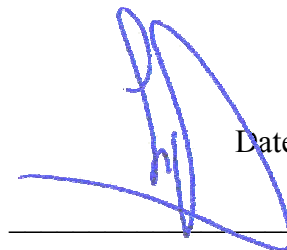


**CDM  
MONITORING REPORT #4  
of  
“N2O Emission Reduction in Onsan,  
Republic of Korea”  
UNFCCC 0099**

**From: Jan. 16<sup>th</sup>, 2007  
To: Feb. 8<sup>th</sup>, 2007**

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Date: Feb. 9<sup>th</sup>, 2007

A handwritten signature in blue ink, appearing to be 'Pascal', written over a horizontal line.

Pascal Siegwart, Rhodia Energy SAS

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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 January 16<sup>th</sup>, 2007 to February 8<sup>th</sup>, 2007 as the 4<sup>th</sup> 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 N<sub>2</sub>O from existing adipic acid production plants (AM0021)

### **Approved Monitoring methodology :**

Monitoring Methodology for decomposition of N<sub>2</sub>O from existing adipic acid production plants (AM0021)

### **Project Design Document :**

N<sub>2</sub>O Emission Reduction in Onsan, Republic of Korea.

Version number of the document : 8

Date : September, 1<sup>st</sup> 2005

### **CDM registration number :**

“N<sub>2</sub>O Emission Reduction in Onsan, Republic of Korea” – UNFCCC ref number 0099

## 3. Definition

y : Monitoring period (in this report, January 16<sup>th</sup> 2007 to February 8<sup>th</sup> 2007.)

PDD : Project Design Document of this project “N<sub>2</sub>O Emission Reduction in Onsan, Republic of Korea.” Version number of the document: 8, issued on September, 1<sup>st</sup> 2005

#### 4. General description of project

##### Project activity

Nitrous oxide (N<sub>2</sub>O) 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 N<sub>2</sub>O 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 N<sub>2</sub>O 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 N<sub>2</sub>O 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 N<sub>2</sub>O was started in September 2006.

The starting date of the project as well as the starting date of the crediting period is defined as 01/09/2006.

This project activity was registered at UNFCCC on November 27<sup>th</sup> 2005 with the number 0099.

##### 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 N<sub>2</sub>O.

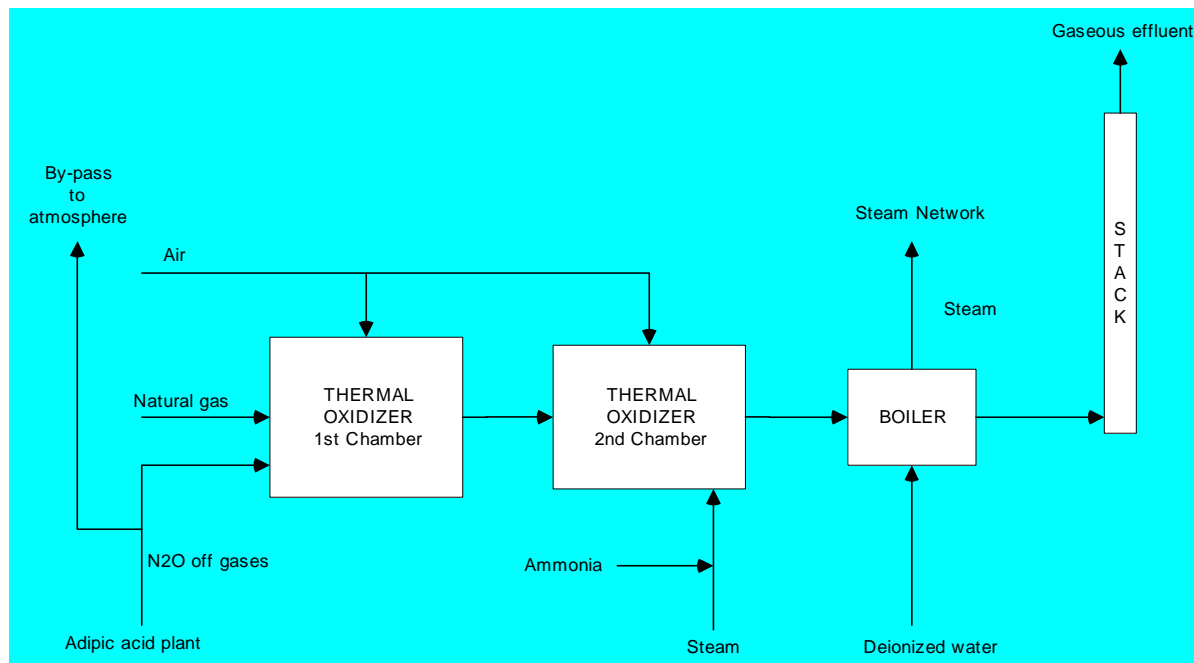
Natural gas is fed with the off gas adipic acid production containing N<sub>2</sub>O and some air in a reduction chamber, where it burns (oxidizes) to carbon dioxide CO<sub>2</sub> and water vapour. N<sub>2</sub>O is used as an oxidizer. Being oxygen deficient, the oxidation is not complete and carbon monoxide and hydrogen are present.



The temperature in the furnace is kept at about 1300°C and under fuel rich conditions, so as to promote the complete decomposition of N<sub>2</sub>O while minimizing the formation of unwanted combustion by-products such as NO and NO<sub>2</sub>.

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 NO<sub>2</sub>.

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.

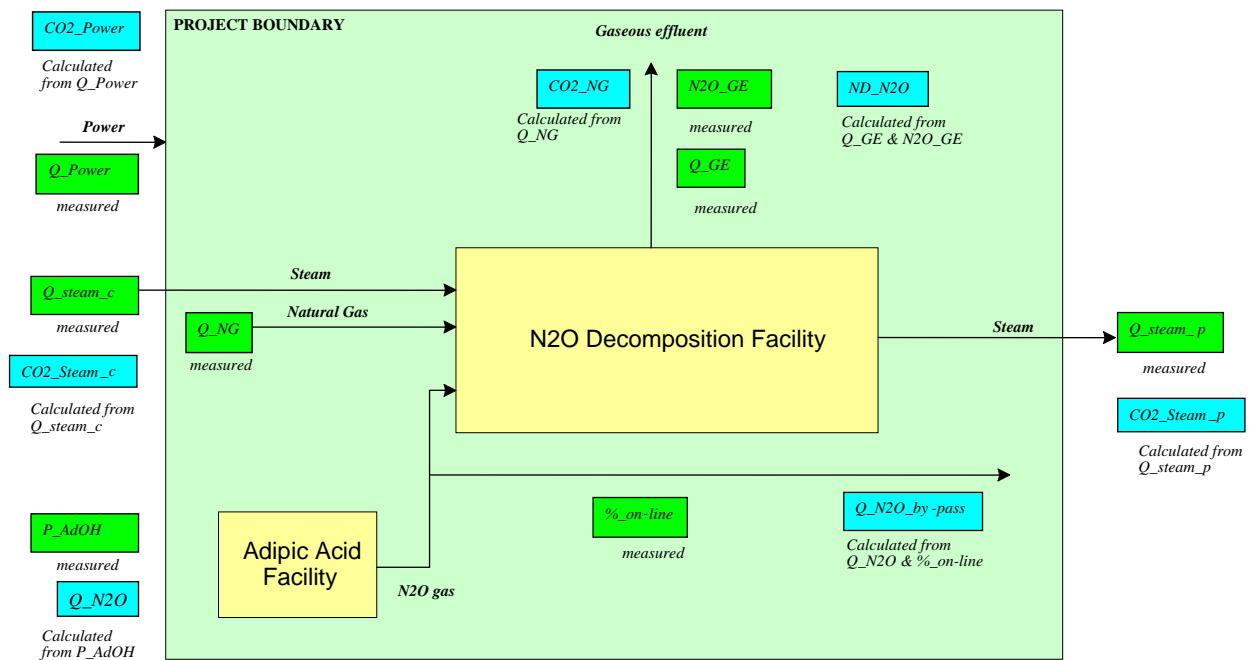


## 5. Baseline methodology

Approved baseline methodology AM 0021: “Baseline methodology for decomposition of N<sub>2</sub>O from existing adipic acid production plants” (AM0021), 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. Monitoring methodology and plan

Approved monitoring methodology AM 0021 / version 1 is applied to this project

This methodology is applicable to projects which decomposes N<sub>2</sub>O from an adipic acid production plant under the following conditions:

- either catalytic or thermal decomposition of the N<sub>2</sub>O 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.

Data being collected to monitor the GHG reduction is 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	Flow meter	Nm <sup>3</sup>	Monthly	Appendix 1
N <sub>2</sub> O_GE	Concentration of N <sub>2</sub> O in the effluent gas	Infra –Red online analyzer	ppm	Monthly	Appendix 2
ND_N2O	Quantity of N <sub>2</sub> O in the effluent gas leaving the stack	Calculated from Q_GE and N <sub>2</sub> O_GE	Kg- N <sub>2</sub> O	Monthly	Appendix 3
Q_NG	Amount of natural gas burned	Natural gas meter	Nm <sup>3</sup>	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
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 (HNO <sub>3</sub> _consumption) & physical losses in the adipic acid production process (HNO <sub>3</sub> _physical)	All data required for calculation of HNO <sub>3</sub> chemical and the N <sub>2</sub> O emission factor N <sub>2</sub> O_AdOH	Excel workbook based on the raw material consumption, DCS data and Lab data	-	Monthly	Appendix 9
Q N <sub>2</sub> O reg	Per Korean regulation allowed N <sub>2</sub> O emissions	South Korean regulation	kg	Date when relevant legislation is in place	Appendix 10
ID	Data variable	Source of data	Data unit	Recording frequency	Reference

N <sub>2</sub> O reg/AdOH	Per Korean regulation allowed N <sub>2</sub> O emissions per kg of adipic acid produced	South Korean regulation	kg	Date when relevant legislation is in place	Appendix 10
r <sub>y</sub>	Per Korean regulation required share of N <sub>2</sub> O emissions to be destroyed	South Korean regulation	%	Date when relevant legislation is in place	Appendix 10
P N <sub>2</sub> O	Market price of N <sub>2</sub> O	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
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 AM0002	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

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

### 7.1. 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 ISO 9001 procedures of the Onsan Adipic Acid plant

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

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



The Onsan plant is certified according to ISO9001 and applies appropriate QA & QC procedures.

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) <i>Q_GE</i>	Low	<i>This flow meter is measured with an Averaging Pitot tube. This instrument is considered as a critical instrument in the QA/QC procedure.</i>
2a.2. (D.2.1.1) <i>N<sub>2</sub>O_GE</i>	Low	<i>Existing procedures are applied to this analyzer for QA &amp; QC.</i>
2a.4. (D.2.1.1) <i>Q_NG</i>	Low	<i>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.</i>
2b.1. (D.2.1.3) <i>P_AdOH</i>	Low	<i>Is obtained from production records of the ONSAN adipic acid plant where the N<sub>2</sub>O waste originates. A QA/QC procedure is implemented. Production quantity is based on the packaged product plus silo volume.</i>
2a.5. (D.2.1.1) <i>%_on-line</i>	Low	<i>Use opening of high integrity performance connecting valves to limit leaks. Procedures currently in place in Chalampé for monitoring N<sub>2</sub>O emissions have been implemented in ONSAN to periodically check their tightness and assure their good operation. They have been added to the QA/QC existing procedures.</i>
2b.7. (D.2.1.3) <i>Q_Steam_p</i>	Low	<i>Steam meter placed on the list of critical instrument data in the QA/QC procedures</i>
3.1. (D.2.3.1) <i>Q_Power</i>	Low	<i>Electricity meter. Standard procedures are used. No QA/QC procedures implemented as this flow represents less than 0.01% of the baseline emissions.</i>
3.4. (D.2.3.1) <i>Q_Steam_c</i>	Low	<i>Steam meter placed on the list of critical instrument data in the QA/QC procedures.</i>

### 7.3. Calibration/Maintenance of Measuring and Analytical Instruments

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

The maintenance methods and procedures have been incorporated as part of the ISO 9001 procedures and form an integral part of the systems and procedures for the organization.

### 7.4. Environmental Impact

The Thermal oxidation plant has been installed with on line analyzers to monitor constantly some parameters that are required by Korean legislation. Starting on July 1<sup>st</sup> 2007, those parameters will be transmitted automatically to the local government environmental agency as part of the Telemonitoring System (TMS) required by a revised environmental law. Until that date regular checking by government agencies can be made.

KumHo Environmental Co, Ltd had carried out the analysis of the gas discharged from the N<sub>2</sub>O stack during the 4<sup>th</sup> crediting 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	Typical on-line analysis	Average value in 4 <sup>th</sup> crediting period
CO	ppm	50 max	< 10 ppm	NA
NH <sub>3</sub>	ppm	50 max	-	1.7 ppm
NO <sub>x</sub>	ppm	200 max	< 100 ppm	52.7 ppm

## 8. GHG Calculations

Statement of GHG emission reduction in 4<sup>th</sup> monitoring period.

As suggested by the methodology (AM0021/Version 1), the GHG emission reduction, (ER<sub>y</sub>), achieved by the project activity for a given year is  
$$ER_y = BE_y - PE_y - L_y$$

### 8.1. Calculation of Q<sub>N<sub>2</sub>Oy</sub>

It has been checked that there are no Korean regulation into place that would limit the quantity of N<sub>2</sub>O 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<sub>N<sub>2</sub>Oy</sub> of N<sub>2</sub>O emitted over the period can then be calculated by:

$$Q_{N_2Oy} = P_{AdOH} \times N_{2O\_}/AdOH$$

Over the period of reference the emission factor from the adipic acid plant was above the capped value of 0.27 kg N<sub>2</sub>O/kg AdOH. So the capped value is being used according to AM 0021.

Parameter	value	Reference
Q_N2O <sub>y</sub>	2 581 740 kg	Calculated
P_AdOH	9 562 t	Appendix 8
N2O_/AdOH	0.27 kg N2O/kg AdOH	Appendix 9
Q_N2O <sub>reg</sub>	No limit	Appendix 10
N2O <sub>reg</sub> / AdOH	No limit	Appendix 10
r <sub>y</sub>	NA	Appendix 10

The production of adipic acid during the year starting on January 16<sup>th</sup> 2006 that includes this period is below the nameplate capacity of the adipic acid plant, and as such the total production of this period can be used as such.

## 8.2. Calculation of baseline emissions

The amount of baseline emissions in the given period y (measured in t CO<sub>2</sub> eq.) is calculated by

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

Parameter	value	Reference
<b>BE<sub>y</sub></b>	<b>802 136 t CO<sub>2</sub> eq.</b>	Calculated
Q_N2O <sub>y</sub>	2 581 740 kg	Calculated in 8.1
GWP_N2O	310	Kyoto Protocol Rule. Decision 2/CP.3
Q_Steam_p <sub>y</sub>	14 729 100 kg of steam	Appendix 12
E_Steam <sub>y</sub>	0.122 kg-CO <sub>2</sub> /kg of steam	Appendix 13

## 8.3. Calculation of (Q\_N2O x (1-%\_on-line))<sub>y</sub>

The quantity of N<sub>2</sub>O 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 N<sub>2</sub>O that by-pass the decomposition facility is registered daily:

$$Q\_N2O\_by-pass = P\_AdOH \times (1-\%\_on-line) \times N2O\_/AdOH$$

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

The quantity of N<sub>2</sub>O that by-passed the decomposition facility over the period is:

$$(Q\_N2O \times (1-\%\_on-line))_y = Q\_N2O\_by-pass_y$$

The %\_on-line<sub>y</sub> equivalent over the period is calculated as:

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

Parameter	Value	Reference
Q_N2O_by-pass <sub>y</sub>	46 835 kg	Appendix 7
P_AdOH	9 562 t	Appendix 8
N2O /AdOH	0.27 kg N2O/kg AdOH	Appendix 9
%_on-line <sub>y</sub>	98.19 %	Appendix 6

#### 8.4. Calculation of project emissions

The emissions due to the decomposition process PE<sub>y</sub> are the emissions due to the N<sub>2</sub>O that has not been sent to the decomposition process, the N<sub>2</sub>O non destroyed by the decomposition process and the emissions due to the use of natural gas.

$$PE_y = ((Q_{N_2O\_by-pass_y} \times (1 - \%_{on-line}))_y + (Q_{GE} \times N_{2O\_GE})_y) \times GWP_{N_2O} + Q_{NGy} \times E_{NGy}$$

$$PE_y = (Q_{N_2O\_by-pass_y} + (Q_{GE} \times N_{2O\_GE})_y) \times GWP_{N_2O} + Q_{NGy} \times E_{NGy}$$

The non-destroyed N<sub>2</sub>O (ND\_N<sub>2</sub>O<sub>y</sub>) is constantly monitored and obtained from the constant monitoring of the flow (Q<sub>GE</sub>) and the concentration of N<sub>2</sub>O (N<sub>2</sub>O<sub>GE</sub>) of the effluent gas:  
 $ND_{N_2O} = Q_{GE} \times N_{2O\_GE}$

$$PE_y = (Q_{N_2O\_by-pass_y} + ND_{N_2O_y}) \times GWP_{N_2O} + Q_{NGy} \times E_{NGy}$$

Parameter	value	Reference
<b>PE<sub>y</sub></b>	<b>16 380 t CO<sub>2</sub> eq.</b>	Calculated
Q_N2O_by-pass <sub>y</sub>	46 835 kg	Appendix 7
Q_GE	9 569 557 Nm <sup>3</sup>	Appendix 1
N <sub>2</sub> O_GE	6 ppm	Appendix 2
ND_N <sub>2</sub> O <sub>y</sub>	110 kg N <sub>2</sub> O	Appendix 3
GWP_N <sub>2</sub> O	310 kg CO <sub>2</sub> eq./ kg N <sub>2</sub> O	Kyoto Protocol Rule. Decision 2/CP.3
Q_NG <sub>y</sub>	817 541 Nm <sup>3</sup>	Appendix 4
E_NG <sub>y</sub>	2.237 kg CO <sub>2</sub> eq./ Nm <sup>3</sup>	Appendix 5

#### 8.5. 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:

$$L_y = Q_{Power} \times E_{Power} + Q_{steam\_c_y} \times E_{steam\_c_y}$$

Parameter	value	Reference
<b>Ly</b>	<b>114.8 t CO2 eq.</b>	Calculated
Q_Power	159 334 kWh	Appendix 14
E_Power	0.649 kg-CO <sub>2</sub> /kWh	Appendix 15
Q_Steam_c <sub>v</sub>	83 764 kg	Appendix 16
E_Steam_c <sub>v</sub>	0.136 kg-CO <sub>2</sub> / kg of steam	Appendix 17

#### 8.6. Calculation of emission reduction

The total emission reduction achieved by this project activity during the first monitoring period is therefore,

$$ER_y = BE_y - PE_y - Ly$$

Or,

$$ER_y = 802\,136\text{ t CO}_2\text{ eq.} - 16\,380\text{ t CO}_2\text{ eq.} - 114.8\text{ t CO}_2\text{ eq.}$$

Or,

$$ER_y = 785\,641\text{ t CO}_2\text{ eq.}$$

The above emission reduction covers the generation of N<sub>2</sub>O during the period from January 16<sup>th</sup> 2007 to February 8<sup>th</sup> 2007.

## Appendix 1

Name of item

Q GE

### Description

Volume of effluent gas leaving the stack

Value in period

9 569 557 Nm3

### Method of monitoring

### Annubar flow meter

Recording frequency

Monthly

## Background data

Log sheet record / flowmeter

Period	Quantity of gaseous effluent Nm <sup>3</sup>
Jan. 16 <sup>th</sup> ~ Jan. 31 <sup>st</sup>	6 311 765
Feb. 1 <sup>st</sup> ~ Feb. 8 <sup>th</sup>	3 257 792
Jan. 16 <sup>th</sup> ~ Feb. 8 <sup>th</sup>	9 569 557

## Appendix 2

Name of item	N2O_GE
Description	Concentration of N <sub>2</sub> O in the effluent gas
Value in period	5 ~ 6 ppm
Method of monitoring	Laser diode online analyzer
Recording frequency	Monthly
Background data	Log sheet record
Calculation method	<p>The instant values of the on-line analyzer are used to calculate the quantity of ND_N2O every 10 sec:</p> $ND\_N2O = Q\_GE * N2O\_GE * Specific\_gravity\_of\_N2O$ <p>The analyzer has a range of 0-200 ppm with a detection limit of 5 ppm, which is used as a default value when the measured value is below the detection limit.</p> <p>Cumulated value for ND_N2O is recorded (see appendix 3).</p> <p>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.</p> <p>This value is for information as the constant calculation of ND_N2O is more accurate.</p>

Period	ND_N2O kg	Quantity of gaseous effluent Nm <sup>3</sup>	Average concentration of N <sub>2</sub> O_GE ppm
Jan. 16 <sup>th</sup> ~ Jan. 31 <sup>st</sup>	76	6 311 765	6
Feb. 1 <sup>st</sup> ~ Feb. 8 <sup>th</sup>	34	3 257 792	5 ~ 6
Jan. 16 <sup>th</sup> ~ Feb. 8 <sup>th</sup>	110	9 569 557	5 ~ 6

### Appendix 3

Name of item	ND_N2O
Description	Quantity of non-destroyed N2O emitted by the decomposition facility
Value in period	110 kg N <sub>2</sub> O
Method of monitoring	On-line DCS calculation
Recording frequency	Monthly
Background data	Log sheet record
Calculation method	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: $ND\_N2O = Q\_GE * N2O\_GE * Specific\_gravity\_of\_N2O$

Period	ND_N2O kg
Jan. 16 <sup>th</sup> ~ Jan. 31 <sup>st</sup>	76
Feb. 1 <sup>st</sup> ~ Feb. 8 <sup>th</sup>	34
Jan. 16 <sup>th</sup> ~ Feb. 8 <sup>th</sup>	110





## Appendix 5

Name of item	E_NG
Description	Supplier data for natural gas for the calculation of E_NG
Value in period for E_NG <sub>y</sub>	2.237 kg CO <sub>2</sub> /Nm <sup>3</sup>
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	<p>The average number of C in a mole of NG is calculated from the composition = <math>\sum</math> (number of C in each mole) x (volume ratio)</p> <p>Following monthly data are used to calculate monthly project emissions due to the consumption of Natural Gas. As February data are not available yet, January data are used for February.</p> <p>The yearly value is calculated (see appendix 17) with the data available for the year prior to the beginning of the period and is used to calculate E<sub>steam</sub>.</p>

Component	January Natural Gas Composition	Number of C
CH <sub>4</sub> (Methane)	90.66	1
C <sub>2</sub> H <sub>6</sub> (Ethane)	5.53	2
C <sub>3</sub> H <sub>8</sub> (Propane)	2.44	3
I-C <sub>4</sub> H <sub>10</sub> (I-Butane)	0.59	4
N-C <sub>4</sub> H <sub>10</sub> (N-Butane)	0.56	4
I-C <sub>5</sub> H <sub>12</sub> (I-Pentane)	0.01	5
N-C <sub>5</sub> H <sub>12</sub> (N-Pentane)	0.00	5
N <sub>2</sub> (Nitrogen)	0.20	0
CO <sub>2</sub> (Carbon dioxide)	0.00	1
Average number of C	1.137	
E_NG <sub>m</sub>	2.235	

The CO<sub>2</sub> specific gravity in standard state is 1.965  
 $E_{NG} = 1.965 \times (\text{average number of C in a mole of NG})$

## Appendix 6

Name of item

%\_on-line

Description

% of production time that the N<sub>2</sub>O is sent to the decomposition facility

Value in period

98.19 %

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

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 Q\_N<sub>2</sub>O\_by-pass (See Appendix 7).

At the end of the period, %\_on-line for the period is calculated as:

$$\%_{\text{on-line}} = 1 - (Q_{\text{N}_2\text{O\_by-pass}} / (P_{\text{AdOH}} \times \text{N}_2\text{O}_{\text{AdOH}}))$$

Period	Q_N <sub>2</sub> O_by-pass <sub>y</sub> kg	P_AdOH <sub>y</sub> t	%_on-line <sub>y</sub> %
Jan. 16 <sup>th</sup> ~ Jan. 31 <sup>st</sup>	46 835	6 365	97.27
Feb. 1 <sup>st</sup> ~ Feb. 8 <sup>th</sup>	0	3 197	100
Jan. 16 <sup>th</sup> ~ Feb. 8 <sup>th</sup>	46 835	9 562	98.19

## Appendix 7

Name of item	Q_N2O_by-pass
Description	N2O by-passing the decomposition facility
Value in period	46 835 kg
Method of monitoring	Production record and %_on-line DCS monitoring
Recording frequency	Monthly
Background data	Production & %_on-line log sheet record
Calculation method	<p>The quantity of adipic acid produced while by-passing the destruction facility is first calculated:</p> $\text{AdOH}_{\text{by-pass}} = \text{P}_{\text{AdOH}} \times (1 - \%_{\text{on-line}})$ <p>The quantity of N2O that by-pass the facility is then recorded daily.</p> $\text{N2O}_{\text{by-pass}_d} = \text{P}_{\text{AdOH}_d} \times \text{N2O}_{\text{}}/\text{AdOH} \times (1 - \%_{\text{on-line}})$ <p>At the end of the period the quantity of N2O that by-passed the facility is :</p> $\text{N2O}_{\text{by-pass}_y} = \Sigma (\text{N2O}_{\text{by-pass}_d})$

Period	N2O_by-pass <sub>y</sub> kg
Jan. 16 <sup>th</sup> ~ Jan. 31 <sup>st</sup>	46 835
Feb. 1 <sup>st</sup> ~ Feb. 8 <sup>th</sup>	0
Jan. 16 <sup>th</sup> ~ Feb. 8 <sup>th</sup>	46 835

## Appendix 8

Name of item

P\_AdOH

Description

Adipic acid production

Value in period

9 562 t

Method of monitoring

Packaged production and silo inventory

Recording frequency

Monthly

Background data

Log sheet record

The production of adipic acid over the year ending on November 19<sup>th</sup> 2006 is below the capped value defined in the PDD.

The quantity of adipic acid produced during this period can then be fully used as such.

Month - year	Adipic acid production t
Jan. 16 <sup>th</sup> ~ Jan. 31 <sup>st</sup>	6 365
Feb. 1 <sup>st</sup> ~ Feb. 8 <sup>th</sup>	3 197
Jan. 16 <sup>th</sup> ~ Feb. 8 <sup>th</sup>	9 562

## Appendix 9

Name of item	N2O_AdOH
Description	N2O emission factor for adipic acid production
Value in period	0.270 kg N2O/ kg AdOH
Method of monitoring	Adipic acid production, nitric acid consumption and physical losses
Recording frequency	Yearly
Background data	Log sheet records
Calculation method	Nitric acid physical losses (HNO3_physical) in the aqueous waste, the off gases, the adipic acid and the by-product are monitored. Those losses are deducted from the nitric acid consumption, (HNO3_consumption) to get the chemical consumption, (HNO3_chemical).

The N2O emission factor is then calculated over the period:  

$$\text{N2O\_AdOH} = \text{HNO3\_chemical} / \text{P\_AdOH} / 63 / 2 \times 0.96 / 44$$

This value is capped by a value of  $\text{KE\_N2O} = 0.27$ , as specified in the PDD table D.2.1.3 and required by the methodology AM0021.

Year ending	Value calculated kg N2O/kg AdOH	KE_N2O kg N2O/kg AdOH	N2O_AdOH kg N2O/kg AdOH
Feb. 8 <sup>th</sup> 2007	> 0.270	0.270	0.270

## Appendix 10

Name of item	Q_N <sub>2</sub> O reg , N <sub>2</sub> O_reg / AdOH and r <sub>y</sub>
Description	<p>Evolution of Korean legislation that may require limitation of N<sub>2</sub>O emissions using one of the following criteria:</p> <ul style="list-style-type: none"> <li>- Q_N<sub>2</sub>O reg : allowed N<sub>2</sub>O emissions</li> <li>- N<sub>2</sub>O_reg / AdOH : allowed N<sub>2</sub>O emissions per kg of adipic acid produced</li> <li>- r<sub>y</sub> : share of N<sub>2</sub>O emissions required to be destroyed</li> </ul>
Value in period	not applicable
Method of monitoring	Survey
Recording frequency	When relevant
Background data	<p>South Korean legislation</p> <p>No evolution of legislation since PDD emission.</p>

Period	Q_N <sub>2</sub> O reg kg	N <sub>2</sub> O_reg / AdOH kg	r <sub>y</sub> %
Jan 16 <sup>th</sup> ~ Feb 8 <sup>th</sup>	No limit	No limit	0.

## Appendix 11

Name of item

P\_N<sub>2</sub>O

Description

Market price of N<sub>2</sub>O in waste gas

Value in period

0 €/t

Method of monitoring

Market survey

Recording frequency

Yearly

Background data

No market for this low level of N<sub>2</sub>O concentration

Year	P_N <sub>2</sub> O
2006	0



## Appendix 12

Name of item	Q_Steam_p
Description	Amount of steam produced by the decomposition facility
Value in period	14 729 100 kg
Method of monitoring	Flowmeter
Recording frequency	Monthly
Background data	Log sheet record

Period	Q_Steam_p kg
Jan. 16 <sup>th</sup> ~ Jan. 31 <sup>st</sup>	9 719 200
Feb. 1 <sup>st</sup> ~ Feb. 8 <sup>th</sup>	5 009 900
Jan. 16 <sup>th</sup> ~ Feb. 8 <sup>th</sup>	14 729 100

### Appendix 13

Name of item	E_Steam
Description	CO <sub>2</sub> emission factor for steam produced by the facility
Value in period	0.122 kg-CO <sub>2</sub> /kg of steam
Method of monitoring	Supplier data
Recording frequency	Yearly
Background data	Monthly external natural gas data from supplier
Calculation method	<p>As we cannot get the data from the supplier, the calculation is made according to the monitoring plan.</p> <p>We first calculate the amount of natural gas required to generate steam in Nm<sup>3</sup>/t of steam in a very efficient boiler</p> $QNG\_steam = \Delta H \text{ (kcal/t)} / (\text{LHV (kcal/Nm}^3\text{)} \times \eta \text{ (\%)})$ <p>The LHV data is the yearly average value for the gas supplied by Kyung Dong City Gas Co, Ltd</p> <p>This leads to a conservative value of E_Steam as the steam from the external supplier is produced from coal.</p>

Year ending	LHV kcal/Nm <sup>3</sup>	$\Delta H$ kcal/t	$\eta$ %	QNG_tsteam Nm <sup>3</sup> /t of steam	E_NG <sub>y</sub> kg- CO <sub>2</sub> /Nm <sup>3</sup>	E_Steam kg-CO <sub>2</sub> / kg of steam
Jan. 31 <sup>st</sup> 2007	10511	557960	97	54.724	2.237	0.122

## **Appendix 14**

Name of item	Q_Power
Description	Electricity consumption by the decomposition facility
Value in period	159 334 kWh
Method of monitoring	Power consumption data
Recording frequency	Monthly
Background data	Log sheet record / counter

Period	Q_Power kWh
Jan. 16 <sup>th</sup> ~ Jan. 31 <sup>st</sup>	103 697
Feb. 1 <sup>st</sup> ~ Feb. 8 <sup>th</sup>	55 637
Jan. 16 <sup>th</sup> ~ Feb. 8 <sup>th</sup>	159 334

## Appendix 15

Name of item	E_Power
Description	CO2 intensity for electric generation
Value in period	<b>0.649 kg-CO<sub>2</sub>/kWh</b>
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 2003, 2004 & 2005.
Calculation method	Calculated using the combined margin (CM) approach according to ACM0002. Conservative value used.

Date (year)	E_Power kg-CO <sub>2</sub> /kWh
2006	0.649

## **Appendix 16**

Name of item	Q_Steam_c
Description	Amount of steam consumed by the decomposition facility
Value in period	83 764 kg
Method of monitoring	Mass flowmeter
Recording frequency	Monthly
Background data	Log sheet record

Period	Q_Steam_c kg
Jan. 16 <sup>th</sup> ~ Jan. 31 <sup>st</sup>	55 819
Feb. 1 <sup>st</sup> ~ Feb. 8 <sup>th</sup>	27 945
Jan. 16 <sup>th</sup> ~ Feb. 8 <sup>th</sup>	83 764

## Appendix 17

Name of item	E_Steam_c
Description	CO2 intensity for steam consumed in the facility
Value in period	0.136 kg-CO <sub>2</sub> /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	<p>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.</p> <p>E_Steam is obtained from the ratio of yearly CO2 emission over the yearly steam production.</p> <p>Q_NG_steam in Nm<sup>3</sup>/t of steam is obtained from the ratio of annual natural gas consumption over the annual steam production.</p> <p>The average factor E_NG<sub>y</sub> over the year is obtained from <math>E\_NG_y = Q\_NG\_steam / E\_Steam</math></p>

Year ending	Q_NG_steam Nm <sup>3</sup> /t of steam	E_NG <sub>y</sub> kg-CO <sub>2</sub> /Nm <sup>3</sup>	E_Steam kg-CO <sub>2</sub> / kg of steam
Jan. 31 <sup>st</sup> 2007	60.462	2.237	0.136