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Validation opinion
Notification / Requesting approval of changes from the project activity as described in the registered project design document

Title of project activity:		
Project for the catalytic reduction of N_2O emissions with a secondary catalyst inside the ammonia reactor of the nitric acid plant at Dongbu Hannong Chemicals Ltd., Ulsan, Korea		
CDM reference number:	DNV project No.:	
1443	PRJC-193536-2009-CCS-NOR	
Type of request:	☒ Notification of changes from project activity as described in the registered PDD (i.e. changes do not raise any concerns with regard to i) additionality, ii) the scale of CDM project activity and/or iii) the applicability and application of baseline methodology ☐ Request for approval of changes from project activity as described in the registered PDD	
Date	Work carried out by:	Work verified by:
30 March 2009	Akira Sekine	Trine Kopperud

We refer to the *procedures for notifying and requesting changes from the project activity as described in registered project design document* adopted at EB 48 (Annex 66), and herewith request changes in the registered project design document for project activity 1443 ‘‘Project for the catalytic reduction of N_2O emissions with a secondary catalyst inside the ammonia reactor of the nitric acid plant at Dongbu Hannong Chemicals Ltd., Ulsan, Korea’’.

1 Background

The project activity was registered as a CDM activity on 1 April 2008 with a crediting period starting from 1 April 2008 to 31 March 2018 (fixed). The project is based on approved baseline and monitoring methodologies AM0034 (Version 02): “Catalytic reduction of N_2O inside the ammonia burner of nitric acid plants”. Furthermore, the project draws on approved baseline methodology AM0028 for the baseline scenario selection and employs the “Tool for the demonstration and assessment of additionality” (Version 03).

Three monitoring periods have been concluded as follows:
Monitoring period 1: 1 April 2008 to 15 May 2008
Monitoring period 2: 16 May 2008 to 7 January 2009
Monitoring period 3: 8 January 2009 to 15 October 2009

At the 3rd verification (25 -26 November 2009), DNV as the verifying DOE identified that the operation of the project activity did not fully conform to the description contained in the registered Project Design Document (PDD). According to the procedures for *notifying and requesting changes from the project activity as described in registered project design document* adopted at EB 48 (Annex 66) the project proponent (PP) has provided DNV with the revised PDD, which describes the changes from the project activity as described in the registered project design document. The nature of the change is related to the types and brand name of the secondary catalyst installed in the ammonia burner of the project nitric acid plan.

2 Description of the changes as compared to the description in the registered PDD

The changes in the revised project design document as per the requirements of para 10 (a) of Annex 66 of EB48 are summarized below:
The description in the registered PDD and the revised PDD are compared and the revisions are marked in *italic* font and deletions are indicated with strike through as follows:

Revisions in section A.4.3. Technology to be employed by the project activity:

(Registered PDD)
"Catalyst Technology
The Johnson Matthey Amoxis Hybrid® RN20/101 catalyst system consists of the standard precious metal gauze pack with an additional base metal catalyst.

The precious metal gauze pack – i.e. the primary catalyst required for the actual production of nitric acid
– has been supplied to Dongbu by Johnson Matthey for a number of years. The design and composition of that gauze pack will remain unchanged during the crediting period.

A secondary catalyst will reduce N_2O levels in the gas mix resulting from the primary ammonia oxidation reaction. A wide range of metals (e.g. Cu, Fe, Mn, Co and Ni) have shown to be of varied effectiveness in N_2O abatement catalysts. The Amoxis Hybrid® RN20/101 abatement catalyst is made of clover leave shaped pellets containing a Lanthanum-Cerium-Cobalt-Perovskite.

The catalyst has been tried and tested in a number of nitric acid plants in Europe. The abatement efficiency has been shown to be at least 80% in the following reaction:
$2N_2O \rightarrow 2N_2 + O_2$

The Amoxis Hybrid® RN20/101 abatement catalyst does not contaminate the nitric acid produced in the respective nitric acid plant, neither with Cobalt nor with any of the other catalyst materials. It does not require additional heat or other energy input, because the temperature levels present inside the Ammonia Oxidation Reactor suffice to ensure its optimum abatement efficiency. There are no additional greenhouse gases or other emissions generated by the reactions on at the N_2O abatement catalyst*"*

(Revised PDD)
"Catalyst Technology
Dongbu has contracted with Johnson Matthey PLC (JM) for the provision of the N2O abatement catalyst. JM has two different types of N2O abatement catalyst available. The choice of abatement catalyst type for any particular plant depends on technical aspects like (i) available bed depth, (ii) expected pressure drop, (iii) desired abatement performance etc.

Initially the Amoxis Hybrid® RN20/101 catalyst was installed (this type was later rebranded for legal reasons and is now called Amoxis 10 -1R®). To optimise the abatement performance of the installed catalyst and to reduce the observed pressure drop inside the reactor, JM and Dongbu decided to change the installed catalyst type to the YARA 58-Y1® catalyst. Both the Amoxis 10 -1R® and the YARA 58-Y1® catalyst contain cobalt as the active catalyst material.

Because N_2O is solely formed in the primary ammonia oxidation catalyst, the type of secondary catalyst has no effect on baseline emissions or on the baseline scenario. Because the cost for the secondary catalyst is the same the type of secondary catalyst has also no effect on the additionality test of the project.

The precious metal gauze pack – i.e. the primary catalyst required for the actual production of nitric acid – has been supplied to Dongbu by Johnson Matthey for a number of years. The design and composition of that gauze pack *has remained unchanged so far and* will remain unchanged ~~during~~ *for the remainder* of the crediting period.

A secondary catalyst will reduce N_2O levels in the gas mix resulting from the primary ammonia oxidation reaction. A wide range of metals (e.g. Cu, Fe, Mn, Co and Ni) have shown to be of varied effectiveness in N_2O abatement catalysts.

The Amoxis Hybrid® RN20/101 abatement catalyst is made of clover leave shaped pellets containing a Lanthanum-Cerium-Cobalt-Perovskite.

Both of t~~T~~he catalysts has~~s~~ve been tried and tested in a number of nitric acid plants in Europe. Their abatement efficiency has been shown to be at least 80% in the following reaction:

$2N_2O \rightarrow 2N_2 + O_2$

~~Amoxis Hybrid® RN20/101~~ *Both* abatement catalyst do not contaminate the nitric acid produced in the respective nitric acid plant, neither with Cobalt nor with any of the other catalyst materials.

Operating a secondary catalyst system does not require additional heat or other energy input, because the temperature levels present inside the Ammonia Oxidation Reactor suffice to ensure its optimum abatement efficiency. There are no additional greenhouse gases or other emissions generated by the reactions on at the N_2O abatement catalyst."

(Registered PDD)
"**N_2O abatement catalyst installation**

The secondary catalyst itself is easily installable during a routine plant shut-down and gauze change. The pellets are poured into the support basket / heat shield arrangement and raked level. The gauze pack is then installed above this bed using the support mechanism provided by the heat shield.

The N_2O abatement catalyst is supplied to Dongbu by Johnson Matthey on a lease basis, which requires Johnson Matthey to take back the catalyst at the end of its useful life and refine, recycle or dispose of it according to EU regulations, hence fulfilling sustainability standards.

(Revised PDD)
"**N_2O abatement catalyst installation**

The secondary catalyst itself is easily installable during a routine plant shut-down and gauze change. The pellets are poured into the support basket / heat shield arrangement and raked level. The gauze pack is then installed above this bed using the support mechanism provided by the heat shield.

The N_2O abatement catalyst – *regardless whether the Amoxis 10-1R® or the YARA 58-Y1 system is being employed* – is supplied to Dongbu by Johnson Matthey on a lease basis, which requires Johnson Matthey to take back the catalyst at the end of its useful life and refine, recycle or dispose of it according to EU regulations, hence fulfilling sustainability standards.

3 Assessment of the changes

Assessment of when the changes occurred
The changes was informed and verified at the site visit for the verification of the 3rd monitoring period. The installation of the new secondary catalyst occurred step-wise during monitoring period 3. [1]

Assessment of the reasons for these changes taking place
It can be seen from the two previous monitoring periods that the achieved abatement efficiency of the previously installed catalyst system was only 56% in average. The baseline emission factor is 0.01063 $tN_2O/tHNO_3$ and the project emission factors were in the range 0.0044 $tN_2O/tHNO_3$ to 0.0050 $tN_2O/tHNO_3$. The expected abatement efficiency of the Yara 58-Y1 catalyst is up to 90%, the abatement efficiency is however depending on the amount (depth of catalyst bed) of the secondary catalyst installed in the ammonia burner basket. Further the catalyst is developed to minimize pressure drop (the latter being important for operations). DNV was able to verify this information from catalyst provider and other references[2]. The reason for the change is that the project proponents (PP) seek to achieve improved abatement efficiency and reduced pressure drop.

4 Assessment of the impact of the changes

Do the changes raise concerns with regard to any of the following aspects?	☐ Additionality ☐ Scale of the CDM project ☐ Applicability and application of baseline methodology ☒ Not applicable (the changes do not raise any concerns)

[1] N.serve Environmental Services GmbH: CDM Monitoring Report: "Project for the catalytic reduction of N2O emissions with a secondary catalyst inside the ammonia reactor of the nitric acid plant at Dongbu Hannong Chemicals Ltd., Ulsan, Korea ("Dongbu")", 11 November 2009.
[2] Nitrogen 2006 , Vienna Austria 12-15 March 2006: G. Lenoir, T. Kopperud, Ø. Nirisen: "Yara De-N2O Secondary Abatement from Nitric Acid Production – A proven Technology"

Assessment of impacts of the changes on additionality

The additionality of the project was demonstrated by a simple cost analysis since the project activity generates no income other than CDM revenue. Thus the change of the type and brand of the secondary catalyst do not affect the additionality (the catalyst is leased against a share of the CERs).

Assessment of impacts of the changes of scale of the CDM project

The scale of the CDM is not changed as the expected abatement in the registered PDD is in the same range as reported for the "*Yara 58-Y1*®" catalyst. [1]

Assessment of impacts of the changes on the applicability and application of baseline methodology

The applicability conditions of the approved methodology, AM0034 version 2 are as follows;

1. The proposed project activity will be applied to an existing production facility installed prior to the 31st December 2005. The plant has been commissioned and is in operation since 1992.
2. Currently, the plant does not have any N_2O destruction or abatement facilities that could be affected by the project activity.
3. The project activity has no influence on the plant's nitric acid production levels.
4. The host country does not have any legal requirements to reduce N_2O emissions from nitric acid plants.
5. Presently, no N_2O abatement technology is installed in the plant.
6. The project activity will not increase in NOx emissions.
7. There is no NSCR DeNOx-unit installed in the plant.
8. The installation of the secondary N_2O abatement catalyst will not lead to any additional direct or indirect GHG emissions within the project boundary.
9. A complete Automated Monitoring System (AMS), comprised of an N_2O analyser and a volume flow meter have been commissioned at the plant in January 2007. The AMS is being operated continuously to collect the baseline data and will continue to be operated to measure concentration and total gas volume flow in the stack during the plant's operation throughout the crediting period of the project activity.

Regarding the applicability condition 1 above, although the new secondary catalyst reduces the pressure drop in the ammonia oxidation reactor, the design capacity at 31st December 2005 can not be expanded. The change in the type and brand of the secondary catalyst do not affect any other applicability conditions.

Further there is no impact on the applicability of the baseline methodology since the analysis is the same regardless of the brand and type of the secondary abatement catalyst.

[1] Nitrogen 2006 , Vienna Austria 12-15 March 2006: G. Lenoir, T. Kopperud, Ø. Nirisen: "Yara De-N2O Secondary Abatement from Nitric Acid Production – A proven Technology"

5 Validation opinion

The revised PDD clearly describes the changes from the registered PDD. DNV was able to confirm the rebranding of the original secondary catalyst"*Johnson Matthey Amoxis Hybrid® RN20/101"* to *Amoxis 10 -1R*®. Also DNV confirmed that the new secondary catalyst"*Yara 58-Y1*®" installed during the 3rd monitoring period was developed to achieve an abatement efficiency up to 90% and to reduce the pressure drop without any adverse effect, i.e. increase of the other greenhouse gases.
The usage of the new secondary catalyst during the transitional period was verified to be in line with information given in the monitoring report for the 3rd verification. The difference in N_2O abatement performance as a result of the new secondary catalyst type will be identified through ex-post monitoring of stack gas N_2O concentration.

Based on the above assessment, DNV is of the opinion that the change in type and brand of the secondary catalyst is to be regarded as a request for notification of change from project activity as described in the registered PDD since it is our opinion that the change do not raise any concerns with regard to i) additionality, ii) the scale of CDM project activity and/or iii) the applicability and application of baseline methodology.

Yours faithfully
for DET NORSKE VERITAS CERTIFICATION AS

Akira Sekine
CDM verifier
Climate Change Services

Trine Kopperud
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