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**Datasheet for the decision
of 22 August 2007**

Case Number: T 0519/05 - 3.3.03

Application Number: 98118183.7

Publication Number: 0905146

IPC: C08F 2/00

Language of the proceedings: EN

Title of invention:

Production of polyethylene having improved crack and/or impact resistance

Patentee:

TOTAL PETROCHEMICALS RESEARCH FELUY

Opponent:

Innovene Manufacturing Belgium N.V

Headword:

-

Relevant legal provisions:

EPC Art. 54, 56, 100(a), 100(b)

Keyword:

"Novelty (yes)"

"Inventive step - problem and solution (yes)"

"Opposition grounds - insufficiency of disclosure (no)"

Decisions cited:

T 0626/91

Catchword:

-



Case Number: T 0519/05 - 3.3.03

D E C I S I O N
of the Technical Board of Appeal 3.3.03
of 22 August 2007

Appellant: Innovene Manufacturing Belgium N.V.
(Opponent) Scheldelaan 482
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Representative: King, Alex
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Respondent: TOTAL PETROCHEMICALS RESEARCH FELUY
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Representative: -

Decision under appeal: Decision of the Opposition Division of the
European Patent Office dated 2 February 2005
and posted 28 February 2005 rejecting the
opposition filed against European patent
No. 0905146 pursuant to Article 102(2) EPC.

Composition of the Board:

Chairman: R. Young
Members: A. Däweritz
C. Heath

Summary of Facts and Submissions

I. The grant of European patent No. 0 905 146 in respect of European patent application No. 98 118 183.7, filed on 25 September 1998 and claiming the priorities of 27 November 1997 and 24 June 1998 of two earlier applications filed in the European Patent Office (97 202 973 and 98 111 644, respectively), was announced on 9 October 2002 (Bulletin 2002/41). The patent was granted with ten claims, Claim 1 reading as follows:

1. A process for producing polyethylene, the process comprising copolymerising ethylene and an alpha-olefinic comonomer comprising from 3 to 8 carbon atoms, in the presence of a chromium-based catalyst in a first reactor to produce a first polyethylene copolymer product having a first melt index and a first molecular weight distribution, feeding the first polyethylene copolymer product thereby produced and the chromium-based catalyst to a second reactor, and in the second reactor copolymerising ethylene and an alpha-olefinic comonomer comprising from 3 to 8 carbon atoms, in the presence of the chromium-based catalyst thereby to produce a second polyethylene copolymer product having a second melt index and a second molecular weight distribution, **characterised in that** the first and second melt indexes are substantially the same and the first and second molecular weight distributions are substantially the same so that the first and second polyethylene copolymer products form a combined polyethylene having a monomodal molecular weight distribution.

The further dependent Claims 2 to 10 relate to further elaborations of the above process.

In this decision, references to passages in the patent in suit as granted will be given underlined in squared brackets, eg Claim [1], § [0001] and Example [1].

II. On 7 July 2003, a Notice of Opposition was filed, in which revocation of the patent in its entirety was requested. More particularly, the Opponent raised an objection under Article 100(b) EPC with regard to the terms "substantially the same melt indexes" (MIs) and "substantially the same molecular weight distributions" (MWDs) in Claim [1] in relation with the products of the first and second reaction stages. According to the Opponent, the term "substantially the same" used to

qualify the above two parameters was indefinite to such an extent that the term was meaningless, and it would, therefore, be unclear as to which extent either of the above parameters in Claim 1 could be different. If there were an effect due to any differences in these properties, it would not be clear which measures had to be taken to achieve the effect.

Furthermore, the Opponent referred to Articles 100(a) and 52 to 56 EPC and asserted lack of novelty and lack of inventive step with respect to

- D1: EP-A-0 739 909;
- D2: US-A-2 936 303;
- D3: US-A-2 978 441 and
- D4: US-A-3 074 922.

In this respect, the Opponent argued that, for the reasons mentioned above with regard to Article 100(b) EPC, the two parameters melt index (MI) and molecular weight distribution (MWD) should in any case be ignored when assessing novelty and inventive step with regard to the above prior art.

III. On the basis of the disclosure and explanations derivable from paragraphs [0029] and [0030] and from Tables [1] and [3], the Opposition Division, in its decision dated 2 February 2005, which was issued in writing on 28 February 2005, took the view, however, that the patent in suit provided sufficient disclosure to enable the person skilled in the field of polyethylene production to carry out the claimed process. Consequently, the objection under Article 100(b) EPC was rejected. The Opposition

Division further added that this objection had rather been an objection under Article 84 EPC, which was no valid ground for opposition under the EPC.

(1) Moreover, the novelty objection was rejected in the decision, because none of the documents disclosed a process wherein the first and the second polyethylene products had substantially the same melt indexes. In particular, the Opponent had not discharged its burden of proof, namely with regard to Example 7 of D1, in this respect. Nor was there in D1 to D4, according to the decision under appeal, any disclosure of a final product having a monomodal MWD.

(2) With respect to D1, which was regarded as the closest piece of prior art, the technical problem to be solved was seen in the decision in the provision of a process for the manufacture of polyethylene having a monomodal molecular weight distribution and improved crack and/or impact resistance.

(3) Whilst, according to the patent in suit, this problem was solved by producing in two serially connected reactors two resins, each of which had substantially the same MI and MWD, whereby the MI was controlled by means of the comonomer incorporation and reaction temperature, so that the final product had a monomodal MWD, D1 was found by the Opposition Division to teach rather the use of two serially connected reactors for the purpose of obtaining two products having different melt indexes. It was, therefore, concluded that D1 taught away from the claimed process and that its final product would have a bimodal MWD. Hence, D1 would provide, neither by itself, nor in

combination with any one of D2 to D4, any suggestion which would make the claimed process obvious.

(4) Consequently, the opposition was rejected by the Opposition Division.

IV. On 26 April 2005, a Notice of Appeal was filed against this decision by the Opponent/Appellant. The prescribed fee was paid on the same date.

(1) In the Statement of Grounds of Appeal (SGA) received on 6 July 2005, the Appellant maintained its previous position concerning the "substantially the same" melt indexes and molecular weight distributions with regard to Article 100(b) EPC and with regard to novelty and inventive step in comparison with each one of the four cited documents.

(2) In addition, the Appellant filed an Appendix I providing five diagrams, each showing the GPC (gel permeation chromatography) traces representing the MWDs of two different polymers and, as a third curve, the GPC trace mathematically constructed from the above traces of the two different polymers. Additionally, the HLMI (high load MI) values of the individual polymers used and the HLMI ratio of each mathematically constructed mixture were given.

According to the Appellant, all the polymers used as a basis for these curves had been commercial products. Products A and B thereof had been prepared by means of the particular Cr-based catalyst described on page [3] and product C had been prepared by means of another commercial Cr-based catalyst. Moreover, the Appellant

stated that Cr-based catalysts, in general, provided polymers having broad MWDs.

In each of the diagrams, the GPC curves of two polymers having different MIs and MWDs were shown together with a third curve mathematically constructed for specified mixtures of these polymers. Thus, the first three diagrams were based on products A and B and different mixtures thereof. The fourth diagram was based on polymers A and C and a mixture thereof. In the fifth diagram, GPC curves of products D and E, which had been derived from products A and B by mathematically shifting their average molecular weights further apart, and the curve of a mixture resulting therefrom.

Irrespective of the differences between the HLMI (high load MI) values of the above commercial and fictitious individual products A to E, all calculated GPC curves of their mixtures showed a single peak. In the Appellant's view, the skilled person could, therefore, always expect a monomodal MWD and the term "substantially the same" was indefinite to the extent that it was meaningless and should not, consequently, be accepted as a distinguishing feature for novelty.

(3) The Appellant additionally argued that Claim [1] would cover products with identical MI and MWD values, which would mean that they were identical in all respects and that there could not be any technical effect. "The second situation is where the composite resin displays a technical effect for example the alleged increase in stress cracking. This cannot be the result of the 'substantially the same HLMI and molecular weight distribution' as these are identical

so that it must be as a result of varying some other parameter that we are not told of and which is not set out in Claim 1. Consequently, ... the patent does not disclose the invention in a manner sufficiently clear and complete for it to be carried out by the person skilled in the art." Due to the lack of any limits concerning the definition of "substantially the same", the same argument would be valid if there were differences in the MI and MWD values. "What is missing is a clear instruction as to what process or product parameters need to be controlled and within what range in order to achieve the alleged benefit." ("Detailed Grounds of appeal" = DGA: page 2, last 8 lines to page 3, line 20).

(4) The arguments referring to novelty and inventive step of Claim [1] in the chapter bridging pages 3 and 4 of the DGA were based on the above view of the Appellant that MI and MWD could be disregarded.

(5) Thus, Example 7 of D1 would disclose all the features of Claim [1] and would, therefore, anticipate the subject-matter of this claim. Furthermore, D4 would disclose the "polymerisation of alpha olefins including ethylene and 1-hexene in the presence of 'a catalyst comprising as the sole essential ingredient chromium oxide...'... The catalyst is fed to the first reactor (therefore is discharged to the second reactor)... In the example, the conditions are the same in each of the reactors." In D2, the copolymerisation of ethylene and propylene using Cr in two reactors in series would be disclosed, and D3 would disclose the copolymerisation of α -olefins using a plurality of reactors in series

applicable to "the foregoing type of polymerisation... which includes chromium-catalysed copolymerisation...".

"All polymers disclosed in each of the cited prior art documents will inevitably have a melt index and a molecular weight distribution even in cases where it is not explicitly disclosed. ... Consequently all the features of Claim 1 of the opposed patent are disclosed in each of D1, D2, D3 and D4." (DGA: page 4, second paragraph).

(6) The technical problem to be solved was, in the opinion of the Appellant, the same in D1 and in the patent in suit, ie the preparation of polymers that have improved stress crack resistance. The finding in the decision under appeal that D1 taught away, because it aimed at different MI values of the polymers in the two polymerisation stages was disputed on the basis of the argument that Claim [1] covered widely differing MI values (section IV(3), above). Moreover, in each of D2, D3 and D4 would be statements to indicate that the polymerisation could be carried out to control the relative molecular weights in order to tailor the final properties of the product. Therefore, the Appellant concluded that the decision that the Opponent had not shown that the claimed subject-matter lacked inventive step had been in error (DGA: page 4).

V. These arguments of the Appellant were disputed by the Respondent in its letter dated 25 November 2005.

(1) In particular, the Respondent underlined that in the claimed process no fresh Cr-based catalyst was introduced in the second reactor, which would lead to a

different behaviour of the catalyst in the second reactor and to a degree of incorporation of the comonomer into the polymer chains different from that in the first reactor. Therefore, the operating conditions in the second reactor had to be adjusted in order to produce therein a polymer with substantially the same MI and MWD, resulting in a combined resin taken from the second reactor showing improved mechanical properties. "By mixing two resins produced in two separate reactors (parallel configuration), this technical effect is absolutely not reproduced. In a parallel configuration, fresh chromium catalyst is added in each reactor and the behaviour of the chromium catalyst is similar in each reactor." Therefore, blends obtained by mixing resins produced in separate reactors each with fresh Cr-based catalyst could not be representative of the polymers prepared according to the claimed process. This would apply a *fortiori* to the "mathematical blending" used by the Appellant (annex to the letter: item 1).

(2) In order to support its arguments, the Respondent filed an Appendix II providing the comonomer distribution analysis of two polyethylene resins, ie of the final products of Example [1] and of Comparative Example [1], obtained by preparative TREF (temperature rising elution fractionation) technique. The results were shown in a column diagram presenting, for both products in parallel, the respective weight percentages of the fractions eluted with xylene at different temperatures in the range of from 40 to 130°C. Based on the argument, which has remained undisputed, that there was "a good relationship between SBC and elution temperature with the most substituted polyethylene i.e.

the highest comonomer content being eluted first" (SBC = short chain branching content; Appendix II, page 1, last two lines), the Respondent concluded from the results presented that, although the two polymers had had similar HLMI, MWD and densities, their TREF profiles, ie their comonomer distributions, were significantly different (annex to the letter: item 2).

(3) With regard to the Appellant's arguments that the MI and MWD parameters would be meaningless, the Respondent pointed out that the boundaries of the term "substantially the same" were to be drawn "where the essential characteristic of the specific subject matter ceases for the person skilled in the art. In other words, one cannot ignore the term but has to turn to the person skilled in the art and ask him." (item 3.1).

Accordingly, the Respondent additionally filed an affidavit, dated 11 November 2005, by one of its employees, Mr. Fouarge, having worked in this field, whose statements were as follows:

1. In 1997, I was production manager at the PE units in Antwerpen; at that time, the commercial specifications on the melt index were routinely set at +/- 20 % of the melt index target value. I therefore consider that melt indexes within +/- 20 % of the melt index target value fulfil the definition "substantially the same".
- 2.1 In 1997, knowing the melt index of the resin produced in the first reactor (by measurement on a PE sample taken from such first reactor), I perfectly knew how to run my second reactor to achieve substantially the same melt index (as the first one) at the exit of such second reactor. I had just to apply very standard and basic PE operating conditions, such as slightly adjusting the reactor temperature and/or hexene to ethylene ratio.
- 2.2 It was indeed common general knowledge that e.g. increasing the temperature increases the melt index (an increase of about 2 to 4°C doubles the melt index), increasing the hexene to ethylene ratio decreases the density and increases the melt index, and the effect of hexene is also dependent on the temperature. Such slight adjustments were (and still are) continuously made to maintain the production of a desired grade.
- 2.3 I therefore consider that the description given in the patent in view of producing substantially the same melt index in two slurry loop reactors connected in series was sufficiently clear.

The Respondent added that the MI margin could even be larger than those $\pm 20\%$ mentioned in the affidavit.

(4) Whilst acknowledging that Cr catalysed polymers showed a broad MWD, the Respondent stated with regard to Appendix I that it might not be excluded that a bimodal polymer showed a single peak in the GPC, nor that shoulders in a GPC curve might be indicative for bimodality. It further criticised that no experimental curves had been provided, despite the only very limited amount of work necessary therefor, by the Appellant, nor any particulars about the marginal conditions underlying the curves presented had been provided (annex to the letter: item 3.3).

(5) With regard to the insufficiency objection, the Respondent argued that the person skilled in this art would know which measures were to be taken in the second reactor in order to obtain a polymer having substantially the same MI and MWD as the polymer transferred from the first reactor, as shown by the affidavit (section V(3), above) and as derivable from the examples in the patent in suit. In particular, reference was made to the influence of the change of comonomer concentration in the second reactor on the HLMI and to the possibility to correct this by adjusting the reactor temperature (annex: item 3.4).

(6) The allegation of lack of novelty vis-à-vis D1 was disputed by the Respondent on the basis of a statement in "column 13, lines 54-57 that the polymer produced in the second reactor exhibits a melt index different than that produced in the first reactor." (annex: page 5, lines 5 and 4 from below) and with reference to the

fact that, in the second reaction hydrogen had been added and the temperature had been increased, which had led the Patent Proprietor to the conclusion at the hearing before the Opposition Division that the HLMI produced in the second reaction stage would have been too high to be measured, whilst that of the product in the first stage had been in the order of about 1, a point of view which had not been contradicted by the Opponent since. Moreover, although being the successor in business of the Applicant of D1, the Appellant had neither provided HLMI data of the product of Example 7 of D1, nor had it repeated that example. With regard to D2 (column 3, lines 11 to 15), D3 ("the sole allusion to copolymerization is the reference to the prior art at the beginning") and D4 (column 2, lines 47 to 51), the Respondent took the view that none of these documents provided any information as to how adapt their processes further described only in terms of homopolymerisation of ethylene to copolymerisation, and it concluded that none of D1 to D4 anticipated the claimed subject-matter (annex to the letter: item 3.5).

(7) The Respondent agreed that D1 was the closest piece of prior art. However, D1 would disclose different first and second melt indexes and in any case did not disclose to the person skilled in the art that the MI would be substantially the same to form a composite resin having a monomodal MWD. Therefore, D1 would teach away from the claimed subject-matter.

Moreover, since D2 and D4, whilst alleging that copolymers could be produced, dealt essentially with homopolymerisation and D3 disclosed, exemplified and claimed only homo-polymerisation, there was no

indication in these documents as to how to modify the teaching of D1 in order to arrive at the claimed subject-matter, which would, therefore, be inventive over the cited prior art (annex: item 3.6).

(8) In addition to its Main Request, directed to the dismissal of the appeal, the Respondent maintained its Auxiliary Request which had already been before the Opposition Division as its Auxiliary Request 1, and filed a further Auxiliary Request 2, later corrected with a further letter dated 20 July 2007.

VI. In a letter dated 24 July 2007, the Appellant disputed the arguments of the Respondent and confirmed all its objections with particular emphasis on its view concerning the term "substantially the same" and the monomodality of the MWD already mentioned above.

VII. Oral proceedings were held before the Board on 22 August 2007. In essence, both parties reiterated their previous arguments as submitted in writing. Therefore, only those points as presented during the hearing, which have been of particular importance for this decision, will be summarised herein below.

(1) At the beginning, the issues concerning the meaning of "substantially the same" MI and MWD and the question of monomodality were intensively and controversially discussed in relation to the alleged insufficiency of disclosure and with regard to Appendix I (section IV(2), above).

(2) Thus, the Appellant reiterated its objection that the features in the characterising part of Claim [1]

would be completely unclear and, therefore, meaningless, because one could not clearly state whether a given product met the requirements of having a monomodal MWD and of having "substantially the same" MI and MWD. (cf. sections II, IV(2), last paragraph, and IV(3), above). Thus, no one would really know what was meant by "substantially the same", because it would include, on the one hand, fluctuations of $\pm 20\%$ or even more as admitted by the Respondent (cf. section V(3), above) or, on the other hand, even complete identity. Moreover, the only explanation of what was meant by this term was referring to a monomodal MWD of the final product. This feature in turn was only defined by the statement in the first sentence of § [0026]: "a monomodal molecular weight distribution has a single peak in the gel permeation chromatography curve of the resin." However, it would be questionable whether a single peak in the GPC curve was a proof for a monomodal MWD of a polymer. Rather, a single peak could also be found when determining the GPC of a polymer having a bimodal MWD.

Furthermore, the Appellant argued that the patent in suit was silent about the measuring conditions of the "molecular weight", and summarised that, in consideration of the wording of Claim [1], no one would know where the alleged benefit would start.

In view of these asserted deficiencies, the Appellant was of the opinion that the claimed subject-matter was insufficiently disclosed. Moreover, MI and MWD could, for the same reasons, be ignored in the assessment of novelty and inventive step in accordance with Decision T 626/91 of 5 April 1995 (not published in the OJ EPO).

(3) On the other hand, the Respondent pointed out that, in its opinion, the features in the claim should not be considered separately or dissected from one another. Rather, the claim should be read coherently. Thus, the MI and MWD of the polymer exiting from either reactors could be measured, ie those of the "first polyethylene copolymer product" and those of the final product. From these data and the known ratio of both components (ie the first and the second polyethylene copolymer products), the properties of "the second polyethylene copolymer product" could (undisputedly) be calculated (as eg shown in Table [3]).

The claims were directed to the person skilled in the art who would understand their wording, including the formulation in the characterising part of Claim [1]. In any case, it could not be said that the features in question would be meaningless. Thus, the Respondent set out that the density of the products could be controlled by the molar ratio of the monomers used in the copolymerisation, and the MI could be controlled by means of the reaction temperature.

The arguments based on Appendix I were, in the Respondent's opinion, not valid for the claimed subject-matter, because they were based on polymers which had been prepared in completely separate polymerisations. Moreover, the GPC curves had only been mathematically constructed, which could easily be done, but such curves would have no meaning for the issue of whether the process of Claim [1] had been disclosed in a clear and complete manner for it to be carried out by a person skilled in the art.

(4) In the course of the discussion about insufficiency, reference was made by the Board to page [3] and, in particular, to § [0021] and § [0022] with regard to the question of whether a clear connection had been made available between process features and the product features in Claim [1].

(5) At the end of the discussion, both parties essentially maintained the views as presented in their respective written submissions. Since neither party wished to make further submissions with regard to this complex, the debate on this topic was closed. After deliberation, the Board announced its decision that the requirements of sufficiency of disclosure were met.

(6) With regard to novelty, the Appellant argued that (i) everything contained in the preamble of Claim [1] was known from D1, as admitted by the Respondent, and (ii) it did not know what "substantially the same" in the characterising part of the claim would mean. Therefore the two features MI and MWD should be disregarded in accordance with the findings in T 626/91 (section VII(2), above).

In addition, the Appellant referred to Example 7 of D1 wherein in step (i) a copolymer having a MI and a MWD had been prepared from ethylene and hexene by means of a Cr-based catalyst. Then in the second stage, a further copolymer was prepared from the same monomers in the presence of the first copolymer and of the catalyst to give a composite, which comprised both copolymers and had a broad MWD. In the Appellant's opinion, this final product fulfilled the criteria as defined in the characterising part of Claim [1], so

that, in summary, the subject-matter of this claim would have been anticipated by that example.

With regard to the remark of the Respondent that it could either have provided data missing from this example or have repeated the example in order to provide such data, the Appellant conceded that the example had been written in a way not susceptible to be reproduced.

(7) With respect to D4, the Appellant relied on three passages to support its novelty case. Thus, D4 would teach a polymerisation process in a series of reaction vessels, whereby the catalyst being a supported chromium oxide catalyst (column 6, first line) was only fed to the first reaction zone (column 1, line 61 *et seq.*) and the monomers to be polymerised were mono-1-olefins, either individually or to form copolymers, such as ethylene and propylene and/or 1- or 2-butene (column 2, lines 37 to 51). Moreover, the document would not indicate that the MI of the polymers produced in the different reactors would be different.

(8) When asked whether it considered the features in the characterising part of Claim [1], which referred to the MI and to the MWD, to be completely meaningless and whether it expected the Board to decide in this direction, the Appellant conceded that these features had some meaning for the claim.

(9) The Respondent disputed the Appellant's arguments concerning Example 7 of D1, because it did not provide any data relating to the properties of the polymer prepared in the first polymerisation, in particular its

MI. Moreover, the Respondent argued along the lines of its written submissions (section V(6), above) and referred, in particular, to the large increase of reaction temperature and to the addition of hydrogen, a chain terminator, and of a cocatalyst in the second polymerisation, all of which process features would contribute to a significant change of the MI of the second product in comparison the MI of the first polymerisation. Finally, the Respondent pointed out that its remarks presented in the hearing before the Opposition Division to this end had not been disputed by the Appellant.

(10) With regard to D4, the Respondent put emphasis on the fact that the hint to copolymerisation in column 2 had not been substantiated in the document, but that the only example of D4 was directed to the homopolymerisation of ethylene. Thus, D4 was even less susceptible to reproduction in respect of a copolymerisation than Example 7 of D1.

(11) As to inventive step, the Appellant argued that D1 was the closest state of the art, that it disclosed the use of a cascade of reactors, of a Cr-based catalyst added only to the first reactor and that each copolymer produced had a MI and a MWD. In view of the lack of clarity with regard to "substantially the same", D1 would provide everything necessary to arrive at the claimed subject-matter.

The Respondent, however, denied that D1 would provide anything which would lead in the direction to the claimed subject-matter.

(12) As neither party wished to comment further on inventive step the debate was closed with respect to the Main Request and the oral proceedings were interrupted for the final deliberation on this request.

VIII. The requests of the parties at this moment were as follows:

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

The Respondent requested that the appeal be dismissed, in the alternative that the patent be maintained on the basis of Auxiliary Request 1 containing Claims 1 to 9 as submitted on 20 February 2004 or on the basis of Auxiliary Request 2 containing Claims 1 to 9 as submitted on 20 July 2007.

Reasons for the Decision

1. The appeal is admissible.

Main Request

2. Before dealing with the grounds for opposition under Articles 100(a) and 100(b) EPC *per se* as raised by the Appellant, the Board deems it necessary to assess the meaning of Claim [1], by interpreting, where necessary, its wording on the basis of the contents of the patent as a whole in particular with regard to the contested expression "substantially the same".

- 2.1 In the *preamble* of Claim [1] (section I, above) and in § [0005], which relates to D1, both referring to a two-stage copolymerisation process, the same wording is used. In this process, ethylene is copolymerised with a C₃-C₈- α -olefin in a first reactor, to which a chromium-based catalyst has also been fed. The reaction mixture, including the copolymer thus produced and the catalyst, is then transferred from the first to a second reactor serially connected thereto, wherein a further copolymerisation of ethylene and a C₃-C₈- α -olefin is carried out. According to the *characterising part* of the claim, it is required that the two copolymers thus produced in either reactor have substantially the same MIs and MWDs so that the final product formed from the two copolymers has a monomodal MWD.
- 2.2 Objections have not been raised against the process as far as it is described in the preamble, but only against the characterising part of the claim which ties the two polymerisation processes closely together.
- 2.3 Nevertheless, the following considerations cannot, for the assessment of the meaning of the claim, be limited to the characterising part of the claim. Rather, the details of the process as a whole, as further explained on [pages [3] and [4], must also be taken into account.
- 2.3.1 Thus, paragraphs § [0015] to § [0018] refer to the catalyst, and § [0018], § [0027], § [0028] and § [0021] (last sentence) to the density of the copolymer and the influence of the comonomer content on this property in both polymerisation stages.

2.3.2 The reaction conditions in the first reactor and their influence on the properties of the polyethylene thus produced are described in more detail in the passage ranging from § [0019] to § [0021], wherein particular reference is made to the process variables such as temperature and pressure, to the composition of the monomer feed (ie the ethylene/comonomer ratio), to the ethylene flow rate, to the ethylene and comonomer concentrations in the first reactor and, finally, the HLMI and the molecular weight of the resulting polyethylene product and their reciprocity: "The HLMI is broadly inversely indicative of the molecular weight of the polymer." ([page 3, line 45]).

In the Board's view, the above process variables are the parameters generally monitored and, when necessary, adjusted in any conventional olefin copolymerisation process in order to control the properties of the product aimed at (cf. No. 2.2 of the affidavit, quoted in section V(3), above). Furthermore, no argument has been provided, nor does the Board see any such argument, to assume that the first polymerisation stage of Claim [1] in itself, which is carried out in the first reactor, cannot be considered a conventional olefin copolymerisation process. Nor is there any reason not to adopt this assumption also for the polymerisation in the second reactor, as such.

Two inevitable properties of any polymerisation product are, as repeatedly stated by the Appellant, a certain MI and a certain MWD (section IV(5), above). This is taken for granted by the Board.

2.3.3 In Claim [1], the above two polymerisation reactions are linked together, on the one hand, by the fact that the reaction mixture of the first reaction (including the intermediate "first polyethylene copolymer" product, the catalyst and residual monomers) is, at some point, transferred from the first reactor to the second to form the basis of the reaction mixture for the second polymerisation reaction and, on the other hand, by the requirements in the characterising part of the claim, which have to be met, ie particular MI and MWD relations between the products of either polymerisation reaction and the final product.

The reaction parameters to be used in the second reactor in order to achieve the required properties are given in § [0022], [page 3, lines 51 to 55], reading as follows:

The same chromium-based catalyst is present in the second reactor as in the first reactor. In the second reactor, the process parameters are varied to produce therein a second polyethylene product whereby the second polyethylene product, and thus the final combined polyethylene product, have substantially the same HLMI, and optionally substantially the same density, as the first polyethylene product produced in the first reactor so that the combined polyethylene product has a monomodal molecular weight distribution.

and in § [0029], [page 4, lines 36 and 37], providing a link between the MI and the MWD: "... substantially the same HLMI, this in turn representing similar molecular weight distributions for the two resins."

2.4 Hence, what is meant by "substantially the same" MI and what is to be done to achieve this, can be derived (a) from § [0021], including the HLMI ranges of the first polyethylene copolymer resin ([page 3, lines 43 to 45]), (b) from the quoted statement in section 2.3.3 (above) and (c) from the HLMI ranges given in § [0026] (in particular on [page 4, lines 11 to 13]) concerning the "HLMI values of each resin". Thus, in each case, the HLMI may range from 5 to 30 or, more particularly, from

8 to 23 g/10 min. Moreover, it can be derived from § [0026] that, whatever (within the requirements as to substantially the same MI and MWD) the exact values of the HLMI of the respective products of the first and second copolymerisation are, they should be controlled (as indicated in § [0022]) so that the product obtained at the outlet of the second reactor (ie the composite product of both polymerisations) will be monomodal.

Furthermore, in § [0030], reference is made to the finding that the amount of comonomer fed to the second reactor has to be different from that metered to the first reactor, because otherwise significantly more comonomer would be introduced into the chain of the second polyethylene copolymer product than into the first polyethylene copolymer, and the Patent Proprietor has offered an explanation for this finding in § [0029] and, with regard to the examples in the patent in suit, also in its letter dated 25 November 2005 (sections V(1) and V(5), above). Additionally, a typical ratio between the two polymer products in the final product has also been given in § [0030], ie an indication of the point in time for the transfer from the first to the second reactor (section 2.3.3, above).

- 2.5 In view of these particulars, explanations and findings concerning the process parameters and their influence on the properties of the final composite product, in particular the passage quoted in section 2.3.3, above, the Board is satisfied that, although the process has been defined in the characterising part of Claim [1] only in terms of properties of the respective polymer products prepared at the different process stages, a clear teaching is derivable from the patent as a whole

as to what is meant by "substantially the same" in the context of the MI and of the MWD for the measures to be taken in the claimed process and as to the process parameters/variables which are to be controlled when carrying out the claimed process in order to achieve the properties of the polymers required in Claim [1].

2.6 Thus, in the Board's view, it is evident that the second reactor has to be run under process conditions which provide, at the outlet of the second reactor, a polymer having a MI and a MWD as equal as possible to the MI and MWD of the polymer product of the first reactor. In other words, (i) the effect of the different incorporation of the comonomer in the second reactor as compared with that in the first reactor and (ii) inevitable fluctuations in the smooth running of the polymerisation reactions, monitored at the outlets of both reactors by determining the MI and the MWD of the respective products, are to be levelled by means of deviation control of the conventional process variables addressed in section 2.3.2, above, not only in the first, but in both reactors. These process variables and their effect on the results of the polymerisation are, in the Board's view, well-known to the person skilled in the art.

2.7 Therefore, the Board cannot accept the Appellant's argument repeatedly submitted in writing (sections II and IV(2) to IV(4), above) that "substantially the same" as used in Claim [1] should be considered as meaningless, because allegedly it "has further clouded the potential scope of the claim", as stated in the Appellant's letter mentioned in section VI, above. In fact, during the discussion about the question of

novelty at the oral proceedings before the Board, the Appellant finally conceded that the term "substantially the same" in the context of MI and MWD was not completely meaningless (section VII(8), above).

- 2.8 Nor can this finding be invalidated by the argument of the Appellant (section IV(2), above), that the mixture of two polymers having HLMI values far apart from each other would also provide a single GPC peak and that, therefore, the term "substantially the same" would not provide any information as to the extent covered by the claim. Firstly, the claim is not directed to a product *per se*, manufactured in some process or other not described in the patent in suit, but to a process requiring certain process steps and certain process variables to be complied with, as considered above. Hence, the above considerations and findings concerning the process parameters cannot simply be disregarded. Secondly, it has become apparent from the contributions to the discussion, that a single peak in the GPC curve does not necessarily mean the polymer to have a monomodal MWD (cf. sections V(4) and VII(2), above). Thirdly, the Board accepts the Respondent's argument that the three definitions in the characterising part of the claim must not be considered separately, because, as addressed in § [0026] and in the passages quoted at the end of section 2.3.3, above, the monomodality expressed in terms of GPC curves has been disclosed as being closely related to the HLMI and the MWD of the polymer components prepared at the two process stages of the claimed process. Therefore, any argument based on mixtures of polymers which were prepared independently from each other in separate processes is not convincing in the present context.

3. From the considerations in the preceding sections 2 to 2.8, above, dealing with the objections and arguments of the Appellant concerning the meaning of the formulations in the characterising part of Claim [1] and their significance and, furthermore, from the wording of Article 100(b) EPC itself referring to the European patent as a whole, but not to only a part of it, it is evident that the arguments provided by the Appellant in support of its insufficiency objection have not been convincing.

Nor does Decision T 626/91, above, provide any convincing arguments to reverse the above findings, because it does not deal with the issue examined in the present case, viz. whether a claimed process has been disclosed in such a clear and complete manner for it to be carried out by a person skilled in the art. Instead, the decision concerned a claim to a product, viz. a catalyst solid, defined in terms of a number of product parameters including the average pore size of mesopores. In that case, the Board took the view that in the absence of a well-known and reliable method for determining the average pore size of the mesopores in a catalyst comprising mesopores and a non-negligible proportion of micropores and in view of the inability of the skilled person's common general knowledge to cure this deficiency, the disclosure of the contested patent was "considered to be insufficient for the corresponding subject-matter of its claim 1. Thus, the request containing that claim must be refused on the ground of insufficiency of disclosure as set out in Article 100(b) EPC." (No. 3.2 of the reasons).

By contrast, in the present case, the requirements of sufficiency are, for the reasons given above, met and the objection under Article 100(b) EPC is, therefore, rejected.

4. *Problem and solution*

4.1 The patent in suit provides a process for producing polyethylene comprising two subsequent polymerisation stages in two serially connected reactors, wherein, in each of these stages, ethylene is copolymerised with a C₃-C₈- α -olefin by means of a Cr-based catalyst. The catalyst is fed to the first reactor and, at the end of the first polymerisation, is then transferred together with the first polyethylene copolymer thus produced from the first reactor to the second reactor, wherein the second polymerisation is subsequently carried out, resulting in the final composite polyethylene withdrawn from the second reactor (cf. section 2.1, above).

4.2 Such a process has already been known from D1 (§ [0005]), which was considered to be the closest piece of prior art in the decision under appeal and by both parties. The Board has no reason to take a different view.

4.2.1 Document D1 relates to ethylene polymers (both homo- and copolymers of ethylene; column 2, lines 26 to 33), having an advantageous combination of characteristics which makes them particularly suitable for the manufacture of articles (such as tubes) which are reported to have, at the same time, a high resistance to crazing under stress (ESCR) and a high die swell ratio (column 1, lines 41 to 46). The document also

provides four different processes for the preparation of these polymers (column 1, first paragraph), including a first, a second and a fourth process each carried out at two stages in two serially connected reactors, whilst the third process was carried out in single stage.

- 4.2.2 In the first of these processes, a single catalytic solid containing Ti and Zr as the active elements is used as the catalyst at both stages. By contrast, in the second processes, two catalytic solids are used in the two reactors. The first solid contains only one active element, ie Ti, whereas the second solid contains two active elements, ie Ti and Zr (column 3, line 13 to 49; column 3, line 50 to column 8, line 11).
- 4.2.3 In each of two further alternative processes, addressed in D1 as the third and the fourth process, respectively, the catalytic solid used is a chromium-based catalyst on a support containing at least two constituents selected from silica, alumina and aluminium phosphate, optionally together with a cocatalyst, in particular an organoboron compound, which allows to increase the catalyst activity (column 9, lines 11 to 27) and/or with a chain-transfer agent such as hydrogen (column 8, lines 24 and 34; column 13, line 51).
- 4.2.4 Whilst the third process is carried out in a single reactor (column 8, lines 12 to 24), the fourth process (column 8, lines 25 to 41) is again carried out in two serially connected reactors, with a transfer of the reaction mixture at some point of time from the first to the second reactor. Furthermore, in this process, the presence of the cocatalyst is mandatory in at least

one of the two reactors, preferably in the second reactor. A particularly preferred cocatalyst is $B(C_2H_5)_3$.

4.2.5 In fact, in Example 7 of D1 (column 20, line 53 to column 21, line 52), upon which the Appellant has relied to support its objections under Article 100(a) EPC and which represents the fourth process (which was, however, simulated by two subsequent separate polymerisation stages in one reactor), both triethylborane as the cocatalyst and hydrogen as the chain-transfer agent were added at the second stage of the polymerisation (column 21, lines 33 to 39). The final product, thus obtained, was characterised by its MI_5 , its dynamic viscosity, its die swell ratio (measuring conditions: column 14, lines 14 to 59) and its standard density. No data were, however, given for the product obtained at the first polymerisation stage, nor for the final product of this example with regard to the ESCR, aimed at according to the introduction of its description (section 4.2.1, above).

Thus, no comparison is possible in D1 between the polymerisations of ethylene and a comonomer in a one-stage process and a two-stage process, respectively, using the same Cr-based catalyst even though Example 6 of D1 describes a one-stage process by means of the same catalyst, and even though it provides a ESCR measurement. However, Example 6 describes a copolymerisation of ethylene and hexene in a fixed molar ratio in the presence of hydrogen as a chain transfer agent at constant pressure and a temperature even higher than in the second polymerisation of Example 7, so that it cannot represent the first reaction of Example 7. Nor did the Opponent/Appellant

discharge its onus of proof in this respect by providing comparative data on the basis of Example 7, as already held in the decision under appeal and as addressed by the Respondent (sections III(1) and V(6), above). Rather, the Appellant admitted that the example was not described in such a way that it could be repeated (section VII(6), above).

4.2.6 Moreover, according to the passage at from column 13, line 47 to column 14, line 3 of D1, the two-stage polymerisation processes of D1 in two serially connected reactors serve mainly the purpose of obtaining a polymer composition wherein the polymer produced in the second reactor has a MI different from the product prepared in the first reactor. This is advantageously achieved by using different conditions in the two stages, viz. temperature, concentrations of the chain-transfer agent, of the optional comonomer and of the optional cocatalyst. The comparison of the two polymerisations (i) and (ii) of Example 7 shows that, in fact, all these conditions had been changed in the example. Hence, it can be concluded that the MI of the two polymers produced therein were indeed different.

4.3 In present Examples [1], [2] and [3], ethylene/1-hexene copolymer products prepared according to the claimed process were, however, compared with ethylene/1-hexene copolymers obtained by conventional one-stage polymerisation by means of the same catalyst (Comparative Examples [1] and [2], respectively).

4.3.1 Thus in Example [1], the products exiting from both reactors, ie the "first ethylene copolymer product" and of the final "combined polyethylene", were

characterised by their respective HLMI and density values. The product of Comparative example [1] showed similar HLMI and density values. Additionally, according to the GPC graphs provided the molecular weights and MWDs of both final products were nearly the same (Table [1], Figures [1] and [2]).

Table [2], shows slow and rapid crack propagation and notch test (ie a burst test at increased temperature and pressure) measurements of pipes, which had been made from the two end products (as explained in § [0037] to § [0040]). The product of Example [1] shows, in respect all three properties mentioned above, distinctly better results than the product of Comparative Example [1].

4.3.2 In Examples [2] and [3], films made from two further ethylene/1-hexene copolymers were compared with films of another conventionally prepared ethylene/1-hexene copolymer (Comparative Example [2]; all having nearly identical HLMI values and the same density). In the tests of these films (of 20 and 40 µm, respectively), the films of Examples [2] and [3] showed significant improvements of the dart impact resistance and had also an improved tear resistance with respect to either the machine direction or the transverse direction in comparison with the films of Comparative Example [2] (§ [0046] and § [0049]).

4.4 In view of the absence of comparative data for the product of Example 7 of D1, the technical problem can, therefore, be seen in the provision of a process for the production of polyethylene copolymers which show

either improved stress crack and burst resistance or improved dart impact resistance and tear strength.

This problem has credibly been solved as demonstrated by the experiments disclosed in the patent in suit.

5. *Novelty*

5.1 As shown in detail in sections 4.2 to 4.2.6, above, none of the processes disclosed in D1 fulfils the requirements of Claim [1]. Nor have any data been made available by the Appellant to demonstrate that by the process of D1, as exemplified in its Example 7, which formed the basis of the Appellant's arguments, the requirements in the characterising part of Claim [1] were obtained, since the example could not be repeated.

Moreover, the description of D1 states in a clear and unambiguous manner (in the paragraph bridging its columns 13 and 14), that the two-stage processes of D1 are to provide composite products of two polymer constituents, each being the result of the polymerisation in one of two reactors and each having an MI different from the polymer obtained in the other reactor, ie contrary to the patent in suit. Moreover, as shown in sections 4.2.5 and 4.2.6, above, Example 7 was carried out in such a manner that the polymers prepared in Example 7 must have differed in their individual MI values.

Consequently, D1 does not disclose the claimed process.

5.2 Although novelty objections had also been based on each of the further documents D2 to D4, the Appellant did

not rely on D2 or D3 at the oral proceedings anymore. Nor does the Board see in either document any facts on which a novelty objection could convincingly be based.

5.3 Although referring once to copolymerisation (D4, column 2, lines 47 and 48: "Copolymers can also be formed.") and to the use of a Cr-based catalyst fed to the first of a series of reaction zones (column 1, lines 63 and 64; column 2, lines 44 to 47), D4 refers mainly to the design of a polymerisation plant comprising a plurality of serially connected reaction zones (Figures 1 and 2; column 3, line 30 to column 5, line 15) as opposed to "comparable reactors arranged in parallel" (column 5, lines 59 to 62). In order to demonstrate the asserted advantages of the new design, the only example discloses a homopolymerisation of ethylene in a series of three reaction vessels, whereby the catalyst was only fed to the first reactor (Table I), whereas ethylene was fed to all three reactors at constant rates, which decreased, however, from the first to the third reactor. The reactor pressures and temperatures were the same in all reactors. No data concerning the properties of the polymer of any one of the reactors are given.

Moreover, as to the reaction variables the following statement is made in column 7, lines 28 to 34:

As will be evident to those skilled in the art, various modifications of this invention can be made, or followed, in the light of the foregoing disclosure and discussion, without departing from the spirit or scope thereof. Although the above example shows all reactors in series to be operating at the same temperature, it is at times advantageous to operate the reactors at different temperatures, preferably increasing in the direction of flow, and thereby obtain a blend of polymer properties which can be varied to meet specific requirements.

This very general remark does not, however, allow to derive from the document any particulars which would have to be observed in the copolymerisation of ethylene with C₃-C₈- α -olefins. Nor does it amount to a disclosure of the preparation of two different polymers components and a final composite product all having substantially the same MI and substantially the same MWD (section 2.3.3, above) so that the final product had a monomodal MWD, let alone to achieve this aim by conducting the second polymerisation as disclosed in § [0022].

5.4 Consequently, the Board is satisfied that the requirements of Article 54 EPC are met by the process of Claim [1].

6. *Inventive step*

It remains to be decided whether the claimed solution of the above problem (section 4.4, above) can be derived in an obvious way from the cited documents.

6.1 As established in sections 4.2 to 4.2.6 and 5.1, above, D1 relates to ethylene polymers, including three embodiments of compositions of two copolymers as obtained in three of four different processes disclosed therein. One of these processes relates to a sequence of two polymerisations in different reactors by means of a Cr-based catalyst in different reaction conditions (as simulated in Example 7), wherein the two copolymer constituents, thus obtained, differ advantageously from one another by their MI. Moreover, although reference is made to ESCR in the introduction of the description of D1, no data are available in the document, which

would suggest to improve the stress cracking properties of ethylene copolymers by selecting the fourth of the four processes disclosed therein (sections 4.2.1 to 4.2.4, above), let alone to modify its fourth process in such a way and contrary to its teaching in column 13 (cf. section 4.2.6, above) so as to arrive at a composition of copolymers which have substantially the same MI and MWD so that the final composition has a monomodal MWD.

- 6.2 Consequently, the Board takes the view that D1 by itself does not make the solution to the above technical problem (section 4.4, above) available in an obvious manner.
- 6.3 As far as the other cited documents are concerned, they relate to different processes for the polymerisation of olefins, in particular for the homopolymerisation of ethylene, and devices therefor described in broad and general terms. None of them does, however, as can be seen from the arguments submitted by both parties, address those properties referred to in section 4.4, above, in the context of the technical problem to be solved, namely ESCR and/or dart impact resistance. Nor does any one of them provide a clear teaching (in the absence of the knowledge of the solution found therefor in the patent in suit) as to which modification(s) of one of the above four processes of D1 would have to be made in order to solve the relevant technical problem (sections IV(6), V(7), VII(11) and 5.3, above).
- 6.4 Consequently, the Board is satisfied that the subject-matter of Claim [1] is also based on an inventive step.

7. By the same token, the above findings are also valid for the elaborations in the remaining Claims [2] to [10], all being appendant to Claim [1].

Auxiliary Requests 1 and 2

8. In view of the above findings, there is no need further to consider the auxiliary requests of the Respondent.

Order

For these reasons it is decided that:

The appeal is dismissed.

The Registrar:

The Chairman:

M. Kiehl

R. Young