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D E C I S I O N
of 12 July 1995

Case Number: T 0237/93 - 3.3.3

Application Number: 83105889.6

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Title of invention:
Bulk polymerization process

Patentee:
S.C. JOHNSON & SON, INC.

Opponent:
BASF Aktiengesellschaft, Ludwigshafen

Headword:
-

Relevant legal provisions:
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"Inventive step - (affirmed)"

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Boards of Appeal

Chambres de recours

Case Number: T 0237/93 - 3.3.3

D E C I S I O N
of the Technical Board of Appeal 3.3.3
of 12 July 1995

Appellant:
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Representative: -

Decision under appeal: Decision of the Opposition Division of the
European Patent Office dated 9 December 1992,
issued in writing on 5 January 1993 revoking
European patent No. 0 096 901 pursuant to
Article 102(1) EPC.

Composition of the Board:

Chairman: C. Gérardin
Members: R. Young
W. M. Schar

Summary of Facts and Submissions

- I. The mention of the grant of European patent No. 0 096 901, relating to a bulk polymerisation process for preparing enhanced yields of high solids, low molecular weight vinylic polymer product having a narrow molecular weight distribution and a low chromophore content, in respect of European patent application No. 83 105 889.6, filed on 15 June 1983 and claiming a US priority of 15 June 1982 (US 388 764) was announced on 13 December 1989 (cf. Bulletin 89/50).
- II. Notice of Opposition was filed on 13 September 1990 on the grounds of lack of novelty and lack of inventive step. The opposition was supported inter alia by the documents:
- D1: DE-A-2 502 172;
D2: DE-A-2 728 459; and
D3: DE-A-2 534 603;
- III. The Opposition Division considered the patent in suit ultimately in the form of three requests, namely, a main request, a first auxiliary request and a second auxiliary request, each having 22 claims.

Claim 1 of the first auxiliary request, which is of relevance for the subsequent appeal, reads as follows:

"Bulk polymerization process for preparing enhanced yields of high solids, low molecular weight vinylic polymer product having a narrow molecular weight distribution and a low chromophore content comprising the steps of continuously:

(a) charging into a continuous stirred reactor zone containing a molten resin mixture;

(i) a mixture of vinyl monomers comprising at least one monoalkenyl aromatic monomer and at least one acrylic monomer;

(ii) a polymerization initiator in amounts to provide a molar ratio of said initiator to said mixture of vinyl monomers from 0.0005: to 0.04:1;

(iii) from 0 to 25% based on the weight of vinyl monomers of a reaction solvent, wherein said molten resin mixture comprises unreacted vinylic monomers and the vinylic polymer product;

(b) maintaining a flow rate through said reaction zone sufficient to:

(i) provide a residence time of said charged vinylic monomer mixture in said reaction zone of from 2 minutes to 1 hour; and

(ii) maintain a predetermined level of reaction mixture in said reaction zone, and;

(c) maintaining the molten resin mixture at a reaction temperature of from 180°C to 270°C, subject to the proviso that if the reaction temperature is in the range 180°C to 215°C, then said molten resin mixture includes a reaction solvent, the reaction temperature being sufficient to provide accelerated conversion to a readily processable, uniform, concentrated polymer product."

Claims 2 to 22 of this request correspond to Claims 2 to 22 as granted. They are dependent claims relating to embodiments of the process according to Claim 1.

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IV. By a decision which was given at the end of oral proceedings held on 9 December 1992 and issued in writing on 5 January 1993, the Opposition Division revoked the patent, because it considered that the subject-matter of Claim 1 did not involve an inventive step in any of the three requests.

According to the decision insofar as it related to the first auxiliary request, the closest state of the art was D2, in which the process exemplified differed from that according to Claim 1 only in that the vessel was not "stirred", and in the use of "solvent" if the temperature was 180° to 215°C. Since, however, the use of a stirred reactor as well as of a solvent were matters of normal design procedure which did not provide any unexpected advantages or benefits, the use of a stirred reactor in any case being known from D1 and D3, and of a solvent from D1, D2 and D3, the skilled person would have regarded their inclusion as normal (Reasons for the decision, paras. 14.3, 14.4 in the context of para. 14.1).

Consequently, the subject-matter of Claim 1 did not involve an inventive step.

V. On 4 March 1993, a Notice of Appeal against the above decision was filed, together with payment of the prescribed fee.

In the Statement of Grounds of Appeal filed on 13 May 1993 and a subsequent submission filed on 27 December 1994, the Appellant (Patentee) argued in substance as follows:

- (i) The process exemplified in D2 was not continuous, but a batch process (Grounds of Appeal, pages 1, 2).

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(ii) Although some kind of agitation was admittedly necessary in D2 (see minutes of oral proceedings before the Opposition Division), the "design possibility" of a pressure vessel fitted with a stirrer, known from D1 and D3, was just one of a variety of possibilities, and then in combination with a process for the production of a completely different kind of polymer. Such a reactor would in any case not produce the same polymer as D2 (Grounds of Appeal, page 3, fourth and fifth complete paras.).

(iii) There was no teaching to modify the process of D2 to be continuous. Even if this modification were carried out, the product would not be "uniform" as required by Claim 1, due the presence of a "static mixer", which would have prevented the latter functioning as a "continuously stirred reactor zone", as was demonstrated by the tests in an experimental report (Grounds of Appeal, page 3, para. 2; and Annex IV, and submission filed on 27 December 1994, Annex).

In order to support the submissions as to the importance of the precise kind of mixing in the reactor on the polymer characteristics, the Appellant referred, in the Statement of Grounds of Appeal, for the first time to three additional documents, in particular:

D9: Penlidis, A., Wood, P.E., "Polymer Reaction Engineering Course, Principles of Polymer Reaction Design and Operation" (Chapter 6), McMaster Institute for Polymer Production Technology, Hamilton, Ontario, Canada, May 1990.

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VI. The Respondent (Opponent) argued in substance as follows:

- (i) Whilst disagreeing with the finding of the decision under appeal that the "design possibilities" for mixing could include rocking or shaking (cf. decision under appeal, para. 13.1), since this would interfere with a controlled feed to and from the reactor, a disclosure of "stirring" was nevertheless inherent for the skilled person (submission filed on 26 November 1993, page 2, first two paras).
- (ii) The use of solvent was also generally taught in D2, so the combination of this feature with a temperature range in Claim 1, without excluding its use over the rest of the range, could not confer novelty (submission filed on 26 November 1993, page 2, third to sixth paras.).
- (iii) The argument that it was not obvious to carry out the process of D2 continuously was refuted because Example A (II) of D2 was continuous (submission filed on 26 November 1993, page 3, first two paras.).
- (iv) The tests provided by the Appellant fell within the terms of Claim 1 of the patent in suit. The product produced in the stirred reactor/tube reactor combination with the static mixer, however, had a lower molecular weight and a narrower distribution than that produced in the stirred reactor alone, thus indicating the benefits of a static mixer, although the results

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of all the tests were of the same order
(submission filed on 26 November 1993, page 4,
first four paras.).

- (v) The tests in any case showed that stirring was indispensable, both to dissipate heat to the walls of the vessel, and also to produce a relatively homogeneous product with a narrow molecular weight distribution, whereby the stirring speed could be increased if the chosen rate were insufficient. The skilled person would have known what measures were necessary to deal with heat transfer problems arising from the processes of D1 to D3 (submission filed on 26 November 1993, pages 4, 5; points 1, 2 and 3).

VII. With a submission filed on 21 June 1995, the Appellant requested certain (minor) amendments to the description of the patent in suit.

VIII. Oral proceedings were held before the Board on 12 July 1995. During the oral proceedings, the Appellant relied, as main request, upon the claims of the first auxiliary request considered by the Opposition Division (cf. Section III., above), and filed a description adapted thereto, as well as a further set of claims forming an auxiliary request.

IX. The Appellant requested that the decision under appeal be set aside and the patent be maintained on the basis of Claim 1 as filed, as first auxiliary request, on 13 May 1993 (see Section III., above) and Claims 2 to 22 as granted, and the following description: pages 2, 5, 6, 8, 10 to 21 as granted and pages 3, 4, 7 and 9 as submitted during oral proceedings (main request),

or on the basis of Claim 1 as filed during the oral proceedings and Claims 2 to 22 as granted (auxiliary request).

The Respondent requested that the appeal be dismissed.

Reasons for the Decision

1. The appeal is admissible.
2. *New documents*

The document D9, cited by the Appellant, is of a neutral, factual nature to corroborate facts, evidence and arguments already forming part of the proceedings. Nothing stands against its being considered.

- A. Main request

3. *Allowability of amendments*

No objection to the amendments was raised under Article 123 EPC by the Respondent. Nor does the Board see any such objection. In particular, Claim 1 is supported by Claims 1 and 8 and the description on page 9, line 17 and page 7, lines 57 to 59 as granted (Claims 1 and 9 and the description on page 19 at lines 6 to 10 and page 23, line 21 as filed). Claims 2 to 22 correspond to Claims 2 to 22 as granted. The amendments to the description are adaptive to the claims, minor in extent, and such as the Board might in any case have required.

Consequently, the amendments are allowable under Article 123 EPC.

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4. *Interpretation of Claim 1*

Of particular significance for the outcome of the appeal is the meaning to be attached to the term "continuous stirred reactor zone" (hereinafter CSTR) in Claim 1 of the patent in suit.

4.1 According to the Appellant at the oral proceedings, "CSTR" is a term of art.

4.2 This submission is supported by the document D9, which is the text of a university course in polymer reaction engineering, according to which CSTR reactors had been used for commercial production of polymers such as SBR and polychloroprene "for many years" (page 31).

4.3 Although D9 was not published until after the priority date of the patent in suit, it is evident from the historical perspective of the above citation, in particular the reference to "many years" that the term "CSTR" would have been known to the skilled person at the relevant date.

4.4 The term "CSTR" is, according to the Appellant, to be interpreted as defining a particular mixing profile providing a zone of composition with no concentration or temperature gradients, and in which back mixing is essential (submission filed on 27 December 1994, pages 3 and 4).

The instantaneous achievement of uniformity of reaction conditions provided by this kind of mixing was explained at the oral proceedings as being an important factor in achieving uniformity in the molecular weight of the product, the entry of

relatively cool monomer composition serving to offset the exothermic nature of the reaction, as described in the patent in suit (page 9, lines 48 to 51).

- 4.5 The Respondent did not dispute the information about the CSTR - i.e. how such a reactor works and the advantages it provides, and the Board equally has no reason to object to it.

Consequently, the term "CSTR" will be interpreted by the Board in the sense given in Section 4.4, above.

5. *The closest state of the art; the technical problem*

- 5.1 The patent in suit is concerned with a bulk polymerisation process for preparing a high solids, low molecular weight vinylic polymer product having a narrow molecular weight distribution and a low chromophore content (page 2, opening para.).

- 5.1.1 The narrowness of the molecular weight distribution may be measured in terms of the polydispersity ratio (M_w/M_n , W/N or ratio of weight average molecular weight to number average molecular weight), products having the same average molecular weight, but having a different molecular polydispersity possessing different solution viscosities. The product with the higher polydispersity always has a higher solution viscosity, because high molecular weight fractions make a significantly greater contribution toward viscosity than low molecular weight fractions (page 2, lines 29 to 34).

- 5.1.2 Additionally, it may be measured in terms of the distribution index (M_z/M_n or Z/N , where M_z is the sedimentation average molecular weight), the latter index giving a more specific measure of the number of

molecules in the higher weight fractions of the molecular weight range, whereby products with a higher distribution index will exhibit higher solution viscosities and less desirable application properties (page 2, lines 35 to 42).

5.1.3 The bulk polymerisation process is carried out using vinylic monomers comprising at least one monoalkenyl aromatic monomer and at least one acrylic monomer, in the presence of small quantities of initiators (to provide a molar ratio of the initiator to the mixture of vinyl monomers from 0.0005 to 0.04:1) at a reaction temperature of from 180° to 270°C (Claim 1).

5.2 Such a process is, however, known from D2, which is considered, in keeping with the views of both parties, to represent the closest state of the art.

According to D2, low-solvent stoving enamels, having improved processing and application qualities (page 3, penultimate para.), consist essentially of

- (A) acrylic resin,
- (B) epoxy resin,
- (C) a mixture of organic solvents,

as well as optionally pigment, catalyst and other adjuvants.

The acrylic resin (A) is a copolymer which contains 10 to 35 wt% of a polymerised α , β -olefinically unsaturated carboxylic acid, has a K-value below 15 and an acid number between 70 and 250, a number average molecular weight M_n of 1500 to 3000 and a polydispersity M_w/M_n of between 1.5 and 2.0 (Claim 1). Preferably, it is a copolymer of 12 to 25 wt% (meth)acrylic acid, 5 to 70 wt% ester of (meth)acrylic

acid with a C₁-C₈ alkanol, 5 to 70 wt% styrene and 0 to 20 wt% alkanediol monoester of (meth)acrylic acid (Claim 2).

The polymers are preferably prepared by radical oligomerisation under pressures of 1.5 to 30 bar at temperatures of 160° to 280°C, either in bulk at 170° to 250°C or in solution at 160° to 250°C, preferably in the absence of molecular weight control agents (page 6, second complete para.).

According to an example involving the preparation of acrylic resin (A) II:

Styrene (60 parts), 2-ethylhexylacrylate (25 parts), acrylic acid (15 parts) and di-tert-butyl peroxide (2 parts) are heated in a continuous pressure autoclave for 10 min. to 210°C at 24 bar. Then the reaction mixture is pressed through a static mixer for post-polymerisation (about 15 min. at 200°C). Then, the unreacted monomers are removed by distillation at 230°C.

The resulting resin has a polydispersity ratio Mw/Mn of 1.86, and a number average molecular weight (Mn) of 1800 (page 8).

- 5.3 Compared with this state of the art, the technical problem underlying the patent in suit is to define a simplified process of selectively producing such vinylic polymers in high (commercial) yields.
- 5.4 The solution proposed according to Claim 1 of the patent in suit is to carry out the bulk polymerisation process by the steps of continuously:

- (a) charging into a continuous stirred reactor zone containing a molten resin mixture;
 - (i) the mixture of vinyl monomers;
 - (ii) the polymerisation initiator;
 - (iii) from 0 to 25% based on the weight of vinyl monomers of reaction solvent, wherein the molten resin mixture comprises unreacted vinylic monomers and the vinylic polymer product;

- (b) maintaining a flow rate through the reaction zone sufficient to:
 - (i) provide a residence time of the charged vinylic monomer mixture in the reaction zone of 2 min. to 1h; and
 - (ii) maintain a predetermined level of reaction mixture in the reaction zone, and

- (c) maintaining the molten resin mixture at the reaction temperature of 180°C to 270°C, subject to the proviso that if the reaction temperature is in the range 180°C to 215°C, then the molten resin mixture includes a reaction solvent, the reaction temperature being sufficient to provide accelerated conversion to a readily processable, uniform, concentrated polymer product.

The polymers produced have a number average molecular weight (Mn) of about 500 to 6000, preferably 750 to 5000, a polydispersity of less than about 2.5, and a distribution index of less than about 4.5 (page 8, lines 33 to 40).

5.4.1 It is clear from the description of the patent in suit, and more particularly the large number of examples showing the effect of reaction temperature,

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residence time, initiator levels, presence of solvent etc. on the polydispersity, distribution index and molecular weight characteristics of the polymers produced, that these features can be mutually manipulated in accordance with the principles disclosed, to obtain the desired results (page 8, lines 23 to 25; examples).

5.4.2 The argument that in replicating Example A (II) of D2 the Appellant applied a method falling within the terms of Claim 1 of the patent in suit, but which was nevertheless unsuccessful in terms of the resulting polymer properties, is no longer relevant, because of the requirement in Claim 1, not fulfilled in the test or Example A (II), for the presence of a solvent at the reaction temperature tested (210°C).

5.4.3 On the contrary, it is evident that the establishment of a CSTR, maintained at the relevant temperature and for the appropriate residence time, is associated with the capability of obtaining, in a single step, a polymer product having the desired low polydispersity, distribution index and molecular weight values in a continuous output corresponding to a commercial yield.

Thus, it is credible to the Board that the claimed measures provide an effective solution of the stated problem.

6. *Novelty*

6.1 According to D1, an anionic paper sizing agent based on a water-soluble salt of a copolymer of (a) a C₂ to C₁₂ olefin having a terminal double bond, (b) acrylic or methacrylic acid, and (c) a non-acrylic ethylenic monomer, in particular maleic acid or maleic anhydride, has a more uniform composition with respect

M2

to the degree of oligomerisation as well as monomer composition than conventional compositions, and is thermally stable, so that papers impregnated with the agent can be dried at higher temperatures without discoloration (Claim 1 and page 3, second para.). The copolymer according to Claim 3 is derived from (a) 30 to 80% by weight of styrene, (b) 10 to 35% by weight of acrylic acid, and (c) 5 to 35% by weight of maleic acid or maleic anhydride.

The agent is characterised by having a molecular weight of 600 to 5,000 and being prepared by continuous copolymerisation of the monomers between 130° and 320°C and at pressures over 1 bar in the absence of molecular weight control agents, preferably at pressures over 3 bar in the absence of initiators, and preferably in the absence of solvents, although non-participating solvents can be used (Claims 1, 2; page 5, lines 1, 2; and page 6).

The monomers are continuously polymerised in an apparatus which may, for example, be a pressure reactor (Druckkessel), a tube reactor or a pressure reactor with a downstream tube reactor provided with a static mixer. Preferably, polymerisation is carried out in two such successive reaction zones. During polymerisation, it must be ensured that the components are effectively mixed with another; for instance, one can use a pressure reactor provided with a stirrer or tube reactors with a static mixer (page 5, second para.).

"Continuous polymerisation" is also to be understood as including a technique in which first of all about 10% of the monomers are present in a polymerization zone, e.g. in a reactor, and then the rest of the monomer mixture is added continuously, though in this

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case the yields are not so high as in continuous polymerisation. Preferably, no solvent is present. The product obtained by either the continuous or semi-continuous polymerisation is a polymer melt which can be reacted directly with gaseous ammonia, aqueous ammonia or other aqueous base (page 6).

For sizing paper, the neutralized or partially neutralized solution of the copolymer is adjusted with water to a concentration of 0.1 to 1% (passage bridging pages 6 to 7).

According to Example 3, a copolymer of 67% styrene, 18% acrylic acid and 5% each of methacrylic acid, maleic acid and vinylphosphoric acid (molecular weight 3 000) was obtained by continuous polymerisation at a temperature of 160°C and a pressure of 20 bar with a residence time of 30 min., using 2% di-tert.-butylperoxide.

6.1.1 Whilst the process described in D1 is said to be "continuous", it is clear from the definition of this term on page 6 that processes in which addition of the reactants is completed, i.e. semi-continuous or semi-batch processes, are also to be understood as "continuous". Furthermore, even the processes that are referred to as "continuous" are not clearly stated to involve the maintenance of a constant level of reactants, as required by feature (b)(ii) of the solution of the stated problem.

Consequently, there is no explicit disclosure of a process which is continuous in the sense of the patent in suit.

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6.1.2 Furthermore, whilst there is admittedly a reference in D1 to the necessity of providing for good mixing during the reaction, and even to pressure-tight vessels provided with a stirrer, the latter are presented only as an alternative to a reaction tube with a static mixer, and no further details of stirring are given (page 5, first complete para.). In particular, none of the examples of D1 mentions stirring, but instead there is a static mixer downstream of the pressure vessel.

6.1.3 Even if it were assumed, as repeatedly urged by the Respondent at the oral proceedings, that the references to pressure reactor vessels in D1 would be understood by the skilled reader as inherently disclosing a stirrer of some kind (so as to prevent an explosive build up of heat in the reactor and to prevent congealing of polymer on the reactor walls), the question arises as to whether the result could be regarded as a "continuously stirred reactor zone" (CSTR) as required by the solution of the stated problem.

6.1.3.1 The argument of the Respondent at the oral proceedings, that it is in any case impossible to establish a theoretically perfect CSTR in practice, is beside the point. The solution of the stated problem requires in substance the closest practical approach to this condition.

6.1.3.2 There is, however, no disclosure in D1 of any particular level of stirring, let alone of one ensuring the absence of gradients of temperature or concentration in accordance with the requirements of a CSTR (cf. Section 4.4, above).

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Consequently, D1 cannot be interpreted as disclosing a CSTR in the sense of the patent in suit.

- 6.1.4 Finally, according to preferred embodiments of D1, the polymerisation is carried out in the absence of an initiator and in the absence of solvents. Indeed, only one of the examples discloses the use of an initiator and this example does not specify the apparatus used (Example 3). The reaction temperature disclosed in this example (160°C) is, furthermore, below the minimum allowed by the solution of the stated problem, and in any case no solvent is used.

Consequently, there is no disclosure of the combination of the features (a) (ii) and (c) of the solution of the stated problem.

- 6.1.5 In summary, D1 discloses neither a CSTR, nor such a zone in combination with the relevant supplementary reaction conditions specified in the solution of the stated problem.

Hence, the subject-matter of Claim 1 is novel with respect to the disclosure of D1.

- 6.2 D3 relates to the preparation of copolymers with N-dialkyl-N-amido groups, by continuous polymerisation of maleic anhydride with at least one other ethylenically unsaturated monomer at pressures above 1 bar and at temperatures of 130° to 320°C, followed by reaction with an unsymmetric diamine (Claim 1). The polymerisation is carried out in the absence of molecular weight control agents and preferably in the absence of initiators (Claim 2; page 3, penultimate para.) and of solvents, though non-participating solvents may be used (page 5, second para.). The products are half-amides which have a uniform

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composition and may be used as paper sizing agents, as binders for paper coating agents, or as binders for stoving enamels and printing pastes, as well as binders for non-woven fabrics (page 2, penultimate para.).

The monomer combinations according to Examples 1 to 3, as well as the details of the polymerisation, the "continuous" character of the process, the mention of stirring, and the characteristics of the polymers produced, especially their polydispersity, are very similar to those of D1, but, as in the latter document, no polydispersity value is specified.

This disclosure therefore does not come closer to the solution of the stated problem than does D1.

Consequently, the subject-matter of Claim 1 is considered to be novel with respect to D3.

6.3 The disclosure of D2 more closely approaches the subject-matter of the patent in suit in that it relates to stoving enamels including styrene-acrylic based resins having specified low polydispersity and Mn values appropriate to such high solids applications. In the only relevant example, these are prepared in a "continuous" pressure reactor at 210°C with a reaction time of 10 min. (cf. Example (A) II).

There is, however, no explicit mention in the example of continuously maintaining a flow rate through the reactor to provide a predetermined level of reaction mixture (feature (c) of the claimed process), or of stirring.

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6.3.1 The argument of the Respondent, that the reference to a "continuous" pressure autoclave means that the entire process is continuous is not convincing, since the process in general is not mentioned as being continuous, and the term "continuous" applied to the autoclave alone does not unambiguously define the manner in which the reactants flow, but could equally refer, for instance, to the continuity of application of pressure.

6.3.2 The alternative argument of the same party, that the term "continuous" should be interpreted in the light of its use in D1 and D3, which had a designated inventor in common with D2, lacks contextual support in the disclosure of D2, since the latter makes no reference to D1 or D3. On the contrary, the reference in D2 (page 3, para. 2) is to a parent application, to which it is an addition and which mentions neither a continuous process nor even a "continuous pressure autoclave".

6.3.3 In any case, even if a contextual connection to D1 or D3 were acknowledged by the Board, this would not help the case of the Respondent, since it has already been established (see Sections 6.1.1 and 6.2, above), that the term "continuous" as used in D1 and D3 does not necessarily mean "continuous" in the sense of the patent in suit, but rather indicates a process which may be a semi-continuous or semi-batch process.

Consequently, D2 cannot be interpreted as disclosing a continuous process in the sense defined in Claim 1 of the patent in suit.

6.3.4 As to the question of stirring, the argument that this would be understood as inherently disclosed for process safety and for ensuring a modicum of

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homogeneity of the reaction mixture must fail for the same reasons as given in relation to D1 (cf. Section 6.1.3 etc., above).

6.3.5 The further argument, that stirring is not only necessary, but must, in order to have resulted in the polymers of polydispersity below 2 disclosed in D2, have been such as to establish a CSTR, is not only unconvincing for the reasons given above, but is also contradicted by the evidence of the Appellant.

6.3.5.1 According to the latter, on the one hand, a repetition of the relevant Example (A) II of D2 using a CSTR mixing regime was unworkable because the reaction mixture became excessively viscous, and resulted in polymers having a number average molecular weight M_n considerably higher than that reported in the example of D2 and a polydispersity undesirably above 2 (see Experimental Report forming Annex IV of submission filed on 13 May 1993, Table 1).

6.3.5.2 On the other hand, according to the latter, an attempt to reproduce the same example as a batch process using small ampoules resulted in a polymer which, although still having a polydispersity above 2, nevertheless exhibited a number average molecular weight similar to that achieved according to Example A (II) of D2. This led to the conclusion, expressed at the oral proceedings, that the use of small reaction volumes (batch process) could facilitate the achievement of a polymer having the M_n and polydispersity parameters reported in D2 without stirring (cf. submission of Appellant filed on 27 December 1994; experimental report forming Annex to the latter).

6.3.5.3 The argument of the Respondent at the oral proceedings, that the results could not be relied upon

because the reaction vessel was not the same as in D2 is not convincing, because on closer examination it is clear that Example A (II) of D2 itself omits relevant details of the reaction vessel, such its volume. Indeed, the relative vagueness of this example as to the physical parameters of the reaction invalidates the general, and unsubstantiated criticism of the Respondent, also expressed at the oral proceedings, that the Appellant had not employed best efforts in attempting to reproduce the teaching of this example.

Thus, the Board considers that it has been convincingly shown that the information given in the only relevant example of D2 is not consistent with a CSTR process, but if anything rather with a batch process.

6.3.5.4 In any case, the absence, at the relevant temperature, of solvent in Example (A) II means that feature (c) of Claim 1 of the patent in suit is not fulfilled.

6.3.6 In summary, D2 cannot be interpreted as disclosing a process which is continuous or which involves the use of a CSTR. Furthermore, in the only relevant example, the absence of solvent means that the process is not the same as that forming the solution of the technical problem.

Consequently, the subject-matter of Claim 1 is novel over the disclosure of D2.

6.4 The disclosure of D9, which contains a general treatment of the nature and properties of CSTR and other reactors, also refers to the possible effects of using a CSTR on the molecular weight distribution of the polymer produced.

6.4.1 It is stated, for instance, on the one hand, that "with a perfectly mixed CSTR it is often possible (where molecular weights are controlled by termination) to achieve an MWD (molecular weight distribution) considerably narrower than can be obtained with a batch or tubular reactor with the same hold up time" (page 29) and, on the other, that "a fundamental difference between CSTR and batch reactors is that at comparable conditions of temperature and conversion, the branching frequency is always higher and the MWD is always broader in the former reactor type" (page 44).

6.4.2 To the extent that this further disclosure does not, by virtue of its publication date, form state of the art within the meaning of Article 54 EPC (cf. Section 4, above), the Board is not bound to take account of it. Even if the whole content of D9, or at least the most relevant passages cited above, were to be considered as state of the art, however, it is not such as to disclose the combination of features forming the solution of the stated problem.

Thus the subject-matter of Claim 1 and, by the same token, of dependent Claims 2 to 22 is considered to be novel.

7. *Inventive step*

To assess this question, it is necessary to consider whether the skilled person, starting from D2, would have considered making the combination of modifications (a), (b) and (c) of the solution defined in Section 5.4 above, in the expectation of selectively providing the desired polymers in continuous, high commercial yield.

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- 7.1 There is no suggestion to do this in the closest state of the art document D2 itself, since, as established above, this document cannot be interpreted as disclosing a CSTR or even a continuous process.
- 7.1.1 The finding in the decision under appeal that the use of a "stirred reactor" is merely one design possibility to solve the problem posed (cf. Reasons for the decision, para. 14.3) does not meet the point at issue, which is concerned not simply with "stirring", but with the establishment of the combination of conditions corresponding to a "CSTR" (cf. Section 4, above).
- 7.1.2 The argument of the Respondent, that the results of the Appellant's tests were better with a CSTR and static mixer than with a CSTR alone (cf. Section VI. (iv), above) is irrelevant, since D2, for the reasons given above, cannot be interpreted as disclosing a CSTR in the first place.
- 7.1.3 The further argument, that the skilled person would have used more vigorous stirring to correct any problems of uniformity of the product exemplified in D2 (cf. Section VI. (v), above) is unconvincing, firstly because stirring is in any case not taught in the relevant example of D2, and secondly because the evidence of the Appellant's tests shows that where, as in the case of Example A (II) of D2, the conditions are unsuitable (lack of solvent), mere vigour of stirring is not alone sufficient to establish an effective CSTR.

Thus D2 leads away from the solution of the technical problem by suggesting a different kind of mixing and a different reaction medium.

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7.2 The skilled person would furthermore have had no reason to consider D1 or D3 as useful in solving the technical problem, since both these documents relate to paper sizes which are used at such low concentrations that polydispersity considerations of the kind applying to high solids polymer compositions such as those of D2 are not relevant. Even if the attention of the skilled person had nevertheless for some reason been drawn to these documents, however, they equally fail to disclose the use of a CSTR, let alone the use of a CSTR under the supplementary conditions, especially the proviso of condition (c), of the solution of the stated problem.

Consequently, there is no pointer to a solution of the stated problem from D1 or D3.

7.3 Subject to the reservation concerning the publication date of D9 (cf. Section 6.4.2, above), it is evident that the effect of using of a CSTR technique on molecular weight distribution in a polymerisation reaction depends on factors such as the type of molecular weight control, and the extent of branching (cf. Section 6.4.1, above).

Thus, where, as in the case of Example A (II) of D2, no such information is given, the skilled person is not in a position to make a prediction as to what effect, if any, the use of a CSTR technique will have on the product.

Consequently, the solution of the technical problem does not arise in an obvious way from the state of the art, whether it is taken as including or excluding the relevant disclosure of D9 (see Section 6.4.2, above).

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7.4 Quite apart from this, the process according to the patent in suit is evidently capable of yielding polymer products fulfilling a more stringent measure of uniformity of molecular weight distribution than that represented by the polydispersity, namely of having a distribution index less than about 4.5 (Sections 5.1.2 and 5.4.1, above).

7.4.1 The objection of the Respondent at the oral proceedings, that the distribution index is a parameter having no significance beyond that of the polydispersity is contradicted by the terms of the description of the patent in suit itself (page 2, lines 35 to 37).

7.4.2 On the contrary, it is clear from the results given in the examples of the patent in suit, that there is no direct correlation between the values of the polydispersity and the distribution index (cf. Table 7; fourth, eighth and second to last run).

7.5 Neither D2 nor any of the other documents cited, however, so much as mentions the distribution index, or even the relevant measure of molecular weight M_z of the polymers.

Such an effect was therefore not foreseeable by the skilled person, and must be regarded as surprising.

8. Consequently the subject-matter of Claim 1 involves an inventive step. By the same token, the subject-matter of dependent Claims 2 to 6 also involves an inventive step.

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B. Other requests

9. In the light of the conclusion in Section 8, above, no other request needs to be considered.

Order


For these reasons it is decided that:

1. The decision under appeal is set aside.
2. The case is remitted to the first instance with the order to maintain the patent on the basis of
 - Claim 1 as filed on 13 May 1993 as first auxiliary request;
 - Claims 2 to 22 as granted; and
 - the following description:
 - pages 2, 5, 6, 8, 10 to 21 as granted, and
 - pages 3, 4, 7 and 9 as submitted during oral proceedings.

The Registrar:


E. Görgmaier

The Chairman:


C. Gérardin

