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# Datasheet for the decision of 24 August 2016

**Case Number:** T 0281/13 - 3.3.10

**Application Number:** 05704387.9

**Publication Number:** 1710227

**IPC:** C07C51/235, C07C57/055

**Language of the proceedings:** EN

**Title of invention:**
METHOD FOR PRODUCING ACRYLIC ACID

**Patent Proprietor:**
Nippon Shokubai Co.,Ltd.

**Opponent:**
ARKEMA FRANCE

**Headword:**
METHOD FOR PRODUCING ACRYLIC ACID/Nippon Shokubai

**Relevant legal provisions:**
EPC Art. 100(b), 56

**Keyword:**
Grounds for opposition - insufficiency of disclosure (no)
Inventive step (yes) - non-obvious alternative

**Decisions cited:**

**Catchword:**

Europäisches Patentamt
European Patent Office
Office européen des brevets

**Beschwerdekammern**
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**Case Number: T 0281/13 - 3.3.10**

# D E C I S I O N
## of Technical Board of Appeal 3.3.10
## of 24 August 2016

| | |
|---|---|
| **Appellant:** (Opponent) | ARKEMA FRANCE<br>420, Rue d'Estienne d'Orves<br>92700 Colombes (FR) |
| **Representative:** | Bonnel, Claudine<br>ARKEMA FRANCE<br>Département Propriété Industrielle<br>420, rue d'Estienne d'Orves<br>92705 Colombes Cedex (FR) |
| **Respondent:** (Patent Proprietor) | Nippon Shokubai Co.,Ltd.<br>1-1, Koraibashi 4-chome, Chuo-ku<br>Osaka-shi, Osaka 541-0043 (JP) |
| **Representative:** | Schön, Christoph<br>Dr. Schön, Neymeyr & Partner mbB<br>Bavariaring 26<br>80336 München (DE) |
| **Decision under appeal:** | **Decision of the Opposition Division of the European Patent Office posted on 10 December 2012 rejecting the opposition filed against European patent No. 1710227 pursuant to Article 101(2) EPC.** |

**Composition of the Board:**

| | |
|---|---|
| **Chairman** | P. Gryczka |
| **Members:** | J.-C. Schmid |
| | C. Schmidt |

## Summary of Facts and Submissions

I. The Appellant (Opponent) lodged an appeal against the decision of the Opposition Division rejecting the opposition against the European patent No. 1 710 227 which was granted on the basis of eight claims, claim 1 of which reading as follows:

"1. A process for producing acrylic acid, comprising the steps of:

subjecting glycerol in the form of an aqueous glycerol solution having a water content of no more than 50% by weight to a dehydration reaction in which said glycerol is used as a raw material in a gas phase; and then applying a gas phase oxidation reaction to a gaseous reaction product formed by the dehydration reaction."

II. Notice of opposition had been filed by the Appellant requesting revocation of the patent in suit in its entirety on the grounds of lack of novelty and inventive step (Article 100(a) EPC), and insufficient disclosure (Article 100(b) EPC). Inter alia the following documents were submitted in the opposition proceedings:

(1) US-A-2 042 224,
(2) Acrylic Acid/Acrylates, Chem Systems, 00/01-7, May 2001, pages 17 to 25,
(3) US-A-5 387 720,
(6) "Methanolyse des huiles végétales", L'Actualité Chimique, November-December 2002, pages 64 to 69, and
(7) WO-A-2006/114506, pages 19 and 20.

III. The Opposition Division did not admit the trial reports filed by the Appellant on 5 October 2012 (documents (9) and (10)) into the proceedings, since they were filed about four weeks before the oral proceedings, thus not given sufficient time to the Respondent to carry out counter-experiments.

The attempts by the Appellant to repeat the examples of the patent-in-suit described in documents (7) and in the further trial filed with a letter dated 30 May 2011 (document (8)) were not carried out as described in the patent-in-suit. Therefore the Appellant did not demonstrate that the invention was insufficiently disclosed. The subject-matter of claim 1 was novel over document (1), since this document did not disclose an aqueous glycerol solution having a water content of not more than 50% by weight. Document (2) which disclosed a process for producing acrylic acid by the oxidation of propylene was the closest prior art to the invention. The technical problem was the provision of an alternative process for producing acrylic acid starting from renewable materials. The solution was the process of claim 1 characterized in that a dehydration reaction is applied in which glycerol is used as raw material in a gas phase, wherein glycerol in aqueous solution having a water content of no more than 50% by weight is subjected to the dehydration reaction. Document (2) did not contain any pointer to using glycerol as starting material for producing acrylic acid, let alone to using glycerol in the form of an aqueous glycerol solution having a water content of no more than 50% by weight. Document (3) disclosed a process for preparing acrolein by dehydration of aqueous glycerol either in the liquid or in the gas phase. This document pointed to condensing the gaseous acrolein reaction product and purifying it by distillation or fractional condensation

and did not contain any hint to using the gaseous reaction product obtained from the dehydration reaction directly for the oxidation to acrylic acid. Hence, the subject-matter of claim 1 involved an inventive step.

IV. According to the Appellant documents (9) and (10) should be admitted into the proceedings. They had been filed in due time in order to support the Appellant's arguments. Document (9) showed that the means used to heat had no influence upon the yield while document (10) showed that the water content of the aqueous glycerol solution was not an essential feature of the claimed process.

The invention was insufficiently disclosed because the reproduction of examples of the patent-in-suit did not achieve the desired result, namely the production of acrylic acid was not obtained in example 3 of document (7) and was obtained as in example 3 of document (8) only with a very poor yield.

Document (2) represented the closed prior art to the invention. This document disclosed a two-stage process for the preparation of acrylic acid comprising the catalytic oxidation of propylene into acrolein, followed by the oxidation of acrolein into acrylic acid. The reaction gas comprising acrolein obtained from the first stage was directly fed into a second oxidation reactor where acrolein was converted into acrylic acid.

The claimed process differed from the process disclosed in document (2) only in that the reaction gas comprising acrolein was obtained by dehydrating an aqueous glycerol solution having a water content of no more than 50% by weight instead of oxidizing propylene.

The technical problem underlying the patent-in-suit was seen in the provision of an alternative process for producing acrylic acid starting from renewable materials. This problem was not solved across the entire scope of the broadly drafted claims. Document (3) disclosed that acrolein was obtained by dehydrating an aqueous glycerol solution having a water content of 60 to 90 % by weight. Nevertheless document (3) indicated that dehydration did indeed still occur if glycerol with a water content under 60% by weight was used but that the use of a higher concentration of glycerol reduced the selectivity of the reaction and the service life of the catalyst. The experimental trials (document (9)) confirmed that the water content of the aqueous glycerol composition had very little impact on the production of acrylic acid. The skilled man faced with the problem of providing an alternative process for preparing acrylic acid would thus have contemplated the solution of producing a reaction gas comprising acrolein by dehydrating a aqueous glycerol solution having a water content of less than 50% by weight and thus would have arrived at the subject-matter of claim 1 without the exercise of inventive activity. The claimed subject-matter lacked therefore an inventive step stating from document (2) in combination with document (3).

The claimed subject-matter was also obvious in the light of document (1) in combination with the general knowledge of the skilled man, starting from document (3) in combination with document (2), or in the light of document (6), which taught that glycerol was a renewal material available in large scale and that acrolein was a by-product obtained in the production of polyglycerols by dehydration of glycerol. Hence the claimed subject-matter lacked an inventive step.

V. The Respondent objected to the admission of documents (9) and (10) in the appeal proceedings because they were late filed and lacked relevance. The experimental results provided in documents (7) and (8) did not provide any evidence that the invention as claimed was not sufficiently disclosed so as to be carried out by a person skilled in the art.

Document (2) was the closest prior art to the invention. The technical problem to be solved was the provision of a continuous and efficient process for manufacturing acrylic acid in large scale. The solution was to use glycerol as a raw material in a gas phase wherein glycerol in an aqueous solution having a water content of no more than 50% by weight is subjected to a dehydration reaction in gaseous phase. The appellant's objection that the technical problem was not solved across the entire scope of the claims was not supported by the experiments provided. On the contrary, experiments 1 and 2 of document (9) demonstrated that the problem was solved by using an aqueous glycerol solution having a water content of not more than 50% in a gas-phase dehydration reaction. Document (3) taught a process for the production of acrolein which subjected a glycerol-water mixture having a water content of 60 to 90 weight % to a dehydration reaction either in a liquid or in a gaseous phase. This document only disclosed the condensation of the reaction gas product containing acrolein and pointed to its purification by distillation or by fractional condensation. Furthermore document (3) taught away from using a concentrate glycerol aqueous solution. Accordingly, the subject-matter of the claims as granted involved an inventive step.

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

VII. The Respondent requested that the appeal be dismissed and the patent be maintained as granted (main request), or, subsidiarily, on the basis of any one of the auxiliary requests 1 to 3, filed with the letter dated 14 August 2013.

VIII. At the end of the oral proceedings held in the absence of the Appellant, which after being duly summoned informed the Board that it would not attend, the decision of the Board was announced.

## Reasons for the Decision

1. The appeal is admissible.

*Late filed documents (9) and (10)*

2. Documents (9) and (10) are experimental reports and had already been filed during the proceedings before the opposition division. They were filed again with the statement of the grounds of appeal in order to support arguments of the Appellant contesting the decision of the opposition division. They do not amount to a fresh case. Given the fact that the Respondent now had had sufficiently time to consider these reports, the Board decides to admit them into the appeal proceedings.

*Main request: claim as granted*

*3. Sufficiency of disclosure (Article 100(b) EPC)*

According to the Appellant the invention was insufficiently disclosed, since attempts to reproduce the processes described in examples 1 to 5 of the

patent specification gave acrylic acid in much poorer yields than those indicated in the patent-in-suit, the reproduction of the process described in referential example 3 of document (7) producing even no acrylic acid, or otherwise according to document (8) with very poor yield.

With respect to sufficiency of disclosure, the relevant question is whether the patent-in-suit provides sufficient information which enables the skilled person to perform the invention as defined in the claims. The Appellant's objection mainly concerns an alleged poor yield of the end product when performing the claimed process.

However, in the present case the yield achieved by the claimed process is not relevant for sufficiency of disclosure, as claim 1 only requires characteristics relating to the process without specifying any yield to be achieved.

The claimed process comprises two steps, the first being a step of dehydration of glycerol in an aqueous solution as described in paragraphs [0011] to [0013] of the patent-in-suit, also known from the prior art (e.g. see document (3)); the second being an oxidation step as described in paragraphs [0014] to [0016], which the skilled is able to carry out using common knowledges. Furthermore the Board notes that the Appellant in order to show that the claimed subject-matter lacked an inventive step filed further trials wherein the claimed process was carried out with success (see trials 4 and 6 of document (9)).

Thus, the Appellant's objection to the sufficiency of the disclosure of the invention fails.

*4. Inventive step*

*4.1 Closest prior art*

The Board considers, in agreement with the opposition division and the Parties, that document (2) represents the closest state of the art to the invention. This document discloses an industrial two-stage continuous process for the manufacture of acrylic acid comprising the catalytic oxidation of propylene into acrolein, followed by the further oxidation of acrolein into acrylic acid. The reaction gas comprising acrolein obtained from the first stage is directly fed into a second oxidation reactor where acrolein was converted into acrylic acid.

4.2 *Technical problem underlying the patent-in-suit*

According to the Respondent, the technical problem underlying the patent-in-suit was to provide a further continuous and efficient process for manufacturing acrylic acid in large scale.

4.3 *Proposed solution*

The solution proposed by the patent-in-suit is the method of claim 1 characterized in that the reaction gas comprising acrolein is produced by subjecting glycerol in an aqueous solution having a water content of no more than 50% by weight to a dehydration reaction in gaseous phase.

4.4 *Success*

The Appellant objected to that the technical problem was not solved across the entire scope of the broadly

drafted claim 1. There existed serious doubts as to whether all possible catalysts and all operating conditions, such as temperature, flow or pressure, which characteristics were absent from claim 1, were solutions to the technical problem.

However, the solution proposed is not characterized by operating conditions or by the catalysts used in the process. The proposed solution is characterized in that the reaction gas comprising acrolein is produced by subjecting glycerol in an aqueous solution having a water content of no more than 50% by weight to a dehydration reaction in a gaseous phase.

The proposed solution involves a single starting material, namely glycerol, which is in an aqueous solution. The Appellant conceded that the water content of the aqueous solution has no impact on the production of acrylic acid (see document (9)). Examples 1 to 5 of the patent-in-suit show that a reaction gas comprising acrolein is produced by dehydrating aqueous glycerol having water contents of less than 50% by weight.

Hence, the Board is satisfied that the technical problem is solved by the process by the process as defined in claim 1 of the patent-in-suit.

4.5 *Obviousness*

Finally, it remains to be decided whether or not the proposed solution to this objective technical problem is obvious in view of the cited state of the art, in other words whether it was obvious for the skilled person to substitute the reaction gas product obtained by oxidizing propylene into acrolein by a reaction gas

obtained by dehydrating an aqueous solution of glycerol.

The Appellant addressed document (3) in this respect. This document discloses a process for the production of acrolein by dehydration of glycerol in the gaseous phase (see examples 1 to 3). The reaction gas produced by oxidizing propylene during the first stage of the process of document (2) comprises water and acrolein as does the reaction product obtained by the process of document (3).

However, neither document (2) nor document (3) taught that aqueous glycerol can replace propylene as the starting material for manufacturing acrylic acid.

In the process described in document (3) the gaseous reaction mixture leaving the catalyst is directly condensed to obtain an aqueous acrolein solution (see examples 1 to 3, column 4, lines 59 and 60). This condensate may additionally contains secondary products which have been formed (see column 3, lines 3 to 8). Document (3) discloses that the condensate may be directly further processed, such as for the production of 1,2-propanediol in an ion exchanger (see example 4), or alternatively, acrolein may be recovered by distillation or fractional condensation. Accordingly, there is no hint in document (3) suggesting that a crude gas product obtained by dehydrating an aqueous solution of glycerol can substitute the reaction gas product obtained in the first stage by oxidizing propylene which is directly to be fed into an oxidation reactor for the production of acrylic acid.

Thus, the Board concurs with the conclusion of the Opposition Division that document (3) does not render

the proposed solution obvious. Therefore, the subject-matter of claim 1 of the main request, and for the same reason, that according to dependent claims 2 to 8 involve an inventive step within the meaning of Article 56 EPC.

5. The Appellant also objected inventive step in the light of document (1), starting from document (3) in combination with document (2) or in the light of document (6).

According to the established jurisprudence of the Boards of Appeal inventive step is assessed on the basis of the "problem-solution" approach, which requires establishing the closest state of the art, determining in the light thereof the technical problem which the invention addresses and successfully solves, and examining the obviousness of the claimed solution to this problem in view of the state of the art. This "problem-solution approach" ensures that inventive step is assessed on an objective basis and avoids an *ex post facto* analysis.

Document (1) is concerned with a process of converting a polyhydric alcohol to a carbonyl compound, document (3) relates to a process for the production of acrolein and document (6) describes the methanolysis of vegetable oils. None of these documents even mentions acrylic acid. Therefore, the skilled would not have considered these documents as a starting point for the manufacture of acrylic acid. Accordingly, these lines of argumentation of the Appellant against inventive step must be rejected.

6. Since the main request is allowable for the reasons set out above, there is no need for the Board to decide on the lower ranking auxiliary requests 1 to 3.

## Order

## For these reasons it is decided that:

The Appeal is dismissed.

The Registrar: The Chairman:

C. Rodríguez Rodríguez P. Gryczka

Decision electronically authenticated