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Datasheet for the decision of 30 September 2020

Case Number: T 2310/17 - 3.3.03

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Language of the proceedings: EN

Title of invention:
POLYMERIZATION REACTIOR HAVING LARGE LENGTH/DIAMETER RATIO

Patent Proprietor:
CHEVRON PHILLIPS CHEMICAL COMPANY LP

Opponent:
Total Research & Technology Feluy

Relevant legal provisions:
EPC Art. 56

Keyword:
Inventive step (no) - all requests

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Case Number: T 2310/17 - 3.3.03

D E C I S I O N
of Technical Board of Appeal 3.3.03
of 30 September 2020

Appellant: (Patent Proprietor)	CHEVRON PHILLIPS CHEMICAL COMPANY LP 10001 Six Pines Drive The Woodlands, TX 77380 (US)
Representative:	Abel & Imray Westpoint Building James Street West Bath BA1 2DA (GB)
Respondent: (Opponent)	Total Research & Technology Feluy Zone Industrielle C 7181 Seneffe (BE)
Decision under appeal:	**Decision of the Opposition Division of the European Patent Office posted on 4 August 2017 revoking European patent No. 1543041 pursuant to Article 101(3)(b) EPC.**

Composition of the Board:

Chairman	D. Semino
Members:	F. Rousseau
	A. Bacchin

Summary of Facts and Submissions

I. The appeal lies from the decision of the opposition division posted on 4 August 2017 revoking European patent No. 1 543 041. The contested decision was based on the documents of the patent as granted as the main request, on an auxiliary request 1 submitted with letter of 21 February 2017 and on auxiliary requests 2 to 4 submitted during the oral proceedings on 5 July 2017.

II. Claims 1 and 11 of the patent as granted read as follows:

"1. A charged polymerization loop reactor comprising:
a loop reaction zone defined by a generally cylindrical wall having a nominal outside diameter of at least 22 inches (56 cm), wherein the length of the loop reaction zone and the nominal outside diameter of the generally cylindrical wall define a length / diameter ratio of at least 1000,
a continuous take off for continuously withdrawing a fluid slurry from said loop reaction zone; and
a fluid slurry disposed in said loop reaction zone, the slurry comprising at least one olefin monomer reactant, solid olefin polymer particles, and a liquid diluent, wherein a concentration of the solid olefin polymer particles in the slurry is greater than 40 weight percent based on the weight of the polymer particles and the weight of the liquid diluent."

11. A polymerization loop reactor comprising:
a loop reaction zone defined by a generally cylindrical wall having a nominal outside diameter of at least 22

inches (56 cm), wherein the length of said loop reaction zone and the nominal outside diameter of said generally cylindrical wall define a length/ diameter ratio greater than 1000, and
a continuous take off for continuously withdrawing the fluid slurry from said loop reaction zone."

III. The following document was inter alia cited in support of the opposition:

D2: EP 0 891 990 A2.

IV. According to the reasons for the contested decision which are relevant for the present decision, D2 represented the closest prior art for the purpose of assessing inventive step, reference being made to Figures 1, 2 and 8 to 10 and the passages on page 2, lines 37-38, page 2, lines 46-47 and page 3, lines 20-21 of that document. The polymerization loop reactor defined in claim 11 of the main request differed from that disclosed in D2 in that the length of the loop reaction zone and the nominal outside diameter of the generally cylindrical wall had a length/diameter ratio (hereafter L/OD ratio) greater than 1000. The problem effectively solved by the polymerization loop reactor of claim 11 over that described in D2 was merely to provide a loop reactor for olefin polymerization having improved cooling efficiency. The alleged, but not supported by evidence, additional benefit that the claimed loop reactor presented an improved versatility was not retained for the formulation of the objective problem. The solution to said problem, namely increasing for a given overall capacity of the loop reactor the length of said reactor in order to increase its surface area and therefore the heat transfer during polymerisation was an obvious measure for the skilled person. Moreover, the general teaching of D2 did not discourage the skilled person from arbitrarily selecting a L/OD ratio greater than 1000. Thus, the loop reactor in accordance with claim 11 as granted did not involve an inventive step. The main request was therefore not allowable. The insertion of the additional features in auxiliary requests 1 and 2 defining the use of an impeller driven by a motor and a L/OD ratio of greater than 1300, respectively, did not overcome the finding in respect of the main request that its subject-matter lacked an inventive step. The same applied to auxiliary request 3 which contained both additional features. Auxiliary request 4 corresponded to the claims as granted restricted to the slurry comprising ethylene as the olefin monomer to produce a polyethylene homopolymer, claim 11 being deleted. Since D2 also described the preparation of a polyethylene homopolymer, an inventive step was also not present for the subject-matter of auxiliary request 4 in view of the same reasons.

V. The patent proprietor (appellant) lodged an appeal against the above decision and filed with the statement of grounds of appeal submitted with letter of 13 December 2017 four sets of claims as auxiliary requests 1 to 4 whose claims 1 defined:

Auxiliary request 1

A charged polymerization loop reactor as in claim 1 of the main request which in addition was defined to comprise "an impeller driven by a motor, the impeller and the casing surrounding the impeller having a diameter greater than the general diameter of the cylindrical wall forming the reactor".

Auxiliary request 2

A charged polymerization loop reactor as defined in claim 1 of the main request, wherein the L/OD ratio was no longer of at least 1000, but of at least 1300.

Auxiliary request 3

The charged polymerization loop reactor defined in claim 1 of the main request.

Auxiliary request 4

The charged polymerization loop reactor defined in claim 1 of the main request, whose definition had been restricted by incorporating the amendments inserted in both auxiliary requests 1 and 2.

VI. In preparation of oral proceedings the Board issued a communication dated 8 July 2020 including a preliminary opinion *inter alia* on inventive step starting from the disclosure of D2 as the closest prior art. Oral proceedings before the Board were held by videoconference on 30 September 2020.

VII. The appellant's and respondent's submissions, in so far as they are pertinent, may be derived from the reasons for the decision below.

VIII. The appellant requested that the decision of the opposition division be set aside and the patent be maintained unamended, i.e. the opposition be rejected (main request), or, in the alternative, that the decision of the opposition division be set aside and the patent be maintained on the basis of one of the sets of claims filed as auxiliary requests 1 to 4 submitted with the statement of grounds of appeal on 13 December 2017.

IX. The respondent requested that the appeal be dismissed.

Reasons for the Decision

Main request

1. The sole point in dispute on appeal in respect of the main request was inventive step.

Closest prior art

2. D2 describes a polymerization process in a loop reactor of at least one olefin monomer in a liquid diluent to produce a fluid slurry comprising said liquid diluent and solid polyolefin polymer particles, whereby a concentration of the solid polyolefin particles in the slurry in the loop reaction zone of greater than 40 weight percent based on the weight of the polyolefin particles and the weight of the liquid diluent is maintained, the slurry being continuously withdrawn from the reactor (claim 1; page 3, lines 13-21 and 25-42). By common consent between the parties the charged polymerization loop reactors described in D2 represent the closest prior art and the Board has no reason to take a different view.

Two loop reactors used for the process of D2 and shown in Figures 1 and 9 thereof are represented below:

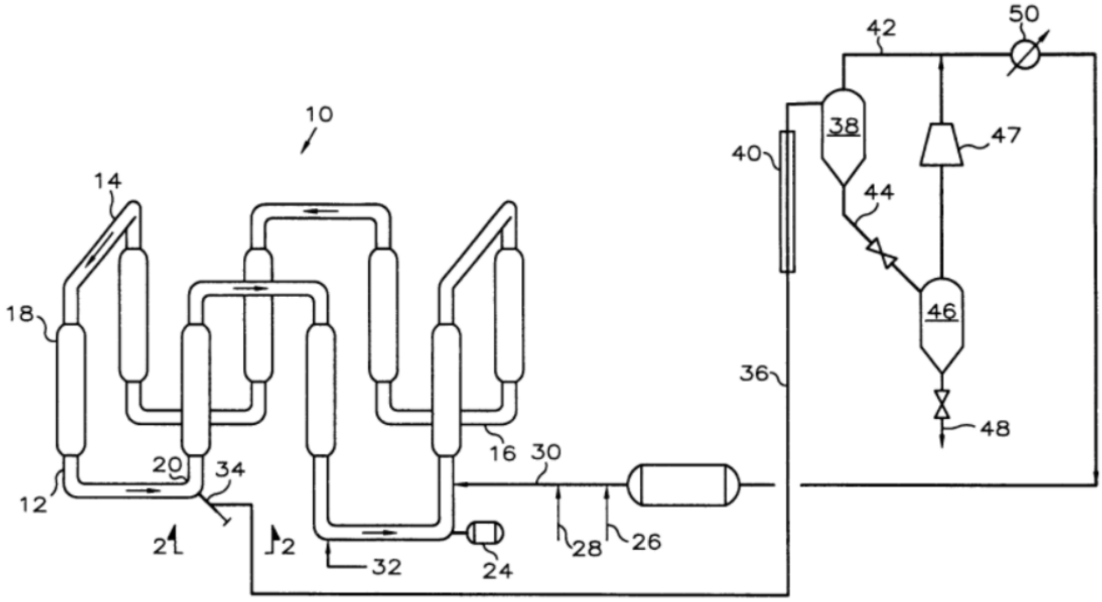

FIG. 1

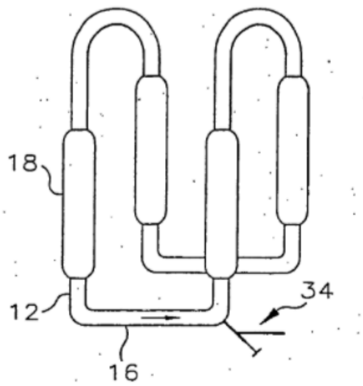

FIG. 9

A detailed description of these reactors is given from page 3, line 50 to page 4, line 40 of D2 referring to Figures 1 to 3 and from page 5, line 18 to page 5, line 38 reference being made to Figures 8 and 9. These figures are identical to Figures 1 to 3, 8 and 9 of the patent in suit and the explanations thereof provided in D2 are essentially the same as those provided in the present specification (paragraphs [0020], [0023], [0027] to [0034] and [0042] to [0044]).

In particular, the loop reactor depicted in Figure 1 has vertical segments **12**, upper horizontal segments **14** and lower horizontal segments **16.** These upper and lower horizontal segments define upper and lower zones of horizontal flow. Each segment is connected to the next segment by a smooth bend or elbow **20** thus providing a continuous flow path substantially free from internal obstructions (page 3, lines 50-54). The loop reactor represented in Figure 9 also comprises vertical segments **12** and lower horizontal segments **16**, the upper segments being 180 degree half circles.

The continuous take off mechanism which is at the core of the invention described in D2 is indicated in Figures 1 and 9 by reference sign **34**, detailed thereof being shown in Figures 2 and 3. It replaces the settling legs employed in the art prior to D2 to recover the olefin polymer. Its use allows in comparison to settling legs to increase the solid concentration in the reactor, while avoiding at the same time the various drawbacks associated with the use of settling legs (page 2, lines 14-30 and page 3, lines 13-21). Moreover, according to page 3, lines 54-55, the polymerization mixture is circulated by means of an impeller **22** driven by a motor **24** shown in Figure 8 which figure is represented below:

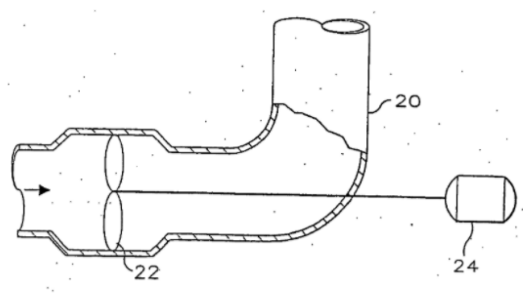

FIG. 8

Furthermore, the features of granted claim 1 that the loop reaction zone has a generally cylindrical wall and a nominal outside diameter of at least 22 inches (56 cm) are also disclosed in D2 on page 5, lines 36-37 describing an internal diameter of about 21.9 inches for the reactors, which undisputedly implies a nominal outside diameter of at least 22 inches, the cylindrical shape of the reactor wall being also shown in Figure 8.

3. It was also a matter of consensus that the only feature of granted claim 1 which is not disclosed in D2 and therefore constitutes a distinguishing feature over the closest prior art is a L/OD ratio of at least 1000. In this respect also the Board has no reason to have a different opinion. Referring to the reactor depicted in Figures 1 and 9 and to a nominal outside diameter of two feet D2 describes on page 5, lines 36 to 38 a flow length generally greater than 500 feet, generally greater than 900 feet, with about 940 to 1,350 feet being quite satisfactory, corresponding to reactors having L/OD ratios greater than 250, greater than 450 and having values ranging from 470 to 675.

Problem successfully solved

4. Having regard to the closest prior art, the appellant and the respondent took differing positions as to which problem could be considered to be successfully solved by the loop reactor of operative claim 1. Relying on the data shown in the Table on page 3 of the opponent's letter of 14 July 2016, the appellant argued that the problem successfully solved over the closest prior art was the provision of a loop reactor which allowed the production of polymers on a greatly increased scale while at the same time also allowing the heat generated by the polymerization reaction to be used more

effectively elsewhere in the polymer production process. As to the respondent, the problem successfully solved over the closest prior art was viewed as to merely reside in the provision of an alternative reactor.

4.1 Concerning the appellant's argument that the claimed charged reactor would allow the heat generated by the polymerization reaction to be used more effectively elsewhere in the polymer production process, this allegation is based on the thermodynamic principle that a heating fluid at a higher temperature is more useful and efficient than a heating fluid at a lower temperature in downstream processing operations used in a polymerization plant, such as treatment of the polymer in the purge columns to remove residual diluent and heating of the polymer fluff going into the extruder for pelletizing, which processing operations require heat energy (appellant's written submissions dated 30 July 2020, page 2, 4th to 6th full paragraphs). Whereas the patent in suit addresses in paragraphs [0055] to [0057] the advantage of increasing the L/OD ratio in terms of increasing the rate of heat transfer and therefore the efficiency of the cooling, the patent in suit is not concerned with a more effective use of the heat generated by the polymerization reaction, but rather with the possibility to produce more efficiently heat transfer limited resins as indicated in said paragraph [0057]. Already on that basis a reformulation of the problem solved taking into account an alleged more effective use of the heat generated by the polymerization reaction elsewhere in the polymer production process, which effect is not hinted at in the specification is not allowable in accordance with established case law (Case Law of the Boards of Appeal of the European

Patent Office, 9th edition, 2019, I.D.4.4.1 and I.D. 4.4.2).

4.2 The appellant also argued that the solution to the problem of producing polymers on a greatly increased scale while at the same time also allowing the heat generated by the polymerization reaction to be used more effectively elsewhere in the polymer production process involved balancing many factors including the likelihood of plugging the reactor, pump power, the saltation behaviour of the slurry, the thickness of the reactor walls, and the temperature of the cooling fluid, which factors had been neglected by the opposition division focusing only on the cooling efficiency, as represented by a simple surface area to volume ratio, taking thereby an overly simplistic view, which pointed towards the claimed process (letter of 30 July 2020, first paragraph of page 5). Noting the absence of any feature concerning these other factors in claim 1, even implicitly, those are not part of the claimed solution, and accordingly this very argument by the appellant confirms that the reactor of operative claim 1 cannot credibly solve the problem formulated by that party at least in respect of a more efficient use of the heat generated by the polymerization reaction elsewhere in the polymer production process.

4.3 Concerning the provision of a loop reactor which allows the production of polymers on a greatly increased scale, the minimum volume of the loop reactor of operative claim 1 can be estimated based on the L/OD ratio of at least 1000 and the minimum outside diameter of 22 inches (corresponding to a minimum reactor internal diameter of 20,72 inches as indicated in Table 1 on page 7 of the specification) defined in operative claim 1. This minimum volume is about 124 m^3. This minimum value can be compared with the volumes resulting from the flow lengths recommended on page 5, lines 32-38 of D2 for the reactors of the type shown in Figures 1 and 9, i.e. generally greater than 500 feet, generally greater than 900 feet, with about 940 to 1,350 feet being quite satisfactory, and the sole internal diameter of about 21,9 inches described in this context. On that basis the reactor volumes implicitly disclosed in D2 for the type of reactors shown in Figures 1 and 9 are greater than 37 m^3, generally greater than 67 m^3, with about 70 m^3 to 100 m^3 being quite satisfactory (said volumes are indicated in Table 5 of the patent in suit, rows 1, 3, 5 and 9 for reactors having the corresponding lengths and diameter).

4.4 Concerning the relationship between the reactor volume and the mass of polymer produced with said reactor, it does not only belong to the common general knowledge, but it is also self evident, that an increase of the reactor volume allows all other things being equal the production of olefin polymers on a increased scale. On that basis, and despite the appellant's view that it would be required in order to solve the problem formulated by the appellant to balance many factors including the likelihood of plugging the reactor, pump power, the saltation behaviour of the slurry, the thickness of the reactor walls, and the temperature of the cooling fluid which as indicated above are not part of the claimed solution, it it is nevertheless considered to the benefit of the appellant that the charged polymerization loop reactor of operative claim 1 in view of its increased volume compared to the loop reactors shown in Figures 1 and 9 of D2 successfully solves the problem of allowing the production of polymers on an increased scale.

4.5 Consequently, it follows from the above that the problem successfully solved over the closest prior art by the subject-matter of claim 1 is to be formulated as the provision of charged polymerization loop reactor allowing the production of polymers on an increased scale.

Obviousness of the solution

5. It remains to be decided whether the skilled person desiring to solve the problem identified above would, in view of the disclosure of D2, possibly in combination with other prior art, including common general knowledge, have modified the loop reactor of the closest prior art in such a way as to arrive at the reactor of operative claim 1.

5.1 Based on the relation between the volume of a polymerization reactor and the amount of polymers which can be produced therein which is known to the skilled person as mentioned in above point 4.4, the skilled person faced with the above problem would have found obvious to increase the volume of the reactor. Moreover, it was undisputed that the skilled person would have found obvious that an increase of the volume of the loop reactor could be achieved by increasing either the diameter or the length of the reactor. The appellant, however, argued that the skilled person would have found in D2 the suggestion to rather increase the diameter of the reactor pipes, but not their length, once the limitation of the maximum diameter of the pipe which resulted from the limited space available for settling legs in the prior art constituting the starting point for the invention of D2 had been suppressed when using a continuous take off mechanism.

The Board notes that, whereas increasing the diameter of the pipe certainly would have constituted an obvious solution to the problem defined in above point 4.5, the skilled person would also have found the explicit teaching in the passage on page 5, lines 32-38 of D2 concerning the reactors shown in Figures 1 and 9 to increase the length of the loop reactor. According to this passage "*any number of loops* (loops to be understood in view of Figures 1 and 9 as vertical segments represented in said figures as indicated in the last full paragraph on page 9 of the Board's communication of 8 July 2020, which was not disputed by the parties) *can be employed in addition to the four depicted here* (Figure 9 being meant) *and the eight depicted in Fig. 1, but generally four or six are used".* It would have been also obvious to the skilled person in view of the reactor configuration shown in Figures 1 and 9 of D2 that the addition of a given number of vertical segments was to be accompanied by the addition of a corresponding number of horizontal segments. Moreover, the Board agrees with the respondent's opinion that the addition of further horizontal and vertical segments would have represented a more tempting solution for the skilled person, as it would only necessitate for the skilled person to use the same vertical and horizontal segments, whereas the use of pipes having an increased diameter would also have necessitated to change other parts of the reactor such as the pump impeller(s) needed for continuously moving the slurry along its flow path.

5.2 In respect of said pump impeller, whose mechanism is shown in Figure 8, D2 teaches on page 5, lines 23-26 that the pressure differential needed for continuously circulating the slurry in the loop reactor can be achieved by controlling the speed of rotation of the impeller, reducing the clearance between the impeller and the inside wall of the pump housing or by using a more aggressive impeller design as was known in the art at the publication date of D2. It is also added in this passage of D2 that the higher pressure differential can also be produced by the use of at least one additional pump, which in the context of said passage and in the light of the passage of D2 on page 5, lines 44-46 concerning the Examples of D2 suggests the use of at least one additional impeller 22 / motor 24 combination, if needed. On that basis the skilled person would have found obvious using the means suggested in D2 to use additional horizontal and vertical segments in order to solve the problem defined in above point 4.5, and if needed to achieve an appropriate continuous circulation of the slurry in the loop reactor by adding at least one additional pump.

5.3 Moreover, the indication on page 5, lines 37-38 in the context of the reactors of the type depicted in Figures 1 and 9 that a flow length from about 940 to 1350 feet for a nominal two foot outside diameter (corresponding therefore to a L/OD ratio of 470 to 675 as indicated in above point 3), is quite satisfactory, is consistent with the indication on page 5, lines 35-36 that generally four or six vertical and horizontal segments each are used and the recommendation on page 5, lines 34-35 for the length of each of the vertical and horizontal segments, namely 190 - 225 feet and 25 - 30 feet, respectively. This suggests for the loop reactor depicted in Figure 1 having eight vertical and horizontal segments each a L/OD ratio of about 900. Accordingly, following the suggestion on page 5, lines

35-36 of D2 to add any number of vertical segments in addition to the eight depicted in Figure 1 and the fact that the selection of the L/OD ratio defined in operative claim 1 corresponding to a minimum volume of the reactor is arbitrary in the sense that it is not associated to a particular effect beyond that of increasing the capacity of the reactor as indicated in above points 4.1 to 4.5, the skilled person would have found obvious within the limits of the technical means available to him/her to add two or more vertical and horizontal segments each, leading to a reactor having a L/OD ratio of at least about 1125, i.e. a charged reactors according to operative claim 1.

5.4 The appellant's argument that the addition of further loops (to be understood as vertical segments as already noted in above point 5.1) taught in D2 did not refer to the addition of vertical and horizontal segments of the same dimension, but rather to the possibility of using a larger number of segments/loops of shorter length for the same total flow length of 940 to 1350 feet recommended in D2 is not persuasive. This interpretation is first of all not supported by any explicit indication in D2 (none was cited by the appellant), but secondly also in contradiction with the apparent teaching provided on page 5, lines 32-38 of D2. As already indicated in above point 5.3, the number of vertical and horizontal segments, generally four or six, of the dimension specified in that passage is consistent with the lower and upper limit of the flow length from about 940 to 1350 feet indicated to be quite satisfactory. This rather suggests that the horizontal and vertical segments to be added to the four depicted in Figure 9 and the eight depicted in Figure 1 are of the same length, resulting thereby in an increase of the total flow length and of the L/OD ratio, i.e. in a reactor having a more elongated shape as formulated by appellant.

5.5 As to whether the skilled person would have been able on basis of the technology existing at the date of priority of the patent in suit to obtain a functioning process when increasing the L/OD ratio to a value of 1125 or more, it is noted that the means described in D2 and in the patent in suit to achieve circulation of the slurry, i.e. an impeller 22 (shown in Figure 8) driven by a motor 24 are identical, this feature being described in the patent in suit as particularly desirable where the loop reactor has a high L/OD ratio. Moreover, the same pumps (Lawrence Pumps Inc. pump impeller D51795/81-281 in a M51879/FAB casing) are used in the examples of D2 and in those of the specification. The appellant's argument that the skilled person would have been taught away to use a higher L/OD ratio fearing that it would result in clogging of the reactor is not supported by evidence, in particular the disclosure of D2 in which the use of additional pump(s) is even recommended if necessary (see above point 5.2). It was also not indicated, let alone evidence provided in this respect, that other technical means going beyond those which were known to the skilled person at the date of priority of the patent in suit or an undue amount of experimental work would constitute technical hindrance to the achievement of a loop reactor as defined in operative claim 1.

5.6 Accordingly, the skilled person starting from the teaching of D2 and seeking to provide a charged loop reactor which allowed the production of polymers on a greatly increased scale would have found in D2 the suggestion to increase the length of the reactor by adding to the reactor depicted in either Figure 1 or

Figure 9 horizontal and vertical legs of the same type as those already disclosed in D2, arriving thereby in an obvious manner at subject-matter falling within the ambit of present claim 1.

6. Consequently, the subject-matter of claim 1 of the main request does not involve an inventive step and this request cannot be allowed.

Auxiliary request 1

7. The charged polymerization loop reactor according to claim 1 of auxiliary request 1 differs from that defined in claim 1 of the main request in that it comprises an impeller driven by a motor, the impeller and the casing surrounding the impeller having a diameter greater than the general diameter of the cylindrical wall forming the reactor. This feature, however, is already part of the closest prior art as indicated in above point 2 with the consequence that the analysis and the conclusion provided with respect to claim 1 of the main request also applies to claim 1 of auxiliary request 1. Accordingly, auxiliary request 1 is not allowable either.

Auxiliary request 2

8. The charged polymerization loop reactor according to claim 1 of auxiliary request 2 differs from that of claim 1 of the main request in that the L/OD ratio is defined to have a higher value, namely at least 1300 instead of at least 1000. The definition of such higher ratio does not result in a different assessment of the question whether claim 1 involves an inventive step, the reasons provided in respect of the main request in above points 2 to 5.6 being also applicable to the

subject-matter of claim 1 of auxiliary request 2. This is because a minimum for the L/OD value of 1300 is also not associated with any technical effect beyond that of increasing the capacity of the reactor, for the same reasons as those indicated in above point 5.3, and because such increase of the L/OD ratio would have been arrived at by the skilled person in an obvious manner by adding for example four vertical and horizontal segments as described on page 5, lines 34 to 36 of D2 to those of the reactor depicted in Figure 1 of that document, suggesting the use of a reactor having a L/OD ratio of about 1350. Despite arguing that such ratio was considerably different from those described in D2, resulting in a completely different scale which might necessitate to overcome additional challenges compared to the provision of a reactor as defined in the main request, the appellant did not contest that the skilled person based on the technology available at the date of priority of the patent in suit, in particular the teaching of D2 concerning the use of at least one additional pump, would be able without exercising inventive ingenuity to obtain a charged polymerization loop reactor in accordance with claim 1 of auxiliary request 2. Therefore, the subject-matter of auxiliary request 2 does not involve an inventive step either and as a consequence auxiliary request 2 is not allowable.

Auxiliary request 3

9. The charged polymerization loop reactor of claim 1 of auxiliary request 3 is that defined in claim 1 of the main request. That charged polymerisation loop reactor is not inventive on the grounds provided in above points 2 to 6. Accordingly, auxiliary request 3 must also fail.

Auxiliary request 4

10. The charged polymerization loop reactor defined in claim 1 of auxiliary request 4 differs from that defined in auxiliary request 2 in that it comprises in addition an impeller driven by a motor, the impeller and the casing surrounding the impeller having a diameter greater than the general diameter of the cylindrical wall forming the reactor. This feature, however, is already part of the closest prior art as indicated in above point 2 with the consequence that the analysis and the conclusion provided with respect to claim 1 of the auxiliary request 2 also apply to claim 1 of auxiliary request 4. Accordingly, auxiliary request 4 is not allowable.

Order

For these reasons it is decided that:

The appeal is dismissed.

The Registrar: The Chairman:

Beschwerdekammern des Europäischen Patentamts · Boards of Appeal of the European Patent Office · Chambres de recours de l'Office européen des brevets

B. ter Heijden D. Semino

Decision electronically authenticated