AKCINĖ BENDROVĖ ACHEMA

JI Project

Nitrous Oxide Emission Reduction Project at GP Nitric Acid Plant in AB Achema Fertiliser Factory

MONITORING REPORT

FIRST PROJECT CAMPAIGN
16/08/2008 - 26/09/2009

Version 1.3

08 December 2009

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Introduction

The Joint Implementation project "Nitrous Oxide Emission Reduction Project at GP Nitric Acid Plant in AB Achema Fertiliser Factory" was successfully carried out by installing secondary catalyst in August 2008. The baseline campaign was launched from September 2007 to July 2008 during which emissions were monitored to determine the baseline emissions of the plant. After installing of the secondary catalyst, the first project campaign was launched and the project emissions monitored until the end of the campaign – 26 September 2009.

This report describes the monitoring measures implemented within the frame of JI project during a period of 16.08.2008 – 26.09.2009. It evaluates the achieved emission reductions for a given period and resumes steps, which were carried out in accordance with the Monitoring plan and the requirements of the CDM methodology AM0034 v.3.3.

1. JI project design

1.1 Engineering solution for N2O reduction

BASF technology was applied by introducing a new catalyst bed which was installed in a new basket, directly under the Platinum gauze in the nitric acid reactors. The technology is owned and patented by BASF (German patent BASF Catalysts 03-85), and has also been installed in several other plants.

The secondary catalyst (on Al_2O_3 basis with active metal oxides CuO and ZnO) was installed underneath the platinum gauze. In order to be able to install a secondary catalyst the reconstruction of a burner basket was performed to make required 20-100 mm additional free space under the Platinum gauze.

Everything was prepared for the basket reconstruction and the catalyst replacement in the middle of July 2008. The GP plant was stopped on 28th July 2008 and after the cooling of the production line the old basket was dismantled. The installation of the new basket was successful as well as the installation of the secondary catalyst. The new catalyst's 03-85 shape is a extrudated Stars 3 mm. The free space in the basket was filled with ceramic Raschig rings and the test of GP plant operation was performed on 16th August 2009. The plant started fully operating at 1am on 17th August 2009.

The lifetime of the secondary catalyst is about 3 campaigns (lifetime of the platinum gauze), i.e. length of a campaign about 330 days in the high-pressure nitric acid reactors and about 1000 days in the medium-pressure nitric acid reactors. The guaranteed efficiency of the BASF secondary catalyst was about 80%. The average efficiency has reached up to 88 % during first project campaign.

1.2 Monitoring system

The N_2O monitoring system is designed according to the requirements set in the approved CDM baseline methodology AM0034 v3.3.

Baseline emissions were monitored and calculated by continuous multi-component measuring system Advance Cemas-NDIR manufactured by ABB, prior to installation of secondary catalysts. The monitoring system allows to measure N_2O concentration in the tail gas flow continuously during the entire lifespan of the primary catalysts in the oxidation reactor i.e. for approximately 11 months.

The monitoring system was installed, adjusted and launched on 30th June 2007 at the end of the campaign IV. Campaign V (baseline campaign) was launched on 5th September 2007. Emissions were monitored during the entire baseline campaign after which, a secondary catalyst was installed and the first project campaign (VI) was launched.

Monitoring results of the baseline campaign give an average value of N_2O emissions released to the atmosphere while producing 1 t of HNO_3 without abatement technique. After the installation of the secondary catalyst, the baseline emissions were compared to the actual emissions that were also continuously measured. The difference between baseline emissions and actual emissions after the installation of the secondary catalyst give emission reduction values.

Location of sampling probes for on-line measurement of tail gas volume flow, temperature, pressure and N_2O concentration with ABB multi-component measuring system at GP nitric acid plant are shown in a figure below.

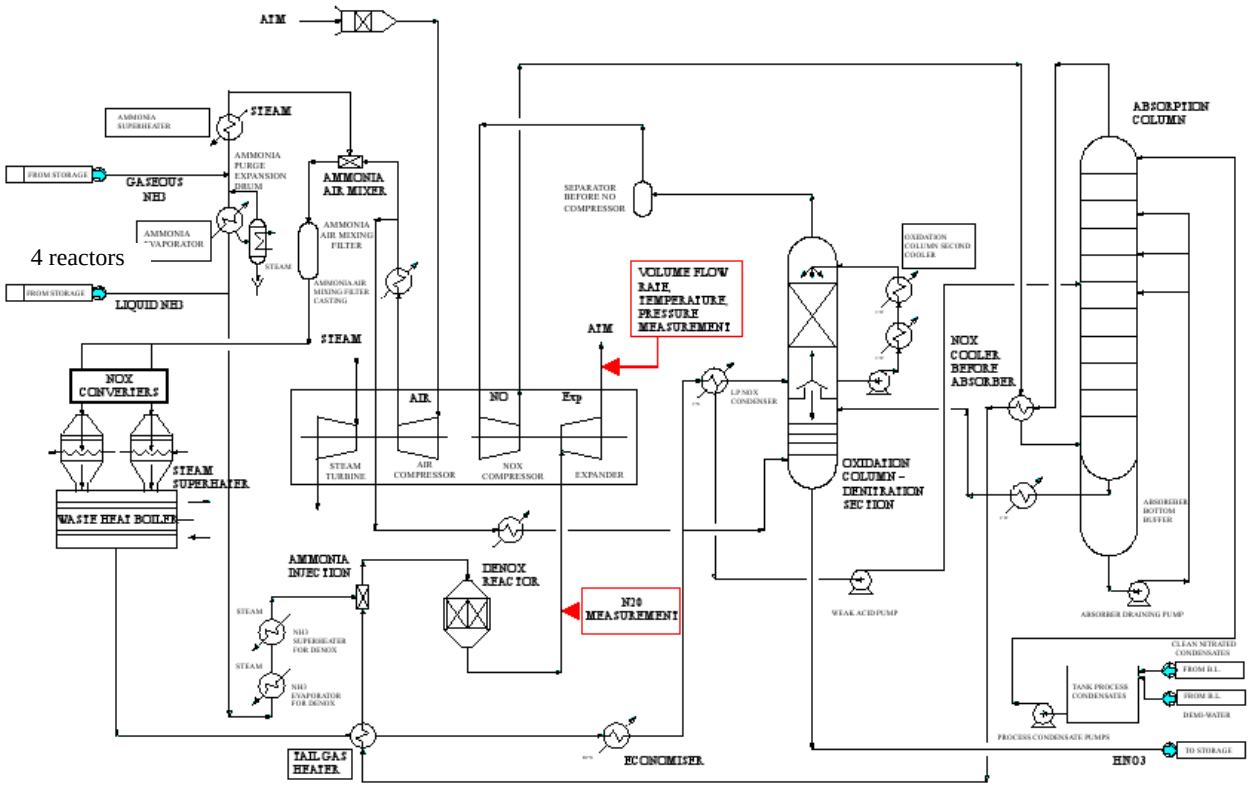

Figure 1 Sampling points for N_2O monitoring at GP plant

As it can be seen on the process scheme above, the volume flow, temperature and pressure measuring probe is installed after expander unit and N_2O sampling probe directly after DeNOx reactor.

Flow volume, temperature and pressure of the tail gas are measured separately from N_2O because length of straight duct at the N_2O sampling point is not long enough according to requirements for such measurements.

The N_2O monitoring system at GP plant consists of the following components:

- ✓ N_2O analyzer AO-2000-URAS-26 (ABB)
- ✓ Flow meter DELTAFLOW (Systec)
- ✓ Data Server EMI 3000
- ✓ Distributed control system (DCS)

A simplified scheme of the monitoring system is presented below:

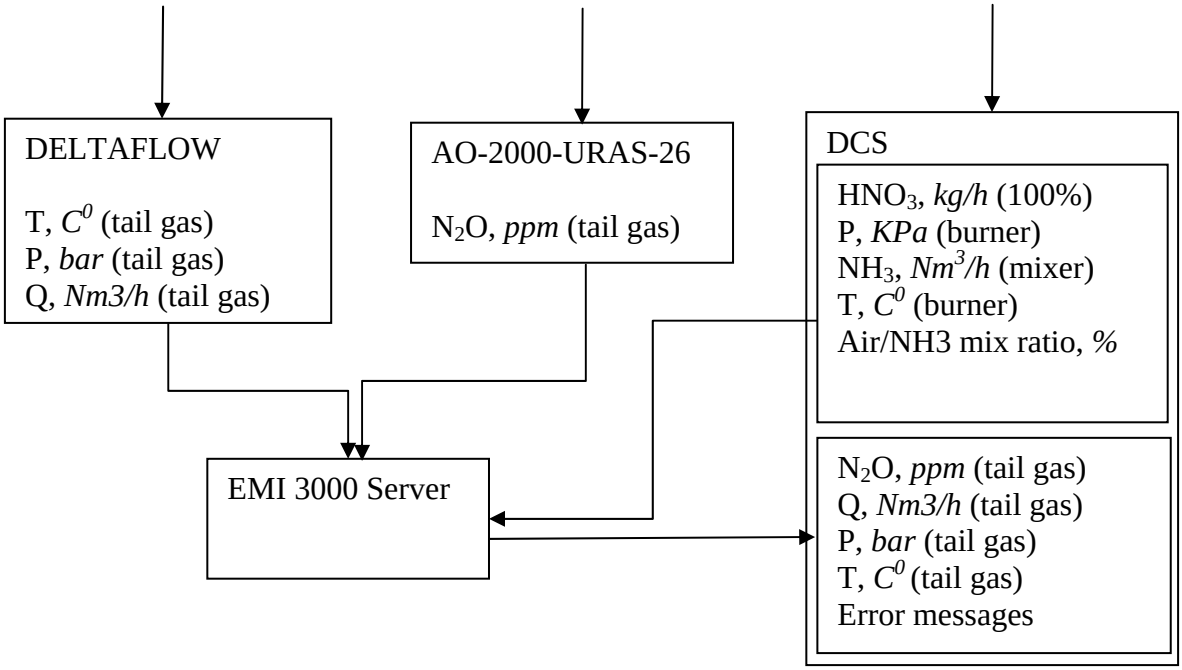

Figure 2 Automated monitoring system at GP plant

A flow meter measures volume flow (m^3/h), temperature and pressure in the tail gas and sends signals to the server. The server stores data and forwards signal to the Distributed Control System (DCS). The N_2O analyzer continuously measures concentration of N_2O in the tail gas and also sends signal to the data server which forwards it to DCS.

The AM0034 methodology requires monitoring scheme to be installed according to the European Norm 14181 (2004). The Norm requires evaluation of the automated measuring system (AMS) against three Quality Assurance Levels (QAL1, QAL2 and QAL3) and an Annual Surveillance Test (AST). Besides that, it must be ensured that the automated measuring system (AMS) is installed in accordance with the relevant European/ international standards and manufacturer requirements and functional test is performed at the commissioning of the AMS.

QAL1 procedure requires compliance of the equipment with EN ISO 14956. AO-2000-URAS-26 and DELTAFLOW are ISO 14956 certified by the manufacturers.

QAL2 procedure requires determination of the calibration function and a test of the measured values of the AMS compared with the uncertainty given by legislation. During the maintenance period of the GP plant (July 2008) the openings required for QAL2 tests were made in the duct.

QAL2 procedure was performed by an accredited independent entity. QAL2 test results were then integrated into the calculations performed by the monitoring software - CDMN2O.

QAL3 is a procedure to check drift and precision in order to demonstrate that the AMS is in control during its operation so that it continues to function within the required specifications for uncertainty. QAL3 is performed automatically as the system calibrates itself once a week. In addition, Achema's experts perform maintenance of the equipment such as fixing faults, changing filters, removing condensate from the system etc.

AST is a procedure to evaluate whether the measured values obtained from the AMS still meet the required uncertainty criteria – as demonstrated in the previous QAL2 test. AST is set to be performed annually by a selected validator.

The AM0034 requires determining the normal ranges for operating conditions for the following parameters: (i) oxidation temperature; (ii) oxidation pressure; (iii) ammonia gas flow rate, and (iv) air input flow rates. To calculate the "permitted range" for oxidation temperature and pressure, a historical data method was chosen and the permitted range then was entered into the AMS.

1.3 Data processing system

The data processing system consists of the following components:

- Data logger CX1000
- Data server EMI3000
- External Backup harddrive
- Software CDMN2O

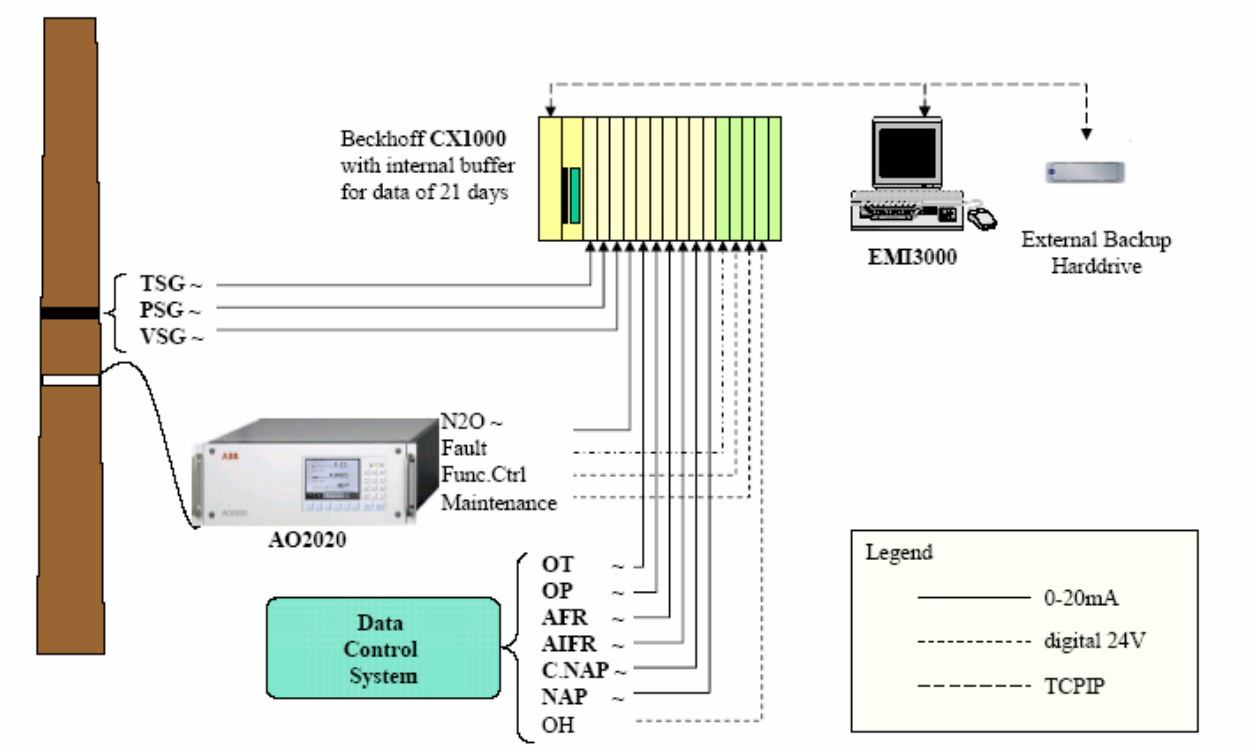

Figure 3 Data processing system

The Data logger CX1000 continuously reads and stores digital data of the monitoring system while EMI3000 handles the communication with the datalogger and evaluates continuously physical second values with status information. Based on this second values 60-minutes averages with status information are calculated.

All data are stored in a MySql-database and thus available for further evaluation. It is also backed up in the external hard drive disc.

Emission calculations are performed by CDMN2O (Version 1.0) software of AFRISO which allows to evaluate data according to the requirements of the approved CDM baseline methodology AM0034. Software is installed on the same PC running EMI3000 and is accessing its database.

The software's compliance with AM0034 requirements has been verified and approved. EMI3000 and CDMN2O are operated by a responsible engineer of AB Achema subsidiary "Sistematika" weekly maintenance and additional services related to the software are provided by AFRISO.

Data processing system follows the methodology of the AM0034 and the monitoring plan, therefore only the final results as output of the system are presented in this report.

2. Evaluation of the monitoring data

2.1 Monitoring data acquired

According to the Monitoring plan these parameters have been monitored and archived by EMI3000:

OH [h] Operating Hours - derived from Digital Input „In Operation"
OT [°C] Oxidation Temperature
OP [kPa] Oxidation Pressure
AFR [kg/h] Ammonia Flow
AIFR [%] Ammonia/Air-Ratio
PSG [hPa] absolute Pressure
TSG [°C] Stack Flow Temperature
VSG.opcond [m³/h] Stack Flow insitu
VSG [Nm³/h] Stack Flow [°C, 1013hPa] = VSG.oc * (273 / (273 + TSG) * (1013 / PSG)
NCSG[L].lR [mg/m³] N20 Low Range
NCSG[L].lR.v [mg/m³] N20 Low Range: Valid Counter = incremented if in Low Range and valid
NCSG[L].hR [mg/m³] N20 High Range
NCSG[L].hR.v [mg/m³] N20 High Range: Valid Counter = incremented if in high Range and valid
NCSG[L] [mg/m³] N20
C(HNO3) [%] Concentration of HNO3
NAP.input [kg/h] HNO3-Production
NAP [kg/h] HNO3-Production at 100%-conc. = C(NAP) * NAP.input

Mass rate of the N_2O flow is automatically calculated from the data of N_2O concentration in the tail gas and from its flow rate. The calculation is executed automatically in the EMI3000, where the calculated data is stored and archived.

2.2 Methodology

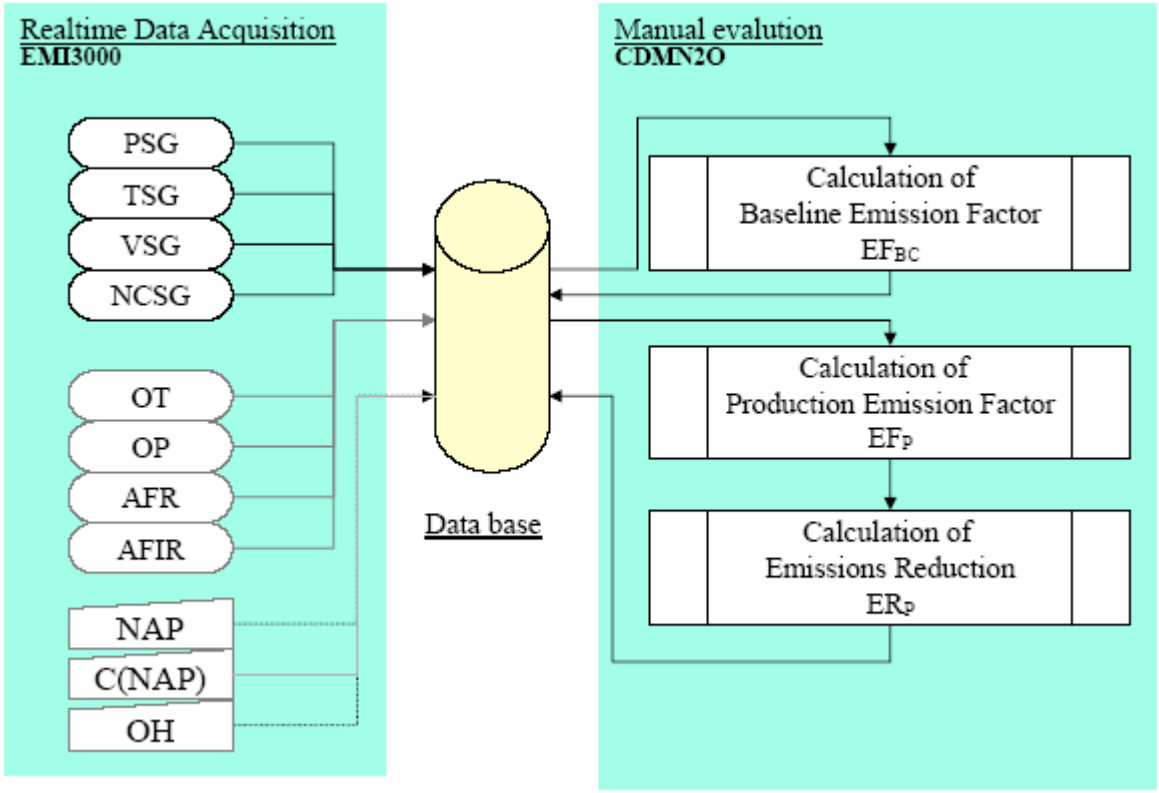

Figure 4 Data evaluation process

General evaluation rules are as follows:

- values for VSG, NSCG when OT, OP, AFR, AIFR inside permitted range:

$$OT_{min} < OT_h < OT_{max}$$
$$OP_{min} < OP_h < OP_{max}$$
$$AFR < AFR_{max}$$
$$AIFR < AIFR_{max}$$

- values for VSG, NSCG are inside 95%-confidence interval

The basic formula used to calculate emission reductions by CDMN2O software is the following:

$$\mathbf{ER} = (\mathbf{EF_{BI}} - \mathbf{EF_P}) * \mathbf{NAP_P} * \mathbf{GWP_{N2O}}$$

$\mathbf{ER_P}$ = campaign specific emission reduction [t CO_2]
$\mathbf{EF_{BI}}$ = N_2O Baseline Emission Factor [t N_2O / t HNO_3]
$\mathbf{EF_P}$ = N_2O Production Emission Factor [t N_2O / t HNO_3]
$\mathbf{NAP_P}$ = HNO_3 production during Production campaign [t HNO_3]
$\mathbf{GWP_{N2O}}$ = constant 310.0 [t CO2 / t N_2O]

The intermediate calculation is as follows:

1. Calculation of Baseline Emissions

$$BE_{BC} = VSG_{BC,95\%} * NSCG_{BC,95\%} * 10^{-9} * OH_{BC} \text{ [t } N_2O\text{]}$$

BE_{BC} = N2O Baseline Emissions [t N_2O]
$VSG_{BC,95\%}$ = average stack flow inside 95%-confidence interval [Nm^3/h]
$NSCG_{BC,95\%}$ = average N2O-concentration inside 95%-confidence interval [mg/Nm^3]
OH_{BC} = operating hours [h]

2. Calculation of Baseline Emission Factor

$$EF_{BL} = BE_{BC} / NAP_{BC} * (1 - UNC / 100\%) \text{ [t } N_2O \text{ / t } HNO_3\text{]}$$

EF_{Bl} = N_2O Baseline Emission Factor [t N_2O / t HNO_3]
BE_{BC} = N_2O Baseline Emissions [t N_2O]
NAP_{BC} = HNO3 Production during campaign [t HNO_3]
UNC = total uncertainty of system [%]

3. Calculation of Campaign Emissions

$$PE_n = VSG_{n,95\%} * NSCG_{n,95\%} * 10^{-9} * OH_n \text{ [t } N_2O\text{]}$$

PE_n = N_2O Campaign Emissions [t N_2O]
$VSG_{n,95\%}$ = average stack flow inside 95%-confidence interval [Nm^3/h]
$NSCG_{n,95\%}$ = average N_2O-concentration inside 95%-confidence interval [mg/Nm^3]
OH_n = operating hours [h]

4. Calculation of Campaign Emission Factor

$$EF_n = PE_n / NAP_n \text{ [t } N_2O \text{ / t } HNO_3\text{]}$$

EF_n = N_2O Campaign Emission Factor [t N_2O / t HNO_3]
PE_n = N_2O Campaign Emissions [t N_2O]
NAP_n = HNO_3 Production during campaign [t HNO_3]

2.3 Illustration of Calculations

$$BE_{BC} = 138946.53 * 2759.54 * 10^{-9} * 7328 = 2809.764 \text{ t } N_2O$$

$$EF_{BL} = 2809.764 / 290000.7 * (1-5.12/100) = 0.009193 \text{ t } N_2O/\text{t } HNO_3$$

$$PE_n = 133840.30 * 304.17 * 10^{-9} * 7630 = 310.618 \text{ t } N_2O$$

$$EF_n = 310.618 / 290004.17 = 0.001071 \text{ t } N_2O/\text{t } HNO_3$$

$$ER = (0.009193 – 0.001071) * 290004.17 * 310 = 730148.56 \text{ t } CO_2$$

2.4 Data correction

The data obtained during the downtime of the monitoring system was handled according to AM0034 (v.3.3) methodology by using CDMN2O software. In the events of the monitoring system disorders, the lowest between the conservative IPCC (4.5 kg N2O / t HNO_3) or the last measured value was automatically selected by CDMN2O for the downtime period for the baseline emission factor, and the highest measured value in the campaign was selected for the downtime period for the campaign emission factor.

2.5 Campaign length

According to the AM0034 methodology (v.3.3), EF_{BL} has to be recalculated in two cases:

1. if $CL_{BL} > CL_{normal}$
2. if $CL_n < CL_{normal}$

where:

CL_{BL} – length of the baseline campaign
CL_{normal} – average historic campaign length
CL_n – length of a project campaign

According to the monitoring results:

CL_{BL} = 299800.8 t HNO_3
CL_{normal} = 303129.33 t HNO_3
CL_n = 290004.17 t HNO_3

$CL_{BL} < CL_{normal}$
$CL_n < CL_{normal}$

Therefore EF_{BL} was recalculated in the CDMN2O software according to the AM0034 (v.3.3) methodology requirements by eliminating all N_2O values from the baseline campaign that are resulting from HNO_3 production which exceeds amount equal to CL_n. The end point of the baseline data selected for calculation of EF_{BL} was 18.07.2008. 3:00 with the NAP equal to 290000,7 t HNO_3.

2.6 Impact of regulations

Regulations have no impact on the current campaign's monitoring data. AB Achema operates according the IPPC permit No.2/15 which was updated on April 30 2008. The IPPC permit issued to AB Achema imposes N_2O limits starting from 2011, which will affect corresponding campaigns. This impact will be reflected in the related monitoring reports.

3. Monitoring results

3.1. Configuration of baseline's campaign calculation

ACHEMA Jonova, Line 1
001 Baseline (05.09.07 10:00 - 28.07.08 24:00)

Date 11/5/2009
Page 1

Configuration 01

Campaigne Data			Minimum	Maximum
Type	: baseline	OT	: 756.00 °C	778.70 °C
Status	: calculated	OP	: 243.00 kPa	283.00 kPa
Start	: 05.09.2007 10:00	AFR	:	11497.16 t NH3/h
Stop	: 28.07.2008 24:00	AIFR	:	10.10 %
UNC	: 5.12 %			
CI.Normal	: 303129.330 t			
GS.Normal	: Johnson Matthey			
GC.Normal	: 95% Pt/5%Rh (Gauze 1-3), 37%Pt/60%Pd/3%Rh (Gauze 4)			
GS.Baseline	: Johnson Matthey			
GC.Baseline	: 95% Pt/5%Rh (Gauze 1-3), 37%Pt/60%Pd/3%Rh (Gauze 4)			

			Range [min]		Range [max]		Gradient		Zero-Offset		Std.Deviation		Factor
			low	high	low	high	low	high	low	high	low	high	
NCSG	[F1] NCSG[L]/R	post calc	0.000	980.000	-0.010	3920.150	61.2	244.8	-244.8	-979.3	-13	-13	1
VSG oc	[F1] VSG opcond	post calc	0.000	218506.000	-	-	15026.9	0	60107.6	0	0	-	-
PSG	[F1] PSG	post calc	0.000	1600.000	-	-	99.07	0	396.3	0	0	-	1
TSG	[F1] TSG	post calc	0.000	400.000	-	-	25.29	0	-101.1	0	0	0	1
VSG 1 oc		none	-	-	-	-	-	-	-	-	-	-	1
PSG 1		none	-	-	-	-	-	-	-	-	-	-	1
TSG 1		none	-	-	-	-	-	-	-	-	-	-	1
VSG 2 oc		none	-	-	-	-	-	-	-	-	-	-	1
PSG 2		none	-	-	-	-	-	-	-	-	-	-	1
TSG 2		none	-	-	-	-	-	-	-	-	-	-	1
OH	[F1] Op.Time	direct	-	-	-	-	-	-	-	-	-	-	1
OT	[F1] OT	direct	-	-	-	-	-	-	-	-	-	-	1
OP	[F1] OP	direct	-	-	-	-	-	-	-	-	-	-	1
AFR	[F1] AFR	direct	-	-	-	-	-	-	-	-	-	-	1
AIFR	[F1] AIFR	direct	-	-	-	-	-	-	-	-	-	-	1
C[NAP]	[F1] C[HNO3]	post calc	0.000	100.000	-	-	0	0	100	0	0	0	1
NAP(op)	[F1] NAP input	direct	-	-	-	-	-	-	-	-	-	-	0.001

AM0034 - Configuration

3.2. Configuration of project's campaign calculation

ACHEMA Jonova, Line 1
002 Production (17.08.08 01:00 - 26.09.09 09:00)

Configuration 01

Campaigne Data			Minimum	Maximum
Type	: project	OT :	0.00 °C	1000.00 °C
Status	: calculated	OP :	0.00 kPa	1000.00 kPa
Start	: 17.08.2008 01:00	AFR :		20000.00 t NH3/h
Stop	: 26.09.2009 09:00	AIFR :		15.00 %
UNC	: 5.12 %			
CI.Normal	: 303129.330 t			
GS.Normal	: Johnson Matthey			
GC.Normal	: 95% Pt/5%Rh (Gauze 1-3), 37%Pt/60%Pd/3%Rh (Gauze 4)			
GS.Baseline	: Johnson Matthey			
GC.Baseline	: 95% Pt/5%Rh (Gauze 1-3), 37%Pt/60%Pd/3%Rh (Gauze 4)			
GS.Project	:			
GC.Project	:			

			Range (min)		Range (max)		Gradient		Zero-Offset		Std.Deviation		Factor
			low	high	low	high	low	high	low	high	low	high	
NCSG	[F1] NCSG[L] IR	post calc	0.000	980.000	-0.010	3920.150	61.2	244.8	-244.8	-979.3	13	13	1
VSG.oc	[F1] VSG opcond	post calc	0.000	218506.000	-	-	15026.9	0	-601076	0	0	0	1
PSG	[F1] PSG	post calc	0.000	1600.000	-	-	99.07	0	-396.3	0	0	0	1
TSG	[F1] TSG	post calc	0.000	400.000	-	-	25.29	0	-101.1	0	0	0	1
VSG.1 oc		none	-	-	-	-	-	-	-	-	-	-	1
PSG.1		none	-	-	-	-	-	-	-	-	-	-	1
TSG.1		none	-	-	-	-	-	-	-	-	-	-	1
VSG.2 oc		none	-	-	-	-	-	-	-	-	-	-	1
PSG.2		none	-	-	-	-	-	-	-	-	-	-	1
TSG.2		none	-	-	-	-	-	-	-	-	-	-	1
OH	[F1] Op.Time	direct	-	-	-	-	-	-	-	-	-	-	1
OT	[F1] OT	direct	-	-	-	-	-	-	-	-	-	-	1
OP	[F1] OP	direct	-	-	-	-	-	-	-	-	-	-	1
AFR	[F1] AFR	direct	-	-	-	-	-	-	-	-	-	-	-
AIFR	[F1] AIFR	direct	-	-	-	-	-	-	-	-	-	-	-
C[NAP]	[F1] C[HNO3]	post calc	0.000	100.000	-	-	0	0	100	0	0	0	1
NAP(op)	[F1] NAP input	direct	-	-	-	-	-	-	-	-	-	-	0.001

3.3 Results of the baseline campaign and of the project campaign

Evaluation AM0034

Begin	: 17.08.2008 01:00:00		
End	: 26.09.2009 09:00:00		
Type	: project		
Status	: calculated		
GS.Normal	: Johnson Matthey		
GC.Normal	: 95% Pt/5%Rh (Gauze 1-3), 37%Pt/60%Pd/3%Rh (Gauze 4)		
GS.Baseline	: Johnson Matthey		
GC.Baseline	: 95% Pt/5%Rh (Gauze 1-3), 37%Pt/60%Pd/3%Rh (Gauze 4)		
GS.Project	: Johnson Matthey		
GC.Project	: 95% Pt/5%Rh (Gauze 1-3), 37%Pt/60%Pd/3%Rh (Gauze 4)		

Baseline Extra Calculation

BL.Start	:	05.09.2007 10:00:00		
BL.Stopp	:	18.07.2008 03:00:00		
BL.OH.total	:	7328	h	
BL.OH.valid	:	6983	h	(95,29%)
BL.VSG (mean)	:	138828,26	Nm³/h	(6983 values)
BL.VSG (Std.Dev)	:	6973,23	Nm³/h	
BL.VSG (mean 95%)	:	138946,53	Nm³/h	(6646 values)
BL.NCSG (mean)	:	2750,63	mg/Nm³	(6983 values)
BL.NCSG (Std.Dev)	:	284,51	mg/Nm³	
BL.NCSG (mean 95%)	:	2759,54	mg/Nm³	(6803 values)
BL.NAP	:	290000,700	tHNO3	
BL.UNC	:	5,12	%	

Project Calculation

OH.total	:	7630	h	
OH.in op.cond.	:	7630	h	(100,00 %)
VSG (mean)	:	133925,96	Nm³/h	(7630 values)
VSG (Std.Dev)	:	10819,34	Nm³/h	
VSG (mean 95%)	:	133840,30	Nm³/h	(7375 values)
NCSG (mean)	:	326,60	mg/Nm³	(7630 values)
NCSG (Std.Dev)	:	203,55	mg/Nm³	
NCSG (mean 95%)	:	304,17	mg/Nm³	(7330 values)
NAP	:	290004,170	tHNO3	

Baseline results

BE	:	2809,764	tN2O
EF (Bl)	:	0,009193	tN2O / tHNO3

Project results

PE	:	310,618	tN2O
EF (n)	:	0,001071	tN2O / tHNO3
EF (mean)	:	0,001071	tN2O / tHNO3
EF (min)	:	0,001071	tN2O / tHNO3
EF.p	:	0,001071	tN2O / tHNO3
ER	:	730148,56	tCO2