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**Datasheet for the decision
of 8 December 2011**

Case Number: T 0871/08 - 3.3.05

Application Number: 00850170.2

Publication Number: 1101733

IPC: C01B 15/023

Language of the proceedings: EN

Title of invention:

Process and composition for the production of hydrogen peroxide

Patent Proprietor:

Akzo Nobel N.V.
Eka Chemicals AB

Opponents:

ARKEMA FRANCE
Evonik Degussa GmbH
Kemira OYJ

Headword:

H₂O₂ production/AKZO

Relevant legal provisions:

EPC Art. 54(1)(2), 56

Keyword:

"Main request: novelty (no): state of the art value to be compared to the claimed value with the same accuracy"
"Third and fifth auxiliary requests: inventive step (no) - absence of a particular effect - ranges of values derivable from the state of the art"

Decisions cited:

T 1186/05, T 0708/05, T 0013/84, T 0530/90

Catchword:

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Case Number: T 0871/08 - 3.3.05

DECISION
of the Technical Board of Appeal 3.3.05
of 8 December 2011

Appellant I:
(Opponent 1)

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Decision under appeal: Interlocutory decision of the Opposition
Division of the European Patent Office posted
26 March 2008 concerning maintenance of
European patent No. 1101733 in amended form.

Composition of the Board:

Chairman: G. Raths
Members: J.-M. Schwaller
D. Prietzel-Funk

Summary of Facts and Submissions

I. These appeals lie from the decision of the opposition division concerning maintenance of European patent No. 1 101 733 in amended form on the basis of the main request filed during the oral proceedings of 4 March 2008, of which independent claim 1 reads as follows:

"1. A process for production of hydrogen peroxide according to the anthraquinone process comprising the steps of alternate hydrogenation and oxidation of anthraquinones and tetrahydro anthraquinones in a working solution, characterised in that the working solution to be hydrogenated comprises a mixture of alkyl-substituted anthraquinones and alkyl-substituted tetrahydro anthraquinones dissolved in at least one organic solvent, wherein from 10 to 55 mole % of the anthraquinones and the tetrahydro anthraquinones are substituted with one amyl group, and the molar ratio of alkyl-substituted tetrahydro anthraquinones to alkyl-substituted anthraquinones is from 3:1 to 9:1."

II. In the contested decision the opposition division concluded that the above claim met the requirements of the EPC in view of the cited prior art, which included the following documents:

D5: US 3 073 680

D6: DE 198 16 297 A1

D7: WO 95/28350

D9: SU 465 070 A and its translation in English (D9a)

D11: Declaration of Dr. R.E. Edvinsson.

The opposition division held the subject-matter of the above claim to be novel over document D9a, in particular over Example 3 which did not disclose any amyl-substituted anthraquinone, which was compulsory in said claim.

It also held the subject-matter of the above claim to involve an inventive step, because starting from either document D5 or document D7, the technical problem was to be seen in the provision of a working solution having high stability against side reactions and enabling high concentration of hydroquinones. The data in D11 gave evidence that the reaction rate increased in the range of the mole fraction claimed while the quinone loss was kept minimal in this fraction. These effects being neither disclosed nor suggested by the documents in the procedure, the claimed subject-matter was not obvious for the skilled person in view of the state of the art.

- III. The three opponents lodged an appeal against the first instance decision.
- IV. In an interlocutory decision dated 23 February 2009, the board judged the appeal of opponent II (hereinafter called "the party as of right) deemed as having not been filed, the appeal fee having not been paid in time.
- V. On 23 January 2009, the patent proprietor (hereinafter "the respondent") submitted three new sets of claims as auxiliary requests 1 to 3, respectively.

VI. The opponents' submissions were as follows:

- Appellant I/Opponent I: letters dated 9 July 2008 (statement of grounds of appeal) and 9 February 2010;
- Party as of right/Opponent II: letters dated 17 June 2008, 16 September 2008 and 28 April 2009;
- Appellant II/Opponent III: letter dated 15 July 2008 (statement of grounds of appeal).

VII. In response to the summons to attend oral proceedings, the respondent submitted with a letter dated 10 October 2011 seven sets of claims as the main request and as first to sixth auxiliary requests, respectively, with the claims of the main request corresponding to those maintained by the opposition division and the claims of the third and fifth auxiliary requests corresponding to those of the second and third auxiliary requests dated 23 January 2009, respectively.

Independent claim 1 of the third auxiliary request reads as follows (differences to independent claim 1 of the main request emphasised by the board):

"1. A process for production of hydrogen peroxide according to the anthraquinone process comprising the steps of alternate hydrogenation and oxidation of anthraquinones and tetrahydro anthraquinones in a working solution, characterised in that the working solution to be hydrogenated comprises a mixture of alkyl-substituted anthraquinones and alkyl-substituted tetrahydro anthraquinones dissolved in at least one

organic solvent wherein from **20 to 50 mole %** of the anthraquinones and the tetrahydro anthraquinones are substituted with one amyl group, **from 55 to 80 mole % of the anthraquinones and the tetrahydro anthraquinones are substituted with one ethyl group**, and the molar ratio of alkyl-substituted tetrahydro anthraquinones to alkyl-substituted anthraquinones is from 3:1 to 9:1."

Independent claim 1 of the fifth auxiliary request reads as follows (differences to independent claim 1 of the main request emphasised by the board):

"1. A process for production of hydrogen peroxide according to the anthraquinone process comprising the steps of alternate hydrogenation and oxidation of anthraquinones and tetrahydro anthraquinones in a working solution, characterised in that the working solution to be hydrogenated comprises a mixture of alkyl-substituted anthraquinones and alkyl-substituted tetrahydro anthraquinones dissolved in at least one organic solvent **and is substantially free from unsubstituted anthraquinone and tetrahydro anthraquinone**, wherein from 10 to 55 mole % of the anthraquinones and the tetrahydro anthraquinones are substituted with one amyl group, **from 45 to 90 mole % of the anthraquinones and the tetrahydro anthraquinones are substituted with one ethyl group**, and the molar ratio of alkyl-substituted tetrahydro anthraquinones to alkyl-substituted anthraquinones is from 3:1 to 9:1."

VIII. In their answers to the summons to oral proceedings, the appellants/opponents requested the board not to admit into the proceedings the first, second, fourth and sixth auxiliary request dated 10 October 2011,

because these requests violated the principles prohibiting the reformatio in peius established in decision G 1/99.

They also raised different objections under Articles 54, 56, 83, 84 and 123 EPC.

IX. Oral proceedings were held on 8 December 2011 in the presence of all the parties.

The board informed the parties of its preliminary opinion that it was not prepared to admit into the proceedings the first, second, fourth and sixth auxiliary requests dated 10 October 2011.

The respondent then declared that it withdrew these requests.

X. The parties' requests were established as follows:

The appellants/opponents requested that the decision under appeal be set aside and that the patent be revoked. Appellant II/Opponent III further requested the reimbursement of its appeal fee.

The respondent requested that the appeals be dismissed. Alternatively, it requested that the decision under appeal be set aside and that the patent be maintained on the basis of one of the sets of claims according to the third or fifth auxiliary request submitted with its letter dated 10 October 2011.

Reasons for the Decision

1. *Main request - Interpretation*

1.1 Claim 1 recites the expression "10 to 55 mole% of the anthraquinones and the tetrahydro anthraquinones are substituted with one amyl group" which allows for two interpretations:

(a) 10 to 55 mole% of **both** the anthraquinones and the tetrahydro anthraquinones are substituted with one amyl group

(b) 10 to 55 mole% of the **total amount of** anthraquinones and tetrahydro anthraquinones are substituted with one amyl group.

1.2 In order to find out which interpretation is to be made for the present decision, the description of the patent in suit is to be taken into consideration.

In this respect, the passage at page 1, lines 30 and 31 describes that "it is also possible to use working solutions almost free from alkyl-substituted anthraquinones". Example 3 of the contested patent discloses a working solution (3D) containing 36 kg/m³ of tetrahydro amyl anthraquinone and 0 kg/m³ amyl anthraquinone.

It follows that the inventor's intention was to consider a composition which necessarily included an amyl-substituted anthraquinone, and so the board endorses the interpretation (b).

2. *Main request - Novelty*

2.1 Document D9 (see D9a, abstract) relates to a method for hydrogen peroxide production by an anthraquinone method involving hydrogenation of a mixture of alkyl and tetrahydroalkyl anthraquinones dissolved in organic solvents. The mixture is further supplemented with amyl anthraquinones and tetrahydroamyl anthraquinones.

2.2 In Example 3 of D9, the working solution contains

- 0.233 mol/l of 2-ethyl anthraquinone,
- 0.312 mol/l of tetrahydro 2-ethyl anthraquinone,
- 0.139 mol/l of tetrahydro anthraquinone,
- 0.386 mol/l of tetrahydro 2-isoamyl anthraquinone.

It follows that in the working solution:

- 36,07 mole % of the anthraquinones and the tetrahydro anthraquinones are substituted with one amyl group;
- the molar ratio of alkyl-substituted tetrahydro anthraquinones to alkyl-substituted anthraquinones - when calculated from the values in Example 3 - is 2.996 : 1.

2.3 The respondent argued that the claimed subject-matter was novel, because the value 2.996 was lower than the lower limit of 3:1 defined in claim 1 at issue.

This argumentation is not accepted by the board. When comparing a value from the state of the art (in the present case the value "2.996") - with those claimed (here the range of values of "from 3:1 to 9:1"), the

state of the art value has to be given the same accuracy as the one claimed. In the case at issue, the values in the claims have been quoted without any digit after the comma, which means that for comparison purposes, the value 2.996 has to be rounded up to 3, which thus falls into the range of the claimed values. This judgement is in agreement with the jurisprudence of the boards of appeal (in particular T 1186/05, points 3.6.1 to 3.6.5 of the reasons; T 0708/05, point 3. of the reasons).

All the other features defined in claim 1 being also disclosed in combination in document D9 (see D9a), claim 1 of the main request lacks novelty under Article 54 (1) and (2) EPC.

3. *Third auxiliary request - Novelty*

The board observes that novelty of claim 1 of this request does not have to be decided upon because - as explained hereinafter - of lack of inventiveness of the subject-matter thus claimed.

4. *Third auxiliary request - Inventive step*

4.1 The contested patent relates to the production of hydrogen peroxide according to the anthraquinone process comprising the steps of alternate hydrogenation and oxidation of anthraquinones and tetrahydro anthraquinones in a working solution comprising a mixture of alkyl-substituted anthraquinones and alkyl-substituted tetrahydro anthraquinones dissolved in an organic solvent.

4.2 The starting point for assessing inventive step has been unanimously acknowledged at the oral proceedings to be represented by document D7.

D7 (claim 1) discloses a method for producing hydrogen peroxide from a working solution containing an anthraquinone compound successively hydrogenated and oxidized, the method providing hydrogen peroxide in high yield with little decomposition of the working solution and minimal formation of by-products. The method in question makes use of a working solution containing substantially "all-tetra" hydroanthraquinone compounds.

As indicated at page 2, line 28 to page 3, line 1, the so called "all-tetra" working solution principally (i.e. at least 50%) consists of nuclearly hydrogenated anthraquinone of ethyl and/or amylanthraquinone", i.e. tetrahydro amylanthraquinone (THAAQ) and/or tetrahydro ethylanthraquinone (THEAQ), in an organic solvent. According to claim 9, the working solution can also contain ethylanthraquinone (EAQ) and amylanthraquinone (AAQ). So, there is a direct and unambiguous teaching in D7 that the molar ratio of alkyl-substituted tetrahydro anthraquinones to alkyl-substituted anthraquinones in the working solution be **at least 1:1**.

Among the specific embodiments disclosed in D7, the closest to the claimed subject-matter is the working solution WS II (D7, page 7) that consists of EAQ (5 g/l), THEAQ (60 g/l), AAQ (10 g/l) and THAAQ (100 g/l) in a solvent mixture. This working solution thus comprises **59 mol%** of amyl substituted anthraquinones and **41 mol%** of ethyl substituted anthraquinones, and

its molar ratio of tetrahydro anthraquinones to anthraquinones is **10.6:1** (these values have been obtained by calculation and have been given the same accuracy as the values defined in claim 1 of auxiliary request 3).

- 4.3 Starting from the above state of the art, the question arises as to which problem is supposed to be solved by the alleged invention.
- 4.3.1 The contested patent (paragraphs [0004] and [0007]) aimed at providing a working solution with high solubility, enabling high concentration of hydroquinones, which working solution was also highly stable against side reactions during the hydrogenation step.
- 4.3.2 This problem is however already solved in document D7, which in particular discloses (page 3, line 1 and 2) that the superior solubility of amylanthraquinone makes it possible to operate at a high degree of hydrogenation and with a minimal formation of by-products. It follows that the problem has to be reformulated.
- 4.3.3 Having been questioned on that issue, the respondent argued that the additional experiments summarised in document D11 showed that the claimed ranges gave rise to high stability of the working solution and high reaction rate, thus enabling operation with a high hydrogenation degree.

The board observes in this respect that a high stability of the working solution and a high degree of

hydrogenation are also observed in the process according to D7. So in the absence of any objective comparison with the process according to D7, no improvement can be recognised to the subject-matter defined in claim 1 at issue.

- 4.3.4 The respondent further argued that it could be seen from D11 that when the fraction of tetrahydro anthraquinones was within the range specified in claims 1 and 7, it would be favourable to operate with a high fraction of tetrahydro anthraquinones, however due to the dramatic drop in reaction rate at too high levels tetrahydro anthraquinones, it was advisable to operate with a reasonable safety margin to the point where the drop occurred. This was because in a full scale plant containing large volumes of working solution it took long time to restore the desired concentrations once a production drop had occurred. A molar ratio of up to 9:1 thus provided a sufficient safety margin for stable operation with a high hydrogenation rate and thereby a possibility of reaching a high hydroquinone concentration in the working solution.

The board observes that a reformulation of the problem taking into account the above arguments would only be allowable, if the new problem could be deduced from the application as filed when considered in the light of the closest state in the art (see in this respect T 0013/84, OJ EPO 1986, 253; T 0530/90, point 4.3 of the reasons). In the present case, there is no basis in the application as filed for the provision of the so-called "safety margin for stable operation" that the respondent emphasised during the oral proceedings, nor

can the latter be deduced from the application as filed by a person skilled in the art.

4.3.5 It follows that the problem is to be reformulated in less ambitious terms, namely, to provide an **alternative** process for the production of hydrogen peroxide according to the anthraquinone process.

4.4 As a solution to this technical problem the contested patent proposes the process defined in claim 1 at issue, which makes use of a working solution characterised in that:

- from **20 to 50** mole % of the anthraquinones and the tetrahydro anthraquinones are substituted with one amyl group,
- from **55 to 80** mole % of the anthraquinones and the tetrahydro anthraquinones are substituted with one ethyl group,
- and the molar ratio of alkyl-substituted tetrahydro anthraquinones to alkyl-substituted anthraquinones is from **3:1 to 9:1**.

4.5 It remains to be decided whether the proposed solution is obvious in view of the state of the art when starting from the disclosure in document D7.

4.5.1 As indicated in point 4.2, D7 teaches that the molar ratio of alkyl-substituted tetrahydro anthraquinones to alkyl-substituted anthraquinones in the working solution is **at least 1:1**. It follows that the person skilled in the art is clearly encouraged to operate within that broad range and all other sub-ranges encompassed by the latter.

4.5.2 As regards the specific sub-range of "from 3:1 to 9:1", it is true - as argued by the respondent - that there is no particular pointer to this sub-range in D7. However according to the jurisprudence of the boards of appeal, in the absence of a particular effect or advantage arising from the values in the sub-range - this is the case here (see the points 4.3.3 and 4.3.4 above) - the selection of such a sub-range boils down to a mere arbitrary choice of values among a broader range of values - here the range of at least 1:1. Such a mere arbitrary choice is however within the competence of the person skilled in the art seeking for an alternative. It follows that the absence of a pointer to a particular sub-range does not necessarily imply non obviousness.

4.5.3 The respondent argued that there was no teaching in the state of the art to operate within the claimed ranges of from a) **20 to 50** mole % and b) **55 to 80** mole %. It referred in this respect to the specific working solutions WS II and WS III in D7, the compositions of which were clearly outside these ranges, and so were teaching away from the ranges defined in claim 1 at issue.

The board does not accept this argument, because even if the specific embodiments in D7 might not fall within these ranges, the skilled person is supposed to be aware of the further state of the art in the technical field at issue, and in this respect it cannot ignore the disclosure of document D6, which - alike D7 and the subject-matter claimed - relates to the production of hydrogen peroxide according to the cyclic anthraquinone process with a working solution containing at least two

differently substituted alkylanthraquinones and/or the corresponding alkyltetrahydroanthraquinones.

4.5.4 D6 discloses in particular in its examples working solutions consisting of a mixture of EAQ, AAQ, THEAQ and THAAQ, i.e. those components also disclosed in the preferred working solutions of D7. Among the working examples shown in tables 1, 2 and 3 of D6 and based on the above mixture, those solutions described in Examples 4.6, 4.8, 4.9, 4.12 and 5.3 have a (calculated) molar composition (20%/80%, 39%/61%, 41%/59%, 23%/77% and 40%/60%, respectively) which fall within the ranges "20 to 50 mole %" and "55 to 80 mole %" defined in claim 1 at issue.

4.5.5 It is true that D6 presents these working solutions for comparative purposes, as they have the disadvantage to be susceptible to interruptions in the hydrogenation stage and hence they lower the economy of the process. These working solutions are nevertheless considered to represent the closest state of the art to the invention disclosed in D6, because of their high hydrogen peroxide production capacity. It follows that the skilled person reading D6 cannot ignore them, since it is clearly taught by these examples that working solutions having the above composition are also plainly suitable for producing hydrogen peroxide in high yields in accordance with the cyclic anthraquinone process.

4.5.6 The process according to D6 being precisely of the same type as the one disclosed in document D7, the person skilled in the art is thus encouraged to operate with the alternative compositions described in the above

Examples of D6 and will thus arrive at the subject-matter of claim 1 at issue.

It is true - as argued by the respondent - that the molar ratio of alkyl-substituted tetrahydro anthraquinones to alkyl-substituted anthraquinones in these alternative compositions (respectively 1.5, 1.68, 2.1, 1.68 and 1.58) is below the range of from 3:1 to 9:1 defined in claim 1 at issue. This molar ratio nevertheless falls within the terms of the ratio of at least 1:1 taught in document D7, and so the skilled person would not be deterred from using the above promising alternative compositions in the process D7 in order to solve the problem addressed in point 3.3.5.

4.5.7 It follows from the above considerations that the subject-matter of claim 1 at issue is obvious from the state of the art for a person skilled in the art, and thus it does not involve an inventive step within the meaning of Article 56 EPC.

5. *Fifth auxiliary request - Inventive step*

5.1 Claim 1 of this request differs from claim 1 of the third auxiliary request in that:

i) the ranges "20 to 50" and "55 to 80" have been amended to "10 to 55" and "45 to 90", respectively;

ii) the working solution has been further characterised in that it is "*substantially free from unsubstituted anthraquinone and tetrahydro anthraquinone*".

- 5.2 The amendment i) boils down to a broadening of both ranges defined in claim 1 of the third auxiliary request. It follows that as regards the obviousness of these broadened ranges, the reasoning is exactly the same as for the most restricted ranges defined in the third auxiliary request (see point 4.5.4 above).
- 5.3 Feature ii) is disclosed in D7 and in D6, too. Reference is made to the preferred embodiments WS I, WS II and WS III in the table at page 7 in D7 and to Examples 4.6, 4.8, 4.9, 4.12 and 5.3 in D6, which do not contain any unsubstituted anthraquinone and tetrahydro anthraquinone.
- 5.4 It follows that for the same reasons as those indicated in points 4.3 to 4.5.7 above, the subject-matter of claim 1 of this request also lacks an inventive step under Article 56 EPC.

6. *Reimbursement of the appeal fee*

- 6.1 Pursuant to Rule 103 EPC, the appeal fee shall be reimbursed where the Board of Appeal deems an appeal to be allowable and if such reimbursement is equitable by reason of a substantial procedural violation. In the present case, appellant II argued that it had requested the revocation of the patent not only on grounds of Articles 54 and 56 EPC, but also on the basis of Article 100(c) EPC. Despite its request to do so, the latter was rejected to be discussed in the oral proceedings before the opposition division concerning the new claims submitted in the oral proceedings, so that Article 100(c) EPC was not discussed in connection with Article 123(2) EPC. Thus the decision was based on

grounds on which it did not have the opportunity to present its comments, so that the decision did not comply with Article 113(1) EPC.

6.2 However, these statements do not justify the reimbursement of the appeal fee.

6.2.1 It is to be observed that, pursuant to the minutes of the oral proceedings before the opposition division, the patent proprietor/respondent withdrew all requests on file at the beginning of the oral proceedings before the opposition division and replaced them by a new main request (and three auxiliary requests) to the effect, that the original feature "at least 3:1", which was attacked by appellant II/opponent 3 with its notice of opposition on the basis of inter alia Article 100(c) EPC, was replaced by "from 3:1 to 9:1". Since the originally attacked feature was no longer defended and as such cancelled by the patent proprietor/respondent, there was no reason to discuss it during the oral proceedings.

6.2.2 As regards a further discussion of extended subject-matter, pursuant to said minutes, the chairman of the opposition division invited the opponents to argue on any formal objections, namely under e.g. Articles 123(2) and 84 EPC, against the amendments in claim 1 and 7 (forming the new main request). All parties then discussed the admissibility of the new claims under Article 123(2) EPC. This means, that not only opponent 3/appellant II had in fact the chance to give comments on this topic. Additionally, while regarding the then current claims, the impugned decision deals explicitly

with Article 123(2) EPC. Considering all this, a violation of the right to be heard cannot be recognised.

- 6.2.3 No substantial procedural violation being established, the main condition stated in Rule 103 EPC for the reimbursement of the appeal fee is not fulfilled so that there is no need to examine whether it would have been equitable to reimburse the appeal fee.

Order

For these reasons it is decided that:

1. The decision under appeal is set aside.
2. The patent is revoked.
3. The request for reimbursement of the appeal fee by appellant 2 is rejected.

The Registrar:

The Chairman:

B. Atienza Vivancos

G. Rath