

Internal distribution code:

- (A) [-] Publication in OJ
- (B) [-] To Chairmen and Members
- (C) [-] To Chairmen
- (D) [X] No distribution

**Datasheet for the decision
of 28 September 2022**

Case Number: T 0015/20 - 3.3.03

Application Number: 07776022.1

Publication Number: 2024402

IPC: C08F2/04, C08F10/02, C08F4/64,
C08F210/16, C08L7/00, C08F4/659

Language of the proceedings: EN

Title of invention:

HIGH TEMPERATURE SOLUTION POLYMERIZATION PROCESS

Patent Proprietor:

Dow Global Technologies LLC

Opponent:

Borealis AG

Relevant legal provisions:

EPC Art. 56
RPBA 2020 Art. 12(4)

Keyword:

Inventive step - (yes)
Admittance of documents



Beschwerdekammern

Boards of Appeal

Chambres de recours

Boards of Appeal of the
European Patent Office
Richard-Reitzner-Allee 8
85540 Haar
GERMANY
Tel. +49 (0)89 2399-0
Fax +49 (0)89 2399-4465

Case Number: T 0015/20 - 3.3.03

D E C I S I O N
of Technical Board of Appeal 3.3.03
of 28 September 2022

Appellant: Borealis AG
(Opponent) Trabrennstrasse 6-8
1020 Vienna (AT)

Representative: Kador & Partner PartG mbB
Corneliusstraße 15
80469 München (DE)

Respondent: Dow Global Technologies LLC
(Patent Proprietor) 2040 Dow Center
Midland, MI 48674 (US)

Representative: Beck Greener LLP
Fulwood House
12 Fulwood Place
London WC1V 6HR (GB)

Decision under appeal: **Interlocutory decision of the Opposition
Division of the European Patent Office posted on
29 November 2019 concerning maintenance of the
European Patent No. 2024402 in amended form.**

Composition of the Board:

Chairman D. Semino
Members: D. Marquis
L. Basterreix

Summary of Facts and Submissions

I. The appeal lies against the decision of the opposition division concerning the maintenance of European patent No. 2 024 402 on the basis of the claims of auxiliary request 1 filed with letter of 16 January 2019.

II. Claim 1 of that request reads as follows:

"1. A process for polymerization of ethylene and optionally one or more α -olefins under continuous, solution polymerization conditions to prepare a high molecular weight polymer, said process comprising conducting the polymerization in the presence of a catalyst composition comprising a transition metal complex and an activating cocatalyst under conditions that result in a value for the polymerization index, Ψ , that is greater than or equal to zero as determined by the following equation:

$$\Psi = \beta_0 + \beta_1 T + \beta_2 X + \beta_3 E + \beta_4 \rho + \beta_5 I_2,$$

where, T is the polymerization temperature in degrees Celsius, X is the ethylene conversion in the reactor in mol percent, E is the catalyst efficiency in g polymer produced per μg of metal in the metal complex fed to the reactor per unit time, ρ is the resulting polymer density in units of g/ml, I_2 is the melt index of the polymer in units of dg/minute, and the equation constants, β_0 - β_5 , are unitless numbers having the values defined in the following table:

Equation Constant	Value	Equation Constant	Value
β_0	-13796.073	β_3	62.5876298
β_1	111.445393	β_4	-18931.8878
β_2	137.437524	β_5	-108.320017

wherein the process is conducted at a temperature from 170 to 250°C in the presence of a chain transfer agent, which is hydrogen in an amount of from 0.015 to 2 mol percent based on ethylene, to prepare a polymer having a density between 0.885 and 0.950 g/cm³, a melt index, I₂, < 2.0, a molecular weight distribution Mw/Mn < 3.0, and a catalyst efficiency of greater than 0.5 g_{polymer}/μ_{metal}".

III. The following documents were *inter alia* cited in the opposition procedure:

D1:WO 00/24793

D7:S.Hasegawa, M.Sone, M.Tanabiki, M.Sato, A.Yano, High-Temperature Ethylene/α-Olefin Copolymerization with a Zirconocene Catalyst: Effects of the Zirconocene Ligand and Polymerization Conditions on Copolymerization Behavior, Journal of Polymer Science: Part A: Polymer Chemistry, 2000, Vol. 38, pages 4641-4648

D11:P.Lehmus, E.Kokko, R.Leino, H.J.G. Luttikhedde, B.Rieger, J.V.Seppälä, Chain End Isomerization as a Side Reaction in Metallocene-Catalyzed Ethylene and Propylene Polymerizations, Macromolecules 2000, 33 (23), pages 8534-8540

D12:WO 96/00246

D13:WO 02/34795

D15:Experimental Data for opposition to EP2024402B1 (Dow) 64084A-EP-EPT, Philip Fontaine, 15 July 2019

IV. The opposition division established in their contested decision that claim 1 of auxiliary request 1 differed from the process disclosed in examples 14a and 14b of D1 considered as the closest prior art in that 0.015-2 mol% of hydrogen was used as chain transfer agent in

the process. The opposition division formulated the problem as the provision of a process with improved control whilst at the same time maintaining other advantages such as high polymerization temperature, low density, and low melt index. The question of obviousness was whether by introducing hydrogen in the process of D1, the skilled person would have arrived at a process within the scope of claim 1 of auxiliary request 1. The opposition division found that the experimental report D15 showed that using hydrogen in the process of the closest prior art in amounts in the range defined in claim 1 of auxiliary request 1 would result in a polymer having a melt index above 2.0 dg/min thereby establishing that the use of hydrogen as chain transfer agent would lead to a polymer that was not according to claim 1 of auxiliary request 1. The opposition division concluded that claim 1 of auxiliary request 1 was inventive over D1.

V. The opponent (appellant) lodged an appeal against the decision of the opposition division and submitted *inter alia* the following documents with their statement of grounds of appeal:

D16: Dictionary of Materials and Testing, R.S. Hodder, 2nd ed., 2000, page 74

D17: A.D. Jenkins, R.G. Jones, G. Moad, Terminology for reversible-deactivation radical polymerization previously called "controlled" radical or "living" radical polymerization (IUPAC Recommendations 2010), Pure Applied Chemistry, 2010, Vol. 82, no. 2, pages 483 to 491

VI. The patent proprietor (respondent) filed a further set of claims as auxiliary request 1 with their reply to the statement of grounds of appeal. The wording of the

claims of that request is not relevant to the present decision.

- VII. The parties were summoned to oral proceedings and a communication pursuant to Article 15(1) RPBA 2020 indicating specific issues to be discussed at the oral proceedings was sent to the parties.
- VIII. Oral proceedings were held on 28 September 2022 by videoconference with both parties attending.
- IX. The final requests of the parties were as follows:
- (a) The appellant requested that the decision of the opposition division be set aside and that the patent be revoked.
 - (b) The respondent requested that the appeal be dismissed (main request) or that the patent be maintained on the basis of the claims of auxiliary request 1 filed with the rejoinder to the statement of grounds of appeal.
- X. The appellant's arguments, in so far as they are pertinent, may be derived from the reasons for the decision below. They are essentially as follows:
- (a) D16 and D17 should be admitted into the proceedings.
 - (b) Starting from examples 14a/b of D1 as the closest prior art, the distinguishing feature was the use of hydrogen as a chain transfer agent in an amount of 0.015 to 2 mol% based on ethylene.

(c) The patent in suit did not establish the presence of an effect from that feature. D15 was not relevant as it did not reproduce the process of the closest prior art. The problem was therefore the provision of an alternative continuous solution polymerization process conducted at high temperatures to reach high molecular weight with high catalyst efficiency. The solution to that problem by means of the distinguishing feature was obvious and the use of hydrogen in the given amount would result in a process according to claim 1. Claim 1 of the main request lacked therefore an inventive step.

XI. The respondent's arguments, in so far as they are pertinent, may be derived from the reasons for the decision below. They are essentially as follows:

(a) D17 was post-published and thus should not be admitted into the proceedings. There was no objection to the admittance of D16.

(b) Starting from examples 14a/b of D1 as the closest prior art, the distinguishing feature was the use of hydrogen as a chain transfer agent in an amount of 0.015 to 2 mol% based on ethylene.

(c) D15 established that it was possible to provide a process of producing a polymer at high polymerization temperature with advantageous polymer properties such as low density and low melt index. The problem was to provide a process with an improved control of the final molecular weight while at the same time maintaining other advantages such as high temperatures, low densities and low melt index. The solution to that problem was not

obvious. In particular the introduction of hydrogen in the process of D1 would not result in a process according to claim 1 as already established by the opposition division. Claim 1 of the main request involved therefore an inventive step.

Reasons for the Decision

Main request

1. Admittance of documents
 - 1.1 D16 and D17 are documents submitted by the appellant with their statement of grounds of appeal. They are both extracts providing generic definitions for chain transfer agents which should mirror the understanding of the skilled person according to their common general knowledge.
 - 1.2 D16 represents indeed the common general knowledge relating to the distinguishing feature over the closest prior art as identified in the contested decision (section 4.6.1). The respondent declared at the oral proceedings before the Board that they did not oppose its admittance into the proceedings. On this basis the Board finds it appropriate to exercise its discretion according to Article 12(4) RPBA 2020 by admitting document D16 into the proceedings.
 - 1.3 With regard to D17, it is not apparent and was also not shown by the appellant how that document, which was published on 18 November 2009, i.e. over three years after the priority date of the patent in suit (17 May 2006), could represent the common general knowledge of the skilled person and be relevant to the discussion of inventive step over D1 as closest prior art. On this

basis the Board finds it appropriate to exercise its discretion according to Article 12(4) RPBA 2020 by not admitting document D17 into the proceedings.

2. Inventive step

2.1 The decision of the opposition division on inventive step is based on D1 as the closest prior art. The parties in appeal also considered that D1 and in particular the process disclosed in examples 14a and 14b (referred to as example 14a/b thereafter) represented the closest prior art. The Board does not see any reason to depart from that view.

2.2 The opposition division established (section 4.6.1 of their decision) that the sole difference between claim 1 of the main request and the closest prior art was the presence, in the ethylene polymerization process, of 0.015 to 2 mol% percent hydrogen based on ethylene as a chain transfer agent.

2.3 Relying on documents D7 (page 4 of the letter of 26 August 2022) and D11-D13 (page 4 of the statement of grounds of appeal) the appellant however contended in appeal that hydrogen was produced in significant amounts during the polymerization reaction of example 14a/b of D1. The Board however does not follow the appellant for the following reasons.

2.3.1 The process of example 14a/b of D1 is a solution copolymerization of ethylene and 1-octene in the presence of a catalyst ((*p*-Et₃Si-phenyl)₂C(2,7-^tBu₂Flu)(Cp)HfMe₂: catalyst A) based on Hafmium (pages 25 and 26 with reference to page 18, lines 15-21 for the catalyst). The production of hydrogen in the course of that process is neither explicitly disclosed nor

directly derivable from the information contained in D1. The Board also finds that none of D7 and D11-D13 establish that the process of example 14a/b of D1 is accompanied by the production of hydrogen.

- 2.3.2 In particular, D7 is an academic publication exploring the high-temperature copolymerization of ethylene/ α -olefin in the presence of Zirconocene catalysts (Abstract). The process cited by the appellant in D7 is a polymerization using $\text{Ph}_2\text{C}(\text{Cp})(\text{Flu})\text{ZrCl}_2$ as a catalyst and is reported in Table VII on page 4646. For that polymerization, D7 proposes a mechanistic pathway involving the release of hydrogen (Scheme 1) but the representation in Scheme 1 relies on a Zirconocene catalyst being used. There is no teaching in D7 from which it could be deduced that the release of hydrogen referred to in Scheme 1 of D7 would also take place when using a Hafnocene catalyst as in example 14a/b of D1.
- 2.3.3 D11-D13 pertain to polymerization processes of ethylene in the presence of metallocene catalysts. As for D7, D11 shows a polymerization based on a Zirconocene catalyst (Scheme 1, page 8535). In that regard, D11 is not more relevant to D1 than D7 discussed above. D12 discloses the release of hydrogen in the copolymerization of ethylene using metallocene catalysts. D12 however uses specifically a gas phase polymerization and not a solution polymerization as in D1. In that regard D12 cannot be directly relevant to D1. D13 pertains to solution polymerization using metallocene catalysts but it is not apparent how the passage on page 4, lines 6-10 cited by the appellant could be relevant to D1 as it merely mentions the generation of hydrogen when using single site catalysts but it cannot be deduced therefrom that hydrogen would

also be produced in the presence of a Hafnocene as used in example 14a/b of D1.

- 2.3.4 Since none of D7 and D11-D13 are relevant to D1, the Board does not see any reason to deviate from the conclusion of the opposition division on the distinguishing feature over the process of example 14a/b of D1.

- 2.4 At the oral proceedings before the Board the respondent formulated the problem solved with respect to D1, example 14a/b as the provision of a process with an improved control of the final molecular weight and at the same time maintaining other advantages such as high temperatures, low densities and low melt index.
 - 2.4.1 According to the established case law, an unexpected effect (advantageous effect or feature) demonstrated in a comparative test can be taken as an indication of inventive step but the nature of the comparison with the closest state of the art must be such that the alleged advantage or effect is convincingly shown to have its origin in the distinguishing feature of the invention compared with the closest state of the art (Case Law of the Boards of Appeal, 10th Edition 2022, I.D.4.3.2).

 - 2.4.2 In the present case, the examples of the patent in suit do not disclose a process in which hydrogen was not used as a chain transfer agent. In view of this, the examples of the patent in suit do not offer a valid comparison with the process according to example 14a/b of D1. The respondent further contended that the experimental report D15 would establish the presence of an effect over the closest prior art. Section "1. Continuous Polymerization Data" of D15 which discloses

several runs for the polymerization of ethylene and 1-octene (runs 1-5, 7 and 8) was found to be relevant by the respondent. These runs however do not establish the presence of an effect that could unambiguously be attributed to the use of 0.015 to 2 mol percent hydrogen as a chain transfer agent during polymerization. In particular, the polymerizations in runs 1 and 2 were carried out in the absence of hydrogen and runs 3-5, for which hydrogen was used during polymerization, are such that they lead to a polymer having a melt index (Table 4: run 3: 3.39 dg/min, run 4: 5.65 dg/min, run 5: 8.41 dg/min) that is outside the range limiting claim 1 (below 2.0). These runs are thus not according to claim 1 of the main request. Runs 7 and 8 in tables 7 and 8 of D15 were conducted in the presence of hydrogen and are according to claim 1 as they lead to a polymer having a melt index below 2.0 (Table 8: run 7: 0.72 dg/min, run 8: 1.45 dg/min) but these runs also lack relevance because for these runs different polymerization conditions were used (Table 7: Catalyst A-10 with scavenger MMAO-3A and 1-octene feed of 0.70 kg/hr) than in runs 1-5 (Table 1: Catalyst A with scavenger TOA and 1-octene feed of 0.45kg/hr). In view of these differences, it is impossible to establish whether any effect seen in runs 7 and 8 is attributable to the distinguishing feature over D1, namely the use of hydrogen in an amount of 0.015 to 2 mol percent.

- 2.5 Under these circumstances, the problem that can be defined in view of the lack of evidence of an effect over D1 is, in agreement with the appellant, the provision of an alternative process conducted at high temperature to reach high molecular weight with high catalyst efficiency.

- 2.6 The appellant held that it was obvious in view of the prior art to use hydrogen as chain transfer agent, in particular when a regulation of the molecular weight of the polymer was needed. Specifically, example 14a/b of D1 already indicated that hydrogen could optionally be used and the hydrogen amount defined in claim 1 of the main request was a conventional one. Furthermore, the appellant mentioned at the oral proceedings before the Board that D12 (page 13, Table 1) and D7 (page 4646, Table VII), which disclosed similar processes to that of D1 and the patent in suit, established that the hydrogen amount defined in claim 1 of the main request was already commonly used in the prior art.
- 2.7 The question of obviousness in the present case however is not whether hydrogen in the specific amount of claim 1 could have been used in the process of example 14a/b of D1. It was in particular not disputed that the use of hydrogen as chain transfer agent in a high temperature polymerization process of ethylene was known in the art or even that the hydrogen amount defined in claim 1 of the main request (0.015 to 2 mol percent based on ethylene) was already known to the skilled person. Indeed the skilled person could have used hydrogen as a common measure in the polymerization process of example 14a/b of D1 as is in fact already suggested on page 25, line 13 of that document.
- 2.8 The decisive question is, however, whether the skilled person starting from the process of example 14a/b of D1 and adding hydrogen in the specific amount would have been able to arrive at a process according to claim 1 of the main request, in particular obtaining a polymer as defined therein. In this respect, the opposition division had decided that this was not the case.

- 2.8.1 The polymers according to example 14a/b of D1 have properties that are according to claim 1 of the main request. Claim 1 of the main request defines the polyethylenes obtained as having a density between 0.885 and 0.950 g/cm³ (also corresponding to kg/m³), a molecular weight distribution Mw/Mn<3.0 and a melt index I₂<2.0. In example 14a/b of D1 the copolymers of ethylene and 1-octene have densities of 0.903 kg/m³ (example 14a) and 0.909 kg/m³ (example 14b), a molecular weight distribution of 2.3 (example 14a) and 2.2 (example 14b) and melt indexes of 0.84 dg/min (example 14a) and 0.96 dg/min (example 14b). Properties within the defined ranges should, however, also be maintained after the introduction of hydrogen in order to arrive at a process according to claim 1.
- 2.8.2 Since the purpose of a chain transfer agent is mainly to influence the molecular weight of a polymer and its use is in particular known to lead to an increase of its melt index, the question is whether the use of a 0.015-2 mol percent of hydrogen (based on ethylene) as a chain transfer agent in the polymerization process of example 14a/b of D1 would still lead to a polymer with a melt index below 2.0 as required in claim 1 of the main request.
- 2.8.3 In that regard, the decision of the opposition division concluded (section 4.6.4) that the addition of hydrogen would have resulted in an increase of melt index above the maximum value of 2.0 defined in claim 1 of the present main request. In particular, D15 showed that using hydrogen in the process of example 14a/b of D1, even in an amount that was at the lower end of the range defined in claim 1 of the main request, resulted in an increase of the melt index of the polymer produced such that the melt index of the polymer was

outside the range defined in that claim. The communication of the Board sent in preparation of the oral proceedings underlined that that point of the decision was also key to the question of obviousness in appeal (sections 3 and 7.8 of the Board's communication).

- 2.9 The appellant however did not provide in appeal sufficient reasons to overturn that conclusion. With regard to D15, the argument of the appellant was essentially that the experimental report D15 lacked relevance because it did not represent a faithful reproduction of the process of example 14a/b of D1. D15 and in particular runs 2 and 3 thereof, however, concern polymerization processes of ethylene and 1-octene that were conducted under comparable conditions, differing only in the presence of 0.016 mol percent of hydrogen in run 3. The comparison of runs 2 and 3 establishes that the copolymer of run 3 obtained in the presence of hydrogen has a melt index (3.39 dg/min) that is significantly higher than that of the copolymer obtained without hydrogen (0.85 dg/min). The melt index of the copolymer obtained in the presence of 0.016 mol percent of hydrogen is clearly well outside the range defined in claim 1 of the main request (below 2.0). The Board therefore finds that run 3 in D15, even though it is not a perfectly accurate reproduction of the polymerization described in example 14a/b of D1 with addition of hydrogen, offers reasonable evidence that addition of even minimal amounts of hydrogen can affect the melt index of the copolymer to such an extent that it is well outside the range defined in claim 1 of the main request. The appellant did not submit counter-evidence in reply to D15. While the onus of proof of showing lack of inventive step starting from the closest prior art was on them, they did not discharge

it with regard to the preparation of a copolymer having the properties defined in claim 1 of the main request starting from the polymerization process of example 14a/b of D1 and adding 0.015-2 mol percent hydrogen based on ethylene. It has thus not been established by the appellant that the polyethylene polymers according to claim 1 of the main request could have been obtained starting from the process of example 14a/b of D1. The Board therefore sees no reason to overturn the decision of the opposition division on inventive step of claim 1 of the main request.

- 2.10 In view of that the Board can only conclude that claim 1 of the main request meets the requirements of Article 56 EPC.

3. As the only objection maintained in appeal does not succeed, the Board does not need to decide on any other issue and the appeal is to be dismissed.

Order

For these reasons it is decided that:

The appeal is dismissed.

The Registrar:

The Chairman:



B. ter Heijden

D. Semino

Decision electronically authenticated