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# Datasheet for the decision
# of 10 March 2015

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| **Case Number:** | T 1933/11 - 3.3.03 |
| **Application Number:** | 01913129.1 |
| **Publication Number:** | 1272547 |
| **IPC:** | C08G75/23, C08G65/40 |
| **Language of the proceedings:** | EN |

**Title of invention:**
LOW COLOR POLY(BIPHENYL ETHER SULFONE) AND IMPROVED PROCESS FOR THE PREPARATION THEREOF

**Patent Proprietor:**
Solvay Specialty Polymers USA, LLC.

**Opponent:**
BASF SE

**Relevant legal provisions:**
EPC Art. 123(3), 83, 54, 56

**Keyword:**
Amendments - broadening of claim
(yes) Main request and first to fourth auxiliary requests
Amendments - broadening of claim (no) Fifth auxiliary request
Sufficiency of disclosure - (yes) Fifth auxiliary request
Novelty - (yes) Fifth auxiliary request
Inventive step - (no) Fifth to ninth auxiliary requests

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**Case Number: T 1933/11 - 3.3.03**

# DECISION
# of Technical Board of Appeal 3.3.03
# of 10 March 2015

**Appellant II:**
(Patent Proprietor)

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**Decision under appeal:**

**Interlocutory decision of the Opposition Division of the European Patent Office posted on 6 July 2011 concerning maintenance of the European Patent No. 1272547 in amended form.**

**Composition of the Board:**

**Chairwoman** B. ter Laan
**Members:** D. Marquis
C. Brandt

## Summary of Facts and Submissions

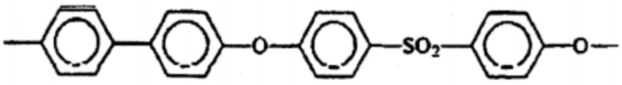
I. The appeals by the opponent and the patent proprietor lie from the decision of the opposition division dated 6 July 2011 maintaining European patent N° 1 272 547 (based on application number 01 913 129.1) in amended form.

II. An opposition against the patent had been filed in which the revocation of the patent was requested on the grounds according to Article 100(a) EPC (lack of novelty and lack of inventive step) and Article 100(b) EPC.

III. The patent as granted contained 10 claims, of which independent claims 1, 4, 8 and 10 read as follows:

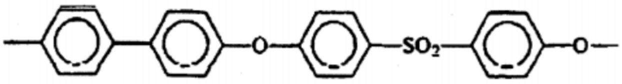
"1. Method for preparing a poly(biphenyl ether sulfone) comprising contacting in a polymerization reaction mixture substantially equimolar amounts of at least one bishydroxybiphenyl compound and at least one dihalodiaryl sulfone with an alkali metal carbonate in the presence of a solvent comprising a polar aprotic solvent to form the poly(biphenyl ether sulfone), characterized in that the alkali metal carbonate is a solid particulate anhydrous potassium carbonate having an average particle size of up to 100 microns."

"4. Poly(biphenyl ether sulfone) having a Molded Color Factor of less than 200 comprising the structural unit



"

"8. Poly(biphenyl ether sulfone) comprising the following structural unit:



having a Solution Color Factor no greater than 50, determined at 8 wt % in a solvent mixture of monochlorobenzene, sulfolane and N-methylpyrolidone, at a 3:2:2 ratio by weight."

"10. Articles made from a poly(biphenyl ether sulfone) chosen from the poly(biphenyl ether sulfone) according to Claim 4 and the poly(biphenyl ether sulfone) prepared by the method according to Claim 1."

Claims 2 to 3 were directed to preferred embodiments of claim 1. Claims 5 to 7 were directed to preferred embodiments of claim 4. Claim 9 was directed to a preferred embodiment of claim 8.

IV. In its decision the opposition division referred *inter alia* to the following documents:

D4: R. Viswanathan et al. Polymer 1984, 25, 1827-1836
D6: EP0347669 A2
D7: US5194561
D8: EP0412499 A2
D10: DE-OS-33 42 433
D12: J.L. Hedrick et al., J. Polymer Science: Polymer Chemistry Edition, Vol. 23, 287-300 (1986)
D13: R. Viswanathan, Ph.D. Thesis, 1981, (Virginia Polytechnic Institute and State University
D18: Comparative examples filed with the Notice of Opposition

D18a: Letter of the Opponent dated 9 November 2010
D19: "Essais de la laboratoire de synthese de poly(biphenyl éther sulphone) PPSU en présence se sulpholane comme solvant aprotique."
D20: "General reaction protocol used by the Patentee for the preparation of poly(biphenyl ether sulfone) using NMP as the aprotic solvent, color assessment and RV measurement."
D21: "Premier ensemble de polymérisation en présence de NMP, et ses résultats."
D22: "Second ensemble de polymérisations en présence de NMP, et ses résultats."
D23: "Troisième ensemble de polymérisation en présence de NMP, et ses résultats."
D24: "Synthèse comparée de poly(éther sulfone) [diol = 4,4'-dihydroxy-diphényl sulfone] et de poly(biphényl éther sulfone) diol = 4,4' biphénol] en presence de NMP comme solvant aprotique."
D35: Translation of the document into English of JP 4-202431

In the decision it was held that the claims as granted were sufficiently disclosed and were novel in view of *inter alia* D6 and D35. The opposition division also found that claim 1 was inventive in view of D6 as the closest prior art. Starting from D6, the technical problem was seen as providing a further process for the production of copolymers from bishydroxy biphenyl and dichlorodiphenylsulfone having low color factors. The opposition division concluded that none of the documents D6, D7, D8, D10, D13 or D35, taken either alone or in combination, suggested a process using potassium carbonate of a particle size of up to 100 microns. The opposition division however found that the subject matter of claims 4 and 8 did not involve and inventive step. That also applied to the corresponding claims of auxiliary requests 1 to 10. As auxiliary request 11 was limited to the process of claims 1 to 3, it was found to be patentable.

V. On 2 September 2011, the patent proprietor (appellant II) lodged an appeal against the decision of the opposition division. The statement setting out the grounds of the appeal was filed on 9 November 2011. The patent proprietor requested that the decision of the opposition division be set aside and the patent be maintained on the basis of the main request or any of nine auxiliary requests. With the statement of grounds of appeal, the patent proprietor filed two sets of experimental evidence D36 and D37. By letter dated 20 March 2012, the patent proprietor filed a reply to the statement of grounds of the appeal of the opponent.

VI. On 6 September 2011, the opponent (appellant I) lodged an appeal against the decision of the opposition division. The statement setting out the grounds of the appeal was filed on 16 November 2011. The opponent requested that the decision of the opposition division be set aside and that the patent be revoked. By letter dated 30 Mai 2012, the opponent filed a reply to the statement of grounds of the appeal of the patent proprietor to which Annex M1 was attached (declaration of Prof. Dr. Rolf Mülhaupt).

VII. On 28 October 2014, the board summoned the parties to oral proceedings on 10 March 2015.

VIII. By letter dated 19 December 2014, the opponent filed filed further arguments in view of D37.

IX. In preparation of oral proceedings, on 5 February 2015 a communication providing the preliminary opinion of the Board was sent to the parties.

X. With letter dated 19 February 2015, the patent proprietor filed a reply and provided a new version of the main request as well as of the first and fifth to ninth auxiliary requests. The auxiliary requests 2 to 4 provided with the statement of grounds of appeal were maintained.

*Main request*

Claims 1 and 8 of the main request were as granted. Claim 10 of the main request read:

"10. Articles made from a poly(biphenyl ether sulfone) according to Claims 4 to 9."

The reference in claim 10 to product claims 4 to 9 therefore included a reference to claim 8, which was directed to a poly(biphenyl ether sulfone) having a Solution Color Factor no greater than 50.

*First to fourth auxiliary requests*

The first to fourth auxiliary requests all contained a claim pertaining to articles that corresponded to claim 10 of the main request and depended on product claims, amongst which a claim corresponding to claim 8 as granted.

*Fifth auxiliary request*

Claim 1 of the fifth auxiliary request was as granted. A claim to articles made from a poly(biphenyl ether sulfone) according to claim 8 was no longer present.

*Sixth auxiliary request*

Claim 1 read (compared to the claim as granted: addition in **bold**, deletion in ~~strikethrough~~):

"1. Method for preparing a poly(biphenyl ether sulfone) comprising contacting in a polymerization reaction mixture substantially equimolar amounts of at least one bishydroxybiphenyl compound and at least one dihalodiaryl sulfone with an alkali metal carbonate in the presence of a solvent comprising a polar aprotic solvent to form the poly(biphenyl ether sulfone), characterized in that the alkali metal carbonate is a solid particulate anhydrous potassium carbonate having an average particle size of up to ~~100~~ **60** microns."

*Seventh auxiliary request*

Claim 1 read:

"1. Method for preparing a poly(biphenyl ether sulfone) comprising contacting in a polymerization reaction mixture substantially equimolar amounts of at least one bishydroxybiphenyl compound and at least one dihalodiaryl sulfone with an alkali metal carbonate in the presence of a solvent comprising a polar aprotic solvent to form the poly(biphenyl ether sulfone), characterized in that the alkali metal carbonate is a solid particulate anhydrous potassium carbonate having an average particle size of up to ~~100~~ **30** microns."

*Eighth auxiliary request*

Claim 1 read:

"1. Method for preparing a poly(biphenyl ether sulfone) comprising contacting in a polymerization reaction mixture substantially equimolar amounts of at least one bishydroxybiphenyl compound and at least one dihalodiaryl sulfone with an alkali metal carbonate in the presence of a solvent comprising a polar aprotic solvent to form the poly(biphenyl ether sulfone), characterized in that the alkali metal carbonate is a solid particulate anhydrous potassium carbonate having an average particle size of ~~up to 100 microns~~ **of from 10 to 40 µm and characterized in that at least 80 % of said particles lie within a range of from 100 µm to 10 µm.**"

*Ninth auxiliary request*

Claim 1 of the ninth auxiliary request was as granted. Claims to a poly(biphenyl ether sulfone) or to articles made therefrom were no longer present.

XI. Oral proceedings were held on 10 March 2015.

XII. The opponent's arguments may be summarised as follows:

*Main request and first to fourth auxiliary requests*

Article 123(3) EPC

Claim 10 as granted did not refer to the subject matter of claim 8, but claim 10 of the main request now included a reference to claim 8 and therefore included an article made from a poly(biphenyl sulfone) having a solution color factor no greater than 50. The subject matter of claim 10 of the main request had therefore been amended in such a way that it extended the protection conferred by the granted claims. That argument also applied to the claim relating to an article in any of the first to fourth auxiliary requests.

*Fifth auxiliary request*

Article 83 EPC

The subject matter of claims 1, 4 and 8 was not sufficiently disclosed. The average particle size of the potassium carbonate was not clearly defined in claim 1 so that a person skilled in the art could find particle size distributions that would not provide a polymer having the required color properties. The color factors of the polymers of claims 4 and 8 were not clearly defined. The examples provided in D18 showed that a polymer according to claims 4 and 8 could not reliably be obtained on the basis of the process disclosed in the patent in suit.

Article 54 EPC

Example 2 of D6 disclosed a method of preparation of poly(biphenyl ether sulfone)s. The average particle size of the potassium carbonate particles was not explicitly disclosed in D6 but it could be deduced from the parameters of the process disclosed in D6 correlated with the value of the reduced viscosity of the produced polymer. Annex M1 provided that correlation between several average particle sizes of potassium carbonate particles and the reduced viscosity of the polymer produced according to example 2 of D6. The average particle size of the potassium carbonate particles obtained from that correlation was below 100 µm. Claim 1 lacked novelty over D6.

Example 2 of D35 disclosed a process of polymerization of hydroquinone and 4,4'-dichlorodiphenyl sulfone in N-methylpyrolidone as a solvent in the presence of anhydrous potassium carbonate having a particle size below 100 µm. The use of 4,4'-biphenol as diphenol compound in that process was implicit. Claim 1 therefore lacked novelty over D35.

Article 56 EPC

The closest prior art was D6. Starting from D6, the problem that was shown to have been solved in the patent in suit was providing a further process for the preparation of poly(biphenyl ether sulfone)s. The use of potassium carbonate particles having an average particle size of up to 100 µm was already known from the prior art documents D35 and D7. Claim 1 therefore lacked an inventive step.

*Sixth to ninth auxiliary requests*

Article 56 EPC

The same arguments applied to claim 1 of the sixth to ninth auxiliary requests. Claim 1 of those requests also lacked inventive step.

XIII. The patent proprietor's arguments may be summarised as follows:

*Main request and first to fourth auxiliary requests*

Article 123(3) EPC

Paragraph 81 of the specification disclosed that the polymer of claim 8 as granted resulted from the process of claim 1. The subject matter of claim 10 when it depended on claim 8 of the main request was therefore based on claim 1 as granted. Claim 10 of the main request satisfied the requirements of Article 123(3) EPC. The same was valid for the corresponding claims of the first to fourth auxiliary requests.

*Fifth auxiliary request*

Article 83 EPC

Paragraphs 39 to 47 and 58 to 60 of the patent in suit showed how the method of claim 1 could be carried out. The methods of measurement of the color factors of the polymers were disclosed in the patent in suit. The requirements of Article 83 EPC were met.

Article 54 EPC

D6 did not disclose the average particle size of the potassium carbonate particles used. Annex M1 was not an accurate repetition of the process of example 2 of D6 so that it could not provide the size of the particles used in that example. Claim 1 was novel over D6.

The preparation process of example 2 of D35 combined with the list of diphenol compounds of page 3 could not be seen as a novelty destroying disclosure for claim 1 of the fifth auxiliary request.

Article 56 EPC

D6 was the closest prior art. The examples of the patent in suit showed a technical effect resulting from the choice of the average particle size of the potassium carbonate. A particle size below 100 µm allowed for a quicker process at a lower temperature and provided less colored polymers. That was also shown in D19 to D24 as well as in annex M1. It was not obvious to use particles of potassium carbonate of an average particle size up to 100 µm in the process of D6. D12 with D4 and D13 disclosed that potassium carbonate of a particle size below 40 µm was not suitable for the polymerization of 4,4'-biphenol. D35 did not teach that particle sizes below 100 µm were suitable to produce poly(biphenyl ether sulfone)s. D7 taught that sodium salts were preferred over potassium. None of the cited documents taught the use of potassium carbonate of an average particle size up to 100 µm. Claim 1 was inventive over D6 as the closest prior art.

*Sixth to ninth auxiliary requests*

Article 56 EPC

For the sixth to ninth auxiliary requests no further arguments were provided.

XIV. The opponent requested that the decision under appeal be set aside and that the patent be revoked.

The patent proprietor requested that the decision under appeal be set aside and that the patent be maintained on the basis of the main request or the first auxiliary request, both filed with letter dated 19 February 2015, or on the basis of any of the second to fourth auxiliary requests, filed with letter dated 8 November 2011 (statement setting out the grounds of appeal), or on the basis of any of the fifth to ninth auxiliary request, filed with letter dated 19 February 2015.

XV. The Board announced its decision at the end of the oral proceedings.

## Reasons for the Decision

1. The appeal is admissible.

*Main request*

2. Article 123(3) EPC

2.1 Claim 10 of the main request pertains to articles made from poly(biphenyl ether sulfone) according to claims 4 to 9. Claim 8 relates to a poly(biphenyl ether sulfone) having a solution color factor no greater than 50. Claim 10 as granted was dependent on claim 4 which related to a poly(biphenyl ether sulfone) having a molded color factor of less than 200, and the poly(biphenyl ether sulfone) prepared by the method according to claim 1. It did not refer to claim 8. The claims as granted did therefore not explicitly encompass articles made from poly(biphenyl ether sulfone) having a solution color factor not greater than 50, as now claimed in claim 10 of the main request.

2.2 Claim 1 as granted relates to a method of preparation of poly(biphenyl ether sulfone)s through polymerization of equimolar amounts of at least one bishydroxybiphenyl compound and at least one dihalodiaryl sulfone with solid particulate potassium carbonate having an average particle size of up to 100 microns in the presence of a solvent comprising a polar aprotic solvent. The reference in claim 10 as granted to articles obtained from poly(biphenyl ether sulfone)s prepared according to the method of claim 1 does not constitute a support for the subject matter of claim 10 of the main request since, on the basis of the wording of claim 8, it cannot be established that any of the poly(biphenyl ether sulfone)s according to present claim 8 has the properties of a product obtained by the method of claim 1, such as the equimolar amounts of constituents.

2.3 It cannot be inferred from the specification that the poly(biphenyl ether sulfone)s having a solution color factor not greater than 50 have all been prepared by the general method of claim 1. Paragraph 25 of the specification briefly mentions that poly(biphenyl ether sulfone)s may be prepared by the carbonate method, but that passage does not indicate if the poly(biphenyl ether sulfone)s obtained are those having a solution color factor in the claimed range. Besides, unlike claim 1 as granted, the method described in that passage limits the amount of alkali metal carbonate to the range of from about 0.5 to about 1.1 mol.

2.4 According to paragraph 81 of the patent in suit, "The process of this invention provides poly(biphenyl ether sulfone)s that are significantly improved in color, and the invention may therefore also be described as directed to improved poly(biphenyl ether sulfone)s having low color, more particularly as having a Solution Color Factor, determined at a concentration of 8 wt% in a mixture of MCB, sulfolane, and NMP in a 3:2:2 ratio by weight, of up to about 50, preferably up to about 40. ...". However, that passage does not specifically describe the process so that it cannot be concluded that it is actually the process of claim 1 that is meant. The passage may equally refer to the process described in the preceding paragraph 79 which is similar to that of claim 1 but is further limited to

4,4'-biphenol as the bishydroxybiphenyl compound, a specific amount of alkali metal carbonate, a solvent mixture comprising a polar aprotic solvent together with a solvent which forms an azeotrope with water and the step of removing water by continuous azeotropic distillation at an elevated temperature. The two paragraphs 79 and 81 read together suggest that poly(biphenyl ether sulfone)s having a solution color factor of not greater than 50 are obtained by a process that differs substantially from that disclosed in claim 1. The specification does therefore not establish that the poly(biphenyl ether sulfone)s as claimed in claim 8 necessarily result from the method of claim 1.

2.5 The examples of the patent in suit only show that under specific reaction conditions poly(biphenyl ether sulfone)s having a reduced viscosity in a limited range of 0.58 to 0.81 dl/g and a solution color factor comprised between 12 and 40 are produced. It cannot be concluded from those examples that any of the poly(biphenyl ether sulfone)s having a solution color factor not greater than 50 can be obtained by the general method of claim 1.

2.6 In view of the above, it cannot be concluded that the present reference in claim 10 to the product of claim 8 is identical to or narrower than the granted reference to the product obtained according to the method of claim 1. The amendment of the claim dependency in claim 10 of the main request therefore extends the protection conferred by the European patent and contravenes the requirements of Article 123(3) EPC.

3. Auxiliary requests 1 to 4 all contain an independent claim pertaining to articles made from poly(biphenyl ether sulfone)s having a solution color factor not

greater than 50. Auxiliary requests 1 to 4 therefore also contravene the requirements of Article 123(3) EPC for the same reason.

*Fifth auxiliary request*

4. Article 123(2)(3) EPC

4.1 Claims 1 to 3 of the fifth auxiliary request correspond to claims 10, 14 and 15 of the claims as originally filed. Claims 4 to 7 correspond to claims 1, 4, 5 and 6 and claims 8 and 9 correspond to claims 7 and 9 as originally filed. The requirements of Article 123(2) EPC are satisfied.

4.2 The claims of the fifth auxiliary request correspond to claims 1 to 9 of the patent as granted. The requirements of Article 123(3) EPC are satisfied.

5. Article 83 EPC

5.1 In its statement of grounds of the appeal the opponent had raised an objection of lack of sufficiency of disclosure without indicating the claims against which that objection was raised. In its communication the board had indicated that it considered the objection of the opponent to refer to inventive step rather than to sufficiency of disclosure. However, in view of the negative outcome regarding inventive step (See point 7 below), it is not necessary to elaborate any further on the issue of sufficiency.

6. Novelty

6.1 D6 describes a process for the preparation of high molecular weight aromatic polyethersulfones by the

reaction of equimolar amounts of diphenols and dihalogenoaryls in a polar, aprotic solvent in the presence of anhydrous alkali metal carbonate, characterised in that
a) from 1 to 1,2 mol of alkali metal carbonate per mol of diphenol is used,
b) N-alkylated acid amides with boiling points in the range of from 150°C to 270°C are used as polar solvents, and
c) the water produced in the reaction is completely removed azeotropically as a mixture of N-alkylated acid amide/water at temperatures from 5° to 20°C below the boiling point of the N-alkylated acid amide used as solvent in the absence of an additional azeotropic former.

It was undisputed that D6 does not explicitly disclose the average particle size of the anhydrous alkali metal carbonate used in that process.

6.1.1 Example 2 of D6 describes the preparation of a polyethersulfone from 4,4'-dihydroxybiphenyl and 4,4'-dichlordiphenylsulfone in N-methylpyrolidone as solvent in the presence of anhydrous potassium carbonate. The polymerization reaction was carried out for 2.5 hours (Table 1) at a temperature of 180°C to 190°C. A white polymer having a reduced viscosity of 0.49 dl/g was obtained. The particle size of the potassium carbonate is not disclosed.

6.1.2 On pages 6 to 8 of Annex M1 an experiment is described with a view to come to a conclusion about the particle size of the potassium carbonate used in example 2 of D6. Apart from the question in how far such a conclusion is at all possible in principle, the example provided on pages 6 to 8 of annex M1 is not a true repetition of example 2 of D6. In particular the polymerization was carried out at a scale 8 times larger than in D6 and during 3 hours instead of the 2.5 hours of example 2 of D6. The parties agreed that it was common general knowledge that the reduced viscosity of the obtained polymer increases with the length of the polymerization, so that the reduced viscosity of the polymers disclosed in Table 3 of annex M1 cannot be compared with that obtained in example 2 of D6. The particle size of the potassium carbonate used in the polymerization of D6 can therefore not be clearly and unambiguously derived from the data reported in Table 3 on page 7 of annex M1. Therefore, the subject-matter of claim 1 is novel over D6.

6.2 D35 discloses a process for producing a polyaryl ether by heating under agitation a dihalogenodiphenyl compound and a diphenol compound in the presence of an alkali metal carbonate in an organic polar solvent, wherein alkali metal carbonate particles comprising below 20 wt.% particles of a particle diameter of 1 µm or below and below 10wt.% particles of a particle diameter of 2mm or above are used as the alkali metal carbonate (page 2, point 2). Example 2 of D35 describes the preparation of a poly(biphenyl ether sulfone) from 4,4'-dichlorodiphenyl sulfone and hydroquinone in the presence of a potassium carbonate consisting of 85 wt.% particles with a diameter of 5 to 90 µm and 15 wt.% particles with a diameter of 5 µm or below. That example however does not disclose the presence of a bishydroxybiphenyl compound as required in claim 1 of the fifth auxiliary request. The use of 4,4'-biphenol as a bishydroxybiphenyl compound in the polymerization reaction of D35 is generally disclosed on page 3. There is however nowhere in D35 a hint towards the substitution of hydroquinone for 4,4'-biphenol in the process of example 2. Also, D35 does not suggest that 4,4'-biphenol could be used in the process of example 2 without a change of the process parameters, as done in example 3 of D35, in which part of the hydroquinone of example 2 was replaced by 4,4'-biphenol, and the particle size of the potassium carbonate was changed to above 100 µm. For that reason the disclosure of 4,4'-biphenol on page 3 cannot be read in the context of the specific example 2 of D35. The subject matter of claim 1 is therefore novel over D35.

6.3 Regarding the subject-matter of claims 4 and 8, neither D6 nor D35 discloses the solution colour factor and the molded colour factor of the poly(biphenyl ether sulfone) compositions disclosed therein, so that for that reason already those claims cannot be considered as being anticipated by D6 or by D35.

6.4 In view of the above, the claimed subject-matter is novel over D6 and D35.

7. Inventive step

7.1 The closest prior art

7.1.1 The patent in suit relates to poly(biphenyl ether sulfone) compositions having an improved, lighter colour, preferably water-white, finding a wider acceptance for many applications where colour is of concern (paragraph 14).

7.1.2 D6 aims at reducing colour in poly(biphenyl ether sulfones) obtained from the carbonate process (page 3, lines 29 to 36). Since D6 addresses the same problem as the patent in suit, it can be considered to be the closest prior art, as was the view of both parties as well as the opposition division.

7.2 The technical problem

7.2.1 D6 relates to the preparation of high molecular weight, aromatic polyethersulfones with a light colour. Example 2 of D6 illustrates that process, in which 4,4'-dihydroxybiphenyl and 4,4'-dichlordiphenylsulfone are polymerized at a temperature between 180°C and 190°C in the presence of anhydrous potassium carbonate in N-methylpyrrolidone before performing an azeotropic distillation, resulting in a white polymer having a reduced viscosity of 0.49 dl/g indicative of a high molecular weight.

7.2.2 In the examples of the patent in suit, anhydrous sulfolane was used to perform the azeotropic distillation of water and not N-Methylpyrolidone as in D6. Also, in the examples of the patent in suit the polymerization was carried out at 220°C, a temperature significantly higher than that of example 2 of D6. In addition to those differences in the process steps, the polymers obtained in the patent in suit have reduced viscosities between 0.57 to 0.81 dl/g, higher than that disclosed in example 2 of D6: 0,49 dl/g. Starting from example 2 of D6 as the closest prior art, the presence of an improvement in the method claimed cannot be established on the basis of the examples of the patent in suit as they do not provide a fair comparison with the process and polymer of example 2 of D6.

7.2.3 The additional experiments provided in D19 to D24, D36 and D37 do not allow a fair comparison between the claimed process and polymers with example 2 of D6 either.

D19 contains further polymerization examples which were all performed according to the examples of the patent in suit, at a temperature of 210°C in sulfolane. None of the examples of D19 provide a fair comparison with the method of example 2 of D6 as they were not performed in the same solvent and in the same temperature range as that of example 2 of D6.

D20 discloses a preparation process of poly(biphenyl ether sulfone)s using N-Methylpyrolidone as the aprotic solvent at a temperature in the region of 180°C to 190°C. That process however does not appear to disclose the total polymerization time and moreover differs significantly from that disclosed in example 2 of D6 since the polymer was endcapped with methyl chloride prior to the colour determination.

The preparations described in D19 and D20 were used to provide the polymers of D21 to D23. As neither of the preparations disclosed in D19 and D20 actually corresponds to that of example 2 of D6, a comparison of the colour properties of the polymers reported in D21 to D23 cannot be used to demonstrate a technical effect of the claimed process and polymers compared to the polymer of example 2 of D6, which is the closest prior art.

D24 is even more remote because the bishydroxybiphenyl monomer used (4,4'-dihydroxy-diphenyl sulfone) was not that of example 2 of D6.

D36 contains two attempts to repeat the polymerization described in example 2 of D6. The experimental procedure given on pages 1 and 4 of D36 indicates that the polymer was endcapped by a reaction with methyl chloride prior to evaluation of its colour. That

process step is not disclosed in example 2 of D6. As a result, the process and polymer of D36 are not according to example 2 of D6.
D37 contains a series of colour experiments carried out on a commercial compound, RADEL® R-5800 Polybiphenylethersulfone. D37 does not contain any experiment according to example 2 of D6.

7.2.4 Starting from the closest prior art D6, the problem to be solved that can be derived from the data provided in the patent in suit and in the supplementary experiments available can therefore only be seen as to provide a further method of preparation of poly(biphenyl ether sulfone)s.

7.3 The solution

7.3.1 The solution to the problem defined above resides in the method of claim 1, in particular in the use of anhydrous potassium carbonate having an average particle size of up to 100 µm. In view of the examples provided in the patent in suit it can be accepted that it effectively solves the problem defined above, namely to provide a further method of preparation of poly(biphenyl ether sulfone)s.

7.4 Obviousness

7.4.1 It remains to be decided whether the solution as defined in claim 1 was obvious in view of the prior art.

7.4.2 The process for the preparation of high molecular weight, aromatic polyethersulphones of D6 requires the reaction of equimolar quantities of diphenols and dihalogenoaryls in a polar, aprotic solvent in the presence of anhydrous alkali metal carbonate (page 2, lines 1 to 4). In so far as the alkali metal carbonate is concerned, the process of D6 limits its use to a range from 1 to 1.2 mol per mol of diphenol (claim 1). Although potassium carbonate is preferred, as long as it is anhydrous, D6 does not limit its nature or its particle size (page 5, lines 14 to 16).

7.4.3 The use of potassium carbonate in the preparation of poly(biphenyl ether sulfones) appears to be well known in the art.

7.4.4 D35 discloses a process for producing a polyaryl ether by heating under agitation a dihalogenodiphenyl compound and a diphenol compound in the presence of an alkali metal carbonate in an organic polar solvent, wherein alkali metal carbonate particles comprising below 20wt.% particles of a particle diameter of 1 µm or below and below 10wt.% particles of a particle diameter of 2mm or above are used as the alkali metal carbonate (page 3, second paragraph). D35 therefore relates to a very similar process as that disclosed in the patent in suit. As to the alkali metal carbonate, D35 further discloses that sodium carbonate and potassium carbonate can be used and that the particle diameter of each of those carbonates needs to be in the range of 1 µm to 2 mm (page 4, second paragraph). Therefore, it was known that potassium carbonate of a broad particle size range (1 µm to 2 mm) including that claimed in the patent in suit (not greater than 100 µm) could be used in the process for producing a polyaryl ether from a dihalogenodiphenyl compound and a diphenol compound. Example 4 of D35 also shows that poly(biphenyl ether sulfone)s based on 4,4'-biphenol and 4,4'-dichlorodiphenyl sulfone had been obtained with anhydrous potassium carbonate of which 85wt.% of the particles had a diameter of 5 to 90 µm and 15wt.% had a diameter of 5 µm or below, that is an average particle size not greater than 100 µm. On the basis of D35 alone, the skilled person would conclude that the technical problem of providing a further method of preparation of poly(biphenyl ether sulfone)s could be solved with anhydrous potassium carbonate particles having an average particle size not greater than 100 µm.

7.4.5 The patent proprietor submitted that a person skilled in the art would not apply the teaching of D35 to D6 when considering the teachings of D12, D4 and D13.

7.4.6 D12 discloses that aromatic poly(arylene ether sulfones) and related structures were obtained by the toluene N-Methylpyrolidone, potassium carbonate synthesis route (page 288), a scheme that is very similar to that of D6 and that of the patent in suit. D12 does however not mention any disadvantage of using potassium carbonate of a specific particle size in the polymerization process. A second passage (page 288; second and third paragraphs) mentions the preparation of poly(arylene ether sulfone)s by either potassium carbonate/dimethyl acetamide or by aqueous caustic/dimethyl sulfoxide techniques which are said to be useful for Bisphenol-A based systems but not as applicable for the synthesis of high molecular weight copolymers based on the wholly aromatic hydroquinone/biphenol polysulfone (Hq/Bp PSF) (top of page 289).

7.4.7 D4 contains a passage indicating that the polymerization reaction was slower in the presence of potassium carbonate (page 1832, first paragraph). Those two passages of D12 and D4 however are vague as to the exact process parameters used and refer to a disadvantage of using potassium carbonate only observed when dimethyl acetamide was used as solvent (D12, page 288, last paragraph; D4 page 1830, section on the kinetic and mechanistic aspects of the potassium carbonate/DMAC process), which is not the solvent used in the processes of D6, D35 and D7 (N-Methylpyrolidone). Those two passages of D12 and D4 therefore do not constitute a clear prejudice or even teaching away of the use of potassium carbonate particles having an average particle size not greater than 100 µm. The reference to D13 contained in D12 is also not conclusive as it pertains to the use of dimethyl acetamide as a solvent and not to N-Methylpyrolidone and because the protocol on page 93 does not even mention the presence of potassium carbonate particles and therefore does not disclose its average particle size.

7.4.8 It is concluded from the above that starting from the closest prior art D6 and in particular from its example 2, a person skilled in the art would have found it obvious to use anhydrous potassium carbonate particles having an average particle size not greater than 100 µm in order to provide a further method of preparation of poly(biphenyl ether sulfones) on the basis of D35, which is confirmed by the teaching of D7. As a consequence, the subject-matter of claim 1 of the patent in suit does not involve an inventive step.

7.5 Therefore, the fifth auxiliary request does not fulfil the requirements of Article 56 EPC.

*Sixth to ninth auxiliary request*

8. Modifications

8.1 The claims 1 of the sixth to eighth auxiliary requests have been modified to limit the range of the particle size of the potassium carbonate. Claim 1 of the ninth auxiliary request is identical to claim 1 of the fifth auxiliary request.

8.2 Based on the second paragraph of page 9 of the description as originally filed, claim 1 of the sixth auxiliary request was modified so as to limit the range to a particle size of up to 60 µm, in the seventh auxiliary request of not more than 30 µm, in the eighth auxiliary request of from 10 to 40 µm and characterized in that at least 80 % of said particles lie within a range of from 100 µm to 10 µm.

The limitation of these ranges finds a basis in the application as filed and is therefore allowable under Article 123(2) EPC. The particle size ranges are limited as compared to the range of up to 100 µm disclosed in claim 1 as granted. The modifications are therefore also allowable under Article 123(3) EPC.

9. Inventive step

9.1 The modification of the range of the average particle size of the potassium carbonate in claim 1 was not shown to be associated with any further technical effect not already disclosed in D35. The patent proprietor did not provide any argument to the contrary, neither in writing during appeal, nor at the oral proceedings before the Board. The technical problem defined above for the fifth auxiliary request therefore also applies to the subject matter of the claims 1 of the sixth to ninth auxiliary requests.

9.2 The ranges disclosed in D35 for the particle size of the alkali metal carbonate used encompass the ranges of the sixth to ninth auxiliary requests so that for those requests the same arguments apply as for the fifth auxiliary request. The choice of an average particle size range as claimed in the sixth to ninth auxiliary requests is therefore obvious in view of D6 in combination with D35.

9.3 For those reasons, the sixth to ninth auxiliary requests do not fulfil the requirements of Article 56 EPC.

## Order

## For these reasons it is decided that:

1. The decision under appeal is set aside.

2. The appeal of appellant II (patent proprietor) is dismissed.

3. European patent No. 1272547 is revoked.

The Registrar:

On behalf of the Chairman
(according to Art. 8(3) RPBA):

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

B. ter Heijden

C. Brandt

Decision electronically authenticated