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ENV-10-40 Improved Air Emissions Estimates - How to Get There

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Improved Air Emissions Estimates - How to Get There

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The quality of emissions inventories prepared by the refining industry has been called into question by numerous organizations over the past several years including both regulatory agencies bodies and citizen groups. The implication is that the industry has historically under-reported its emissions. In response, EPA has explored potential remedies in recent documents including an assessment by the EPA Inspector General [1] and the draft protocol issued requiring the application of specific calculation methodologies for estimating refinery emissions [2]. Refiners should understand the implications of this increased focus on the emission inventory and how it can impact compliance with reporting rules, emission limits and risk assessments.

This paper discusses the quality concerns documented by EPA related to industry's use of published emissions estimating methodologies. Issues raised relative to the recent draft refinery emissions estimating protocol are summarized. Recommendations for inventory improvement are provided including specific areas where increased emphasis on emissions inventory development can result in material improvements in quality. Procedures for conducting audits are proposed.

QUESTIONS ON APPROPRIATE METHDOLOGY

One of the main sources of methodology and guidance for estimating emissions has been the US Environmental Protection Agency (US EPA). Publications have included major compendiums for estimating a variety of sources [3], guidance for improving source estimates [4] and directions for estimating from specific sources such as fugitive equipment leaks [5]. These documents have been used for many years by industry to develop emissions estimates for permitting, preparing inventory reports and as input to risk assessments. These activities have been accepted and supported by Federal, State and Local environmental agencies.

Over the past several years, EPA has raised concerns about the quality of emissions inventories based on use of the published methodologies [6]. These concerns have included both the representativeness of the methodologies used and their application. The Agency has explored the issues and remedies in recent documents including an assessment by the EPA Inspector General [7]. Suggested remedies have

included adjustments to emissions estimates to reflect variability of the average factors.

One major complaint is that the EPA-published emission factors were not intended to be used for developing permitting limits. While this may have been initially correct, they have in fact been used extensively for this purpose at the direction of many State and Local agencies. In the absence of measurements (which would not exist for a source being initially permitted) there appears to be no alternative to using published emission factors and vendor performance guarantees.

Another concern raised with the use of the EPA published emission factors is that they reflect the industry average of "well" performing and maintained sources. While this may be correct for sources such as tanks, where rim seals are assumed to be tight, it is not true for many emission factors for combustion sources where trace toxics (metals, PNAs, etc.) prediction tools are based on available site test measurements.

How closely the average emission factor represents a specific source is also a concern raised by regulatory agencies. The use of an average emission factor to represent a specific source has always been problematic. The results have been deemed acceptable since within a specific processing unit or plant there are likely many similar sources and this random variability tends to dampen the differences between the actual and predicted emissions.

NEW REFINERY DRAFT EMISSIONS ESTIMATING PROTOCOL

In an attempt to bring consistency to emissions estimates, EPA has recently developed a draft protocol that requires the application of specific calculation methodologies for estimating refinery emissions [2]. This protocol includes tiered listings of acceptable estimating methodologies for each source type and provides expectations regarding available data.

As raised in industry comments on the document, the new protocol appears to be problematic in that it sets specific requirements in an emissions estimating document that would normally be require a formal rulemaking process [7]. Typically, there are several methods which can be used to generate an emissions estimate and the choice, based on available data and applicability to the specific source, is usually left to the estimator.

Among the deficiencies with the EPA Draft Emissions Estimating Protocol are omissions of many accepted methods, contradictions of existing Agency guidance and inappropriate method application. These issues and others have been documented in industry comments to the Agency [7, 8].

There is additional concern within the industry regarding how the protocol use will be mandated, including how it may be used in the conducting of additional data collection related to residual risk for the refining industry.

The exact path EPA will be taking with respect to the draft guidance document is not yet clear. This paper focuses on actions that refiners should take today which can provide improved inventory quality over current practice.

IMPROVING INVENTORY QUALITY

In preparing air emission inventories, many opportunities exist for errors to be made which can result in poor quality estimates being reported to regulatory agencies. Increasing the focus in preparing the estimate and in reviewing the results can provide more defendable reports and reduce regulatory compliance problems for the plant.

Plants have many incentives to compile complete and representative emissions reports that can be completely defended under rigorous agency review. The complexity of collecting operating data and using various methods to obtain emissions estimates, however, provides many opportunities for inaccuracies to be introduced. Identification of the potential problem areas and increased emphasis on data collection and selection and use of calculation methods can minimize errors; thereby providing results that are more representative of actual plant emissions and are more defendable when challenged by regulatory agency inspectors or third parties.

As an indication of how an inadvertent error estimating emissions can cause a lead to unwarranted attention and considerable effort to correct, consider the following example from a few years ago. A major refiner inadvertently used a published emission factor that led to reporting formaldehyde emissions significantly higher than past years and far above any other similar facilities. Although, it was later found that the estimating methodology was not correctly applied because of unfamiliarity with the development of the method and not reviewing the documentation published with the factors, the higher number was used by regulatory agencies and environmental activist groups as proof that industry was underreporting emissions. The original error caused significant disruption to the company as they attempted to explain and revise their emission reports and to the industry committees like API who had to address the issue. If the discrepancy had not been caught, it could have led to a significant increase in calculated risk and added capital and operating expense.

The above example is but one of a number of potential problem areas associated with developing an emissions inventory. A previous article looked at these inaccuracies in detail and provided recommendations for avoiding them [9]. Some of these recommendations are summarized below.

A major cause of incorrect inventories is missing emission sources. This type of omission can be caused by unfamiliarity with plant operations, uncertainty of potential emitters or insufficient effort to identify all the potential contributors. There are several ways to minimize missing sources including comparisons to previous reports, reviewing guidance documents, talking to operators at the plant and "benchmarking" through industry organizations. Previous year's reports can be checked for sources included in thresholds and those with reported emissions. A comparison with other sites or companies may identify additional sources which should be considered for inclusion in the inventory

While most methods for estimating emissions are relatively straightforward, in all cases guidance should be read and understood prior to using a new factor or method. In addition, many factors and methods are specifically applicable to a particular type of equipment and operation so care should be used in matching the method or factor as closely as possible to actual plant operation.

Another problem that comes from not reviewing the documentation or guidance that is provided with methodology or factors is improper use. Check that the factor or method applies to the source and is the most applicable method or factor that is available. For example, the multiplier on the factor should be checked to ensure that it is being used correctly in the emission calculation.

Emission estimating results are only as good as the operating and design data used to generate them. In most cases, information on operations is obtained from personnel who have no direct responsibility for reporting plant emissions and they may place a lower priority on the need for data for environmental reporting. The importance of the reporting effort and the need to get the best information possible should be well-understood, as should the implications of poor reporting results. If possible, the inventory preparer should seek independent verification of the information. Best practice would also include a check for consistency by comparing information with that provided for the previous reporting period. If identical, you may be receiving the previously year's report and will want to confirm that there are no changes. With more and more electronic reporting, some states, such as New Jersey, are already making such comparisons between current and previous year’s data to flag potential issues.

Calculation errors can occur. Errors in data entry can be found by repeating the calculation. Check the formula and cell references in spreadsheets. Check data input

and output for computer models. Check all results for reasonableness and question any outliers to determine the cause before accepting them. Compare to previous year's results, other sites and if possible, "benchmark" with other companies.

Human nature will drive us in the direction of reducing the reported emissions, even if these are just paper reductions due to the choices of methods and factors. Changes in methods and factors used are not a problem as long as the most representative and defendable methods and factors are used and the choices are not made solely to reduce the reported emissions. The need for accurate and representative estimates should be stressed to all involved in the data collection, calculation and reporting effort so that decisions are not made to arbitrarily create a lower estimate. When there are choices between different methods and factors, make sure to document the reasons for the approach chosen. This will facilitate future reviews or inspections. The basis for selecting a method should be defensible and not be solely because it results in a lower estimate. Personnel who are charged with selection of methods should fully understand and appreciate the consequences for inappropriately reporting emissions.

How the data collection, reporting and estimating functions are organized can have a significant impact on the inventory quality. For example, many locations use these positions as opportunities for junior staff to learn about other parts of the plant. This can create a lack of continuity in the emissions estimating and reporting process as new engineers need to quickly learn their new assignments before they are again reassigned. This also can lead to mistakes being perpetuated since, most often, these new engineers just continue the same procedures utilized previously without much opportunity to make improvements. Method revisions published by EPA and API are often missed by personnel new to the environmental area.

Most plants need to submit emission reports to several organizations such as state and federal agencies. The bases of all reports (fuel use, flow rates, speciation, etc.) should be consistent. Reports that include the same pollutant for the same source and time period will normally be identical. If there are differences between reports, consider documenting the reasons for these so that differences can be readily explained. All assumptions and methods should be fully documented. It is essential that in the future, someone be able to understand which data were used and how the calculations were done.

In locations with monitoring and maintenance (e.g. LDAR) programs, the results from monitoring should feed directly into the fugitive emissions calculation effort. The emissions estimate is dependent on the quality of the monitoring. A good LDAR system QA/QC program with measurement and documentation checks is essential. Monitoring records should be checked for an excessive number of components per day when using US EPA Reference Method 21. Review all documentation, including

calibration records, monitoring times and rechecks for consistency. If component-specific monitoring data are available, it should be used for estimating purposes in place of average factors. Insulated and other unmonitored components should use average factors representative of their repair frequency. Components that are not monitored or repaired should use average "uncontrolled" emission factors. API has published a manual on estimating fugitive emissions [10] that provides additional guidance.

For floating roof storage tanks, primary tank rim seal type and the number and type of roof fittings are the two most important mechanical parameters in estimating emissions. In many cases these are not accurately known. Original drawings and design plans may not reflect what exists in the field. The US EPA TANKS software can be used to estimate atmospheric storage tank emissions. However, for floating roof tanks, the set of roof fittings chosen as the default may not match conditions in the field. Additionally, methodology has been developed for estimating emissions from tank roof landings [11] and from tank cleaning operations [12] and these should be reviewed for their applicability.

Typical emissions from combustion sources such as SO_x, NO_x, PM, and CO_2 are rarely missed when preparing an inventory. It is not always recognized, however, that trace toxics (e.g. metals, PAHs, etc.) can also be emitted from furnaces, boilers, FCCUs, etc. Trace toxic emission factors for boilers, heaters, engines and turbines have been published by both API and EPA. There are also trace toxic emission factors developed for FCCUs and catalytic reforming units. Also, combustion sources with fuel sulfur will generate SO3/H2SO4 emissions. Sources for these emission factors are provided in Reference 9.

Estimating loading emissions is relatively straight forward provided information on the type of transport, prior cargo and any cleaning of the compartment is known. If these operational conditions are not known, the estimated emissions using average factors can be quite different than the actual emissions. The basis for choosing all parameters in the calculation should be fully documented. Further, the efficiency of any vapor recovery or destruction system has a major impact in developing the emissions estimate. This should be based on verified testing / measurement and fully documented. All material vented to the atmosphere after the control system should be included in the emissions inventory. This includes the unburned material from a flare.

Since plants do not typically have continuous measurements of the destruction efficiency of their flares, it is important to fully document the source of this parameter. Many guidance documents recommend a destruction efficiency of 99.5%. That is, 0.5% of the material sent to the flare is emitted to the atmosphere without chemical change. Any plant reporting higher flare destruction efficiencies may be

questioned. Some states and localities require use of a lower destruction efficiency unless additional documentation is provided. Texas instructs plants to use 99% or 98% depending on the materials sent to the flare. Application of the flare vendor's combustion efficiency should be used if available.

There is significant uncertainty in the reported flow rates to the flare especially during process up-sets. Quantities and composition estimates should be fully documented. There are no published trace toxic emission factors developed specifically for flares.

Emissions of specific chemicals are mostly calculated by first determining the quantity of overall hydrocarbon emissions and then multiplying by the fraction of the specific species in the vapors emitted. The use of old or unrepresentative stream speciation data can result in inaccurate emission estimates. Stream sampling is expensive, but can help to ensure representative estimates. Alternatively, API has published refinery stream speciation profiles that include a number of toxic species [13].

AUDITING

Reviewing completely the data and methodology used to develop the inventory can usually improve report quality and can reduce future regulatory compliance problems. An independent audit of the emissions inventory is often useful to confirm appropriateness and identify potential improvements.

PROCEDURES AND BENEFITS FOR CONDUCTING AUDITS

The complexity of collecting operating data and using various methods to obtain emissions estimates introduces many opportunities for inaccuracies. Conducting a systematic audit of the emissions inventory development process can: identify potential problem areas, check if appropriate calculation methods are being applied, minimize errors and provide results that are more representative of actual plant emissions and are thus more technically defendable when challenged by regulatory agency inspectors and/or third parties.

The purpose of a plant emissions inventory audit is to identify areas in the estimating procedures that need improvement. A previous article presented detailed procedures for organizing and conducting an audit [14].

Preparation

Before staring an audit, the goals for the audit should be established. The specific tasks should be defined and reviewed with the plant personnel so they know what to expect before and during the site visit and are more prepared to provide information.

Once the goals are established, preliminary data is requested and plans to visit the plant are made. The site visit is an important part of the audit process. Although many aspects of the audit can be accomplished prior to the site visit, the visit allows for more detailed review and interaction with the plant personnel who provided the data and developed the inventory.

The team reviewing the emissions inventory must clearly understand how the inventory is used. Often there are several purposes including regulatory reporting and corporate emissions tracking. Knowing the reasons that the inventory was developed will help guide the reviewers in identifying appropriate recommendations for improvement.

As part of "pre-work" done prior to the site visit, the plant should send copies of previous inventory reports and summaries of the methods used. This allows the non-plant personnel to become somewhat familiar with the site and identify some areas to pursue in additional depth during the site visit. Plant assistance in collecting and sending this material before the site visit is essential.

To ensure that all areas are reviewed, a preliminary list of all pollutants, sources and items to check should be developed before the site visit. The source lists are the most critical items to develop correctly. Significant time should be spent making sure that all sources are included in the inventory.

Audit Visit

The first topics on the agenda for a site visit are to review and confirm the objectives of the audit, confirm the regulatory and company reporting requirements, and discuss any existing concerns. This preliminary discussion may include briefing plant management. It will guide the remainder of the audit since it will highlight areas needing emphasis.

During the audit, methods used and input data for calculation should be evaluated, including a check for reasonableness. Further, execution of the source completeness check should be completed - to confirm that all emission sources are included. This applies even to relatively small sources since omission from the inventory can create a regulatory compliance issue. All calculation models and factors used to estimate emissions should be checked to confirm that they are appropriate for representing the sources and are being used correctly. Too often methods are not chosen well and their use results in estimates that are not as representative as might be obtained with

alternative methods. Alternative methods could include use of industry average emission factors when data are available to use more representative methods (such as for fugitives, product loading, wastewater air emissions) or use of defaults in software models (e.g. TANKS, when construction details are known).

All assumptions and input data should be thoroughly reviewed. The quality of the inventory depends on the quality of the specific plant operating data. Check to make sure that all assumptions are reasonable, are fully documented and can be defended during a regulatory review.

The order for reviewing specific pollutants and sources is not critical, but it is best to do the combustion sources and hydrocarbon sources separately since the pollutants are similar in each group but much different between them.

Input data for calculating emissions from each source should be checked with emphasis on the methodology used and the input data quality. The validity of the detailed input data should be checked and it should be confirmed to be representative of actual operating or field conditions. The check should include a review on all the details of how the data are used in obtaining an estimate of the emissions.

Make sure there is full and detailed documentation for all assumptions made to complete the inventory. While the basic assumption may be correct, the plant personnel need to be able to fully explain its use and show that is was appropriate for the source and pollutant. Any instances where the choice of a method, factor or data could be interpreted as the plant making a choice solely to report lower emissions should be corrected.

Time should be left at the end of the site visit to review the findings and recommendations in detail. This is more than just a "closeout presentation" and is needed to ensure that the plant staff understands the basis of recommended changes and how to accomplish these changes.

Documentation of the results and recommended corrective actions is as important as doing a thorough review and audit. The audit effort is of limited value if the follow-ups are not clear and the plant is not able or willing to implement the recommendations. A closeout meeting with plant management is recommended.

Audit findings typically fall into two general areas: 1) items where there is an oversight or omission that needs to be corrected, and 2) items where the estimate could be improved. Where there is a clear omission, the plant has significant incentive to make the corrections. Where the current method is adequate but may not be the best, the auditor will need to explain to the plant personnel that the

improvement will not only result in a more representative estimate but that there are tangible benefits to the plant.

Results should clearly state the emission source, the issue that needs to be addressed and specific recommendations on how to proceed with follow-up. The recommendations should be detailed enough so that the plant can implement them without a significant amount of recycle back to the audit team.

CONCLUSIONS

The complexity of estimating emissions provides many opportunities for errors and inaccuracies. Identification of potential problem areas and increased emphasis can minimize errors and provide results that are more representative of actual plant emissions. Conducting an audit of the emissions inventory results can help identify potential problem areas, check calculation methods, minimize errors and provide results that are more representative of actual plant emissions. These results will then be more defendable when challenged by regulatory agency inspectors, community organizations or environmental "watchdog" groups.

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