

Internal distribution code:

- (A) [-] Publication in OJ
- (B) [-] To Chairmen and Members
- (C) [-] To Chairmen
- (D) [X] No distribution

**Datasheet for the decision
of 18 May 2018**

Case Number: T 2005/15 - 3.3.06

Application Number: 08793909.6

Publication Number: 2185279

IPC: B01J23/00, B01J23/86,
B01J23/889, C01B21/26,
C01B21/38

Language of the proceedings: EN

Title of invention:

PRODUCTION OF NITRIC OXIDE BY OXIDATION OF AMMONIA IN PRESENCE
OF A MIXED METAL OXIDE CATALYST

Patent Proprietor:

YARA International ASA

Opponent:

ThyssenKrupp Industrial Solutions AG

Headword:

AMMONIA CATALYTIC OXIDATION / YARA

Relevant legal provisions:

EPC Art. 100(a), 100(b), 100(c), 52(1), 54, 56

Keyword:

Objections based on grounds for opposition under Articles 100(b) and (c) EPC shall be part of the appeal proceedings. Principle of reformatio in peius only applies to final result (reasons, 2)

Extension of subject-matter, patent as granted (no)

Insufficiency of disclosure, patent as granted (no)

Novelty, patent as granted - (yes)

Inventive step, patent as granted - (yes)

Decisions cited:

Catchword:



Beschwerdekammern
Boards of Appeal
Chambres de recours

Boards of Appeal of the
European Patent Office
Richard-Reitzner-Allee 8
85540 Haar
GERMANY
Tel. +49 (0)89 2399-0
Fax +49 (0)89 2399-4465

Case Number: T 2005/15 - 3.3.06

D E C I S I O N
of Technical Board of Appeal 3.3.06
of 18 May 2018

Appellant:
(Patent Proprietor)

YARA International ASA
P.O. Box 2464 Solli
0202 Oslo (NO)

Representative:

Pappaert, Kris
De Clercq & Partners
Edgard Gevaertdreef 10 a
9830 Sint-Martens-Latem (BE)

Respondent:
(Opponent)

ThyssenKrupp Industrial Solutions AG
ThyssenKrupp Allee 1
45143 Essen (DE)

Representative:

Brosch, Oliver
Kutzenberger Wolff & Partner
Theodor-Heuss-Ring 23
50668 Köln (DE)

Decision under appeal:

**Interlocutory decision of the Opposition
Division of the European Patent Office posted on
11 August 2015 concerning maintenance of the
European Patent No. 2185279 in amended form.**

Composition of the Board:

Chairman P. Ammendola
Members: M. Maremonti
C. Heath

Summary of Facts and Submissions

I. The appeal by the Patent Proprietor lies from the interlocutory decision of the Opposition Division concerning the maintenance of the European Patent No. 2 185 279 in amended form on the basis of the then pending fifth auxiliary request.

II. The patent in suit was granted with a set of 6 claims, independent claim 1 of which reading as follows:

*"1. A method for the production of gas comprising nitric oxide, **characterized in that** a gas blend comprising ammonia and oxygen is converted in presence of a catalyst comprising the composition $A_{3-x}B_xO_4$, wherein a combination of A and B are selected from:*

A = Mn or Cr and B = Co where $0 < x < 3$."

Dependent claims 2 to 6 are directed to embodiments of the method of claim 1.

III. The Opponent raised objections on the grounds of Articles 100(a), (b) and (c) EPC.

The evidence cited during the opposition procedure included

D1: Schmidt-Szalowski K. *et al.*; "The properties of cobalt oxide catalyst for ammonia oxidation", Applied Catalysis A: General, ELSEVIER, AMSTERDAM, NL, vol. 175, no. 1-2, 14 December 1998, pages 147-157;

D2: GB 1 436 346 A;

D4: DE 21 48 707 A1;

D7: US 4 389 339 A;

- D8: Experimental Report enclosed to the notice of opposition dated 17 October 2013.
- D10: Nomenclature of inorganic chemistry - IUPAC Recommendations 2005, RCS Publishing, pages 237-238;
- D11: Singh, U.G. *et al.*: "A Pd-doped perovskite catalyst, $BaCe_{1-x}Pd_xO_{3-\delta}$, for CO oxidation", JOURNAL OF CATALYSIS, ACADEMIC PRESS, DULUTH, MN, US, vol. 249, no. 2, 04 July 2007, pages 349-358;
- D12: Bordeneuve, H. *et al.*: "Structure and electrical properties of single phase cobalt manganese oxide spinels $Mn_{3-x}Co_xO_4$ sintered classically and by spark plasma sintering (SPS)", JOURNAL OF SOLID STATE CHEMISTRY, ORLANDO, FL, US, vol. 182, no. 2, 1 February 2009, pages 396-401.

The Opposition Division came to the following conclusions:

- The opposition grounds under Article 100(c) and (b) did not prejudice the maintenance of the patent as granted.
- However, the method of claim 1 as granted was not novel over each of D2, D1, D4 and D7.
- Also the then pending first to fourth auxiliary requests did not comply with the requirements of the EPC.
- The patent in amended form on the basis of the amended claims and description of the fifth auxiliary request complied with the requirements of the EPC.

- IV. In its statement of grounds of appeal, the Patent Proprietor/Appellant ("Appellant" hereinafter) contested the findings of the the Opposition Division and filed therewith three sets of claims as auxiliary requests 1 to 3. It maintained *inter alia* that claim 1 as granted was novel and inventive over the cited prior art. It also put forward that the opposition grounds under Article 100(b) and (c) EPC should not be admitted into the appeal proceedings.
- V. In its reply to the statement of grounds, the Respondent/Opponent ("Respondent" hereinafter) *inter alia* argued in favour of the introduction of the opposition grounds under Article 100(b) and (c) EPC into the appeal proceedings and maintained that the subject-matter of claim 1 as granted extended beyond the content of the application as originally filed and was not sufficiently disclosed in the contested patent. Moreover, claim 1 was not novel over all documents D1, D2, D4 and D7 and did not involve an inventive step in view of D2 taken as the closest prior art.
- VI. The parties were summoned to oral proceedings. In preparation therefor, the Board issued a communication expressing *inter alia* its preliminary opinion that the opposition grounds under Article 100(c) and (b) EPC were part of the appeal proceedings but these grounds of opposition did not appear to prejudice the maintenance of the patent as granted.
- VII. Oral proceedings before the Board were held on 18 Mai 2018. The debate focused on the opposition grounds under Article 100(c) and (b) EPC as well as on the novelty and inventive step of the subject-matter of claim 1 as granted.
- VIII. Parties' Requests

The **Appellant** (Patent Proprietor) requested that the decision under appeal be set aside and that the patent be maintained as granted (main request) or, in the alternative, that the patent be maintained in amended form on the basis of the claims according to one of auxiliary requests 1 to 3 as filed with the statement of grounds of appeal.

The **Respondent** (Opponent) requested that the appeal be dismissed.

IX. The Appellant's arguments of relevance for the present decision can be summarised as follows.

Non-admissibility into the appeal proceedings of objections based on the opposition grounds under Article 100(c) and (b) EPC:

- The opposition grounds based on Article 100(c) and (b) EPC should be regarded as non-admissible since the Opponent did not file an appeal against the decision of the Opposition Division.

Objections to granted claim 1 under Article 100(c) EPC:

- The expression "*x is between 0 and 3*" in claim 1 as originally filed had to be understood as excluding the end points.
- Even considering that the end points were included in claim 1 as filed, their exclusion in claim 1 as granted was a restriction directly and unambiguously disclosed in the original application.
- In fact, the original application (see page 2, lines 18 to 20 and the examples) indicated that the invention concerned "*mixed-metal oxides*", i.e.

compositions of formula $A_{3-x}B_xO_4$ with $0 < x < 3$. Accordingly, "cobalt oxide", resulting from $x = 3$, was clearly identified as pertaining to prior art (see page 1, lines 17 to 20).

- The claimed subject-matter did thus not extend beyond the content of the application as filed.

Objections to granted claim 1 under Article 100(b) EPC:

- The oxidation of ammonia by the Ostwald process was a well known process to the person skilled in the art, whose operating conditions were well established. Moreover, paragraphs [0012] to [0014] of the contested patent disclosed suitable reaction conditions. Catalysts based on cobalt oxide were used for decades, as well.
- Paragraph [0011] of the contested patent as well as the examples indicated how the claimed mixed metal oxides could be produced. No undue burden was posed on the skilled person.
- Therefore, the claimed subject-matter was sufficiently disclosed.

Interpretation of the formula $A_{3-x}B_xO_4$:

- The formula $A_{3-x}B_xO_4$ mentioned in claim 1 as granted should be read in accordance with the IUPAC rules for inorganic chemistry (reported e.g. in D10).
- According to such rules the above formula defined a mixed tetroxide phase involving isovalent substitution of element A for element B.
- This reading of the formula was consistent with the description of the contested patent, particularly

with the examples 2 and 3. A further confirmation could be obtained by consulting D11 and D12.

- This formula could thus not be interpreted as defining mixtures of single metal oxides (i.e. mixtures of different oxides, each comprising a single sort of metal atoms).

Objections to granted claim 1 under Article 100(a) EPC:

- A method of catalytic oxidation of ammonia to nitric oxide involving a catalyst comprising the composition $A_{3-x}B_xO_4$ was not disclosed in any of the cited documents.
- In D2, the starting materials used for the catalyst production were different as compared with the patent in suit. Moreover a much lower calcination temperature was used.
- No evidence was present that a mixed metal oxide phase would form under the conditions of the ammonia oxidation process.
- The claimed subject-matter was thus novel.
- D2 could be regarded as the closest prior art.
- The technical problem was the provision of a catalytic ammonia oxidation method with improved nitric oxide yields (see paragraph [0018] of the patent in suit).
- The solution as proposed in the contested patent was neither disclosed nor suggested in the available prior art. Therefore, claim 1 as granted involved an inventive step.

X. The Respondent essentially counter-argued as follows.

Admissibility into the appeal proceedings of objections based on the opposition grounds under Article 100(c) and (b) EPC:

- The principle of the prohibition of the *reformatio in peius* only concerned the final result of the appeal procedure. Thus, any party who does not lodge an appeal may, as Respondent, submit to the appeal proceedings anything which it considers necessary and expedient for the defence of the same result already obtained before the first instance.

Objections to granted claim 1 under Article 100(c) EPC:

- The composition mentioned in claim 1 as granted derived from multiple selections from multiple lists leading to an extension of the claimed subject-matter beyond the content of the application as filed.
- The expression "*x is between 0 and 3*" in claim 1 as originally filed had to be understood as to clearly including the end points. This was confirmed by Tables 1 to 3 on pages 2 and 5 of the application as filed.
- Also original page 4 at lines 2 to 3 indicated that the "*catalyst of the present invention consists of low cost oxides*", clearly including oxides of only one metal.
- No basis for excluding the end points was present in the original application.
- Therefore, the claimed subject-matter extended beyond the content of the application as filed.

Objection to granted claim 1 under Article 100(b) EPC:

- Neither claim 1 as granted nor the whole patent contained enough information allowing a skilled person to put the claimed ammonia oxidation method into practice.
- Particularly, the description did not contain any information as to important process conditions to be used.
- Moreover, the contested patent as a whole did not allow the skilled person to produce catalytic compositions in accordance with granted claim 1.
- The production process was defined only very broadly without indicating any of the typical features characterizing catalytic compositions.
- Even assuming that the formula defined in claim 1 indicated a mixed metal tetroxide phase, such phase did not exist over the whole scope of claim 1, i.e. for any value of x comprised between 0 and 3, as confirmed by figure 3 of D12. An example was when $x = 0.5$.
- Moreover, at the temperatures typical for the claimed method, several mixed oxide phases would immediately decompose.
- Therefore, the method of claim 1 as granted was not sufficiently disclosed in the contested patent.

Interpretation of the formula $A_{3-x}B_xO_4$:

- The formula mentioned in claim 1 as granted should be read in conjunction with the much more general formula as included in claim 1 as originally filed, which read $A_{3-x}B_xO_{9-y}$.

- In this formula, A and B could be selected from several compounds, x between 0 and 3 and y between 0 and 6.
- Such a general formula could thus not indicate any specific structure, let alone a crystalline tetroxide structure.
- The formula of claim 1, therefore, merely described the stoichiometry of the composition, i.e. the molar ratio of A and B with respect to oxygen. Hence, it also included mixtures of single metal oxides satisfying the mentioned ratio.
- The formula did also not imply that a single phase had to be present. Mixed metal oxides generally comprised multimetal, multiphase oxides as confirmed by the corresponding citation reported in the Ullmann's Encyclopedia of Industrial Chemistry 2011. In fact, the IUPAC was not the only standard used to interpret chemical formulas.

Objections to granted claim 1 under Article 100(a) EPC:

- Even when considering claim 1 to be limited to a method carried out in the presence of a composition comprising a mixed metal tetroxide phase, D2 would anticipate the claimed subject-matter. In fact, when looking at the preparation of the catalytic compositions according to D2 and to the contested patent, the same starting materials and the same process conditions were adopted. Therefore, a mixed metal oxide phase would inevitably form when following the teaching of D2.
- Should the novelty of claim 1 be acknowledged, D2 would represent the closest prior art. The only

difference would be the presence of a mixed metal oxide phase.

- No technical effect was associated with this difference, so that the technical problem was the provision of an alternative method for ammonia oxidation.
- The proposed solution did not solve this problem across the whole scope of claim 1 as confirmed by figure 3 of D12.
- Therefore, no inventive step could be acknowledged.

Reasons for the Decision

Admissibility into the appeal proceedings of objections to the patent as granted based on the invoked opposition grounds under Article 100(c) and (b) EPC

1. The Appellant put forward that objections (to the granted patent) based on the invoked opposition grounds under Article 100(c) and (b) EPC should be regarded as non-admissible since the Opponent did not file an appeal against the decision of the Opposition Division. In fact, according to the impugned decision, the opposition grounds under Article 100(c) and (b) EPC did not prejudice the maintenance of the patent as granted.
2. The Board disagrees. The principle of the prohibition of the *reformatio in peius*, which the Appellant apparently refers to, only concerns the final result of the appeal procedure. It does not relate to any of the reasoning as to why the opposition division arrived at its conclusions, which is clear already from the fact that any decision can only be appealed in regard of its

final result and not of the reasons based on which such result was arrived at.

Therefore, and since the opposition to the patent in the form as granted was successful, the Respondent is allowed to invoke any of the grounds that it has already invoked in its notice of opposition for contesting the grant of the patent in suit.

The Board thus comes to the conclusion that the Respondent's objections to the patent as granted based on the invoked grounds of opposition under Article 100(b) and (c) EPC are admitted into the appeal proceedings.

Main request - Claim 1 as granted - Article 100(c) EPC

3. The Respondent put forward that the catalytic composition mentioned in claim 1 as granted derived from multiple selections from multiple lists originally disclosed in the application as filed, particularly in original claim 1, thus leading to an extension of the claimed subject-matter beyond the content of the original application.
- 3.1 Moreover, the expression "*x is between 0 and 3*" mentioned in original claim 1 had to be understood as to unambiguously including the end points. This was confirmed by Tables 1 to 3 on pages 2 and 5 of the application as filed clearly disclosing $x = 0$ and $x = 3$ as part of the teaching of the invention. No basis for excluding the end points was present in the original application.
- 3.2 It also pointed to original page 4, lines 2 to 3, indicating that the catalyst of the invention consisted

of "low cost oxides", clearly meaning mixtures of single metal oxides.

4. The Board is not convinced by this argumentation, as set out below.
- 4.1 Original claim 1 defines a catalytic composition of the general formula $A_{3-x}B_xO_{9-y}$, with x varying between 0 and 3 and A and B selected from a number of alternative possibilities. Original claim 2 then specified for y the value of 5, thus leading to the formula $A_{3-x}B_xO_4$. Original claim 3, referring back to claim 2, restricted A and B to the combinations claimed in granted claim 1. The composition mentioned in claim 1 as granted is thus directly and unambiguously disclosed in claim 3 as originally filed. No selection has to be done. Moreover, this composition also finds basis on page 2, line 14 in combination with page 2, line 7 of the application as filed.
- 4.2 The fact that such composition is employed in a method for the production of gas comprising nitric oxide as defined in claim 1 at issue is unambiguously disclosed e.g. on page 2, lines 22 to 24 of the application as filed.
- 4.3 Additionally, the selection of x to be comprised between 0 and 3, the end points being excluded, does not represent a new piece of information for the skilled person.
- 4.3.1 Firstly, the fact that the embodiments corresponding to $x = 0$ and $x = 3$ could have possibly been part of the original disclosure does not mean that their exclusion inevitably leads to an extension of the claimed subject-matter. What is relevant for the assessment is whether or not the subject-matter remaining in the

claim is directly and unambiguously disclosed in the application as originally filed.

4.3.2 Secondly, the Board is satisfied that the whole original application is in fact directed to a method for the production of gas comprising nitric oxide, comprising the use of a catalyst including a mixed metal oxide composition, specifically $A_{3-x}B_xO_4$, wherein $0 < x < 3$. This is derivable directly and unambiguously from page 2, lines 18 to 20 mentioning "*mixed-metal oxides*" as well as from the examples reported in the original application (see e.g. Tables 2 and 3 as well as examples 2 and 3), which disclose compositions having $0 < x < 3$.

4.3.3 Thirdly, the sentence in the passage of page 4 referred to by the Respondent, describing the catalyst of the invention as consisting of "*low cost oxides*", is vague. Hence, it cannot justify ignoring the clear disclosure of the application identified at 4.3.2, *supra*.

4.4 The Board comes thus to the conclusion that the opposition ground under Article 100(c) EPC does not prejudice the maintenance of the patent as granted.

Main request - Claim 1 as granted - Article 100(b) EPC

5. The Respondent objected to the sufficiency of disclosure of the claimed method. The whole patent did not contain any information as to fundamental operating conditions of the claimed ammonia oxidation method, thus not allowing a skilled person to put the method into practice. Moreover, the process for producing catalytic compositions in accordance with the formula of claim 1 at issue was only very broadly defined, without indicating any of the typical features characterizing catalytic compositions, like porosity,

pore distribution and specific surface. Even assuming that the formula indicated a mixed metal tetroxide phase, such phase did not exist over the whole scope of claim 1, i.e. for any value of x comprised between 0 and 3. This was confirmed by figure 3 of D12. At the temperatures typical for the claimed method, some mixed metal oxide phases would immediately decompose. An example was when $x = 0.5$. The whole patent neither addressed this issue nor provided any solution for avoiding such decomposition problem. Therefore, the method of claim 1 as granted was not sufficiently disclosed to the skilled person in the contested patent.

6. Contrary to the opinion of the Respondent, the Board is convinced that the method as defined in claim 1 as granted does fulfil the requirements of sufficiency of disclosure, and this for the following reasons.

6.1 The process of catalytic oxidation of ammonia, also known as Ostwald's process has been known to the skilled person since the beginning of 1900 (see the contested patent, paragraphs [0002] and [0003]). The operating conditions of such process are thus well established. This fact was also not contested by the Respondent. Moreover, the contested patent in paragraphs [0012] to [0014] as well as in examples 1 to 3 does disclose typical operating conditions of the claimed method in terms of e.g. pressure and temperature.

6.2 As to the catalyst preparation method, this is described in detail e.g. in examples 2 and 3 of the patent in suit. Furthermore, according to paragraph [0011]: "*The catalyst may be prepared by co-precipitation, complexation, combustion synthesis,*

freeze-drying or solid-state routes, or by other state-of-the-art methods of producing mixed-metal oxides".

The Board is thus satisfied that sufficient information is contained in the contested patent to allow a person skilled in the art to prepare catalytic compositions in accordance with the formula defined in claim 1. It is noted that the Respondent itself in document D8 showed that it was perfectly able to produce a catalytic composition in accordance with claim 1.

- 6.3 The optimization of parameters like porosity, pore distribution and specific surface of the catalyst pertains to the common general knowledge of the skilled person that will select appropriate values according to the circumstances. The Board does not see any undue burden in such routine optimization.
- 6.4 The Board further observes that D12 in figure 3 discloses a diagram showing phase relations in the system cobalt oxide-manganese oxide in air. Depending on temperature and composition (x value), the mixed oxides $Mn_{3-x}Co_xO_4$ may exist alone or co-exist in equilibrium with other solid phases. Such co-existence, however, is not in contradiction with the wording of granted claim 1 ("*in the presence of a catalyst **comprising** the composition $A_{3-x}B_xO_4$* " (emphasis by the Board)).
- 6.4.1 The Respondent submitted that according to D12 at e.g. $x = 0.5$, no mixed metal oxide existed at $900^\circ C$, i.e. at the typical temperature of ammonia oxidation. The Board observes, however, that the temperature referred to in figure 3 of D12 corresponds to the preparation temperature of the composition and not to the temperature, to which a certain already prepared composition is exposed during ammonia oxidation.

Moreover, for $x = 0.5$, a mixed metal oxide phase (cubic spinel) may still be prepared at temperatures higher than 900°C . In this respect, it is observed that the Respondent itself in document D8 used a temperature as high as 1100°C in order to prepare its catalytic composition (see D8, page 1, "Katalysatorpräparation").

- 6.4.2 The Board finally notes that the Respondent submitted no experimental evidence supporting its allegation that certain mixed metal oxide compositions would decompose at the temperatures typical of ammonia oxidation.
- 6.5 The Respondent therefore did not discharge its burden of proof that catalytic compositions as defined in claim 1 at issue could not be prepared over the whole claimed scope.
- 6.6 The Board thus concludes that the opposition ground under Article 100(b) EPC does not prejudice the maintenance of the patent as granted.

Main request - Claim 1 as granted - Interpretation of the formula $A_{3-x}B_xO_4$

7. Claim 1 as granted defines a method (complete wording under II, *supra*), in which "a gas blend comprising ammonia and oxygen is converted in presence of a catalyst comprising the composition $A_{3-x}B_xO_4$ ".

The parties disagreed as to the meaning of the mentioned formula. In particular, while the Appellant submitted that the formula was representative of a mixed metal tetroxide phase involving isovalent substitution of element A for element B, the Respondent argued that the formula merely described the stoichiometry of the composition, i.e. the molar ratio of A and B with respect to oxygen.

- 7.1 The Respondent referred to the much more general formula as mentioned in original claim 1, which read $A_{3-x}B_xO_{9-y}$. In this formula, A and B could be selected from several compounds, x between 0 and 3 and y between 0 and 6. Such a general formula could thus not indicate any specific structure, let alone a crystalline tetroxide structure. The formula did also not imply that a single phase had to be present. Mixed metal oxides generally comprised multimetal, multiphase oxides as confirmed by the corresponding citation reported in the Ullmann's Encyclopedia of Industrial Chemistry 2011 (see the reply to the statement of grounds of appeal, 3.10, page 6). In fact, the IUPAC invoked by the Appellant was not the only standard used to interpret chemical formulae. It concluded that mixtures of single metal oxides satisfying the stoichiometry of the formula were also covered by the formula defined in claim 1 at issue.
- 7.2 The Board is not convinced by this argumentation, as set out below.
- 7.2.1 The Board holds that the formula $A_{3-x}B_xO_4$ as mentioned in granted claim 1 is conventionally used in the art to define a mixed metal oxide phase, involving substitution of atom A for B. As a matter of fact, this reading of the formula $A_{3-x}B_xO_4$ is in line with the IUPAC definition as reported in D10 (cf. IR-11.3.2 "Phases with variable composition"), which is regarded by the Board as the standard to be used to interpret chemical formulae.
- 7.2.2 Additionally, should the skilled reader have doubts as to the meaning of the mentioned formula, further clarifications are provided in the description of the patent in suit. Paragraph [0011] for example, teaches

that the catalysts according to the invention may be prepared by "*state of the art methods of producing **mixed-metal oxides***" (emphasis by the Board). Both examples 2 and 3 then describe the preparation of catalysts according to the invention, whereby single-phase mixed oxides are obtained (see paragraphs [0029] and [0033]).

7.3 The Respondent did not provide any verifiable evidence that the formula $A_{3-x}B_xO_4$ may also be used in the art to describe mixtures of single metal oxides. In particular, also the passage of the Ullmann's Encyclopedia of Industrial Chemistry 2011 referred to by the Respondent (see 7.1, *supra*), which defines mixed metal oxides as "**multimetal multiphase oxides**" (emphasis by the Board) could at most imply more than one phase of mixed metal oxides but not mixtures of single metal oxides.

7.4 The fact (6.4, *supra*) that depending on temperature and x value, the mixed metal oxide phase of formula $A_{3-x}B_xO_4$ may possibly co-exist in equilibrium with other phases (cf. figure 3 of D12) does not have any bearing on the meaning to be attributed to the mentioned formula.

7.5 Therefore, the Board does not see any reason to deviate from the standard reading of the formula $A_{3-x}B_xO_4$ and concludes that claim 1 as granted requires the presence of a catalyst, comprising in its composition at least one phase of mixed metal oxide according to the formula $A_{3-x}B_xO_4$, i.e. involving substitution of A (Mn or Cr) for B (Co).

Main request - Claim 1 as granted - Novelty

8. During the oral proceedings, the Respondent, once heard the interpretation given by the Board to the formula

$A_{3-x}B_xO_4$ (7.5, *supra*), called into question the novelty of the subject-matter of claim 1 as granted with document D2, only.

It argued that, when looking at the preparation of the catalytic compositions according to D2 (see example 1 on pages 2 and 3) and to the contested patent, the same starting materials and the same process conditions were adopted. Therefore, a mixed metal oxide phase in the sense of claim 1 inevitably formed when following the teaching of D2. This was confirmed by figure 3 of D12: when cobalt tetroxide with a spinel structure formed as disclosed in example 1 of D2, at the indicated preparation temperature some manganese would substitute for cobalt leading to the mixed metal oxide phase.

9. The Board is not convinced for the following reasons.
 - 9.1 Document D2 discloses (cf. page 1, line 30 to page 2, line 85, the examples and claims 1, 2 and 9) the oxidation of ammonia in the presence of a catalytic composition, particularly comprising metal oxides, said to be *fused together* (cf. page 2, line 123). These oxides can particularly be those of cobalt, manganese and chromium. Typical compositions are listed on page 3 of D2 as "Composition A1" and "Composition A2", which are said to comprise *inter alia* cobalt tetroxide and manganese tetroxide, and cobalt tetroxide and chromium trioxide, respectively. The formation of a mixed metal oxide phase in the sense of granted claim 1 (7.5, *supra*) is not mentioned in D2.
 - 9.2 Moreover, according to example 1 of D2 (cf. page 2, line 123 to page 3, line 17), the components of said compositions A1 and A2 "*were fused together, partly in the form of nitrates **and partly in the form of oxides.** Heating was effected **up to 700°C***" (emphases by the

Board). Examples 2 and 3 of the contested patent illustrate how catalytic compositions used in the claimed method can be prepared. The mixed metal oxide is prepared by "*co-precipitation*" or "*complexation*" from mixed metal **nitrate solutions of the metals involved** (see paragraphs [0028] and [0032]).

Calcination is carried out **at 900°C** (see paragraphs [0029] and [0032]). Both the starting materials and the process conditions described in the patent in suit are thus different from those used in D2.

9.3 No evidence based on verifiable facts is therefore present that a mixed metal oxide phase in the sense of claim 1 (7.5, *supra*) would inevitably form under the process conditions disclosed in D2, as alleged by the Respondent.

9.4 The Board thus concludes that the subject-matter of granted claim 1 is novel over D2 (Article 52(1) and 54 EPC).

Main request - Claim 1 as granted - inventive step

10. The invention

10.1 The invention concerns a method for the production of nitric oxide, whereby a gas blend comprising ammonia and oxygen is converted in presence of a specific catalyst (see paragraph [0001] and claim 1 of the contested patent).

10.2 In the description of the patent in suit the following is indicated:

"[0003] The basis of the current Ostwald's process is combustion of ammonia over a platinum based metal or alloy catalyst in the form of a gauze or mesh or net. The gauzes are either woven or knitted.

[0004] Over the last sixty years, many attempts have been made to replace the expensive platinum-based combustion catalyst with a lower cost catalyst. To date, the only commercially available oxide-based catalyst for ammonia combustion is [...] based on a cobalt oxide phase. However, in terms of its selectivity of combustion of ammonia to the desired nitric oxide product, its performance is inferior to that of platinum-based systems."

11. Closest prior art

11.1 It was common ground between the parties that document D2 could be regarded as representing the closest prior art for the subject-matter of claim 1 at issue. Considering the similarities between the patent in suit and D2 in terms of issues addressed and catalytic compositions disclosed, the Board has no reason to take another stance.

11.2 Indeed, D2 also aims at replacing the conventional platinum-based catalysts in the catalytic oxidation of ammonia (cf. page 1, lines 15 to 29 and 69 to 86). D2 discloses (cf. page 1, line 87 to page 2, line 8) a process for the catalytic oxidation of ammonia in a solid bed wherein a reaction mixture comprising ammonia and air is passed over a catalytic composition. According to example 1 of D2 (page 2, line 123 to page 3, line 45) the latter can comprise mixtures of *inter alia* cobalt tetroxide and manganese tetroxide ("Composition A1") or mixtures of *inter alia* cobalt tetroxide and chromium trioxide ("Composition A2"). In particular, said "Composition A1" was tested for ammonia oxidation under different operating conditions (cf. examples 1 to 4 on pages 3 and 4).

11.3 Any of the ammonia oxidation methods disclosed in examples 1 to 4 of D2 may thus be considered to represent the most appropriate starting point for the purpose of assessing inventive step.

12. Technical problem

During the oral proceedings, the parties disagreed as to the formulation of the technical problem to be solved.

12.1 The Appellant pointed to paragraph [0018] and to example 2 of the contested patent in combination with figure 2, showing increased selectivity by increasing temperature. It submitted that the technical problem had to be seen in the provision of an ammonia catalytic oxidation method with improved nitric oxide yields.

12.2 The Respondent contested any improvement of the claimed method over the closest prior art, by referring particularly to Tables III and IV of D2, which in its opinion also showed increased yields by increasing temperature. It argued that the technical problem had to be merely seen in the provision of an ammonia oxidation method employing an *alternative* catalytic composition.

12.3 In the following assessment of inventive step, the Board bases its considerations, for the sake of argument only but in the Respondent's favour, on this latter minimalistic formulation of the technical problem.

13. Solution

As a solution to this technical problem, the patent in suit proposes the "*method for the production of gas comprising nitric oxide*" according to claim 1,

wherein "a gas blend comprising ammonia and oxygen is converted in presence of a catalyst"

which is particularly characterised in that said catalyst comprises

"the composition $A_{3-x}B_xO_4$, wherein a combination of A and B are selected from:

A = Mn or Cr and B = Co where $0 < x < 3$ ".

14. Success of the solution
- 14.1 The Respondent contested that the method defined in claim 1 at issue solved the posed technical problem (12.2, *supra*) across the whole claimed scope, particularly for any x lying between 0 and 3. It referred again to figure 3 of D12 arguing that for several values of x the mixed metal oxide mentioned in claim 1 could not even be formed.
- 14.2 The Board, however, notes that the patent in suit contains two examples (see examples 2 and 3 on pages 4 and 5) of catalytic compositions in accordance with the definition given in claim 1 at issue, which were used in the oxidation of ammonia to nitric oxide. The results in terms of selectivity are reported in figures 1 to 4.
- 14.3 Moreover, the Board holds that in the present case the burden of proof lies with the Respondent that, despite of its allegation, did not make any attempt to show that a mixed metal oxide as defined in claim 1 could not be produced over the whole claimed breadth. On the contrary, the technical report D8 submitted by the Respondent demonstrates that it was perfectly able to produce a catalytic composition in accordance with claim 1 as granted and to employ it in the oxidation of

ammonia. Also figure 3 of D12 actually suggests that a mixed metal oxide phase (spinel) may indeed be obtained for any x value by appropriately selecting the preparation temperature.

- 14.4 In the absence of any evidence based on verifiable facts, the Board has, therefore, no reason to doubt that a mixed metal oxide according to the formula $A_{3-x}B_xO_4$ can be produced across the whole scope of claim 1 and used in the oxidation of ammonia to nitric oxide, thus solving the posed technical problem (12.2, *supra*).
15. Non-obviousness of the solution
- 15.1 The subject-matter of claim 1 differs from the method as disclosed in the closest prior art (11.2-11.3, *supra*) in that the catalyst comprises "*the composition $A_{3-x}B_xO_4$, wherein a combination of A and B are selected from: A = Mn or Cr and B = Co where $0 < x < 3$* ".
- 15.2 What remains to be decided is thus whether or not, having regard to the state of the art and common general knowledge, it was obvious to the skilled person seeking to solve the posed technical problem (12.2, *supra*) to modify the method of the closest prior art by replacing the catalytic composition employed therein such as to arrive at the method defined in claim 1 as granted.
- 15.3 The Respondent based its inventive step attack solely on the argument that the technical problem was not solved over the whole breadth of claim 1, i.e. for any value of x lying between 0 and 3.
- 15.4 However, for the reasons already mentioned under 14.2 to 14.4, *supra*, this argument fails to convince the Board.

15.5 The Board observes that none of the prior art documents referred to by the Respondent fairly suggests replacing the catalytic composition according to the closest prior art with a composition comprising a mixed metal oxide phase as defined in claim 1 at issue.

15.5.1 In particular, document D1 discloses (cf. "2.1 Experimental" and "2.2 Cobalt catalyst in the ammonia oxidation") an ammonia oxidation method making use of a catalyst comprising cobalt tetroxide and some further metals as impurities, among which manganese is also mentioned.

15.5.2 Documents D4 and D7 also disclose (cf. D4: page 2, last paragraph to page 3 last paragraph and page 6, first full paragraph; D7: col. 1, line 38 to col. 2, line 42) an ammonia oxidation method making use of a catalyst comprising cobalt tetroxide. Other components may be included like chromium or aluminium.

15.6 The Board thus concludes that the prior art and the relevant common general knowledge did not induce the person skilled in the art to solve the technical problem posed (12.2, *supra*) by modifying the method of the closest prior art in a manner leading to a method as claimed, which thus involves an inventive step.

16. Therefore, in the Board's judgement, the subject-matter of claim 1 as granted and, consequently, the subject-matter of claims 2 to 6 dependent thereon, are not objectionable for lack of inventive step (Articles 100(a), 52(1) and 56 EPC).

Conclusion

17. None of the opposition grounds invoked by the Respondent prejudices the maintenance of the patent as granted.

Order

For these reasons it is decided that:

The decision under appeal is set aside.

The patent is maintained as granted.

The Registrar:

The Chairman:



D. Magliano

P. Ammendola

Decision electronically authenticated