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D E C I S I O N
of 27 October 1999

Case Number: T 0102/98 - 3.3.3

Application Number: 86201422.2

Publication Number: 0213671

IPC: C08G 67/02

Language of the proceedings: EN

Title of invention:

New polymers of carbon monoxide and ethene

Patentee:

Shell Internationale Research Maatschappij B.V.

Opponent:

BP International Limited Patents and Agreements Division

Headword:

-

Relevant legal provisions:

EPC Art. 56, 114(1), 114(2)

Keyword:

"Inventive step (yes) - no problem "pull" or solution "push"
from the state of the art "to solving the technical problem"

Decisions cited:

G 0010/91, G 0001/92, T 1002/92

Catchword:

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Boards of Appeal

Chambres de recours

Case Number: T 0102/98 - 3.3.3

D E C I S I O N
of the Technical Board of Appeal 3.3.3
of 27 October 1999

Appellant: BP International Limited
(Opponent) Patents and Agreements
Chertsey Road
Sunbury-on-Thames
Middlesex TW16 7LN (GB)

Representative: -

Respondent: Shell Internationale Research
(Proprietor of the patent) Maatschappij B.V.
Carel van Bylandtlaan 30
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Representative: -

Decision under appeal: Interlocutory decision of the Opposition Division
of the European Patent Office dated 2 December
1997 and issued in writing on 16 January 1998
concerning maintenance of European patent
No. 0 213 671 in amended form.

Composition of the Board:

Chairman: C. Gérardin
Members: R. Young
J. A. Stephens-Ofner

Summary of Facts and Submissions

I. The mention of the grant of European patent No. 0 213 671, entitled "New polymers of carbon monoxide and ethene", in respect of European patent application No. 86 201 422.2, filed on 15 August 1986 and claiming a NL priority of 29 August 1985 (NL 8502372) was announced on 27 April 1994 (Bulletin 87/11) on the basis of 7 claims.

II. Notice of Opposition was filed on filed 25 January 1995, on the grounds of Articles 100(a) and 100(c) EPC. The opposition was supported *inter alia* by the following documents:

D1: "Textbook of Polymer Science", F.W. Billmeyer, 2nd Edition, Wiley-Interscience, Chapter 7;

D2: "The Polymer Handbook", Edited by J. Brandrup, E. H. Immergut, Second Edition, Wiley-Interscience, page V-14;

D3: "Principles of Polymerization", G. Odian, McGraw-Hill, 1970, Chapter 2, page 129;

D4: "Encyclopedia of Polymer Science and Technology", John Wiley & Sons Inc., Vol. 11, 1969, pages 77-78;

D5: EP-A-0 121 965; and

D6: GB-A-1 409 994,

as well as the later filed, but admitted:

D10: Declaration of Prof. N. Grassie of 30 September 1997; and

D13: Reply of 17 August 1990 to communication of 12 April 1990, filed by Shell Internationale Research Maatschappij during the examination procedure.

III. By an interlocutory decision, announced orally on 2 December 1997 and issued in writing on 16 January 1998, the Opposition Division held that the grounds for opposition did not prejudice the maintenance of the patent on the basis of the following set of Claims 1 to 7:

Claim 1 reads as follows:

"Polymers of carbon monoxide with ethene and propene characterized in that

- a) the polymers have a linear structure,
- b) they consist of units $-\text{CO}-(\text{C}_2\text{H}_4)-$ and units $-\text{CO}-(\text{C}_3\text{H}_6)-$,
- c) said units $-\text{CO}-(\text{C}_3\text{H}_6)-$ are distributed at random points in the polymer chains,
- d) the ratio m/n lies between 0.023 and 0.235, wherein m and n are the average number of units $-\text{CO}-(\text{C}_3\text{H}_6)-$ and $-\text{CO}-(\text{C}_2\text{H}_4)-$, respectively, and
- e) the polymers are obtainable by polymerising carbon monoxide, ethene and propene with the aid of catalyst which is obtainable by reaction of a palladium, cobalt or nickel compound with an anion of a non-hydrohalogenic acid having a pKa of less than 2, and with a bidentate ligand having the general formula $\text{R}^1\text{R}^2-\text{M}-\text{R}-\text{M}-\text{R}^3\text{R}^4$, where

M represents phosphorus, arsenic or antimony, R¹, R², R³ and R⁴ represent hydrocarbon groups, and R represents a bivalent organic bridge group containing at least two carbon atoms in the bridge."

Claims 2 to 6 are dependent claims directed to elaborations of the polymers according to Claim 1.

Claim 7, an independent claim, is worded as follows:

"Process for the preparation of polymers according to any of claims 1-6, characterized in that the monomers are polymerized with the aid of catalyst which is obtainable by the reaction of a palladium, cobalt or nickel compound with an anion of a non-hydrohalogenic acid having a pKa of less than 2, and with a bidentate ligand having the general formula R¹R²-M-R-M-R³R⁴, where M represents phosphorus, arsenic or antimony, R¹, R², R³ and R⁴ represent hydrocarbon groups, and R represents a bivalent organic bridge group containing at least two carbon atoms in the bridge."

According to that decision:

- (a) As to the issues under Article 100(c) EPC, the claims met the requirements of Article 123(2) and (3) EPC.
- (b) As to novelty, the subject-matter of Claim 1 was distinguished from the disclosure of D6, by the following features:
 - (i) the required m/n ratio of 0.023 to 0.235

was not disclosed; furthermore it was significantly removed from the ratio 1:1 apparently shown in D6 and, since there was no teaching in D6 relating to improved processability, based on a purposive selection;

(ii) the random nature of the incorporated monomer propene was not disclosed in D6; and

(iii) the crystalline nature of the claimed terpolymers was also not disclosed.

Consequently, the claimed subject-matter was novel.

(c) As to inventive step, the technical problem, of improving the processability of ethylene/CO polymers suffering from crosslinking when processed above their melting points, was solved by providing a specific ethylene(E)/CO/propylene(P) terpolymer defined by way of a specific P:E ratio as well as of having a crystalline structure and a random distribution of the P units. Whilst the skilled person confronted by the problem would certainly be induced to reduce the melting point to enable melt processing at a lower temperature, there were a number of methods of doing this, and he would have expected a reduction of thermal stability to be associated with the incorporation by copolymerisation of propene groups. Since, however, thermal stability was

maintained simultaneously with a reduction in melting point in the claimed polymers, the subject-matter involved an inventive step.

IV. On 27 January 1998 a Notice of Appeal against the above decision was filed together with payment of the prescribed fee. In the Statement of Grounds of Appeal, filed on 15 May 1998, the Appellant (Opponent) filed eleven new documents, numbered D18 to D28, and argued in substance as follows:

- (a) It was well known, at the relevant priority date, that alternating E/CO polymers were highly crystalline, and that to lower the melting point of such a polymer, one needed to disrupt the crystallinity. This was generally achieved by incorporating an extra monomeric or co-unit randomly in a polymer chain.
- (b) The skilled person would have known that the alternating E/CO polymers according to D6 were crystalline, if only because they were disclosed as having a certain melting point.
- (c) Contrary to the finding in the decision under appeal, there was no common general knowledge which would have led the skilled person to expect problems of thermostability in the replacement of a small amount of ethylene by propylene units in the claimed polymers, as was indicated by the declaration of Professor Grassie (D10). Thus the effects of introducing specific amounts of propene into an E/CO polymer were predictable. The claimed method of reducing

the melting point was consequently obvious.

- (d) The principle of replacing some of the ethylene units with other olefin units was known at the priority date of the patent, from D6, which showed that ethylene/propylene/CO polymers had been contemplated.
- (e) The selected range of m/n was arbitrary, having been dictated by formal and not technical considerations. Nor could the single example filed by the Patentee with the submission of 6 November 1997 support the criticality of a "range". This was, however, the only feature distinguishing the claimed polymers from the state of the art (D5, D6). If novelty resided in such a feature, it could not support an inventive step.
- (f) Since it was predictable that the melting point would be lowered by replacement of a proportion of the ethylene units by propylene units, it would be possible to devise a set of experiments that would show a difference between the processability of E/CO and E/P/CO polymers at their respective processing temperatures. This was, however, predictable from Flory theory. Thus, the data in the patent in suit and the m/n range of 0.023 to 0.235 in Claim 1 of the patent in suit were entirely predictable.

V. The Respondent (Patentee) objected, in a submission filed on 2 December 1998, to the filing, by the Appellant, of a substantial number of new documents

almost three years after the expiry of the nine month opposition period, and contested their admissibility both from the point of view of the inexcusability of their late filing and their lack of *prima facie* relevance in substance as follows:

- (a) Since the Appellant had not contested the findings of the decision under appeal under Articles 123(2), 123(3) and 54 EPC, the only issue in the appeal was that of Article 56 EPC (inventive step).

- (b) As regards the latter issue, none of the documents D18 to D28, the disclosures of which went beyond the factual framework of the case so far, met the criteria applied by the Boards of Appeal for the admission of such documents at the appeal stage, except possibly for D26, which gave evidence for common general knowledge applied in the reasoning of the decision under appeal.

- (c) The closest state of the art was D5 or D6, neither of which, however, mentioned the problem of melt processability, melt stability or crystallinity of the E/CO polymers. In this connection, there were a number of approaches to solving the relevant problem, of which the copolymerisation with other monomeric units, although taught as a general principle in D1, did not always lead to a reduction in melting point.

- (d) Even to apply the teaching of D1 in this respect

would pre-suppose a knowledge that the polymers according to D6 were crystalline. This had not been shown to belong to the general knowledge of the skilled person.

(e) The arguments of the Appellant concerning what the skilled person would expect in terms of thermal stability on replacing a proportion of ethylene by propylene units in the claimed polyketones were not fully supported by the evidence submitted. Rather, the latter indicated that the incorporation of propene co-units would be expected to be accompanied by a loss of thermal stability.

(f) The experimental evidence on file had not been contested *per se* and supported the recognition of an inventive step.

VI. In a further submission received on 24 September 1999, the Respondent filed additional documents, numbered D31 to D34, intended to highlight a long felt need and that the commercial success of the claimed polymers was related to their technical features. This submission furthermore contained the statement, "As auxiliary sets of claims we herewith introduce into the proceedings the five auxiliary sets of claims filed on 2 December 1997, during the opposition proceedings."

VII. The Appellant criticised, in a submission filed on 30 September 1999, the evidential weight as well as the relevance of the documents cited by the Respondent. The submission was accompanied by a

graphical representation of the information contained in documents D21 to D24.

- VIII. Following a request by the Registrar of the Board, copies of the five sets of claims were filed on 11 October 1999.
- IX. Finally, with a submission received on 25 October 1999, i.e. two days before the oral proceedings, the Respondent filed two further documents, numbered D35 and D36, alleged to concern the Appellant's views on the merits of aliphatic polyketones.
- X. Oral proceedings were held before the Board on 27 October 1999. After hearing the parties, initially on the procedural points, firstly of the admissibility of issues arising from Articles 123 and 54 EPC into the appeal, and secondly of the admissibility of certain documents filed for the first time in the appeal, the Board decided (i) that the scope of the appeal should be restricted to issues arising under Article 56 EPC, and (ii) that, save for document D26, all the documents filed for the first time in the appeal (i.e. those numbered D18 to 28, D29, D30, D31 to D34, D35 and D36) should be excluded from the appeal. The parties then addressed the Board on the remaining admissible issues, relying essentially on the points already made in the written submissions. In particular, the questions of whether D5 and D6 made available polyketones which were crystalline, and whether the claimed ratio m/n represented a meaningful selection from the state of the art were discussed.
- XI. The Appellant requested that the decision under appeal

be set aside, and the patent in suit revoked in its entirety.

The Respondent requested that the appeal be dismissed and the patent maintained on the basis of the main request.

Reasons for the Decision

1. The appeal is admissible.
2. *Procedural matters*

The primary function of an appeal, according to the principles set out in the Enlarged Board opinion G 10/91 (OJ EPO 1993, 420), is to give the losing party the chance to challenge the decision of the opposition division on its merits. This presupposes that the legal and factual framework of the proceedings does not change following the issue of the first instance decision (T 1002/92, OJ EPO 1995, 605; Reasons, 3.4-(2); supplementing G 10/91).

2.1 Scope of the appeal

Since the Appellant confirmed, at the oral proceedings before the Board, that the grounds of opposition of Article 100(c) EPC and 100(a) EPC as far as the latter related to novelty were no longer contested, and following the above principles as far as they apply to the legal framework of the proceedings, these grounds are held not to form part of the appeal. Consequently,

the only issue remaining to be considered is that of inventive step.

2.2 Late-filed documents

A large number of documents was filed for the first time in appeal, specifically the documents numbered D18 to D28 filed by the Appellant with the Statement of Grounds of Appeal, and D29 to D30, D31 to D34 and D35 to D36, filed by the Respondent with the submissions of 1 December 1998, 24 September 1999 and 25 October 1999, respectively.

Whilst it was argued by the Appellant at the oral proceedings that certain of these documents, in particular D21 to D24, had been cited in support of arguments refuting points made for the first time towards the close of the proceedings before the Opposition Division, and consequently did not change the "issues" in the appeal, the evident intention to rely on specific data in these documents was indicative that the "factual framework", in the sense of T 1002/92 above, would be exceeded were these documents to be introduced into the appeal.

According to the principles set out in the latter decision, such new facts evidence and arguments which go beyond the "indication of facts, evidence and arguments" presented in the notice of opposition should only very exceptionally be admitted to the proceedings if such new material is *prima facie* highly relevant in the sense that it is highly likely to prejudice maintenance of the patent in suit (Reasons for the decision, point 3.4).

In the present case, none of the documents appeared, upon examination by the Board, to fulfil this criterion of relevance.

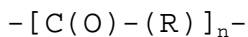
Consequently, the Board decided to disregard, pursuant to Article 114(2) EPC, all the above documents numbered D18 to D36, with the exception of D26, which was relied upon by both parties and which, following the principle of "*volenti non fit injuria*", was admitted, exceptionally, to the proceedings under Article 114(1) EPC.

3. *The patent in suit; the technical problem*

The patent in suit is concerned with linear alternating polymers of carbon monoxide and ethylenically unsaturated compounds, such as ethene, which have excellent mechanical properties, in particular very high strength, rigidity and impact resistance (page 2, line 3 and lines to 15). Such polymers are known from the prior art, in particular from D5 or D6, either one of which was, by general consent, to be regarded as the closest state of the art.

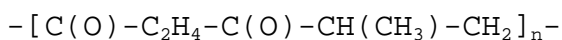
3.1 According to D6, there is disclosed a compound having the formula $\text{Pd}(\text{CN})_3$, a method for its preparation and its use as a catalyst in the preparation of high molecular weight copolymers of carbon monoxide with ethylenically unsaturated compounds (page 1, lines 11 to 16). Examples of suitable such unsaturated compounds are ethylene, propylene, butylene,

isobutylene, and pentylene, ethylene being particularly preferred (page 1, line 77 to page 2, line 10). Copolymers prepared by the relevant process have the general formula:



wherein R is the residue of the copolymerisable comonomer and n is an integer having a value of from about 200 to 40,000 or, expressed in another way, n has a value commensurate with a total molecular weight of roughly 10^4 to 2×10^6 (page 2, lines 11 to 19).

Furthermore, R may represent residues of different monomers in the same copolymer when two or more comonomers are employed (page 2, lines 26 to 29). Thus, if a mixture of ethylene and propylene were employed, a representative idealized structural formula would be:



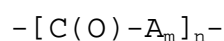
wherein n has an appropriate value as noted above, e.g. to produce a molecular weight of 10^4 to 2×10^6 (page 2, lines 29 to 35).

According to a typical example (Example 3), an ethylene-carbon monoxide copolymer is prepared using the catalyst $HPd(CN)_3$. A white polymer melting at about $260^\circ C$ is obtained (page 3, lines 41 to 56).

- 3.2 According to D5, there is provided a process for the preparation of polyketones by polymerizing a mixture of CO and an alkenically unsaturated hydrocarbon in

the presence of a Group VIII metal catalyst containing ligands, which comprise hydrocarbon groups that are bonded to an element from Group Vb (page 1, lines 1 to 5). Examples of suitable alkenically unsaturated hydrocarbons are propylene, butylene-1, butylene-2, isobutylene, the isomeric pentenes, hexenes, octenes and dodecenes, cyclo-octene and cyclododecene, ethylene being most preferred (page 3, lines 16 to 19).

The polymers obtained are genuine co-polymers which are generally characterized by the formula



wherein m is a relatively small number, for Example 1 to 6, A is the "monomer" unit which is converted into a saturated hydrocarbon group and n a number of 2, 3 or more preferably more than 10, e.g. 3000, 6000 or higher (page 6, line 30 to page 7, line 4).

Instead of one "monomer A", there may also be two different "monomers", e.g. ethylene and styrene, ethylene and acrylic acid, ethylene and vinyl acetate, ethylene and butylene-1, propylene and methyl methacrylate, butylene-1 and acrylic acid, etc. (page 7, lines 5 to 10).

According to the examples, CO and ethylene are polymerised using various catalysts, and the polymer yield calculated.

3.3 Whilst it was acknowledged by the Respondent at the oral proceedings, that the polyketone disclosed, for

instance in D6, was **in fact** a crystalline high polymer, it was disputed that either D5 or D6 made this information available to the skilled reader at the relevant priority date.

3.3.1 The argument of the Appellant, that the mere fact that the species described were high polymers having a certain melting point would indicate to the skilled reader unambiguously that they were highly crystalline is not convincing to the Board, for the following reasons:

3.3.1.1 Firstly, D5 does not mention any melting points of the polyketones produced.

3.3.1.2 Secondly D6, although referring, in Example 3, to a "white polymer melting at about 260°C" (section 3.1, last sentence, above) not only fails to use the term "melting point" but is also unspecific, in its use of the term "about", as to the temperature above which melting actually takes place.

3.3.2 Thus, even accepting the thesis of the Appellant, neither D5 nor D6 contains the relevant information to establish, on the basis of having "a certain melting point" that the polyketone is crystalline.

3.4 Nevertheless, it was not disputed that, according to Example 3 of D6, a specific ethene homopolyketone had been prepared and isolated. Consequently, such a product had been made available to the public prior to the relevant filing date of the patent in suit. In this connection, according to the Enlarged Board of Appeal decision G 1/92 (OJ EPO 1993, 277), a

commercially available product *per se* does not implicitly disclose anything beyond its composition or internal structure (Reasons, point 3). Although this statement applied to the alleged prior use of a product, it is considered to apply equally to a concretely characterised product made available by an enabling disclosure in a prior publication. Crystallinity being, in the Board's view, an aspect of the internal structure of such a product, it must be considered to have been made available by the isolation, according to Example 3 of D6, of a specific such polyketone. Consequently, D6 is held to disclose a crystalline CO/E homopolymer.

- 3.5 The same cannot, however, be said of the variant referred to, in D6, in terms of the possibility of using a mixture of ethylene and propylene, leading to the specified "representative idealized structural formula" (section 3.1, last sentence, above), which purports to represent a terpolymer. Although what is shown in the formula is a 2:1:1 carbon monoxide:ethene (E):propene (P) terpolymer-type species, there is no example of preparation leading to a physically isolated or, therefore, concretely characterised sample of such a product, nor even any indication that such a product had ever been made using the catalyst system according to D6. On the contrary, the use of the conditional phrase, "if a mixture...**were** employed, a representative idealized formula **would be...**" (emphasis by the Board) indicates that such a product had not, at that juncture, actually been prepared. Consequently, the content of the passage referred to in D6 does not amount to an enabling disclosure of such a terpolymer.

3.5.1 The argument of the Appellant in the Statement of Grounds of Appeal, which was repeated at the oral proceedings, that it must be concluded from the teaching of D6 that the preparation of such polymers was possible using the catalyst system disclosed in D6 is not supported by the disclosure of D6, which, for the reasons given above, does not justify drawing any such conclusion. On the contrary, according to the submission of the Respondent in D13, which was not refuted by the Appellant, it was not possible to prepare such a 2:1:1 product using the catalyst system described in D6, or any other catalyst system known at the filing date of the patent in suit (submission D13, page 3, paragraph 7).

3.5.2 The more general position taken by the Appellant, that the principle of replacing some of the ethylene units by other olefin units had been made available by D6 (section III(d), above) was based on the assumption that the skilled person would have realised that the "representative idealised structural formula" in D6 was incorrect, and consequently interpreted it as disclosing the introduction of other, in particular lower, quantities of propene into the polymer chain, in a random manner. This assumption is not, however, justified, for the following reasons:

3.5.2.1 Firstly, there is no error as such in the formula. Consequently, there is no reason for the skilled reader to interpret it as meaning something other than what it says.

3.5.2.2 Secondly, the formula is precise and requires a ratio of propene (P) units to ethene (E) units of 1:1. In

particular, there is no suggestion of a variable range of such ratios, let alone of random incorporation of P units.

3.5.2.3 Consequently, D6 fails to make available the concept, referred to above, of introducing lower quantities of P units to form a random terpolymer.

3.5.3 In summary, the "idealised structural formula" neither makes available a 2:1:1 CO/E/P terpolymer having a real existence, nor a CO/E/P terpolymer having a smaller number of incorporated P units, let alone a terpolymer in which such units are randomly distributed in the polymer chains.

3.5.4 It follows from the above, that D6 cannot make available any physical or chemical property of such a terpolymer.

It also follows, that the range of m/n values claimed in the patent in suit is not the only feature distinguishing the claimed subject-matter over D6. Hence, the question of such a range being a "selection" from D6 does not arise.

3.5.5 On the contrary, each and every value of m/n according to the patent in suit (to which no objection of insufficiency has been raised) corresponds to a discrete polymer lying outside the ambit of D6.

3.5.6 Thus, the extent of the disclosure of the closest state of the art for the purposes of the technical problem is not a CO/E/P terpolymer having a range of E:P ratios, but, on the contrary, a CO/E copolymer

melting at about 260°C, as disclosed in Example 3 of D6.

- 3.6 It has been found, according to the patent in suit, that the high melting point of such CO/E homopolymers leads to stability problems, in processing, for instance, by injection moulding, which should take place in the molten state, and requires the material to be at above 280°C, at which temperatures it is found to discolour and decompose (patent specification, page 2, lines 14 to 21). Although attempts have been made to lower the melting point, for instance by chemical reactions, such as the conversion of part of the carbonyl groups to furan-, pyrrole- or thioketal groups, the thermal stability of the polymers is reduced to such an extent that the previously mentioned problem occurs to the same extent, albeit now at a somewhat lower processing temperature (page 2, lines 22 to 30).
- 3.7 Thus the technical problem may be seen as the search for a means of improving the processability of the known CO/E copolymers without incurring a corresponding penalty of higher thermal instability.
- 3.8 The solution proposed according to Claim 1 of the patent in suit is to lower the melting temperature of the polyketone by replacing a proportion of the E groups by P groups distributed at random points in the polymer chains, using a specified bidentate ligand catalyst system, thus forming a CO/E/P terpolymer, in which the ratio m/n lies between 0.023 and 0.235, wherein m and n are the average number of units P and E respectively.

3.9 It can be seen from the results of the illustrative examples of the patent in suit (Examples 4 to 7), that the melting point of a CO/E/P terpolymer decreases from 238°C to 178°C when increasing amounts of P units are incorporated, corresponding to m/n values from 0.030 to 0.235 (Table, page 6), compared with a CO/E copolymer, which has a melting point of 257°C (Example 3). Furthermore, pressing the terpolymer of Example 6 (melting point 214°C) at 240°C for 15 minutes resulted in a product having no gelling and no discolouration (page 6, lines 19 to 21), whereas pressing the homopolymer for the same time at 285°C resulted in complete gelling and a strong yellow colouration (page 6, lines 16 to 19).

3.9.1 The criticism of the Appellant, that the lowering of the polymer melting point would self-evidently lead to an apparent higher thermal stability, if only because the processing could be done at a relatively lower temperatures, is beside the point, since it does not demonstrate that the problem has not been solved. In particular, it is evident from the acknowledgment of the prior art in the patent in suit, the accuracy of which has not been challenged, that previous attempts to reduce the melting point, although successful in themselves, had led to a correspondingly increased thermal instability, and thus to the same level of thermal degradation, albeit at the lower processing temperature (patent specification, page 2, lines 22 to 30). Thus the problem is effectively solved when such a loss of thermal stability is not experienced. It has not been refuted that this is the case with the exemplified polymers.

3.9.2 The argument of the Appellant, that the polymers of Example 6 and Example 3 respectively could not properly be compared, since the limiting viscosity number (LVN) of the terpolymer of Example 6, at 0.7, was much lower than that of the copolymer of Example 3, at 3.3, the latter therefore having an intrinsically higher tendency to gel, has been refuted, in the Board's view, by the further experiment, filed with the Respondent's submission dated 5 November 1997 (Appendix I), in which a CO/E copolymer and a CO/E/P terpolymer ($m/n = 0.056$) of more closely similar, i.e. comparable LVN were both pressed at 30°C above their respective polymer melting points, the terpolymer showing less gelling (4 wt%) than the copolymer (11 wt%), even though the LVN and hence the molecular weight of the terpolymer was, at 1.7, if anything higher than that of the copolymer, at 1.1 dl/g.

3.9.3 The further argument of the Appellant, that a single such experiment could not establish the effectiveness of the solution according to the patent in suit over the whole range claimed is, in the Board's view, refuted by the experimental evidence filed by the Appellant itself with the submission of 1 October 1997, according to which a CO/E copolymer of intrinsic viscosity of 1.32 dl/g, when heated for 15 minutes, gelled to the extent of 72%, whereas a CO/E/P terpolymer of intrinsic viscosity 1.46, i.e. slightly higher than the homopolymer, produced only 70% gel when heated at 255°C for 15 minutes.

3.9.4 Finally, the argument of the Appellant at the oral proceedings, that the difference in gelling was in any

case within experimental error, was unsupported by any evidence, and thus amounts to a mere assertion. This assertion is, if anything, contradicted by the presentation of the Appellant's own evidence (section 3.9.2, above), in which gelling levels as close together as 70% and 72% are presented without any reservation as to their significance.

3.9.5 Even if the arguments of the Appellant had not been refuted as indicated above, they do not in themselves amount to convincing evidence that the effects relied upon were not obtained using the measures forming the solution proposed according to Claim 1 of the patent in suit. Yet the onus was on the Appellant to show this, which he has failed to do.

3.9.6 Consequently, it is credible to the Board that the claimed measures provide an effective solution of the stated problem.

4. *Inventive step*

In order to determine the issue of inventive step, it is necessary to address the question of whether the skilled person, wishing to improve the processability of a CO/E homopolymer without incurring a penalty in terms of loss of thermal stability, would have had any incentive randomly to incorporate a small quantity of P units in the polymer chains.

4.1 The disclosure of D6 is not concerned either with improving processability or with lowering melting points. On the contrary, it is merely concerned with a catalyst and its use in the preparation of various

polyketones. Consequently, it cannot provide a hint to try to lower the melting temperature of the polyketones for any purpose, let alone that of solving the stated problem. There is, in short, nothing in the problem it addresses, which would "pull" the attention of the skilled person in the direction of solving the stated problem.

4.2 If the attention of the skilled person were nevertheless, for some other reason, to have fallen upon the variant having a CO/E/P ratio of 2:1:1 (section 3.1, above), he would not have been able to reduce such an embodiment to practice with the means taught in D6 (section 3.5.1, last sentence, above). Since, furthermore, D6 does not make available to the skilled person the incorporation of a lower quantity of P units to form a random terpolymer (section 3.5.2.3, above), or indeed any physical or chemical property of such a terpolymer (section 3.5.3, above), it cannot provide a solution "push" encouraging the skilled person to pursue an experimental investigation of other such variants having a E/P ratio closer to that according to the solution of the technical problem.

4.2.1 Even if some attempt had been made, using the available catalyst systems, to produce a terpolymer having a level of P incorporation approximating to the 1:1 ratio of E:P shown in D6, the result, according to the unrefuted submission of the Respondent in D13, would have been a liquid or rubbery product which would have been difficult to analyse (submission D13, page 3, point 7).

- 4.2.2 Consequently, the skilled person would have had no incentive to pursue such an evidently futile line of investigation.
- 4.3 In summary, there is neither a problem "pull" nor a solution "push" in D6 towards solving the technical problem.
- 4.4 Similar considerations apply, *a fortiori*, to D5, since this does not even mention the combination of P and E in a polyketone.
- 4.5 Hence, the Board is unable to concur with the finding of the decision under appeal, that "A skilled person confronted with the problem...would certainly be induced to reduce the melting point to enable melt processing at a lower temperature" (cf. Reasons for the decision, point 4,4). On the contrary, there is nothing in D5 or D6 which would induce the skilled person to try to lower the melting point of the polyketones disclosed therein for any reason, let alone for the purpose of solving the stated problem.
- 4.6 It is against this background that the relevance of D1 to D4 and D26 is to be assessed.
- 4.6.1 According to D1, it is stated, when discussing the effect of polymer structure on physical properties and in particular crystalline melting point, that "In most cases, the substitution of nonpolar groups for hydrogens of a polymer chain leads to a reduction of T_m or possibly complete loss of crystallinity". Furthermore, "If the substitution is random, as in branched polyethylene, the primary effect is a

reduction in the size and perfection of the crystalline regions, usually accompanied by a decrease in the degree of crystallinity. The crystalline melting point of polyethylene is lowered 20 to 25°C on going from the linear to the branched material (page 224). In addition, it is stated in relation to the effect of copolymerisation that "When copolymers are made from monomers which form crystalline homopolymers, degree of crystallinity and crystalline melting point decrease as the second constituent is added to either homopolymer" (page 227).

Not only are the general statements it makes somewhat equivocal, being qualified by such phrases as "In most cases"; and vague, since it is not stated whether crystallinity would be simply reduced, or destroyed altogether, but there are other factors also referred to, such as the effect of the spacing of the polar groups (page 222, first paragraph) and chain flexibility (page 224, first paragraph), which also may affect the melting temperature of polymers without being dependent on their crystallinity. In the latter connection, furthermore, there is no reference to polyketones. Finally, nothing is said which indicates how the phenomena described could be of significance in improving processability of a polymer.

4.6.2 Similar considerations apply to D2, which refers only to melting point behaviour of polyethylene, and to D3, which contains only general statements along the lines already set out in D1.

4.6.3 According to D4, which is concerned only with polyesters, different melting point behaviour patterns

are described, on the one hand for the replacement, in polyethylene terephthalate, of a proportion of the terephthalate moiety randomly by sebacate moieties, in which a eutectic is reached (page 77; "Random copolyesters") and on the other, for copolymers in which the component units have closely similar molecular geometries, which have a monotonic change of melting points, for instance in the replacement of cis- by trans- 1,4-cyclohexanedimethylene terephthalate (page 78; "Isomorphism and Mixed-Crystal Formation").

Not only is it evident that the change in melting point behaviour of polymers when comonomers are substituted is variable, with no indication of any precise way of predicting what the outcome might be in any particular case, but, as in the cases of D1 to D3, there is no reference to polyketones, or any statement relating the presence of monomers to polymer processability.

- 4.6.4 Even if these documents had given a clear message concerning the effects, on crystalline melting point, of introducing a proportion of comonomers into high polymers, or had any relevance to polyketones, there is no reason why the skilled person, starting from D5 or D6, should consult them, since neither D5 nor D6 provides any incentive to lower the crystalline melting points. Even if the remaining documents were consulted independently, they have no apparent relevance to the stated problem, since they do not relate the introduction of comonomers to improving melt processability. Consequently, they do not assist the skilled person to the solution of the technical

problem.

4.7 The argument of the Appellant, that the reduction of the crystalline melting point consequent upon the introduction of P units was predictable as a result of disrupting the crystallinity of the polyketone is irrelevant, since it is based on the concept that the skilled person starting from D5 or D6 and faced with the technical problem would necessarily seek to reduce the melting points of the polyketones by introducing a small number of random P units. Such a concept does not, however, arise from the state of the art (section 3.5.2.3, above). On the contrary, the disruption of the crystallinity of the polyketones by introducing P units corresponds to a consequence of the solution of the technical problem, and not to the terms of the problem itself.

4.8 Similarly, the argument of the Appellant, according to which "A skilled person would have no difficulty in carrying out a polymerisation process using a mixture of propylene and ethylene as an alpha-olefin. When this was done, it would have been immediately evident, from analysis of the resulting polymer, that the correct formula would be a terpolymer in which -CO-C₃H₆- units were randomly distributed along the polymer chain" (Statement of Grounds of Appeal, page 10, first paragraph) is based on the same unsupported concept, and is consequently irrelevant.

4.9 Finally, the line of argument relied upon by the Appellant, according to which the proportion of P units incorporated in the polyketones, corresponding to the m/n values required in the patent in suit, was

arbitrary and therefore not "crucial" to the relevant effect, was based on the unjustified assumption that these values were to be regarded as a "selection" from something already disclosed in D5 or D6. Not only is this not the case (sections 3.5.4, 3.5.5, above), but the claimed values are effective to solve the technical problem (section 3.9.6, above). The question of whether the problem may be solved at other, non-disclosed values of m/n is therefore irrelevant, since these values do not belong to the state of the art.

4.10 In view of the above, the Declaration of Prof. Grassie (D10), according to which the typical polymer chemist would not have expected that such replacement would result in a thermally destabilising effect on the polymer (Declaration, page 3, first paragraph) is irrelevant, since, for the reasons given above, it has not been shown that such replacement would occur to the typical polymer chemist faced with the technical problem.

4.11 The only state of the art concerned with the reduction of the melting points of polyketone polymers with a view to improving melt processability is that already acknowledged in the patent in suit (section 3.6, above). This is concerned with "derivativising" a proportion of the carbonyl groups, by converting them to furan-, pyrrole, thio- or thioketal groups, however, which results in a loss of thermal stability on such a scale that the same problems of processability are still encountered, albeit at the lower temperature (patent in suit, page 2, lines 22 to 30). Thus these disclosures not only offer no prospect of solving the stated problem, but the measures they

provide lead away from its solution, since they involve replacing the CO units, rather than the E-units, of a polyketone, and this by a derivative which has no evident relationship to a propene termonomer.

4.12 In summary, the solution of the stated problem does not arise in an obvious way from the state of the art. Furthermore, the avoidance, following replacement of some E units by P units, of a penalty of loss of thermal stability must be regarded as a surprising result. Consequently, the subject-matter of Claim 1 involves an inventive step, as does the subject-matter of the dependent Claims 2 to 6. The same applies to the subject-matter of independent Claim 7, since the process is limited to preparing polymers according to Claim 1.

5. In view of the above, the main request of the Respondent must be allowed.

6. It is not, therefore, necessary further to consider the sets of claims forming the auxiliary requests.

Order

For these reasons it is decided that:

The appeal is dismissed.

The Registrar:

The Chairman:

E. Görgmaier

C. Gérardin