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**Datasheet for the decision
of 8 January 2009**

Case Number: T 0804/06 - 3.3.03

Application Number: 95308906.7

Publication Number: 0719816

IPC: C08G 64/30

Language of the proceedings: EN

Title of invention:
Preparing method of polycarbonate

Patentee:
GENERAL ELECTRIC COMPANY

Opponent:
Bayer MaterialScience AG

Headword:

-

Relevant legal provisions:
EPC Art. 54, 56

Relevant legal provisions (EPC 1973):

-

Keyword:
"Novelty - yes"
"Inventive step - yes"

Decisions cited:

-

Catchword:

-



Case Number: T 0804/06 - 3.3.03

D E C I S I O N
of the Technical Board of Appeal 3.3.03
of 8 January 2009

Appellant: Bayer MaterialScience AG
(Opponent) Law and Patents,
Patents and Licensing
D-51368 Leverkusen (DE)

Representative:

Respondent: GENERAL ELECTRIC COMPANY
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Decision under appeal: Interlocutory decision of the Opposition
Division of the European Patent Office dated
23 March 2006 and posted 03 April 2006
concerning maintenance of European patent
No. 0719816 in amended form.

Composition of the Board:

Chairman: R. Young
Members: M. C. Gordon
C.-P. Brandt

Summary of Facts and Submissions

I. Mention of the grant of European Patent No. 0 719 816 in the name of General Electric Company in respect of European patent application No. 95 308 906.7, filed on 7 December 1995, published on 3 July 1996 and claiming a priority date of 28 December 1994 from JP 327759/94 was announced on 23 May 2001 (Bulletin 2001/21) on the basis of 6 claims.

Claim 1 read as follows:

"A method for manufacturing polycarbonate, characterized in that when an aromatic dihydroxy compound and a carbonic acid diester are subjected to melt polycondensation in the presence of a catalyst including (a) a nitrogen-containing basic compound, the aforementioned (a) nitrogen-containing basic compound is dissolved or dispersed in an aliphatic or aromatic monohydroxy compound or an aqueous solution of an aliphatic or aromatic monohydroxy compound to make a catalyst solution. [sic] this catalyst solution is added to the melt polycondensation reaction system, and the aromatic dihydroxy compound and the carbonic acid diester are subjected to melt polycondensation."

Dependent claims 2-6 were directed to preferred embodiments of the method of claim 1, whereby claim 3 specified that the monohydroxy compound was an aromatic monohydroxy compound.

II. A notice of opposition to the patent was filed on 20 February 2002 by Bayer AG. In the course of the opposition proceedings following a restructuring of the opponent's business, the opposition was assigned to Bayer MaterialScience AG (letter dated 17 March 2004).

The grounds of opposition pursuant to Art. 100(a) EPC (lack of novelty, lack of inventive step) were invoked. The following documents, *inter alia* were cited in support of the opposition:

D1: DE-A1-43 12 390

D2: DE-A1-42 38 123

D3: JP-A 2-153 925

D4: JP-A 2-153 924

D5: JP-A 2-153 926

D6: JP-A 2-153 927

D9: EP-A2-0 360 578.

D3, D4, D5 and D6 were cited in the form of English language translations.

The objections pursuant to Art. 54 EPC raised in the Notice of Opposition relied on the disclosures of D1 and D2.

III. By a decision dated 23 March 2006 and issued in writing on 3 April 2006 the opposition division held that the patent could be maintained in amended form on the basis of the sole request, consisting of five claims, filed with a letter dated 8 May 2002, and an amended description submitted during the oral proceedings before the opposition division (23 March 2006). Claim 1 differed from claim 1 as granted in that the alternative "aliphatic" monohydroxy compound as a solvent or dispersant for the (a) nitrogen-containing basic compound had been deleted. As a consequence of this claim 3 as granted had been deleted and the subsequent claims 4-6 renumbered as 3-5.

According to the decision:

- (a) With regard to novelty it was held that the subject matter of the amended claims was distinguished from the disclosure of a process for manufacturing polycarbonate employing a catalyst comprising tetramethyl ammonium hydroxide in a solution of methanol in comparative example 5 of D1 by the restriction to an aromatic monohydroxy compound.

With respect to D9 it was held that claim 1 and examples 1-21 thereof disclosed a process for manufacturing polycarbonate characterised in that a catalyst composition was utilised comprising tetramethyl ammonium hydroxide, NaOH and boric acid. The subject matter of operative claim 1 was distinguished from the disclosure of D9 in that the catalyst was dissolved or dispersed in an aromatic monohydroxy compound.

- (b) With regard to inventive step, D9 was considered to be the closest prior art.

A comparison between Practical Examples 1-3 and Comparison Examples 1-3 of the patent in suit showed that the use of an aromatic monohydroxy solvent (phenol) improved the yellowness index and the water resistance haze.

Based on this, the objective technical problem could be formulated as to provide a method for manufacturing polycarbonate which was improved in colour tone and water resistance haze.

None of the documents cited during the opposition procedure suggested to use such aromatic solvents for the preparation of nitrogen containing

catalysts.

Further the evidence referred to above was considered to be sufficient to establish an effect arising from the distinguishing feature.

Accordingly an inventive step could be acknowledged.

- (c) The opponent had accepted D9 as being the starting point for the evaluation of inventive step, but had argued that nothing had been evidenced that the use of phenol as a solvent in a catalyst mixture resulted in improvements in the colour and water resistance haze. Accordingly, a less ambitious technical problem was proposed, namely to provide an alternative method for the production of polycarbonate. The document D3 would provide sufficient information to encourage the skilled person to come to the claimed solution. The opposition division did not concur with this argumentation. It was clear from Practical Example 1 and Comparison Example 1 of the patent in suit that the addition of phenol reduced the yellowness of the final polycarbonate product and at the same time improved its water resistance. Accordingly the objective technical problem could only be formulated as to improve certain properties of the PC polymer. D3 however provided no incentive to solve this problem.
- (d) Accordingly it was held that the patent in suit could maintained in amended form (Art. 102(3) EPC).

IV. A notice of appeal against this decision was filed by the opponent on 24 May 2006, the prescribed fee being

paid on the same day.

- V. The statement of grounds of appeal was received on 29 July 2006.
- (a) With respect to novelty it was stated that the subject matter of operative claims 1-5 was distinguished from the disclosures of D1 and D2 by the limitation to aromatic monohydroxy compounds.
 - (b) Objections pursuant to Art. 56 EPC were maintained in view of D9 in combination with D3.
 - (c) The problem according to closest state of the art D9 was a process for the preparation of polycarbonate which had good colour, heat resistance and water resistance.
 - (d) This problem was solved according to D9 by a melt polycondensation process of an aromatic dihydroxy compound and a carbonic acid diester whereby 0.05 to 15 mol-% (based on 1 mol of the aromatic dihydroxy compound) of a phenol with 10-40 carbon atoms was employed, as well as a nitrogen-containing compound as a catalyst, a certain content of an alkali metal or alkaline earth metal compound and optionally boric acid or boric acid ester.

The phenol compounds employed according to D9 were monophenol compounds and were generally known as chain terminating agents, reference being made to page 3 line 64 to page 4 line 37 of D9.

- (e) The appellant concurred with the finding of the decision under appeal that the objective technical problem was to provide a process for the production of polycarbonate with improved colour and water resistance, and further with improved heat resistance.
- (f) This problem was solved according to the patent in suit by the process of claim 1 (see section I above), whereby additionally an alkali metal and/or alkaline metal compound and/or boric acid or boric acid ester could be present as cocatalysts, reference being made to paragraphs [0014], [0061] and [0062] of the patent in suit.
- (g) The process of D9 differed from that according to the patent in suit in that the nitrogen-containing compound was not dissolved in an aromatic monohydroxy compound.
- (h) D3 also disclosed a melt polycondensation process for the preparation of polycarbonates from aromatic organic dihydroxy compounds and carbonic acid diesters. The catalysts and co-catalysts as defined in the patent in suit were used, namely a nitrogen-containing compound, an alkali or alkaline earth metal compound and boric acid or boric acid ester. D3 disclosed explicitly in the last paragraph of page 17 that boric acid or boric acid ester was added in solution in a monomer or in phenol.
- (i) Thus as shown by D3 it was known that catalysts, namely boric acid or boric acid ester could be

dissolved in an aromatic monohydroxy compound in order to obtain the desired properties, in particular since D3 taught on pages 16 and 17 that the use of such a catalyst resulted in improved heat resistance, water resistance, colour and transparency.

(j) Accordingly it was obvious also to add the nitrogen containing catalyst in the process of D9 in solution in phenol. D3 (page 16, final paragraph to page 17 first line) taught that the use of such a catalyst system resulted in improvements in heat and water resistance, colour and transparency.

(k) Even if the examples of the patent in suit showed an effect they could not establish an inventive step since the combination of D3 and D9 necessarily would lead to polycarbonates having the desired properties being obtained.

VI. The patent proprietor - now the respondent - replied with a letter dated 28 November 2006.

(a) It was noted that the findings of the decision under appeal concerning the closest prior art, the objective problem and the evidence provided by the Comparison and Practical Examples of the patent in suit that this problem had been solved by using an aromatic monohydroxy solvent had not been seriously contested in the statement of grounds of appeal.

(b) It was submitted that the argument of the appellant that a combination of D9 and D3 made the

claimed subject-matter obvious was not valid.

- (c) The object of D3 was to provide a process for producing a polycarbonate having improved colour and excellent mechanical properties.
- (d) According to the summary of the invention of D3, this object was attained by using a two step process in which a special reactor was used in the second step.

The summary of the invention of D3 did not refer to the use of a catalyst, let alone to the way to add a catalyst.

It was explained in the general description of D3 that it was preferable to use as catalysts a nitrogen-containing basic compound ("Type (a)") and an alkali metal compound ("Type (b)"). It was taught that use of a combination of both these Types of catalysts had high polymerisation activity and could afford a high molecular polycarbonate excellent in heat resistance, water resistance and furthermore with improved colour and excellent transparency.

- (e) Page 17 line 2 to page 22 line 5 and figure 1 gave a representative step view for carrying out the process of D3. According to this embodiment one of the catalysts, i.e. boric acid or boric acid ester dissolved in a monomer or phenol was continuously supplied to the reactor.
- (f) The skilled person faced with the problem of D9 and considering D3 would either use the two step

process (as had been done by the patent proprietor in the respective Practical and Comparison Examples 1-3) with or without the described reactor (not done in the examples of the patent in suit) and use one of the suggested combinations of catalysts as had been done in the Practical Examples and Comparison Examples of the patent in suit.

- (g) There was no suggestion in D3 that a further improvement of the desired properties could be obtained by adding the nitrogen-containing basic compound in an aromatic monohydroxy compound as required by operative claim 1.
- (h) D3 merely disclosed in one embodiment of the invention that it was possible to add the boric acid dissolved in a monomer or in phenol. It did not give any indication at all what the effect of this way of introduction of the catalyst might be.

VII. The Board issued on 27 June 2008 a summons to attend oral proceedings.

VIII. In a letter dated 7 October 2008 the appellant provided further arguments.

- (a) It was submitted that the examples of the patent in suit showed that the use of a phenolic solution of the catalyst resulted in better values for Yellowness Index (YI) and "water resistance haze" than when an aqueous or methanolic solution was used.

- (b) The skilled person would realise that the occurrence of discolorations (YI) and haze was due to side reactions and would be aware that these were at least in part the consequence of an inhomogeneous distribution of the catalyst in the reaction mixture. This effect was particularly relevant in the case of solids, since at the phase boundary (solid/liquid) concentration peaks occurred and additional reactions could take place at the surface of the solid.
- (c) Accordingly in the case of the present reaction, which was required to proceed with homogeneous catalysis, the skilled person would employ a solution of the catalyst as taught by D9.
- (d) It would be appropriate to use a solvent which did not itself give rise to side reactions, for example a component which was in any case already present in the reaction system and which could serve as a solvent. In D9 water was employed for this purpose.
- (e) The skilled person was aware that other components of the reaction medium would also be suitable for use as solvents. This was established for example by D1 (page 4, lines 20, 21) which taught that catalyst components could be added in the form of solutions in water, phenol, oligo- or polycarbonate.
- (f) Similarly D3, D4, D5 and D6 proposed using phenol or a monomer as a solvent for catalyst components. Phenol had a particular significance in this

context since, unlike monomers or oligo- or polycarbonates this would not lead to any subsequent reactions.

- (g) Phenol was also suitable as an alternative to water due to the higher boiling point which had the consequence that the dissolved catalysts would have more time to become homogeneously distributed in the reaction system at the reaction temperature before the solvent was fully evaporated.
- (h) Accordingly the skilled person would clearly have used phenol as a solvent for the nitrogen-containing basic compound in the expectation of achieving a more homogeneous distribution of the catalyst in the reaction mixture and thus to suppress side reactions and as a result obtain a product with lower YI and reduced water resistance haze.

IX. With a letter received on 18 December 2008 the appellant announced that it would not attend the oral proceedings.

X. Oral proceedings were held on 8 January 2009 attended only by the respondent (see section IX above).

- (a) With respect to the argument of the appellant in the submission of 7 October 2008 that it would be obvious to use a solution of the catalyst to improve distribution thereof (see section VIII.(b) above) it was submitted that no evidence had been provided that this had been known to the skilled person prior to the priority date of the patent in suit.

This argument rather appeared to be based on a statement in paragraph [0011] of the patent in suit in the context of an explanation of how the invention worked. This passage was however not presented as representing the knowledge of the skilled person.

- (b) Even if this had been known to the skilled person the conclusion would have been that any solvent would have given rise to the desired effects.
- (c) The evidence of Practical (i.e. illustrative) Examples 1-3 and Comparison Examples 1-3 of the patent in suit demonstrated that superior results were obtained only when the claimed monohydroxy aromatic solvent was employed. In particular the Practical Examples showed initial stage yellowness indices of 1.25-1.36 while the Comparison Examples reported values of 1.55-1.83. A similar trend was demonstrated for the water haze resistance values.
- (d) With regard to the arguments advanced with respect to the teachings of D1 and D3-D6 it was submitted that these disclosed different reactions employing different catalysts. There was no evidence in these documents that improved results would have been obtained if the nitrogen-containing basic catalysts had been employed dissolved in aromatic monohydroxy compounds.

XI. The Appellant (opponent) requested that the decision under appeal be set aside and that the European patent EP-B1-0 719 816 be revoked.

The Respondent (patent proprietor) requested that the appeal be dismissed.

Reasons for the Decision

1. The appeal is admissible.
2. *Art 123(2) and (3) EPC.*
 - 2.1 The claims have been amended compared to the patent as granted. Accordingly it is necessary to examine whether the resulting amended claims meet the requirements of Art. 123(2) and (3) EPC (G 9/91, OJ EPO 1993, 408, Reasons 19).
 - 2.2 Claim 1 is based on the subject matter of claim 1 as originally filed and claim 3 as originally filed (aromatic monohydroxy compound).
Claims 2, 3, 4 and 5 are identical to claims 2, 4, 5 and 6 as originally filed respectively.

Accordingly the amended claims meet the requirements of Art. 123(2) EPC.

- 2.3 Compared to claim 1 as granted the scope of operative claim 1 has been restricted to aromatic monohydroxy compounds, the alternative aliphatic monohydroxy compounds having been deleted.

Accordingly the amended claims meet the requirements of Art. 123(3) EPC.

3. *Novelty*

3.1 The decision under appeal held that the subject matter of the operative claims was novel with respect to the disclosure of D1 (see section III.(a) above), which finding was not challenged by the appellant. The appellant further submitted that the subject matter of the operative claims was distinguished from the disclosure of D2 (see section V.(a) above).

3.2 The Board is satisfied that the conclusion of the decision under appeal is correct since the relevant disclosures of D1 (comparative example 5) and D2 (comparative example 6) employ methanol, i.e. an aliphatic monohydroxy compound as the solvent for the nitrogen-containing basic compound (see section III.(a) above with respect to the findings of the decision under appeal with respect to D1).

This subject matter is excluded from the scope of the operative claims due to the restriction to aromatic monohydroxy compounds as the solvent or dispersant for the nitrogen-containing basic compound.

3.3 Accordingly the subject matter of operative claim 1 and consequently also of the dependent claims 2-5 is novel.

3.4 The subject matter of the operative claims is therefore novel (Art. 54 EPC).

4. *The patent in suit - the technical aims*

4.1 According to paragraphs [0001] and [0009] of the patent in suit the aims of the invention are to provide a method for manufacturing polycarbonate in which an

aromatic dihydroxy compound and a carbonic acid diester are subjected to melt polycondensation, using a small amount of catalyst allowing polycarbonate to be obtained which shows outstanding colour-matching properties, has outstanding retention stability during moulding (thermal stability, colour-matching stability) and shows outstanding water resistance.

- 4.2 According to paragraph [0010] and claim 1 of the patent in suit (see section I above) this problem is solved by a method characterized in that when an aromatic dihydroxy compound and a carbonic acid diester are subjected to a melt polycondensation in the presence of a catalyst including a nitrogen-containing basic compound (designated "(a)") this compound is dissolved or dispersed in an aromatic monohydroxy compound or aqueous solution thereof to make a catalyst solution which is added to the melt polymerisation reaction system.
- 4.3 According to paragraph [0052] of the patent in suit a combination of the compound (a) with an alkali metal compound and/or an alkaline earth metal compound, for example NaOH (paragraph [0054]) (designated "(b)") may be employed as the catalyst.
- 4.4 According to paragraphs [0061] and [0062] of the patent in suit a combination of the above mentioned basic catalysts (a) and (b) with a boric acid compound (designated "(c)") for example boric acid and boric acid esters may be employed.
- 4.5 The Practical Examples 1-3 (i.e. according to the invention) and Comparison Examples 1-3 demonstrate the

effects of employing the nitrogen-containing basic compound in the presence of a monohydroxy aromatic compound and in the presence of water. The results of these examples are summarised in Table 1 of the patent in suit, the relevant parts of which are reproduced below.

Table 1

	Practical Example 1	Practical Example 2	Practical Example 3
Catalyst dispersion			
(a) Alkali compound (x 10 ⁻⁷ moles/BPA)	NaOH 10	NaOH 10	NaOH 10
Monohydroxy compound (x 10 ⁻⁷ moles/BPA)	Phenol 100	Phenol 300	- -
Water (x 10 ⁻⁷ moles/BPA)	600	2000	-
(b) Nitrogen-containing compound (x 10 ⁻⁴ moles/BPA)	Tetramethylammonium hydroxide 2.5	Tetramethylammonium hydroxide 2.5	Tetramethylammonium hydroxide 2.5
Monohydroxy compound (x 10 ⁻⁴ moles/BPA)	Phenol 3.0	Phenol 3.0	Phenol 3.0
Water (x 10 ⁻⁴ moles/BPA)	20	20	20
Addition method	Solutions (a) and (b) added after mixing	Solutions (a) and (b) added separately	Solutions (a) and (b) added separately
[B] Acidic compound Amount used (mole factor/ catalyst (a))	butyl p-toluenesulfonate 2.0	butyl p-toluenesulfonate 2.0	butyl p-toluenesulfonate 2.0
[C] Water (ppm)	100	100	100
Initial-stage properties			
[IV] (dl/g)	0.49	0.49	0.49
MFR (g/10 minutes)	10.3	10.3	10.3
YI	1.25	1.32	1.36
Optical transmittance (%)	90.8	90.8	90.8
Haze	0.2	0.2	0.2
Retention stability			
MFR (g/10 minutes)	10.5	10.5	10.5
MFR increase rate (%)	2	2	2
YI	1.33	1.40	1.42
Water-resistance Haze	1.7	1.7	1.8

	Comparison Example 1	Comparison Example 2	Comparison Example 3
Catalyst dispersion			
(a) Alkali compound (x 10 ⁻⁷ moles/BPA)	NaOH 10	NaOH 10	NaOH 10
Monohydroxy compound (x 10 ⁻⁷ moles/BPA)	Phenol 300	- -	- -
Water (x 10 ⁻⁷ moles/BPA)	-	-	600
(b) Nitrogen-containing compound (x 10 ⁻⁴ moles/BPA)	Tetramethylammonium hydroxide 2.5	Tetramethylammonium hydroxide 2.5	Tetramethylammonium hydroxide 2.5
Monohydroxy compound (x 10 ⁻⁴ moles/BPA)	-	-	-
Water (x 10 ⁻⁴ moles/BPA)	20	20	20
Addition method	Solutions (a) and (b) added separately	Solutions (a) and (b) added separately	Solutions (a) and (b) added after mixing
[B] Acidic compound Amount used (mole factor/ catalyst (a))	butyl p-toluenesulfonate 2.0	butyl p-toluenesulfonate 2.0	butyl p-toluenesulfonate 2.0
[C] Water (ppm)	100	100	100
Initial-stage properties			
[IV] (dl/g)	0.49	0.49	0.49
MFR (g/10 minutes)	10.3	10.3	10.3
YI	1.55	1.83	1.80
Optical transmittance (%)	90.8	90.8	90.8
Haze	0.2	0.2	0.2
Retention stability			
MFR (g/10 minutes)	10.5	10.5	10.5
MFR increase rate (%)	2	2	2
YI	1.64	2.13	2.10
Water-resistance Haze	2.0	2.7	2.6

4.6 The following may be deduced from these data:

4.6.1 Practical (i.e. illustrative) Example 3 adds the basic nitrogen compound together with phenol and water; Comparison Example 2 employs only water. These two examples are in all other respects identical.

4.6.2 The resulting yellowness index (YI) at the "initial stage" is 1.36 and 1.83 respectively, i.e. the "Practical" example has lower YI (i.e. better colour) than the "Comparison" example. The YI values determined

after heating at 320°C for 15 minutes (designated "Retention Stability" - see paragraph [0152] of the patent in suit) are 1.42 and 2.13 respectively.

- 4.6.3 Thus the YI of the polycarbonate prepared according to the process of the invention at the initial stage is lower than that of the product of the Comparison Example.
- 4.6.4 It is also the case that the YI of the product of the Practical Example (even) after heat aging is lower than the YI of the product of the comparison example as measured at the "initial stage" (1.42 compared to 1.83).
- 4.6.5 Further the extent of increase of YI upon heating in the case of the inventive example is by a factor of 1.04 whereas in the case of the comparison example it is by a factor of 1.16, i.e. a 4-fold greater (relative) increase in YI.
- 4.6.6 Comparison Example 1 differs from the above mentioned Practical Example 3 in that although phenol is present, this is added together with the alkali metal compound (NaOH) (b) rather than with the nitrogen-containing basic compound (a).
- 4.6.7 In this case the YI values of the product of Comparison Example 1 before/after heat aging are 1.55 and 1.64 respectively, i.e. in both at the "initial stage" and regarding "retention stability" higher than the YI of the aged sample of Practical Example 3 (1.42) according to the invention.

- 4.6.8 The results in respect of the water-resistance haze show corresponding trends: Practical Example 3 reports a value of 1.8, whereas Comparison Examples 1 and 2 give values of 2.0 and 2.7 respectively.
- 4.6.9 The results of Comparison Example 2 show that it is not sufficient to have merely some kind of solvent (e.g. water) present but that it is necessary that phenol be employed.
- 4.6.10 The results of Comparison Example 1 further show that it is not sufficient simply to have phenol present in some part or manner in the system but that it must be added together or in association with the nitrogen-containing basic compound (a).
- 4.7 The evidence of the examples thus shows that the technical aims of the patent are achieved by the measures specified in claim 1, i.e. the use of the nitrogen-containing basic compound dissolved or dispersed in an aromatic monohydroxy compound or aqueous solution thereof.
5. *The closest prior art*
By common consent D9 represents the closest prior art.
- 5.1 D9 relates according to claim 1 thereof to a process for the production of polycarbonate by melt polycondensation of an aromatic dihydroxy compound and a carbonic acid diester. The polycondensation is carried out in the presence of 0.05-15 mol% per mole of the aromatic dihydroxy compound of a phenol having 10-40 carbon atoms or a carbonic acid diester having 13 to 50 carbon atoms preferably 17 to 50 carbon atoms

(claim 6). On page 2, lines 35-55 these two variants are designated "first process" and "second process respectively".

According to page 2 line 56ff there is a further variant (designated "third process") which is characterised by carrying out the melt polycondensation in the presence of 0.05-15 mol% based on 1 mole of the aromatic dihydroxy compound of a carbonic acid diester having from 13 to 16 atoms.

All three variants of the process are carried out using a catalyst comprising:

- (a) a nitrogen-containing basic compound;
- (b) an alkali metal or alkaline earth metal compound and optionally
- (c) boric acid or boric acid ester (see also page 8 line 20 of D9).

5.2 According to the paragraphs entitled "Field of the Invention", "Background of the Invention" and "Object of the Invention" the aim of D9 was to provide process for the production of polycarbonates having excellent colour tone, heat resistance and water resistance. These aims correspond to those of the patent in suit (see section 4.1 above).

This is achieved according to page 2, lines 24-27 of D9 by reducing terminal hydroxy groups of polycarbonates being formed by end capping them with specific compounds.

This end capping is accomplished by the use of the phenol (as explained at page 4 lines 39-44), or by use of the carbonic acid diester compound having 17 to 50 or 13 to 16 carbon atoms as explained at page 6

lines 10-15 and page 6 lines 34-37 respectively.

- 5.3 The catalysts are discussed starting at page 7 line 13 of D9. It is taught that preferably combinations of all three named catalysts are employed since this yields much higher polymerisation activity and a better quality of product with respect to heat resistance water resistance, colour tone and transparency than when the boric acid or boric acid ester compound is absent (page 8 lines 24-29).

There is no discussion in the description of D9 of adding any of the catalyst components in the form of a solution of any kind.

- 5.4 Example 1 of D9 discloses a process whereby the nitrogen-containing basic catalyst component is added in the form of an aqueous solution. The other examples refer back to example 1 and therefore also add the nitrogen-containing basic catalyst in this manner.

- 5.5 In view of the correspondence between the technical problem underlying D9 and that of the patent in suit, and the correspondence between the means for achieving this (melt polycondensation, same catalyst components) the Board is satisfied that D9 represents the closest state of the art.

6. *The objective technical problem compared to D9*

- 6.1 The subject matter of the operative claims is distinguished from the teaching of D9 by the feature that the nitrogen-containing basic compound is dissolved or dispersed in an aromatic monohydroxy compound or an aqueous solution thereof.

6.2 Comparison example 2 of the patent in suit corresponds to the teaching of the examples of D9 in that the nitrogen-containing basic compound is added in the form of an aqueous solution (see sections 4.5, 4.6 and 5.4 above).

6.3 As explained above (section 4.6) the evidence of the examples of the patent in suit is that the effect of employing the nitrogen-containing basic compound (a) dissolved or dispersed in an aromatic monohydroxy compound is to yield a polycarbonate having improved colour, and improved stability to heat and water as compared to the polycarbonate obtained when operating according to the process disclosed in D9, i.e. adding the nitrogen-containing basic compound as an aqueous solution.

These effects correspond to the aims set out in the patent in suit (see section 4.1 above) and according to the evidence arise from the distinguishing feature with respect to D9.

6.4 Accordingly the problem set out in the patent in suit can be adopted as the objective problem to be solved with respect to the closest prior art D9.

7. *Obviousness*

7.1 D9 itself does not provide any discussion of the manner of adding the nitrogen-containing basic compound.

7.2 Regarding the submission of the appellant that it was known that incorporating a catalyst in a solvent would result in a more homogeneous distribution of the catalyst and hence fewer side reactions (see section VIII.(b) above) the Board notes that the Appellant has

not identified any basis for this submission in the prior art. On the contrary, and as submitted by the respondent (see section X.(a) above), the only basis for this statement appears to be in the patent in suit itself (paragraph [0011]).

Accordingly as it has not been shown that this was known in the prior art, this argument cannot be taken into account in the assessment of inventive step.

However, even if such a teaching had been identified in the prior art, the examples of the patent in suit, as explained in section 4.6 above show that the use of a solvent or dispersant as specified in the claims gives rise to a technical effect compared to the solvent employed in D9 (water). No evidence has been advanced that the effect arising from the use of the specified type of solvent was known or could have been predicted from the prior art.

- 7.3 D3 has been alleged to render the use of the specified solvent for the nitrogen-containing basic compound modification obvious (see sections V.(h) and VIII.(f) above).
- 7.3.1 D3 relates to a process for producing a polycarbonate by melt polycondensation of an aromatic organic dihydroxy compound with a carbonic diester (claim 1). D3 is also concerned with the provision of polycarbonates excellent in mechanical properties, heat resistance and transparency (page 2 second complete paragraph).
- 7.3.2 According to D3 an obstacle to obtaining products with the desired properties arises from the problems associated with distilling off the phenol byproduct

(paragraph bridging pages 2 and 3). Various types of apparatus are considered inadequate in this respect, *inter alia* due to the thermal stress to which the polymer is exposed. One such apparatus explicitly identified as inadequate is a centrifugation thin film evaporating apparatus (page 3 line 14, page 4 line 6). The Board observes that such an apparatus is employed in the examples of the patent in suit (paragraph [0157]).

7.3.3 The solution proposed by D3 is to employ a specific evaporation apparatus of defined construction (page 5 under "Summary of the Invention).

This apparatus is also specified in claim 1 of D3. Accordingly it is apparent that this particular apparatus forms the core of the invention of D3.

7.3.4 The discussion of the catalyst to be employed commences in the final paragraph of page 13 of D3. It is disclosed that it is particularly preferable to use a catalyst containing two or three components designated as (a), (b) and (c) which are of the same classes as those compounds employed as catalysts in the patent in suit and in D9, namely:

- (a) a nitrogen-containing basic compound;
- (b) an alkali metal compound or an alkaline earth metal compound and
- (c) boric acid or boric ester (i.e. boric acid ester).

These components can be used in any combination i.e. (a) and (b), (a) and (c), (b) and (c) or all of (a) (b) and (c) (page 13 final paragraph and page 16, final paragraph).

Thus unlike the process of the patent in suit the use of a nitrogen-containing basic compound is not

mandatory according to the invention of D3.

- 7.3.5 Starting at the second line of page 17 of D3 a process for producing a polycarbonate according to the method of D3 is disclosed.

In the final paragraph of page 17 it is taught that the boric acid or boric acid ester catalyst component is dissolved in a monomer or phenol and then added to the reactor.

In the first paragraph of page 18 it is taught that in a further stage the nitrogen-containing basic compound and/or the alkali metal or alkaline earth compound are added. However it is not stated in what form these components are added.

- 7.3.6 Accordingly D3 does not contain any teaching, that in the - non-mandatory - case that the nitrogen-containing basic compound is employed this be added in the form of a solution or dispersion in a monohydroxy aromatic compound or an aqueous solution thereof.

- 7.3.7 The argument of the appellant (see sections V.(h) - (j) and VIII.(f) above) that the skilled person, in the light of the teaching in D3 relating to the addition of the boric acid compound in solution in phenol, would find it obvious to modify the process of D9 by adding a different component of the catalyst (the nitrogen-containing basic compound) in a solution or dispersion in an aromatic monohydroxy compound assumes firstly that the skilled person with knowledge of D9 and seeking to address the problem underlying the patent in suit would even consult D3. It has not been explained

why the skilled person would do so, in particular since the route adopted in D3, i.e. use of a specific evaporation apparatus to remove unwanted byproducts is unrelated to the route adopted in D9 (capping of hydroxyl end groups). Secondly, even if the skilled person with knowledge of D9 were nevertheless to consult D3 it would be necessary initially to elect to discard the central teaching of D3, i.e. the use of the specific evaporation apparatus and then to make a number of selections from the residual disclosure thereof in order to arrive at the required modification of the teaching of D9. None of these required modifications is however taught or even hinted at in D3:

- Firstly it would be necessary to select to employ instead of the boric acid or boric acid ester a different component of the catalyst in the form of a solution.
- Secondly it would be necessary to select which of the other two components of the catalyst to so add.
- Thirdly it would be required to select between phenol or monomer as the solvent for said component of the catalyst.

7.3.8 From the foregoing it is apparent that there is no teaching in D9 that would lead the skilled person to consult D3 in order to address the problems underlying the patent in suit. Even if D3 were to be consulted it would be necessary to make a number of selections, one of which discards the central teaching of the disclosure, and the others of which have no basis

therein.

Accordingly it would not be obvious to make the indicated modifications to the teaching of D9 in the light of D3.

7.3.9 Even if the skilled person were nevertheless to combine the teachings of D9 and D3 in the manner proposed by the appellant and make the necessary selections from the disclosure of D3 there remains the matter of the technical effects that have been demonstrated to arise from making said modification to the teaching of D9 (discussed in sections 4 and 6 above).

7.3.10 As explained in section 7.2 above, the appellant has failed to establish that there is an indication either in D9, D3 or in any other of the documents cited by the appellant that would lead the skilled person to expect a technical effect of any kind to arise as a result of employing the nitrogen-containing basic compound dissolved or dispersed in an aromatic monohydroxy compound or solution thereof, let alone the particular technical effects demonstrated by the examples and comparative examples of the patent in suit.

7.3.11 Accordingly it is concluded that the subject matter of operative claim 1 is not rendered obvious by the cited prior art.

7.4 The teachings of the documents D4, D5 and D6 correspond essentially to those of D3, in particular these documents employ the same apparatus for accomplishing the removal of by-products, and also include the same teaching regarding the mode of addition of the boron compound.

Accordingly the analysis presented, and conclusions reached with respect to D3 apply also to the teachings of these documents.

7.5 The appellant has also submitted that the subject matter of the operative claims would be rendered obvious by the combination of D9 with the teachings of D1, page 4 lines 20 and 21 (see section VIII.(e) above).

7.5.1 D1, like the patent in suit relates to a melt polycondensation process for the preparation of polycarbonate starting from aromatic dihydroxy compounds and carbonic acid diesters. The aim of D1 is to provide low branched polycarbonates in order to obtain products with improved optical and mechanical properties (see page 2 lines 3-5 and 22-27). According to page 2 lines 51-54 and claim 1 of D1, this is achieved by a process carried out in two steps, with a different catalyst in each stage. As catalysts for the first step either quaternary ammonium compounds, i.e. nitrogen-containing basic compounds or phosphonium compounds may be employed (claim 1). In the second step alkali metal or alkaline earth metal compounds are employed.

7.5.2 Accordingly although the process of D1 addresses broadly the same aims as the closest prior art D9, i.e. to obtain polycarbonates with improved optical and mechanical properties, a different strategy is adopted. Accordingly there would not in the view of the Board be any reason for the skilled person to consult D1 in the expectation of finding information which would be relevant to the problem of identifying further

optimisations or improvements of the process of D9.

7.5.3 Even if the skilled person were nevertheless to consult D1 the required teaching is not provided thereby.

7.5.4 The passage of D1 referred to by the appellant (page 4 lines 20, 21) teaches that the catalyst employed in the second step, i.e. the alkali metal or alkaline earth metal compound may be added in the form of a solid, or as a solution in water, phenol, oligo- or polycarbonate.

7.5.5 Thus similarly to the position with respect to D3, it is necessary to make a number of selections from D1, the first of which is to apply the said teaching to a different catalyst component employed in a different stage of the process.

There is no basis in D1 for making such a selection.

7.5.6 Even if such a selection were to be made, a further selection would then be required because D1 teaches that one of two types of compound may be employed in the first stage (ammonium or phosphonium compounds). Thus it would be necessary to select which of the two permitted first stage catalysts of D1 to so add, i.e. the nitrogen-containing basic compound.

7.5.7 Having made these selections, for which there is no indication in D1, it is then necessary to select the solvent or dispersant from the list of four given. No preference is given in this list nor is there any teaching that would lead the skilled person to favour any one of these for any reason. In particular there is no teaching that would lead the skilled person to expect that one of these four classes of compounds

might be expected to give rise to any technical effects, let alone those specifically demonstrated in the patent in suit (see section 4.6 above).

7.5.8 Accordingly it is concluded that the combination of the teachings of D9 and D1 necessary to arrive at the subject matter of the operative claims is not derivable in an obvious manner from the disclosures thereof, even if the skilled person would consider these documents in combination in the first place.

Further there is no teaching in D1 that would lead the skilled person to expect that the technical effects demonstrated in the patent in suit would be obtained by the features specified in operative claim 1.

7.5.9 Accordingly it is concluded that the combination of the teachings of D9 and D1 does not render the subject matter of claim 1 obvious.

7.6 In the light of the considerations in the foregoing sections 7.1 to 7.5 it is therefore concluded that the subject matter of operative claim 1 is not derivable in an obvious manner from the cited prior art.

Since claims 2, 3, 4 and 5 are dependent on claim 1 this conclusion applies *mutatis mutandis* to the subject matter of these claims.

7.7 The subject matter of the operative claims is therefore inventive (Art. 56 EPC).

Order

For these reasons it is decided that:

The appeal is dismissed.

The Registrar:

The Chairman:

E. Görgmaier

R. Young