# CDM
# MONITORING REPORT #30
# of
# "N2O Emission Reduction in Onsan, Republic of Korea"
# UNFCCC 0099

## Revision 1

**From: September. 28th, 2009**
**To: October. 14th, 2009**

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## 1 Introduction

The purpose of this monitoring report is to calculate and clarify GHG emission reduction quantity achieved by this project for periodic verification.

This monitoring report covers the activity from September 28th, 2009 to October 14th, 2009 as the 30th crediting period.

Duration of the project activity period
The starting date of the project is defined as 01/09/2006.

## 2. Reference

**Approved Baseline methodology** :
Baseline Methodology for decomposition of N2O from existing adipic acid production plants (AM0021 version 1)

**Approved Monitoring methodology** :
Monitoring Methodology for decomposition of N2O from existing adipic acid production plants (AM0021 version 1)

**Project Design Document** :
N2O Emission Reduction in Onsan, Republic of Korea.
Version number of the document : 8
Date : September, 1st 2005

**CDM registration number** :
"N2O Emission Reduction in Onsan, Republic of Korea" – UNFCCC ref number 0099

**Directly related EB guidance:**
EB45 Annex13 "Guidance to calculate adipic acid production in cases where it cannot be measured directly" version 1, February 13th 2009

## 3. Definition

| | |
|---|---|
| y | : Monitoring period (period as defined in the first paragraph) |
| PDD | : Project Design Document of this project "N2O Emission Reduction in Onsan, Republic of Korea." Version number of the document: 8, issued on September, 1st 2005 |

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## 4. General description of project

4.1 Project activity

Nitrous oxide ($N_2O$) is a by-product of adipic acid production. It is of low toxicity but is a greenhouse gas (GHG), whose GWP is large (GWP=310 in the IPCC 2nd Assessment Report). Emissions of N2O will be controlled under the Kyoto Protocol. As far as we are aware, there are however no national or regional regulations or restrictions on the emission of N2O in South Korea. There are in fact no governmental regulations with quantified emission limits in any non-Annex I countries at this point.

In this project, Rhodia Polyamide Co. Ltd additionally installed N2O collection and a thermal decomposition process equipment to the currently operating adipic acid manufacturing plant. This installation reduces the GHG emissions, which would otherwise be released to the atmosphere if the project was not implemented.
The decomposition facilities was installed in the factory site of Onsan Rhodia Polyamide Co., Ltd. in May 2006 and destruction of N2O was started in September 2006.
The starting date of the project is defined as 01/09/2006.
This project activity was registered at UNFCCC on November 27th 2005 with the number 0099.

4.2 Technical description of the project

**Location of the project activity**

The decomposition facilities were installed in the factory site of Onsan Rhodia Polyamide Co. Ltd, in May 2006. The surrounding area is the Onsan industrial complex area.

**Technology to be employed by the project activity**

A thermal oxidizer with 2 chambers is the technology used to decompose N2O.

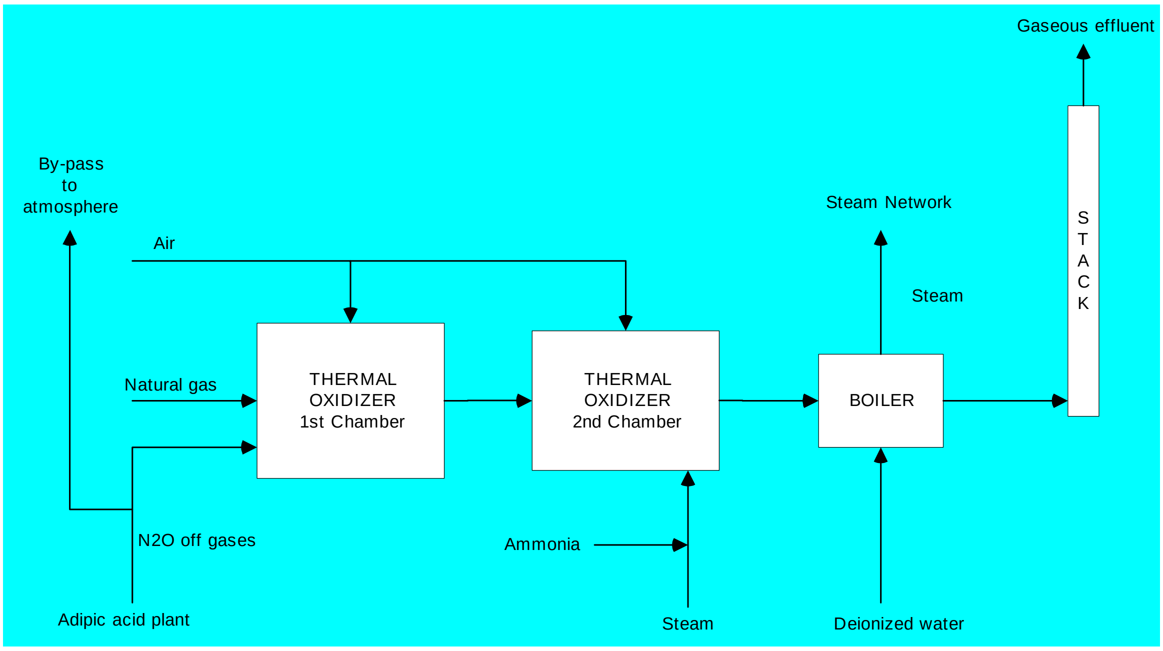
Natural gas is fed with the off gas adipic acid production containing N2O and some air in a reduction chamber, where it burns (oxidizes) to carbon dioxide CO2 and water vapour. N2O is used as an oxidizer. Being oxygen deficient, the oxidation is not complete and carbon monoxide and hydrogen are present.

$$CH_4 + 4\,N_2O \rightarrow CO_2 + 2\,H_2O + 4\,N_2$$

The temperature in the furnace is kept at about 1300°C and under fuel rich conditions, so as to promote the complete decomposition of N2O while minimizing the formation of unwanted combustion by-products such as NO and NO2.

The gas is then quenched with air to complete the combustion of carbon monoxide and hydrogen at a temperature of about 950°C in a second chamber. Steam and ammonia are injected to control the emission of NO and NO2.

Before release to the stack, the flue gas coming from the thermal oxidizer is used to produce saturated steam, which is fed into the existing on-site steam network.



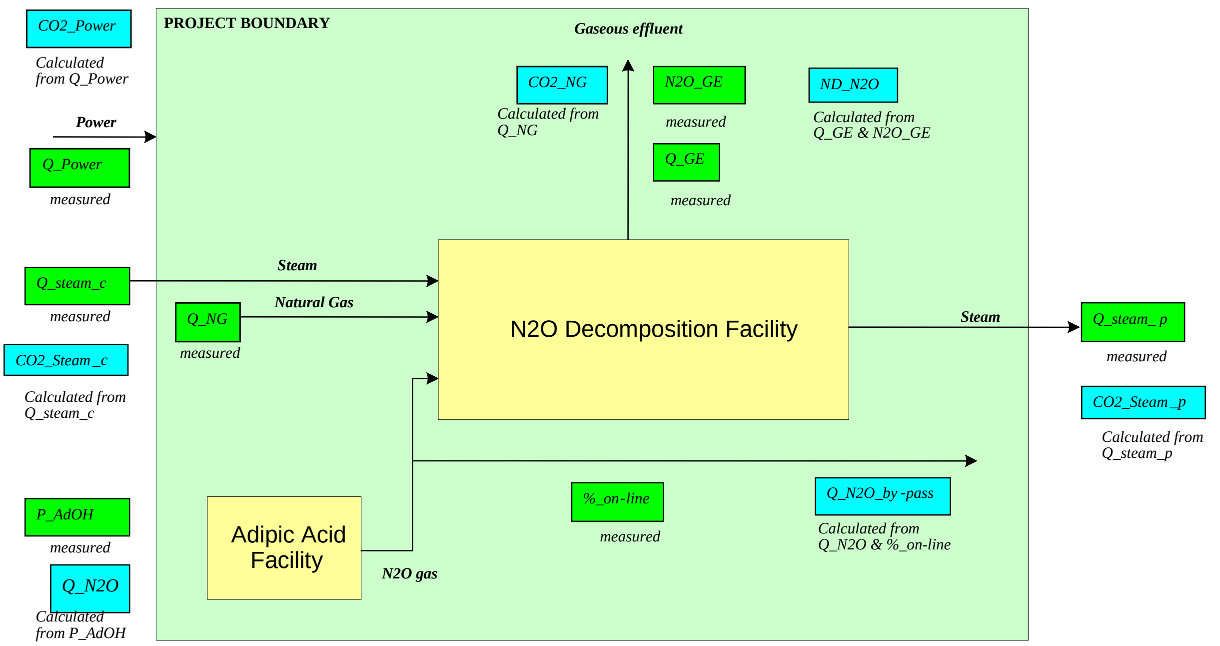

4.3 <u>Implementation of the project</u>

The project is fully implemented according to the description presented in the PDD. The project activity is completely operational.

## 5. Baseline methodology

Approved baseline methodology AM0021 version 1: "Baseline methodology for decomposition of N2O from existing adipic acid production plants", is applied to this project

The project boundary related to the baseline methodology is shown below and this project boundary is used and explained in the PDD.
Potential sources of anthropogenic emissions by sources of GHG within the project boundary and emissions which are not included in the project boundary are also shown in below.




## 6. Applicability of the methodology

Approved monitoring methodology AM0021 version 1 is applied to this project

This methodology is applicable to projects which decomposes N2O from an adipic acid production plant under the following conditions:

- Either catalytic or thermal decomposition of the N2O by-product of adipic acid production at existing production plants
- The methodology is spatially generic, being applicable across regions where the data (both related and project activity as well) exist to undertake the assessment
- The methodology is applicable only for installed capacity (measured in tonnes of adipic acid per year) that exists by the end of the year 2004.

The present project satisfies these conditions as

- Thermal decomposition of the N2O by-product of adipic acid production was implemented in an existing production plant

- All required data (see following paragraph) are available and used
- The production of adipic acid within the current year is below the installed capacity that exists by the end of the year 2004 and defined in the PDD.

For the sake of clarity, the amount of Emission Reductions can exceed the amount calculated in a year period in the PDD in "SECTION E. Estimation of GHG emissions by sources" as all data were conservative, in particular the performance of the N2O abatement unit (in fact, %_on-line (unit efficiency) > 85%, and destruction rate > 99%)

## 7. **Monitored Parameters**

According to the methodology AM0021 version 1 and the Monitoring Plan, the data being collected to monitor the GHG reduction are given in the table below:

| ID | Data variable | Source of data | Data unit | Recording frequency | Reference |
|---|---|---|---|---|---|
| Q_GE | Volume of effluent gas leaving the stack on wet basis converted to standard conditions by temperature and pressure correction | Flow meter | $Nm^3$ | Monthly | Appendix 1 |
| $N_2O$_GE | Concentration of $N_2O$ in the effluent gas on wet basis, in volume fraction | Laser diode online analyzer | vppm | Monthly | Appendix 2 |
| ND_N2O | Quantity of $N_2O$ in the effluent gas leaving the stack | Calculated from Q_GE and $N_2O$_GE | Kg- $N_2O$ | Monthly | Appendix 3 |
| Q_NG | Amount of natural gas burned | Natural gas meter | $Nm^3$ | Monthly | Appendix 4 |
| NGC | Natural gas composition required for calculation of E_NG | Gas supplier | - | Monthly | Appendix 5 |
| %_on-line | % of production time the position switches on the by-pass valves are closed | Position switches on by-pass valves | % of production time | Monthly | Appendix 6 |
| Q_N2O_by-pass | N2O by passing the decomposition facility | Calculated from Q_N2O and %_on-line | kg | Monthly | Appendix 7 |

| ID | Data variable | Source of data | Data unit | Recording frequency | Reference |
|---|---|---|---|---|---|
| P_AdOH | Amount of adipic acid production | Log sheet for packaged product and DCS for silo inventory | tonne AdOH | Monthly | Appendix 8 |
| Nitric acid consumption (HNO3_consumption) & physical losses in the adipic acid production process ($HNO_3$_physical) | All data required for calculation of $HNO_3$ chemical and the N2O emission factor N2O_AdOH | Excel workbook based on the raw material consumption, DCS data and Lab data | - | Monthly | Appendix 9 |
| Q $N_2O$ reg | Per Korean regulation allowed $N_2O$ emissions | South Korean regulation | kg | Date when relevant legislation is in place | Appendix 10 |
| $N_2O$ reg/AdOH | Per Korean regulation allowed $N_2O$ emissions per kg of adipic acid produced | South Korean regulation | kg | Date when relevant legislation is in place | Appendix 10 |
| $r_y$ | Per Korean regulation required share of $N_2O$ emissions to be destroyed | South Korean regulation | % | Date when relevant legislation is in place | Appendix 10 |
| P $N_2O$ | Market price of $N_2O$ | Estimated | €/t | Yearly | Appendix 11 |
| Q_Steam_p | Amount of steam produced by the decomposition process | Steam meter | kg | Monthly | Appendix 12 |
| Steam supplier data | All data required for calculation of E_Steam | External steam supplier and steam properties | - | Yearly | Appendix 13 |

| ID | Data variable | Source of data | Data unit | Recording frequency | Reference |
|---|---|---|---|---|---|
| Q_Power | Electric consumption of the decomposition facility | Electricity meter | kWh | Monthly | Appendix 14 |
| Electricity grid data | All data required for calculation of E_Power according to ACM0002 version 2 | Korean Energy Economics Institute | - | Yearly | Appendix 15 |
| Q_Steam_c | Amount of steam consumed by the decomposition facility | Steam meter | kg-steam | Monthly | Appendix 16 |
| Steam suppliers data | All data required for calculation of E_Steam_c | Internal & External steam suppliers | - | Yearly | Appendix 17 |

## 8. Quality Control (QC) and Quality Assurance (QA)

### 8.1. Quality Management System

The thermal oxidation plant is operated by Rhodia operating personnel. Rhodia has assigned the responsibility for operating, monitoring and reporting to the Adipic Acid Plant Manager.

The operation, data transfer and reporting procedures are incorporated into the ISO9001:2000 procedures of the Onsan Adipic Acid plant

The personnel have been trained by the technology supplier i.e. M/s John Zink International Luxembourg.

### 8.2. Quality control (QC) and quality assurance (QA) procedures that are being undertaken for data monitored

The Onsan plant is certified according to ISO9001:2000 and applies appropriate QA & QC procedures covering also the adipic acid plant and the $N_2O$ decomposition unit. The Quality Management System includes as part of the standard the Management Responsibility, the Resource Management, the Product Realization, and the Measurement, analysis and improvement.

The equipment and analytical methods given by the technology supplier M/s John Zink International Luxembourg as well as those supplied by Rhodia are done according to internationally accepted standards.

The QA & QC procedures are set and implemented in order to:

1. Secure a good consistency through planning to implementation of this CDM project and,
2. Stipulate who has responsibility for what and,
3. Avoid any misunderstanding between people and organization involved.

| Data *(Indicate table and ID number e.g. 3.-1.; 3.2.)* | Uncertainty level of data (High/Medium/ Low) | Explain QA/QC procedures planned for these data, or why such procedures are not necessary. |
|---|---|---|
| *2a.1. (D.2.1.1) Q_GE* | *Low* | *This flow meter is measured with an Averaging Pitot tube. This instrument is considered as a critical instrument in the QA/QC procedure.* |
| *2a.2. (D.2.1.1) $N_2O$_GE* | *Low* | *Existing procedures are applied to this analyzer for QA & QC.* |
| *2a.4. (D.2.1.1) Q_NG* | *Low* | *Is measured using natural gas meter from the supplier and as such is part of a regular procedure control between the Natural Gas supplier and Rhodia.* |
| *2b.1. (D.2.1.3) P_AdOH* | *Low* | *Is obtained from production records of the ONSAN adipic acid plant where the $N_2O$ waste originates. A QA/QC procedure is implemented. Production quantity is based on the packaged product plus silo volume.* |
| *2a.5. (D.2.1.1) %_on-line* | *Low* | *Use opening of high integrity performance connecting valves to limit leaks. Procedures currently in place in Chalampé for monitoring $N_2O$ emissions have be implemented in ONSAN to periodically check their tightness and assure their good operation. They have been added to the QA/QC existing procedures.* |
| *2b.7. (D.2.1.3) Q_Steam_p* | *Low* | *Steam meter placed on the list of critical instrument data in the QA/QC procedures* |
| *3.1. (D.2.3.1) Q_Power* | *Low* | *Electricity meter. Standard procedures are used. No QA/QC procedures implemented as this flow represents less than 0.01% of the baseline emissions.* |
| *3.4. (D.2.3.1) Q_Steam_c* | *Low* | *Steam meter placed on the list of critical instrument data in the QA/QC procedures.* |

Main QC and QA procedures specific to the project activity:

706-30 Data handling protocol PR(Korean English).doc
706-31 Data review protocol.doc

8.3. Calibration/Maintenance of Measuring and Analytical Instruments

All measuring and analytical instruments are being calibrated as per the methodology AM0021 version 1 and created as a protocol in Onsan's Quality management system procedures.

Calibration frequency requirements for the measuring equipments are described in the Excel Workbook ER ONSAN, "Cal_Maint" worksheet.

The maintenance methods and procedures have been incorporated as part of the ISO9001: 2000 procedures and form an integral part of the systems and procedures for the organization.

During this period, we made Calibration/Maintenance of Measuring and analytical instruments according to PDD.

The Monitoring Equipment Calibration and Maintenance status is presented on Appendix 18.

8.4. Environmental Impact

The Thermal oxidation plant has been installed with on line analyzers to monitor constantly some parameters that are required by Korean legislation.
According to local government environmental low, NOx value is continually transmitted to local government agency as a part of the TeleMonitoring System (TMS) from July 1st 2007.

To make sure of the on-line analysis value, KumHo Environmental Co, Ltd had carried out the analysis of the gas discharged from the N2O stack during this monitoring period. The analysis values were under the control specification limit of the Korea environmental regulation and the average values of those results are shown in the table below.
(KumHo Company has an analysis license for air emission which is permitted by the Korean environmental government)

Table showing analysis Gaseous Emission for Thermal Oxidation plant

| Parameter | Unit | Value as per applicable standard | On-line analysis value of the period | Average value in monitoring period by KumHo |
|---|---|---|---|---|
| CO | ppm | 50 max | < 5 ppm | Not measured |
| NH3 | ppm | 50 max | - | < 3 ppm |
| NOx | ppm | 200 max | 80 ppm | 86.5 ppm |

The project was compliant with all environmental Korean regulation.

## 9. GHG Calculations

A spreadsheet Excel file "ER ONSAN" containing all the values of the monitoring parameters and the emission reduction calculation according to the methodology (AM0021/version 1) and the PDD is submitted to the DOE and to the UNFCCC for the request of issuance.

Statement of GHG emission reduction in this monitoring period.

As suggested by the methodology (AM0021 Version 1), the GHG emission reduction, (ERy), achieved by the project activity for the period is
ERy = BEy - PEy - Ly

9.1. Calculation of Q_N2Oy

It has been checked that there are no Korean regulation into place that would limit the quantity of $N_2O$ emitted that can be taken into account for the calculation of the baseline emissions (see D.2.1.4. in the PDD).

The quantity Q_N2Oy of N2O emitted over the period can then be calculated by (AM0021/version 1 equation (2) ):

Q_N2Oy = P_AdOH x N2O_/AdOH

Over the period of reference the emission factor from the adipic acid plant was above the capped value of 0.27 kg N2O/kg AdOH (see appendix 9). So the capped value is being used according to AM0021 version 1.

| Parameter | value | Reference |
|---|---|---|
| Q_N2Oy | 2 127 465 kg | Calculated |
| P_AdOH (eligible) | 7 879.5 ton | Appendix 8 |
| N2O_/AdOH | 0.27 kg N2O/kg AdOH | Appendix 9 |
| Q_$N_2O$ reg | No limit | Appendix 10 |
| $N_2O$_reg / AdOH | No limit | Appendix 10 |
| $r_y$ | NA | Appendix 10 |

9.2. Calculation of baseline emissions

The amount of baseline emissions in the given period y (measured in t CO2 eq.) is calculated by (AM0021/version 1 equation (1) ) :

$$BEy = Q\_N2O_y \times GWP\_N2O + Q\_Steam\_p_y \times E\_Steam_y$$

and rounded down in t CO2 eq. to get conservative consistency of final calculation of Emission Reductions formula.

| Parameter | value | Reference |
|---|---|---|
| **BEy** | **660 824 t CO2 eq.** | Calculated |
| Q_$N2O_y$ | 2 127 465 kg | Calculated in 9.1 |
| GWP_N2O | 310 | Kyoto Protocol Rule. Decision 2/CP.3 |
| Q_Steam_$p_y$ | 10 739 442 kg of steam | Appendix 12 |
| E_$Steam_y$ | 0.122 kg-CO2/kg of steam | Appendix 13 |

9.3. Calculation of (Q_N2O x (1-%_on-line))y

The quantity of N2O that has by-passed the decomposition facility is calculated from the adipic acid production made while by-passing the decomposition facility.

The quantity of adipic acid produced while by-passing the destruction facility is monitored and the quantity of N2O that by-pass the decomposition facility is registered daily:

Q_N2O_by-pass = P_AdOH x (1-%_on-line) x N2O_/AdOH

This value is a value by excess as during each connection/ disconnection phases the production is counted as completely by-passed.

The quantity of N2O that by-passed the decomposition facility over the period is:

$(Q\_N2O \times (1-\%\_on\text{-}line))y = Q\_N2O\_by\text{-}pass_y$

The $\%\_on\text{-}line_y$ equivalent over the period is calculated as:

$\%\_on\text{-}line_y = 1 - (Q\_N2O\_by\text{-}pass_y / Q\_N2O_y)$

| Parameter | Value | Reference |
|---|---|---|
| $Q\_N2O\_by\text{-}pass_y$ | 0 kg | Appendix 7 |
| P_AdOH_ period | 7 879.5 ton | Appendix 8 |
| N2O_/AdOH | 0.27 kg N2O/kg AdOH | Appendix 9 |
| $\%\_on\text{-}line_y$ | 100 % | Appendix 6 |

9.4. Calculation of project emissions

The emissions due to the decomposition process PEy are the emissions due to the N2O that has not been sent to the decomposition process, the N2O non destroyed by the decomposition process and the emissions due to the use of natural gas.

$PEy = ((Q\_N_2O \times (1-\%\_on\text{-}line))y + (Q\_GE \times N_2O\_GE \times Specific\_gravity\_of\_N2O)y) \times GWP\_N_2O + Q\_NGy \times E\_NGy$ (AM0021/version 1 equation (6) )
(The specific gravity of N2O is used to transform vppm in kg/ Nm3)

$PEy = (Q\_N2O\_by\text{-}pass_y + (Q\_GE \times N_2O\_GE \times Specific\_gravity\_of\_N2O)y) \times GWP\_N_2O + Q\_NGy \times E\_NGy$

The non-destroyed $N_2O$ ($ND\_N_2O$ y) is constantly monitored and obtained from the constant monitoring of the flow (Q_GE) and the concentration of $N_2O$ ($N_2O$ _GE) of the effluent gas:
$ND\_N_2O = Q\_GE \times N_2O\_GE \times Specific\_gravity\_of\_N2O$

$PEy = (Q\_N2O\_by\text{-}pass_y + ND\_N_2O_y) \times GWP\_N_2O + Q\_NGy \times E\_NGy$ (AM0021/version 1 equation (5) )
PEy is rounded up in t CO2 eq. to get conservative consistency in final calculation of emission reductions formula.

| Parameter | Value | Reference |
|---|---|---|
| **PEy** | **1 352 t CO2 eq.** | Calculated |
| $Q\_N2O\_by\text{-}pass_y$ | 0 kg | Appendix 7 |
| Q_GE | 7 480 566 $Nm^3$ | Appendix 1 |
| $N_2O$_GE | 5 vppm | Appendix 2 |
| Specific _gravity_of_N2O | 1.963 x 10^-6 | Appendix 2 or 3 |
| ND_ $N_2O_y$ | 76 kg $N_2O$ | Appendix 3 |
| GWP_ $N_2O$ | 310 kg CO2 eq./ kg $N_2O$ | Kyoto Protocol Rule. Decision 2/CP.3 and IPCC |
| Q_NGy | 599 960 $Nm^3$ | Appendix 4 |
| E_NGy | 2.209 kg CO2 eq./ $Nm^3$ | Appendix 5 |

**Note** :

1) The value of E_NGy shown above is the yearly moving average of E_NG as required by the PDD for calculation of E_Steam. The project emissions are more accurately calculated using monthly values of E_NG shown in Appendix 5, following the methodology AM0021 version 1 and the Monitoring Plan.
2) The value of ND_N2Oy is calculated by the DCS using every 10 second data of Q_GE and N2O_GE (see Appendix 2 and 3) and is more accurate than the value calculated using total average values.

9.5. Calculation of leakage

Leak emissions comprise the emissions associated with the energy sources used to generate any steam and electricity used by the decomposition plant.

Leakage amounts to (AM0021/version 1 equation (7) ):

$L_y = Q\_Power \times E\_Power + Q\_steam\_c_y \times E\_steam\_c_y$

Ly is rounded up in tCO2 eq. to get conservative consistency in final calculation of emission reduction formula.

| Parameter | Value | Reference |
|---|---|---|
| **Ly** | **51 t CO2 eq.** | Calculated |
| Q_Power | 62 722 kWh | Appendix 14 |
| E_Power | 0.685 kg-$CO_2$/kWh | Appendix 15 |
| Q_Steam_ $c_y$ | 55 962 kg | Appendix 16 |
| E_Steam_ $c_y$ | 0.132 kg-$CO_2$ / kg of steam | Appendix 17 |

9.6. Calculation of emission reduction

Following the PDD section D.2.4, the total emission reduction achieved by this project activity during this monitoring period is therefore,

ERy = BEy – PEy – Ly

Or,

ERy = **660 824 t CO2 eq. – 1 352 t CO2 eq. – 51 t CO2 eq.**

Or,

**ERy = 659 421 t CO2 eq.**

The above emission reduction covers the generation of N2O during this monitoring period.

9.7. Comparison of the emission reduction with the PDD estimates

In the PDD section E, the annual emission reduction is estimated to be 9 147 301 tCO2eq. So the PDD estimated emission reduction relative to the monitoring period of 17 days is 426 038 tCO2eq.

The increase of the actual emission reduction is explained by

a) The significant higher performance of the N2O abatement unit (the actual %_on-line of 100 % in this period is significantly higher than the value of 85% estimated in the PDD due to excellent operational performance).
b) The adipic acid production used for the ex-ante emission reduction was conservatively taken as 130 000 t/y which is lower than the cap 142 551 t/y (415 t/d x 365 x 94,109 % operational rate). To meet the market demand the plant produced 463 t/d on average during this short period. With time and experience the production capacity can exceed plant nominal capacity thanks to good unit operational performance (clean equipment, no maintenance problem...). It is important to note that according to the methodology AM0021/version 1, the eligible adipic acid that can be used in the baseline is capped on a yearly basis, so it can limit the emission reduction claimed for CERs only in the last or next to last period of the project year. In this period of the 4$^{th}$ project year the yearly cap is not reached (see further details in Appendix 8).
c) A higher destruction rate of the N2O which is in excess of 99.99 % during this period versus 99 % taken conservatively in the PDD.

The estimate of 85% in the PDD assumed a low performance rate of the destruction equipment given lack of experience with such equipment. Moreover, given the general experiences with consistent overestimation of CER volumes in the first years of CDM project development, Rhodia wanted to set a counter-example by doing the CER estimates in the PDD in a very conservative fashion, both regarding the parameters performance of the abatement equipment and the production level of adipic acid.

**Appendix 1**

Name of item Q_GE
Description Volume of effluent gas leaving the stack

Value in period **7 480 566 Nm3**

Method of monitoring Annubar flow meter on wet gas basis

Recording frequency Monthly
Background data Log sheet record / flowmeter

| Period | Quantity of gaseous effluent $Nm^3$ |
|---|---|
| Sep. 28th ~ Sep. 30th | 1 254 238 |
| Oct. 1st ~ Oct. 14th | 6 226 328 |

**Appendix 2**

| | |
|---|---|
| Name of item | N2O_GE |
| Description | Concentration of $N_2O$ in the effluent gas |
| Value in period | 5 vppm |
| Method of monitoring | Laser diode online analyzer on wet gas basis |
| Recording frequency | Monthly |
| Background data | Log sheet record |
| Calculation method | According to AM0021/version1, the actual quantity of non destroyed N2O is calculated on-line in the DCS every 10 sec from the concentration of N2O and the flow rate of the gaseous effluent:<br>ND_N2O = Q_GE * N2O_GE * Specific_gravity_of_N2O<br>The specific_gravity_of_N2O = 44/22.414 x 10^-6 is used to transform vppm in kg/ Nm3<br><br>The analyzer has a range of 0-200 vppm with a detection limit of 5 vppm, which is used as a default value when the measured value is below the detection limit.<br>Cumulated value for ND_N2O is recorded (see appendix 3).<br><br>At the end of the month/period based upon the flow Q_GE, and ND_N2O the concentration of N2O equivalent for the month/period is calculated.<br>N2O_GE = ND_N2O / (Q_GE x N2O_GE x Specific_gravity_of_N2O)<br>This value is for information as the constant calculation of ND_N2O is more accurate. |

| Period | ND_N2O<br><br>kg | Quantity of gaseous effluent<br>$Nm^3$ | Average concentration of $N_2O$_GE<br>vppm |
|---|---|---|---|
| Sep. 28th ~ Sep. 30th | 13 | 1 254 238 | 5 |
| Oct. 1st ~ Oct. 14th | 63 | 6 226 328 | 5 |

**Appendix 3**

| | |
|---|---|
| Name of item | ND_N2O |
| Description | Quantity of non-destroyed N2O emitted by the decomposition facility |
| Value in period | 76 kg $N_2O$ |
| Method of monitoring | On-line DCS calculation |
| Recording frequency | Monthly |
| Background data | Log sheet record |
| Calculation method | According to AM0021/version1, the actual quantity of non destroyed N2O is calculated on-line in the DCS from the concentration of N2O and the flow rate of the gaseous effluent both measured on a wet basis (Equivalent to method D of EB47 “Tool to determine the mass flow of a greenhouse gas in a gaseous stream”):<br>ND_N2O = Q_GE * N2O_GE * Specific_gravity_of_N2O<br>The specific_gravity_of_N2O = 44/22.414 x 10^-6 is used to transform vppm in kg/ Nm3 |

| Period | ND_N2O<br>kg |
|---|---|
| Sep. 28th ~ Sep. 30th | 13 |
| Oct. 1st ~ Oct. 14th | 63 |

**Appendix 4**

| | |
|---|---|
| Name of item | Q_NG |
| Description | Amount of natural gas used by the decomposition process |
| Value in period | 599 960 Nm3 |
| Method of monitoring | Natural gas consumption data |
| Recording frequency | Monthly |
| Background data | Log sheet record / flowmeter |

| Period | Q_NG $Nm^3$ | CO2_NG tCO2e |
|---|---|---|
| Sep. 28th ~ Sep. 30th | 106 654 | 236 |
| Oct. 1st ~ Oct. 14th | 493 306 | 1 092 |

**Appendix 5**

| | |
|---|---|
| Name of item | E_NGy with NGC |
| Description | Emission coefficients for natural gas combustion<br>Natural Gas Composition (NGC) from Supplier for natural gas |
| Value in period for $E\_NG_y$ | 2.209 kg $CO_2/Nm^3$ |
| Method of monitoring | Natural Gas Composition (NGC) |
| Recording frequency | Monthly |
| Background data | Composition data received from Kyung Dong City Gas Ltd, the natural gas supplier |
| Calculation method | Following the PDD Monitoring Plan<br>The average number of C in a mole of NG is calculated from the composition = ∑ (number of C in each mole) x (volume ratio).<br>The CO2 specific gravity in standard state is 1.965<br>E_NG = 1.965 x (average number of C in a mole of NG)<br>The yearly value (E_NGy) is calculated as the average weighted by the natural gas consumption of the twelve months available prior to the beginning of the period.<br>E_Steam is calculated yearly as per the Methodology and needs a yearly value of E_NG (see Appendix 13). All monthly values of E_NG for the year are within +/- 0.5% of the yearly value of E_NGy.<br>For this monitoring period only the September data was applied, because the October data was not available yet. The value of the period is used in the calculation of the project emissions (part due to the natural gas combustion of the N2O unit) |

| Component | September Natural Gas Composition | Number of C |
|---|---|---|
| CH4 (Methane) | 91.07 | 1 |
| C2H6 (Ethane) | 5.78 | 2 |
| C3H8 (Propane) | 2.07 | 3 |
| I-C4H10 (I-Butane) | 0.46 | 4 |
| N-C4H10 (N-Butane) | 0.47 | 4 |
| I-C5H12 (I-Pentane) | 0.02 | 5 |
| N-C5H12 (N-Pentane) | 0.00 | 5 |
| N2 (Nitrogen) | 0.13 | 0 |
| CO2 (Carbon dioxide) | 0.00 | 1 |
| Average number of C | 1.127 | |
| **$E\_NG_m$** | 2.214 | |

**Appendix 6**

| | |
|---|---|
| Name of item | %_on-line |
| Description | % of production time that the N2O is sent to the decomposition facility |
| Value in period | 100 % |
| Method of monitoring | Position of limit switches on the valves allowing to by-pass the decomposition facility |
| Recording frequency | Monthly |
| Background data | Log sheet record |
| Calculation method | %_on-line is determined following the PDD. Based upon the position of the limit switches on the valves by-passing the decomposition facility, the % of time that the production is connected to the facility is continuously counted and used to calculate the daily value of Q_ N2O_by-pass (See Appendix 7). The daily values of Q_ N2O_by-pass are added to determine the monthly values of Q_ N2O_by-pass, as required by the PDD<br><br>At the end of the period, %_on-line for the period is calculated as:<br>$\%\_on\text{-}line_y = 1 - (Q\_N2O\_by\text{-}pass_y / (P\_AdOH_y \times N2O\_/AdOH))$ |

| Period | $Q\_N2O\_by\text{-}pass_y$ kg | $P\_AdOH_y$ t | $\%\_on\text{-}line_y$ % |
|---|---|---|---|
| Sep. 28th ~ Sep. 30th | 0 | 1 379 | 100 |
| Oct. 1st ~ Oct. 14th | 0 | 6 500.5 | 100 |

## Appendix 7

Name of item: Q_N2O_by-pass

Description: N2O by-passing the decomposition facility

Value in period: **0 kg**

Method of monitoring: Production record and %_on-line DCS monitoring

Recording frequency: Monthly

Background data: Production & %_on-line log sheet record

Calculation method: The quantity of adipic acid produced while by-passing the destruction facility is first calculated:

AdOH_by-pass = P_AdOH x (1 - %_on-line)

The quantity of N2O that by-pass the facility is then recorded daily and calculated following AM0021/version1.

$Q\_N2O\_by\text{-}pass_d = Q\_N2O_d \times (1 - \%\_on\text{-}line)$ or

$Q\_N2O\_by\text{-}pass_d = P\_AdOH_d \times N2O\_/AdOH \times (1 - \%\_on\ line)$

At the end of the period the quantity of N2O that by-passed the facility is :

$Q\_N2O\_by\text{-}pass_y = \Sigma\ (Q\_N2O\_by\text{-}pass_d)$

| Period | $Q\_N2O\_by\text{-}pass_y$ kg |
|---|---|
| Sep. 28th ~ Sep. 30th | 0 |
| Oct. 1st ~ Oct. 14th | 0 |

**Appendix 8**

| | |
|---|---|
| Name of item | P_AdOH (eligible) |
| Description | Adipic acid production after cap application |
| Value in period | 7 879.5 t |
| Method of monitoring | Packaged production and silo inventory |
| Recording frequency | Monthly |
| Background data | Log sheet records and DCS data for silo weight |

The daily Adipic Acid production is measured directly by the weight of packed finished product and the silo weight difference between two consecutive days. The EB45 guidance Annex 13 in reference does not apply to such cases.
The Executive Board has confirmed on EB36 the application of a yearly Adipic acid production cap as required by the methodologies (issue 1of the Requests of review for the Monitoring Period #9 Aug 8th,2007 ~ Aug 31st,2007).
The cumulated production of Adipic acid over the current year (starting last September 1st and ending with the last day of this period) is 19 852 t. This production is below the cap clarified in the EB48. Following EB48 clarification, the cap is 142 551 t/y calculated as 415 t/d x 365 x 94,109 % (information available in the Excel Workbook "ER ONSAN", sheet BE, submitted to UNFCCC).
The quantity of adipic acid produced during this period and the eligible production for the baseline emission calculation are given below:

| | Adipic acid production after cap application P_AdOH (eligible) t | Adipic acid production P_AdOH t |
|---|---|---|
| Sep. 28th ~ Sep. 30th | 1 379 | 1 379 |
| Oct. 1st ~ Oct. 14th | 6 500.5 | 6 500.5 |

## Appendix 9

| | |
|---|---|
| Name of item | HNO3_consumption & HNO3_physical |
| Description | Nitric acid consumption and losses in the adipic acid process |
| Value in period | (see table below) |
| Method of monitoring | Excel workbook based on monitoring data and analysis |
| Recording frequency | Monthly |
| Background data | Log sheet records |
| Calculation method | Nitric acid physical losses (HNO3_physical) in the aqueous wastes, the off gases, the adipic acid and the by-product are monitored.<br>Those losses are deducted from the nitric acid consumption, (HNO3_consumption) to get the chemical consumption, (HNO3_chemical) (AM0021/version 1 equation (3) ). |

| Period | HNO3_consumption t | HNO3_physical t | HNO3_chemical t |
|---|---|---|---|
| Sep. 28th ~ Sep. 30th | 1 161 | 18 | 1 143 |
| Oct. 1st ~ Oct. 14th | 5 589 | 115 | 5 474 |
| Rolling year Oct. 14th , 2009 | 131 798 | 2 501 | 129 297 |

| | |
|---|---|
| Name of item | N2O_AdOH |
| Description | N2O emission factor for adipic acid production |
| Value in period | 0.270 kg $N_2O$/kg AdOH |
| Method of monitoring | Adipic acid production, nitric acid consumption and physical losses |
| Recording frequency | Yearly |
| Calculation method | The N2O emission factor is then calculated over the period on one year using the last rolling year data (AM0021/version 1 equation (4) ): |

N2O_AdOH = HNO3_chemical / P_AdOH / 63 /2 x 0.96 x 44

The calculated value for this period is above 0.270 and is then capped by the value of KE_N2O = 0.27, as specified in the PDD table D.2.1.3 and required by the methodology AM0021/version 1 referring to the IPCC Good Practice Guidance.

| Period | Value N2O_AdOH calculated kg N2O/kg AdOH | KE_N20 kg N2O/kg AdOH | N2O_AdOH kg N2O/kg AdOH |
|---|---|---|---|
| Rolling year Oct. 14th , 2009 | 0.281 | 0.270 | 0.270 |

**Appendix 10**

| | |
|---|---|
| Name of item | Q_$N_2O$ reg , $N_2O$_reg / AdOH and $r_y$ |
| Description | Evolution of Korean legislation that may require limitation of $N_2O$ emissions using one of the following criteria:<br>- Q_$N_2O$ reg : allowed $N_2O$ emissions<br>- $N_2O$_reg / AdOH : allowed $N_2O$ emissions per kg of adipic acid produced<br>- $r_y$ : share of $N_2O$ emissions required to be destroyed |
| Value in period | not applicable |
| Method of monitoring | Survey |
| Recording frequency | When relevant |
| Background data | South Korean legislation<br>Rhodia follows the evolution of Korean legislation part of its SIMSER+ procedures (System Integrating Management for Safety and Environment). SIMSER+ is covering ISO 14001 standard which requires to follow any updates on environmental regulations. For the monitoring of the new HSE (Hygiene, Safety and Environment) local and national regulations, Rhodia Korea has joined two committees: “Onsan Environment Management Society” and “Korea Environmental Engineers Federation”.<br><br>No evolution of legislation since PDD emission |

| Period | Q_$N_2O$ reg<br>kg | $N_2O$_reg / AdOH<br>kg | $r_y$<br>% |
|---|---|---|---|
| Oct. 14th 2009 | No limit | No limit | 0. |

## Appendix 11

| | |
|---|---|
| Name of item | P_$N_2O$ |
| Description | Market price of $N_2O$ in waste gas |
| Value in period | 0 €/t |
| Method of monitoring | Market survey |
| Recording frequency | Yearly |
| Background data | |

Refer to study "N2O market study NITROUS OXIDE Korea" –update September 2009
The N2O market is rather small and limited, requires highly pure N2O, not waste gas. The largest market usage is for the medical use (anesthetic and analgesic) then for food and electronics. Beside the very high investment cost in a purification-concentration-liquefaction unit to extract the $N_2O$ from the exhaust flow of the adipic acid plant, neither the process nor the product will get the necessary certifications for these markets.
The market study concludes that there is no $N_2O$ market for the $N_2O$ produced as by-product of adipic acid.

| Year | P_$N_2O$ |
|---|---|
| 2009 | 0 |

**Appendix 12**

| | |
|---|---|
| Name of item | Q_Steam_$p_y$ |
| Description | Amount of steam produced by the decomposition facility |
| Value in period | 10 739 442 kg |
| Method of monitoring | Flowmeter |
| Recording frequency | Monthly |
| Background data | Log sheet record |

| Period | Q_Steam_$p_y$<br>kg | CO2_Steam_p<br>tCO2e |
|---|---|---|
| Sep. 28th ~ Sep. 30th | 1 910 029 | 233 |
| Oct. 1st ~ Oct. 14th | 8 829 413 | 1077 |

## Appendix 13

| | |
|---|---|
| Name of item | E_Steam |
| Description | $CO_2$ emission factor for steam produced by the facility |
| Value in period | 0.122 kg-$CO_2$/kg of steam |
| Method of monitoring | Supplier data |
| Recording frequency | Yearly |
| Background data | Monthly external natural gas data from supplier |
| Calculation method | As we cannot get the data from the supplier, the calculation is made according to the monitoring plan.<br>We first calculate the amount of natural gas required to generate steam in Nm3/t of steam in a very efficient boiler<br>QNG_tsteam = △H (kcal/t) / (HHV (kcal/Nm3) x ɳ (%))<br>The HHV data is the yearly average value for the gas supplied by Kyung Dong City Gas Co, Ltd<br>The yield η (%) of the boiler is conservatively taken as 97%, while the yield is generally below 90%.<br>The yearly value of E_Steam is calculated with the data available for the year prior to the beginning of the period in order to assure to have the data.<br>E_Steam = QNG_steam x E_NGy<br><br>This leads to a conservative value of E_Steam as the steam from the external supplier is produced from coal. |

| Year ending | HHV kcal/$Nm^3$ | △H kcal/t | ɳ % | QNG_tsteam Nm3/t of steam | $E\_NG_y$ kg-$CO_2$/Nm3 | E_Steam kg-$CO_2$/ kg of steam |
|---|---|---|---|---|---|---|
| Oct. 14th 2009 | 10 411 | 557 960 | 97 | 55. 250 | 2.209 | 0.122 |

Rhodia

**Appendix 14**

| | |
|---|---|
| Name of item | Q_Power |
| Description | Electricity consumption by the decomposition facility |
| Value in period | 62 722 kWh |
| Method of monitoring | Power consumption data |
| Recording frequency | Monthly |
| Background data | Log sheet record / counter |

| Period | Q_Power kWh | CO2_Power tCO2e |
|---|---|---|
| Sep. 28th ~ Sep. 30th | 11 503 | 7.9 |
| Oct. 1st ~ Oct. 14th | 51 219 | 35.1 |

## Appendix 15

| | |
|---|---|
| Name of item | E_Power |
| Description | CO2 intensity for electric generation |
| Value in period | 0.685 **kg-$CO_2$/kWh** |
| Method of monitoring | Survey of data publication |
| Recording frequency | Yearly |
| Background data | KEPCO data make publicly available by the Korean Energy Economics Institute (KEEI) for 2008. |
| Calculation method | Calculated using the combined margin (CM) approach according to ACM0002 version 2 in file[1] (Grid_EF_SouthKorea 2008 rev1.xls). |

| Date (year) | E_Power kg-$CO_2$/kWh |
|---|---|
| 2009 | 0.685 |

[1] AM00021 version 1 requires calculation of E_Power as "the highest of the operating margin and the build margin according to ACM0002 version 2 for the grid connected to the facility". The way the emission factor is calculated follows exactly the requirement of the methodology for the following reasons:

(i) "according to ACM0002" means among other things to follow the combined margin CM approach (CM is the weighted average of OM and BM, with default weights of 50%/50%),

(ii) "the highest of the operating margin" means the simple OM as it is the highest operating margin of all alternatives listed in ACM0002 for calculation of the OM since the simple OM excludes all low-operating costs and must-run power plants which are nuclear power plants, hydro power plants and all renewable energy power plants, and

(iii) "the build margin" means the build margin (option 2 updated annually ex post) as required to be calculated following ACM0002 version 2.

**Appendix 16**

| | |
|---|---|
| Name of item | Q_Steam_c |
| Description | Amount of steam consumed by the decomposition facility |
| Value in period | 55 962 kg |
| Method of monitoring | Mass flowmeter |
| Recording frequency | Monthly |
| Background data | Log sheet record |

| Period | Q_Steam_c<br>Kg | CO2_Steam_c<br>tCO2e |
|---|---|---|
| Sep. 28th ~ Sep. 30th | 9 882 | 1.3 |
| Oct. 1st ~ Oct. 14th | 46 080 | 6.1 |

**Appendix 17**

| | |
|---|---|
| Name of item | E_Steam_c |
| Description | CO2 intensity for steam consumed in the facility |
| Value in period | 0.132 kg-$CO_2$/kg of steam |
| Method of monitoring | Calculated from steam supplier data |
| Recording frequency | Yearly |
| Background data | Log sheet records / Composition from Kyung Dong City Gas Ltd, the natural gas supplier |
| Calculation method | This steam is supplied by existing boilers on site. Steam production and natural gas consumption are monitored. From the monthly natural gas consumption and the monthly value of E_NG, monthly emissions of CO2 for steam production are calculated and cumulated over the year.<br>Q_NG_tsteam in Nm3/t of steam is obtained from the ratio of annual natural gas consumption over the annual steam production.<br>The E_Steam_c is obtained from:<br>E_Steam_c = $E\_NG_y$ x Q_NG_tsteam |

| Year ending | Q_NG_tsteam Nm3/t of steam | $E\_NG_y$ kg-$CO_2$/Nm3 | E_Steam_c kg-$CO_2$/ kg of steam |
|---|---|---|---|
| Oct. 14th 2009 | 59.363 | 2.209 | 0.132 |

**<u>Appendix 18</u>    INSTRUMENT CALIBRATION & MAINTENANCE STATUS** (see remarks in the Workbook ER Onsan, sheet Cal_Maint)

| Related PDD parameter | Instrument / equipment | Tag number | Periodicity | Done by | 2008 | | | | | | | | | | | | 2009 | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| %_online | By-pass Valves Integrity Check | HV-57001 | Annually | Rhodia | | | | | | ● | | | | | | | | | ● | | | | | | | | | |
| %_online | By-pass Valves Integrity Check | HV-57003 | Annually | Rhodia | | | | | | ● | | | | | | | | | ● | | | | | | | | | |
| P_AdOH | Small bags and bags Balance | W42811 | Annually | Rhodia | | | | ● | | | | | | | | | | | | ● | | | | | | | | |
| P_AdOH | Big bags and bags Balance | W43741 | Annually | Rhodia | | | | ● | | | | | | | | | | | | ● | | | | | | | | |
| P_AdOH | Big bags and bags Balance | W43742 | Annually | Rhodia | | | | ● | | | | | | | | | | | | ● | | | | | | | | |
| Q_steam_c | Steam import to N2O system | FIQ-58082 | Annually | Third party | | | | | | ● | | | | | | | | | ● | | | | | | | | | |
| Q_steam_p | Steam production by N2O system | FIQ-58213 | Annually | Third party | | | | | | ● | | | | | | | | | ● | | | | | | | | | |
| Q_steam_P | Boiler feed water to N2O system | FIQ58204 | Annually | Third party | | | | | | | | | | | | | | | ● | | | | | | | | | |
| Q_steam_p | Boiler continuous purge flow rate | FIQ58303 | Annually | Rhodia | | | | | | | | | | | ● | | | | ● | | | | | | | | | |
| N2O_GE | Stack N2O analyzer (in-situ, laser diode) | AIT-58408 | 2 / year | Rhodia | | | | ● | | | | | | ● | | | | | ● | | | | | | ● | | | |
| N2O_GE | Stack N2O analyzer (extractive infrared) | AI58418 | Weekly | Rhodia | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | | |
| Q_NG | Natural Gas burning | FQ91485A | Annually | Third party | | | | ● | | | | | | | | | | | ● | | | | | | | | | |
| Q_NG | Natural Gas burning (Back up flow meter) | FQ91485B | Annually | Third party | | | | | | | ● | | | | | | | | | | | | ● | | | | | |
| Q_GE | Effluent Gas | FIQ-58407 | Annually | Third party | | | | ● | | | | | | | | | | | ● | | | | | | | | | |
| Q_Power | Electricity meter | LV22WH | Every 7 years | Third party | | | | | | | | | | ● | | | | | | | | | | | | | | |
| Nitric Cons | Potentiometric titrator | Lab analyzer | weekly | Rhodia | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | | |
| Nitric Cons | HPLC | Lab analyzer | Daily | Rhodia | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | | |
| Nitric Cons | Truck Scale | W-90000 | Annually | Third party | | | | | | | | | ● | | | | | | | | | | | | ● | | | |
| Nitric Cons | FRESH NIITRIC ACID HANWHA | FT6C069 | Annually | Third party | | | | ● | | | | | | | | | | | ● | | | | | | | ● | | |
| Nitric Cons | FRESH NIITRIC ACID HANWHA | FT760CD | Annually | Third party | | | | | | | | | | ● | | | | | | | | | | | | | | |
| Nitric Cons | FRESH NIITRIC ACID TANK R92000 | LT-92005 | Annually | Rhodia | | | | | ● | | | | | | | | | | | ● | | | | | | | | |
| Nitric Cons | FRESH NIITRIC ACID TANK R92010 | LT-92015 | Annually | Rhodia | | | | | ● | | | | | | | | | | | | ● | | | | | | | |
| Nitric Cons | NOX GAS DCN INLET | AYA-51526 | 4 / year | Rhodia | ● | | | ● | | | ● | | | ● | | ● | | ● | | ● | | ● | ● | ● | | ● | | |
| Nitric Cons | LNOX E56010 TO A56020 | AYA-56026 | 4 / year | Rhodia | ● | | | ● | | | ● | | | ● | | ● | | ● | | ● | | ● | ● | ● | | ● | | |
| Nitric Cons | KAOP TO OXIDATION | FT-12701 | Annually | Third party | | | | | | ● | | | | | | ● | | | ● | | | | | | | | | |
| Nitric Cons | LNOX D51500 TO E55030 | FQ-51525 | Annually | Rhodia | | | | | | ● | | | | | | ● | | | | | | | | | | | | |
| Nitric Cons | LNOX D52400 TO E56030 | FQ-52428 | Annually | Rhodia | | | | | | ● | | | | | | ● | | | | | | | | | | | | |
| Nitric Cons | HPCE R61380 TO K83160 | FQ-61782 | Annually | Third party | | | | | | ● | | | | | | | | | ● | | | | | | | | | |
| Nitric Cons | DBA TO F81200 | FQ-81115 | Annually | Third party | | | | | | ● | | | | | | | | | ● | | | | | | | | | |
| Nitric Cons | DBA R81100 TO K83300 | FQ-82351 | Annually | Third party | | | | | | ● | | | | | | | | | ● | | | | | | | | | |
| Nitric Cons | Waste water to R83200 | FQ-83401 | Annually | Third party | | | | | | ● | | | | | | | | | ● | | | | | | | | | |
| Reference | KA OIL TANK R92100 | LT-92106 | Annually | Rhodia | | | | | ● | | | | | | | | | | | | ● | | | | | | | |
| Reference | KA OIL TANK R92200 | LT-92206 | Annually | Rhodia | | | | | ● | | | | | | | | | | | | ● | | | | | | | |
| P_AdOH | SILO R42500 | W-42505 | Annually | Rhodia | | | | | | ● | | | | | | ● | | | ● | | | | | | | | | |