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**Datasheet for the decision  
of 24 September 2009**

**Case Number:** T 0611/05 - 3.3.07

**Application Number:** 97115748.2

**Publication Number:** 0829300

**IPC:** B01J 31/24

**Language of the proceedings:** EN

**Title of invention:**

Process for preparing a rhodium complex solution and process  
for producing an aldehyde

**Patent Proprietors:**

Mitsubishi Chemical Corporation

**Opponents:**

Celanese Chemicals Europe GmbH

**Headword:**

-

**Relevant legal provisions:**

-

**Relevant legal provisions (EPC 1973):**

EPC Art. 54, 56

**Keyword:**

"Novelty (no) - Main Request"

"Inventive step (no) - obvious solution - Auxiliary Requests I  
and II"

**Decisions cited:**

-

**Catchword:**

-



Case Number: T 0611/05 - 3.3.07

**D E C I S I O N**  
of the Technical Board of Appeal 3.3.07  
of 24 September 2009

**Appellants:** Mitsubishi Chemical Corporation  
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**Decision under appeal:** Decision of the Opposition Division of the  
European Patent Office posted 7 March 2005  
revoking European patent No. 0829300 pursuant  
to Article 102(1) EPC.

**Composition of the Board:**

**Chairman:** S. Perryman  
**Members:** G. Santavicca  
D. Semino

## Summary of Facts and Submissions

I. The appeal lies from the decision of the Opposition Division revoking European patent 0 829 300 granted on European application N° 97 115 748.

II. The patent in suit was granted with 18 Claims, the two independent claims reading respectively as follows:

"1. A process for preparing a solution of a rhodium complex in an organic solvent, which comprises contacting an aqueous solution of a water-soluble rhodium compound and an organic solvent solution of a water-insoluble tertiary organic phosphorus compound in a gas atmosphere containing carbon monoxide, followed by two phase separation, and recovering an organic solvent phase containing a rhodium-tertiary organic phosphorus compound complex.";

"12. A process for producing an aldehyde by hydroformylating a compound having an olefinic unsaturated bond with carbon monoxide and hydrogen in the presence of a rhodium complex in a water-insoluble solvent, which comprises:

- 1) a waste catalyst separation step of separating a rhodium-containing liquid from a hydroformylation reaction step,
- 2) an oxidation/extraction step of subjecting the rhodium-containing liquid to oxidation treatment in the presence of an aqueous medium containing a recovery accelerator to extract rhodium into an aqueous phase,
- 3) a rhodium-containing aqueous phase separation step of separating the aqueous phase from an organic phase,
- 4) a complexing step of contacting the aqueous phase

containing rhodium, with an organic solvent solution of a water-insoluble tertiary organic phosphorus compound, in a gas atmosphere containing carbon monoxide, to extract rhodium in the form of a tertiary organic phosphorus compound complex into the organic solvent,  
5) a rhodium complex separation step of separating the organic phase from the aqueous phase, and  
6) a recycling step of recycling the organic phase containing the rhodium-tertiary organic phosphorus compound complex to the above-mentioned hydroformylation step."

III. An opposition was filed against the patent on the grounds that the claimed subject-matter lacked novelty and an inventive step (Article 100(a) EPC) having regard to *inter alia* the following documents:

D1: US-A-3 547 964;  
D2: US-A-4 880 546;  
D4: DE-A-3 934 824;  
D5: DE-A-4 025 074; and,  
D6: DE-A-4 110 212.

IV. The decision under appeal was based on the patent as amended according to Claims 1 to 17 of the Main Request (Claim 1 being identical to Claim 1 as granted) and Claims 1 to 15 of, respectively, Auxiliary Requests I and II, both submitted with letter dated 24 January 2005. In particular, Claims 1 and 10 of Auxiliary Request II read as follows (additions to the respective claims as granted in bold, deletions in strike-through):

"1. A process for preparing a solution of a rhodium complex in an organic solvent, which comprises contacting an aqueous solution of a water-soluble

rhodium compound and an organic solvent solution of a water-insoluble tertiary organic phosphorus compound in a gas atmosphere containing carbon monoxide, followed by two phase separation, and recovering an organic solvent phase containing a rhodium-tertiary organic phosphorus compound complex, **wherein the aqueous solution of a water-soluble rhodium compound is a rhodium-containing aqueous solution obtained by treating a rhodium-containing solution separated from the hydroformylation reaction solution of an olefin, with oxygen or an oxygen-containing gas as an oxidizing agent in the presence of a recovery accelerator and an aqueous medium.**";

"~~1~~210. A process for producing an aldehyde by hydroformylating a compound having an olefinic unsaturated bond with carbon monoxide and hydrogen in the presence of a rhodium complex in a water-insoluble solvent, which comprises:

- 1) a waste catalyst separation step of separating a rhodium-containing liquid from a hydroformylation reaction step,
- 2) an oxidation/extraction step of subjecting the rhodium-containing liquid to oxidation treatment **using oxygen or an oxygen-containing gas** in the presence of an aqueous medium containing a recovery accelerator to extract rhodium into an aqueous phase,
- 3) a rhodium-containing aqueous phase separation step of separating the aqueous phase from an organic phase,
- 4) a complexing step of contacting the aqueous phase containing rhodium, with an organic solvent solution of a water-insoluble tertiary organic phosphorus compound, in a gas atmosphere containing carbon monoxide, to

extract rhodium in the form of a tertiary organic phosphorus compound complex into the organic solvent,  
5) a rhodium complex separation step of separating the organic phase from the aqueous phase, and  
6) a recycling step of recycling the organic phase containing the rhodium-tertiary organic phosphorus compound complex to the above-mentioned hydroformylation step."

V. According to the decision under appeal:

- (a) The amended claims of the Main Request and those of Auxiliary Requests I and II fulfilled the requirements of Article 123(2) EPC, which fact was not contested by the opponents.
- (b) The subject-matter of Claim 1 of the Main Request lacked novelty having regard to each of D1 and D2 (Article 54 EPC).
- (c) The subject-matter of Claim 1 of Auxiliary Request I likewise lacked novelty having regard to D1 (Article 54 EPC).
- (d) The subject-matter of Claim 1 of Auxiliary Request II lacked an inventive step over D1, describing the closest prior art, and any of D4, D5 and D6.
- (e) Therefore, none of the requests fulfilled the requirements of the EPC.
- (f) Since a ground of opposition under Article 100(a) EPC prejudiced the maintenance of the patent in suit, it should be revoked.

VI. The patent proprietors appealed against that decision. In their statement setting out the grounds of appeal, dated 15 July 2005, the appellants enclosed a set of amended Claims 1 to 15 as the Main Request, which were identical to Claims 1 to 15 of Auxiliary Request II

underlying the decision under appeal (Point IV, *supra*), as well as a copy of Tables 1, 2, 3-1, 3-2 and A, in which the results of some of the experiments of the patent in suit were reproduced.

VII. In their response (by letter of 24 October 2005) to the statement setting out the grounds of appeal, the opponents (respondents in these proceedings) maintained that the subject-matter of the claims of the Main Request lacked an inventive step.

VIII. The Board, in a communication in preparation for oral proceedings summarised the points to be discussed, in particular whether the product-by-process feature inserted in Claim 1 of the Main Request was suitable to distinguish the process of Claim 1 from that of D1.

IX. In response to the communication of the Board:

(a) The appellants, with their letter of 21 August 2009, submitted a set of amended Claims 1-15 as Auxiliary Request I as well as a set of Amended Claims 1-6 as Auxiliary Request II.

(b) In their letter of 27 July 2009, the respondents also argued lack of novelty of the subject-matter of Claim 1 of the Main Request over D1 and submitted copy of a further document:

D7: Römpp's Chemie Lexikon, 8. Auflage,  
Franckh'sche Verlagshandlung, Stuttgart,  
page 3509, 1987.

X. As regards the claims of Auxiliary Requests I and II, Independent claim 10 of Auxiliary Request I and Claim 1 of Auxiliary Request II are identical to Claim 10 of the Main Request (Points VI and IV, *supra*). Claim 1 of

Auxiliary Request I reads as follows (additions to Claim 1 as granted in bold, deletions in strikethrough):

"1. A process for preparing a solution of a rhodium complex in an organic solvent, which comprises **treating a rhodium-containing solution separated from the hydroformylation reaction solution of an olefin, with oxygen or an oxygen-containing gas as an oxidizing agent in the presence of a recovery accelerator and an aqueous medium to obtain an aqueous solution of a water-soluble rhodium compound,** contacting ~~the~~ aqueous solution of a water-soluble rhodium compound and an organic solvent solution of a water-insoluble tertiary organic phosphorus compound in a gas atmosphere containing carbon monoxide, followed by two phase separation, and recovering an organic solvent phase containing a rhodium-tertiary organic phosphorus compound complex."

XI. Oral proceedings were held on 24 September 2009. At the end of the oral proceedings, the decision was announced.

XII. The appellants essentially argued as follows:

- (a) The amended claims of the Main Request as well as those of Auxiliary Requests I and II were based on the application as filed and complied with Article 123(2) as well as with Rule 80 EPC.
- (b) The subject-matter defined in each Claim 1 or 10 of all requests, even that of Claim 1 of the Main Request including a product-by-process feature, concerned a process that differed from the process disclosed by D1 in the use of oxygen or oxygen containing gas, instead of peroxides, in the oxidation/extraction step. The use of oxygen



implied that no residues were left in the aqueous solution, so that it could be directly sent to the extraction step with the organic solvent. Instead, the process of D1 required, after oxidation, an additional step for destroying the residues of the peroxides used, so that the aqueous solution could not be sent directly to the extraction step with the organic solvent. Hence, the claimed subject-matter of all requests was novel.

- (c) As to inventive step, D1 described the closest prior art. The problem to be solved, as stated in the patent in suit, was, on the one hand, to overcome the drawbacks of the prior art (including the additional steps and/or facilities for the destruction of the residues of peroxides and for the handling of the peroxides, which were dangerous and costly products), and, on the other hand, to provide a method for efficiently recovering rhodium, which was a costly metal, for re-use, from a hydroformylation reaction solution. The numerous examples in the patent in suit showed that that problem had been solved within the whole breadth of each Claim 1 of all requests and Claim 10 of the Main Request and Auxiliary Request I by the proposed solution that included the use of oxygen or oxygen containing gas, instead of peroxides, in the oxidation/ extraction step (i.e. the distinction of the claimed subject-matter over D1). That solution was not obvious having regard to the prior art cited. D1 only dealt with peroxides. D4 (the disclosure of which was equivalent to that of any of D5 and D6), published 19 years after D1, still acknowledged that the process of D1 was disadvantageous, as it used

peroxides. Further, D4 required the addition of monocarboxylic acid and alkali salts in a first stage, in which oxidation was carried out, and of water for extraction in a second stage. Instead, D1 concerned a one-stage oxidative/extraction step. Hence, D1 and D4 (or any of D5 and D6) disclosed different reaction concepts. As regards the implications of the different concepts, the experimental results of the proprietors showed that the two-step process of D4 (or of any of D5 and D6) did not attain satisfactory recovery of rhodium. This was emphasized in Tables 1, 2, 3-1, 3-2 and A, which showed a causal relationship between the difference in rhodium recovery of the reference examples according to the invention and of the comparative example representing D4, due to the different reaction concepts (two- versus one-step). Since in those experiments the reaction conditions (temperature and time) respected the reaction rate-time rule, the better recovery over D4 was not due to a higher temperature. Rhodium was costly, so that any improvement, even a slight one, in its recovery was important. Hence, the fact that the skilled person could have combined D1 with D4 was in the present case not sufficient, as there was no hint to do it in the expectation of an improved recovery of rhodium. In any case, if the problem solved was not the attainment of an improvement but the provision of a further process, the claimed solution would nevertheless not be obvious over the combined teaching of D1 and D4 (or of any of D5 and D6), for the following reasons: since the documents concerned different reaction concepts (one or two-step), it could not

be expected that the replacement of the peroxides of D1 with oxygen gas was compatible with a two-step process according to D4; although D1 was published long time before D4, in which it was acknowledged, D4 still suggested a two-step treatment as an improvement over D1. The time elapsed from the publication of D1 and D4 until the patent in suit showed a long felt need. Hence, the claimed subject-matter was inventive.

- (d) Since the process of Claim 1 was an essential aspect of the process of Claim 10, the arguments on Claim 1 also applied to Claim 10.

XIII. The respondents essentially (counter) argued as follows:

- (a) The rhodium containing aqueous solution obtained in the process of D1 after destruction of the peroxides and before the separation and complexing steps was identical to the rhodium containing aqueous solutions described in the patent in suit and defined in Claim 1 of the Main Request. Hence, the last feature of Claim 1 of the Main Request was a product-by-process feature, which did not distinguish the claimed from the known solution, so that the process of Claim 1 lacked novelty over D1.
- (b) D1 indisputably described the closest prior art, as its process was suitable for recovering almost the entirety of the rhodium contained in the waste solution. Having regard to that performance, the problem to be solved by the claimed subject-matter over D1 was merely to provide a further process. Apart from the fact that also the patent in suit acknowledged that peroxides were suitable for oxidising and recovering rhodium from waste solutions coming from hydroformylation, in Claim 1

of the Main Request it made no difference whether the rhodium containing aqueous solution had been obtained by oxidation with oxygen or peroxides, as after peroxides destruction the two aqueous solutions were identical. Moreover, the replacement of peroxides with oxygen in the oxidation reactions not only was common general knowledge but was already known in the field of hydroformylation, as acknowledged in the introduction of D4. Hence, the claimed subject-matter was obvious. Also the combined disclosure of D1 with D4, in order to provide a further process, rendered obvious the claimed subject-matter, as D4 pertained to the same technical field of D1 and taught the use of oxygen or oxygen containing gases for oxidising the rhodium. The argument of the appellants that D1 could but would not be combined with D4, which argument relied on an alleged better recovery of rhodium resulting from some of the experiments in the patent in suit, was not convincing. In fact, in Comparative Example 2 a temperature of 80°C had been used, which was lower than that (120°C) of the Reference Examples, although it was generally known that the temperature greatly influenced the reaction rate, as shown by D7. Also, the time played no role, as until the necessary activation energy was attained no reaction would take place. Instead, from some examples it was apparent that the concentration of e.g. the oxygen and the acid played a role. Therefore, the alleged advantages, if any, were not in causal relationship with the number of steps during the oxidation and extraction of rhodium, as had also been acknowledged in the decision under appeal. In fact, also the process of

D4 attained a good recovery of rhodium. As regards the presence of alkali salts in D4, the same was disclosed in the patent in suit and was not excluded by the wording of the claims. Furthermore, D1 disclosed that the one-step method and the two-step methods were equally valid possibilities and D4 showed that an aqueous medium was present during the oxidation step. As the two-step process of D4 would not have deterred the skilled person from replacing peroxides with oxygen, the process of each Claim 1 of all requests and Claim 10 of the Main Request and Auxiliary Request I was obvious.

(c) Therefore, the patent should remain revoked.

XIV. The appellants (patent proprietors) requested that the decision under appeal be set aside and the patent be maintained on the basis of the Main Request submitted on 15 July 2005 or the Auxiliary Request I or II submitted on 21 August 2009.

XV. The respondents (opponents) requested that the appeal be dismissed.

### **Reasons for the Decision**

1. The appeal is admissible.

2. *Amendments (All requests)*

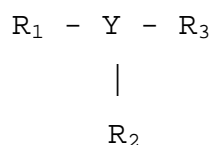
2.1 The amendments to the claims as granted have been emphasized in bold by the Board (Points IV and X, *supra*).

- 2.2 According to the decision under appeal (Point 11, last paragraph, of the Reasons), it was not contested by the opponents that the amended claims of the then Auxiliary Request II, now the Main Request, fulfilled the requirements of Article 123(2) EPC.
- 2.3 In the appeal proceedings, the respondents have not raised any objections under Article 123(2) EPC, nor under Article 84 and Rule 80 EPC, against the amended claims of the requests.
- 2.4 The Board has no reason to take a different position. Moreover, the appeal fails for lack of novelty or for lack of an inventive step (*infra*), so that the Board need not give further details on the amendments.

*Main Request*

3. *Novelty*

- 3.1 D1 (Claim 8) *inter alia* concerns the liquid extraction of a rhodium complex from a high-boiling, hydroformylation residue stream containing a soluble complex of rhodium having a biphyllic ligand having the following formula:

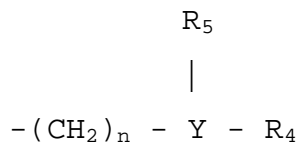


wherein:

Y is As, Sb, Bi; P(O)<sub>3</sub>

R<sub>1</sub> and R<sub>2</sub> each represent an alkyl or aminoalkyl having from 1 to 8 carbons, a cycloalkyl or aminocycloalkyl having from 5 to 9 carbons, or an aryl aminoaryl having from 6 to 9 carbons; and

R<sub>3</sub> is an alkyl having from 1 to 6 carbons, an aryl having from 6 to 8 carbons or a univalent radical having the following formula:



wherein:

n is a whole number from 1 to 6; and

R<sub>4</sub> and R<sub>5</sub> each represent an alkyl having from 1 to 8 carbons or an aryl having from 6 to 8 carbons;

which comprises contacting said residue stream in an extraction zone at a temperature of between about 25° and 200°C and at a pressure of between about 1 and 1000 atmospheres, with an aqueous solution having a pH less than 7.0 and containing a peroxide in an amount between 0.25 and about 5 times the molar quantity of said biphyllic ligand to effect a transfer of said rhodium complex from said residue stream into said aqueous solution and recovering said aqueous solution from said extraction zone;

said peroxide selected from the group consisting of hydrogen, alkali and alkaline earth metal peroxides, persulfuric acid and alkali metal salts thereof, C<sub>1</sub>-C<sub>8</sub> alkanolic and aromatic percarboxylic acids, C<sub>1</sub>-C<sub>8</sub> alkyl, cycloalkyl and aralkyl hydroperoxides and dialkyl, diaryl and diaroyl peroxides having alkyl, aryl and aroyl groups with from 1 to about 8 carbons.

- 3.1.1 The aqueous solution recovered from the extraction zone can be contacted with a non-polar-solvent solution containing the biphyllic ligand and the carbon monoxide to extract said rhodium metal complex from the aqueous solution into the non-polar-solvent solution (Claim 9), followed by phase-separation (Column 6, lines 6-12).

- 3.1.2 In particular, the rhodium complex can be recovered in a form that can be directly recycled to the hydroformylation zone by treating the aqueous extract phase separated in the extraction step with a non-polar solvent containing the biphyllic ligand, in the absence of any peroxide, preferably in the presence of carbon monoxide, whereby the non-polar solvent can be a hydroformylation solvent (Column 2, lines 48-63), in particular those selected from the group of aromatic, aliphatic or alicyclic hydrocarbons (Column 6, lines 26-36), although amides, esters, sulfoxides or ethers can be used as well (Column 6, lines 40-43).
- 3.1.3 When simultaneous peroxide treatment and extraction into the aqueous solution is practiced (Column 3, lines 47-49, and Column 4, lines 44-51), the aqueous solution should contain from about 0.1 to about 3 normal nitric, hydrohalic or sulfuric acid (Claim 10), although C<sub>2</sub>-C<sub>5</sub> alkanolic acids can also be used (Column 4, lines 49-50). These acids corresponds to the recovery accelerators as defined in Claim 1 and described in the patent in suit (Paragraphs [0044] and [0045]).
- 3.2 Hence, by reference to the wording of Claim 1 of the Main Request, D1 discloses a process for preparing a solution of rhodium complex in an organic solvent, which comprises contacting an aqueous solution of water-soluble rhodium compound and an organic solvent solution of a water-insoluble tertiary organic phosphorous compound in a gas atmosphere containing carbon monoxide, followed by two phase separation, and recovering an organic solvent phase containing a rhodium tertiary organic phosphorous compound complex.



3.3 Since the aqueous solution of a water-soluble rhodium compound according to the method of D1 has been obtained by treating the rhodium containing solution separated from the hydroformylation reaction solution of an olefin with hydrogen peroxide, in the presence of a recovery accelerator and an aqueous medium, the last feature of Claim 1 of the Main Request, defining that the rhodium-containing aqueous solution has been obtained by treating a rhodium-containing solution separated from the hydroformylation reaction solution of an olefin with oxygen or oxygen-containing gas as an oxidising agent, in the presence of a recovery accelerator and an aqueous medium, is not disclosed as such in D1, as a different oxidising agent (peroxides) has been used.

3.4 Hence, it has to be established whether or not the product-by-process definition contained in the process of Claim 1 according to the Main Request distinguishes the claimed aqueous solution of the water-soluble rhodium compound (to be contacted with an organic solvent solution of a water-insoluble tertiary organic phosphorous compound) from that obtained in the process of D1 by the peroxide treatment and the concomitant extraction step. In particular, as argued by the appellants, it has to be determined whether any distinction may result from the presence of peroxides residues in the aqueous solution of D1, which may need to be destructed according to D1.

3.5 In the process of D1, after or during peroxide treatment, the rhodium compound that has become water-soluble is extracted with an aqueous solvent (Column 3,

lines 44-47), whereby peroxide treatment and phase separation preferably take place simultaneously in D1 (Column 3, lines 47-49, and Column 4, lines 44-45). The aqueous solution (extract) is then allowed to separate from the tar-laden solvent (phase separation) (Column 5, lines 33-34). Thereafter, residual peroxide present in the extract, if any, is decomposed by heat treatment (Column 5, line 40-45). This heat treatment need not be practiced if organic peroxides having more than 3 carbon atoms are used, as they are soluble in the organic solvent, and will not be present in any significant quantity in the aqueous extract solution (Column 5, lines 46-51). In any case, in the process of D1, the recovery step of rhodium from the aqueous solution is carried out in the absence of any peroxide (Column 2, lines 53-54). Hence, in the process of D1, an aqueous extract that does not contain peroxide residues is contacted with the non-polar solvent containing a biphyllic ligand. In the absence of peroxide residues, after heat treatment if necessary, it cannot be seen how, when using peroxides instead of oxygen as oxidizing agent, the aqueous solution containing the oxidized rhodium compound of D1 may be different from the aqueous solution obtained by the treatment with oxygen, as defined in Claim 1 of the Main Request. Hence, the aqueous solution of rhodium compound defined by the product-by-process feature of Claim 1 of the Main Request is not distinguishable from that obtained in D1 (i.e. after peroxide treatment and peroxide residues removal, if any).

It follows from the above, that the process of Claim 1 of the Main Request lacks novelty over the process disclosed by D1 (Article 54 EPC).

Consequently, the Main Request is not allowable.

*Auxiliary Request I*

4. *Amendments*

Compared to Claim 1 according to the Main Request, Claim 1 of Auxiliary Request I does not contain the product-by-process feature defining the aqueous solution of the water-soluble rhodium compound, but a process definition of the step and the means used (i.e. of the use of oxygen or oxygen containing gas) to obtain the aqueous solution of the rhodium water-soluble compound.

These amendments have not been objected to and the Board has no reason to take a different position. Since Auxiliary Request I fails for lack of an inventive step (*infra*), the Board need not detail why the amendments are formally allowable.

5. *Novelty*

D1 (Points 3., *supra*) discloses the use of peroxides as oxidizing agent. Claim 1 of Auxiliary Request I now defines in a process step the use of oxygen or oxygen containing gas as the oxidizing agent to obtain the aqueous solution of the rhodium water-soluble compound. Hence, the claimed subject-matter no longer lacks novelty over the process of D1.

6. *Inventive step*

6.1 The patent in suit concerns a process for preparing a rhodium complex solution and a process for producing an aldehyde.

*Closest prior art*

6.2 D1 (Points 3., *supra*) indisputably discloses the closest prior art. It pertains to the same technical field as the patent in suit, i.e. the hydroformylation of olefins by an oxo process using a rhodium catalyst complex, in particular the recovery of the rhodium compound after the reaction, it addresses and solves the problem of recovering as completely as possible that rhodium compound and it discloses almost all of the process steps as claimed, apart from the use of a different oxidising agent.

*Problem and solution*

6.3 According to the patent in suit, the problem to be solved is to overcome the drawbacks of the prior art and to provide a method for efficiently recovering rhodium for reuse from a hydroformylation reaction solution containing rhodium (Paragraph [0030]).

6.4 Having regard to D1 as the closest prior art, which is not acknowledged in the patent in suit, it is not contested by the appellants that the advantages or improvements attained by the claimed process do not reside in a better efficiency of recovery (no evidence in that regard has been submitted) but in the avoidance

of the use of the peroxides, which are costly, dangerous and require further facilities.

6.5 Since however no evidence either as regards savings and process/plant simplification has been submitted, the problem to be solved can only be formulated as the provision of a further process.

6.6 That problem is solved by the use of oxygen or oxygen-containing gas in the step of oxidation of the hydroformylation reaction solution containing the rhodium complex to obtain a water-soluble rhodium compound, to be extracted by contacting with an aqueous solution, as shown by the examples in the patent in suit.

#### *Character of the solution*

6.7 It remains to be decided whether or not the solution defined in Claim 1 of Auxiliary Request I was obvious having regard to the cited prior art.

6.8 Before considering the cited prior art, it has to be noted that the fact that oxygen as such is an oxidizing agent is generally known, as implied by the name itself of the reaction, so that the use of oxygen as an oxidizing agent when facing the problem of providing a further process is obvious.

6.9 D4 (Point III, *supra*) concerns a process for the recovery of rhodium from distillation residues of crude products from the oxo synthesis, in which rhodium complexed with an organic phosphorous (III) compound is contained, by treating the said distillation residues

with oxygen or an oxygen containing gas characterized in that the treatment of the residues is carried out with oxygen or oxygen containing gas at 60 to 120°C, in the presence of an alkali metal salt of a C<sub>2</sub>-C<sub>5</sub> monocarboxylic acid, at atmospheric or elevated pressure, to form a water-soluble rhodium compound to be extracted from the mixture with water, to separate aqueous and organic phases, to obtain an aqueous phase containing the water soluble rhodium compound (Claim 1). Air can be used as the oxygen-containing gas (Claim 2).

6.10 Hence, D4 discloses the use of oxygen or oxygen containing gas in the step of oxidation of the rhodium complex contained in the residues of a hydroformylation reaction solution, to obtain a water-soluble rhodium compound, which can be extracted with water, thus recovered.

6.10.1 Moreover, D4, in its introductory part (page 2, lines 40-67), *inter alia* acknowledges the prior art as follows:

- (a) The recovery of rhodium from the products of the oxo synthesis, including the residues of crude oxo products, had been investigated many times. This work led to the development of a large number of processes, some of which had also found application on an industrial scale.
- (b) U.S. Pat. No. 4,400,547 disclosed hydroformylation of olefins containing 2 to 20 carbon atoms in the presence of unmodified rhodium as catalyst. After the reaction was complete, a complexing compound such as triphenylphosphine was added to the crude oxo product, and the aldehyde was distilled off. The distillation residue was then treated with

**oxygen** (emphasis added by the Board) to eliminate the ligand from the complex compound and to recover the rhodium in its active form.

- (c) The separation of noble metals such as rhodium from high-boiling hydroformylation residues was described in U.S. Pat. No. 3,547,964 (D1 in these proceedings), in which the residues were treated in the presence of acids such as formic acid, nitric acid or sulfuric acid with hydrogen peroxide. Due to the high price of hydrogen peroxide and its difficult handling, the industrial application of the process was however limited.
- (d) In U.S. Pat. No. 4,390,473, a process for the recovery of rhodium and cobalt from a solution which had been used as catalyst in a low-pressure oxo process was described. To separate the metals which were bound in the form of a complex, aqueous formic acid was added to the solution, and an **oxygen-containing gas** (emphasis added by the Board) was passed through the solution.

6.10.2 It follows from the above that:

- (a) D4 confirms the common general knowledge that oxygen is a suitable oxidising agent;
- (b) D4 discloses that oxygen or oxygen containing gas has already been used in the recovery of rhodium contained in the residues from the hydroformylation reaction in a number of processes.
- (c) From the comparison made in D4 between processes in which peroxides were used and processes in which oxygen was used, it is also apparent that oxygen or oxygen containing gas was known as a further oxidising agent (i.e. as a substitute for peroxides).

- (d) The disadvantages mentioned in the introductory part of D4 (*supra*) acknowledging the prior art are related to the use of peroxides (high price and difficult handling) or of formic acid (it acts as a reducing agent), or to the fact that the separation of rhodium once oxidised might be difficult.
- (e) No disadvantage is however related to the use of oxygen as an oxidizing agent.

6.10.3 Hence, there is no evidence of anything that might have dissuaded the skilled person from using oxygen or oxygen gas in a further process of recovery and reuse of the rhodium catalyst for hydroformylation.

6.10.4 The arguments brought forward by the appellants against the obviousness of the combination of D1 with D4, namely that the two-step process of D4 was less favourable than the one step process of D1, so that their combination would not be envisaged by the skilled person, and that the claimed subject-matter fulfilled a long felt need, are not convincing for the following reasons:

- (a) It has not been shown that the claimed process is more efficient than that of D1, and this is not disputed either.
- (b) D4 does not represent the closest prior art (more differences than D1).
- (c) Comparative Example 2 of the patent in suit, used to show the alleged disadvantages over D4, does not appear to reproduce D4, at least because it does not reproduce exactly the subsequent extraction with water, as more water is used in Example 1 of D4, which has an impact on the quantities extracted.



- (d) In any case, possibly disadvantageous modifications, such as the replacement of peroxides with oxygen where it is known that peroxides are more active, cannot involve an inventive step, if the skilled person could predict the disadvantages, unless any unexpected technical advantage compensated those disadvantages (Case Law of the Boards of Appeal of the EPO, 5th edition 2006, I.D.8.5).
- (e) In the present case, the high cost of peroxides and the difficulty of handling them (because of their high reactivity) were already known (D4, *supra*), and could be predicted by the skilled person.
- (f) As regards the simplification of the facilities, if any, it has not been shown that it unexpectedly compensated the expected reduction in efficiency.
- (g) As regards the alleged existence of a long-felt need, it needs to be proven, which has not been done in the present case. The fact that exactly the same process as claimed had not been described during a number of years before the patent in suit cannot be considered alone as evidence of a long-felt need (Case law, *supra*, I.D.9.4).

6.10.5 Therefore, the process of Claim 1 of Auxiliary Request I was obvious having regard to D1 and the relevant common general knowledge, confirmed by D4, as well as over the combination of D1 with D4.

6.11 Auxiliary Request I is thus not allowable.

#### *Auxiliary Request II*

7. Claim 1 of Auxiliary Request II corresponds to Claim 10 of the Main Request and of Auxiliary Request I.

- 7.1 The process for preparing a solution of a rhodium complex in an organic solvent defined in Claim 1 of the Main Request and in Claim 1 of Auxiliary Request I is an essential part of the process for producing an aldehyde by hydroformylation of an olefin defined in Claim 1 of Auxiliary Request II.
- 7.2 It is not contested (e.g. Point XI.b, *supra*) that the additional features of Claim 1 (or the then Claim 10) are known from D1. The only acknowledged distinction is the use of oxygen as oxidising agent. D1 discloses a process for producing an aldehyde by hydroformylation of an olefin in the presence of a rhodium complex catalyst in an organic solvent. So does D4 as well.
- 7.3 Therefore, for the reasons given *supra* in relation to the Main Request and Auxiliary Request I, the process of Claim 1 of Auxiliary Request II is obvious over the disclosure of D1 in combination with the common general knowledge, which is confirmed by D4.
- 7.4 Auxiliary Request II is thus not allowable.
- 7.5 It follows from the above that a ground of opposition (lack of an inventive step) prejudices the maintenance of the patent in suit.

**Order**

**For these reasons it is decided that:**

The appeal is dismissed.

The Registrar:

The Chairman:

S. Fabiani

S. Perryman