Information Note

Benchmark for the N_2O emission factor from nitric acid plants

I. Background

1. Nitric acid is widely used as a raw material mainly in the manufacture of nitrogenous-based fertilizers. Nitric acid is also used in organic oxidation to manufacture terephthalic acid and other organic compounds. It may also be used in the production of adipic acid and explosives (e.g. dynamite), for metal etching and in the processing of ferrous metals.[1]

2. N_2O is generated as an undesirable by-product of the high temperature catalytic oxidation of ammonia (NH_3) during the production of nitric acid (HNO_3). The N_2O formed in the production of nitric acid depends on various factors such as combustion conditions (pressure, temperature), catalyst composition and age, and burner design. In addition, the technology used to mitigate NO_X emissions that also occur during the production of the nitric acid could affect the N_2O emissions of the plant.

3. The CDM Executive Board released guidance on the expansion of industrial gas recovery methodologies to new facilities (EB 46 Annex 10) which clarifies that future submissions on expanding industrial gas reduction methodologies to new facilities (i.e. facilities not meeting the criteria of the respective approved methodologies) should address the following issues:

(a) Incentive to choose technologies with higher by-product rates;

(b) Diversion of the production from existing facilities to the new facility;

(c) Disincentives for technological development.

4. This note explains the rationale for the baseline emission factor in the draft approved methodology for new nitric acid plants and explains how the three issues above, regarding the expansion of industrial gas recovery methodologies to new facilities are addressed in the methodology.

II. Available emission factors for nitric acid production

5. A number of data sources for N_2O emission factors are available and are summarised below.

A. Data from IPCC

6. The emission factors in the 2006 IPCC Guidelines ranges from 5 to 9 kg of N_2O per ton of nitric acid produced, depending on the pressure of the production process.[2] If the uncertainties are conservatively taken into account, the range is from 4.5 kg to 5.6 kg N_2O per ton of nitric acid produced (see 2006 IPCC Guidelines page 3.23).

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[1] 2006 IPCC Guidelines for National Greenhouse Gas Inventories. Chapter 3: Chemical Industry Emissions, p. 3.19. <http://www.ipccnggip.iges.or.jp/public/2006gl/pdf/3_Volume3/V3_3_Ch3_Chemical_Industry.pdf>.

[2] Ibid.

Table 1: Default emission factors in the 2006 IPCC Guidelines

Production Process	**N_2O Emission Factor**
Atmospheric pressure plants (low pressure)	5 kg N_2O/t HNO_3 ±10%
Medium pressure combustion plants	7 kg N_2O/t HNO_3 ±20%
High pressure combustion plants	9 kg N_2O/t HNO_3 ±40%

B. Monitoring reports of CDM project activities using methodologies AM0028 and AM0034

7. In order to assess the range of N_2O emission factors from existing nitric acid plants, the baseline emission factor in each registered CDM project was evaluated. According to this evaluation, the baseline emission factor for the current projects widely varies with the lowest value of 3.5 kgN_2O/tHNO_3 and the highest value up to 20 kgN_2O/tHNO_3. The average baseline emission factor of the top 20% performing CDM plants without abatement corresponds to a value of 5.1 kg N_2O/tHNO_3.

Table 2: Baseline emission factors (without N_2O abatement) observed in registered CDM projects

Emission factor	**N_2O Emission Factor**
Lowest emission factor	3.5 kg N_2O/t HNO_3
Average emission factor	8.7 kg N_2O/t HNO_3
Highest emission factor	20 kg N_2O/t HNO_3
Average emission factor for the top 20% CDM plants	5.1 kg N_2O/t HNO_3

8. Note that the scope of the approved methodologies AM0028 and AM0034 discourages any technological improvement implemented during the project activity crediting period. If operators would implement process improvements, in the case of AM0034 they would need to reassess a new baseline campaign and in the case of AM0028 the amount of CERs would be lowered.

9. Practically this means that a project participant will be unlikely to implement any process optimization measures (which could reduce the emission factor) during the crediting period, while they may do so in the absence of the CDM. Therefore it is possible that the emission factors would be lower without the CDM.

10. It is not clear from the information from the CDM-PDDs and monitoring reports, why some production plants emit much higher N_2O than others. With the limited information available it is supposed that the likely explanation lies in the technology being used in nitric acid plants and the age of the ammonia burner.

C. European Reference Document on Best Available Techniques for the Manufacture of Large Volume Inorganic Chemicals - Ammonia, Acids and Fertilisers[3]

11. The document provides information on reported N_2O emission levels from different sources (including IPCC). The document shows a wide variety of emission levels and finally

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[3] Large Volume Inorganic Chemicals – Ammonia, Acids and Fertilisers, chapter 3, pages 103-140.

summarizes these findings in table 3 below, recommending their suggested emission factors levels for the best available technologies.[4]

Table 3: Emission factors for best available technologies

Type of plant	N_2O Emission Factor
New plants	0.2 - 0.6 kg/t HNO_3
Existing plants	0.12 - 1.85 kg/t HNO_3

12. In contrast to the IPCC default values and the baseline emission factors from CDM plants, these values are derived based on the assumption that secondary or tertiary abatement measures could be installed.

13. The values reported for new plants are lower than the values mentioned above, because the report considered that they should have secondary or tertiary abatement systems installed by design, among other measures such as optimization. For existing plants the range for emission factors is wider because existing plants may not be able to implement abatement measures due to technical limitations.

14. The report also includes the split view from the industry and one Member State of the European Union that claim the BAT range should include 2.5 kg N_2O/t HNO_3 for existing plants. This is because they consider that:

(a) There is limited experience with the use of secondary and tertiary N_2O abatement systems, and in some cases it may not be possible to implement them in existing plants;

(b) There is a variance in the results obtained from pre-selected test installations; and

(c) There are many technical and operational constraints for applying these abatement techniques in nitric acid plants in operation.

III. Technological development

15. For economic reasons, the nitric acid production industry is continuously implementing measures to increase the nitric acid production yield of their processes, and some of these measures also reduce the N_2O emissions. Some of the possible ways to decrease N_2O emissions are:

(a) Optimisation of the oxidation step;

(b) Increase the performance of the oxidation catalyst performance and reduce campaign length;

(c) Alternative oxidation catalysts. New type of catalysts have emerged over the past years which result in 30 – 50 % lower N_2O emissions, including:

  (i) Improved platinum catalysts;

  (ii) Two-step catalysts;

  (iii) Co_3O_4 based catalysts.

(d) N_2O decomposition by extension of the reactor chamber. A decomposition rate of 80 % is achievable using this option.

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[4] Large Volume Inorganic Chemicals – Ammonia, Acids and Fertilisers, chapter 3, page 140.

IV. Meth Panel recommendation

16. The Meth Panel recommends to use a benchmark approach to establish the baseline emissions. The baseline emissions are determined from a benchmark baseline emission factor using the information available for N_2O emission factors for existing facilities. Two options have been considered to establish the benchmark emission factor:

17. Apply a value of 5.1 $kgN_2O/tHNO_3$ as the benchmark for emission reductions that would be achieved in year 2005. This benchmark value declines by ≈1/6$kgN_2O/tHNO_3$ per year, to reflect and account for the autonomous technology improvement that is likely to take place in the sector, until it reaches the emission factor of 2.5 $kgN_2O/ tHNO_3$ in year 2020.

18. The following table shows the baseline emission factor per year.

Table 4: Baseline emission factors

Year	**Emission factor ($kgN_2O/tHNO_3$)**
2005	5.10
2006	4.90
2007	4.70
2008	4.60
2009	4.40
2010	4.20
2011	4.10
2012	3.90
2013	3.70
2014	3.50
2015	3.40
2016	3.20
2017	3.00
2018	2.80
2019	2.70
2020	2.50
2021	2.50
2022	2.50
2023	2.50
Year n	2.50

V. Rationale for using 5.1 kg N_2O/ $tHNO_3$ and 2.5 kg N_2O/ $tHNO_3$ as benchmark

19. The proposal to use the value of 5.1 kg N_2O/ $tHNO_3$ for year 2005 is because the value is considered as representing the emission factor obtained for the top 20% nitric acid plants, in terms of N_2O emissions, in Non-Annex I countries for the year 2005.

20. The proposal to apply a value of 2.5 kg N_2O/ $tHNO_3$ as the benchmark value from year 2020 is because this value represents the currently best available technology and is a value that can be achieved by the different nitric acid plants.

Addressing the guidance on the expansion of industrial gas recovery methodologies to new facilities

21. The Meth Panel is of the opinion that this approach addresses the issues highlighted in the guidance by the CDM Executive Board on the expansion of industrial gas recovery methodologies to new facilities.

(a) Incentive to choose technologies with higher by-product rates, as it does not allow project proponents to set a baseline higher than the benchmark and because this benchmark is set in a conservative manner. The value for the benchmark is defined taking into account the range of baseline emission factors observed in registered CDM projects;

(b) Diversion of the production from existing facilities to the new facilities, as the ambitious emission benchmark ensures that the CDM revenues are very small when compared to the sales revenues of the final product of the plant using the nitric acid, i.e. fertilizer or explosives. It is therefore unlikely that a significant amount of nitric acid production would be shifted from existing to new facilities, especially as nitric acid is usually produced as an intermediary product within a chemical complex.

Moreover, even if production shifts would occur within the host country, this is not likely to result in an overestimation of emission reductions as it is unlikely that the plants from which production have shifted (if any), would have a lower baseline emission factor than the default values proposed in the draft approved methodology; and

(c) Disincentives for technological development are avoided, because the proposed approach does not discourage project proponents to implement the best options to reduce N_2O emissions. The proposed methodology uses the benchmark as baseline emission factor even if the real baseline emission factor would be, in few cases, lower than the benchmark.

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History of the document

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