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

**Case Number:** T 0339/91 - 3.3.3

**Application Number:** 82900690.7

**Publication Number:** 0068024

**IPC:** C08F 2/02

**Language of the proceedings:** EN

**Title of invention:**

Process for continuous bulk copolymerization of vinyl monomers  
and product thereof

**Patentee:**

S.C. JOHNSON & SON, INC

**Opponent:**

BASF Aktiengesellschaft, Ludwigshafen

**Headword:**

-

**Relevant legal provisions:**

EPC Art. 54, 56, 64(2)

**Keyword:**

"Novelty - main and first auxiliary requests (product-by-  
process) - denied"

"Inventive step - second auxiliary request (process) -  
affirmed"

**Decisions cited:**

T 0150/82, T 0248/85

**Catchword:**

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Boards of Appeal

Chambres de recours

Case Number: T 0330/91 - 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:** BASF Aktiengesellschaft, Ludwigshafen  
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**Representative:** -

**Respondent:** S.C. JOHNSON & SON, INC.  
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**Decision under appeal:** Decision of the Opposition Division of the  
European Patent Office dated 28 January 1991,  
issued in writing on 28 February 1991 rejecting  
the opposition filed against European patent  
No. 0 068 024 pursuant to Article 102(2) 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. 0 068 024, with nine claims, in respect of European patent application No. 82 900 690.7, derived from International application No. PCT/US82/00010, filed on 7 January 1982 and claiming a priority of 9 January 1981 (US 223 597) was announced on 30 March 1988 (Bulletin 88/13). Claim 1 of the granted patent reads as follows:

"Bulk polymerization process for preparing low molecular weight vinylic polymers having a dispersion index less than 2 and a number average molecular weight from 1000 to 6000 comprising the steps of continuously:

- (a) charging a mixture of vinylic monomers into a continuously stirred reactor zone containing a molten resin mixture of unreacted vinylic monomers and said vinylic polymers;
- (b) maintaining the molten resin mixture at a reaction temperature from 235°C to 310°C; and
- (c) maintaining a flow rate through said reaction zone sufficient (1) to provide a residence time of said charged vinylic monomer mixture in said reaction zone of at least 2 minutes to provide a reaction product; and (2) to maintain a predetermined level of reaction mixture in said reaction zone; wherein said mixture of vinylic monomers comprises at least one monoalkenyl aromatic monomer and at least one acrylic monomer."

Claims 2 to 6 are dependent claims relating to elaborations of the process according to Claim 1.

Claim 7 of the granted patent, an independent claim, reads as follows:

"Bulk vinylic polymers having a dispersion index less than about 2 and a number average molecular weight from 1000 to 6000 comprising at least one monoalkenyl aromatic monomer and at least one acrylic monomer, the bulk vinyl polymers being prepared by continuously charging a mixture of vinylic monomers into a continuous stirred reactor zone containing a molten resin mixture of unreacted vinylic monomers and said vinylic polymers, maintaining the molten resin mixture at a reaction temperature from 235°C up to 310°C, and maintaining a flow rate through said reaction zone sufficient to provide a residence time of said charged vinylic monomer mixture in said reaction zone of at least 2 minutes to provide a reaction product, and to maintain a predetermined level of reaction mixture in said reaction zone."

Dependent Claims 8 and 9 relate to embodiments of the bulk vinylic polymers according to Claim 7.

II. Notice of Opposition was filed on 30 December 1988 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-2 534 603;  
D3: DE-A-2 728 459;  
D5: EP-A-0 047 889;  
D6: EP-A-0 054 139; and  
D7: DE-A-2 439 341.

III. By a decision which was given at the end of oral proceedings held on 28 January 1991 and issued in writing on 28 February 1991, the Opposition Division rejected the opposition.

According to the decision, the most important characteristics of the process of the patent in suit, which was capable of selectively producing low molecular weight vinylic copolymers having a uniform molecular weight (low dispersion index), a high purity and the ability to form a high solids content and a desirable alkali-soluble resin cut, were:

- (a) the continuous stirred reactor zone (CSTR) into which the monomers were charged;
- (b) the reaction temperature being maintained from 235° to 310°C; and
- (c) the residence time being at least 2 minutes.

Whilst D1 and D3 described somewhat similar processes conducted at temperature ranges overlapping that of the patent in suit, and, as one alternative, in a stirred reactor, there was no disclosure or indication of imposing a positive agitation together with high temperatures in order to improve the process and product properties. Thus, the subject-matter of Claims 1 to 6 was novel and inventive.

The polymers as defined in Claims 7 to 9 were considered to be novel because no evidence to the contrary had been submitted and because the polymers described in D3 as having the relevant dispersion index and molecular weight were produced at different temperatures from those of the patent in suit.

IV. On 25 April 1991 a Notice of Appeal against the above decision was filed, together with payment of the prescribed fee.

In the Grounds of Appeal filed on 27 June 1991 and in subsequent written submissions, the Appellant (Opponent) argued in essence as follows:

- (i) It was known from D1 that vinyl polymers of the relevant molecular weight and with a low dispersion index were obtainable by continuous polymerisation in a reactor at the relevant temperatures. Bearing in mind the fact that such reactors were in general always stirred, and that the claimed residence time requirement was hardly limiting and was in any case disclosed in the cited process, all the claimed features had been disclosed (Statement of Grounds of Appeal, page 5, last para. to page 6, third para.).
  
- (ii) The use of the polymers of D1 for paper sizing was of no significance. On the contrary, the process of D1 could be used to produce the most varied copolymers for the most varied purposes. According to D2 and D3 copolymers were known, which were prepared by the bulk polymerisation process of D1. According to D3 the copolymer had a dispersion index between 1.5 and 2. It was thus clear to the skilled person that copolymers of the most varied monomers having the relevant molecular weight and a dispersion index less than 2 were obtained with the prior art processes (Statement of Grounds of Appeal, page 6, last fourth and fifth paras.).
  
- (iii) The documents D5 and D6, although not prepublished, were relevant for novelty within the meaning of Art. 54 (3) EPC, since they disclosed all the process features of the patent in suit (Statement of Grounds of Appeal, page 7).

V. The Respondent (Patentee) argued in essence:

- (i) There was no indication in D1 that a dispersion index of less than 2 was achievable, since the application as a paper sizing agent did not require a low dispersion index, and the Examples of D1 in fact gave products with dispersion indices falling outside this limit. The skilled person would not seriously contemplate employing higher reaction temperatures in the area of overlap with the claimed range. Nor was the feature of a stirrer explicitly mentioned in D1. Even if it were implied, it did not necessarily equate with a "continuously stirred reactor zone", which had a particular mixing profile with no concentration or temperature gradients. Similar comments applied to D2 (submission filed on 7 November 1991, pages 2, 3, and submission filed on 27 December 1994, page 3, last para.).
  
- (ii) The process of D3, although producing vinylic polymers having a dispersion index of 1.5 to 2, was not a continuous process but a batch process, and could not be used to make the claimed polymers, as was demonstrated by experimental evidence (submission filed on 7 November 1991, page 4, first complete para., and submission filed on 4 August 1993, page 2, last para.).
  
- (iii) Furthermore, D3 related to stoving paints and hence it was not obvious to combine it with D1 or D2 which related to paper sizes in which dispersion index was unimportant. Even if such a combination were contemplated, however, the preferred temperatures indicated in the

documents were below the minimum claimed (submission filed on 7 November 1991, page 4, last two paras.).

(iv) With regard to D5 and D6, the molecular weight and dispersion index were also features of the process claimed (submission filed on 4 August 1993, page 2).

VI. In order to demonstrate the influence of the different types of reactor on the polymer characteristics, the Respondent referred, in the submission filed on 4 August 1993, 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.

VII. With a submission dated 20 June 1995, received on 21 June 1995, the Respondent filed two auxiliary requests, the first involving cancellation of Claims 7 to 9 and their replacement by Claims 7 and 8 filed together with this submission, and the second involving the simple cancellation of Claims 7 to 9.

VIII. Oral proceedings were held before the Board on 12 July 1995.

IX. The Appellant requested that the decision under appeal be set aside and the patent be revoked.



The Respondent requested that the appeal be dismissed, or that the patent be maintained on the basis of auxiliary request 1 or auxiliary request 2 filed on 21 June 1995.

### Reasons for the Decision

1. The appeal is admissible.

2. *New documents*

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

3. *Allowability of amendments*

3.1 Main request

This does not involve any amendments compared with the version of the patent as granted.

No objection therefore arises under Article 123 EPC.

3.2 Auxiliary request 1

According to this request, Claims 7 to 9 of the granted version are replaced by new Claims 7 and 8. New Claim 7 reads as follows:

"Bulk vinylic polymers having a dispersion index less than about 2 and a number average molecular weight from 1000 to 6000 comprising as vinylic monomers a mixture of styrene or a mixture of a methyl styrene

and styrene having a weight ratio of from 1:2 to 2:1, with acrylic acid, the bulk vinyl polymers being prepared by continuously charging a mixture of vinylic monomers into a continuous stirred reactor zone containing a molten resin mixture of unreacted vinylic monomers and said vinylic polymers, maintaining the molten resin mixture at a reaction temperature from 235°C up to 310°C, and maintaining a flow rate through said reaction zone sufficient to provide a residence time of said charged vinylic monomer mixture in said reaction zone of at least 2 minutes to provide a reaction product, and to maintain a predetermined level of reaction mixture in said reaction zone."

- 3.2.1 Amended Claim 7 corresponds, with some re-wording, to a combination of Claims 7 and 8 as filed and granted.
- 3.2.2 Claim 8 corresponds, with an appropriate change of appendancy, to Claim 9 as filed and granted.

The amendments are thus supported by the disclosure of the application as filed and do not extend the scope of protection of the patent as granted. No objection therefore arises under Article 123 EPC to this request.

3.3 Auxiliary request 2

This merely involves the deletion of Claims 7 to 9 of the granted patent.

Consequently, no objection under Article 123 EPC arises in respect of this request either.

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, which has the same wording in all of the requests.

4.1 According to the Respondent 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 Respondent, 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 dated 22 December 1994, received on 27 December 1994, enclosing a copy of a letter of the same date submitted in the appeal T 237/93, pages 3 and 4 of the latter).

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 5, lines 27 to 31).

- 4.5 The Appellant 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.

A. Main request

5. The patent in suit is concerned with a bulk polymerisation process for preparing low molecular weight vinylic polymers having a dispersion index (the ratio of the weight average molecular weight ( $M_w$ ) to the number average molecular weight ( $M_n$ ), i.e.  $M_w/M_n$ ) less than 2 and a number average molecular weight ( $M_n$ ) from 1000 to 6000, the vinylic monomers comprising at least one monoalkenyl aromatic monomer, such as styrene, and at least one acrylic monomer, such as acrylic acid (Claims 1 to 6), and to bulk vinylic polymers produced by such a process (Claims 7 to 9).

Such polymers are capable of producing a high solids (25 to 35%) alkali-soluble resin cut for use in polishes, inks and other finishes without having the disadvantages of conventional solution polymers of being unduly viscous and difficult to handle due to their high dispersion index (page 2, lines 30 to 33; page 3, lines 48 to 50).

5.1 The preparation of a polymer having these characteristics of dispersion index and molecular weight by bulk polymerisation is, however, known from D3, which is considered, in keeping with the views of both parties, to represent the closest state of the art.

According to D3, 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  $\alpha$ ,  $\beta$ -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 dispersion index  $M_w/M_n$  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  $C_1$ - $C_8$  alkanol, 5 to 70 wt% styrene and 0 to 20 wt% alkanediol monoester of (meth)acrylic acid (Claim 2).

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 minutes at 200°C). Then, the unreacted monomers are removed by distillation at 230°C.

The resulting resin has a dispersion index of 1.86, and a number average molecular weight (Mn) of 1800 (page 8).

5.2 Compared with this state of the art, the technical problem underlying the patent in suit is seen as being to define a simplified process of producing selectively such vinylic polymers having a similar dispersion index and number average molecular weight in high (commercial) yields.

5.3 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 a mixture of vinylic monomers into a continuously stirred reactor zone (CSTR) containing a molten resin mixture of unreacted vinyl monomers and the vinylic polymers;

(b) maintaining the molten resin mixture at a higher temperature from 235°C to 310°C; and

(c) maintaining a flow rate through the said reaction zone sufficient (1) to provide a residence time of the charged vinylic monomer mixture in the reaction zone of at least 2 minutes to provide a reaction product and (2) to maintain a predetermined level of reaction mixture in the reaction zone.

5.3.1 Although it was admitted that not all combinations of temperature and residence time conditions within the indicated limits would inevitably result in polymers

of the claimed molecular weight and dispersion index for all combinations of monomers, it was not disputed that the principles disclosed in the patent in suit enabled the manipulation of the relevant parameters reliably to achieve this purpose.

5.3.2 In this connection, 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, residence time etc. on the dispersion index and molecular weight parameters of the product, that the relevant features can be mutually manipulated to obtain the desired results.

5.3.3 It is thus evident that the establishment of a CSTR, maintained at the relevant temperature and with the appropriate residence time, is associated with the capability of producing, in a single step, a polymer product having the desired low dispersion index and number average molecular weight, in a continuous output corresponding to a commercial yield.

It is consequently credible to the Board that the claimed measures provide an effective solution of the stated problem.

6. *Novelty; process Claims 1 to 6*

6.1 According to D1, an anionic paper sizing agent based on a water-soluble salt of a copolymer of (a) a  $C_2-C_{12}$  olefin having a terminal double bond, (b) acrylic and/or methacrylic acid, and (c) a non-acrylic ethylenically unsaturated monomer, in particular maleic acid or maleic anhydride has a more uniform composition with respect 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. The copolymer may be derived from (a) 30 to 80 wt% of styrene, (b) 10 to 35 wt% of acrylic acid, and (c) 5 to 35 wt% of maleic acid or maleic anhydride (Claim 1 and page 3, second para.; Claim 3)

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 (Claim 1).

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 polymerisation zone, e.g. in a reactor, and then the rest of the monomer mixture is added continuously, though in this 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 examples, the polymerisation is carried out in a 1 l. pressure reactor with a downstream tube reactor having a static mixer.

- 6.1.1 Although D1 is directed to polymers having a more uniform degree of oligomerisation and monomer composition than conventional polymers, there is no mention of their having a dispersion index less than 2. Nor is there any reason to suppose that such a low dispersion index would inevitably be achieved, since the polymers are only disclosed for use at low concentrations in water (less than 1 wt%) for the sizing of paper. At such low concentrations, a dispersion index of around 2 is of no significance for the viscosity of the solution.
- 6.1.2 In any case, according to an acknowledgement of D1 in the document D5 having the same Applicant as D1 who is also the Appellant in the present case, the resins of D1 are difficultly or not at all soluble in alkali, and are not suitable as resin components in resin dispersions (D5, page 2).
- 6.1.3 Finally, although the reaction temperature range broadly referred to in D1 (130° to 320°C) extends at its upper end to within, and indeed beyond the range claimed in the patent in suit, the temperatures used in the examples are invariably below the lower limit claimed (235°C). According to the uncontested teaching of the patent in suit, however, at such temperatures

the uniformity of the product deteriorates unacceptably and the dispersion index spectrum is broadened considerably (page 3, lines 43 to 46).

Consequently, there is no disclosure of polymers having the claimed dispersion index values, or of a process inevitably producing them.

6.1.4 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 (c) 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.

6.1.5 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.

6.1.6 Even if it were assumed, as repeatedly urged by the Appellant 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 CSTR as required by Claim 1 of the patent in suit.

6.1.6.1 The argument of the Appellant 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.

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

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

6.1.6.3 In summary, D1 does not mention or indeed relate to a polymer having the dispersion index required by the patent in suit, nor does it disclose a combination of process continuity, stirring regime and reaction temperature which would result in such a polymer. In particular it fails to disclose a CSTR.

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

6.2 D2 relates to the preparation of copolymers with N-dialkyl-N-amido groups, by reaction of unsymmetric diamines with a maleic anhydride copolymer. The

copolymer itself is obtained 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 (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 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 molecular weight values, are very similar to those of D1, but, as in the latter document, no dispersion index 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 D2.

6.3 The disclosure of D3 more closely approaches the subject-matter claimed in the patent in suit insofar as it relates to styrene-acrylic based resins having the claimed dispersion index and molecular weight parameters. These are prepared in a "continuous" pressure reactor with a reaction time of 10 min. (cf. Example (A) II). A broad range of reaction

temperatures (170 to 280°C) which overlaps the lower part of the range claimed in the patent in suit is also disclosed.

The relevant exemplified reaction temperature (210°C) does not, however, fall within the claimed range. Furthermore, there is no explicit mention of continuously maintaining a flow rate through the reactor to provide a predetermined level of reaction mixture (feature (c) of the solution of the stated problem), nor of stirring.

6.3.1 The argument of the Appellant, that the reference to a "continuous" pressure autoclave means that the entire process was 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 D2, which had a designated inventor in common with D3, lacks contextual support in the disclosure of D3, since the latter makes no reference to D1 or D2. On the contrary, the reference in D3 (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 D2 were acknowledged by the Board, this would not help the case of the Appellant, since it has already been established (see Sections 6.1.4 and 6.2, above), that

the term "continuous" as used in D1 and D2 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, D3 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 homogeneity of the reaction mixture must fail for the same reasons as given in relation to D1 and D2 (cf. Section 6.1.6 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 dispersion index below 2 disclosed in D3, 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 Respondent.

6.3.5.1 According to the latter, on the one hand, a repetition of the relevant Example (A) II of D3 using a CSTR mixing regime was unworkable because the reaction mixture became excessively viscous, resulted in polymers having a number average molecular weight  $M_n$  considerably higher than that reported in the example of D3 and in any case failed to provide a polymer having a dispersion index value of below 2 as required by the patent in suit (see Experimental Report forming Annex I of submission filed on 4 August 1993, Table 1).

6.3.5.2 On the other hand, an attempt to reproduce the same example as a batch process using small ampoules resulted in a polymer which, although still having a dispersion index above 2, nevertheless exhibited a number average molecular weight similar to that achieved according to Example A (II) of D3. 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 Mn and dispersion index parameters reported in D3 (cf. submission of Respondent filed on 27 December 1994 including copy of submission of same date relating to companion appeal No. T 237/93; experimental report forming Annex to the latter).

6.3.5.3 The argument of the Appellant at the oral proceedings, that the results could not be relied upon because the reaction vessel was not the same as in D3 is not convincing, because on closer examination it is clear that Example A (II) of D3 itself omits relevant details of the reaction vessel, especially 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 Appellant, also expressed at the oral proceedings, that the Respondent 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 D3 is not consistent with a CSTR process, but, if anything, rather with a batch process.

6.3.6 In summary, D3 cannot be interpreted as disclosing a process which is continuous or which involves the use of a CSTR. On the contrary, it is evident that the

polymers disclosed in D3, although exhibiting values of dispersion index and Mn within the claimed ranges, are obtained by a process which is not the same as the "continuous process" forming the solution of the technical problem.

Consequently, the subject-matter of Claim 1 is novel over the disclosure of D3.

- 6.4 The document D5 is a published European application having a publication date 24 March 1982; filing date 26 August 1981; priority 11 September 1980; and - designated states AT BE CH DE FR GB IT LI NL SE.

It constitutes prior art in the sense of Article 54(3) EPC.

- 6.4.1 According to D5, alkali soluble resins are prepared by copolymerisation of alkenyl aromatic monomers and olefinically unsaturated carboxyl group-containing monomers, at temperatures of 200° to 400°C and at pressures above 1 bar, preferably pulsed, but in the absence of radical initiators and chain controllers (Claim 1).

In Example 1, 47 parts styrene, 50 parts acrylic acid and 3 parts maleic anhydride are fed to a 1 l. pressure reactor having a downstream tube reactor of double this volume. The system is heated to 310°C. The pressure is maintained between 5 and 50 bar and once within one minute varied within this range. The copolymer melt is withdrawn in the same amount as fresh monomer mixture is fed in. The copolymer has an average molecular weight of 650.

The resins obtained are used in self-gloss emulsions for coating floors and other surfaces (opening para.).



6.4.2 Thus, although the process would appear to be fully continuous in character, with a reaction temperature at the upper limit of the range claimed, the resins exemplified have a value of Mn below the lower limit specified in Claim 1 of the patent in suit. Furthermore, there is neither any mention of dispersion index, nor, in the examples, of stirring.

Consequently, for reasons similar to those given in relation to D1 in Section 6.1.6 above, D5 cannot be interpreted as disclosing a polymer having the required molecular weight and dispersion index, nor a process involving the use of a CSTR.

Therefore, the subject-matter of Claim 1 is considered to be novel over the disclosure of D5.

6.5 The document D6 has a publication date of 23 June 1982; filing date 22 October 1981; priority 10 December 1980; designated states DE FR GB NL, and is also prior art in the sense of Article 54(3) EPC. Its content does not, however, come significantly closer to the claimed subject-matter than that of D5, because it equally fails to disclose the relevant CSTR and dispersion index features.

Consequently, the subject-matter of Claim 1 is considered to be novel over the disclosure of D6.

6.6 The document D7 relates to a two-stage process for polymerising vinylaromatic compounds and copolymerising them with alkyl esters or nitriles of (meth)acrylic acid, the process requiring no solvent and being suitable for highly viscous products (pages 1, 2).

In a first step the monomers are continuously led at elevated pressure into a first reaction zone and polymerised there at 80 to 170°C to an extent of 5 to 40% conversion (Claim 1).

In a second step the reaction mixture is led, with maintenance of the overpressure, through a reaction zone adapted for conveying highly viscous melts, e.g. with a twin screw arrangement (cf. Example, page 7), with a degree of overpumping, at temperatures of 120° to 250°C, until a degree of conversion of 40 to 95% is reached, the overpressure being so chosen that the monomers are fluid, and removing this mixture from the zone with release of the overpressure (Claim 1).

In a third step, unreacted monomer is separated by volatilisation, the pressure being so chosen that the monomer(s) evaporate and the polymer is obtained as a melt (Claim 1).

The first reactor may be provided with wiping or wall-following stirrers. These are dimensioned so that the mixing time is at most 10% of the average residence time, the latter being 5 to 120 min. (page 4, para. 3). An anchor type stirrer rotating at 80 to 100 r.p.m. may be provided (page 7, examples).

The molecular weight distribution, expressed as the parameter  $Un = (Mw/Mn - 1)$  may be varied by controlling the throughput, residence time and temperature conditions and may be between 0.5 and 40 (pages 6, 7), with values as low as 1.6 or 1.7 (corresponding to a dispersion index  $Mw/Mn$  of 2.6 or 2.7 respectively) being exemplified using chain controllers (pages 8, 9 and Examples 8 and 16 in Table on page 10).

- 6.6.1 The necessity for a second reactor designed for highly viscous polymers indicates that the process of D7 has an essentially different character from that of the patent in suit, since it is not capable of producing the relevant polymers in a single step. The second reactor is in any case clearly not a CSTR.
- 6.6.2 Although the first reactor is apparently operated continuously at low viscosity and is provided with a stirrer, there is no evidence that it is operated in a manner to establish a CSTR. On the contrary, the purpose of the stirrer is evidently to keep the walls clear. The relatively generously set limit of the mixing time furthermore indicates that there is no special provision for achieving a reaction zone free of concentration and temperature gradients as required for a CSTR.
- 6.6.3 The evident absence of this capability is furthermore reflected in the products of the examples, none of which, with the exception of Examples 8 and 16 where chain controllers are used, has a dispersion index  $M_w/M_n$  below 2.
- 6.6.4 In any case, the range of temperatures at which the first reactor is permitted to be operated is far below the lower limit claimed in the patent in suit.

Hence, D7 cannot be interpreted as disclosing feature (a) or (b) of the solution of the technical problem, let alone a combination of both.

The subject-matter of Claim 1 is thus considered to be novel with respect to the disclosure of D7.

- 6.7 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.
- 6.7.1 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).
- 6.7.2 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 passage 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.
- 6.8 In summary, the subject-matter of Claim 1 is novel. By the same token, the subject-matter of Claims 2 to 6, which are directly or indirectly dependent on Claim 1, is also novel.

7. *Novelty; product Claims 7 to 9*

7.1 Claim 7 is directed to bulk vinylic polymers having a dispersion index less than about 2 and a number average molecular weight from 1000 to 6000 comprising at least one monoalkenyl monomer and at least one acrylic monomer and having been prepared by a process corresponding to that defined in Claim 1. It is thus a product-by-process claim.

7.2 According to the practice of the Boards of Appeal of the EPO (see also the Guidelines for Examination in the EPO, C. III. 4.7b), claims may be allowed for products defined in terms of a process of manufacture, provided the products themselves fulfil the requirements for patentability (T 150/82, OJ EPO 1984, 309, and T 248/85, OJ EPO 1986, 261).

7.3 As to the question, raised by the Respondent at the oral proceedings, of whether the above practice is still appropriate in the light of a restrictive interpretation by a national Court of the extent of protection to a product afforded by Article 64(2) EPC, the Board concurs with the view expressed in the first of the two decisions cited above. According to this, whilst national laws might refer to certain acts which would or would not be interpreted as an unauthorised use of the claimed invention, such matters are outside the scope of the EPC (cf. T 150/82, Reasons for the decision, para. 6).

Consequently, the Board finds no reason to diverge in its assessment of patentability in the present case from the above practice.

7.4 The product of Claim 7 itself, in this connection, is defined only in terms of the presence of two classes

of monomer (monoalkenyl aromatic and acrylic) and two other parameters, namely the dispersion index and the number average molecular weight. No other essential characterising feature of the product itself has been argued to exist.

- 7.5 A polymer product comprising, as monomers, styrene and acrylic acid and having a dispersion index and  $M_n$  falling within the ranges claimed in Claim 7 is, however, known from Example A (II) of D3.

Consequently, the subject-matter of Claim 7 is considered to lack novelty in the light of the disclosure of D3.

8. In view of the above conclusion, it is necessary to refuse the main request.

B. Auxiliary request 1.

9. Whereas Claims 1 to 6 of this request correspond to Claims 1 to 6 of the main request and are therefore directed to subject-matter which is novel for the reasons given under Section 6 etc., above, Claim 7 is a product-by-process claim of similar format to that of Claim 7 of the main request and is also directed to "bulk vinylic polymers".

9.1 The bulk vinylic polymers are further defined as "comprising as vinylic monomers a mixture of styrene or a mixture of a methyl styrene and styrene having a weight ratio of from 1:2 to 2:1, with acrylic acid".

9.2 The polymer disclosed in Example A (II) of D3 equally fulfils the latter definition, however, since it also comprises styrene and acrylic acid.

Consequently, the subject matter of Claim 7 lacks novelty in the light of the disclosure of D3.

10. For this reason, it is necessary to refuse auxiliary request 1.

C. Auxiliary request 2.

11. The claims of this request consist only of Claims 1 to 6 of the main request, there being no product claims. The subject-matter of these claims has, however, already been found to be novel (cf. Section 6.8, above).

Consequently, it remains only to consider whether the subject-matter of these claims also involves an inventive step.

12. *Inventive step*

To assess this question, it is necessary to consider whether the skilled person, starting from D3, would have considered making the combined modifications (a), (b) and (c) of the solution defined in Section 5.3 above, in the expectation of selectively providing the desired polymers in continuous, high commercial yield.

12.1 There is no suggestion to do this in the closest state of the art document D3 itself, since, as established under Sections 6.3.3 and 6.3.6, above, this document cannot be interpreted as disclosing a CSTR or even a continuous process. On the contrary, the type of mixer it does disclose and exemplify (a reaction tube provided with a static mixer) has a quite different mixing profile from a CSTR, and in particular differs from a CSTR in not providing a significant degree of

back-mixing. The exemplified process is furthermore carried out at a reaction temperature lower than that claimed in the patent in suit.

Thus D3 if anything leads away from the solution of the technical problem by suggesting a different kind of mixing and a different reaction temperature.

- 12.2 The skilled person would have had no reason to consider D1 or D2 as useful in solving the technical problem, since neither of these documents relates to polymers of dispersion index below 2. 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 at a reaction temperature within the range claimed.

Consequently, there was no pointer to a solution of the stated problem from D1 or D2.

- 12.3 The disclosure of D7 can hardly be regarded as leading to a simplification of the process of D3, since it requires two distinct further stages, one to increase the rate of polymerisation and one to eliminate the residual monomers. For the reasons given in Sections 6.6.1 to 6.6.4, above, moreover, there is no indication of a CSTR, and the temperatures required are generally even lower than those of D3 and in any case lower than those specified in feature (b) of the solution of the technical problem.

Consequently, there was no hint in D7 either which would have assisted the skilled person to reach the solution of the stated problem.



12.4 Subject to the reservation concerning the publication date of D9 (cf. Section 6.7.2, 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 6.7.1, 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.

13. Hence, 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.

14. There is thus no obstacle to the maintenance of the patent on the basis of the claims according to auxiliary request 2.

In this connection, it is clear that no adaptation of the description compared with that as granted is necessary.

Order

For these reasons it is decided that:

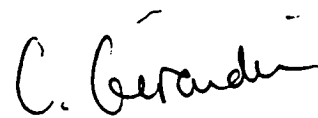
1. The decision under appeal is set aside.
2. The case is remitted to the first instance with the order to maintain the patent on the basis of auxiliary request 2.

The Registrar:



E. Görgmaier

The Chairman:



C. Gérardin