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D E C I S I O N
of 8 August 2002

Case Number: T 0471/99 - 3.3.1

Application Number: 92109599.8

Publication Number: 0518241

IPC: C07C 45/50

Language of the proceedings: EN

Title of invention:
Hydroformylation process and bisphosphite compound used therein

Patentee:
MITSUBISHI CHEMICAL CORPORATION

Opponent:
Union Carbide Corporation

Headword:
Hydroformylation/MITSUBISHI

Relevant legal provisions:
EPC Art. 54, 56

Keyword:
"Novelty (yes) - generic disclosure does not reveal particular feature - selection of particular combination of features"
"Inventive step (no) - determination of closest prior art - foreseeable improvement of property - no deterrent teaching of prior art"

Decisions cited:
-

Catchword:
-



Case Number: T 0471/99 - 3.3.1

D E C I S I O N
of the Technical Board of Appeal 3.3.1
of 8 August 2002

Appellant:
(Opponent) Union Carbide Corporation
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Respondent:
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Decision under appeal: Decision of the Opposition Division of the
European Patent Office posted 4 March 1999
rejecting the opposition filed against European
patent No. 0 518 241 pursuant to Article 102(2)
EPC.

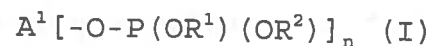
Composition of the Board:

Chairman: A. J. Nuss
Members: R. Freimuth
M. J. Vogel

Summary of Facts and Submissions

I. The Appellant (Opponent) lodged an appeal on 29 April 1999 against the decision of the Opposition Division posted on 4 March 1999 rejecting the opposition against European patent No. 518 241 which was granted on the basis of ten claims, independent claim 1 reading as follows:

"1. A hydroformylation process for preparing a hydroformylated product by reacting an olefinic compound with hydrogen and carbon monoxide in the presence of a Group VIII metal catalyst, in the reaction of which there is present a phosphite compound having the formula (I),



wherein R¹ and R² are respectively an aromatic hydrocarbon group which may be the same or different and the aromatic hydrocarbon group has at least a hydrocarbon group on a carbon atom adjacent to a carbon atom bonded with an oxygen atom as a substituent; A¹ is an n-valent organic group having an aliphatic hydrocarbon group, a cycloaliphatic hydrocarbon group or an aromatic hydrocarbon group bonded with an adjacent oxygen atom, which may respectively have a substituent; n is an integer of from 2 to 4; and the respective



group may be the same or different."

II. Notice of Opposition had been filed by the Appellant requesting revocation of the patent as granted in its entirety on the ground of lack of inventive step. *Inter alia* the following document was submitted in opposition proceedings:

(1) EP-A-285 136.

- III. The Opposition Division held that the subject-matter claimed was novel and involved an inventive step in the light of the documents cited. Document (1) did not anticipate the subject-matter of the patent in suit since the phosphites of formula (I) wherein both radicals R^1 and R^2 were aromatic and α -substituted could not be derived directly and unambiguously therefrom. The phosphites of that document according to formula XV having the substituents W and R as defined on page 17 were not disclosed to comprise aromatic and α -substituted radicals R. Starting in the assessment of inventive step from document (1) the problem underlying the patent in suit was seen in providing a hydroformylation process wherein the phosphite ligands showed improved thermal stability while maintaining the n/i ratio at a satisfactory level over the reaction time. This problem having been successfully solved, the Opposition Division found that document (1) did not suggest that the particular phosphites according to claim 1 would present a higher thermal stability, therefore acknowledging inventive step.
- IV. The Appellant argued that document (1) anticipated the subject-matter claimed since it already disclosed the characterising feature of the phosphites used in claim 1, i.e. a hydrocarbon group in the α -position of the substituents R^1 and/or R^2 . That document was directed to a hydroformylation process employing specific phosphite compounds, *inter alia* phosphites of formula XV which were double open ended as those used in the claimed process. Phosphites of formulae XII and XIV in document (1) had a hydrocarbon group at the α -position of those substituents with the consequence that one could easily imagine specific phosphites of formula XV having α -hydrocarbon groups. Furthermore, formula (I) of the patent in suit covered also those phosphites disclosed in document (1) wherein the aromatic substituents R^1 and R^2 were linked to each

other at their α -positions by a chemical single bond thereby forming a ring together with both oxygen atoms and the phosphorus atom since the single bond at the α -positions could be read as a "substitution" within the meaning of present claim 1. The Appellant pointed to the phosphites on the top of page 14 and the bottom of page 21 of document (1) as examples of that structure.

With respect to inventive step the Appellant considered document (1) as the closest prior art. In view of that state of the art the problem underlying the patent in suit could only be seen in improving the activity and selectivity of the hydroformylation reaction and in improving the catalyst stability. The first partial problem had not been solved and, thus, should be disregarded in the assessment of inventive step. The second partial problem was solved in an obvious manner since the document

(4) US-A-4 599 206

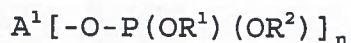
already taught to select those phosphites having a hydrocarbon group at the α -position of the aromatic substituents in order to improve their stability. This fresh document was filed with the letter dated 23 July 2002 in response to the Respondent's fresh experimental report.

With respect to the auxiliary requests, the Appellant objected to the amendments made since they were not disclosed in combination in the application as filed thereby generating fresh subject-matter.

- V. At the oral proceedings before the Board, held on 8 August 2002, the Respondent defended the maintenance of the patent in suit in the form as granted and subsidiarily in amended form on the basis of auxiliary

requests 1 and 2, both requests submitted during these oral proceedings. The first auxiliary request comprised a set of five claims, independent claim 1 reading as follows:

"1. A hydroformylation process for preparing a hydroformylated product by reacting an olefinic compound with hydrogen and carbon monoxide in the presence of a Group VIII metal catalyst, in the reaction of which there is present a phosphite compound having the formula (I),



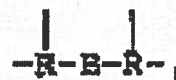
wherein R¹ and R², which may be the same or different, are a phenyl group, a naphthyl group or an anthracenyl group having at least a hydrocarbon group on a carbon atom adjacent to a carbon atom bonded with an oxygen atom as a substituent; A¹ is selected from -R-, -R-B-R-, a trivalent group represented by:



or a tetravalent group represented by :

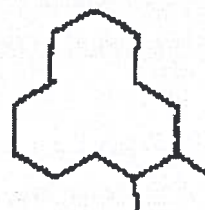
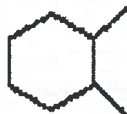
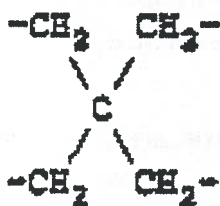


OR



wherein R represents:

-CH₂CH₂-, -CH₂CH₂CH₂-



a phenylene group, a biphenylene group or a naphthylene group,

when A¹ has an aromatic hydrocarbon ring bonded with an adjacent oxygen atom, the aromatic hydrocarbon ring may have a isopropyl, t-butyl group or t-pentyl group on a carbon atom adjacent to a carbon atom bonded with an oxygen atom and

B represents a group selected from the group consisting of -CR⁷R⁸-, -O-, -S-, and -CO- whereby R⁷ and R⁸ is a group selected from the group consisting of hydrogen, alkyl, aryl, arylalkyl, alkylaryl and cycloalkyl; n is an integer of from 2 - 4 and the respective



group may be the same or different."

The second auxiliary request comprised a set of four claims wherein claim 1 was identical to claim 1 according to the first auxiliary request apart from selecting the substituent on the radicals R¹ and R² from alkyl groups with 3 to 20 carbon atoms and from restricting the substituent B to the groups -O-, -S- and -CO-.

The Respondent argued that document (1) did not anticipate the subject-matter claimed since the phosphites according to the patent in suit were a selection within the generic disclosure of that document, namely of double open ended bisphosphites substituted with a hydrocarbon group at the α -position of the substituents R¹ and/or R². Furthermore the Appellant's reading of document (1) that the chemical single bond linking the aromatic substituents R¹ and R² at their α -positions thereby forming a ring was a "substitution" within the meaning of present claim 1, was a clear misconstruction of the subject-matter claimed contrary to the chemical art.

The Respondent doubted that document (1) could be considered to be the closest prior art since it referred to the purification of phosphites, not to a hydroformylation process. When starting nevertheless from that document in the assessment of inventive step the problem underlying the invention was to improve the thermal stability of the phosphite ligands, which was the key issue of a hydroformylation process, while maintaining the activity and selectivity of the catalyst at a reasonable level. The Respondent submitted with the letter dated 12 July 2002 an experimental report of Mr. Takai to demonstrate that the thermal stability of a phosphite according to the invention was improved vis-à-vis a phosphite according to document (1). That experimental report compared the stability of two phosphites both being double open ended and differing from each other exclusively in the presence or absence of a tertiary butyl group at the α -position of the aromatic substituents R^1 and R^2 thereby showing that the improvement in stability was due to that structural difference. Document (1) gave no hint to the causal connection between this structural feature and the improvement of that property. Document (4) addressed exclusively phosphites having a ring structure while the phosphites according to document (1) and the patent in suit were open ended. Therefore the teaching of that document was restricted to the former phosphites and was not translated to the latter by the skilled person. Therefore the invention in the form as granted was not obvious.

The auxiliary requests were designed to restrict the breadth of the claims distancing the subject-matter claimed further from the state of the art. The amendments made to claim 1 according to either

auxiliary request did not contribute on their own to inventive step. The amendments were disclosed in the application as filed without violating the requirements of Article 123 (2) EPC.

- VI. The Appellant requested that the decision under appeal be set aside and that the patent be revoked.

The Respondent requested as main request that the appeal be dismissed and the patent be maintained as granted and subsidiarily that the patent be maintained as amended on the basis of auxiliary requests 1 or 2, both submitted during the oral proceedings before the Board.

- VII. At the end of the oral proceedings the decision of the Board was given orally.

Reasons for the Decision

1. The appeal is admissible.

Main request

2. *Novelty*

The Appellant challenged the novelty of the claimed invention exclusively with regard to document (1), not relying on any further document cited so far in the proceedings. Therefore, the Board limits its considerations with respect to novelty to that document.

2.1 Document (1) addresses a rhodium complex catalyzed hydroformylation process using organophosphites (claim 16). That document discloses in formula XV *inter alia* bisphosphites which are double open ended as those used in the claimed process. The substituents on those bisphosphites according to formula XV are as defined in formula XIII (page 22, line 8). According to formula XIII of document (1) the linking group between both phosphorus atoms of the bisphosphites, named "A¹" in terms of the patent in suit, may be an alkylene or arylene group (page 17, line 14) and the substituents on the phosphorus atoms of the bisphosphites, named "R¹ / R²" in terms of the patent in suit, may be substituted hydrocarbon aryl radicals (page 17, lines 20 and 21) without identifying any specific substituent on these aryl radicals. Thus, formula XV of document (1) generically discloses substituted double open ended bisphosphites covering the particular bisphosphites used in the claimed process. However, in view of the silence in that document about the nature of the substituent(s) on those aryl radicals R¹ / R² the generic disclosure of any substitution does not reveal to the skilled person a particular substituent on those radicals. Thus, there is no basis in that document for the finding that the aryl radicals R¹ / R² are substituted at their α -position by a hydrocarbon group. Therefore document (1) does not disclose, either explicitly or implicitly, the essential feature of the claimed invention to use α -hydrocarbon substituted double open ended bisphosphites.

2.2 The Appellant argued that document (1) disclosed in formulae XII and XIV *inter alia* bisphosphites substituted by a hydrocarbon group at the α -position of the aryl radicals R¹ / R² with the consequence that the skilled person reading that document could easily imagine bisphosphites of formula XV bearing α -hydrocarbon substituents likewise.

However, in document (1) the bisphosphites according to formulae XII or XIV are not disclosed in combination with those according to formula XV. Moreover, the former are structurally different from the latter since in the bisphosphites of formulae XII and XIV the aryl radicals R^1 and R^2 are linked together by a chemical bond thereby forming a ring with the consequence that these bisphosphites are not double open ended as are the bisphosphites of formula XV. Document (1) does not comprise any pointer to the particular combination of double open ended bisphosphites disclosed in formula XV and of α -hydrocarbon substituents on the aryl radicals R^1 / R^2 disclosed in formulae XII or XIV. Thus, said particular combination results from a selection of isolated and unrelated structural features which does not, for the skilled person, emerge clearly and unambiguously from that document. Therefore α -hydrocarbon substituted double open ended bisphosphites according to claim 1 of the patent in suit are not disclosed in document (1).

The Appellant's argument that the skilled person reading that document could easily "imagine" the bisphosphites according to claim 1 refers to considerations relevant to the evaluation of obviousness, i.e. to the matter of inventive step, rather than to that of novelty. The assessment of patentability, however, calls for a clear distinction between the respective requirements pertaining to novelty and inventive step. Therefore the Appellant's argument cannot convince the Board.

- 2.3 Nor does the Appellant's submission convince the Board that the bisphosphites according to formulae XII and XIV as such, in particular the individual bisphosphites on the top of page 14 and the bottom of page 21 of document (1), anticipated the bisphosphites according to claim 1 of the patent in suit. In those

bisphosphites of the prior art the aryl radicals R^1 and R^2 are linked to each other at their α -positions by a chemical single bond thereby forming a ring together with both oxygen atoms and the phosphorus atom. The Appellant construed that this chemical single bond linking the aryl radicals R^1 and R^2 in the known bisphosphites was covered by claim 1. However, this is to be considered as a misconstruction of the subject-matter claimed contrary to the chemical art. On the one hand the bisphosphites according to claim 1 are open ended as the radicals R^1 and R^2 are not bonded together to form a ring. The patent specification even points explicitly to the fact that the bisphosphites used in the claimed process do not comprise such a ring structure (page 5, lines 13 and 14). On the other hand the aryl radicals R^1 and R^2 are required in claim 1 to be substituted by a hydrocarbon group which substitution is different to a chemical single bond.

2.4 From the above it follows, in the Board's judgement, that document (1) does not anticipate the subject-matter of the patent in suit.

3. *Inventive step*

3.1 According to the established jurisprudence of the Boards of Appeal it is necessary, in order to assess inventive step, to establish the closest state of the art, to determine in the light thereof the technical problem which the invention addresses and successfully solves, and to examine the obviousness of the claimed solution to this problem in view of the state of the art. This "problem-solution approach" ensures assessing inventive step on an objective basis. In this context, the Boards of Appeal have developed certain criteria that should be adhered to in order to identify the closest state of the art to be treated as the starting point. The crucial criteria are that the "closest prior

art" is normally a prior art document disclosing subject-matter conceived for the same purpose as the claimed invention and additionally having the most relevant technical features in common, i.e. requiring the minimum of structural modifications.

- 3.2 The patent in suit is directed to a metal complex catalyzed hydroformylation process using aromatic bisphosphite ligands which are double open ended and wherein the hydrocarbon aryl substituents on the phosphorus atoms have a hydrocarbon group at their α -positions (claim 1). The ligands should be effective in the hydroformylation reaction and have an excellent stability (patent specification page 2, lines 26 and 27; page 28, lines 3, 4 and 9).

A similar process already belongs to the state of the art. Document (1) which is cited and acknowledged in the specification of the patent in suit on page 2, lines 5 and 6, addresses *inter alia* a rhodium complex catalysed hydroformylation process using organophosphite ligands (claim 16; page 4, lines 16 and 17; page 25, lines 11 and 12) as does the claimed process. The organophosphites may be bisphosphites which are double open ended and wherein the substituents on the phosphorus atoms are substituted hydrocarbon aryl radicals (formula XV in combination with page 17, lines 20 and 21). That document deals also with the inertness of the organophosphites, i.e. with their stability (example 49 at page 52, line 24).

Thus, document (1) relates to the same purpose as the patent in suit and it uses in the hydroformylation process organophosphites having the same structural pattern as the claimed invention, namely double open ended bisphosphites. For these reasons the Board considers, in agreement with the Appellant, with the Respondent's written submission dated 15 November 1999,

section III, and with the Opposition Division, that the disclosure of document (1) specified above represents the closest state of the art, and, hence, the starting point in the assessment of inventive step.

At the oral proceedings before the Board the Respondent considered alternatively document (4) as closest piece of prior art. However, that document is further away from the claimed invention than document (1) since document (4) refers to a hydroformylation process using phosphites having an essentially different structural pattern. Thus, the phosphites used therein are monophosphites, not bisphosphites as those used in document (1), and the aromatic substituents on their phosphorus atom are linked to each other by a chemical single bond thereby forming a ring, hence, being not open ended as in document (1). This finding disqualifies document (4) as substitute for document (1) in representing the closest piece of prior art.

- 3.3 In view of this closest state of the art the problem underlying the patent in suit as submitted by the Respondent consists in providing a hydroformylation process using phosphite ligands having improved thermal stability while maintaining activity and selectivity at a reasonable level.
- 3.4 As the solution to this problem the patent in suit proposes a hydroformylation process using double open ended bisphosphites which structure is characterised by the presence of a hydrocarbon group at the α -position of the aryl radicals on the phosphorus atoms.
- 3.5 The Appellant never disputed that the claimed hydroformylation process successfully achieves a reasonable level of activity and selectivity, and that the bisphosphites used in this process show improved thermal stability; and the Board is not aware of any

reason for challenging this finding. The experimental report of Mr. Takai submitted by the Respondent demonstrates that the thermal stability of a bisphosphite according to the invention, "ligand A", was improved vis-à-vis a bisphosphite according to document (1), "ligand B". As shown by ³¹P-NMR chart the bisphosphite ligand A is completely stable after five hours at room temperature while the bisphosphite ligand B is decomposed to about 8%. That experimental report compares the thermal stability of two bisphosphite ligands both being double open ended and differing from each other exclusively in the presence or absence of a tertiary-butyl group at the α -position of the aryl radicals on the phosphorus atoms. Therefore, the comparison of the experimental data for ligand A and B indicated in that test report truly reflects the impact of the structural modification of the aryl radicals on the phosphorus atoms, distinguishing the solution suggested by the patent in suit from the closest prior art document (1). This specific comparison of compounds A and B is, thus, a fair basis for the assessment of inventive step. For these reasons, the Board is satisfied that the problem underlying the patent in suit has been successfully solved.

3.6 Finally, it remains to be decided whether or not the proposed solution to the problem underlying the patent in suit is obvious in view of the cited state of the art.

When starting from the hydroformylation process using organophosphites ligands known from document (1) it is a matter of course that the person skilled in the art seeking to improve the thermal stability of the organophosphites would turn his attention to that prior art in the field of hydroformylation processes just dealing with the same technical problem. As a skilled person he would be struck by document (4) which relates

to a hydroformylation process operating at high activity at selectivity (column 2, lines 43 and 56) and which aims at improving the stability of the organophosphites used therein (column 2, lines 40 and 63; column 5, line 1). Moreover, he would take that document into consideration since it is particularly relevant for the reason that it points him to specific structural elements of the phosphites to be met for improving their stability. Thus, document (4) teaches at column 10, line 61 to column 11, line 41 in detail the essential structural element to be met, namely to substitute the α -position of the aryl radicals on the phosphorus atom, called "ortho"-position in that document (column 10, line 66), with a sterically hindered group such as iso-propyl or tertiary-butyl (column 11, lines 27, 28, 37 and 38) in order to improve the stability of the phosphite ligands (column 11, line 21).

The Board concludes from the above that the state of the art, in particular document (4), gives the person skilled in the art a concrete hint as to how to solve the problem underlying the patent in suit as defined in point 3.3 above, namely by substituting the α -position of the aryl radicals on the phosphorus atom of the double open ended bisphosphites known from the closest prior art document (1) (cf. point 3.2 above) by an iso-propyl or tertiary-butyl group, thereby arriving at the solution proposed by the patent in suit. In the Board's judgement, it was obvious to try to follow the avenue indicated in the state of the art with a reasonable expectation of success without involving any inventive ingenuity.

- 3.7 The Respondent argued in support of inventive step that document (4) dealt with phosphites wherein the aromatic substituents on the phosphorus atom were linked to each other by a chemical single bond thereby forming a ring

while the phosphites used in document (1) were open ended. Thus, the improvement of the stability of the phosphites in document (4) was only due to their ring structure (cf. column 5, lines 1 to 5). Therefore the teaching of that document with respect to the impact of the substitution at the α -position of the aryl radicals on the stability was restricted to phosphites having a ring structure and the skilled person was deterred from applying it to the open ended phosphites of document (1).

However, document (4) addresses precisely the problem underlying the patent in suit, namely to improve the stability of the phosphites used in a hydroformylation process, with the consequence that a skilled person necessarily takes that document into consideration when looking for a solution to that problem. Furthermore document (4) teaches clearly and unambiguously that just the substitution at the α -position of the aryl radicals with a sterically hindered iso-propyl or tertiary-butyl group, which are preferred substituting groups in the claimed invention, results in an improvement of the stability of the phosphites. Nothing was submitted by the Respondent from which the Board could reasonably conclude that the improvement of the stability of the phosphites was not due to the sterically hindered α -substitution of the aryl radicals but to the ring structure of the phosphites. Table 8 on column 62 of document (4) rather demonstrates experimentally that the improvement of stability has not its basis in the ring structure since for example phosphite No. 4, despite its ring structure, decomposes completely within one day, thus being inferior to the corresponding open ended phosphite No. 3. The passage at column 5, lines 1 to 5 of document (4) cited by the

Respondent does not support his allegation that the improvement in stability was due to the ring structure of the phosphites, since that passage does not associate any structural element of the phosphites to this effect. Insofar, the Respondent's argument is mere speculation without any basis in that state of the art.

The person skilled in the art, thus, is not deterred from applying the teaching of document (4) to the open ended phosphites known from the closest prior art document (1) in order to solve the problem underlying the patent in suit.

3.8 For these reasons, the solution to this problem proposed in claim 1 is obvious in the light of the prior art.

4. As a result, the Respondent's main request is not allowable for lack of inventive step pursuant to Article 56 EPC.

First and Second Auxiliary request

5. *Amendments*

The amendments made to claim 1 according to either auxiliary request are found on page 4, line 17, page 5, lines 2 and 3, page 6, lines 17 to 21, page 7, lines 2 to 13 and page 13, lines 2 to 7 of the application as filed, respectively. The Appellant conceded that the amended features were disclosed as such in the application as filed but objected thereto that they were not disclosed in combination thereby generating fresh subject-matter. However, a decision of the Board on this issue is unnecessary since claim 1 according to either auxiliary request does not involve an inventive step as set out below in point 7.

6. *Novelty*

In view of the considerations of the Board with respect to the main request indicated in point 2 above, the Board considers the requirements of Articles 54 EPC to be satisfied with respect to either claim 1. This finding has been conceded by the Appellant.

7. *Inventive step*

Claim 1 according to either auxiliary request differs from claim 1 according to the main request exclusively in that the definitions of the substituents R^1 , R^2 and A^1 in the phosphites of formula (I) have been restricted. The Respondent submitted at the oral proceedings before the Board that these amendments were solely designed for restricting the scope of the claims to overcome the Appellant's objection in the written proceedings of overbroad claims. The Respondent conceded that these amendments do not contribute to an inventive step.

Document (1) still represents the closest state of the art and the starting point in the assessment of inventive for the reasons given in point 3.2 above. The solution proposed by the patent in suit to the problem as defined in point 3.3 above remains to be characterised exclusively by the presence of a hydrocarbon group at the α -position of the aryl radicals on the phosphorus atoms.

The considerations having regard to inventive step given in point 3.6 with respect to the main request are neither based on nor affected by the restrictions made to the definitions of the substituents R^1 , R^2 and A^1 in the phosphites of formula (I) according to claim 1. Therefore the conclusion drawn in point 3.8 above with regard to the main request still applies for the first and the second auxiliary request, i.e. the subject-

matter of claim 1 of either auxiliary request is obvious and does not involve an inventive step.

8. In these circumstances, the Respondent's first and second auxiliary request are not allowable for lack of inventive step pursuant to Article 56 EPC as well.

Order

For these reasons it is decided that:

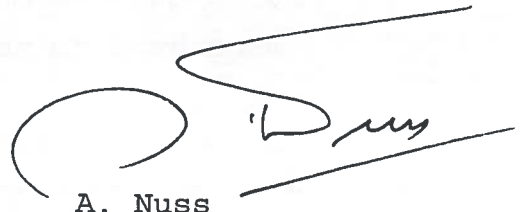
1. The decision under appeal is set aside.
2. The patent is revoked.

The Registrar:



N. Maslin

The Chairman:



A. Nuss