (85 percent) of GHG emissions in the United States, fugitive emissions account for much of the remaining GHG emissions. This abstract will discuss how fugitive GHG emissions from two industrial sectors, MSW landfills and petroleum and natural gas systems, are regulated, reported, and inventoried. These two sectors were selected for discussion to compare the similarities and differences in the way fugitive emissions are addressed.

Both MSW landfills and petroleum and natural gas systems are sources of methane, a GHG more powerful than carbon dioxide. Both categories are required to report under the EPA's GHG Reporting Program (GHGRP) (40 CFR Part 98) and both categories are included in the EPA's national GHG inventory. Together, these source categories make up 21 percent of the non-fossil fuel combustion GHG emissions in the 2013 GHG inventory prepared by the United States Environmental Protection Agency (EPA). Only enteric fermentation is a larger source of methane emissions than petroleum and natural gas systems and MSW landfills.

This paper will discuss how fugitive GHG emissions are addressed by GHG regulations, the methodologies used, and how those programs and methodologies impact facilities. This paper will also discuss how GHG reporting programs and methodologies can interact with Clean Air Act (CAA) permitting programs and impact facilities.

For purposes of this discussion "fugitive" is meant in a broader sense than it is used by the EPA for regulatory purposes. It should be taken to mean gases that are emitted without passing through a stack or similar system where the use or emission rate can be reasonably measured. For purposes the EPA GHG inventory and this paper, "natural gas systems" refer to the production and transport systems for natural gas and related produces. It does not refer to the combustion of natural gas as a fuel, which is included in the inventory as fossil fuel combustion.

PETROLEUM AND NATURAL GAS EMISSION SOURCES

Petroleum and natural gas systems sources as defined by Subpart W of the EPA's GHGRP include the following industry sources offshore and onshore petroleum and natural gas production, onshore natural gas processing, onshore natural gas transmission compression, underground natural gas storage, liquefied natural gas (LNG) storage, LNG import and export equipment, and natural gas distribution. Natural gas is composed primarily of methane with traces of carbon dioxide and other gases. Examples of fugitive GHG emissions from natural gas systems occur when natural gas leaks from pipelines or is vented from equipment or blowdowns to the atmosphere. Petroleum consist of various hydrocarbons and organic compounds which when vented to the atmosphere constitute an array of GHGs. Examples of fugitive emissions from petroleum systems are well venting for liquids unloading, storage tank vented emissions from produced hydrocarbons, reciprocating compressor rod packing venting, well testing venting, and equipment leaks. Unique to Subpart W reporting is the inclusion of flaring, when it was excluded from all other subparts, however depending on the combustion source of the flare from petroleum and natural gas systems, the fuel source may or may not include fugitive sources. Petroleum and natural gas systems are included in the Prevention of Significant Deterioration (PSD) and Title V permitting programs. One issue with petroleum and natural gas facilities is that there boundaries under GHG reporting programs is not as straight forward and will contain an entire well field and multiple facilities which are not continuous.

Petroleum and natural gas system fugitive emissions occur from venting events, system leaks, and accidental releases. Venting is the planned or deliberate release of emissions to the atmosphere, typically for safety reasons such as when maintenance must be performed. System leaks are much more difficult to account for and are typically calculated using equipment counts and default emission factors. All of these emissions represent a loss of product which could otherwise be sold, so there is a built in incentive for petroleum and natural gas systems to reduce emissions when it is cost effective and does not result in hazards.

Petroleum and natural gas system emissions in the EPA GHG inventory have decreased by 12.2 percent since 1990. The EPA attributes this decrease to changes in practice (e.g. the use of plunger lifts) and regulatory reductions as a result of the New Source Performance Standards (NSPS), and a variety of voluntary measures.

MSW LANDFILL EMISSION SOURCES

MSW landfills create an oxygen-deprived (anaerobic) environment in which carbon-containing waste decomposes to create landfill gas (LFG), a mixture of approximately 50-55 percent methane (CH_4), 45-50 percent carbon dioxide (CO_2), and one percent non-methane organic compounds (NMOC) which often contain various organic hazardous air pollutants (HAPs). A portion of a landfill's LFG will escape through the landfill surface, resulting in fugitive emissions of methane and carbon dioxide to the atmosphere. Both methane and carbon dioxide are GHGs. The EPA requires that landfills report fugitive GHG emissions as part of the GHGRP under Subpart HH. The EPA also regulates the landfill fugitive GHG emissions as part of Title V and PSD permitting programs under certain circumstances.

Landfill fugitive emissions are calculated based on a first order decay model to determine the quantity of LFG which is emitted to the atmosphere. Unlike stationary combustion emissions from a landfill which can be measured with a flow meter, fugitive emissions are modeled. A landfill can use surface emission monitoring to determine an instantaneous look at a landfill's fugitive emissions but does not capture the entire picture. LFG-derived carbon dioxide is not included in the EPA GHG inventory. This exclusion includes both the carbon dioxide generated as part of the LFG and any carbon dioxide resulting from the oxidation or combustion of the methane in LFG. Carbon dioxide derived from LFG is considered to be biogenic by the EPA and most GHG inventories, and thus does not represent a net increase in atmospheric carbon dioxide. Finally, the carbon dioxide removed from the atmosphere due to the sequestration of carbon in landfilled yard trimmings and food waste is included in the EPA as a net carbon reduction.

Landfill GHG emissions in the EPA's GHG inventory have decreased by 38.4 percent. The EPA attributes these reductions to reductions in the amount of degradable waste and increases in LFG collection.

CHALLENGE OF FUGITIVE EMISSIONS AND DIFFERING APPROACHES

Fugitive emissions are inherently difficult to quantify because they cannot be directly measured on a large scale. Fugitive emissions have been measured or estimated for individual cases. For landfills, these measurements can utilize flux chambers, remote optical measurements, or downwind measurements combined with modeling. For natural gas systems, these measurements can include individual equipment counts, leak detection surveys, and pipe size measurements. These measurement methodologies may provide a snapshot of emissions for a single location under certain conditions, but they do not encompass a larger period of time, scale an entire site, nor show all circumstances. This difficulty has resulted in simplified emission estimation methodologies.

For natural gas systems, most fugitive emissions are calculated using generalized emission factors and national activity rate information. In general, the fugitive emission factor multiplied by the activity rate (e.g. number of pneumatic valves or meters of pipe) yields the GHG emissions. This approach in the national EPA GHG inventory is applied at the site level for individual site reports for the GHGRP. For individual sites, the error introduced with this approach is proportional to the error in the emission factor for each emission source. While there is variation among the sources, the overall error is limited but significant. The Gas Research Institute (GRI) estimated the accuracy of the initial 1992 GHG inventory at plus or minus 33 percent. Reassessment of several emission factors may have improved this accuracy, but significant uncertainty still exists.

The approach to quantifying landfill fugitive emissions is similar in that it is developed from national average factors, but the variation at the site level could be far greater. National inventories are developed using estimated critical parameters. Some of these inputs such as the tonnage of waste or the amount of LFG collected can be directly measured. Other factors, such as the quantity of methane generated or the amount of methane oxidized in the landfill cover cannot be measured at each site. Every landfill manages the landfill cover differently based on climate and precipitation quantities at the site which will greatly impact the generation and emission of fugitive emissions on a site specific basis. Fugitive emissions are calculated by methane generation modeling methane generation and reducing emissions by the amount of methane collected or not oxidized. Unlike emission factor-based methodologies, errors in the inputs are not linear.

Additional uncertainty in landfill emissions is introduced in the activity rates. Recent studies have found that basic inputs such as the quantity of waste landfilled were less than half the quantity of landfilled waste reported under the GHGRP. Analysis of reported data indicates that there are significant differences in the efficiency of LFG collection at open and closed sites, which is inconsistent with historical treatment of the collection efficiency of landfills.

IMPLICATIONS OF PERMITTING PROGRAMS

Fugitive emissions are not included in determining federal air permitting requirements under Title V or PSD programs unless the source is already a major source, but a significant number of landfills and petroleum and natural gas systems are major sources. Thus, determining the fugitive emissions can have permitting implications, including criteria pollutant offset requirements and health risk assessment. These permitting consequences make the determination of the quantity of fugitive emissions an important element of the permitting process.

Permitting requirements are implemented at the site level, but federal emission factors and values are frequently used in that permitting. Using these national values without respect for site-specific conditions has the potential to reduce the incentive for facilities to reduce emissions. For example, a landfill that improves LFG collection will lower fugitive emissions of GHG, criteria pollutants, and toxic pollutants. If that facility is required to use a fixed 75 percent collection efficiency, the calculated emissions will increase and effectively disincentives improved LFG collection.

Similarly, petroleum and natural gas systems may have the option to utilize a component with lower fugitive emissions as determined by a manufacturer or similar test. If the facility is required to use national average emission factors, there is no emissions driven incentive to utilize the lower emission equipment.

Finally, the EPA and air quality agencies can implement command and control requirements for fugitive emission sources. It is reasonable for these agencies to claim credit for the emission reductions achieved by these regulations. This attribution occurs in the EPA’s national GHG inventory where the EPA attributes GHG reductions in both the petroleum and natural gas system and MSW landfill sectors to the NSPS. Development of revised national emission factors and assumptions may lag significantly behind implementation of revised regulations, but facilities making changes to equipment or operations should be able to reflect the emission reductions required by the regulations when undergoing permitting.

CONCLUSIONS

Fugitive emissions represent a significant portion of GHG emissions and accurately quantifying those emissions is especially challenging. The increased scrutiny on GHG emissions has led to more attention to fugitive emissions quantification methodologies from several sectors, including petroleum and natural gas systems and MSW landfills. It has also led to increased attention to command and control regulation for GHG and other fugitive pollutants from those sources.

Quantifying fugitive emissions remains a potential major source of error in GHG and other pollutant emissions inventories. As new emission factors and methodologies are developed, they must be reconciled with regulatory requirements. As operational requirements and equipment requirements are imposed by agencies to reduce fugitive emissions, the changes driven by those requirements must be reconciled at the site level as well as reflected in regional inventories.

Finally, significant research and analysis is still needed to refine fugitive emission inventories. Some recent work has been done to refine fugitive emission inventories such as those of the Solid Waste Industry for Climate Solutions (SWICS), a collaboration between academics and the waste industry, and recent improvements to the EPA's emission quantification for hydrologically fracturing natural gas wells.

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