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

Guide to calculation worksheets (December 2007)

Table of Contents

I. Overview

I.A. Purpose and Domain

This guideline is written for plant managers and site personnel to facilitate measurement and reporting of greenhouse gas direct emissions resulting from adipic acid production. A step-by-step approach is presented to cover every phase of the calculation process from data gathering to reporting. This sector guideline should be applied by the industries whose operations involve the production of adipic acid.

I.B. Process Description

The primary use of adipic acid is in the manufacturing of 6,6 nylon. Cyclohexane is used to produce a ketone-alcohol, which is subsequently oxidized with nitric acid to produce adipic acid. Nitrous oxide (N_2O) is produced as a by-product of this reaction, with an associated emission factor of 300 g N_2O/kg Adipic acid produced (plus/minus 10 percent depending on the ratio of ketone to alcohol). This emission factor does not incorporate any reductions associated with abatement technologies.

N_2O emissions can be abated by:

(1) Treating the off-gases in a reductive furnace.
(2) Thermally decomposing the N_2O in a flame reactor (T>900 C) to produce recyclable NO.
(3) Catalytically decomposing the N_2O.
(4) Consuming the N_2O as an oxidation process feedstock.

The majority of the large adipic acid producers (representing more than 80% of worldwide capacity in 2000) currently treat N_2O emissions.

I.C. Applicability of the tool

Greenhouse gases are also emitted from the fuel combustion process associated with adipic acid production. These emissions are not accounted for in the guidelines described below. Please see the Stationary Combustion guidelines for more details and for the methodology used to estimate these emissions.

II. Choice of activity data and emission factors

This protocol estimates nitrous oxide emissions based on the quantity of adipic acid produced, an N_2O emission factor, an abatement technology destruction factor, an abatement technology utilization rate. Adipic acid production and details about abatement technologies should be available from the facility. Default values for an emissions factor and approximate destruction factors for some technologies can be used if factory-specific data is unavailable.

III. Calculation method used in the tool

The equation used to calculate N_2O emissions from the production of adipic acid is summarized as follows [source: 2006 IPCC Guidelines]:

N_2O Emissions = (Adipic Acid Production x Emission Factor) x (1 – Fraction Abated x Utilization Factor)

Where:
Adipic Acid Production (metric tons)
Emission Factor (metric tons of N_2O/metric ton of adipic acid produced)
Fraction Abated (%) – percent of emissions abated by reduction technologies and practices
Utilization Factor (%)– percent of time the abatement technology was in use

Worksheet 1 has been provided to assist in estimating N_2O emissions from the adipic acid production process. Factory specific data should be used whenever possible. However, default values are provided in Table 1 of Worksheet 1. If a factory specific emission factor is not known, the 2006 IPCC Guidelines provide a default emission factor of 300 g N_2O /kg adipic acid produced, which converts into 0.3 tonnes of N_2O /tonne of adipic acid produced. In addition, default Fraction Abated values are given by the 2006 IPCC Guidelines for a variety of abatement technologies.

IV. Direct N_2O emissions from Adipic Acid Production

Direct emissions are those that are produced within the boundary (fence) of the reporting facility, or in this case, emissions directly associated with the production of adipic acid.

Worksheet

1. Enter the amount of adipic acid produced (tonnes) during the reporting period in Column A.
2. Enter the N_2O emissions factor (tonnes of N_2O /tonnes of adipic acid produced) in Column B. This emission factor should not incorporate any abatement technologies.
3. Calculate N_2O emissions by multiplying the amount of adipic acid produced by the N_2O emissions factor (Columns A and B). Column C should now display the product of A and B. If this is not the case, press “F9” to calculate.
4. **If the facility uses N_2O abatement technologies, please follow steps 5 through 9. Otherwise, please skip to Step 10.**
5. Enter the type of N_2O abatement technology in Column A.
6. Enter the percent of N_2O that is abated through reduction technologies in Column B. These pollution controls must be specific to reducing N_2O emissions.
7. Enter the utilization factor for the N_2O abatement technology in terms of the percent of time that technology was used (Column C).
8. Estimate N_2O emissions by multiplying the potential annual N_2O emissions calculated in Step 1 above by one minus the N_2O abatement factor (Column B) times the utilization factor (Column C).
9. Please enter the Global Warming Potential (GWP) for N_2O. Currently, the GWP for N_2O over a 100-year time horizon is 310.
10. Calculate Carbon Dioxide Equivalents by multiplying the potential annual N_2O emissions (Column E) by the GWP of N_2O (Column F)

V. CO_2 Emissions from Fuel Combustion Associated with Adipic Acid Production

The production of adipic acid consumes various types of fuels. Greenhouse gas emissions associated with this fuel combustion are not directly accounted for in the adipic acid production protocol. Please use the Stationary Combustion guideline to estimate these emissions.

VI. References

IPCC (2006), 2006 IPCC Guidelines for National Greenhouse Gas Inventories. These Guidelines can be accessed at: http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/3_Volume3/V3_3_Ch3_Chemical_Industry.pdf.