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D E C I S I O N
of 24 February 2000

Case Number: T 0280/98 - 3.3.3

Application Number: 89117681.0

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Title of invention:
High strength linear, low density polyethylene polymerization process and film (phenomenal film)

Patentee:
PHILLIPS PETROLEUM COMPANY

Opponent:
Union Carbide Chemicals and Plastics Company Inc.

Headword:
-

Relevant legal provisions:
EPC Art. 54, 56

Keyword:
"Inventive step - non-obvious combination of known process and product features"

Decisions cited:
T 0595/90

Catchword:

Case Number: T 0280/98 - 3.3.3

D E C I S I O N
of the Technical Board of Appeal 3.3.3
of 24 February 2000

Appellant: (Opponent)
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Decision under appeal: **Decision of the Opposition Division of the European Patent Office posted 21 January 1998 rejecting the opposition filed against European patent No. 0 361 363 pursuant to Article 102(2) EPC.**

Composition of the Board:

Chairman: C. Gérardin
Members: P. Kitzmantel
J.-C. De Preter

Summary of Facts and Submissions

I. Mention of the grant of European patent No. 0 361 363 in respect of European patent application No. 89 117 681.0 in the name of PHILLIPS PETROLEUM COMPANY, which had been filed on 25 September 1989, was announced on 9 August 1995 on the basis of two sets of claims, a set A comprising 17 claims for the Contracting States AT, BE, CH, DE, FR, GB, GR, IT, LI, LU, NL, SE and a set B comprising 10 claims for the Contracting State ES.

Independent Claims 1, 10 and 11 of set A read as follows:

"1. A slurry polymerization process comprising contacting in a reaction zone under polymerization conditions, at a temperature in the range of from 82 to 88.3°C;
a) a diluent selected from the group consisting of paraffins, cycloparaffins, aromatic hydrocarbons, and mixtures thereof;
b) ethylene monomer;
c) at least one comonomer selected from the group consisting of 1-butene, 1-pentene, 1-hexene, 1-octene, 4-methyl-1-pentene, and mixtures thereof, present in an amount in the range of from 5 to 20 weight percent, based on the amount of ethylene; and
d) a trialkyl boron compound, present in an amount in the range of from 0.5 to 4 ppm, based on the mass of the diluent;
e) a catalyst comprising chromium supported on a silica-titania support, wherein said support comprises from 2 to 10 weight percent titanium, based on the weight of the support, and wherein said catalyst has

been activated in an oxygen-containing ambient and subsequently reduced in the presence of carbon monoxide in an inert ambient;
and recovering a polymer."

"10. A polymer produced according to the process of claim 1, wherein said polymer has:
a) a density in the range of from 0.915 to 0.932 g/cc;
b) a dart impact of greater than 400 g;
c) a HLMI/MI in the range of 70 to 150; and
d) a heterogeneity index in the range of about 10 to about 20."

"11. A copolymer composition of ethylene and a higher alpha-olefin comprising:
a) from 2 to 3.5 mole percent higher alpha-olefin in said copolymer; and
b) from 100 to 180 short chain branches per 10,000 backbone carbons of said copolymer; and
wherein said copolymer has a density within the range of 0.915 to 0.932 g/cm³, a dart impact of greater than 400 g for 0.025 mm (1 mil) film, a Spencer impact value of greater than 1.2 J, a HLMI/MI ratio in the range of 70 to 150, and a heterogeneity index in the range of 10 to 20."

Claims 2 to 9 and 16 of set A are dependent on Claim 1; Claims 12 to 15 of set A are dependent on Claim 11; Claim 17 is dependent on Claim 10.

Claims 1 to 9 of set B are identical with the same claims of set A, Claim 10 of set B is essentially identical with Claim 16 of set A.

II. Notice of Opposition requesting revocation of the patent in its entirety on the grounds of Article 100(a) EPC and - only with respect to Claim 11 - also on the ground of Article 100(b) EPC was filed by UNION CARBIDE CORPORATION on 7 May 1996.

In the course of the opposition i.a. the following documents have been cited:

D1: US-A-4 668 752
D2: US-A-4 438 238
D3: EP-A-0 270 890
D4: US-A-3 248 179
D6 : US-A-4 499 706
D7: ASTM D 1709-75 (1980)
D9: ASTM D 3420-91 (1992).

III. By its decision issued in writing on 21 January 1998, the Opposition Division rejected the opposition.

That decision held that the Opponent's objection of insufficiency of disclosure (Article 100(b) EPC in combination with Article 83 EPC) with regard to Claim 11 was unfounded und that the claimed subject-matter was, moreover, novel and inventive over the cited prior art.

In particular, the subject-matter of Claim 1 involved an inventive step over the closest prior art represented by D3 which did not suggest (i) that swelling problems during the slurry copolymerization of ethylene with the comonomers according to Claim 1 could be avoided by the use of a trialkyl boron cocatalyst and (ii) that the specified polymerisation temperature range of 82 to 88.3°C was critical for obtaining a tough copolymer having good processability.

As to the copolymers and copolymer compositions according to Claims 10 and 11, their inventivity over document D2 was acknowledged in view of the finding in T 595/90 (OJ EPO 1994, 695) that "a product which can be envisaged as such with all the characteristics determining its identity, together with its properties in use, i.e. an otherwise obvious entity, may become non-obvious and claimable as such if there is no known way or applicable (analogy) method in the art to make it and the claimed methods for its preparation are the first to achieve this in an inventive manner" (point 5 of the reasons).

IV. On 23 March 1998 the Opponent (Appellant) lodged an appeal against the decision of the Opposition Division and paid the appeal fee on the same day. The Statement of Grounds of Appeal was submitted on 21 May 1998.

(i) Therein the Appellant contended that the subject-matter of Claim 1 of the patent in suit lacked an inventive step over the disclosure of document D3, because it was obvious to the person skilled in the art aiming at a higher toughness to use lower temperatures of polymerisation, i.e. in the range as specified in said Claim 1, as he was aware that this measure would increase the molecular weight and, thus, the toughness of the ethylene α-olefin copolymers.

This conclusion could not be invalidated by the argument that the use, according to Claim 1, of a trialkyl boron cocatalyst unexpectedly enhanced the swelling control of the copolymer during its preparation, because according to D3 the use of this cocatalyst was the result of a "one way street" situation and the improved swelling control was an inherent consequence of its use, or in other terms a non-inventive "bonus effect".

The afore-mentioned change of the polymerisation temperatures of D3 was, furthermore, in line with the reference in this document to the slurry polymerisation conditions according to document D4, which allowed temperatures down to 65.5°C.

In this context the Appellant stated moreover, that the evidence in the patent in suit was unable to prove the critical importance of the range of temperatures claimed in Claim 1, because the dart impact strength of Run 601, using a polymerisation temperature in excess of the upper limit according to Claim 1, was lower than the same property of the copolymer according to Run 502, using a polymerisation temperature within the claimed range.

In the Appellant's view, all other features of Claim 1 were met by D3; this applied in particular

(a) to the fact that, according to D3, the α-olefin comonomer was not added to the reaction mixture as such, but was generated *in situ* during the ethylene polymerisation (because this was not excluded by Claim 1), and

(b) to the amount of comonomer thereby produced, which latter could be calculated from the densities of the resultant copolymer to overlap the density range specified in Claim 1 of the patent in suit.

(ii) In the Appellant's opinion, the subject-matter of Claims 10 and 11, directed to **single** copolymers, was obvious over the **blends** of copolymers according to D2 having the same properties; on the one hand homogeneous blends of two copolymers were indistinguishable from single copolymers, and on the other hand a person skilled in the art, who was not concerned with the advantages offered by the blends according to D2, would undoubtedly turn to single copolymers having the same properties, for whose preparation D2 contained sufficient information.

This conclusion was supported by the facts

(a) that document D1 disclosed single ethylene-α-olefin copolymers having higher impact strength than those according to Claim 11 of the patent in suit, and

(b) that document D6 disclosed linear low density polyethylenes having properties similar to those according to Claim 11 of the patent in suit, including a heterogeneity index above 10.

The conclusion of the first instance, that in accordance with T 595/90 the subject-matter of Claims 10 and 11 was non-obvious, was, thus, at variance with the facts, because this conclusion was based on the false assumption that the prior art was devoid of any teaching for the preparation of such copolymers.

(iii) The Appellant has not commented in this appeal upon the objections under Articles 54 and 100(b) EPC which were issues before the first instance.

V. The Respondents (Proprietors of the patent) presented their counterstatements in a submission dated 26 January 1999.

(i) With respect to Claim 1 of the patent in suit the Respondent essentially argued that the polymerisation method according to D3, which involved the *in situ* preparation of a comonomer, was beyond the scope of said Claim 1, which required that the comonomer be **present** in the reaction mixture. It was not possible to quantify the amount of comonomer **present** according to D3, because comonomer formation and polymerisation occurred simultaneously on different active sites of the catalyst system.

Furthermore, since according to D3 the trialkyl boron cocatalyst was used for the formation of comonomer and since this function was not required by the process according to present Claim 1, its use therein was not the inevitable result of a "one way street" situation, nor was the swelling inhibition effect caused by the trialkyl boron cocatalyst foreseeable. Moreover, the latter phenomenon could not have been achieved during the *in situ* preparation of the copolymers according to D3 having a density in the range of 0.930 to 0.955, because the effect of polymer swelling was essentially a problem of the lower density copolymers according to Claim 1 in combination with their preparation in the presence of comonomer in the reaction mixture; thus, the swelling inhibition effect was not an "inherent property" of the use of a trialkyl boron cocatalyst.

In the Respondent's opinion it was also not possible to gather any relevant information lacking in D3 from D4, because the latter document had been filed 27 years earlier and was silent on the *in situ* comonomer generation technique which was the essence of D3.

Furthermore, the Respondent refuted the Appellant's assumption that the use of lower temperatures than those employed according to D3 was obvious if one wished to achieve higher toughness values, because this argument did not take account of the fact that polymers having higher molecular weights (and thus higher toughness) normally had worse processability. This fact was supported by the evidence in the patent in suit, which showed that commercial linear low density polyethylenes, despite their higher melt index (= lower molecular weight) and, thus, worse toughness, had a poorer processability than the copolymers within the terms of the patent in suit.

(ii) In the Respondent's view, the Appellant had also failed to prove that the subject-matter of Claims 10 and 11 was obvious over document D2, not only because the technical solution disclosed in this document focussed specifically on polymer **blends**, not on **single** copolymers, but also because the cited prior art would not suggest any process suitable for making the products specified in these claims, thus, fulfilling the conditions for non-obviousness set out in T 595/90.

Finally, document D6 was completely irrelevant, because it related to double layer thermoplastic films made e.g. from linear low density polyethylene (LLDPE), whose properties was undisclosed and which had been prepared using different catalysts.

VI. The Appellant requested that the decision under appeal be set aside and that the European patent No. 0 361 363 be revoked.

With its letter dated 8 September 1999 the Appellant submitted "that the Opponent has decided not to pursue this Appeal further" and requested "that the outcome of the Appeal should be determined on the basis of the Appeal Statement submitted on behalf of Union Carbide Corporation and the submission of the Patentees dated 26th January, 1999."

VII. The Respondent requested that the appeal be dismissed.

With its letter dated 29 September 1999 and in reaction to the Appellant's afore-mentioned submission of 8 September 1999 the Respondent maintained its request for oral proceedings "as an alternative request".

Reasons for the Decision

1. The appeal is admissible.

2. *Article 113 EPC*

Considering the outcome of this appeal, i.e. its dismissal, there was no need to hold oral proceedings.

3. *Citations*

3.1 Document D1

This document (cf. Claim 1; column 1, line 21 to column 2, line 18; column 4, lines 18 to 48) relates to a copolymer of ethylene with 0.5 to 40 mole%, preferably 0.5 to 30 mole%, especially preferably 1.5 to 2 mole% of at least one C_4-C_{20} α-olefin having i.a. the following characteristics:

(A) a melt flow rate (ASTM D 1238E) of from 0.01 to 200 g/10 min.,
(B) a density of from 0.880 to less than 0.930 g/cm^3 ,
(D) the amount of components having a degree of branching of not more than 2/1000 being not more than 10% by weight based on the ethylene copolymer,
(E) the amount of components having a degree of branching of at least 30/1000 being not more than 70% by weight based on the ethylene copolymer, and
(J) a molecular weight distribution M_w/M_n of from 2.5 to 10.

Example 1 discloses the preparation of an ethylene copolymer comprising 3.5 mole% 4-methyl-1-pentene. This copolymer has a density of 0.913, a degree of branching of 16.4 per 1000 carbon atoms, a ratio M_w/M_n of 2.74 and an impact strength of 6200 kg-cm/cm (column 14, line 30 to column 15, line 18; Tables 2 and 3).

According to the sentence bridging columns 9 and 10 the molecular weight distribution (= heterogeneity index) should not exceed the value of 10, in order to avoid that "its impact strength and environmental stress cracking resistance are markedly reduced".

3.2 Document D2

This document relates to an ethylene-α-olefin copolymer composition having a density of 0.915 to 0.929 g/cm^3, a melt index of 0.02 to 50 g/10 min. and a melt flow ratio of 35 to 250, which comprises

(i) 10 to 70% by weight of an ethylene-α-olefin copolymer A having a density of 0.895 to 0.935 g/cm^3 and 7 to 40 short chain branchings per 1000 carbon atoms and

(ii) 90 to 30% by weight of an ethylene-α-olefin copolymer B of higher molecular weight having a density of 0.910 to 0.955 g/cm^3 and 5 to 35 short chain branchings per 1000 carbon atoms,

both copolymers A and B having a ratio weight average molecular weight/number average molecular weight (= heterogeneity index) of 2 to 10 (Claim 1; column 8, lines 20 to 25; column 9, lines 22 to 30).

The copolymer blend according to Example 27, which comprises the ethylene-butene-1-copolymer A3-1 obtained according to Example 24 and the ethylene-butene-1-copolymer B3-1 obtained according to Example 25 in a 50/50 weight ratio, is i.a. reported to have the following properties (column 36, line 32 to column 37, line 54; column 38, line 65 to column 40, line 51, Table 18; column 44, Table 20):

density: 0.920 g/cm^3 (patent in suit: 0.915 to 0.932 g/cm^3);

MI: 0.5 g/10 min;

MFR: 70 [according to column 18, lines 6 to 9: MFR = $MI_{21.6}$/MI and is measured according to ASTM D 1238, i.e. according to the method also used in the patent in suit (page 6, lines 7 to 8)];

Short Chain Branching (SCB)-distribution index: 2.5;

Dart impact strength: 700 kg.cm/cm.

3.3 Document D3

This document relates to a method for producing a catalyst system characterized by (a) forming a chromium catalyst component on a silica support; (b) subjecting the composition of (a) to activation in an oxygen-containing ambient at an elevated temperature to convert at least a portion of any chromium in a lower valent state to the hexavalent state; (c) thereafter subjecting the activated catalyst composition of (b) to carbon monoxide under reducing conditions; and (d) thereafter contacting the thus reduced supported catalyst composition of (c) with a cocatalyst selected from trialkylboron compounds, e.g. triethyl borane (hereinafter TEB), and dialkyl aluminum alkoxide compounds (Claims 1 and 6).

This catalyst system may be used to prepare ethylene polymers having a density in the range of 0.920 to 0.960 g/cm^3 under slurry conditions (e.g. according to US-A-3 248 179 identified as document D4 in the present proceedings). In the latter case the cocatalyst is used in amounts of 0.5 to 20, preferably 2 to 8 ppm based on diluent in the reactor (Claims 8, 10; page 3, lines 32 to 34; page 4, lines 10 to 13).

The ethylene copolymers are prepared from pure ethylene feed without the addition of significant amounts (not more than 1 mole%) of comonomer by *in situ formation* of comonomer, especially hexene, at a temperature in the preferred range of 200 to 230°F (93.3 to 110°C) (cf. page 3, line 49 to page 4, line 1; page 4, lines 14 to 15).

3.4 Document D4

This document relates to the production of high molecular weight solid olefin polymers, e.g. copolymers of ethylene with other olefins, in a loop reactor by slurry polymerisation in a diluent, in the presence of a chromium oxide catalyst containing hexavalent chromium associated with silica-alumina at a temperature of 230°F (110°C) or below, especially between 150 and 225°F (e.g. 65 and 107°C). By this process reactor fouling is minimized (Claim 1; column 3, line 15 to column 4, line 10; column 4, lines 66 to 71).

3.5 Document D6

This document relates to a method of bundling a body of goods with a dual layer film, preferably a flattened tube made from a copolymer of ethylene and an α-olefin (Claims 1, 2; column 2, lines 3 to 30). The preferred film is prepared from LLDPE, produced by low pressure polymerisation of ethylene with up to 14 weight-% of an α-olefin in gas phase, liquid phase or in solution using a chromium or Ziegler catalyst. Such LLDPEs have a density between 0.915 and 0.935, a M_w/M_n ratio (heterogeneity index) of 3 to 15 and an MI between 0.1 to 50 g/10 min (column 4, lines 14 to 25).

Set A of claims

4. *Novelty*

For the following reasons the claimed subject-matter is novel over the cited prior art.

4.1 Claim 1

This claim comprises the following features:

(a) slurry polymerization process
(b) reaction zone
(c) polymerization conditions
(d) temperature in the range of from 82 to 88.3°C
(e) diluent selected from the group consisting of paraffins, cycloparaffins, aromatic hydrocarbons, and mixtures thereof
(f) ethylene monomer
(g) at least one comonomer selected from the group consisting of 1-butene, 1-pentene, 1-hexene, 1-octene, 4-methyl-1-pentene, and mixtures thereof
(h) comonomer present in an amount of 5 to 20 weight percent, based on the amount of ethylene
(i) trialkyl boron compound, present in an amount in the range of from 0.5 to 4 ppm, based on the mass of the diluent
(j) chromium catalyst
(k) supported on a silica-titania support
(l) support comprising from 2 to 10 weight percent titanium, based on the weight of the support
(m) catalyst activated in an oxygen-containing ambient
(n) catalyst subsequently reduced in the presence of carbon monoxide in an inert ambient
(o) recovering the polymer.

4.1.1 Document D3

The afore-mentioned features (a) to (c), (e) to (g), (i) as far as it concerns the use of a trialkyl boron cocatalyst and (j) to (o) are disclosed in combination in D3. As far as feature (i) concerns the amounts of the trialkyl boron catalyst, the range of 0.5 to 20 ppm disclosed in D3 overlaps that of 0.5 to 4 ppm according to Claim 1 of the patent in suit (cf. page 2, line 38 to page 3, line 11; page 3, lines 26 to 34; page 3, line 49 to page 4, line 13).

D3 does not disclose feature (d). On page 4, lines 14 to 15 it mentions a polymerisation temperature within the range of 200 to 230°F (93.3 to 110°C), which is above the range of 82 to 88.3°C specified in Claim 1. The reference in D3, page 4, lines 11 to 13 cannot be interpreted to incorporate into the disclosure of D3 any temperature conditions disclosed in D4, even if arguably they would meet the temperature requirements of present Claim 1, because the latter document does not use the same catalysts and does not relate to the polymerisation technique of D3, i.e. does not involve the in *situ* generation of comonomer (cf. following point 4.1.2 (v)).

Nor does D3 disclose feature (h): since according to D3 the comonomer is generated *in situ* and since this process step cannot be separated from the simultaneous consumption of the comonomer during the ongoing copolymerisation, it is not possible to infer from the density of the resultant copolymer any amount of comonomer **present** in the reaction mixture.

The subject-matter of Claim 1 is, thus, novel over document D3.

4.2 Claims 11 and 10

Claim 11 comprises the following features:

(E) copolymer composition
(F) of ethylene and
(G) higher α-olefin
(H) in an amount of 2 to 3.5 mole percent
(I) from 100 to 180 short chain branches (hereinafter "SCB") per 10,000 backbone carbons
(J) density within the range of 0.915 to 0.932 g/cm^3
(K) dart impact of greater than 400 g for 0.025 mm (1 mil) film
(L) Spencer impact value of greater than 1.2 J
(M) HLMI/MI ratio in the range of 70 to 150
(N) heterogeneity index in the range of 10 to 20.

Claim 10 differs from Claim 11 (i) in that it relates to copolymer produced according to the process of Claim 1, not to a copolymer composition *per se* as according to Claim 11, and (ii) in that its characterising part only comprises features (J), (K), (M) and (N) of Claim 11.

In view of the description of the "product" of the polymerisation set out on page 4, line 51 to page 5, line 40 of the patent in suit and also in view of the worked examples therein, it must be concluded that the factual meaning of the terms "polymer produced according to the process of claim 1" and "polymer composition" is identical. In particular, there is no suggestion in the patent specification of any further polymer component possibly influencing the properties of the copolymer "composition" according to Claim 11, nor is there any suggestion of a polymerisation method different from the one according to Claim 1 (Article 69 EPC).

The subject-matter of Claim 11 is, thus, comprised by the subject-matter of Claim 10. From that it follows that the acknowledgement of the novelty of the subject-matter of Claim 10 will necessary entail that the subject-matter of Claim 11 is novel as well.

4.2.1 Document D1

Example 1 of this document discloses a copolymer having in combination the afore-mentioned features (E) to (I) (cf. point 2.1 supra).

Feature (J) is not fulfilled by this copolymer, because its density of 0.913 g/cm³ is slightly below the lower limit of 0.915 g/cm³ according to Claims 10 and 11 of the patent in suit. Otherwise, the density range of 0.850 g/cm³ to 0.930 g/cm³ according to D1 (cf. column 1, line 26) overlaps that of 0.915 g/cm³ to 0.932 g/cm³ according to Claims 10 and 11 of the patent in suit.

Furthermore, neither this Example 1 nor the description of D1 as a whole, although referring to copolymers having high toughness (cf. column 1, first paragraph), disclose impact strength values, which meet those according to said claims 10 and 11. In particular there is no information concerning the dart impact strength (feature (K)) and the Spencer impact strength (feature (L)).

The Appellant's mathematical conversion (cf. Statement of Grounds for Appeal, point 3.6) of the impact value of 6200 kg-cm/cm of Example 1 (D1: column 17, Table 3) to a Spencer impact value of 1.54 J/mil (and thus above the lower limit of 1.2 J/mil according to feature (L)) is not convincing, because (i) the methods of measurement are not the same according to D1 and according to the patent in suit (cf. D1: column 13, lines 61 to 65; patent in suit: page 6, line 10, e.g. document D9) and (ii) because the thickness of the test sample used according to D1 (50 µm = 1.97 mils: column 13, lines 43 to 57) was almost twice the thickness of 1 mil required by Claim 1 of the patent in suit; the latter is an important difference since according to D7 ("Standard Test Methods for Impact Resistance of Polyethylene Film by the Free-falling Dart Method", page 229, left-hand column, point 3.4) a reliable conversion is only possible for specimens the thickness of which does not vary by more than 25%.

For both reasons the assumptions relied upon by the Appellant for its calculations are not justified.

Concerning the feature (N) (heterogeneity index) there is an overlap at the value of 10 of the range of 10 to 20 according to Claims 10 and 11 of the patent in suit with the range of 2.5 to 10 according to Claim 1 of D1. The value of 10 is, however, not disclosed in D1 in conjunction with the other features of Claims 10 or 11. This is particularly conspicuous with regard to the copolymer according to Example 1, whose heterogeneity index (M_w/M_n) is as low as 2.74 (Table 2).

Thus, the subject-matter of Claim 10 is novel over D1, because features (K), (L) and (N) are undisclosed in this document, and feature (J) is a selection from the broader density range according to D1.

Consequently, the subject-matter of Claim 11 must also be novel. Moreover, from the features comprised by Claim 11 in addition to those of Claim 10 features (H) and (I) are disclosed in D1, but features (L) and (N) are not. The latter features, thus establish a further difference between that document and the subject-matter of Claim 11.

4.2.2 Document D2

The fact that this document relates to **blends** of different ethylene α-olefin copolymers, whereas Claims 10 and 11 of the patent in suit relate to **single** copolymers is not a distinguishing feature, because the process for the preparation of a composition has no distinguishing character as long as it does not lead to features which are characteristic for the respective method only. Since this is not the case here, the fact that the compositions according to D2 are blends does not distinguish them from compositions based on a single copolymer.

Example 27 of this document discloses copolymer blends exhibiting in combination the afore-mentioned features (E) to (G), (J) and (M).

This example does not indicate the amount of comonomer in the blend (feature (H), i.e. 2 to 3.5 mole% α-olefin), nor can this feature be inferred with certainty from the density of 0.920 g/cm³ of this copolymer blend.

Feature (I) is also not met by the copolymer blend according to Example 27, because the average SCB number of the 1:1 blend of copolymer A, having a SCB number of 380, and of copolymer B, having an SCB number of 150, must be above the upper limit of 180 according to Claim 11 of the patent in suit.

Concerning feature (K), Table 20 in column 44 of D2 discloses for the copolymer blend according to Example 27 a Dart impact strength of 700 kg-cm/cm for a film specimen having a thickness of 35 μ (1.4 mils) (cf. column 41, line 32 to column 42, line 35, Example 32; column 44, Table 20). According to the

Opponent's submission of 5 December 1997, pages 8 to 9, "Feature K", the figure of 700 kg-cm/cm may be converted to a value of about 377g (for a 1 mil film). It is thus apparent that feature (K), which requires a value of > 400 g, is not met; there is no evidence for the Opponent's argument in the afore-mentioned submission, that - because of the error inherent to this method of measurement - the value of 377g would nevertheless be within the claimed scope, and this argument must therefore be dismissed.

Similarly, there is no evidence for the argument that the Dart impact strength value of 700 kg-cm/cm according to Example 27 of D2 corresponds to a Spencer impact strength value > 1.2 J and, consequently, feature (L) of Claim 11 of the patent in suit is not met either.

Finally, D2 does not disclose, in combination with the other features, a copolymer blend having a heterogeneity index in the range of 10 to 20 as required by Claims 10 and 11. This is demonstrated by the fact that all of the single copolymers forming the ultimate blend, which are disclosed in D2, have a heterogeneity index below 10, most of them considerably lower (cf. Tables 1 to 6, 15 to 17, 22 to 24).

Thus, the subject-matter of Claim 10 is novel over D2, because features (K) and (N) are undisclosed in this document.

Consequently, the subject-matter of Claim 11 must also be novel. Moreover, the features (H), (I) and (L) comprised by Claim 11 in addition to the features of Claim 10 are also not disclosed in D2, establishing, thus, a further difference between that document and the subject-matter of Claim 11.

4.3 The subject-matter of the independent Claims 1, 10 and 11 is thus novel over the cited prior art.

5. *Inventive step*

5.1 Claim 1

There is agreement between the parties that document D3 represents the closest prior art. The Board sees no reason to deviate from this view.

5.1.1 Problem and solution

(i) As compared to the polymerisation process according to D3, the problem underlying the subject-matter of Claim 1 is the provision of an alternative polymerisation process for the preparation of similar ethylene α-olefin copolymers that can be easily processed into tough, impact resistant film (page 2, lines 27 to 31 of the patent ; page 2, lines 2 to 9 of the original application).

(ii) According to Claim 1 this problem is to be solved by carrying out the copolymerisation in the presence of a mixture of ethylene and α-olefin in certain amounts and within a certain temperature range.

(iii) Examples 1, 2, 5 (Runs 501 and 503), 6 (Run 602) and 7 (Run 701) show that the existing technical problem is effectively solved by adhering to the process parameters according to Claim 1 (cf. page 6, lines 24 to 56; page 8, Tables III and IV; page 9, Table V).

(iv) This conclusion is not affected by the unsatisfactory impact strengths results of the ethylene-butene copolymer according to Example 5, Run 502 (Table III), because accidental failures have no impact on the feasibility of the teaching of a patent claim, which in a generalized manner concentrates on the essential features. Similarly, it is not harmful to this conclusion that the copolymer according to Example 6, Run 601 (Table IV), which was prepared at a temperature of 90.5°C, i.e. outside the required temperature range, exhibits better impact strength values than the afore-mentioned copolymer according to Example 5, Run 502.

5.1.2 Obviousness

The subject-matter of Claim 1 is not obvious over D3.

(i) D3 is concerned with the preparation of ethylene α-olefin copolymers by a slurry polymerisation process wherein the α-olefin comonomer is prepared *in situ*. Only small amounts of comonomers (not more than 1 mole%) may be present in the ethylene feed. D3 explicitely states that the addition of comonomer "would dilute one important aspect which is the economy effected by being able to produce copolymers without the use of a separate comonomer feedstream" (page 3, lines 49 to 55).

(ii) The amount of comonomer formed, which determines the density of the copolymer, increases with increasing amounts of cocatalyst, e.g. TEB (page 4, lines 3 to 5; page 9, Table 5). A further condition is that the cocatalyst is added to the "main" chromium catalyst before its contact with the ethylene feed (page 12, Example VII).

(iii) This information in D3 does not allow the skilled person any conclusion as to the effectivity of the catalyst system used in D3 in a polymerisation process, where the α-olefin comonomer is present in the reaction mixture, i.e. in the ethylene feed right from the beginning of the copolymerisation reaction. The skilled person would rather assume that the catalyst system used according to D3 is specifically adapted to the *in situ* method; he would not, therefore, expect any benefit from the use of this catalyst system in a polymerisation process not requiring the *in situ* preparation of the comonomer. A "one way street" situation, which obliged the skilled person to use the catalyst decribed in D3 under the different reaction conditions of the patent in suit, did, therefore, not exist.

(iv) In particular, there is no clue in D3 at the activity of the cocatalyst, e.g. TEB, as swelling inhibitor of the copolymer particles formed in the diluent (cf. Example 3 and Table I of the patent in suit) and there is no reason for him, therefore, to consider the use of the cocatalyst in order to achieve this effect. It appears, moreover, credible, as argued by the Respondent, that the swelling phenomenon is particularly aggravated by the presence of comonomer in the reaction mixture and is less problematic if only low amounts of free comonomer are present in the reaction mixture (cf. Counterstatement of Appeal, point IV.3). For this reason as well, D3 is unable to provide guidance for the prevention of the swelling phenomenon.

(v) In view of the situation outlined in the previous paragraphs (i) to (iv) it is only an additional argument against the Appellant's obviousness objection that D3 does not contain any hint at a possible reduction of the polymerisation temperature below the preferred range of 93.3 to 110°C. The reference to document D4 on page 4, lines 10 to 13 is to no avail in this respect, because

(a) the catalyst used according to D4 is different from that according to D3 in that it requires the presence of hexavalent chromium (cf. D4: column 4, lines 66 to 71, column 6, lines 43 to 54, Example 1), whereas D3 requires that the chromium should generally be in the divalent state (cf. D3: page 3, lines 14 to 16),

(b) the process according to D4 does not involve the *in situ* formation of α-olefin comonomer, and

(c) the temperature range of 150 to 225°F (65.5 to 107°C) indicated in D4 (column 3, lines 70 to 73) does not necessarily point towards the narrow range of 82 to 88.3°C required by Claim 1 of the patent in suit.

(vi) With respect to the last mentioned argument the Appellant contended that the evidence in the patent in suit would not prove the critical importance of the selected temperature range. While this is true, it can also not be contested that the existing technical problem is solved when operating the polymerisation process at the specified temperature range (cf. point 3.1.1 (iv) supra). In view of the fact that the solution of the existing technical problem is not obvious over the closest prior art in the light of the conclusions drawn in the preceding subpoints (i) to (iv), there is no need to demonstrate a critical importance of the selected limits of the temperature range.

(vii) The Appellant's further argument that the person skilled in the art seeking to enhance the toughness of the copolymers would automatically turn to temperatures lower then the ones used according to D3 is also not convincing. While it is accepted that lower polymerisation temperatures favour higher molecular weights, which are associated with higher toughness, the skilled person will normally assume that an increase of the molecular weight of ethylene-α-olefin copolymers would affect their processability. It was, therefore, not to be expected that the copolymer according to Example 7, Run 701, which because of its melt index of 0.09 g/10 min, has a much higher molecular weight than that of the comparative copolymer according to Run 702, whose melt index is 0.9 g/10 min, exhibits a far better processibility (higher screw rotation, rate and speed).

(viii) Consequently, the subject-matter of Claim 1 involves an inventive step over document D3 alone or in combination with document D4.

5.2 Claims 10 and 11

There is agreement between the parties that document D2 represents the closest prior art. The Board sees no reason to deviate from this view.

5.2.1 Problem and solution

(i) As compared to the compositions according to D2 the problem underlying the subject-matter of Claims 10 and 11 was the provision of further copolymers of ethylene and α-olefin having good balance of impact strength and processability (page 2, lines 30 to 31; Examples 7 and 8 of the patent specification; page 2, lines 7 to 9; Examples 7 and 8 of the original application).

(ii) This problem is to be solved by the combination of

(a) certain amounts of comonomer (defined in Claim 10 via the amount of comonomer used in its preparation = feature (h) of Claim 1; defined in Claim 11 by feature (H)),

(b) short chain branches (comprised by Claim 10 as result of the process parameters used according to Claim 1; defined in Claim 11 by feature (I)), and

(c) a heterogeneity index within a certain range (feature (N) in Claims 10 and 11).

(iii) The Board is satisfied that the existing technical problem has effectively been solved by the subject-matter of Claims 10 and 11. This conclusion may be drawn from the processability and impact strength results comprised in Table V of Example 7, Run 701 which show that a copolymer of ethylene and 4-methyl-1-pentene having a density of 0.925 g/cm^3, a melt index of 0.09 g/10 min and a broad molecular weight distribution (heterogeneity index 10-18), which was produced according to the requirements of Claim 1, exhibits at the same time a good processability and a high impact strength (cf. point 4.1.2 (vii) supra).

5.2.2 Obviousness

(i) The subject-matter of Claims 10 and 11 was not obvious over the disclosure of document D2, because - apart from any other consideration - this document does not suggest a low density ethylene-α-olefin copolymer having a heterogeneity index in the range of 10 to 20 **and** having the high impact strength value required by these claims.

(ii) Indeed D2 does not suggest a copolymer, single or blend, having a heterogeneity index in the required range (cf. point 3.2.2 supra), altough it is also concerned with achieving a favourable balance of processability and mechanical strength, including impact strength, as is set out in column 3, lines 64 to 68: "Thus, both of processability and physical properties are not met together yet, and any low density ethylene-α-olefin copolymer excellent in processability and mechanical strength have not yet been provided." Since the solution offered to this problem by D2 resides essentially in the blending of copolymers having i.a. a heterogeneity index below 10, it cannot be argued that another solution to this problem involving copolymers having a heterogeneity index above 10 would be obvious. This conclusion is not invalidated by the fact that copolymers A and B according to Claim 1 of D2 may each have a maximum heterogeneity index of 10, because D2 nowhere discloses a blend of such copolymers A and B and the worked examples clearly show that such a composition was not envisaged.

(iii) In this context it is also interesting to note that documents D1 and D2 relate to very similar ethylene-α-olefin copolymer compositions (cf. points 2.1 and 3.2.1 supra) and that D2 was considered during the prosecution of D1 before the USPTO (cf. front page, References Cited, U.S. Patent Documents). However, document D1 filed well after D2 states in the sentence bridging columns 9 and 10: "If the molecular weight distribution of the ethylene copolymer exceeds 10, its impact strength and ... are markedly reduced." This is a clear pointer, that even after the filing of D2 the skilled person faced with the objective of high impact strength copolymers was not considering heterogeneity indices M_w/M_n above 10.

(iv) Document D6 , which mentions the possible use of linear low density polyethylene (LLDPE) having a ratio M_w/M_n of up to 15, thus overlapping the range of 10 to 20 according to feature (N) of Claims 10 and 11, does not lend itself to a combination with the teaching of D2, because the short disclosure therein to the preparation of the LLDPEs in the presence of chromium or Ziegler catalysts, in the absence of any reference to their properties, cannot suggest that this document is of any relevance to the solution of the existing technical problem (cf. D6: column 4, lines 14 to 25).

(v) Considering the above, the Appellant's argument that it was obvious to a skilled person starting from the teaching of D2 and heading for improved processability would immediately turn to copolymers having a broader molecular weight distribution, is clearly at variance with the facts. On the contrary, on the basis of the information available to him the skilled person was rather biased against such a measure, because he had to expect that in this case the copolymers would not exhibit a satisfactory impact strength. Unexpectedly, the subject-matter of Claims 10 and 11 provides a solution combining good processability (= higher heterogeneity index) and good impact strength.

(vi) The subject-matter of Claims 10 and 11 is, thus, not obvious over D2.

(vii) In view of the considerations in sub-point (iii) supra the subject-matter of Claims 10 and 11 was likewise not obvious over the disclosure of document D1.

6. The subject-matter of the independent Claims 1, 10 and 11 is, therefore, novel and inventive over the cited prior art. The same conclusion applies *a fortiori* to the subject-matter of the dependent Claims 2 to 9 and 12 to 17.

Set B of claims

7. Claims 1 to 10 of this set correspond to Claims 1 to 9 and 16 of set A. The subject-matter of these claims is, therefore, also novel and inventive over the cited prior art.

8. Concerning the ground of opposition under Article 100(b) EPC, which was not maintained in the appeal (cf. point V (iii) supra), the Board concurs with the opinion set out in points 2.1 to 2.4 of the reasons of the decision under appeal, i.e. that the patent does disclose the invention, especially its compositional aspect according to Claim 11 of set A, in a manner sufficiently clear and complete for it to be carried out by a person skilled in the art.

Order

For these reasons it is decided that:

The appeal is dismissed.

The Registrar:

E. Görgmaier

The Chairman:

C. Gérardin