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**D E C I S I O N**  
**of 6 April 2004**

**Case Number:** T 0158/02 - 3.3.3

**Application Number:** 96109829.0

**Publication Number:** 0733653

**IPC:** C08F 297/08

**Language of the proceedings:** EN

**Title of invention:**

Method for the preparation of ethylene polymer compositions

**Patentee:**

MITSUI CHEMICALS, INC.

**Opponent:**

THE DOW CHEMICAL COMPANY

**Headword:**

-

**Relevant legal provisions:**

EPC Art. 56

**Keyword:**

"Inventive step - problem and solution"

**Decisions cited:**

G 0010/91

**Catchword:**

-



Case Number: T 0158/02 - 3.3.3

**D E C I S I O N**  
**of the Technical Board of Appeal 3.3.3**  
**of 6 April 2004**

**Appellant:**  
(Opponent)

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**Respondent:**  
(Proprietor of the patent)

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**Representative:**

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**Decision under appeal:**

**Decision of the Opposition Division of the  
European Patent Office dated 20 November 2001  
and issued in writing on 28 November 2001  
rejecting the opposition filed against European  
patent No. 0733653 pursuant to Article 102(2)  
EPC.**

**Composition of the Board:**

**Chairman:** R. Young  
**Members:** A. Däweritz  
H. Preglau

## Summary of Facts and Submissions

I. The grant of European patent No. 0 733 653 in respect of European patent application No. 96 109 829.0, being a divisional application of European patent application No. 91 301 167.2, which had been filed on 13 February 1991 and claimed the priority of 13 February 1990 of two earlier patent applications in Japan (32092/90 and 32093/90), was announced on 11 November 1998 (Bulletin 1998/46) on the basis of 4 claims, Claim 1 as granted reading as follows:

- "1. A method for the preparation of an ethylene polymer composition having a density of 0.87-0.93 g/cm<sup>3</sup> and an intrinsic viscosity  $[\eta]$  of 0.5-6 dl/g, which comprises carrying out a multi-stage process comprising
- polymerization step (c): wherein ethylene and another  $\alpha$ -olefin are copolymerized using an olefin polymerization catalyst [II], which comprises a transition metal compound [A] containing a ligand having a cycloalkadienyl skeleton and an organoaluminum oxy-compound [B], to form an ethylene copolymer [III] having a density of lower than 0.91 g/cm<sup>3</sup> and an intrinsic viscosity  $[\eta]$  of 0.5-6 dl/g, and
- polymerization step (d): wherein ethylene is homopolymerized or ethylene and another  $\alpha$ -olefin are copolymerized using an olefin polymerization catalyst [III], which comprises a titanium catalyst component [C] containing titanium, magnesium and halogen as its essential ingredients, an organo-

aluminum compound [D] and/or an organo-  
aluminum oxy-compound [E] to form an  
ethylene copolymer [IV] having a density  
greater than that of the ethylene copolymer  
[III] and an intrinsic viscosity  $[\eta]$  of  
0.5-6 dl/g,

wherein the polymerization steps (c) and (d) are  
carried out such that step (c) is carried out  
first and step (d) is carried out in the presence  
of the ethylene copolymer [III] or step (d) is  
carried out first and step (c) is carried out in  
the presence of the ethylene polymer [IV] so that  
the ethylene polymer [IV] amounts to 10-1000 parts  
by weight based on 100 parts by weight of the  
ethylene copolymer [III]."

The remaining Claims 2 to 4 are dependent claims  
relating to elaborations of the method according to  
Claim 1.

II. On 11 August 1999, a Notice of Opposition was filed in  
which revocation of the patent in its entirety was  
requested on the ground of Article 100(a) EPC as the  
subject-matter of the claims lacked patentability  
within the terms of Articles 52 to 57 EPC. The only  
ground for opposition substantiated in the Notice  
concerned an objection of lack of inventive step with  
reference to twelve documents, including:

D1: EP-A-0 057 238,

D3: US-A-4 205 021,

D4: GB-A-2 093 044,

D6: JP-A-62-121 709 (English translation submitted with the Notice of Opposition) and

D8: US-A-4 659 685.

III. In a decision announced orally on 20 November 2001 and issued in writing on 28 November 2001, the opposition was rejected.

In the decision, document D4 was identified as representing the closest state of the art. It disclosed an ethylene- $\alpha$ -olefin copolymer composition which was excellent in strength and less sticky than conventional ethylene- $\alpha$ -olefin copolymers and, in particular, did not cause blocking. It was made up of two different ethylene- $\alpha$ -olefin copolymers having densities in ranges overlapping with those in Claim 1 under consideration and intrinsic viscosities within the ranges defined in this claim. One way of mixing the two polymers was their preparation in a two-stage polymerisation with one catalyst for both stages. The document did not suggest that different catalysts could be used. Moreover, it was stated that, according to D4, polymers having a broad molecular weight distribution (MWD), namely over 10, caused the blocking of films made from compositions containing such polymers.

The technical problem to be overcome with respect to this document was seen in the provision of a multi-stage process "wherein an ethylene- $\alpha$ -olefin copolymer is obtained by metallocene catalyst in the presence of an ethylene homopolymer or an ethylene- $\alpha$ -olefin copolymer of higher density obtained by conventional

catalyst (the sequence of steps may be inverted) in order to prepare compositions which are excellent in anti-block properties and heat resistance despite the fact that they are low in density".

The second document taken into account in the decision was D8, the examples of which disclosed a two-step process corresponding to the method under consideration with the exception that neither the density nor the intrinsic viscosity of the constituents was indicated. This document aimed at the provision of polymers having a broader MWD.

It was concluded, that the skilled person faced with the problem of providing a composition having excellent anti-block properties was not led to combine the teachings of these two documents in order to arrive at the claims in the patent in suit.

Since, moreover, none of the other cited documents was concerned with the technical problem underlying the patent in suit, an inventive step was acknowledged.

IV. On 7 February 2002, a Notice of Appeal was filed by the Opponent (Appellant) with simultaneous payment of the prescribed fee.

(a) In the Statement of Grounds of Appeal, received on 8 April 2002, and in further letters dated 23 April 2002, 20 June 2002 and 5 March 2004, respectively, the Appellant reiterated its objection of lack of inventive step on the basis of the position, which seemed *in confesso* between all parties, inclusive of the Opposition Division,

that polymerisation steps (c) and (d) were known *per se* by the skilled artisan. Otherwise the functionally defined steps, the reactions of which were to be carried out in such a way that the polymers corresponding to ethylene copolymer [III] and ethylene polymer [IV] were obtained, would not be described in a manner sufficiently clear and complete for it to be carried out by the person skilled in the art (cf. Article 83 EPC).

In this connection, the definition of the transition metal component [A] was deemed too broad, because it included compounds which did not exhibit any polymerisation activity. Consequently, the claims were too broad to solve the problem which was to make any polymer composition, let alone the specified polymer composition, and, therefore, the claims as granted covered subject-matter which did not involve an inventive step.

Referring to the fact that the composition as such was never claimed in the application as filed or the patent in suit, respectively, the Appellant argued that the product had been known *per se* from D1 or D4. Thus, the relevant properties of the composition to be produced by the process claimed overlapped broadly with those of the products of each of the two documents D1 and D4, both of which could therefore be used as possible starting points for the question of inventive step. From the standpoint of process features which came closest to the granted claims, D8 was considered as a further starting point.

Nevertheless, the formulation of the objective problem in the patent in suit was essentially product related. However, a process for making a known composition could not be made inventive by relying on known product properties of known products.

Therefore, the problem underlying the patent in suit was, at best, the provision of an alternative process for making known products. More particularly, with regard to D4, the Appellant argued that "the problem to be solved over D4 is to find an alternative catalyst for making the known lower density component having a known composition", ie a catalyst "capable to copolymerise ethylene and another  $\alpha$ -olefin comonomer to form an ethylene copolymer having a density of lower than  $0.91 \text{ g/cm}^3$  and an intrinsic viscosity  $[\eta]$  of  $0.5-6 \text{ dl/g}$ ".

Such a process did, however, not involve an inventive step, nor did the finding of a catalyst for such a process.

- (b) In reply to the appeal (letter dated 27 February 2003), the Respondent indicated with reference to Decision G 10/91 (OJ EPO 1993, 420) that it did not give its consent to take into account any ground of opposition other than the sole ground of opposition raised and substantiated in the opposition proceedings, namely the question of inventive step. It also disputed all the further arguments of the Appellant.



Thus, it argued that the term "olefin polymerization catalyst" would be well known in the art and the patent in suit was limited to the use of transition metal compounds and organo-aluminium oxy-compounds which together formed active catalysts.

The Respondent agreed with the decision under appeal that D4 represented the closest state of the art, because it was directed to resin compositions less sticky than conventional ethylene- $\alpha$ -olefin copolymers, ie displaying less blocking, and maintained that the patent in suit was directed to providing improved methods for the preparation of polymer compositions which were excellent in anti-block properties and heat resistance despite the fact that they were low in density (as set out in the decision under appeal).

Document D4 disclosed several multi-stage polymerisation processes which were, however, carried out using the same conventional catalyst in both steps. There was no teaching which would have motivated the skilled person to retain the D4 catalyst in one of the stages of the multi-stage polymerisation, whilst replacing it in the other stage. Nor, with regard to the relevant technical problem, would any one of the other documents provide such a teaching.

- V. On 6 April 2004, oral proceedings were held in the presence of both parties. Their arguments may be summarised as follows:

- (a) After having been informed at the beginning of the oral proceedings that, in view of the statement of the Respondent and of decision G 10/91 mentioned in that statement (section IV(b), above), the Board would not consider any ground for opposition other than inventive step, the Appellant made it clear that the argument referring to Article 83 EPC had been used only with the intention to support its arguments relating to inventive step.
- (b) With regard to inventive step, the Appellant focused its arguments on D4 as representing the closest state of the art and argued that the technical problem was confined to finding an alternative method for preparing compositions having the same heat resistance and anti-block properties as those known from that document. However, the broad wording of Claim 1 would encompass embodiments not capable of achieving the products having the required properties. What remained unknown from D4, was considered to be obvious with respect to any combination of D4 with any one of D6, D8, D1 and D3.

The heat resistance and non-tackiness of the composition were considered by the Appellant as properties, the first of which could be attributed to the use of the titanium catalyst in step (d), whilst the second was deemed to be the result of the use of the metallocene catalyst in step (c).

The Appellant also extended its criticism as to the breadth of the definition of catalyst component [II] by arguing that not all those

conceivable catalysts would provide a polymer having a narrow MWD to prevent larger amounts of low molecular weight solubles from being formed, which solubles would compromise the anti-block properties, in particular in view of the fact that Claim 1 required only that copolymer [III] had a density of lower than 0.91 (without defining a lower limit), whilst the density of polymer [IV] was required to be higher than the density of copolymer [III]. Thus, a 50:50 mixture of the copolymer [III] of Example 1 and the copolymer of Comparative Example 2 of the patent in suit would be encompassed by the claim. This composition would, however, certainly contain higher amounts of solubles than the two examples according to the claim. This would demonstrate that not all of the conceivable compositions within the definition of Claim 1 would be excellent in anti-block properties, some of them would rather be sticky and, hence, the technical problem would not be solved over the whole range of the claim.

- (c) The Respondent disputed all these arguments, most of which were, in its opinion, not based on the state of the art, but on the hindsight knowledge of the patent in suit. Moreover, no information about the relevant properties was quantified in D4, which would have allowed to directly verify the contentions based on the document. Finally, the Respondent pointed out that the Appellant had not discharged its burden of proof for its allegations.

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

The Respondent requested that the appeal be dismissed.

### **Reasons for the Decision**

1. The appeal is admissible.

2. *Procedural matters*

As set out at the beginning of the oral proceedings (section V(a), above), this decision deals only with the sole ground of opposition raised and substantiated within the nine-month opposition period, ie the question of inventive step (Article 99(1), Rule 55 EPC).

3. *Problem and solution*

3.1 The patent in suit concerns a method for the preparation of an ethylene polymer composition having a density of 0.87 to 0.93 g/cm<sup>3</sup> (all densities referred to in this decision are to be considered in terms of g/cm<sup>3</sup>) and an intrinsic viscosity  $[\eta]$  of 0.5 to 6 dl/g.

3.2 In the decision under appeal, document D4 was identified as representing the closest state of the art. Whilst in the Statement of Grounds of Appeal, D1, D4 or D8 had been considered by the Appellant as suitable starting points for the assessment of inventive step, it waived this issue in the oral proceedings, did not further contest the above finding of the Opposition Division, as already agreed with by the Respondent, and focused its arguments on D4 in combination with any one

of D6, D8, D1 and D3 (sections V(b) and (c), above). Nor does the Board see any reason to deviate from this finding.

3.2.1 Document D4 discloses an ethylene- $\alpha$ -olefin copolymer composition having a density of 0.910 to 0.940, a melt index of 0.02 to 50 g/10 min. and a melt flow ratio of 35 to 250. It is made up of two ethylene-C<sub>3</sub>- to -C<sub>18</sub>- $\alpha$ -olefin copolymers A and B being present in amounts of 10 to 70 and 90 to 30 % by weight, respectively. Copolymer A has a density of 0.895 to 0.935, an intrinsic viscosity of 1.2 to 6.0 dl/g and a short chain branching ("S.C.B.") number of 7 to 40 per 1000 carbon atoms; copolymer B has a density of 0.910 to 0.955, an intrinsic viscosity of 0.3 to 1.5 dl/g, and an S.B.C. number of 5 to 35. The two copolymers are chosen such that the ratio of (S.C.B. of copolymer A)/ (S.C.B. of copolymer B) is at least 0.6 (Claim 1).

3.2.2 The properties of the composition referred to are processability, impact, tensile and tear strengths, environmental stress cracking resistance (ESCR), low temperature resistance, transparency, and creep, heat-sealing and chemical characteristics. These properties are compared to those of low density ("high pressure") polyethylene (LDPE) in order to demonstrate advantages of the claimed compositions over LDPE, in particular with regard to "hot tack", heat sealing strength, ESCR, water-tree resistance and low temperature resistance in specific conditions or uses. Mention is also made of a number of unsatisfactory or unsuccessful attempts to overcome the problems of LDPE, such as the copolymerisation of ethylene with vinyl acetate, the

preparation of ionomers made from ethylene-(meth)-acrylic acid copolymers, the mixing of LDPE with a further  $\alpha$ -olefin polymer or a rubber, the manufacture of ethylene- $\alpha$ -olefin copolymers having low densities under a medium or low pressure using a transition metal catalyst, such as titanium catalysts in "normal" polymerisation conditions, vanadium or chromium catalysts (page 1, line 5 to page 2, line 28).

In all of these attempts, the improvement with respect to one defect caused other problems, including those in heat and weather resistance and mechanical strengths due to low degrees of crystallisation, poor melt rheology characteristics and many problems in processing because of a narrower MWD than that of LDPE.

- 3.2.3 The surface stickiness and poor mechanical strengths are explained as the result of an increased solubility of the lower molecular weight components of the product in solvents, being the consequence of the polymerisation under a medium to low pressure using a transition metal catalyst, the effect of  $\alpha$ -olefins acting as chain-transfer agents, and an increased S.C.B. of the lower molecular weight polymer component. This tendency to increased S.C.B. is particularly remarkable in those ethylene- $\alpha$ -olefin copolymers which are polymerised with a catalyst giving wider MWD. Upon broadening the MWD, however, transparency worsens and the surfaces of the moulded product get sticky (page 2, lines 32 to 58).

Whilst stating, on the one hand, that the resin composition as claimed in D4 obtained by mixing components A and B is less sticky than low density

ethylene- $\alpha$ -olefin copolymers hitherto prepared by the conventional technique (page 4, lines 60 to 62), it also makes clear, on the other hand, that the MWD of both copolymer A and copolymer B in terms of  $M_w/M_n$  should not exceed 10, to avoid lowering the mechanical strengths of the polymer compositions and, when processed into films, to avoid blocking and surface tackiness (page 5, lines 59 to 64; page 6, lines 24 to 28), which deficiencies also occur when the density of copolymer B is below 0.910 (page 6, lines 4 to 7).

Ziegler type (optionally supported on a carrier) and Phillips type catalysts may be used as the transition metal catalyst for the preparation of both copolymer components A and B. The titanium compounds (their halides, alkoxy or aryloxy halides are mentioned in D4) are most preferred from the standpoints of weather resistance and heat resistance (page 6, line 29 to page 7, line 2).

- 3.2.4 Apart from various methods of mechanical mixing of the two components, the composition can also be made by carrying out a two- or multi-stage polymerisation, wherein copolymer A and copolymer B are prepared in subsequent stages, using the same catalyst but changing other polymerisation conditions, until the composition containing the copolymers A and B at an intended ratio is obtained (page 8, line 64 to page 9, line 3).
- 3.2.5 Two-stage polymerisations are shown in Examples 6, 7, 26, 35 and 47. The densities of the polymers (product of the first stage/final composition) obtained were in Example 6: 0.902/0.920 (page 25, and Tables 5 and 9), Example 7: 0.910/0.923 (page 25, and Tables 6 and 10),

Example 26: 0.900/0.919 (page 56, and Tables 17 and 19), Example 35: 0.912/0.921 (page 73, and Tables 24 and 26) and Example 47: 0.912/0.921 (page 87, and Tables 30 and 32), ie the density resulting from the first step complies with the limitation in Claim 1 of the patent in suit only in Examples 6 and 26. In each of these examples, the first stage polymerisation was carried out "using the catalyst produced in Example 1" and triethyl aluminium as the cocatalyst. In the successive second stage, the only process features changed were the hydrogen partial pressure and the ethylene partial pressure. The catalyst of Example 1 was a supported catalyst prepared from an n-butyl magnesium chloride Grignard reagent, silicon tetrachloride and titanium tetrachloride.

3.2.6 In the tables of D4, tackiness of the final products is assessed in terms of three different symbols, ie a small circle ("o"), a small triangle ("Δ") and a small cross ("x") without giving any values for the limits between the degrees of tackiness indicated by each of these symbols. Nor does this assessment allow a further evaluation of the qualities of these three groups, let alone an assessment of the tackiness of the products in quantitative terms. The only conclusion concerning the meaning of these symbols can be based on the fact that "x" and "Δ" are only found in comparative examples, which can only mean that they indicate different degrees of less than sufficient or poor tackiness behaviour in comparison to the results in the examples concerning the subject-matter claimed in D4, which are graded "o". Thus, this circle may have the meaning of only just "adequate" or "sufficient", whilst it was



interpreted by the Appellant to mean "satisfactory" (letter dated 5 March 2004, page 8, line 2).

Nor is it possible, on the basis of the data of the examples in the tables of D4, to establish that certain compositions within the limits defined in Claim 1 of D4 (section 3.2.1, above) would have better anti-block properties than others which are only adequate or sufficient. Thus, no differentiation is possible between, on the one hand, the products of Examples 6 and 26, referring to two-step polymerisations and low density products in the first step (section 3.2.5, above) and, on the other hand, those of the other examples, irrespective of whether those other examples describe two-step polymerisations, but densities in the first step which are higher than required in the patent in suit, or the mechanical mixing of the components.

3.3 In line with the description in the patent in suit, in particular page 2, lines 7 to 9, 33, 34 and 54 to 56, the technical problem underlying the patent in suit with respect to D4 may be seen as the definition of a process for the preparation of ethylene polymer compositions being excellent in anti-block properties, ie an improvement of this property in terms of "a smaller amount of portion soluble in n-decane" (page 12, lines 37/38), at a high heat resistance (in terms of a high melting point; page 13, lines 7/8), in spite of their low density.

3.4 This formulation of the technical problem was contested by the Appellant who contended that the technical problem was rather directed to an alternative process to that known from D4, since this document allegedly

aimed at the same features of the product as the patent in suit, ie a low density ethylene composition having a high heat resistance (D4, page 7, line 2) without being sticky (tacky) (page 2, lines 29 to 31, 41 to 45 and page 4, lines 60 to 62). More particularly, the Appellant argued that, as acknowledged in the patent in suit, ethylene copolymers obtained by using Ti based catalysts (ie a titanium compound and an organo-aluminium compound) were excellent in heat resistance and, as described in D4 (page 7, lines 1/2), high heat resistance was the typical result of the use of the titanium compounds.

3.4.1 To support its position, the Appellant relied on the data of the examples and comparative examples in the patent in suit (letter dated 5 March 2004: page 3, line 25 to page 4, line 18) and argued on their basis that only the component prepared with the Ziegler type catalyst was responsible for the heat resistance of the composition as could be seen from the melting points of 122, 112 and 93°C in Example 1 and of 122.7, 112.6 and 96°C in Comparative Example 2 (prepared with the titanium catalyst according to step (d) of Claim 1). Only the lowest melting point could be attributed to the product prepared with the metallocene catalyst [II] according to polymerisation step (c) as shown in Comparative Example 1 of the patent in suit.

3.4.2 However, these arguments are not convincing, because they are based on the assumptions that each property (or even each value for such a property) of the final composition can be assigned, independently from the others, to a specific component of the composition and the polymerisation reaction in one step and the

respective product thereof will not have any influence on the reaction in the other step and the product obtained therein, irrespective of the presence of the product of the first step during the second polymerisation as required by Claim 1.

In its above letter, dated 5 March 2004 (the table on page 4), the Appellant, itself, provided an overall view of the different densities, intrinsic viscosities and n-decane solubles of the respective (intermediate) products as disclosed in the patent in suit as a basis for its arguments. However, the values of these properties and of the melting point of the product of the first step as described in the last paragraph of Example 1 are completely different from the respective values in Comparative Example 1 relating to the "same" polymerisation reaction using catalyst (II). For example, the single melting point of the product of reaction (c) in Example 1 (83°C) is clearly distinct from the single melting point in Comparative Example 1 (97°C) and from the lowest melting point of the final composition of Example 1 (93°C). This difference in one feature alone, irrespective of the others, refutes the respective argument of the Appellant.

Moreover, the comparison of the results of Example 1 and of the comparative examples has no proper basis either because of the significant differences in the reaction conditions, all of which have a strong influence on the products. Thus, step (c) was carried out in Example 1 at temperatures of from 75 to 80°C at a total pressure of 8 kg/cm<sup>2</sup> using bis(methylcyclopentadienyl)zirconium dichloride as the metallocene compound. In Comparative Example 1, however, the

reaction was carried out using bis(cyclopentadienyl)-zirconium dichloride at temperatures of from 90 to 100°C at a total pressure of 20 kg/cm<sup>2</sup>. Furthermore, in the polymerisation steps (d) as disclosed in Example 1 and in Comparative Example 2, the ratios of the catalyst components (ethylaluminium sesquichloride/titanium catalyst component [C] in terms of titanium atom) were different from each other (0.3 mmol/0.003 mg atom v. 0.35 mmol/0.013 mg atom).

Hence, the experimental results in the examples and comparative examples in the patent in suit cannot be compared with each other in view of the differences in individual parameters of the (intermediate) products and in view of the different process parameters. Moreover, no reference was made by the Appellant to experimental results in the prior art in order to support its above arguments, since the only data relied on were selected from the patent in suit.

Consequently, no convincing conclusion can be based on such a comparison.

- 3.4.3 Moreover, the Respondent pointed out that in D4 emphasis was put repeatedly on heat sealing properties, in particular good heat-sealing properties at low temperatures (cf. D4: page 3, lines 58/59 in conjunction with page 1, lines 25 to 45, in particular line 28; cf. also page 7, line 30, page 9, line 49, page 10, lines 49/50; page 64, lines 29 to 39; page 80, line 16) rather than on heat resistance, and it emphasised that experimental data which would support the above arguments of the Appellant were neither

derivable from the prior art nor submitted by the Appellant, on whom the onus of proof had lain.

With respect to the targets of the patent in suit, the Respondent argued during the oral proceedings, that the property aimed at was the improvement of the anti-block properties of a heat-resistant polyolefin composition.

- 3.4.4 As already pointed out above in sections 3.2.3 and 3.2.6, the description and the experimental data in D4 provide only assessments of the anti-block property (tackiness) in very general, relative terms (page 4, lines 60/61: "less sticky than low density ethylene- $\alpha$ -olefin copolymers by the conventional technique") and in terms of symbols (in the tables: "o", " $\Delta$ " and "x"), respectively, on which, however, no quantitative evaluation of this property is possible. Nor has any evidence been provided by the Appellant which would allow to carry out a more meaningful evaluation of the experimental data of D4 with respect to the question at issue. What is derivable from the description of that document, is only that conventional low density ethylene- $\alpha$ -olefin copolymer products are less good in tackiness than the product as claimed in D4 (D4: page 2, lines 29 to 58; section 3.2.6, above). By contrast, in the patent in suit, the "excellent" anti-block properties have been quantified in terms of the solubles in n-decane. That this method of evaluating the tackiness of a ethylene- $\alpha$ -olefin copolymer product is relevant, can be seen in D4 (eg page 2, lines 44/45) and has not been contested by the Appellant (see section 3.4.1, above).

3.4.5 Consequently, the Board has come to the conclusion that the relevant objective technical problem underlying the patent in suit vis-à-vis D4 is not only confined to the provision of an alternative method as argued by the Appellant (section 3.4, above), but can be worded as formulated in section 3.3, above.

3.5 This technical problem is solved by carrying out a multi-stage process comprising two subsequent polymerisation steps (c) and (d) in either order, using two different catalysts [II] and [III], respectively, in the two steps, until the polymer [IV] obtained in step (d) amounts to 10 to 1000 parts by weight based on 100 parts by weight of the copolymer [III] of the step (c), the second step being carrying out in the presence of the product of the first step to provide a composition having a density of 0.87 to 0.93 and an intrinsic viscosity  $[\eta]$  of 0.5 to 6 dl/g (Claim 1).

3.5.1 With regard to the definitions of the catalysts in Claim 1, the Appellant contended that the technical problem would not be solved within the full scope of the claim (section V(a) in conjunction with sections IV(a) and V(b), above).

3.5.2 The relevant arguments of the Appellant were disputed by the Respondent, who pointed out that (i) the imaginary combination of parts of an example with a comparative example, both taken from the patent in suit, was neither prior art nor an appropriate basis for such an argument, (ii) the composition to be prepared was defined *inter alia* in terms of the ratio of its two components and of limited ranges of density and intrinsic viscosity, (iii) the expression "olefin

polymerisation catalyst" was a term which was well known in the art and encompassed only catalytic active substances, and (iv) no proof nor data nor evidence had been provided by the Appellant for the allegations that the problem was not solved in the full scope of the claims.

3.5.3 The Board accepts that the term "olefin polymerisation catalyst" is a functional definition referring to a compound which gives rise to the effects which a skilled person normally expects. Moreover, in the absence of counter-evidence which is based on prior art, which means that the Appellant has not discharged its burden of proof, the Board sees no reason for not accepting that the results in the examples of the patent in suit are representative for the subject-matter claimed.

3.5.4 Consequently, in view of the results of the examples and the comparative examples of the patent, the results of which have not been disputed, the Board is satisfied that the above relevant technical problem is effectively solved by the claimed subject-matter.

#### 4. *Inventive step*

It remains to be decided whether the solution found was obvious to a person skilled in the art.

4.1 As discussed above, D4 relates to ethylene- $\alpha$ -olefin copolymer compositions having certain properties. In particular, heat-sealing properties, hot tack and sealing strength were to be improved in comparison to LDPE and previous ethylene- $\alpha$ -olefin copolymers (page 1,

lines 5 to 11 and 25 to 59; and page 3, lines 58 to 62). The desired improvement of the heat sealing properties at low temperatures, however, does not clearly point in the direction of a polymer having a high melting point (as an index for heat resistance), but rather suggests to provide a composition containing a sufficient amount of low melting components to provide this desired improvement, as argued by the Respondent at the oral proceedings.

The tackiness of its compositions is addressed in D4 in very general terms and, in the examples, assessed in the form of symbols (sections 3.2.3, 3.2.6 and 3.4.4, above). In order to achieve the properties desired in D4, its compositions could be made by mechanically mixing two specific copolymers A and B or by preparing those two copolymers in a two- or multi-stage polymerisation by means of one catalyst, whereby the modifications in the properties of the two copolymers were achieved by changing only the reaction conditions, namely the partial pressures of hydrogen and ethylene (sections 3.2.4 and 3.2.5, above).

Hence, it is neither derivable from the document that at least some of its compositions showed "excellent" anti-block properties, nor did D4 provide any incentive to deviate from its teaching in order to solve the relevant technical problem (ie the improvement in the quantity of n-decane solubles in combination with high heat-resistance in spite of a low density; section 3.3, above) in such a way so as to arrive at something within the scope of Claim 1.



In other words, D4, by itself, does not provide a teaching which would lead the skilled person to a method within the scope of Claim 1 in order to solve the relevant technical problem.

4.2 Therefore, it remains to be decided whether any one of the further documents, in particular D6 and D8, relied upon by the Appellant at the oral proceedings provided such an incentive.

4.2.1 Document D6 relates to a low crystallinity ethylene type random copolymer which is to serve as an additive for thermoplastic resins, eg another ethylene type polymer (such as high, middle and low density polyethylenes and ethylene-C<sub>3</sub>- to -C<sub>30</sub>- $\alpha$ -olefin copolymers) or engineering resins, in order to improve a number of properties of the resulting blend *without deteriorating* its transparency and the non-stickiness of its surface. When blended to another ethylene type polymer, those properties to be improved include impact resistance, in particular low temperature impact strength, the bend resistance and the low temperature heat sealing ability. For its blends with other crystalline olefin polymers or engineering resins, transparency and non-stickiness are not to deteriorate (page 10, last line to page 11, paragraph 4; page 25, paragraph 1; page 26, lines 5 to 7; page 27, lines 8 to 10). Repeatedly, reference is made to the addition of a heat resistance stabiliser, if necessary (page 25, line 5 from below; page 26, last line; page 28, line 1).

The low crystallinity ethylene type random copolymer additive has a density of 0.90 or less and is made up of 35 to 85 % by weight of ethylene and 15 to 65 % by

weight of a C<sub>3</sub>- to C<sub>20</sub>- $\alpha$ -olefin. The copolymerisation of these comonomers is carried out in the presence of a zirconium hydride having a ligand with "a conjugated  $\pi$ -electron" and an aluminoxane with the aim of obtaining narrow molecular weight and composition distributions in the copolymer, excellent transparency, non-sticky surface and dynamic physical properties (Claims 1 and 2; page 5, item 3; page 10, last complete paragraph). As also pointed out by the Respondent, the document does not provide any information which would allow to draw conclusions about the heat resistance of either the copolymers alone or their blends with ethylene polymers. Moreover, no convincing argument has been provided in favour of a replacement of the single conventional titanium catalyst (according to the Appellant the appropriate means for obtaining a high heat resistance) as used in both polymerisation steps of the multi-stage polymerisation process of D4, by the zirconium catalyst of D6 in one and only one of the two polymerisation steps, as required in Claim 1 of the patent in suit (cf. sections V(b), 2<sup>nd</sup> paragraph, and 3.2.3, last paragraph, above).

Hence, this document provides no incentive to prepare an ethylene- $\alpha$ -olefin copolymer composition in a multi-stage polymerisation process using different catalyst systems in those stages in order to improve the anti-block properties of the composition (defined in terms of n-decane solubles), the composition having a high heat resistance despite its low density. In other words, it does not deal with the relevant technical problem (section 3.3, above). Nor does the document suggest to modify the teaching of D4 in such a way

which would lead to the method claimed in the patent in suit.

4.2.2 Document D8 concerns catalyst compositions for polymerising olefins which comprise a combination of at least one supported titanium-containing catalyst and at least one other separately supported or non-supported organometallic catalyst. The combination of these two types of catalysts yields polymers which have "broader molecular weight distributions and are multimodal" (column 1, lines 9 to 14, 24 to 29 and 35 to 38). In the eleven examples of the document, the molecular weight distributions in terms of  $M_w/M_n$  range from 9.85 to 58.7, whereby  $M_w/M_n$  values close to 10 are disclosed in only two of these examples.

Based on these facts, the Respondent argued that the skilled person would derive from D8, on the one hand, that the use of two different catalysts resulted in a broad MWD and from D4, on the other, that a broad MWD, namely above 10 was disadvantageous in respect to blocking behaviour of a film made from such a composition (D4: page 2, lines 45 to 47 and page 5, lines 62 to 64). Consequently, he would not contemplate such a process for the solution of the relevant technical problem.

The Appellant disputed this argument by contending that MWD could also be given in terms of melt flow ratios, and that big differences between the  $M_w/M_n$  values would not necessarily mean significantly different molecular weight distributions for the following reasons: as known by the skilled person, melt flow ratios  $I_{21.6}/I_{2.16}$  of from 35 to 250 as recommended in D4 (page 7, line 52

and page 11, lines 45 to 51) would, in general, be three to four times the values of the corresponding  $I_{10}/I_2$  ratios; ie an  $I_{21.6}/I_{2.16}$  value of 70 (Example 26 of D4) corresponded to an  $I_{10}/I_2$  ratio in the range of 15 to 20, which was within the range of those values shown in the Table of D8. Therefore, the Appellant concluded that the molecular weight distributions of the polymers of D8 would be of the same magnitude as those in D4 and, therefore, the skilled person would have considered D8 when modifying the teaching of D4.

However, these conclusions were disputed by the Respondent with reference to the argument that the measurements of melt flow index were related to rheology and did not only depend on the molecular weight, but also on further structural features of the polymer.

The Board cannot concur with the arguments of the Appellant, because no experimental evidence has been provided by the Appellant for the validity of its argument, and D8, in any case, clearly states that it aims at the preparation of polymers having a "broader" MWD, and the  $M_w/M_n$  ratio, which is based on two different methods of measurement of the molecular weight of polymers, is generally used in the art as the index for the MWD. By contrast, the melt flow ratios are based on measurements of rheological properties which are not, according to the undisputed argument of the Respondent, only dependent on the molecular weight. Even in D4 (the closest state of the art) which mentions both the  $M_w/M_n$  ratio and the  $MI_{21.6}/MI_{2.16}$  (=  $I_{21.6}/I_{2.16}$ ) ratio (for the measuring conditions see ASTM D-1238: condition E = 190°C/2.16 kg; condition F =

190°C/21.6 kg), the MWD is only considered in relation to the  $M_w/M_n$  ratio (page 5, lines 59 to 64), whilst in connection with the  $MI_{21.6}/MI_{2.16}$  ratio, reference is only made in general terms to extrusion processability and mechanical strengths (page 7, lines 50 to 57).

Consequently, the Board has no reason not to accept the arguments of the Respondent in this respect. It follows that D8 clearly points in a direction (of broad MWD), which is *expressis verbis* discouraged in D4 (section 3.2.3, above). Therefore the skilled person would not contemplate the combination of D4 and D8 in order to solve the relevant technical problem (section 3.3, above). Quite apart from this, there is no reference in D8 to stickiness which would provide the basis of an incentive to solve the relevant technical problem, let alone by a method within the ambit of Claim 1.

Consequently, D8 does not assist the skilled person in coming closer to the solution of the technical problem than D4.

- 4.2.3 Document D1 concerns the provision of an ethylene- $\alpha$ -olefin copolymer composition having excellent low-temperature heat-sealability, heat seal strength, flexural resistance, transparency and impact strength, making it suitable for packaging purposes (page 2, lines 9 to 15). The composition suggested is composed of two random copolymers (A) and (B) of ethylene and  $\alpha$ -olefins in distinct amounts characterised by their melt indices, densities, crystallinity, melting points and ethylene contents. Copolymer A is prepared by means of a highly active catalyst system comprising a

component made from titanium and magnesium compounds and an organoaluminium component (page 5, line 26 *et seq.*), copolymer B by means of a catalyst system composed of a conventional vanadium compound (*viz.* vanadyl trichloride, ethoxydichloride or triethoxide, vanadium oxydiacetylacetonate or triacetylacetonate) and an organoaluminium compound (page 8, line 24 *et seq.*). The only method of forming packaging films disclosed and suggested in D1 comprises the step of mechanically mixing the two separately prepared copolymers (A) and (B) in the specified ratios and forming the mixture directly in a film.

Whilst reference is made to sticking and blocking of the final film, if the density of copolymer (A) is below 0.870 or the crystallinity of copolymer (B) is lower than 5 %, the document is completely silent as to a multi-stage polymerisation. Nor does it provide an incentive to modify the method known from D4 in a way of the direction to the claimed subject-matter in order to solve the relevant technical problem. Conversely, D4 clearly teaches away from using vanadium catalysts because of low degrees of polymerisation and problems in heat resistance (D4: page 1, lines 63/64).

Consequently, this document does not contain any hint to the solution of the relevant technical problem, let alone to its solution by means of a multi-stage polymerisation as claimed in the patent in suit.

- 4.2.4 Document D3 relates to ethylene copolymers having unique structural characteristics and superior mouldability to provide superior transparency and improved tear and impact resistances to films made

therefrom, thus avoiding the unsatisfactory properties of (high pressure) LDPE in this respect as well as the unsatisfactory heat resistance of conventional ethylene copolymers (column 1, lines 4 to 16). The disclosed copolymers have a density of from 0.90 to 0.94, an intrinsic viscosity  $[\eta]$  of 0.8 to 4.0 dl/g, a maximum melting point (DSC) of 115 to 130°C; the ratio of  $[\eta]$  of the polymer and  $[\eta]$  of a linear polyethylene of the same weight average molecular weight being 0.05 to 0.78. The minimum density of 0.90 is necessary for achieving "freedom of stickiness" and superior mechanical characteristics, which can only be compared to those properties of the conventional previous polymers mentioned in the document (column 2, lines 60 to 66).

What could be derived from the document would be at most that the copolymers claimed therein can be made by copolymerising ethylene and a C<sub>5</sub>- to C<sub>18</sub>- $\alpha$ -olefin by means of a previously known catalyst composed of a solid titanium catalyst component and an organo-aluminium compound (column 4, line 48 *et seq.*). D3 is, however, completely silent about a multi-stage polymerisation process.

There is no suggestion in the document to solve the relevant technical problem, let alone in combination with D4, namely in view of the fact that D3 was state of the art in relation to the disclosure of D4.

- 4.3 For the reasons given above, the Board is satisfied that the solution of the technical problem represented by the method of Claim 1 does not arise in an obvious way from the state of the art. The subject-matter of Claim 1 is, therefore, based on an inventive step.

By the same token, this conclusion is also valid for the elaborations in the dependent Claims 2 to 4.

**Order**

**For these reasons it is decided that:**

The appeal is dismissed.

The Registrar:

The Chairman:

E. Görgmaier

R. Young