Calculating N_2O Emissions from the Production of Nitric Acid, (Version 2.0)

Guide to calculation worksheets (December 2007)

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I. Overview

I.A. Purpose and domain of this section

This guideline is intended to facilitate corporate-level and plant-level measurement and reporting of greenhouse gas <u>direct</u> emissions resulting from the production of nitric acid (HNO_3). A step-by-step approach is used to cover every phase of the calculation process from data gathering to reporting.

This sectoral guideline covers process related N_2O (nitrous oxide) emissions from the production of nitric acid. However, this guideline does not cover a) direct emissions from the combustion of fossil fuel occurring during the production of nitric acid and b) indirect emissions from the purchase of energy (electricity or steam) used for nitric acid production. These GHG emissions are covered by the cross-sectoral guideline on stationary combustion.

I.B. Applicability of the tool

N_2O emissions from the production of nitric acid depend on the quantity of nitric acid produced, plant design, burner conditions and on the amount of N_2O destroyed in any subsequent abatement process.

Many nitric acid producers already treat the emissions with the intention of reducing nitrogen oxides (NO_X) emissions. In Europe, the most common NO_X abatement technology is selective catalytic reduction, which does not reduce N_2O emissions and can sometimes lead to an increase of NO_X emissions. In The United States and Canada, many plants use non-selective catalytic reduction to reduce NO_X emissions, and this technology also results in reduced N_2O emissions. If not otherwise mentioned, tons or t always stand for metric tonnes.

II. Choice of Activity Data and Emission Factors

This guideline contains a multi-tier approach, offering reporters the choice between simple and more advanced approaches for measuring N_2O emissions from the production of nitric acid.

The most accurate emissions data can be obtained through direct monitoring of N_2O emissions.

Using site-specific emission factors is the second best solution. Least accurate results are obtained by using default emission factors.

III. Calculation of the N_2O Emissions

Approach 1: Direct monitoring of N_2O emissions

N_2O emissions vary significantly from one nitric acid plant to another. The N_2O emissions depend very much on site-specific factors such as plant design, process conditions and abatement technologies employed. Consequently, direct monitoring of emissions generates most accurate emissions data.

Precise direct monitoring of N_2O emissions requires measurement of both the exit stream[1] and the uncontrolled stream[2]. However, data quality is satisfactory even where measurement data are available only for the exit stream. To obtain N_2O emissions data from direct monitoring, the concentration of the pollutant in the flue gas is measured, and this concentration is multiplied by the flow rate of the flue gas to arrive at a mass emission rate. The mass emission rate is then annualized to obtain the emissions for an entire year or for a different reporting period.

N_2O emissions data are usually obtained on the basis of continuous monitoring. Where monitoring is not done continuously, it is necessary to conduct sampling and analysis whenever a plant makes any significant process changes that would affect the generation rate of N_2O and sufficiently often otherwise to ensure that operating conditions are constant. A number of different technologies can be used for direct emissions monitoring. When applying direct measurement techniques, the instructions provided by technology suppliers and/or environmental regulatory offices should be closely observed.

Approach 2: Using N_2O site-specific emissions factors (Worksheet 1) and
Approach 3: Using N_2O default emissions factors (Worksheet 1)

N_2O emissions vary significantly from one nitric acid plant to another. The N_2O emissions depend very much on site-specific factors such as plant design, process conditions and abatement technologies employed. Consequently, applying site-specific emission factors generates more accurate data than using default emission factors. Default emission factors can only deliver rough emission estimates and do not reflect the actual emission performance of individual plants. The question whether a correlation exists between the oxidation pressure and the level of N_2O emissions per ton of HNO_3 produced is still discussed within the industry.

Site-specific emission factors can be derived from direct measurement of emissions. It is necessary to conduct sampling and analysis whenever a plant makes any significant process changes that would affect the generation rate of N_2O and sufficiently often otherwise to ensure that operating conditions are constant.

Worksheet 1 is based on the following formula:
N_2O Emissions = nitric acid production x N_2O emissions factor x (1 − (N_2O destruction factor x abatement technology use factor))

You will need to determine the following:
• Quantity of nitric acid produced (metric tonnes)
• N_2O emissions factor (kg of N_2O / metric tonnes of nitric acid produced)
• If you have elected not to use a default emission factor you will also need data on the destruction efficiency of any abatement system used as well as the amount of time that that

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1 Exit stream: confined emission streams in stacks or vents, therefore relatively easy to measure
2 Uncontrolled stream: emissions that are not confined, therefore much harder to measure

system has been used at the plant. Both of these values are entered as fractions into the spreadsheet.

Default factors are provided for five different types of nitric acid production plants. As several of these defaults have been derived assuming the use of specific abatement technologies, plants may not need to supply data on their abatement systems, depending on the default used.

1.1 Enter the quantity (in metric tonnes) of nitric acid produced in column A.

1.2 Default N_2O emission factors are provided in column B. In preference to the default values, use site-specific N_2O emission factors and enter those values in column C. If provided, column D automatically selects the custom N_2O emission factor.

1.3 Depending on the type of emission factor chosen, enter plant-specific data on the destruction efficiency and usage of any abatement technology. This data is required whenever a custom emission factor is specified and when certain of the default emission factors are chosen. In nitric acid plants, N_2O can be removed/reduced either in the process gas, directly after ammonia oxidation or in the tailgas. The N_2O destruction factor takes values between 0 and 1, e.g. 0.95 if 95 % of total N_2O emissions is destroyed during the abatement system. The abatement system utilisation factor takes values between 0 and 1, e.g. 0.95 if the abatement equipment was operating for 950 hours while production of nitric acid occurred during 1,000 hours.

1.4 All values obtained in Columns G and H are automatically calculated.

IV. Quality Control

To identify calculation errors and omissions, the quality of the emissions data obtained should be controlled. Two simple and effective alternatives are recommended:

1. Emissions comparisons

Compare the emissions data obtained with emissions data calculated for the same facility in previous years. A calculation error is probable if differences between current data and data from previous years cannot be explained by changes in activity levels or changes in production technologies employed.

2. Order of magnitude checks

If you have used Approaches 1 or 2 to calculate your emissions, you can employ the method proposed in Approach 3 to check whether your results are in the correct range.

V. References

The data and methods presented in this tool come from the 2006 IPCC Guidelines for National Greenhouse Gas Inventories (Volume 3, Chapter 3.3). These Guidelines can be accessed at: http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/3_Volume3/V3_3_Ch3_Chemical_Industry.pdf.