It's All in the Numbers: A Look Into Emission Factors Used in GHG Permitting and Reporting

Extended Abstract #48

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INTRODUCTION

In 2009, the Environmental Protection Agency's (EPA's) administrator signed an endangerment finding stating that greenhouse gases (GHGs), including carbon dioxide (CO_2) and methane (CH_4), threaten public health and welfare.[1] This allowed the EPA to take regulatory action to track, monitor, request information on, or otherwise limit emissions of GHGs. In addition, Congress passed the Consolidated Appropriations Act which required the EPA to develop and publish a draft rule to require mandatory reporting of GHG emissions in all sectors of the economy.[2] These two actions led to the creation of GHG Reporting Program (GHGRP), which requires the reporting of GHGs for some sources. In addition, on May 13, 2010, EPA finalized the GHG Tailoring Rule, which sets thresholds for the New Source Review/Prevention of Significant Deterioration (NSR/PSD) and Title V Operating Permit programs.[3]

The purpose of the GHGRP is to provide information for decisions about future emissions reduction regulations.[4] In reporting, the presumed goal is to capture a large amount of data without overly burdening reporters or the agency collecting information. Current thresholds laid out in the rule are designed to capture 85% to 90% of US GHG emissions.[4] The purpose of the GHG Tailoring Rule is to set a higher regulatory threshold for the NSR/PSD program, thereby reducing the burden placed on permitting authorities and sources, and to phase-in compliance with the program.[5]

While these actions impact all industries, the oil and natural gas industries have raised concerns regarding onerous reporting. The following discussion is based on Subparts C and W of the GHGRP that apply to the oil and natural gas industry. Although limited to these subparts, the discussion is applicable to many different industries.

Questions regarding emission factors and manufacturer's data are applicable to a variety of sources. It is important to compare manufacturer provided emissions to other methodologies to prevent errors in permitting and reporting. Any emission source that can be modeled via software, directly measured, or calculated using emission factors, such as tanks or amine units, could benefit from an analysis such as this.

The implications of an absence of guidance provided by EPA are potentially significant in permitting new sources. Facilities may inadvertently trigger PSD permitting as a result of how GHGs are calculated, either via manufacturer's data or the fuel based method provided in the GHGRP. It is also of concern that a facility may be reporting significantly different numbers for different regulatory programs. Without considering different methods of calculation there is no way to know which is "correct" for which regulatory program. It also raises questions with regards to the accuracy of the reporting.

APPROACH

The authors chose to compare emissions calculated using guidelines from the regulation to emissions calculated from manufacturer data and/or from specific emissions software to emissions calculated from emission factors. The Compilation of Air Pollutant Emission Factors (AP-42) was used for comparison to the regulatory emission factors when possible as these are often widely accepted.[6] When applying conditions to manufacturer data, the standard natural gas composition was used with a 500 ft altitude and ISO conditions.

In evaluating glycol dehydrators, the authors used the GRI GlyCalc software to evaluate emissions from multiple subbasins in one area of the county. Representative annual averaged conditions were used in this analysis.

ENGINE AND TURBINE EMISSIONS

Reporting for Subpart C combustion units is based on fuel use and emission factors derived from carbon content of the fuel. Consistent with other CO_2 emission factors, Subpart C assumes 100% conversion of any carbon into CO_2. This results in very conservative CO_2 emissions values. By suggesting a single emission factor for CH_4 in Subpart C, EPA does not consider potentially significant contributions to overall GHG emissions resulting from unburned fuel (fuel slip). Fuel slip may be a significant source of methane emissions from combustion units, and varies depending on the type of unit. Emission factors are available from AP-42 that are more specific to various types of combustion units, such as such as lean burn and rich burn engines, or two-stroke and four-stroke engines. This allows for more specific emissions factors and factors such as fuel slip to be accounted for.

Manufacturers may also provide emission data sheets for engines or turbines at specific site conditions. These data sheets summarize predicted emissions and "not to exceed" values that sources may be expected to provide when properly operated. In developing source-specific data sheets, there are many factors that affect predicted emissions that must be accounted for, such as fuel composition, elevation, etc. Yet many times values provided by manufacturers are actually derived from emissions factors, and very little engine specific testing is done to develop results.[7]

When comparing emissions calculated from the above approaches, significant differences can be seen. Table 1, below, summarizes CO_2 differences for a small selection of combustion units. All emissions are reported in metric tons per year (MTPY).

Table 1. Combustion Unit CO_2 Emissions.

Type	Model	Subpart C Emissions (MTPY)	AP-42 Emissions (MTPY)	Manufacturer Emissions (MTPY)
Rich Burn Engine	Waukesha L7042GSI	5877.98	4981.77	5812.17
Ultra Lean Burn Engine	Caterpillar G3516B 0.5gNOx	5199.51	4406.75	5733.98
Turbine	Mars 100 15000S	57971.96	49733.04	58139.47

Although there are differences between various methods, there are some general trends. Across the types of engines studied, AP-42 emissions factors generally produce lower emissions for CO_2 than those for Subpart C or manufacturer data. Table 2, below, summarizes CH_4 emissions for the same methodologies for the combustion units.

Table 2. Combustion Unit CH_4 Emissions.

Type	Model	Subpart C Emissions (MTPY)	AP-42 Emissions (MTPY)	Manufacturer Emissions (MTPY)
Rich Burn Engine	Waukesha L7042GSI	0.11	10.42	22.06
Ultra Lean Burn Engine	Caterpillar G3516B 0.5gNOx	0.10	50.08	48.99
Turbine	Mars 100 15000S	1.09	3.84	13.96

With regards to CH_4, AP-42 emissions factors and manufacturer emission factors are significantly higher than emissions using Subpart C methodology. CH_4 has a Global Warming Potential of 21 for GHGRP reporting, making a small difference in CH_4 emissions significant when converted to CO_2 equivalent emissions (CO_2E).

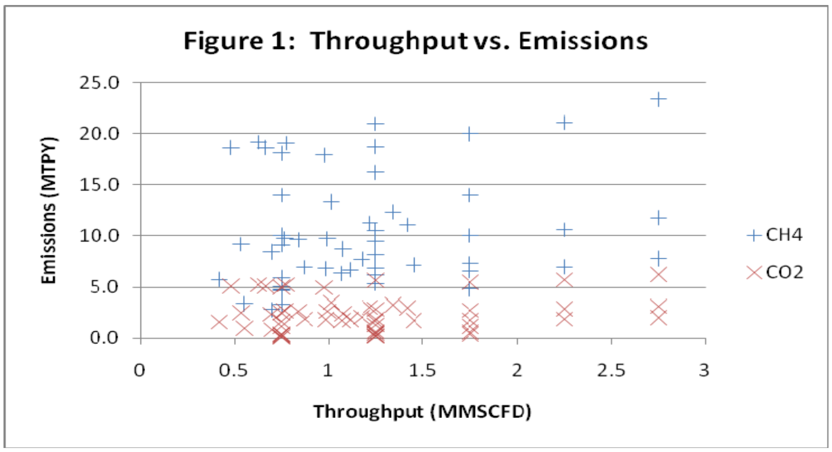
In using the most conservative value a facility can easily be forced to permit fewer engines in order to avoid exceeding a permitting threshold and triggering more stringent permitting requirements under the PSD program. Subpart C calculation methodologies were designed to be substantially less burdensome than other permitting methodologies. The underestimates Subpart C emission factors make in regards to CH_4 emissions from engines, however, should concern those who may use this data in permitting. Permitting methodologies are meant to be more stringent, so it is recommended that manufacturer emissions should be used for permitting. Caution should be used, however, when examining the information from the various programs as each is striving for different outcomes and each provides different information. As agencies get more sophisticated in permitting these sources, compliance verification, possibly including stack testing, will be based on permitting.

GLYCOL DEHYDRATOR EMISSIONS

The inclusion of glycol dehydrators in Subpart W has caused uncertainty regarding applicability of the regulation to thousands of well-site dehydrators located in remote areas. The GHGRP stipulates a GlyCalc run for each glycol dehydrator over 0.4 MMscfd of throughput, while an emission factor can be applied for any dehydrator under the threshold. GlyCalc was originally designed to estimate VOC and HAPs emissions for the purposes of permitting and compliance with Clean Air Act (CAA) requirements. While Subpart W allows for representative gas samples and engineering calculations for inputs, performing thousands of GlyCalc runs requires a significant time commitment.

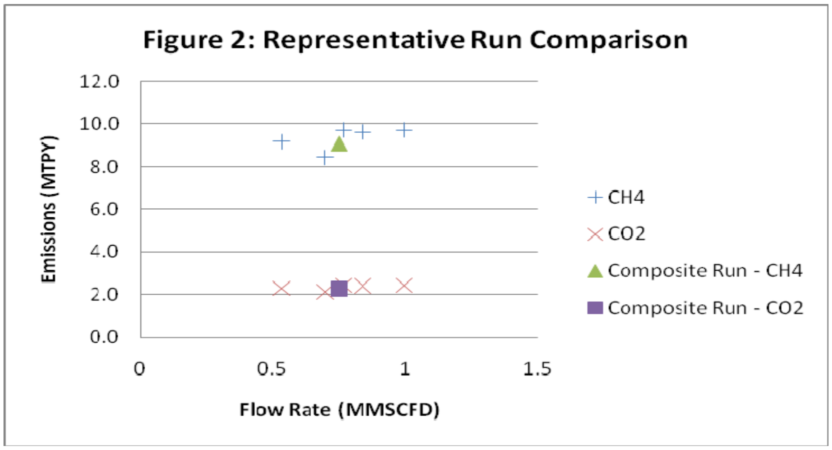
As a further point of reference, we compared EPA's approved emission factor provided in Subpart W for small dehydrators to specific GlyCalc runs for dehydrators in the range of 0.4-1.0 MMscfd and found that emission factors significantly underestimate resulting GHG emissions.

Although many commenters have suggested using an emission factor for dehydrators with throughput under 3 MMscfd, the results of a series of GlyCalc runs shown in Figure 1 confirm EPA's assertion that there is a poor correlation between throughput and emissions.



There are other options outside of an emission factor to reduce reporting burdens. One method involves representative data to successfully characterize groups of dehydrators. Subpart W already allows for the use of engineering estimates based on best available data or representative gas analyses, as well as a number of other data assumptions. Representative groupings of dehydrators can be established based on pump type, glycol circulating rate, flow rate, and basin gas composition. Based on multiple GlyCalc runs, the authors' observation is that the most useful groupings have been based on subbasin gas quality and composition, and pump flow rate characterizations. This has allowed us to reduce the potential number of runs from more than 3,000 (the number of individual wellsite dehydration units) to approximately 45.

Analysis of GlyCalc data for these groupings indicates that overall average data inputs yield emissions estimates that seem representative of the individual dehydrators evaluated. The correlations, while not perfect, seem acceptable for the purpose of reporting. Occasionally, specific runs produced outliers compared to the other dehydrators in the grouping. These may be due to large variability in the inlet gas pressures. Figure 2 shows a group of dehydrator emissions as compared to the emissions from the representative run.



In spite of occasional outliers, when included and averaged across a large number of dehydration units, we believe this methodology is an acceptable and appropriate way to reduce the burden of individually quantifying large numbers of small sources while still providing accurate and representative data.

SUMMARY

EPA's regulatory actions, including the GHGRP and the GHG Tailoring Rule, have different purposes and therefore different requirements and methodologies for reporting emissions from engines and dehydrators. The GHGRP does not need to be as accurate in reporting of GHG emissions from sources, while the GHG Tailoring Rule requires a more detailed examination of potential to emit values in order to accurately permit new sources. It should be noted that there are significant differences between resultant emissions of one program versus another, bringing concerns about accuracy of emission factors used in the GHGRP and accuracy of data being provided for permitting under the GHG Tailoring Rule.

Additional questions remain regarding dehydrator emissions. Dehydrator reporting requirements for Subpart W may be very onerous for many companies. Although use of a simple emission factor based on throughput may not be an acceptable methodology, using representative data and conditions to limit the number of GlyCalc runs required may provide acceptable results. By using representative data and representative runs, it is possible to properly characterize dehydrator emissions striking a compromise between the use of inadequate emission factors and a requirement to perform thousands of GlyCalc runs.

For these sources and others, there must be a balance struck between relative accuracy of emissions predictions, overall reporting burdens, purposes of the regulatory programs, and achievability of obtaining accurate and repeatable data both on the part of the operator and on the part of the manufacturer.

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KEY WORDS LISTING

Greenhouse gas, emission factor, dehydrator, engine, turbine, emissions