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D E C I S I O N
of 28 April 1998

Case Number: T 0646/94 - 3.3.1

Application Number: 87117070.0

Publication Number: 0268999

IPC: C07C 69/54

Language of the proceedings: EN

Title of invention:
Process for producing t-butyl methacrylate

Patentee:
MITSUBISHI RAYON CO., LTD.

Opponent:
BASF Aktiengesellschaft

Headword:
Methacrylate/MITSUBISHI RAYON

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

Keyword:
"Correction of an obvious mistake - extension under Article 123(2) and (3) (no)"
"Inventive step (no) - obvious solution of the problem underlying the patent in suit"

Decisions cited:
G 0003/89

Catchword:

Europäisches Patentamt | European Patent Office | Office européen des brevets

Beschwerdekammern | Boards of Appeal | Chambres de recours

Case Number: T 0646/94 - 3.3.1

D E C I S I O N
of the Technical Board of Appeal 3.3.1
of 28 April 1998

Appellant: (Proprietor of the patent)
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Representative:
-

Decision under appeal:
Decision of the Opposition Division of the European Patent Office posted 7 June 1994 revoking European patent No. 0 268 999 pursuant to Article 102(1) EPC.

Composition of the Board:

Chairman: A. J. Nuss
Members: J. M. Jonk
W. Moser

Summary of Facts and Submissions

I. The Appellant (Proprietor of the patent) lodged an appeal against the decision of the Opposition Division by which European patent No. 0 268 999 was revoked in response to an opposition, based on Article 100(a) EPC, which had been filed against the patent as a whole.

II. The decision was based on the claims as granted, Claim 1 reading as follows:

"A process for producing t-butyl methacrylate by a continuous process by reacting methacrylic acid and isobutylene in the presence of a sulfonic acid group-containing ion exchange resin at a temperature of -20°C to +20°C and removing unreacted methacrylic acid and circulating it to the reaction step, characterized by carrying out the reaction so as to satisfy the following condition:

$y < 100 - 50x$

wherein x is the ratio of the total molar number of isobutylene and its reaction products in unit based on isobutylene to the total molar number of methacrylic acid and its reaction products and y is conversion (%) of isobutylene, followed by degassing the unreacted isobutylene, removing the low boiling substances by distillation under reduced pressure, and then sending the remainder to a t-butyl methacrylate purifying tower where a product of high purity is withdrawn from the destillate side and where solid unreacted methacrylic acid is withdrawn from the tower bottom side for circulation."

III. The opposition was supported by several documents including document:

(1) US-A-3 037 052.

IV. The Opposition Division held that the subject-matter of Claim 1 of the disputed patent did not involve an inventive step in the light of the document (1).

In this context, they considered in particular that the problem underlying the patent in suit was the provision of a process for the preparation of t-butyl methacrylate in high yields minimising the forming of by-products, in particular triisobutylene, and that the solution of this problem in accordance with the patent in suit was characterisd by the conditions given by the relation $y < 100-50x$. Moreover, they considered that in accordance with said relation unsatisfying amounts of triisobutylene could be avoided

(a) by reducing the conversion of isobutylene for a given ratio of isobutylene to methacrylic acid,

(b) by reducing the ratio of isobutylene to methacrylic acid for a given conversion of the isobutylene, or

(c) by combining said measures (a) and (b).

However, in view of the teaching of document (1) (i) that long reaction times and consequently high conversions of the reactants favoured the forming of triisobutylene, and (ii) that an excess of olefin (here isobutylene) could result in undesirable polymerisation thereof, they concluded that the solution of said technical problem as claimed in the patent in suit was obvious to the skilled person.

V. Oral proceedings were held on 28 April 1998.

VI. During these oral proceedings the Appellant defended the patentability of the subject-matter of the patent in suit on the basis of Claim 1 as filed with his statement of grounds of appeal on 6 October 1994 and Claims 2 to 5 as granted.

The new Claim 1 differed from the Claim 1 as granted only in that the term "solid" was deleted from the passage "..... where solid unreacted methacrylic acid is withdrawn from the tower bottom side for circulation."

VII. The Appellant argued with respect to the amendment of Claim 1 as granted that the deletion of the word "solid" represented a correction of an obvious error in view of the specification of the patent in suit and of the fact that methacrylic acid had a freezing point of 16°C.

He also argued that the subject-matter of present Claim 1 involved an inventive step. In this context, he emphasised by referring to Table 1 and Fig. 1 as submitted on 6 October 1994 that it was difficult to separate the by-product triisobutylene from the methacrylic acid. Moreover, he denied that the process as claimed would be obvious to a person skilled in the art, since document (1) did not contain any hint that the forming of triisobutylene could be reduced, let alone an incentive that this could be accomplished by decreasing the conversion of isobutylene at a given molar ratio of isobutylene to methacrylic acid or by decreasing the molar ratio of isobutylene to methacrylic acid at a given conversion of the isobutylene. He noted in this respect that it could only be derived from document (1) that the reaction of isobutylene with methacrylic acid should be performed

by using an equimolar mixture of these reactants, that the reaction time was adapted to the reaction temperature in such a way that at higher temperatures shorter reaction times were used, and that as high a conversion as possible should be obtained.

VIII. The Respondent had no objection against the correction of Claim 1 as granted by deleting the word "solid". On the other hand, he fully agreed with the reasoning of the Opposition Division that the process according to present Claim 1 did not involve an inventive step in the light of document (1). In this context, he emphasised that document (1) gave the skilled person, faced with the problem to reduce the formation of triisobutylene, a clear pointer to its solution as claimed according to the patent in suit, since it clearly taught that the forming of triisobutylene could be reduced by avoiding (i) an excess of the isobutylene, (ii) high temperatures, and (iii) a long reaction time, i.e. a high conversion. Thus, the skilled person trying to achieve a high conversion of the reactants to t-butyl methacrylate and, at the same time, a satisfying low formation of triisobutylene had only to select those reaction conditions giving a desirable compromise in this respect. In view of the teaching of document (1), such a selection could be carried out without undue burden by performing a few standard experiments.

IX. The Appellant requested that the decision under appeal be set aside and the patent be maintained on the basis of Claim 1, filed on 6 October 1997, and Claims 2 to 5 as granted.

The Respondent requested that the appeal be dismissed.

X. At the conclusion of the oral proceedings the Board's decision was pronounced.

Reasons for the decision

1. The appeal is admissible.

2. The deletion of the word "solid" in Claim 1 as granted is allowable, since it is immediately evident from the patent application as filed and from the fact that methacrylic acid has a freezing point of 16°C that the methacrylic acid can only be withdrawn from the bottom side of the distillation tower and recycled to the reactor in its liquid form, i.e. in its normal state of aggregation. In this context, the Board observes that in accordance with the decision of the Enlarged Board of Appeal G 3/89 (OJ EPO 1993, 117) such an obvious correction is of a strictly declaratory nature and, therefore, does not affect the content of the patent application as filed, so that it does not infringe the prohibition of extension under Article 123(2) EPC.

   Moreover, in the Board's judgment, this obvious correction also does not extend the protection of Claim 1 as granted as prohibited under Article 123(3) EPC, since a skilled person, interpreting the scope of said claim and having regard to the considerations in the preceding paragraph, would have disregarded this unambiguously erroneous and thus meaningless feature.

   Furthermore, the Respondent did not raise any formal objection to the present claim, and the Board sees no reason to put forward other formal objections under the EPC.

3. After examination of the cited prior art document, the Board has reached the conclusion that the subject-matter as defined in all claims is novel. Since novelty was not disputed, it is not necessary to give reasons for this finding.

4. The remaining issue to be dealt with is whether the subject-matter of the present claims involves an inventive step.

4.1 The Board considers, in agreement with the parties, that the closest state of the art with respect to the process according to present Claim 1 is the disclosure of document (1).

4.2 Document (1) relates to a process for the preparation of esters in high yields by reacting an olefin with a saturated or monoethylenically unmatured carboxylic acid at low temperatures of preferably 0°C to 20°C in the presence of a particular sulphonic acid cation exchange resin which possess a macro-reticular structure (see column 1, first paragraph, column 2, lines 16 to 37, column 6, lines 38 to 46, column 13, lines 42 to 56, and Claim 1). The process can be carried out continuously by employing a continuous distillation unit in which the unreacted olefin and the unreacted acid are removed from the produced ester, by continuously recycling said unreacted compounds with the necessary additions of fresh reactants and by continuously removing the desired ester (see column 6, line 70 to column 7, line 5). An example of such a process, which is clearly representative for the teaching of this document, is the preparation of t-butyl methacrylate by reacting isobutylene with methacrylic acid (see Claim 15, Examples I to IV relating to a discontinuous process, and Example IX relating to a continuous one).

Thus, in accordance with the submissions of the parties, in the Board's judgment, the process as claimed in present Claim 1 differs from that as disclosed in document (1) only by the selection of a

conversion (y) of the isobutylene and a ratio (x) as specified in present Claim 1 so as to satisfy the condition $y < 100-50x$.

4.3 Regarding this prior art, the Respondent argued that according to the claimed invention the forming of the by-product triisobutylene causing separation problems with respect to the starting compound methacrylic acid and, therefore, leading to a lower yield of the desired ester or to a undesirable increase of said by-product in the reaction mixture, could effectively be suppressed.

4.4 Therefore, in the light of this closest prior art, the Board sees the technical problem underlying the patent in suit as the provision of a process for the production of t-butyl methacrylate in high selectivities and yields suppressing the formation of the by-product triisobutylene to a satisfying degree (see also page 2, lines 46 to 50 and 54 to 58, and page 5, lines 20 to 24, of the patent in suit).

4.5 The patent in suit suggests, as the solution to this problem, a process according to Claim 1, which is characterised by selecting a conversion (y) of the isobutylene and a ratio (x) of the total molar number of isobutylene and its reaction products in unit based on isobutylene to the total molar number of methacrylic acid and its reaction products so as to satisfy the condition $y < 100-50x$.

4.6 In view of the technical information of the patent in suit, in particular Table 1, Examples 1 and 2, as well as Comparative Example 1, the Board is satisfied that the above technical problem is solved. This was never challenged by the Respondent.

4.7 It remains to be decided, whether the claimed process involves an inventive step.

4.8 As indicated above (see point 4.2), document (1) discloses a process for preparing t-butyl methacrylate which corresponds to the process according to present Claim 1 of the patent in suit, except that it does not indicate that the conversion (y) of the isobutylene and the ratio (x) as specified in present Claim 1 must satisfy the condition $y < 100-50x$. Therefore, the question to be answered when examining inventive step is whether or not document (1) provides an incentive to the skilled person which would lead him to the solution of the technical problem underlying the patent in suit, i.e. to the selection of such reaction conditions that said condition $y < 100-50x$ would be met.

4.8.1 Moreover, it can be derived from document (1) that the **reaction temperature for preparing t-butyl methacrylate** is preferably about 0°C and also may be somewhat higher up to 20°C at appropriate shorter reaction times (see the Examples I to IV and IX, and column 6, lines 40 to 42). However, within this temperature range the forming of the undesired triisobutylene increases at higher temperatures (see Example VIII, in particular the last paragraph). In any case, the reaction temperatures according to Claim 1 of the patent in suit are completely in line with the teaching of document (1).

4.8.2 Furthermore, document (1) also discloses that the **ratio of the starting compounds isobutylene and methacrylic acid** for preparing t-butyl methacrylate is preferably 1:1 (see the Examples I to IV and IX). However, in this context, it is clearly indicated that high concentrations of olefin (here isobutylene) could result in undesirable polymerisation (see column 6, lines 29 to 31).

4.8.3 Concerning the **reaction time** document (1) discloses that its upper limit is determined by the rate of the esterification reaction and the rates of unwanted reactions, such as those which cause polymerisation of the reactants (see column 6, lines 52 to 57). In this context, it also teaches (i) that the present process concerns an equilibrium reaction (see column 7, lines 16 to 21), (ii) that after a certain reaction time, i.e. at a certain **degree of conversion**, a steady state giving a maximum yield of the desired ester is reached (see the Examples I to III), and (iii) that at longer reaction times the reaction tends to reverse so that the ester is converted to the starting compound methacrylic acid and to a mixture of di-, tri- and tetraisobutylene (see column 8, line 69 to column 9, line 6).

4.8.4 Therefore, in view of the teaching of document (1) that the polymerisation of the starting compound isobutylene to the unwanted triisobutylene could be suppressed by using low temperatures of about 0°C, relatively low concentrations of isobutylene, and relatively short reaction times or lower degrees of conversions, a person skilled in the art, faced with the technical problem as defined above, would try to find an acceptable compromise so that, on the one hand, a satisfying reduction of the forming of triisobutylene and, on the other hand, a satisfying yield of the ester is obtained.

4.8.5 In doing so, in the Board's judgment, the skilled person would have started by using the apparently preferred reaction conditions as indicated in the examples for the preparation of t-butyl methacrylate, and in particular Example I or IX using Catalyst A giving the highest conversions at corresponding reaction times (see the conversions as indicated in the Tables of the Examples I to IV, e.g. at a reaction time

of 2 hours). Accordingly, he would have used a temperature of about 0°C and a ratio (x) of isobutylene and methacrylic acid of 1:1. Moreover, **he would have tried some reaction times giving conversions (y) being increasingly lower than the conversion at the steady state** in order to find an acceptable compromise between an adequate suppression of the forming of triisobutylene and a satisfying high yield of the desired ester. **In addition**, in view of the teaching of document (1) that - as indicated above - an unwanted polymerisation of isobutylene could be reduced by using appropriate low concentrations thereof, **he would then have tried some lower ratios (x) of the starting compounds than the ratio 1:1**, such as the ratio 1:1.5 indicated as being generally suitable or even lower (see document (1), column 6, lines 29 to 37), as a promising measure to suppress the forming of triisobutylene **as such** or **in combination with the selection of an appropriate degree of conversion**.

4.8.6 Thus, in the Board's judgment, by performing a reasonable number of routine experiments the skilled person would have selected such degrees of conversion (y) and ratios of isobutylene and methacrylic acid (x) which would meet the relation $y < 100-50x$ as claimed in present Claim 1. In this context, the Board observes that **according to the Examples I to IV and IX of document (1)** the steady states of the reactions corresponding to the maximum yields of the crude ester are obtained **at conversions (y) of about 55%** (see the Table of Example I at a reaction time of about 5 hours and column 9, lines 2 to 6) **or less** (see also the Tables of Examples II to IV, and column 11, lines 11 to 17), whereas **according to present Claim 1** of the patent in suit the **conversion y** should be **less than 50%** if the selected ratio x were 1:1 (i.e. the ratio applied in the relevant examples of document (1)) and **less than 66.7%** if the selected ratio were 1:1.5 (i.e. a ratio

indicated in document (1) as being generally suitable, which - as indicated above - would likely be more suitable in order to avoid unwanted polymerisation of isobutylene).

4.8.7 In conclusion, the Board finds that the process according to present Claim 1 does not involve an inventive step as required according to Article 56 EPC.

4.9 Claims 2 to 5 fall with Claim 1, since the Board can only decide on the request as a whole.

Order

For these reasons it is decided that:

The appeal is dismissed.

The Registrar: The Chairman:

E. Görgmaier A. Nuss