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Datasheet for the decision of 11 March 2021

Case Number: T 1605/17 - 3.3.06

Application Number: 10726484.8

Publication Number: 2442903

IPC: B01J19/24, C08F2/14, C08F10/02

Language of the proceedings: EN

Title of invention:
Polymerization process with improved polymer homogeneity

Patent Proprietor:
TOTAL RESEARCH & TECHNOLOGY FELUY

Opponents:
Borealis AG
INEOS Europe AG
Chevron Phillips Chemical Company LP

Headword:
Olefin polymerization / TOTAL

Relevant legal provisions:
EPC Art. 56, 100(a)

Keyword:
Inventive step (all requests) - (no) - standard optimisation

Decisions cited:

Catchword:

Europäisches Patentamt
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Beschwerdekammern

Boards of Appeal

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Case Number: T 1605/17 - 3.3.06

D E C I S I O N
of Technical Board of Appeal 3.3.06
of 11 March 2021

Appellant: (Patent Proprietor)	TOTAL RESEARCH & TECHNOLOGY FELUY Zone Industrielle C 7181 Seneffe (BE)
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Respondent: (Opponent 1)	Borealis AG IZD Tower Wagramerstrasse 17-19 1220 Wien (AT)
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Respondent: (Opponent 2)	INEOS Europe AG Avenue des Uttins 3 Rolle CH-1180 Vaud (CH)
Representative:	King, Alex Mathisen & Macara LLP Communications House South Street Staines-upon-Thames, Middx TW18 4PR (GB)

Respondent: (Opponent 3)	Chevron Phillips Chemical Company LP 10001 Six Pines Drive The Woodlands, Texas 77380 (US)
Representative:	Abel & Imray Westpoint Building James Street West Bath BA1 2DA (GB)
Decision under appeal:	**Decision of the Opposition Division of the European Patent Office posted on 30 May 2017 revoking European patent No. 2442903 pursuant to Article 101(3)(b) EPC.**

Composition of the Board:

Chairman	P. Ammendola
Members:	L. Li Voti
	R. Cramer

Summary of Facts and Submissions

I. The appeal is from the decision of the opposition division to revoke European patent no. 2 442 903.

II. With its statement of grounds the appellant (patent proprietor) defended the patent as granted and filed three set of amended claims as auxiliary requests 1 to 3.

III. The respondents (opponents 1, 2 and 3) maintained in their replies to the grounds of appeal objections under articles 100(a), (b) and (c) EPC.

The respondents referred inter alia to the following documents:

O1: WO 2007/113308 A1
O3: US 3,817,962
O5: US 3,476,729
O6: US 3,356,667
O9: Instruments Engineers' Handbook, fourth edition, ed. B.G.Liptak, "Process Control and Optimization" volume 2, 2006, pages 99-103 and 137-139.

Moreover, Respondent 1 filed two new documents labeled O16 and O17 and requested that they be admitted into the proceedings. Respondents 2 and 3 requested that all auxiliary requests be not admitted.

IV. Following the communication expressing the board's preliminary opinion, the appellant filed by letter dated 13 May 2020 eight sets of amended claims as auxiliary requests 4A, 4B, 5A, 5B, 6A, 6B, 7A and 7B.

V. Respondent 3 replied with letter dated 8 January 2021 and inter alia requested that the auxiliary requests filed on 13 May 2020 be not admitted.

VI. During oral proceedings held before the board on 11 March 2021 inventive step of all requests was discussed.

The final requests of the parties were the following:

The appellant requested that the decision under appeal be set aside and that the patent be maintained as granted (main request) or, auxiliarly, on the basis of any one of the auxiliary requests 1 to 3, filed with the statement of grounds or of auxiliary requests 4A, 4B, 5A, 5B, 6A, 6B, 7A and 7B, all filed with letter dated 13 May 2020.

Respondent / Opponent 1 requested that the appeal be dismissed and that documents O16 and O17 be admitted into the proceedings.

Respondent / Opponent 2 requested that the appeal be dismissed and that auxiliary requests 1 to 3 be not admitted into the proceedings.

Respondent / Opponent 3 requested that the appeal be dismissed and that all auxiliary requests be not admitted into the proceedings.

VII. Claim 1 as granted (main request), has the following wording:

"*1. Process for the polymerization of an olefin monomer and one or more optional comonomers in a polymerization reactor, said process comprising the steps of*

(a) feeding an olefin monomer, one or more optional comonomers, at least one polymerization catalyst, and hydrogen to the polymerization reactor,
(b) polymerizing said olefin monomer and the one or more optional comonomers to produce an olefin polymer, and
(c) discharging said olefin polymer from the polymerization reactor,
characterized in that the hydrogen in step (a) is fed to the polymerization reactor at a ratio of hydrogen feed line volume to hydrogen mass flow of at most 5.0 l $kg^{-1}h$."

Claim 1 according to auxiliary request 1 differs from claim 1 as granted insofar as step (a) of the claimed process reads (amendments with respect to granted claim 1 put in evidence by the board):

"*(a) feeding an olefin monomer, one or more optional comonomers, at least one polymerization catalyst, and hydrogen to the polymerization reactor,* ***wherein the at least one polymerisation catalyst is a single-site polymerization catalyst,***".

Claim 1 according to auxiliary request 2 differs from claim 1 as granted insofar as step (a) of the claimed process reads:

"*(a) feeding an olefin monomer, one or more optional comonomers, at least one polymerization catalyst, and hydrogen to the polymerization reactor,* ***wherein hydrogen is mixed with the olefin monomer and optionally with the one or more optional comonomer(s), prior to injection into the polymerization reactor,***".

Claim 1 according to auxiliary request 3 differs from claim 1 as granted insofar as step (a) of the claimed process includes both the amendments to auxiliary requests 1 and 2.

Claim 1 according to auxiliary requests 4A and B is identical to claim 1 of the main request.

Claim 1 according to auxiliary requests 5A and 5B is identical to claim 1 of auxiliary request 1.

Claim 1 according to auxiliary requests 6A and 6B is identical to claim 1 of auxiliary request 2.

Claim 1 according to auxiliary requests 7A and 7B is identical to claim 1 of auxiliary request 3.

Reasons for the Decision

Main request (patent as granted)

1. Inventive step (Articles 100(a) and 56 EPC) - Claim 1

1.1 Claim 1 concerns a process for the polymerization of an olefin monomer in presence of a polymerization catalyst and hydrogen.

As stated in the patent (paragraphs [0002]-[0003]) in this type of polymerization polymer chain length is essentially determined by the concentration of hydrogen, which is used as a chain terminating agent, in the polymerization reactor. A higher hydrogen concentration in the reactor leads thus to shorter polymer chains and by consequence to a polyolefin having a higher melt flow rate. By contrast, a lower

hydrogen concentration leads to longer polymer chains and therefore to a polyolefin having a lower melt flow rate.

As explained in the description (paragraphs [0005]-[0006]) it is thus very important to control the hydrogen concentration as closely as possible in order to allow the production of a polyolefin having uniform properties.

The purpose of the alleged invention is thus stated in the patent (paragraphs [0008] and [0010]) as the provision of an improved control of the hydrogen concentration in the polymerization reactor and (paragraphs [0012]-[0013]) of a polyolefin having improved compositional homogeneity and improved quality and melt flow rate consistency.

According to the patent (paragraph [0014]) at least one of these objectives can be met by feeding the hydrogen to the polymerization reactor at a well defined ratio of hydrogen feed line volume to hydrogen mass flow (in the following **ratio R**). As stated in the patent (paragraphs [0045] and [0047]), the hydrogen feed line volume relevant for the ratio R is the volume of the hydrogen feed line between the hydrogen flow controlling means and the entry into the polymerization reactor or into the mixing means wherein hydrogen and olefin monomer are mixed before entering the reactor whilst the hydrogen mass flow is that in this feed line portion.

1.2 All parties agreed that document O1, acknowledged as prior art in the patent description (paragraph [0006]), is a suitable starting point for the evaluation of inventive step.

O1 concerns in fact the same type of polymerization process of the patent and (page 3, lines 1-6) the provision of a process for controlling the concentration of hydrogen in the polymerization reactor and providing a polyolefin having improved compositional homogeneity and improved quality. Therefore, this document concerns indeed the same purpose as the patent.

1.2.1 The board thus takes O1 as the starting point for the evaluation of inventive step.

In particular, example A of O1 represents the closest prior art as it discloses a process wherein melt flow fluctuations of the resulting polymer are minimised (see page 15, line 20 to page 16, line 1 and figure 3A), thus already realizing the purpose of the patent in suit.

1.2.2 The closest prior art differs from the subject-matter of claim 1 as granted only insofar as the ratio R is not mentioned.

1.3 Example 1 of the patent shows that, by carrying out a polymerization similar to that of example A of O1, melt index fluctuations of the resulting polymer are minimised (figure 2 of the patent) in a similar way as in O1 (figure 3A) by carrying out the polymerization with an R value of 0.79 $lkg^{-1}h$, in accordance with the requirement of claim 1 at issue, which requires an upper limit for R of 5 $lkg^{-1}h$.

However, it is not in dispute that the patent does not show any improvement over the closest prior art.

Therefore, the technical problem underlying the invention can only be formulated as the provision of a further polymerization process for producing a polymer having good compositional homogeneity and quality through control of the hydrogen concentration in the reactor. The appellant also accepted this formulation of the technical problem.

1.3.1 In view of example 1 of the patent the board finds it credible that the above technical problem has been solved by the process of claim 1 at issue.

1.4 It remains thus to be decided if it was obvious for the skilled person to choose a ratio R according to granted claim 1 for providing a further process allowing control of the hydrogen concentration in the reactor and the production of a polymer having good compositional homogeneity and quality.

1.4.1 Document O1 does not contain any teaching concerning the selection of a suitable hydrogen feed line volume or mass flow of hydrogen.

However, it was known in the art that in this type of polymerization fluctuations in the hydrogen mass flow to the reactor were also a cause of inhomogeneity for the resulting polymer. In fact, several documents (O3: column 1, lines 3-15 and column 3, lines 48-53; O5: column 1, lines 63-71, column 2, lines 32-44 and column 5, lines 12-20; and O6: column 1, line 51-72 and column 7, lines 8-35) teach the necessity of controlling hydrogen mass flow to the reactor in order to ensure quality of the resulting product and that it is easier to control the hydrogen mass flow to the reactor and thus the feed composition than to control the hydrogen concentration directly in the liquid reaction mixture.

Since the polymer obtained by applying these controlling means is more homogenous, the means for controlling the feed composition which enters the reaction zone disclosed in these documents necessarily also control at least to a certain extent the hydrogen concentration in the reactor.

1.4.2 Therefore, the skilled person, faced with the technical problem posed, would have obviously implemented also these known means of process control taught in O3, O5 and O6 to the process disclosed in O1/example A in order to guarantee the homogeneity of the resulting product.

1.4.3 It is not in dispute in this respect that the control means mentioned in the above documents imply a minimisation of dead time (also called transportation lag), which is determined (O9, page 103, left column, lines 9-12) as the distance over which the material is transported (feed line length) divided by the velocity at which the material travels. The minimisation of dead time is according to common general knowledge (see for example O9, page 103, left column, lines 1-8 below 2.1(8)) indeed a desirable feature in process control as also explicitly stated in O3 (column 1, lines 3 to 7).

Since the minimisation of dead time implies a reduction of the distance between the control means and the reactor or the mixing points (in the present case of hydrogen and olefin monomer) and a reduction of this distance implies necessarily a reduction of the relative feed line volume, it also necessarily brings about a reduction of the ratio R.

Since the feed line length in consideration starts from the control means, the conclusion above applies even though the portion of the feed line which is reduced in minimising dead time does not exactly correspond to the feed line length considered in calculating the hydrogen feed line volume of R, as stated by the appellant. Therefore, a minimisation of dead time necessarily brings about a minimisation of the ratio R.

1.4.4 The board remarks also that the examples of the patent do not prove any criticality of the upper limit for the selected range of R since, as already found in the decision under appeal (page 12, point 3.5.3), they are not comparable with each other already because the production rates and thus the conditions existing in the reactor are not comparable with each other. Moreover, both parameters constituting the ratio R are varied in the examples of the patent, thereby rendering impossible to recognise, for example, if a variation of the feed line length/volume only (which also brings about a variation of R) affects the resulting polymeric product. The board remarks also that the comparative example 1 of the patent has an R value of 73, which is extremely distant from the upper limit according to granted claim 1, and thus is not representative for embodiments outside the scope of the claims but close to the claimed upper limit of R. Therefore, as found in the decision under appeal, the experimental data do not show the criticality of the claimed parameter R.

1.4.5 The appellant has additionally argued that the respondents have not shown that feed lines as short as those chosen in the patent would be common in the art. The board remarks, however, that in the absence of any criticality of the selected range for R, it was up to the appellant to show that this was indeed the case.

Moreover, the appellant's argument is manifestly flawed since the ratio R only partially limits the feed line length and section.
As a matter of fact, even when using the same mass flow of hydrogen used in the patent examples, the range of R values defining the claimed process also allows for combinations of lengths and sections of the hydrogen feed lines very different from and greater than those of the examples. Of course, such differences are even much larger when using substantially different mass flows of hydrogen.

1.4.6 The appellant argued additionally that the skilled person, faced with the technical problem posed, would not have considered the minimisation of dead time in a process as claimed which is allegedly carried out in steady state.

However, granted claim 1 is not limited to a process carried out in steady state and even the examples of the patent do not state that the exemplified processes are carried out without any means for controlling possible fluctuations of the feed concentration. The board thus cannot follow this argument from the appellant either.

1.4.7 The board remarks also that the alleged relationship of the ratio R with the speed of entry of hydrogen into the reactor and the bubble diameter of the gas inside the reactor, put forward by the appellant in writing only, is not supported by the description or by further evidence and cannot be directly derived from the ratio R. Therefore, also this argument has to be disregarded.

1.4.8 Since the upper limit of R is arbitrary, the board concludes that it was obvious for the skilled person, in the light of the cited prior art and of common general knowledge, to reduce dead time in the process of the closest prior art and thus to reduce correspondingly the feed line length and volume to such an extent to arrive without inventive skill to a value of R within the scope of claim 1 as granted. Such a modification is thus the result of a standard optimisation of the process of O1.

1.5 Claim 1 as granted thus lacks inventive step.

Admissibility of the auxiliary requests and of O16 and O17

2. Since, as explained below, it has also become immediately apparent to the board that all the auxiliary requests lack inventive step for the reasons exposed below there was no need to decide on their admissibility, nor on the admissibility of documents O16 and O17, filed by Respondent / Opponent 1.

Auxiliary request 1

3. Inventive step (Article 56 EPC) - Claim 1

3.1 Claim 1 of auxiliary request 1 differs from claim 1 as granted only insofar as the used catalyst is a single-site polymerization catalyst.

3.2 However, the process of the closest prior art, O1/ Example A, already includes the use of a supported metallocene catalyst which is a single-site polymerization catalyst. Therefore, this amendment does not distinguish further the claimed subject-matter.

3.3 Claim 1 thus lacks inventive step for the same reasons as those given for the main request.

Auxiliary request 2

4. Inventive step (Article 56 EPC) - Claim 1

4.1 Claim 1 of auxiliary request 2 differs from claim 1 as granted only insofar as hydrogen and olefin monomer are mixed before entering the reactor. Thus, the hydrogen feed line volume of ratio R is measured in this case between the hydrogen controlling means and the mixing means of hydrogen and olefin monomer.

4.2 The appellant argued that in such a process the calculation of the ratio R would be easier and that safety would be improved because the controlling means would not be too close to the reactor. However, none of these alleged advantages are mentioned in the patent.

Moreover, in the board's view it is not perceivable in which way the calculation of the ratio R would be rendered easier since the distances from the controlling means to the mixing means or to the reactor should both be equally known from the plant design.

Furthermore, claim 1 does not specify the length of the feed line after the mixing means (the volume of the feed line from the mixing means to the entry into the reactor not being part of the parameter R in the amended claim) which thus can be relatively short. Moreover, according to the patent (paragraph [0045]) a preferred lower limit for the ratio R is 0.0001 $l kg^{-1}$, a value implying a very small feed line volume or very short feed line length. Therefore, also in the process

of amended claim 1 the control means can still be very close to the reactor.

Therefore, these alleged advantages invoked by the appellant are not credible and not attainable anyway across the entire scope of claim 1. Hence they have to be disregarded.

4.3 Document O1 (page 11, line 20 to page 12, line 5 and passage bridging pages 12 and 13) already discloses that hydrogen and olefin monomer can be introduced into the reactor by means of the same feeding entry and thus that the two streams can be mixed before entering the polymerization reactor as required by auxiliary request 2.

Therefore, it was certainly obvious for the skilled person, faced with the technical problem posed, to apply this alternative to the process of example A.

Moreover, the same inventive step arguments as those given for the main request still apply to this request.

4.4 The board thus concludes that claim 1 of this request lacks inventive step.

Auxiliary request 3

5. Inventive step (Article 56) - Claim 1

5.1 Claim 1 of auxiliary request 3 differs from claim 1 as granted insofar as it contains both the amendments of auxiliary requests 1 and 2.

5.2 The appellant argued that the selected catalyst (already disclosed in O1/Example A) is very responsive

to hydrogen as stated in paragraph [0006] of the patent and that therefore the selection of R is especially important when using this type of catalyst and amounts to a further improvement over O1.

5.2.1 However, as remarked by the respondents, the patent does not comprise any comparison versus the closest prior art O1/Example A and an unexpected or synergistic effect arising from this combination of features, which are already disclosed or suggested in O1, has not been made credible by the appellant.

5.3 Since the additional features of this claim 1 are known or suggested in O1 as explained above, the board concludes that claim 1 of auxiliary request 3 is not inventive for the same reasons as those given for auxiliary requests 1 and 2.

Auxiliary requests 4A to 7B

6. For the same reasons given above the respective identical claims of auxiliary requests 4A to 7B also lack inventive step.

Order

For these reasons it is decided that:

The appeal is dismissed.

The Registrar: The Chairman:

A. Pinna P. Ammendola

Decision electronically authenticated