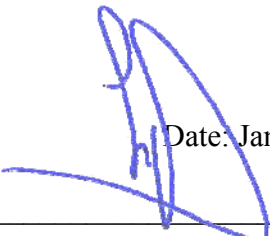




**CDM  
MONITORING REPORT #21  
of  
“N2O Emission Reduction in Onsan,  
Republic of Korea”  
UNFCCC 0099**

**From: November. 1<sup>st</sup>, 2008  
To: December. 31<sup>st</sup>, 2008**

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Date: January 6th, 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 November 1<sup>st</sup>, 2008 to December 31<sup>st</sup>, 2008 as the 21<sup>st</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 version 1)

### **Approved Monitoring methodology :**

Monitoring Methodology for decomposition of N<sub>2</sub>O from existing adipic acid production plants (AM0021 version 1)

### **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 (period as defined in the first paragraph)

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 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.

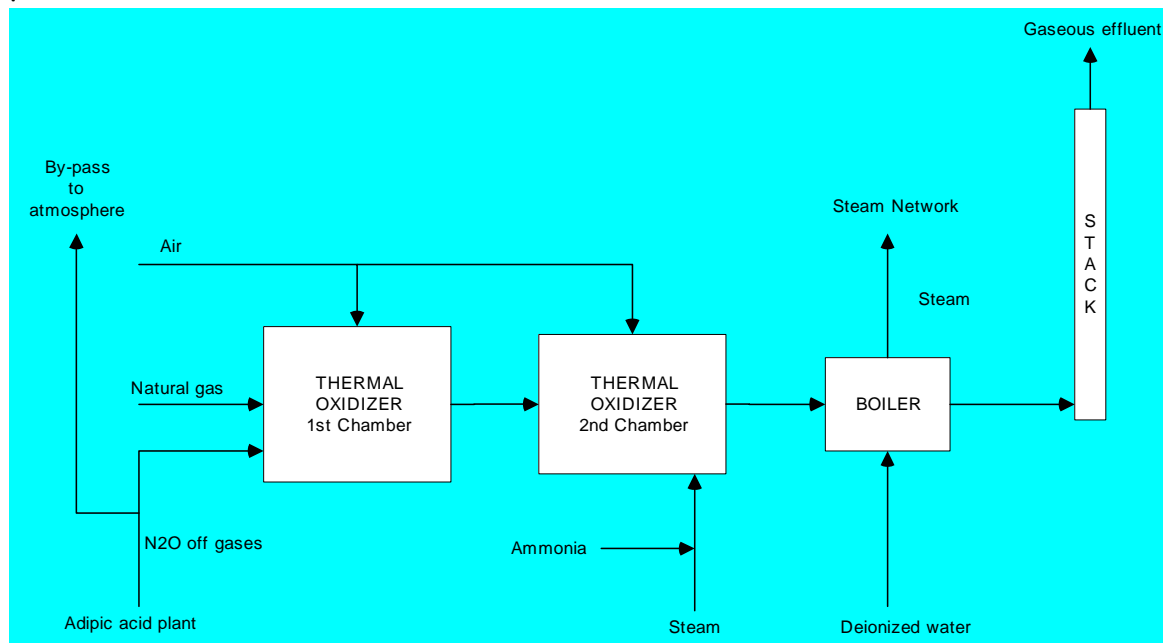


The temperature in the furnace is kept at about 1300°C and under fuel rich conditions, so as to promote the complete decomposition of N<sub>2</sub>O while minimizing the formation of unwanted combustion by-products such as NO and NO<sub>2</sub>.

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.







- 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 N<sub>2</sub>O 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	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	vppm	Monthly	Appendix 2
ND_N <sub>2</sub> O	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_N <sub>2</sub> O_by-pass	N <sub>2</sub> O by passing the decomposition facility	Calculated from Q_N <sub>2</sub> O 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 (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
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



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 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 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) Q_GE	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) N <sub>2</sub> O_GE	Low	<i>Existing procedures are applied to this analyzer for QA &amp; QC.</i>
2a.4. (D.2.1.1) Q_NG	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) P_AdOH	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) %_on-line	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 be 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) Q_Steam_p	Low	<i>Steam meter placed on the list of critical instrument data in the QA/QC procedures</i>
3.1. (D.2.3.1) Q_Power	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) Q_Steam_c	Low	<i>Steam meter placed on the list of critical instrument data in the QA/QC procedures.</i>

### 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.

The maintenance methods and procedures have been incorporated as part of the ISO9001 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

### 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 law, NO<sub>x</sub> value is continually transmitted to local government agency as a part of the TeleMonitoring System (TMS) from July 1<sup>st</sup> 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 N<sub>2</sub>O 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	74 ppm	75 ppm

The project was compliant with all environmental Korean regulation.

## **9. GHG Calculations**

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<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\_N2Oy of N<sub>2</sub>O emitted over the period can then be calculated by:

$$Q_{N2Oy} = P_{AdOH} \times N2O_{AdOH}$$

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 (see appendix 9). So the capped value is being used according to AM0021 version 1.

Parameter	value	Reference
Q_N2O <sub>y</sub>	6 511 165 kg	Calculated
P_AdOH	24 115.425 ton	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

As the total production of adipic acid over the year ending with the last day of this period is below the nameplate capacity of the adipic acid plant (information available in the Excel Workbook “ER ONSAN”, sheet AM, submitted to UNFCCC), the total production of this period can be used as such.

The Executive Board has confirmed on EB36 the application of a yearly Adipic acid production cap as required by the methodologies (issue 1 of the Requests of review for the Monitoring Period #9 Aug 8<sup>th</sup> 2007 ~ Aug 31<sup>st</sup> 2007).

## 9.2. 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

$$BE_y = Q_{N2O_y} \times GWP_{N2O} + Q_{Steam_{p_y}} \times E_{Steam_y}$$

and rounded down in t CO<sub>2</sub> eq. to get conservative consistency of final calculation of Emission Reductions formula.

Parameter	value	Reference
<b>BE<sub>y</sub></b>	<b>2 022 705 t CO<sub>2</sub> eq.</b>	Calculated
Q_N2O <sub>y</sub>	6 511 165 kg	Calculated in 9.1
GWP_N2O	310	Kyoto Protocol Rule. Decision 2/CP.3
Q_Steam <sub>p_y</sub>	34 793 381 kg of steam	Appendix 12
E_Steam <sub>y</sub>	0.122 kg-CO <sub>2</sub> /kg of steam	Appendix 13

## 9.3. 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  $\%_{on-line}_y$  equivalent over the period is calculated as:

$$\%_{on-line}_y = 1 - (Q_{N2O\_by-pass}_y / Q_{N2O}_y)$$

Parameter	Value	Reference
Q <sub>N2O by-pass<sub>y</sub></sub>	28 003 kg	Appendix 7
P <sub>AdOH</sub>	24 115.425 ton	Appendix 8
N <sub>2</sub> O <sub>/AdOH</sub>	0.27 kg N <sub>2</sub> O/kg AdOH	Appendix 9
$\%_{on-line}_y$	99.57 %	Appendix 6

#### 9.4. Calculation of project emissions

The emissions due to the decomposition process P<sub>Ey</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.

$$P_{Ey} = ((Q_{N2O} \times (1 - \%_{on-line}))_y + (Q_{GE} \times N_{2O\_GE} \times Specific\_gravity\_of\_N2O)_y) \times GWP_{N2O} + Q_{NGy} \times E_{NGy}$$

(The specific gravity of N<sub>2</sub>O is used to transform vppm in kg/ Nm<sup>3</sup>)

$$P_{Ey} = (Q_{N2O\_by-pass}_y + (Q_{GE} \times N_{2O\_GE} \times Specific\_gravity\_of\_N2O)_y) \times GWP_{N2O} + Q_{NGy} \times E_{NGy}$$

The non-destroyed N<sub>2</sub>O (ND<sub>N2O 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:

$$ND_{N2O} = Q_{GE} \times N_{2O\_GE} \times Specific\_gravity\_of\_N2O$$

$$P_{Ey} = (Q_{N2O\_by-pass}_y + ND_{N2O}_y) \times GWP_{N2O} + Q_{NGy} \times E_{NGy}$$

P<sub>Ey</sub> is rounded up in t CO<sub>2</sub> eq. to get conservative consistency in final calculation of emission reductions formula.

Parameter	Value	Reference
<b>P<sub>Ey</sub></b>	<b>13 280 t CO<sub>2</sub> eq.</b>	Calculated
Q <sub>N2O by-pass<sub>y</sub></sub>	28 003 kg	Appendix 7
Q <sub>GE</sub>	27 049 616 Nm <sup>3</sup>	Appendix 1
N <sub>2</sub> O <sub>GE</sub>	5 vppm	Appendix 2
Specific gravity of N <sub>2</sub> O	1.963 x 10 <sup>-6</sup>	Appendix 2 or 3
ND <sub>N2O y</sub>	267 kg N <sub>2</sub> O	Appendix 3
GWP <sub>N2O</sub>	310 kg CO <sub>2</sub> eq./ kg N <sub>2</sub> O	Kyoto Protocol Rule. Decision 2/CP.3
Q <sub>NGy</sub>	2 040 848 Nm <sup>3</sup>	Appendix 4
E <sub>NGy</sub>	2.213 kg CO <sub>2</sub> eq./ Nm <sup>3</sup>	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:

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

L<sub>y</sub> is rounded up in tCO<sub>2</sub> eq. to get conservative consistency in final calculation of emission reduction formula.

Parameter	Value	Reference
<b>L<sub>y</sub></b>	<b>218 t CO<sub>2</sub> eq.</b>	Calculated
Q_Power	322 145 kWh	Appendix 14
E_Power	0.597 kg-CO <sub>2</sub> /kWh	Appendix 15
Q_Steam_cy	194 121 kg	Appendix 16
E_Steam_cy	0.132 kg-CO <sub>2</sub> / kg of steam	Appendix 17

### 9.6. Calculation of emission reduction

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

$$ER_y = BE_y - PE_y - L_y$$

Or,

$$ER_y = 2\,022\,705\text{ t CO}_2\text{ eq.} - 13\,280\text{ t CO}_2\text{ eq.} - 218\text{ t CO}_2\text{ eq.}$$

Or,

$$\mathbf{ER_y = 2\,009\,207\text{ t CO}_2\text{ eq.}}$$

The above emission reduction covers the generation of N<sub>2</sub>O during this monitoring period.



### Appendix 1

Name of item	Q_GE
Description	Volume of effluent gas leaving the stack
Value in period	27 049 616 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>
Nov. 1 <sup>st</sup> ~ Nov. 30 <sup>th</sup>	13 959 545
Dec. 1 <sup>st</sup> ~ Dec. 31 <sup>st</sup>	13 090 071



## Appendix 2

Name of item

N2O\_GE

Description

Concentration of N<sub>2</sub>O in the effluent gas

Value in period

5 vppm

Method of monitoring

Laser diode online analyzer

Recording frequency

Monthly

Background data

Log sheet record

Calculation method

The instant values of the on-line analyzer are used to calculate the quantity of ND\_N2O every 10 sec:

$ND\_N2O = Q\_GE * N2O\_GE * Specific\_gravity\_of\_N2O$

The specific\_gravity\_of\_N2O =  $44/22.414 \times 10^{-6}$  is used to transform vppm in kg/ Nm<sup>3</sup>

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.

Cumulated value for ND\_N2O is recorded (see appendix 3).

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.

This value is for information as the constant calculation of ND\_N2O is more accurate.

Period	ND_N2O kg	Quantity of gaseous effluent Nm <sup>3</sup>	Average concentration of N <sub>2</sub> O_GE vppm
Nov. 1 <sup>st</sup> ~ Nov. 30 <sup>th</sup>	138	13 959 545	5
Dec. 1 <sup>st</sup> ~ Dec. 31 <sup>st</sup>	129	13 090 071	5





### Appendix 3

Name of item	ND_N2O
Description	Quantity of non-destroyed N2O emitted by the decomposition facility
Value in period	<div>267 kg N<sub>2</sub>O</div>
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: $ND\_N2O = Q\_GE * N2O\_GE * Specific\_gravity\_of\_N2O$ The specific_gravity_of_N2O = 44/22.414 x 10^-6 is used to transform vppm in kg/ Nm3

Period	ND_N2O kg
Nov. 1 <sup>st</sup> ~ Nov. 30 <sup>th</sup>	138
Dec. 1 <sup>st</sup> ~ Dec. 31 <sup>st</sup>	129



#### **Appendix 4**

Name of item	Q_NG
Description	Amount of natural gas used by the decomposition process
Value in period	2 040 848 Nm3
Method of monitoring	Natural gas consumption data
Recording frequency	Monthly
Background data	Log sheet record / flowmeter

Period	Q_NG Nm <sup>3</sup>
Nov. 1 <sup>st</sup> ~ Nov. 30 <sup>th</sup>	1 054 248
Dec. 1 <sup>st</sup> ~ Dec. 31 <sup>st</sup>	986 600



## Appendix 5

Name of item	E_NGy with NGC
Description	Emission coefficients for natural gas combustion Natural Gas Composition (NGC) from Supplier for natural gas
Value in period for E_NGy	2.213 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	The average number of C in a mole of NG is calculated from the composition = $\sum$ (number of C in each mole) x (volume ratio) Following monthly data are used to calculate monthly project emissions due to the consumption of Natural Gas.

Component	November Natural Gas Composition	December Natural Gas Composition	Number of C
CH <sub>4</sub> (Methane)	90.97	91.11	1
C <sub>2</sub> H <sub>6</sub> (Ethane)	5.78	5.71	2
C <sub>3</sub> H <sub>8</sub> (Propane)	2.09	2.05	3
I-C <sub>4</sub> H <sub>10</sub> (I-Butane)	0.45	0.49	4
N-C <sub>4</sub> H <sub>10</sub> (N-Butane)	0.48	0.46	4
I-C <sub>5</sub> H <sub>12</sub> (I-Pentane)	0.02	0.02	5
N-C <sub>5</sub> H <sub>12</sub> (N-Pentane)	0.00	0.00	5
N <sub>2</sub> (Nitrogen)	0.21	0.15	0
CO <sub>2</sub> (Carbon dioxide)	0.00	0.00	1
Average number of C	1.126	1.126	
<b>E_NG<sub>m</sub></b>	2.213	2.212	

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 N2O is sent to the decomposition facility
Value in period	99.57 %
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_ N2O_by-pass (See Appendix 7).
	At the end of the period, %_on-line for the period is calculated as: $\%_{\text{on-line}}_y = 1 - (Q_{\text{N2O\_by-pass}}_y / (P_{\text{AdOH}}_y \times \text{N2O\_}/\text{AdOH}))$

Period	Q_N2O_by-pass <sub>y</sub> kg	P_AdOH <sub>y</sub> t	%_on-line <sub>y</sub> %
Nov. 1 <sup>st</sup> ~ Nov. 30 <sup>th</sup>	0	13 023.025	100
Dec. 1 <sup>st</sup> ~ Dec. 31 <sup>st</sup>	28 003	11 092.4	99.07



## Appendix 7

Name of item	Q_N2O_by-pass
Description	N2O by-passing the decomposition facility
Value in period	28 003 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:  <math>AdOH_{by-pass} = P_{AdOH} \times (1 - \%_{on-line})</math>  The quantity of N2O that by-pass the facility is then recorded daily.  <math>Q_{N2O\_by-pass_d} = P_{AdOH_d} \times N2O_{/AdOH} \times (1 - \%_{on-line})</math>  At the end of the period the quantity of N2O that by-passed the facility is :  <math>Q_{N2O\_by-pass_y} = \sum (Q_{N2O\_by-pass_d})</math></p>

Period	Q_N2O_by-pass <sub>y</sub> kg
Nov. 1 <sup>st</sup> ~ Nov. 30 <sup>th</sup>	0
Dec. 1 <sup>st</sup> ~ Dec. 31 <sup>st</sup>	28 003



## **Appendix 8**

Name of item	P_AdOH
Description	Adipic acid production after cap application
Value in period	24 115.425 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 with the last day of this period is below the capped value defined in the PDD (information available in the Excel Workbook “ER ONSAN”, sheet AM, submitted to UNFCCC). The quantity of adipic acid produced during this period can then be fully used as such. The Executive Board has confirmed on EB36 the application of a yearly Adipic acid production cap as required by the methodologies (issue 1 of the Requests of review for the Monitoring Period #9 Aug 8 <sup>th</sup> , 2007 ~ Aug 31 <sup>st</sup> , 2007).

Month - year	Adipic acid production t
Nov. 1 <sup>st</sup> ~ Nov. 30 <sup>th</sup>	13 023.025
Dec. 1 <sup>st</sup> ~ Dec. 31 <sup>st</sup>	11 092.4

## Appendix 9

Name of item HNO<sub>3</sub>\_consumption & HNO<sub>3</sub>\_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 (HNO<sub>3</sub>\_physical) in the aqueous wastes, the off gases, the adipic acid and the by-product are monitored.  
 Those losses are deducted from the nitric acid consumption, (HNO<sub>3</sub>\_consumption) to get the chemical consumption, (HNO<sub>3</sub>\_chemical).

Period	HNO <sub>3</sub> _consumption t	HNO <sub>3</sub> _physical t	HNO <sub>3</sub> _chemical t
Nov. 1 <sup>st</sup> ~ Nov. 30 <sup>th</sup>	11 119	202	10 917
Dec. 1 <sup>st</sup> ~ Dec. 31 <sup>st</sup>	9 564	191	9 373
Rolling year Dec. 31 <sup>st</sup> , 2008	127 156	2 211	124 945

Name of item N<sub>2</sub>O\_AdOH  
 Description N<sub>2</sub>O emission factor for adipic acid production  
 Value in period 0.270 kg N<sub>2</sub>O/kg AdOH  
 Method of monitoring Adipic acid production, nitric acid consumption and physical losses  
 Recording frequency Yearly

Calculation method The N<sub>2</sub>O emission factor is then calculated over the period on one year using the last rolling year data:

$$N_2O\_AdOH = HNO_3\_chemical / P\_AdOH / 63 / 2 \times 0.96 \times 44$$

The calculated value for this period is above 0.270 and is then capped by the value of KE\_N<sub>2</sub>O = 0.27, as specified in the PDD table D.2.1.3 and required by the methodology AM0021/version 1.

Period	Value N <sub>2</sub> O_AdOH calculated kg N <sub>2</sub> O/kg AdOH	KE_N <sub>2</sub> O kg N <sub>2</sub> O/kg AdOH	N <sub>2</sub> O_AdOH kg N <sub>2</sub> O/kg AdOH
Rolling year Dec.31 <sup>st</sup> , 2008	0.280	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 Evolution of Korean legislation that may require limitation of N<sub>2</sub>O emissions using one of the following criteria:  
 - Q\_N<sub>2</sub>O reg : allowed N<sub>2</sub>O emissions  
 - N<sub>2</sub>O\_reg / AdOH : allowed N<sub>2</sub>O emissions per kg of adipic acid produced  
 - r<sub>y</sub> : share of N<sub>2</sub>O emissions required to be destroyed

Value in period

not applicable

Method of monitoring

Survey

Recording frequency

When relevant

Background data

South Korean legislation

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”.

No evolution of legislation since PDD emission

Period	Q_N <sub>2</sub> O reg kg	N <sub>2</sub> O_reg / AdOH kg	r <sub>y</sub> %
December 31 <sup>st</sup> 2008	No limit	No limit	0.





## Appendix 11

Name of item

Description

Value in period

Method of monitoring

Recording frequency

Background data

P<sub>N<sub>2</sub>O</sub>

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

0 €/t
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Market survey

Yearly

Refers to study

Background data Refers to study “N<sub>2</sub>O market study NITROUS OXIDE Korea” –update

September 2008

Beside the very high investment cost in a purification-concentration-liquefaction unit to extract the N<sub>2</sub>O from the exhaust flow of the adipic acid plant, neither the process nor the product will get the necessary certifications for the pharmaceutical (80% share), food and semiconductor markets.

We can conclude that there is no N<sub>2</sub>O market for the N<sub>2</sub>O produced as by-product of adipic acid.

Year	P <sub>N<sub>2</sub>O</sub>
2008	0



## Appendix 12

Name of item	Q_Steam_py	
Description	Amount of steam produced by the decomposition facility	
Value in period	<table border="1"><tr><td>34 793 381 kg</td></tr></table>	34 793 381 kg
34 793 381 kg		
Method of monitoring	Flowmeter	
Recording frequency	Monthly	
Background data	Log sheet record	

Period	Q_Steam_py kg
Nov. 1 <sup>st</sup> ~ Nov. 30 <sup>th</sup>	18 277 815
Dec. 1 <sup>st</sup> ~ Dec. 31 <sup>st</sup>	16 515 566

### 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> $QNG\_tsteam = \Delta H \text{ (kcal/t)} / (\text{HHV (kcal/Nm}^3\text{)} \times \eta \text{ (\%)})$ <p>The HHV 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	HHV 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
December 31 <sup>st</sup> 2008	10 424	557 960	97	55.180	2.213	0.122



#### **Appendix 14**

Name of item	Q_Power
Description	Electricity consumption by the decomposition facility
Value in period	322 145 kWh
Method of monitoring	Power consumption data
Recording frequency	Monthly
Background data	Log sheet record / counter

Period	Q_Power kWh
Nov. 1 <sup>st</sup> ~ Nov. 30 <sup>th</sup>	174 830
Dec. 1 <sup>st</sup> ~ Dec. 31 <sup>st</sup>	147 315

## Appendix 15

Name of item	E_Power
Description	CO <sub>2</sub> intensity for electric generation
Value in period	0.597 kg-CO <sub>2</sub> /kWh
Method of monitoring	Survey of data publication
Recording frequency	Yearly
Background data	KEPCO data made publicly available by the Korean Energy Economics Institute (KEEI) for 2007.
Calculation method	Calculated using the combined margin (CM) approach according to ACM0002 version 2 in file <sup>1</sup> (Grid_EF_SouthKorea 2005, 2006, 2007 rev1.xls). Calculation has been validated by DOE

Date (year)	E_Power kg-CO <sub>2</sub> /kWh
2008	0.597

<sup>1</sup> 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	<table border="1"><tr><td>194 121 kg</td></tr></table>	194 121 kg
194 121 kg		
Method of monitoring	Mass flowmeter	
Recording frequency	Monthly	
Background data	Log sheet record	

Period	Q_Steam_c Kg
Nov. 1 <sup>st</sup> ~ Nov. 30 <sup>th</sup>	95 701
Dec. 1 <sup>st</sup> ~ Dec. 31 <sup>st</sup>	98 420

## Appendix 17

Name of item	E_Steam_c
Description	CO <sub>2</sub> intensity for steam consumed in the facility
Value in period	0.132 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 CO<sub>2</sub> for steam production are calculated and cumulated over the year.</p> <p>Q_NG_tsteam 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 E_Steam_c is obtained from:</p> $E\_Steam\_c = E\_NG_y \times Q\_NG\_tsteam$

Year ending	Q_NG_tsteam Nm <sup>3</sup> /t of steam	E_NG <sub>y</sub> kg-CO <sub>2</sub> /Nm <sup>3</sup>	E_Steam_c kg-CO <sub>2</sub> / kg of steam
December 31 <sup>st</sup> 2008	59 596	2.213	0.132