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**Datasheet for the decision
of 10 June 2010**

Case Number: T 1357/07 - 3.3.03

Application Number: 98930869.7

Publication Number: 0993478

IPC: C08F 297/08

Language of the proceedings: EN

Title of invention:
Olefin polymerization process

Patentee:
Borealis Technology Oy

Opponent:
INEOS EUROPE LIMITED

Headword:

-

Relevant legal provisions:
EPC Art. 54, 56, 83

Relevant legal provisions (EPC 1973):

-

Keyword:
"Sufficiency of disclosure - yes (main request)"
"Novelty - yes (main request)"
"Inventive step - yes (main request)"

Decisions cited:
G 0004/95, G 0001/03, T 1002/92

Catchword:

-



Case Number: T 1357/07 - 3.3.03

D E C I S I O N
of the Technical Board of Appeal 3.3.03
of 10 June 2010

Appellant:
(Opponent)

INEOS EUROPE LIMITED
Compass Point
79-87 Kingston Road
Staines
Middlesex TW18 1DT (GB)

Representative:

Hawkins, David George
Compass Patents LLP
120 Bridge Road
Chertsey
Surrey KT16 8LA (GB)

Respondent:
(Patent Proprietor)

Borealis Technology Oy
P.O. Box 330
FI-06101 Porvoo (FI)

Representative:

Cockbain, Julian
Dehns
St Bride's House
10 Salisbury Square
London
EC4Y 8JD (GB)

Decision under appeal: Interlocutory decision of the Opposition Division of the European Patent Office dated 31 October 2006 and posted 13 June 2007 concerning maintenance of European patent No. 0993478 in amended form.

Composition of the Board:

Chairman: R. Young
Members: O. Dury
C.-P. Brandt

Summary of Facts and Submissions

I. The mention of the grant of European patent No. EP-B-0993478, based on application 98930869.7, filed on 16 June 1998 in the name of Borealis Technology Oy was published on 7 April 2004 in Bulletin 2004/15.

II. The granted patent was based on 20 claims, wherein the sole independent claim read as follows:

"1. A process for olefin polymerization, which process comprises at least two polymerization stages, a relatively earlier of said stages comprising polymerizing an α -olefin in the presence of hydrogen and a metal: η -ligand olefin polymerization catalyst in which the metal is Zr, Ti or Hf whereby to produce a first polymerization product, and a relatively later of said stages comprising polymerizing said α -olefin in the presence of said metal: η -ligand olefin polymerization catalyst whereby to yield a polymerization product having a lower MFR₂ than said first polymerization product wherein hydrogen is substantially entirely consumed in the relatively earlier of said stages."

Claims 2-20 were dependent claims directed to elaborations of the process of claim 1.

III. Notice of opposition against the patent was filed by BP Chemicals Ltd. on 6 January 2005 on the ground of Art. 100 (a) EPC (lack of novelty, lack of inventive step) and Art. 100 (b) EPC.

IV. In its decision announced at the end of the oral proceedings held before the opposition division on 31 October 2006 and issued in writing on 13 June 2007 the opposition division considered that the patent could be maintained in its amended form according to the main request of the patent proprietor (claim 1 as filed during the oral proceedings; claims 2-20 as received on 9 January 2006 with letter of 4 January 2006 and corresponding to granted claims 2-20). The sole independent claim of this main request was worded as follows:

"1. A process for olefin polymerization, which process comprises at least two polymerization stages, a relatively earlier of said stages comprising polymerizing an α -olefin in the presence of hydrogen and a metal: η -ligand olefin polymerization catalyst in which the metal is Zr, Ti or Hf whereby to produce a first polymerization product, and a relatively later of said stages comprising polymerizing said α -olefin in the presence of said metal: η -ligand olefin polymerization catalyst whereby to yield a polymerization product having a lower MFR₂ than said first polymerization product wherein hydrogen is substantially entirely consumed in the relatively earlier of said stages with the proviso that said catalyst is not a bistetrahydroindenyl compound of formula (IndH₄)₂R"MQ₂ in which each Ind is the same or different and is indenyl or substituted indenyl, R" is a bridge which comprises a C₁₋₄ alkylene radical, a dialkyl germanium or silicon or siloxane, or an alkyl phosphine or amine radical, which bridge is substituted or unsubstituted, M is a group (IV) metal and each Q is hydrocarbyl having 1 to 20 carbon atoms or halogen."

Regarding Art. 83 EPC, the opposition division considered that the patent contained sufficient information, in particular in the examples, to enable the skilled person to carry out the invention. In addition, the proviso of claim 1 was considered as a disclaimer vis-à-vis document D1, which was allowable according to G 1/03 (OJ EPO 2004, 413). **D6** (EP-A2-0770629), which had been filed after the nine months time limit set in Art. 99 EPC, was considered prima facie relevant and admitted into the proceedings. The opposition division further decided that the subject matter claimed was novel over documents **D1** (EP-A1-0881237), **D2** (WO 95/07942 A) and **D6**, which had all been cited by the opponent with regard to novelty, because none of these prior art documents disclosed the specific combination of features claimed. Finally, an inventive merit was acknowledged starting from **D2** as closest prior art.

- V. In the course of the opposition proceedings the original opponent BP Chemicals Ltd. transferred its rights to Innovene Europe Ltd., now Ineos Europe Ltd..
- VI. Notice of appeal against the decision of the opposition division was filed on 7 August 2007 by the opponent with simultaneous payment of the prescribed fee. In its statement of grounds of appeal received on 9 October 2007, the opponent, now appellant, requested that the contested decision be set aside and the patent be revoked in its entirety.

The appellant cited for the first time the following documents:

D7: US-A-4 962 248

D8: US-A-5 470 811

D9: Prog. Polym. Science, Vol. 20, 341-342, 1995

D10: Makromol. Chem., Rapid Commun. 5, 225-228, 1984

D11: US-A-5 276 115.

The objection regarding a lack of sufficiency of disclosure pursuant to Art. 83 EPC was related to the expression "wherein hydrogen is substantially entirely consumed in the relatively earlier stage" present in claim 1 of the amended patent. Considering that the patent in suit did not provide sufficient information to define either the meaning of the expression "substantially entirely" or the experimental conditions required in order to achieve the claimed consumption of hydrogen, the appellant concluded that the skilled person was not in a position to carry out the invention. It was in particular contested that the invention could be practised across the entire range of the claims, both because example 3.3 showed that up to 13 % hydrogen would be present and thus not have been consumed in the earlier stage of a process as claimed and because the patent did not specify the conditions required in order to achieve the claimed consumption of hydrogen. Regarding novelty the appellant considered that the process disclosed in **D2**, in particular in the paragraph bridging pages 4 and 5, anticipated the subject matter claimed. Finally, the inventive merit was denied starting from either **D2** or **D11** as closest prior art. The respondent in particular considered that it would have been obvious to use metallocene catalysts instead of those known in the processes taught in **D11** as closest prior art because it was known at the

priority date of the contested patent e.g. from **D7-D10** that metallocene catalysts consumed hydrogen rapidly.

VII. In its reply to the statement of grounds of appeal dated 22 February 2008, the patent proprietor, now respondent, requested that the appeal be dismissed and the patent be maintained based on the claims found allowable by the opposition division (main request). Auxiliary requests I-III were additionally filed in the event that the main request would not be accepted. A modified version of said auxiliary requests I and III was further filed on 28 February 2008.

The respondent argued that the objection raised by the appellant pursuant to Art. 83 EPC was in fact a clarity objection pursuant to Art. 84 EPC, which was not a ground of opposition and which could not be raised at this stage of the proceedings because the expression in question - "wherein hydrogen is substantially entirely consumed" - was present in the claims as granted. The respondent was further of the opinion that the examples of the contested patent, in particular examples 3.3-3.5 showed that this expression meant that hydrogen was not detectable. The values of hydrogen conversion of >87%, >90% and >96% which had been reported for these examples in Table 2 were in fact related to the detection threshold of the apparatus used for the measurement, which was gas chromatography. Based on the information provided in Table 2 the respondent further calculated said detection limit as being of about 0.015 mol.% and concluded that the examples of the patent showed that hydrogen was consumed at a level less than 0.015 mol.%. The respondent explained also that the claimed substantially total consumption of

hydrogen did not only require the mere use of a catalyst as recited in claim 1 of the main request but also the use of appropriate experimental conditions such as a sufficient residence time (see for instance point 30 of the reply of the respondent to the statement of grounds of appeal), which were also taught in the patent in suit. Hence, the requirements of Art. 83 EPC were met.

Regarding novelty, the respondent contested that **D2** disclosed the specific combination of features claimed. There was in particular no evidence on file that hydrogen would be entirely consumed in the most relevant examples of **D2**. Hence, novelty should be acknowledged.

While the respondent considered **D11** as representing the closest prior art, an argumentation supporting the presence of an inventive merit based on both documents contemplated by the appellant in this respect, namely **D2** and **D11**, was provided.

Finally, the respondent requested that documents **D7-D11** should not be admitted into the proceedings because they had been filed late and were not relevant (see point 48 of the reply to the statement of grounds of appeal).

VIII. On 18 December 2009 the board issued a summons to attend oral proceedings and informed the parties of its provisional opinion.

Regarding Art. 83 EPC, the board considered that the fact that the patent in suit did not provide a clear definition for the expression "wherein hydrogen is substantially entirely consumed in the relatively

earlier stage" was rather a matter of clarity according to Art. 84 EPC - which was not a ground of opposition - than one of sufficiency of disclosure according to Art. 83 EPC. In the board's view, the skilled person was taught in the claims what kind of process was considered, what kind of reactants and catalyst were suitably used, and from the description and the examples he was further taught which experimental conditions should be used in order to provide a substantially complete depletion of hydrogen during the "earlier stage" (see e.g. [0022]-[0023] and examples 3.3-3.5). Hence, the contested patent gave sufficient information with regard to the appropriate conditions to be used in order to provide the claimed consumption of hydrogen. Besides, it was noted that the appellant had neither shown nor made plausible that the skilled person working according to the processes claimed would not be in a position to carry out the invention.

The board further considered that the requirements of Art. 54 EPC were satisfied by the main request, in particular because **D2** did not disclose the specific combination of technical features as presently claimed (mosaic disclosure). In particular, the most pertinent passage of **D2**, namely the processes disclosed on pages 4-5, did not specify that:

- the metal of the catalyst used in the earlier stage was selected from either Zr, Ti, or Hf;
- the same catalyst was used in both stages;
- hydrogen was "substantially entirely consumed" in the "earlier" stage;
- a polymerisation product having lower MFR₂ was obtained in the second stage as compared to the first stage.

Furthermore, the examples of **D2**, in particular examples 1-2 which could be considered as representing a two-stage polymerisation process, did not unambiguously disclose that hydrogen was "substantially entirely consumed" before the second amount of catalyst is added or that the requirements regarding MFR_2 as claimed were met.

Finally, the board indicated that the assessment of the inventive merit would be done following the problem-solution approach, probably starting from either **D2** or **D11** as closest prior art.

The communication of the board further addressed other issues in relation to the allowability of auxiliary requests I-III, which are, however, not important for the present decision.

- IX. In its submission of 10 May 2010 the respondent filed new auxiliary request II in replacement of former auxiliary request II, as well as additional auxiliary requests IV-VII.

Regarding the inventive merit, the respondent explained that the combination of the teaching of **D11** with that of **D10** was not obvious. The respondent further filed the first page of four US patents cited in **D11** (col. 2, lines 15-16) as evidence that **D11** was exclusively directed to the use of transition metal halides as Ziegler-Natta catalysts. Finally, **D12** (McGraw-Hill dictionary of scientific and technical terms, 5th Ed., 1994, page 2189) was filed in order to confirm that the skilled person would understand that the Ziegler-Natta

catalysts taught in **D11** were derived from a transition metal halide and a metal hydride or metal alkyl, and were different from the catalysts recited in claim 1 of the main request.

- X. In its submission dated 19 May 2010, the appellant announced that he would be accompanied at the oral proceedings by Mr. S. Spitzmesser as technical expert and requested that the latter be allowed to speak "on technical matters" during the hearing.
- XI. Oral proceedings were held on 10 June 2010 in the presence of both parties.

Initial requests

The **appellant** (opponent) requested that the decision under appeal be set aside and the patent in suit be revoked in its entirety.

The **respondent** (patent proprietor) requested that the appeal be dismissed or, in the alternative, that the patent be maintained on the basis of auxiliary request I as filed with the letter dated 26 February 2008, or on the basis of auxiliary request II, filed with the letter dated 10 May 2010, or on the basis of auxiliary request III, filed with the letter dated 22 February 2008, or on the basis of one of the auxiliary requests IV-VII as filed with the letter dated 10 May 2010.

- XII. During the oral proceedings the respondent objected to the technical expert of the appellant being allowed to speak because the request of the appellant had been

filed too late and because the subject matter on which the expert would be speaking had not been indicated.

The Chairman of the board explained that Mr. Spitzmesser would not be allowed to speak because the respondent objected to it and because the strict requirements regarding oral submissions made by accompanying persons indicated in the headnote of G 4/95 (OJ EPO 1996, 412) were in the present case not met (late filing; absence of precise indication on which subject matter the expert would make submissions). However, sufficient time would be provided on request to allow the representative of the appellant to consult his technical expert when required. The respondent did not contest the decision taken by the board not to allow Mr. Spitzmesser to speak.

- XIII. In the course of the hearing the patent proprietor further withdrew its request not to admit documents **D7-D11** into the proceedings.

The following issues were addressed during the oral proceedings:

Sufficiency of disclosure: Art. 83 EPC

- XIV. Both parties repeated their arguments already provided in writing in relation to the expression "wherein hydrogen is substantially entirely consumed in the relatively earlier stage".

In addition, the appellant raised the objection that the examples of the patent in suit showed that the requirements of Art. 83 EPC were in particular not met

in the case of continuous processes, which were encompassed by claim 1 of the main request. In the appellant's opinion, it was not possible that hydrogen be "entirely consumed" in such processes. Example 2 of the contested patent, which was a kind of "semi-continuous" process according to the invention, showed that hydrogen had to be removed at the end of stage 1 (page 7, line 54 of the patent).

The respondent contested that example 2 was a continuous process. The only disclosure in the examples of the patent in suit of such a process was example 3 (see page 8, line 14 of the patent), which showed that hydrogen was depleted at the end of stage 1. Regarding example 2, the respondent explained that hydrogen was in fact not detectable at the end of the first stage. The sentence on page 7, line 54 indicated by the appellant was to be understood as meaning that any trace of hydrogen, which could have been present in an amount below the detection limit, would have been removed. It was not to be understood as meaning that large amounts of hydrogen were still present at the end of the earlier stage.

The respondent also pointed out that the burden to proof insufficiency of disclosure relied on the appellant. There was, however, no evidence on file to support the allegation of the appellant that the skilled person was not in a position to carry out the invention.

- XV. After deliberation the Chairman of the board announced that the main request met the requirements of Art. 83 EPC.

Novelty over D2: Art. 54 EPC

XVI. The appellant repeated its novelty objection with regard to the two-step process disclosed in the paragraph bridging pages 4-5 of **D2**. The appellant explained that said disclosure only allowed two possibilities regarding the sequence in which both steps were performed and that it was in particular clear from page 36, line 2 of **D2** that both steps of said process could be made in any order. The disclosure of **D2** thus, encompassed a process as claimed wherein the polymer of higher MFR_2 was made in the second stage. It was further clear from paragraph (d) of said process that the catalyst used was a single site catalyst, which was a catalyst as claimed and having the inherent property to consume hydrogen. Besides, it was plausible that the catalyst used in example 2 had led to the complete depletion of hydrogen at the end of the first stage.

The respondent contested that **D2** provided a direct and unambiguous disclosure of all the features of claim 1 in combination. Regarding the process disclosed on pages 4-5 of **D2**, reference was made to the analysis provided in the communication of the board, in particular paragraph 2.2, wherein four distinguishing features had already been identified. The respondent further stressed that only examples 1-2 of **D2** could arguably be considered as multi-step processes as claimed. These examples did not provide any information regarding MFR_2 values as claimed. In addition, Example 2 disclosed a process run in opposite way to claim 1 of the main request, i.e. wherein a polymer having a higher MFR_2 (lower molecular weight) was prepared in the

second step. Finally, there was no evidence on file that hydrogen was "substantially entirely consumed" in the earlier stage of the processes of said examples 1-2. Hence, **D2** did not anticipate the subject matter claimed.

XVII. After deliberation the Chairman of the board announced that the subject matter of the main request was novel.

Inventive step: Art. 56 EPC

XVIII. Considering the former discussion on novelty and the decision of the board in that respect, the appellant withdrew its objection made in writing concerning the lack of inventive step starting from **D2** as closest prior art.

XIX. Following the problem-solution approach, both parties agreed to consider **D11** as closest prior art.

In the appellant's view, **D11** disclosed a two-step process for the polymerisation of olefin and comprising the same sequence of steps as recited in claim 1 of the main request (**D11**: col. 1, lines 21-25). **D11** further also dealt with the same problem to be solved as the patent in suit, namely to provide a process which avoids that hydrogen be removed before the higher molecular weight (lower MFR₂) polymer is produced (**D11**: col. 1, lines 10-18). Hence, the process claimed differed from those of **D11** only in that it required the use of a metal: η -ligand catalyst instead of a Ziegler-Natta catalyst. The appellant agreed that **D11** did not disclose metallocene catalysts, in particular catalysts as defined in claim 1 of the main request. However, considering that it was known at the priority date of

the contested patent that metallocene catalysts had the ability rapidly to consume hydrogen, it was obvious to provide an alternative to the process of **D11** by merely replacing the Ziegler-Natta catalysts taught in **D11** by any known metallocene catalyst, including those defined in claim 1 of the main request. Concerning the ability of metallocene catalysts to consume hydrogen, reference was made to **D7** (col. 2, lines 36-39) and **D10** (bottom of page 226 and Fig. 1). In the appellant's view, the teaching of **D7** that metallocene catalysts are "sensitive" to hydrogen was equivalent to the requirement of claim 1 that "hydrogen is substantially entirely consumed". On the basis of this information, it would have been obvious for the skilled person at least to try to replace the Ziegler-Natta catalysts of **D11** by known metallocene catalysts as claimed.

The respondent explained that the two-step process of **D11** was limited to those using Ziegler-Natta catalysts which required the use of high amounts of hydrogen. In order to get rid of the excess hydrogen at the end of the first stage, the inventors of **D11** used a cyclopentadienyl compound as scavenger to use up all the hydrogen in excess. Hence, although **D11** addressed the same problem as the patent in suit, the solution proposed was radically different. The solution proposed in **D11** was neither technically recommended, since it led to the presence of more impurities in the final product, nor economical since an expensive gas, hydrogen, was irremediably reacted with an expensive compound, the scavenger. In contrast, the solution provided by the patent in suit, which consisted in the use of a specific metallocene catalyst together with appropriate reaction conditions, did not have these

drawbacks. Considering that both solutions were conceptually so different, the subject matter claimed could not be obvious in the light of **D11**.

Besides, the respondent contested that at the priority date of the patent, metallocene catalysts were known to consume hydrogen. None of the documents cited by the appellant disclosed this. In particular **D7** and **D10** were not related to the consumption of hydrogen by metallocene catalysts, as argued by the appellant, but merely taught the well established use of hydrogen for regulating the molecular weight of polyolefins prepared by processes using metallocene catalysts.

Regarding the alleged obvious exchange of Ziegler-Natta catalysts taught in **D11** by metallocene catalysts which was contemplated by the appellant, the respondent explained that this was not a simple task and that the whole process would have had to be modified accordingly. Besides, the inventors of **D11** had decided to use Ziegler-Natta catalysts - and no others - for good reasons, namely in order to prepare polyolefins having specific properties and characteristics. Changing the catalysts would definitely affect these properties, which could not have been the aim of the inventors of **D11**: hence, there were no good reasons to move away from the precise and restricted teaching of **D11** regarding the type of catalysts to be used.

Even if one would have contemplated changing the catalysts of **D11**, which was highly questionable, the respondent saw no motivation in the cited prior art for the skilled person to specifically turn to those claimed in the main request.

The respondent recalled that up to the priority date of the patent, hydrogen was used in processes as those recited in claim 1 of the main request either only in

the second stage or used in the first stage but in combination with a removal step of hydrogen. It was, thus, only with hindsight that the appellant could contemplate using a metallocene catalyst in the first stage in order to use up hydrogen.

Regarding the combination of **D11** with the teaching of either **D7** or **D10** made by the appellant, the respondent considered that these prior art documents were technically so remote from **D11** that it would not have been obvious for the skilled person to consider their combination, let alone in order to solve the technical problem identified. Besides, the respondent pointed out that these prior art documents were known at the time the invention of **D11** had been made. Had it been obvious to combine their teachings, as argued by the appellant, it was not understandable why the inventors of **D11** had not done so and, therefore, provided a very expensive solution to the problem of removing excess hydrogen. The respondent concluded that the subject matter claimed was not obvious in the light of the cited prior art and should, therefore, be acknowledged an inventive merit.

Final requests

XX. The **appellant** (opponent) requested that the decision under appeal be set aside and that European patent No. 993478 be revoked.

The **respondent** (patent proprietor) requested that the appeal be dismissed or, in the alternative, that the patent be maintained on the basis of auxiliary request I as filed with the letter dated 26 February 2008, or on the basis of auxiliary request II, filed with the

letter dated 10 May 2010, or on the basis of auxiliary request III, filed with the letter dated 22 February 2008, or on the basis of one of the auxiliary requests IV-VII as filed with the letter dated 10 May 2010.

XXI. The board announced its decision at the end of the oral proceedings.

Reasons for the Decision

1. The appeal is admissible.

Main request

2. *Sufficiency of disclosure: Art. 83 EPC*

2.1 The objection of the appellant is related to the expression "wherein hydrogen is substantially entirely consumed in the relatively earlier stage" present in claim 1 of the main request. The appellant argued that, in the absence of a clear definition for this term, the skilled person would not be in a position to carry out the invention.

2.2 The board agrees with the appellant that the patent in suit does not provide a clear and unambiguous definition of what this expression means. The only passage of the granted patent related to this feature is found on page 2, lines 32-33 of the description, which exactly recites the wording of said feature. No further details which would enable the skilled person to define in an absolute manner the exact meaning of this feature are, however, given. The conclusion

reached by the board is, thus, that the patent does not provide an unambiguous definition of the expression "wherein hydrogen is substantially entirely consumed in the relatively earlier stage" present in claim 1 of the main request. This could, however, at most amount to a possible lack of clarity pursuant to Art. 84 EPC but is not a valid objection of lack sufficient disclosure pursuant to Art. 83 EPC. An alleged lack of clarity is, however, not a ground for opposition under Art. 100 EPC and may not form the basis for a valid objection at this stage of the proceedings because the expression in question was already present in the claims as granted (G 9/91, OJ EPO 1993, 408: see point 18 of the reasons). The claims will have, however, to be interpreted in their broadest sense.

- 2.3 Regarding the objection of the appellant pursuant to Art. 83 EPC, it remains to be examined whether or not the skilled person is in a position to carry out the invention on the basis of the information provided in the patent in suit.

In the board's view, the skilled person is taught in the claims what kind of process is considered, what kind of reactants and catalyst are suitably used, and from the description and the examples he is further taught which experimental conditions should be used in order to provide a substantially complete depletion of hydrogen at the end of the "earlier stage" (see e.g. paragraphs [0022]-[0023] and examples 3.3-3.5 of the patent). Hence the patent gives sufficient information with regard to the appropriate conditions to be used in order to provide the claimed consumption of hydrogen: in order to put the invention into practice the skilled

person should i) perform a multi-stage process as claimed using in the "earlier" and in the "later" stages a catalyst as defined in claim 1 and ii) ensure that a much lower level of hydrogen is present in the reactor at the end of the "earlier" stage on the basis of the information provided in the patent and using his conventional skills e.g. by controlling the flow of hydrogen, the amounts of monomers, the reaction temperature, and the reaction time as taught in the patent. Examples 3.3-3.5, in particular, explicitly deal with a process as claimed. The respondent has further shown that it is possible to derive from the data of Table 2 that in these examples hydrogen was indeed consumed and could only be present at a concentration less than 0.015 mol.%, which is much lower than the input rate of hydrogen. Although this information may not be considered in order to interpret the claims, it demonstrates that examples 3.3-3.5 are indeed illustrative of the subject matter claimed. The skilled person is, thus, taught how to put the claimed invention in practice by following the instructions provided both in the description and at least in examples 3.3-3.5.

The argument of the appellant that the patent in suit does not disclose the conditions required to achieve the claimed consumption of hydrogen has, thus, to be rejected.

- 2.4 The appellant argued that the invention could not be carried out on the whole scope of the claims because examples 3.3-3-5 illustrate that in the earlier stage of a process as claimed the conversion of hydrogen could be of only e.g. 87 % (as reported in Table 2 for

example 3.3), which meant that 13 % hydrogen had not been "substantially entirely consumed" in the earlier stage, contrary to the requirement of claim 1.

The board agrees with the appellant that examples 3.3-3.5, which are illustrative of the earlier stage of the subject matter claimed, provide in Table 2 some information related to the consumption of hydrogen. Table 2 first indicates that no hydrogen was detected at the end of the first stage (see reference "ND") and second gives for each of these examples a hydrogen conversion rate of ">87 %", ">90 %" and ">96 %", respectively. In the board's view, the respondent has convincingly demonstrated that these conversion rates were calculated taking into account the limit of detection of the apparatus used for the measurements. Considering that no hydrogen had been detected, the inventors came to the conclusion that the amount of hydrogen present at the end of the first stage was below the detection limit of the apparatus used. Since the total amount of hydrogen was very low, they were, however, not in a position to determine it in a quantitative manner but only relatively i.e. as being below the detection threshold of the apparatus used for the measurements. By comparison of this value with the known input rate of hydrogen, they were then able to determine the minimum amount of hydrogen which had been consumed in the earlier of the two stages of the process and reported it in Table 2 accordingly. The real amounts of hydrogen which had been converted at this end of this earlier stage may, however, have been higher than the value reported in Table 2 but they could not have been measured experimentally because the amounts of hydrogen left were below the detection

threshold of the apparatus used. This explains why the inventors have reported the results as ">X", wherein X corresponds to the detection limit of the apparatus. This conclusion is further confirmed by the fact that the highest "minimum" conversion rate (">96%") is reported for example 3.5, which was certainly performed, on the basis of the feed rates of hydrogen and monomers reported in Table 2, using the highest amounts of hydrogen. This example, is, thus, less affected by the detection threshold of the apparatus than the other examples, which made use of lower amounts of hydrogen.

The board concludes that examples 3.3-3.5 do not show that 13 % hydrogen had not been converted and was left at the end of the earlier stage of the process, as argued by the appellant. The objection based on this argument is, thus, rejected.

- 2.5 The appellant considered that the claims may be interpreted so as to encompass continuous processes and raised the objection that hydrogen could not be "substantially entirely consumed in the relatively earlier" stage of such a process, as attested by example 2 of the patent. Hence, it was argued that the invention could not be carried out on the whole scope of the claims, contrary to the requirements of Art. 83 EPC.

Although the board agrees with the appellant that the claims may be interpreted so as to encompass continuous processes, it did not come to the same conclusion as the appellant regarding Art. 83 EPC. Indeed, Example 3 of the patent in suit illustrates the first stage of such a continuous process, as indicated in paragraph

[0058] of the patent. As explained above, said example 3 illustrates the subject matter claimed and in particular demonstrates that the claimed consumption of hydrogen in the earlier stage of the process was achieved.

The board was not convinced by the argument of the appellant that example 2 demonstrated that hydrogen was not depleted in the earlier stage of the process reported therein. Indeed, the sentence on page 7, line 54 of the patent quoted by the appellant reads: "At the end of polymerization, the pressure was reduced to boil off unreacted ethylene and traces of hydrogen.". The reference to "traces of hydrogen" indicates that at most very low amounts of hydrogen, if any, might have been present at this stage of the process. There is, however, no evidence on file that this was, indeed, the case. The appellant has, however, neither submitted evidence, nor presented convincing arguments in order to refute the presumption created by the patent that hydrogen was indeed "substantially entirely consumed" at the end of the earlier stage of the process reported in example 2. Hence, independently whether or not example 2 of the patent is a continuous process, which was disputed by the parties, the information provided in example 2 does not allow the board to conclude that said example shows that hydrogen is not "substantially entirely consumed" in the earlier stage of the process i.e. that the invention could not be carried out on the whole scope of the claims.

2.6 To conclude, the appellant has neither shown nor made plausible that the skilled person working according to the processes claimed would not be in a position to carry out the invention. In addition, in the absence of

any evidence in this regard, the argument of the appellant that the invention could not be practised across the entire range of the claims is rejected.

2.7 Hence, the requirements of Art. 83 EPC are met.

3. *Novelty: Art. 54 EPC*

3.1 Interpretation of the claims

3.1.1 As discussed above, the expression "hydrogen is substantially entirely consumed" represents a limiting technical feature of the claims and imposes that low amounts of hydrogen should be present at the end of the first stage as compared to the input rate of hydrogen used. This conclusion was not contested by the parties during the oral proceedings.

3.1.2 Claim 1 does not require that the claimed consumption of hydrogen in the relatively earlier of said stages is related to the catalyst used as e.g. indicated in the description on page 3, lines 2-5 of the patent. Claim 1 requires only that "hydrogen is substantially entirely consumed in the relative earlier of said stage". Hence, for the assessment of novelty, it will have to be examined whether or not the prior art document(s) disclose(s) that hydrogen is "consumed" in the earlier stage, no matter how this result is achieved. It will in particular be irrelevant to determine whether or not the catalysts used in the prior art have the ability to consume hydrogen, as long as they correspond to the definition recited in claim 1.

3.1.3 Regarding the claimed consumption of hydrogen, it was argued by the respondent that not only the nature of the catalyst but also the experimental conditions were important in order to achieve the claimed consumption of hydrogen. Hence, for the assessment of novelty, it is not only required to make sure that the catalysts used in the prior art correspond to those defined in the claims of the patent in suit, it should also be assessed whether or not the experimental conditions disclosed in the prior art are such as to ensure that hydrogen is "substantially entirely consumed" at the end of the earlier stage.

3.2 Novelty over **D2**

3.2.1 Disclosure of **D2**

D2 is the sole prior art document which was cited by the appellant as anticipating the subject matter claimed.

The process disclosed in the paragraph bridging pages 4-5 of **D2** reads as follows:

"Another aspect of this invention is a process for in situ blending of polymers comprising continuously contacting, under polymerization conditions, a mixture of ethylene and at least one or more α -olefin or diolefin in at least two fluidized bed reactors connected in series, with a catalyst with the polymerization conditions being such that an ethylene copolymer having a higher melt index is formed in at least one reactor and an ethylene copolymer having a

lower melt index is formed in at least one other reactor with the provisos that:

(a) in a reactor in which the lower melt index copolymer is made:

(1) said alpha-olefin or diolefin is present in a ratio of about 0.01 to about 3.5 total moles of alpha-olefin and diolefin per mole of ethylene;

and

(2) hydrogen is present in a ratio of about 0 to about 0.3 mole of hydrogen per mole of ethylene;

(b) in a reactor in which higher melt index copolymer is made:

(1) said alpha-olefin or diolefin is present in a ratio of about 0.005 to about 3.0 total moles of alpha-olefin and diolefin per mole of ethylene;

and

(2) hydrogen is present in a ratio of about 0.05 to about 2 moles of hydrogen per mole of ethylene,

(c) the mixture of catalyst and ethylene copolymer formed in one reactor in the series is transferred to an immediately succeeding reactor in the series.

(d) the catalyst system comprises a constrained geometry catalyst and optionally, another catalyst.

(e) catalyst may be optionally added to each reactor in the series, provided that catalyst is added to at least the first reactor in the series;".

3.2.2 Lower MFR₂ polyolefin prepared in the second stage

D2 discloses, thus, a two-step process for olefin polymerisation wherein a lower melt index polymer (i.e. lower MFR₂ as recited in claim 1) is prepared either in the first or in the second stage. In order to fulfil the requirement of claim 1 that a polymer having "a lower MFR₂" is obtained in the second stage, a selection has to be made within the ambit of **D2**, namely to perform above step (b) first, followed by step (a). Although this represents a selection within only two alternatives, it remains that a first selection has to be made here in order to disclose a process comprising the sequence of steps claimed. Such a process is, thus, not specifically disclosed on pages 4-5 of **D2**.

3.2.3 Nature of the catalysts disclosed in **D2**

The passage of **D2** cited above requires under point (d) that "the catalyst system comprises a constrained geometry catalyst".

In the board's view, said "system" comprises any catalyst(s) used in the whole process, including those used in steps (a) and (b) recited above. Reading **D2** as a whole, it is, however, not mandatory that a constrained geometry catalyst be used in both stages (a) and (b). Page 6, below paragraph (c) reads: "In all embodiments of the invention, the constrained geometry catalyst is used in at least one of the reactors. An advantage of this invention is that at least one constrained geometry catalyst can be used alone or in conjunction with at least one other catalyst in reactors operated in series or parallel". Similarly, it

is stated on page 35, first paragraph, that "Each reactor separately can have a constrained geometry catalyst or a conventional Ziegler-Natta catalyst as needed (...) as long as there is a constrained geometry catalyst in at least one reactor". Hence, the processes of **D2** may be such that e.g. a Ziegler-Natta catalyst is used in the first stage and a constrained geometry catalyst according to the teaching of **D2** is used in the second stage only. However, such Ziegler-Natta catalysts are not metal: η -ligand catalysts as defined in claim 1. Hence, a further selection within the ambit of **D2** is required in order to have a process wherein a metal: η -ligand catalyst is present in both the earlier and the later stages of the process, as required by claim 1.

Besides, although constrained geometry catalysts which are complexes of Group 4 metal, i.e. complexes of Zr, Ti or Hf, are preferably used in **D2**, the teaching of **D2** is not restricted to such catalysts as may be derived from the passage on page 14, last paragraph. In the absence of any restriction regarding the nature of the constrained geometry catalyst to be used in the process disclosed on pages 4-5 of **D2** (see point (d) recited in above paragraph 3.2.1), it is concluded that said passage does not clearly and unambiguously disclose that the constrained geometry catalyst to be used in at least one stage, let alone in both steps, of the process is a "metal: η -ligand (...) in which the metal is Zr, Ti or Hf" as required by claim 1.

3.2.4 Hydrogen substantially entirely consumed

As already discussed under paragraph 2 above, the feature of claim 1 that "hydrogen is substantially entirely consumed in the relatively earlier of said stages" does not only imply that a specific catalyst is used in said earlier stage but also that specific experimental conditions are used in order to achieve this effect. In the absence of any information in this regard in **D2**, this feature of claim 1 of the main request is, thus, also not mandatorily met. There is in particular no evidence on file that such a feature would be inherent to the catalysts disclosed in **D2** if the conditions recited in point (b)(2) of the process disclosed on pages 4-5 of **D2** were used, as argued by the appellant. Hence, even under the assumption that such a catalyst would be used in the earlier stage, said stage corresponding to point (b) of page 5 of **D2**, the appellant has not discharge its burden of proof that the feature of claim 1 related to the "substantially entire consumption" of hydrogen in the relatively earlier stage of the process disclosed on pages 4-5 of **D2** would be satisfied.

3.2.5 Examples 1 and 2

These examples disclose the polymerisation of ethylene wherein a metal: η -ligand catalyst is added to a reactor which is under ethylene and hydrogen pressures at a specific temperature, whereby a first exotherm is observed. After a while, a second portion of catalyst is added, a second exotherm is observed and a polymer is obtained.

In the board's view, examples 1-2 of **D2** represent a two-stage polymerisation process wherein a catalyst as defined in claim 1 is used. However, these examples do not unambiguously disclose that hydrogen is "substantially entirely consumed" before the second amount of catalyst is added and/or that the requirements regarding MFR_2 as presently claimed are met. In the absence of any evidence provided by the appellant in this respect, there is no reason to expect that these features of claim 1 are implicitly met in said examples 1-2.

3.2.6 The board, thus, concludes that **D2**, either in the description or in its examples, fails to disclose the specific combination of features recited in the claims of the main request. Said main request is, thus, novel.

3.3 Other prior art documents

No other novelty objections have been raised by the appellant. The board is satisfied that none of the other documents cited by the appellant anticipates the subject matter claimed.

3.3.1 The board in particular considers that the novelty destroying subject matter of D1, which is a prior art under Art. 54 (3) EPC and Art. 54 (4) EPC 1973, is excluded by the proviso present in claim 1, which is an allowable disclaimer fulfilling the requirements of G 1/03. Since D1 was filed on 26 May 1997, i.e. before the priority date of the contested patent (16 June 1997), and does not claim any priority, D1 is only relevant for novelty and will not be considered hereafter for the assessment of the inventive step.

3.3.2 **D11** discloses a two stage process for olefin polymerisation similar to those presently claimed (**D11**: claim 1; example) and wherein the catalyst is selected among the "Ziegler-Natta type catalysts known in the art" (**D11**: col. 2, lines 9-10). **D11**, however, fails to disclose metal: η -ligand olefin polymerisation catalysts as defined in the claims of the main request. This conclusion was agreed upon by the parties during the oral proceedings.

4. *Inventive step: Art. 56 EPC*

The inventive merit will be assessed according to the problem-solution approach.

4.1 Closest prior art

The problem to be solved by the contested patent is to provide a multi-stage polymerisation process for the preparation of multi-modal polyolefins which uses a metallocene or other single site catalyst as well as hydrogen in one of the "earlier" polymerisation stages and in which the effect of remaining hydrogen in the later stage of the process is decreased (see paragraphs [0001]-[0003] and [0007]-[0008] of the patent).

The only document cited in the current proceedings which deals with the problem of removing unreacted hydrogen in multi-stage processes is **D11** (see col. 1, lines 5-45). Hence, in agreement with both parties, the board considers that **D11** represents the closest prior art.

The other prior art documents cited, including **D2** which was considered as closest prior art in the contested decision, do not deal with the problem addressed by the patent in suit. They would, thus, not represent the most promising starting point for the skilled person dealing with the above identified problem.

Although **D11** was filed by the appellant (opponent) late in the proceedings (it was cited for the first time in the statement of grounds of appeal), it is nevertheless admitted into the proceedings since it is considered by the board as "prima facie highly relevant" in the sense of T 1002/92 (OJ EPO 1995, 605). This issue was not disputed by the respondent (see above point XIII).

4.2 Defining the alleged problem solved in view of the closest prior art

Normally, the problem addressed in the patent may be taken as the starting point. The respondent identified this problem as the provision of an improved i.e. more economical process to those of **D11**, as stated in paragraphs [0007]-[0008] of the contested patent.

4.3 The solution

The solution provided by the patent is to perform a multi-stage polymerisation process comprising the preparation of a low molecular weight (higher MFR₂) in an earlier stage and of a high molecular weight polyolefin (lower MFR₂) in a later stage, characterised in that:

- the same metal:η-ligand catalyst is used in both stages; and

- it is controlled that hydrogen is "substantially entirely consumed" in the "earlier" stage of preparation of the low molecular weight polymer.

4.4 Examination of the success of the solution

Examples 3.3-3.5 of the contested patent show that the problem is solved when a catalyst as claimed is used together with appropriate experimental conditions (in particular: residence time, feed rate of (co)monomers, pressure and temperature as taught in the description): Table 2 illustrates, indeed, the first stage of a process as claimed wherein hydrogen was not detected at the end of said stage and, thus, wherein hydrogen was "substantially entirely consumed" as required by the claims. Such a process does not require a removal step of excess hydrogen at the end of the earlier stage and is, thus, more economical than those of the prior art. The above identified problem is, thus, indeed solved.

The board considers that no similar conclusion can be drawn from example 2 of the patent in suit. As discussed earlier (see paragraph 2), it is stated on page 7, line 54 in relation with said example 2 that at the end of the earlier stage, the pressure was reduced to remove "traces of hydrogen". In the absence of any information from the patent proprietor on the level of said "traces" as compared to the feed rate of hydrogen, there is no evidence that the claimed "substantially entire" consumption of hydrogen was achieved in said examples. Besides, a removal step is explicitly performed at the end of the earlier stage: hence, and to this extent, the problem identified above would not have been solved.

From the comparison of the data presented in Tables 2 and 3 of the patent in suit, the latter being related to comparative example 4 wherein a Ziegler-Natta catalyst is used, the appellant has raised the objection that the alleged problem would not have been solved. This objection, however, did not convince the board because the reaction conditions used in the examples reported in these Tables are very different so that no fair comparison may be made: in addition to the different types of catalysts used, examples 4.1-4.3 (Table 3) differ from examples 3.1-3.5 (Table 2) for instance, in that different comonomers are used (butane instead of hexane) and in that different feed rates of monomers, comonomers, diluent and hydrogen are applied. Besides, no MFR_2 values are indicated in Table 3.

Hence, the board concludes that the problem identified above under paragraph 4.2 is indeed solved and may be considered as the objective problem effectively solved by the patent in suit.

4.5 Examining whether the proposed solution is obvious with regard to the state of the art

4.5.1 Concerning the closest prior art **D11**

(a) **D11** specifically deals with Ziegler-Natta catalysts, which are known to require high concentrations of hydrogen to produce low molecular weight compounds (see e.g. **D11**: col. 1, lines 27-29; col. 2, lines 9-19). **D11** does not disclose either explicitly or implicitly metal: η -ligand catalysts as defined in claim 1. As shown by the respondent, the preferred catalysts taught

and exemplified in **D11** (col. 2, lines 13-17) are all transition metal halides, which do not correspond to the definition of the catalysts to be used in the process of the patent in suit. This has not been contested by the appellant, who has indeed admitted during the oral proceedings that **D11** did not disclose catalysts as defined in claim 1.

D11, could, thus not provide on its own any motivation to replace the Ziegler-Natta catalysts taught therein by catalysts as defined in the main request.

(b) It is further agreed with the respondent that the exchange of Ziegler-Natta catalysts by metallocene catalysts is not as obvious as alleged by the appellant, since the whole process of polymerisation would be affected by such a modification and would have had, as a consequence, to be adapted accordingly. Should the skilled person contemplate modifying the process of **D11**, there is no reason why he would change the class of catalysts specifically taught in **D11** and, thus, go beyond the categorical teaching of **D11**.

(c) Furthermore, should the skilled person have contemplated changing the nature of the catalysts used, he would have found no indication in **D11** to decide on which alternative catalysts should be used. He would have had in particular no motivation to use the catalysts recited in claim 1, among all the alternatives catalysts available in the art, instead of the Ziegler-Natta catalysts taught in **D11**.

(d) Hence, the skilled person would not have found any hint in **D11**, which would have led to the solution

proposed by the patent in order to solve the objective problem identified above.

4.5.2 Concerning the other cited prior art documents

During the oral proceedings, the appellant based its inventive step objections on the combination of **D11** with either **D7** or **D10**.

(a) **D7** deals with the preparation of 1-olefin stereoblock polymer waxes and teaches at col. 2, lines 35-40 the use of hydrogen as molecular weight regulator. It is further recited that "The metallocenes used have a surprisingly high sensitivity for hydrogen, which means that waxes can be produced using small amounts of hydrogen".

D10 reports the influence of hydrogen on the polymerisation of ethylene using specific metallocene catalysts, which are metal: η -ligand as defined in claim 1 of the main request. **D10** in particular teaches that the molecular weight of polyethylene is influenced by the addition of hydrogen and states that "In contrast to most heterogeneous catalysts, only traces of hydrogen were necessary to lower the molecular weight in a wide range" (page 226, one before last paragraph).

It is, thus, conspicuous to the board that neither **D7** nor **D10** deals with multi-stage polymerisation of polyolefins and/or aims at eliminating hydrogen during their process. In this regard, the technical field of **D7**, namely the preparation of polyolefin waxes, is completely different from that of the present invention.

Finally, **D10** only considers single stage processes. Hence, it is highly questionable whether the skilled person looking for a modification of the multi-stage process of **D11** would have contemplated the teaching of **D7** and **D10** at all.

(b) The board further sees no teaching in **D7** and **D10** related to the consumption of hydrogen by metallocene catalysts, in particular with catalysts as defined in claim 1 of the main request.

D7 merely teaches that metallocene catalysts are "sensitive" to hydrogen. This does not mean, in the board's view, that metallocene catalysts have the ability to "substantially entirely consume" hydrogen under specific conditions, as alleged by the appellant. The board rather concurs with the respondent that a high sensitivity as reported in **D7** means that low amounts of hydrogen will have a noticeable impact - in terms of molecular weight regulation - on the process of **D7**.

Regarding **D10**, the board agrees with the respondent that this document also deals with the well known use of hydrogen as molecular weight regulator. The finding of **D10** is that low amounts of hydrogen are needed in order to reduce significantly the molecular weight of polyethylene. This amounts, again, to the teaching that the processes of **D10** are "sensitive" to hydrogen, but is different from the use of catalysts as claimed in order to consume and eliminate hydrogen. Fig. 1 of **D10** in particular illustrates the relationship between molecular weight and hydrogen used. Again, the board does not consider that Fig. 1 is an evidence of the ability of the catalysts of **D10** to consume hydrogen: it

merely illustrates that hydrogen may be used with success to modify the molecular weight of polyethylene. In the absence of any teaching relating to the ability of catalysts as claimed to deplete hydrogen, the board considers that the skilled person starting from **D11** as closest prior art would have had no reason to contemplate using such catalysts instead of the Ziegler-Natta catalysts taught in **D11** in order to eliminate hydrogen in the earlier stage of the process disclosed therein.

(c) A further argument which goes against the obviousness of the combination of **D11** with either **D7** or **D10** is that these latter documents were available at the priority date of **D11**. Despite this, **D11** did not consider it obvious to use metallocene in its process, not even as a mere alternative to the Ziegler-Natta catalysts claimed and exemplified therein. The result is that the solution provided in **D11**, even if it is successful, remains expensive, as explained by the respondent, since it consumes irremediably hydrogen, which is an expensive gas, with an expensive scavenger. Besides, the product of this reaction either remains as impurities in the polyolefin produced or will have to be separated, both of which being technically not desired. Hence, should the catalysts recited in claim 1 have been an obvious alternative to the Ziegler-Natta catalysts of **D11**, the inventors of that process would have at least considered them and at least mentioned them in their patent but would certainly not have limited their process so as to exclude a solution having such advantages.

(d) For these reasons, the board considers that it was not obvious for the skilled person starting from **D11** as closest prior art to solve the above objective problem by using catalysts such as those taught in **D7** and/or **D10** instead of the Ziegler-Natta catalysts taught in **D11**.

(e) For the same reasons, an identical conclusion was reached by the board regarding the objection raised in writing by the appellant on the combination of **D11** with either **D8** or **D9**.

4.5.3 Diametrically opposite conceptual ideas

The teaching of **D11** is related to the use of specific cyclopentadienyl compounds as scavengers to remove excess hydrogen at the end of the earlier stage wherein a low molecular weight polymer is prepared, in order to prevent that any remaining hydrogen be detrimental to the production of a higher molecular weight polymer in the following, second stage of the process. Hence, the gist of the invention of **D11** is related to the presence of hydrogen at the end of the earlier stage of the process.

The conceptual idea behind the present invention, however, is to provide a process which ensures the absence of hydrogen at the end of the earlier stage of a multi-stage polymerisation process, which is, thus, in complete contradiction with that behind the invention of **D11**, which is based on the removal of hydrogen residually present at the end of said earlier stage. The appellant did not provide convincing arguments in order to explain where the skilled person starting from **D11** as closest prior art would find the

idea that, in order to get rid of the hydrogen present at the end of the earlier stage of **D11**, he should look at the type of catalyst employed. The argument brought by the appellant that it would have been "obvious to try" was rejected by the board because it is, in the board's view, based on hindsight since there is no indication in any of the cited prior art on file that the catalysts defined in claim 1 of the main request have the ability to consume and deplete hydrogen.

4.6 Conclusion

The above analysis shows that in order to arrive at the present invention starting from **D11** as closest prior art, two steps are necessary:

- the first one is to come to the conceptual idea supporting the invention, which is to have no hydrogen left at the end of the earlier stage of the multi-stage process, in diametric opposition to the process of **D11**;
- the second one is to put this into practice, i.e. to provide the solution of the patent, which is to use a specific catalyst as recited in claim 1 of the main request and to employ such conditions that hydrogen is depleted at the end of the earlier polymerisation stage.

The board is of the opinion that neither of these steps emerges in an evident manner from the prior art cited in the proceedings and concludes that it was not obvious for the skilled person to solve the above identified objective problem by modifying the process of the closest prior art **D11** according to the claims of

the main request. An inventive merit is, thus, to be acknowledged.

4.7 Therefore, the board is satisfied that the main request fulfils the requirements of Art. 56 EPC.

5. The main request of the respondent (patent proprietor) being allowable there is no need for the board to consider the auxiliary requests I-VII.

Order

For these reasons it is decided that:

The appeal is dismissed.

The Registrar:

The Chairman:

E. Görgmaier

R. Young