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D E C I S I O N
of 16 May 2006

Case Number: T 0675/03 - 3.2.07

Application Number: 96830133.3

Publication Number: 0796919

IPC: C21D 1/00

Language of the proceedings: EN

Title of invention:
Process and plant for thermal treatment of metals in protecting atmosphere

Patentee:
SOL S.p.A.

Opponent:
L'AIR LIQUIDE S.A.
LINDE AKTIENGESELLSCHAFT

Headword:
-

Relevant legal provisions:
EPC Art. 54, 56, 123(2)(3)

Keyword:
"Allowability of amendments (yes)"
"Novelty (yes)"
"Inventive step (yes)"

Decisions cited:
T 0473/98

Catchword:
-

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Case Number: T 0675/03 - 3.2.07

D E C I S I O N
of the Technical Board of Appeal 3.2.07
of 16 May 2006

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Decision under appeal:
Decision of the Opposition Division of the European Patent Office posted 4 April 2003 revoking European patent No. 0796919 pursuant to Article 102(1) EPC.

Composition of the Board:

Chairman: K. Poalas
Members: H. Hahn
E. Lachacinski

Summary of Facts and Submissions

I. The proprietor lodged an appeal against the decision of the Opposition Division to revoke European patent No. 0 796 919.

II. Two oppositions had been filed against the patent as a whole and were based on Article 100(a) EPC (i.e. lack of novelty and lack of inventive step).

The Opposition Division held that the subject-matter of apparatus claims 7 of the main, and of the first and second auxiliary request lacked novelty with respect to the apparatus described in document D1. Furthermore, the amendment of claim 7 according to the first auxiliary request was considered to meet the requirements of Articles 123(2) and (3) EPC. According to an *obiter dictum* added in its decision the Opposition Division was of the opinion that process claim 1 of the main request was novel and inventive with respect to the disclosure of documents D1 (V.B. Skakal'skii et al. "Commercial nitrogen - the basis for a universal controlled atmosphere" Metal Science and Heat Treatment, vol. 20, no. 5/6, pp. 377-381, 1978) and D3 ("Heat Treating", Metals Handbook, pages 391, 395-399, 9th Edition, vol. 4, 1981, American Society for Metals, Ohio, USA).

III. With a communication dated 27 January 2006 and annexed to the summons to oral proceedings the Board presented its preliminary opinion with respect to claims 1 to 9 as granted according to the main request, and with respect to the claims of a first, second and third

auxiliary request, all auxiliary requests as submitted with the letter dated 10 January 2005.

IV. As a response to the communication of the Board the appellant filed by fax on 12 April 2006 a new main request and auxiliary requests I to V together with further arguments and the document D9 (US-A-5 242 509).

V. Oral proceedings before the Board were held on 16 May 2006.

(a) The appellant (patent proprietor) requested that the decision under appeal be set aside and the patent be maintained on the basis of the claims 1 to 9 according to the main request as filed during the oral proceedings on 16 May 2006 before the Board.

(b) As announced with the letter dated 2 February 2006, nobody was present on behalf of respondent I (opponent I).

(c) Respondent II (opponent II) requested that the appeal be dismissed.

(d) The documents D1, D3 and D9 were discussed.

VI. Claims 1 and 7 of the main request under consideration read as follows:

"1. A process for the heat-treatment of metals in a protective atmosphere, comprising the following steps:

- heating a reactor (2) containing a Nickel-based catalyst to a temperature within the range of 1000°C to 1200°C;
- feeding said reactor (2) with a stream of nitrogen containing from 0.1 to 9% oxygen;
- feeding said reactor (2) with a stream of hydrocarbons in an amount substantially stoichiometric to give CO and H_2;
- feeding the gas leaving the said catalytic reactor (2) to a heat-treatment furnace (1) to form the protective atmosphere inside the same;
- interrupting periodically and/or by command said stream of hydrocarbons, while maintaining said stream of nitrogen, and resuming said hydrocarbons stream after a pre-set or calculated period of time."

"7. A plant for carrying out a process of heat-treatment of metals according to any previous claim, comprising a heat-treatment furnace (1) and means of generating a protective atmosphere, the said means comprising:
a catalytic reactor (2) containing a Nickel-based catalyst (3); means (5,7) of feeding the said reactor with a stream of nitrogen containing oxygen within the range of 0.1% to 9%; means (6,8) of feeding the said reactor with a stream of hydrocarbons; means (10) of regulating and of interrupting the flow rate of the said stream of hydrocarbons; and means (11) to control the operation of said regulating and interrupting means (10), characterized in that:
said control means is a computer (11), comprising both means of processing data and of recording it, that is set to operate said interrupting means (10) periodically, according to a program run on said

computer, while maintaining said stream of nitrogen and to resume said hydrocarbon stream after a pre-set period of time."

VII. The appellant argued essentially as follows:

The amendments of plant claim 7 are based on claim 7 as granted in combination with page 3 of the description (see patent, paragraphs [0023] and [0031]). Dependent claim 9 was only formally adapted to claim 7. Claims 1 to 6 and 8 remained unamended, i.e. in the form as granted. Thus the requirements of Articles 123(2) and (3) EPC are met.

The plant for the heat-treatment of metals according to claim 7 and the process for the heat-treatment of metals according to claim 1 of the patent in suit are novel since the features of interrupting the stream of hydrocarbons periodically according to a program run on the computer and of resuming said stream of hydrocarbons after a pre-set period of time are not known either from D1 or from D3.

The process according to D1 uses a temperature range for the catalyst of from 950 to 1000°C (see page 379, penultimate paragraph) in combination with an oxygen content in commercial nitrogen of from either 1-21% (see figure 1) or 5-21% (see page 381, second paragraph). D1 mentions neither the problem of soot formation nor any regeneration of the Ni-catalyst. D1 actually only teaches to regulate the ratio air/hydrocarbons to control the dew point of the reacted mixture and hence its carbon potential of the neutral atmosphere (see page 380, fourth and sixth

paragraph). Document D1 is thus not the correct starting point for the problem solution approach since it does not mention the formation of soot, let alone how this problem could be solved.

Furthermore, document D3 represents a standard text book and discloses a process for thermal treatment of metals using an endothermic atmosphere generated from reaction of air and hydrocarbon gas at a temperature of 980-1040°C on a nickel catalyst (see page 397, left hand column, first paragraph and penultimate paragraph to central column, second paragraph; right hand column, fourth paragraph). D3 teaches the skilled person that soot formation is a problem of endothermic reactors and that a clean and active catalyst is extremely important for an accurate control of the carbon potential (see page 397, right hand column, second and third paragraph). D3 further states that said carbon deposits (i.e. the soot) are to be removed weekly or monthly according to the maintenance schedule (see page 398, left hand column, penultimate paragraph). Document D3 does not mention that a) nitrogen containing 0.1 to 9.0% of oxygen should be fed into the reactor, b) that the flow of hydrocarbons should be interrupted periodically and/or by command while maintaining the flow of said nitrogen during the interruption of hydrocarbons, and c) that the flow of hydrocarbons should be resumed after a pre-set or calculated period of time. Likewise document D3 teaches that most endothermic reactors are controlled by monitoring the dew point which is controlled by either manual or automatic adjustment of the ratio of air and gas going into the reactor (see page 398, left hand column, second paragraph). The regeneration of catalysts

(page 398, left hand column) is normally carried out off-line at a lower temperature than the production of the endothermic atmosphere to avoid damage to the catalyst material caused by a thermal shock since the burn out of soot is normally carried out with air and not with nitrogen containing only lower amounts of oxygen. In view of D3 the problem to be solved by the skilled person was to avoid or reduce formation of soot in the reactor, so as to have as few shutdowns as possible of the furnace for maintenance.

Even if the skilled person would consider combining D1 with the regeneration process of D3 he would not arrive at the solutions claimed in claims 1 and 7. According to D1 the gas flow of hydrocarbons is never zero (see page 378, figure 2). D1 also does not suggest that the results of the reactor gas analysis are used for closing the needle valve 26 (see page 380, sixth paragraph). The formation of soot at the nickel catalyst disturbs the formation of CO and results in the formation of CO_2 which shifts the carbon potential (and the dew point) and causes problems with the heat-treatment of the metals. To correct this shift of carbon potential the amount of hydrocarbons would have to be increased but such a responsive action would not resolve the problem but make it even worse. Furthermore, D3 published in 1981 represents common general knowledge and was published after D1 and thus should have included its teaching.

The closest prior art document actually appears to be D9 which corresponds to EP-A-0 482 992 already identified in the description of the patent in suit (see patent in suit, paragraph [0006]). D9 also aims to

prepare a protective atmosphere for heat-treatment of metals while avoiding the formation of soot in the reactor used for the generation of said protective atmosphere (see column 1, lines 22 to 48). However, D9 suggests the use of a noble metal catalyst at a lower temperature (see claim 1). Consequently, the subject-matter of the claims 1 and 7 of the main request is novel and inventive.

VIII. Respondent II argued essentially as follows:

Novelty of plant claim 7 is given due to the feature "after a pre-set period of time". As regards inventive step, it is common knowledge to block the flow of hydrocarbons into the catalyst furnace as desired by using a computer, which normally comprises a data processing unit and means for recording data. Furthermore, the apparatus according to D1 comprises an "automatic control system" which is considered to represent such a computer. Therefore plant claim 7 lacks an inventive step.

Only the alternative of claim 1 concerning the interruption by command is attacked for lack of inventive step. The process according to D1 based on the plant shown in figure 3 is interrupted by command through the needle valve 26, which can open and close the hydrocarbon stream (see page 379, figure 3). It differs from the process of claim 1 of the patent in suit only in the temperature range used for heating the Ni-catalyst. It is clear for the skilled person that the flow rate of hydrocarbon has to be reduced when the amount of hydrocarbon leaving the reactor is too high; the gas leaving the reactor according to D1 is analysed

(see D1, page 380, sixth paragraph). Therefore process claim 1 lacks an inventive step.

Reasons for the Decision

1. *Allowability of amendments (Articles 123(2) and (3) EPC)*

The amendments of independent plant claim 7 are based on claims 1, 2, 8 and 9 in combination with description page 5, lines 7 to 11; page 6, lines 15 to 18 and page 7, lines 2 to 8 of the application as originally filed (this basis corresponds to claim 7 and to paragraphs [0023] and [0031] of the patent as granted, respectively). By further defining the control means (11) the scope of claim 7 has been restricted compared to claim 7 as granted.

Claims 1 to 6 and 8 remained unamended, i.e. they are in the form as granted, while the wording of dependent apparatus claim 9 was only formally adapted for full agreement with claim 7.

The description pages 2 and 2A were adapted to include a brief description of the prior art documents D1 and D3.

Therefore the claims 1 to 9 and the description pages 2 and 2A of the main request meet the requirements of Articles 123(2) and (3) EPC.

2. *Novelty (Article 54 EPC)*

Novelty of the subject-matter of process claim 1 and of plant claim 7 of the main request was not disputed by respondent II. The Board is satisfied that none of the available prior art documents discloses a process for heat-treatment of metals or a plant for carrying out the same having all the features of either claim 1 or claim 7 (compare paragraph 3, below).

The Board therefore concludes that the subject-matter of claims 1 and 7 of the main request is novel.

3. *Inventive step (Article 56 EPC)*

3.1 *Document D1*

Document D1 discloses a process for producing gas compositions which can be used for the heat-treatment of metal parts. The gas compositions are obtained by reacting commercial nitrogen containing either 1 to 21% (see page 377, third paragraph) or 5 to 21% oxygen (see page 381, second, seventh and ninth paragraphs) and natural gas (CH_4 methane) in a reaction chamber containing a nickel-catalyst. The resulting controlled atmosphere contains, based on the concentrations of the starting materials, a concentration of hydrogen (from 4 to 40% H_2) and carbon monoxide (from 2 to 20% CO) (see page 377, third to seventh paragraph; figure 1; and page 379, second to seventh paragraph). The described apparatus for generating these atmospheres has inputs for nitrogen and air which are mixed in a jet injector 4, the oxygen content thereof being controlled by an analyzing system comprising an RS indicator 24, an MGK

gas analyzer 23 and an auxiliary instrument 22 connected to an IM 2/220 pulsed actuating mechanism 2 and control valve 25. The mixed nitrogen/oxygen mixture is metered by meter 5 and then mixed with natural gas, which is also metered by meter 6, at gas blower 8 and reacted in reaction chamber 10 at a temperature of 950-1000°C with said nickel-catalyst. A part of the atmosphere prepared is analysed to determine the concentrations of CO_2, CO, H_2, CH_4 and H_2O in gas analyzer 19 and auxiliary instrument 20; the dew point of said atmosphere is measured (i.e. the H_2O content). By changing the amount of natural gas added to the nitrogen the carbon potential of the atmosphere is also controlled (see page 379 second paragraph to page 380, sixth paragraph; figure 3).

Document D1 is silent with respect to any regeneration procedure of the nickel-catalyst and/or any interruption of the hydrocarbon stream, let alone periodically.

3.2 *Document D3*

Document D3 represents a standard text book and discloses a process for thermal treatment of metals using an endothermic atmosphere generated from reaction of air and hydrocarbon gas at a temperature of 980-1040°C on a nickel catalyst (see page 379, left hand column, first paragraph and penultimate paragraph to central column, second paragraph; right hand column, fourth paragraph; figure 7). D3 teaches the skilled person that soot formation is a problem of endothermic reactors and that a clean and active catalyst is extremely important for accurate control of the carbon

potential and that a nickel bearing catalyst, most commonly nickel oxide, is used (see page 397, left hand column, first paragraph and right hand column, second to fourth paragraph). D3 further states that said soot (i.e. the carbon deposits) have to be removed weekly or monthly according to the maintenance schedule (see page 398, left hand column, penultimate paragraph). D3 teaches further that most endothermic reactors are controlled by monitoring the dew point which is controlled by either manual or automatic adjustment of the ratio of air and gas going into the reactor (see page 398, left hand column, second paragraph). No further details of said burn out procedure are mentioned in D3.

3.3 *Document D9*

Document D9 corresponds to the prior art EP-A-0 482 992, which is identified in the description of the patent in suit (see patent, paragraph [0006]). D9 teaches to prepare a protective atmosphere for the heat-treatment of metals while avoiding the formation of soot in the reactor used for the generation of said protective atmosphere by using a noble metal catalyst at a lower temperature of between 400°C and 900°C (see column 1, lines 22 to 48; column 2, lines 24 to 34; and claim 1).

D9 is also silent with respect to any regeneration treatment of said noble metal catalyst.

3.4 Taking account of paragraphs 3.1 to 3.3 above document D1 is considered to represent the closest prior art for the plant claim 7 while document D3 is considered to represent the closest prior art for the process claim 1.

Both documents are considered to meet all criteria for determining the closest prior art as set out in the existing jurisprudence of the Boards of Appeal (see Case Law of the Boards of Appeal of the European Patent Office, 4th edition 2001, sections I.D.3.1 to I.D.3.5).

3.4.1 This is due to the fact that the apparatus according to D1 has most of the relevant features in common with plant claim 7 and thus requires a minimum of structural modifications. Last but not least, D1 is considered to represent the "most promising springboard" towards the subject-matter of plant claim 7 which was available to the skilled person although it does not mention any soot formation in the gas reactor.

3.4.2 This is also caused by the fact that the processes of D3 and D9 - similarly to the patent in suit (see patent, paragraph [0019]) - also aim to reduce or suppress the formation of soot at the catalyst in the gas generator reactor. Thus the general problem is the same. However, the process of D3 apparently has more relevant features in common with the patent in suit than D9 since the latter suggests a different solution requiring a different catalyst to be used at a lower temperature range.

Furthermore, respondent II has not presented any arguments at all as to why D1 should be considered to represent the closest prior art for process claim 1.

3.5 *Problems to be solved*

3.5.1 The process according to claim 1 comprises the following features which are not present in D3:

a) nitrogen containing 0.1 to 9.0% of oxygen should be fed into the reactor,
b) that the flow of hydrocarbons should be interrupted periodically and/or by command while maintaining the flow of said nitrogen during the interruption of hydrocarbons, and
c) that the flow of hydrocarbons should be resumed after a pre-set or calculated period of time.

The objective technical problem to be solved with respect to the heat-treatment process of D3 is thus the provision of a process for heat-treatment in a protective atmosphere which is inexpensive, industrially applicable and has controllable CO and H_2 contents and very low CO_2 contents which implicitly achieves the suppression or reduction of soot formation (compare patent in suit, paragraph [0009] in combination with paragraph [0033]).

3.5.2 The plant as defined in claim 7 of the main request is distinguished from the apparatus according to D1 in that interrupting means are operated periodically according to a program run on a computer to resume the hydrocarbon stream after a pre-set period of time. The Board cannot accept the respondent's allegation that said "automatic control system" according to D1 comprises a computer since D1 is silent about it. On the contrary in D1 it is stated that "Apart from the gas analyzer - the sensor 19 and auxiliary instrument 20 - the automatic control system **consists** of an actuating mechanism 21 and control valve 26 with a needle valve" (see page 380, fourth paragraph).

The objective technical problem to be solved with respect to the heat-treatment apparatus according to D1 is thus the provision of a plant for carrying out such a process wherein the soot formation is suppressed or reduced (compare patent in suit, paragraph [0009] in combination with paragraph [0033]).

3.6 *Solution to the problems*

The problems as defined in paragraphs 3.5.1 and 3.5.2 above are solved by a process as defined in claim 1 and by a plant as defined in claim 7 of the main request.

It is credible that the claimed measures provide an effective solution to said technical problems (see e.g. patent in suit, examples 1 and 2).

3.7 The Board considers that the subject-matter of process claim 1 and of plant claim 7 of the main request is not obvious to the person skilled in the art for the following reasons:

3.8 Claim 1

3.8.1 The respondent argued that the alternative of claim 1 concerning the interruption by command lacks an inventive step because the process according to D1 using the plant as shown in figure 3 is or can be interrupted by command (e.g. through the manual operator of the plant) through the needle valve 26, which can open and close the hydrocarbon stream (see page 379, figure 3) and only differs in the temperature range used for heating the Ni-catalyst. It is clear for the skilled person that the flow rate of hydrocarbon

according to D1 has to be reduced when the amount of hydrocarbon leaving the reactor is too high since the gas leaving the reactor is analysed (see D1, page 380, sixth paragraph).

These arguments cannot be accepted for the following reasons.

3.8.2 The process according to D1 uses a temperature of the catalyst of from 950-1000°C (see page 379, penultimate paragraph) in combination with an oxygen content in commercial nitrogen of from either 1-21% (see figure 1) or 5-21% (see page 381, second paragraph). Therefore there exists only an overlap at a catalyst temperature of 1000°C in combination with a concentration range of oxygen in the nitrogen gas of from either 1 to 9% or from 5 to 9% when compared with the temperature range of from 1000°C to 1200°C and the oxygen content of from 0.1 to 9% according to claim 1 of the main request.

3.8.3 Furthermore, D1 actually only teaches to regulate the ratio air/hydrocarbons to control the dew point of the reacted mixture and hence its carbon potential of the neutral atmosphere (see page 380, fourth and sixth paragraph). Furthermore, the formation of soot at the nickel catalyst disturbs the formation of CO and results in the formation of CO_2 which shifts the carbon potential (and likewise the dew point) thereby causing problems with the metals during their heat-treatment. To correct this shift of carbon potential the skilled person, contrary to the respondent's alleged interruption of the hydrocarbon stream, would have increased the amount of hydrocarbons but such a

reaction would not resolve the said carbon potential problem but make it even worse.

3.8.4 D1 does not mention any interruption of the hydrocarbon gas flow nor does it suggest the same since the amount of natural gas according to the diagram for determining the input thereof is never zero (see page 378, figure 2). D1 does also not disclose to maintain the nitrogen gas flow during a regeneration of the used nickel-based catalyst since it neither addresses the soot formation problem nor mentions any regeneration at all.

3.8.5 Even if the skilled person would combine D1 with the regeneration process according to the standard text book D3 he would not arrive at the solution claimed in process claim 1.

As convincingly argued by the respondent the regeneration of catalysts (see D3, page 398, left hand column) is normally carried out off-line during maintenance work at a lower temperature than the production of the endothermic atmosphere to avoid damage to the catalyst material during the burn-out procedure. If the nickel catalyst material were to be treated at the higher endothermic atmosphere generation temperature this would cause a thermal shock to the catalyst material since the burn out of soot is normally carried out with air, i.e. nitrogen containing about 21 % oxygen and not with nitrogen containing only lower amounts of 0.1 to 9 % of oxygen as proposed according to the patent in suit. These statements of the appellant were not contested by respondent II.

3.8.6 Document D9 is also not suitable for arriving at the claimed solution since it suggests a different solution including a noble metal catalyst at a lower temperature range.

3.9 Claim 7

3.9.1 Respondent II argued that it is common knowledge to block the flow of hydrocarbons into the catalyst furnace as desired by using a computer which normally comprises a data processing unit and means for recording data. Furthermore, the apparatus according to D1 comprises an "automatic control system" which is considered to represent such a computer. Therefore plant claim 7 would lack an inventive step.

These arguments cannot be accepted for the following reasons.

3.9.2 First of all, document D1 is silent with respect to any soot formation in the gas generation reactor containing a nickel catalyst and only teaches to control the dew point and thus the carbon potential by regulating the air to hydrocarbon ratio at a lower temperature of the nickel catalyst of from 950-1000°C in combination with a different oxygen content of from either 5-21 or 1-21% (compare points 3.8.2 to 3.8.4).

3.9.3 Secondly, as already considered under point 3.5.2 above the automatic control means of the apparatus according to D1 does not necessarily contain any computer and could also contain an analog controlling means not including any program.

3.9.4 Thirdly, the gas flow of hydrocarbons according to D1 is never zero (see page 378, figure 2). D1 also does not suggest that the results of the reactor gas analysis is used for closing the needle valve 26 (see page 380, sixth paragraph) which could stop the hydrocarbon gas flow. Furthermore, as already considered, the formation of soot at the nickel catalyst would raise the carbon potential. Any attempt of the skilled person to correct the carbon potential by increasing the amount of hydrocarbons would make said problem even worse (compare point 3.8.3 above). As a consequence, the skilled person starting from D1 is neither aware that the soot problem exists nor gets any advice therefrom as to how to overcome the same.

3.9.5 Even if the skilled person would consider combining D1 with the regeneration process according to the standard text book D3 he would also not arrive at the solution claimed in claim 7 for the reasons given in point 3.8.5 above).

3.10 The Board therefore concludes that the subject-matter of the independent claims 1 and 7 of the main request involves an inventive step (Article 56 EPC).

3.11 The Board thus considers that the patent in suit based on the main request meets all requirements of the EPC.

Order

For these reasons it is decided that:

1. The decision under appeal is set aside.

2. The case is remitted to the department of first instance with the order to maintain the patent on the basis of the following documents:

   - claims: 1 to 9 as filed during the oral proceedings;

   - description: pages 2 and 2A as filed during the oral proceedings, and pages 3 and 4 as granted;

   - drawings: figure 1 as granted.

The Registrar: The Chairman:

G. Nachtigall K. Poalas