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D E C I S I O N
of 22 August 1995

Case Number: T 0851/91 - 3.3.3

Application Number: 87201877.5

Publication Number: 0262745

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Language of the proceedings: EN

Title of invention:
Polymer preparation

Applicant:
SHELL INTERNATIONALE RESEARCH MAATSCHAPPIJ B.V.

Opponent:
-

Headword:
-

Relevant legal provisions:
EPC Art. 56

Keyword:
"Inventive step (affirmed)"
"Re-statement of technical problem - effects achieved - no hint
to focus on potentially rewarding area of problem solving
modification"

Decisions cited:
T 0031/84, T 0229/85

Catchword:
-



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Boards of Appeal

Chambres de recours

Case Number: T 0851/91 - 3.3.3

D E C I S I O N
of the Technical Board of Appeal 3.3.3
of 22 August 1995

Appellant:

SHELL INTERNATIONALE RESEARCH
MAATSCHAPPIJ B.V.
Carel van Bylandtlaan 30
NL-2596 HR Den Haag (NL)

Representative:

-

Decision under appeal:

Decision of the Examining Division of the European
Patent Office dated 4 June 1991 refusing European
patent application No. 87 201 877.5 pursuant to
Article 97(1) EPC.

Composition of the Board:

Chairman: C. Gérardin
Members: R. Young
W. Schar

Summary of Facts and Submissions

I. European patent application No. 87 201 877.5, filed on 30 September 1987 and published under No. 0 262 745, was refused by a decision of the Examining Division dated 4 June 1991. The ground of refusal was lack of inventive step in the light of the document D1: EP-A-0 181 014.

II. The decision was based on Claim 1 as filed on 30 April 1991, and Claims 2 to 6 as filed on 25 January 1991. Independent Claim 1 reads as follows:

"Process for the preparation of polymers, in which a mixture of carbon monoxide with one or more olefinically unsaturated compounds is polymerised at elevated temperature by using a catalyst composition based upon

- a) a palladium compound,
- b) an anion of an acid, and
- c) a bidentate ligand of the general formula $R_1R_2M-R-MR_3R_4$,

wherein M represents phosphorus, arsenic or antimony, R_1 , R_2 , R_3 and R_4 are hydrocarbyl groups, and R represents a bivalent organic bridging group containing at least two carbon atoms in the bridge,

characterised in that the acid has a pKa of from 2 to 4, and that the polymerisation is carried out at a temperature below 115°C."

Claims 2 to 6 relate to elaborations of the process defined in Claim 1.

III. According to the decision, the only distinction over the closest state of the art, which was D1, was the pKa value of the acid anion. This, according to Claim 1 of the application in suit, was from 2 to 4, whereas D1 described a pKa value < 2 (and 4.75 in the comparative

example). The technical problem was therefore to provide further anions suitable for use in a catalyst composition for the copolymerisation of carbon monoxide and olefins. It would have been obvious for the skilled person to apply acids having a pKa of 2 and above, but below 4.75, since this range was the only feasible alternative. The argument that there was invention in the combination with a processing temperature below 115°C could not be accepted, since no prejudice against the lower temperatures could be established from D2: EP-A-0 121 965, this being only a single document and furthermore originating from the Applicant.

IV. On 7 August 1991, the Applicant filed a Notice of Appeal against the above decision, the prescribed fee being paid on the same day.

In the Statement of Grounds of Appeal filed on 2 October 1991, the Appellant argued essentially as follows:

- (i) The closest state of the art was not D1, but D2. This disclosed a similar process using an anion of an acid having a pKa between 2 and 4 as well as process temperatures below 115°C. Nevertheless, the relevant experiment (with phosphoric acid) had been carried out at 135°C so that the claimed combination was not disclosed. It was also taught in D2 that a catalyst composition containing acetic acid was ineffective at 135°C. Since it was general chemical knowledge that reactions proceeded slower at lower temperatures, it was not obvious to try a temperature lower than that at which such a composition had already been shown to be ineffective.

- (ii) Whilst process temperatures of below 115°C were known from D1, these applied to different catalyst systems. The fact that most of the examples had been carried out at 90°C was solely to enable comparison of yields. There was no suggestion that lower processing temperatures were particularly advantageous. The conclusion that 90°C was the preferred temperature was therefore not warranted.

- (iii) There was in any case a prejudice against the use of ions having a pKa above 2, as demonstrated by D1, D2 and D3: GB-A-2 058 074, the latter already being referred to in D2, which were the first such documents published in the relevant field. The Applicant's identity should not influence the matter.

V. The Appellant requested cancellation of the decision under appeal and the grant of a patent on the basis of the original documents with the amendments suggested in the letters dated 21 January 1991 and 26 April 1991 (cf. Notice of Appeal), together with a minor correction requested in a further letter filed on 27 April 1995.

Reasons for the Decision

- 1. The appeal is admissible.

- 2. *Text on which the decision is based*

The present decision is based, in accordance with the request of the Appellant, on the following documents:
Claims:

Claim 1, received on 30 April 1991 with letter of 26 April 1991;

Claims 2 to 6, received on 25 January 1991 with letter of 21 January 1991;

Description:

Pages 1 and 3 to 6 as originally filed;

Pages 2, 7 and 8, received on 25 January 1991 with letter of 21 January 1991,

with the following amendments according to the requests dated (i) 26 April 1991:

Description pages:

7 (deletion of Examples 5 and 6), and

8 (amendment of lines 1 to 3 to read as follows:

"Of Examples 1-4, Example 4 is an example according to the invention. In this example, polymer was prepared at a temperature below 115°C, using a catalyst composition"); and

(ii) 27 April 1995:

Description page 8 (amendment at lines 11 to 12 of "copolymers prepared according to Examples 4-6" to read "copolymer prepared according to Example 4").

3. *Allowability of the amendments*

- 3.1 Claim 1 corresponds to Claim 1 as originally filed, with the features rearranged into a different two part form and the phrase "similar or dissimilar" before "hydrocarbyl groups" deleted.

These changes make no difference to the meaning of the Claim.

- 3.2 Apart from the correction of an erroneous appendancy in Claim 7, the remaining amendments merely involve the deletion of original Claims 5 and 8 and of Examples 5 and 6 and necessary consequential amendments of the description.

There are thus no objections under Article 123(2) EPC to the amendments requested.

4. *The closest state of the art*

A process for the preparation of polymers according to the pre-characterising portion of Claim 1 of the application in suit, (cf. Section II, above) is known from the state of the art as represented by D1, which the Board considers, in line with the finding of the decision under appeal, to be the closest state of the art.

In this connection, the allegation of the Appellant that D2 lies still closer (cf. Section IV.i), above) acquires significance for the fate of the application only in the event that the Board is unable to support the finding of obviousness starting from D1 as closest prior art.

- 4.1 According to D1, the catalyst is a complex compound obtained by reaction of a palladium, cobalt or nickel compound, an anion of a carboxylic acid with a pKa lower than 2 and a bidentate ligand identical to ligand c) as defined in Section II, above (cf. Claim 1).

The carboxylic acid is preferably trifluoroacetic acid (Claim 2).

The polymerization temperature is preferably between 20° and 200°C, in particular between 50° and 150°C (page 5, last para.).

According to the examples, an autoclave filled with ethylene and CO under pressure and containing a catalyst system based on palladium acetate, a specified carboxylic acid and 1,3-di(diphenylphosphine)propane in methanol was heated at 90°C for one hour. A polymer

yield of 4000 g/g Pd/h was obtained when the acid was trifluoroacetic acid, 200 g/g Pd/h when the acid was CCl_3COOH (Table I, Test 2), and 3 000, 400 or 250 g/g Pd/h when the acid was $\text{C}_6\text{F}_5\text{COOH}$, the last two results being obtained using, instead of ethylene, propene or butene-1 monomer respectively (Tests 3, 4 and 5). In a comparison using acetic acid at 120°C , however, no polymer was formed (Test 7).

- 4.2 Compared with this state of the art, the objective technical problem is seen by the Board as the definition of a further process for polymerising a mixture of carbon monoxide with one or more olefinically unsaturated compounds with a comparable yield of polymer product per gram of catalyst per hour.

The solution proposed according to Claim 1 of the application in suit is to replace the anion of the acid of pKa lower than 2 with an anion of an acid having a pKa of from 2 to 4.

- 4.3 According to the results of Example 4 of the application in suit, as well as of the amended Examples 5 and 6 filed on 25 January 1991 (which remain on file as supplementary technical information), a polymer yield of 440, 465 or 128 g/g Pd/h is obtainable using a catalyst system including an anion of phosphoric acid (pKa=2.12), tartaric acid (pKa=2.98) or 2,5-dihydroxybenzoic acid (pKa=2.97) respectively. Although the yields in the relevant tests in D1 vary widely, those obtained using the process claimed in the application all lie between the highest and the lowest, and are of the same order of magnitude as the majority of them. They are, therefore, considered comparable.

Thus it is plausible to the Board that the proposed measure is effective to solve the stated problem.

5. *Novelty*

The decision under appeal found that the subject-matter of Claim 1 was novel (see Reasons for the decision, para. 2). The Board sees no reason to depart from this finding.

Consequently, the subject-matter of Claim 1, and hence of dependent Claims 2 to 6, is considered to be novel.

6. *Inventive step*

Starting out from the disclosure of D1 as closest state of the art, it is necessary to establish whether the skilled person would have expected that further, comparably effective catalysts for the polymerisation of carbon monoxide with one or more olefinically unsaturated compounds would have resulted from replacing the anion of an acid of pKa lower than 2 with the anion of an acid of pKa between 2 and 4.

6.1 There is no suggestion to do this in D1 itself, since it is a specific requirement of its teaching that the anion of the acid has a pKa lower than 2 (cf. D1, Claim 1). There is no reference to the use of an acid having a pKa above 2 except for the comparison of Test 7 in which acetic acid (pKa 4.75) is used, but yields no polymer at all.

Consequently, the skilled person would have had no incentive to depart from the teaching of that citation, in particular to extend the pKa limit in the direction of 4.

6.2 As to the question whether such an incentive can be found elsewhere in the state of the art, D2 relates to a similar polymerisation process and catalyst including an

anion of an acid having a pKa lower than 2, but provides further that the acid is neither a hydrohalogenic acid nor a carboxylic acid (cf. Claim 1).

- 6.2.1 The polymerisation temperature may be between 20° and 200°C, in particular between 50° and 150°C (page 6, lines 23 to 26).
- 6.2.2 In the examples, the anions used in the catalysts are those derived from toluene p-sulphonic acid or HBF₄ and various polymerisation temperatures from 70° to 135°C are used. In a comparison test, H₃PO₄ is used at 135°C (cf. Table I, Test 1c). It can be seen that polymer yields of between 100 and 6 000 g/g Pd/h are obtained using Pd salts of acids of pKa lower than 2, but only 10 g/g Pd/h with H₃PO₄ at 135°C.

Thus the teaching of D2 is entirely consistent with that of D1 in requiring that the anion used in the catalyst be that of an acid having a pKa lower than 2. The test using phosphoric acid (pKa = 2.12) in this connection is a comparison falling outside the enabling teaching of D2. It merely illustrates the importance of the pKa limit by showing that only a minimal yield of polymer is obtained when an anion of an acid of higher pKa is used.

Hence the skilled person would have had no incentive from D2 either to use anions of acids having a pKa of 2 or above in the catalyst system of D1.

- 6.3 The argument in the decision under appeal that the application of anions of acids having a pKa value of 2 and above but below 4.75 was "the only feasible alternative" is itself traceable to the statement of problem, which, being drafted in terms of the provision of further anions, already contains pointers to the

solution adopted. Such an approach is, however, not appropriate in the assessment of inventive step (cf. decision T 0229/85, OJ EPO 1987, 237).

- 6.3.1 In contrast, the essential requirement, according to the jurisprudence of the decision T 0031/84 (OJ EPO 1986, 369), mentioned in the decision under appeal (in connection with the selection of the most relevant piece of prior art), is to "define the object of the invention on the basis of an objective analysis considering the difference or surplus of the results of the invention (effect) beyond such most relevant art" (cf. Reasons for the decision, para. 6(ii)).
- 6.3.2 If the statement of problem is drafted, following these principles, in terms of the effects achieved (cf. Section 4.2, above) rather than in terms of the measures adopted for their achievement, it is clear that there is no longer any hint for the skilled person to focus on the anion as a potentially rewarding area of problem-solving modification in the first place.

Consequently, the question of the replacement of an anion being "the only feasible alternative" does not arise. On the contrary, there is no reason for the skilled person to expect that a solution of the stated problem could be found in a modification of the anion at all, let alone in the manner adopted according to Claim 1, which is directly contradictory to the teachings of both D1 and D2.

- 6.4 For these reasons, the solution to the technical problem does not arise in an obvious way from D1 as closest state of the art.
- 6.5 In the light of this finding, it remains, in view of the argument of the Appellant in Section IV (i), above (see

also Reasons, Section 4, above, second sentence) to consider the question of whether there is also an inventive step when starting from the document canvassed by the Appellant as closest state of the art, namely D2.

The relevant disclosure here is the use of phosphoric acid (Test 1c). This results, however, in a minimal yield of polymer product, since it is a comparison falling outside the enabling teaching of D2 (cf. Section 6.2.2, above).

Consequently, the technical problem must be stated in more ambitious terms to reflect the improved yield obtainable using the process according to the application in suit.

- 6.5.1 The technical problem objectively arising is thus to be seen as the search for an improved process of polymerising a mixture of carbon monoxide with one or more olefinically unsaturated compounds giving a higher polymer yield per gram of catalyst per hour.
- 6.5.2 The solution proposed according to Claim 1 of the application in suit is to lower the polymerisation temperature from 135°C to below 115°C.
- 6.5.3 A comparison of Example 4 of the application in suit with Test 1c of D2 shows that a forty-fold increase in polymer yield results from the relevant reduction in polymerisation temperature. Even in the worst case (amended Example 6 filed on 25 January 1991) the polymer yield is still an order of magnitude greater than that in Test 1c of D2.

Thus it is plausible to the Board that the proposed measure is effective to solve the stated problem.

6.5.4 As to the question of obviousness, there is no teaching in D2 itself which associates a lower polymerisation temperature with a higher yield of polymer product.

On the contrary, the preferred temperature range extends from well below, to well above the relevant limit of 115°C (cf. page 5, last para.), and, in the examples, nearly half the relevant tests are carried out at or above 115°C, with good results.

6.5.5 The argument in the decision under appeal that such a relationship might be derived from a comparison of Tests 1 and 5 or 14 and 15 in D2 is not convincing because these tests differ in more than just the temperature, and are therefore not directly comparable.

6.5.6 As regards the disclosure of D1, although it is true that five out of six examples in this document use a temperature of 90°C, the catalyst systems are not identical with those of D2, and the general teaching does not identify any particular temperature within the preferred ranges (which are the same as those in D2) as optimum. In particular, there is no evident connection between the exemplified value of 90°C and an optimum yield of polymer product. On the contrary, the wide variation of polymer yields obtained at this temperature directs attention away from the significance of temperature as a relevant factor.

Consequently, there would be no reason for the skilled person to expect higher yields by adopting, in D2, the polymerisation temperatures exemplified in D1.

6.5.7 In this connection, the argument in the decision under appeal that no prejudice against lower processing temperatures could be established from D2 alone (Reasons for the decision, point 6, para. 2, last sentence), is

inappropriate here, because the Appellant was not relying on a single document, but on general chemical knowledge.

In the light of such general chemical knowledge, according to which the skilled person would be aware that reactions tend to go faster at higher temperatures, and which the Board has no reason to doubt, the skilled person, far from expecting a reduction in the polymerisation temperature below 135°C to give an enhanced yield of polymer product, would expect the opposite effect.

Consequently, the solution of the stated problem does not arise in an obvious way starting from D2 either.

7. With regard to the question of establishing a general prejudice with regard to certain pKa values (cf. Section IV iii), above), the latter would normally be regarded as supported by the evidence of numerous documents and/or a technical encyclopaedia reflecting common general knowledge. In the case of patent documents, such as D1 and D2, where the teaching tends to be specific to a particular problem, the contextual base may be too narrow to be a reliable indication of what was a generally prevailing view in the art. Thus, even if a coherent pattern of teaching were recognisable in such documents, in particular if they were not unrelated in their origin, this might still be attributable to factors arising from their commonality, rather than to a generally held prejudice. Each case would have to be judged on its merits.

In the present case, however, it is not necessary, in view of the findings in Section 6 etc., above, for the Board to determine whether or not there was a general prejudice in the art against certain pKa values.

8. In summary, the subject-matter of Claim 1 involves an inventive step. By the same token, the subject-matter of Claims 2 to 6, which are directly or indirectly dependent on Claim 1, also involves an inventive step.

Order

For these reasons it is decided that:

1. The decision under appeal is set aside.
2. The case is remitted to the first instance, with the order to grant a patent on the basis of the documents set out in the Reasons for the Decision, Section 2, above.

The Registrar:


E. Görgmaier

The Chairman:


C. Gérardin