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# D E C I S I O N
# of 6 October 1999

**Case Number:** T 0328/96 - 3.3.6

**Application Number:** 89304676.3

**Publication Number:** 0341977

**IPC:** D21H 13/40

**Language of the proceedings:** EN

**Title of invention:**
Composites from wet formed blends of glass and thermoplastic fibers

**Patentee:**
Virginia Tech Intellectual Properties, Inc.

**Opponent:**
Glaswerk Schuller GmbH

**Headword:**
Blends of glass and thermoplastic fibers/VIRGINIA TECH

**Relevant legal provisions:**
EPC Art. 56

**Keyword:**
"Inventive step - yes (after amendment)"

**Decisions cited:**
-

**Catchword:**
-

**Case Number:** T 0328/96 - 3.3.6

# D E C I S I O N
## of the Technical Board of Appeal 3.3.6
## of 6 October 1999

**Appellant:** (Proprietor of the patent)
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**Decision under appeal:** **Decision of the Opposition Division of the European Patent Office posted 13 February 1996 revoking European patent No. 0 341 977 pursuant to Article 102(1) EPC.**

**Composition of the Board:**

**Chairman:** P. Krasa
**Members:** G. Dischinger-Höppler
J. A. Stephens-Ofner

## Summary of Facts and Submissions

I. The appeal is from a decision of the Opposition Division to revoke European patent No. 0 341 977, relating to composites from wet formed blends of glass and thermoplastic fibres. The decision was based on amended claims according to a main and four auxiliary requests.

II. In its decision, the Opposition Division held that in view of document

(3) BE-A-715 130 (English and German translations)

the claimed subject-matter was not inventive.

III. On 6 October 1999, oral proceedings were held before the appeal Board, at the end of which the Appellant (Proprietor) requested that the decision under appeal be set aside and that the patent be maintained on the basis of auxiliary request II (hereinafter referred to as main request) or IV (hereinafter referred to as auxiliary request) as submitted during the oral proceedings.

The main request consists of the claims as granted with 6 method claims for all designated contracting states and 7 product claims for the designated contracting states, except for Spain. The independent claims of the main request read as follows:

"1. A method for forming a preform layer composed of individual glass staple filaments intimately mixed with a thermoplastic fiber, comprising: dispersing in agitated, neutral water a plurality of 0.5 to 20 denier

(0.55 to 22 d.tex), 1 mm to 5 cm staple length thermoplastic fibers and a quantity of wet chopped glass strand to the agitated water, said chopped glass strand consisting of bundles of numerous aligned glass fibres of length 1 cm to 8 cm and diameter 5 to 50 $\mu$m and having on their surface a sizing agent comprising a coupling agent and a film-forming agent; continuing agitation to disperse substantially the glass fiber bundles forming a homogenous filamentary slurry of thermoplastic and glass fibers, feeding the slurry to a screen in a layer, removing water from the layer; drying the layer, further heating the layer to a temperature to bond thermally the thermoplastic component fiber; and then cooling the layer to form a self-supporting preform layer.

7. A self-supporting preform layer of individual reinforcing glass fibers intimately mixed with thermoplastic fibers comprising: an intimate homogenous blend consisting of 10 to 70 percent by weight glass staple fibers substantially dispersed as individual filaments randomly arrayed in the plane of the layer and having on their surface a sizing agent comprising a coupling agent and a film forming agent, said glass fibers having a length of 1 cm to 8 cm and a diameter of 5 to 50 $\mu$m, intimately mixed with 90 to 30 percent by weight thermoplastic staple fibers substantially dispersed as individual filaments from 0.5-20 denier (0.55-22 d.tex) having a length of 1.0 mm to 5 cm.

13. A composite formed from at least one preform layer of anyone of claims 7 to 12, said composite being substantially void-free."

The claims of the auxiliary request differ from those of the main request only in that

- in the respective Claims 1 the feature reading "... comprising: dispersing in agitated, neutral water a plurality of ..." has been amended into "... consisting of dispersing in agitated, neutral water a plurality of ...", and

- in Claim 7 for all designated contracting states except ES the feature reading "... comprising: an intimate homogenous blend consisting of ..." has been amended into "... consisting of an intimate homogenous blend consisting of ...".

IV. During the oral proceedings, the following further documents were considered as pertinent:

(1) DE-A-3 117 280;

(4) Laue E. W., Glasfaserverstärkte Polyester und andere Duromere, Speyer, Wien, Zürich, 1969, pp 96-101; and

(5) Morgan Ph., Glass reinforced plastics, London, New York, 1957, pp 2-18.

V. The Appellant's arguments can be summarized as follows:

- None of the cited prior art documents related to the manufacture of a preform as defined in the patent in suit.

- The teaching of document (1) was distinguished from the claimed subject-matter in that the resin was in the form of fibrids or fibrils and that formation of the dispersion required using a mill.

Milling was also needed according to document (3) if dispersion of the fiber bundles into individual filaments was aimed at. Moreover, this process and product required a separate binder.

- The object of the patent in suit was to provide preforms wherein the fibers were very homogenously distributed, which were mechanically stable and could be handled. The closest prior art was that cited in the patent in suit and included the use of additives furthering dispersion but being detrimental to the composite properties. The problem solved by the patent in suit was to avoid such additives.

- The solution was to use the binding resin in the form of fibers and to apply heat to bond the resin fibers sufficiently to provide mat strength for processability.

- This was not hinted at, neither by documents (1) or (3), nor by any of the other citations.

VI. The Respondent (Opponent) requested that the appeal be dismissed. He supported the opinion set out in the contested decision and presented, in essence, the following further arguments:

- The purpose of the patent was to provide preforms which may be worked to form finished products. Documents (1) and (3) also disclosed such preforms and, equally, represented the closest prior art.

- Despite the new wording of the claims the presence of a binder as in document (3) was not, in fact, excluded.

- The product of document (3) had the same properties as the claimed one and the binder used therein could be in the form of fibers. The only difference consisted in the fact that document (3) did not mention a sizing on the glass fibers. This was, however, made obvious by the teaching of documents (4) and (5).

- The teaching of document (1) differed from the claimed subject-matter in that neither the minimum length of 1 cm for the glass fibers nor a sizing thereon was mentioned. Using glass fibers having the claimed length was, however, known from document (3).

## Reasons for the Decision

1. Amendments

The claims of the main request are those as granted and based on the claims as originally filed in combination with the description as originally filed. Therefore, no objections under Article 123 EPC arise.

The Board is satisfied that the claims according to the auxiliary request comply with the requirements of Articles 123(2), (3) and 84 EPC. This not being contested, no detailed reasoning is required.

2. Novelty

The Board is satisfied that none of the citations on file disclose the subject-matter of the claims according to the main request or according to the

auxiliary request. As this was no longer contested by the Respondent, this finding requires no detailed reasoning either.

3. It remains, therefore, to be decided whether or not the claimed subject-matter is based on an inventive step.

3.1 Technical background

The patent in suit concerns the manufacture of preform layers having sufficient strength for being easily processable into glass fibre reinforced thermoplastic composites. The preform layers are produced from a highly homogenous dispersion of the glass fibres and the resinous matrix in water by using conventional wet forming or papermaker's equipment (page 2, lines 3 to 5, 18 and 33 to 35).

According to the patent in suit it was known to bond the glass fibres with a molten resin. Further, it was known to admix the glass fibers together with a powdered form of the resin. To achieve the desired dispersion of the fibres, it was necessary either to proceed at low or high slurry pH or to add surface active dispersing aids to the slurry mixture. However, the high or low pH application and the additives, were both said to have detrimental effects on the properties of the resulting composite structure (page 2, lines 6 to 15).

Therefore a method for producing a self-supporting preform layer is aimed at, the latter consisting of a highly uniform dispersion of glass fibres in thermoplastic material, which preform layer can be readily converted into a glass fibre reinforced thermoplastic composite wherein, however, the above drawbacks associated with high or low pH and additives are overcome (page 2, lines 16 to 24).

3.2 Closest prior art

Document (1) relates to the production of layers and composites made from a glass fibre reinforced thermoplastic polymer wherein the glass fibres are homogenously distributed in the product (see page 4, lines 1 to 6 and 33 to 39) by dispersing the glass fibres together with thermoplastic fibrids or fibrils in water and by using paper makers equipment (page 7, line 28 to page 8, line 22).

Document (3) pertains to a wet-lay method for producing webs from a dispersion of glass fibres and polyester fibres, polyamide fibres or polyvinyl chloride fibres in water wherein a binder is used to bond the fibres one to another during drying (page 2, lines 23 to 38 and page 5, line 30 to page 6, line 12; unless otherwise stated all references to document (3) will refer to the English translation).

Documents (4) and (5) were both cited with respect to the application of sizing agents during commercial manufacture of glass filaments and strands. They do not relate to the production of fibrous webs or glass fiber reinforced plastic articles.

According to the established case law of the Boards of appeal of the European Patent Office, the closest prior art must be directed to the same or a closely related purpose or effect as the invention. In the present case, therefore, the closest prior art must be one which relates to a glass fiber structure which is self-supporting and suitable to be processed into a glass fiber reinforced thermoplastic composite.

The Appellant argued that neither document (1) nor document (3) related to a preform as disclosed in the patent in suit. They would not, therefore, constitute a suitable starting point for assessing inventive step.

In fact, document (1) does not unequivocally disclose a self-supporting preform layer. Certainly, the intermediate product obtained after forming the layer composed of glass fibers and thermoplastic fibrils on the papermaker's screen may be dried by heat treatment at a temperature of 120°C, i.e. below a melting temperature of 135°C (see Example 1) before it is transformed into the final glass fiber reinforced resin composite by totally melting the thermoplastic fibrils (see also Claim 1 and page 8, line 24 to page 9, line 29). However, there is no hint in document (1) that such a heat treatment at 120°C would be more than a mere drying step and cause a bonding of the fibers into a self-supporting structure. Even if one considers that the dried intermediate products of document (1) can be arranged into a sandwich-structure and, hence, have to be handled, such a handling does not necessarily imply the property of being self-supporting, but may instead be achieved by other measures, e.g. by the aid of an external carrier layer.

Further, document (1) uses the thermoplastic polymer component in the form of fibrils or fibrids for making the dispersion. Contrary to the Respondent's opinion, the Board is convinced that the terms "fibrids" and "fibrils" as used in the context of document (1) are, in contrast to staple fibers and filaments, irregularly formed fibre-like structures which, due to a particular method of manufacture by flash-spinning or by a shredding or shearing operation during or after polymer

precipitation (see page 6, lines 5 to 28), have a particular, e.g. porous or frazzled, surface structure. In any case, the specific surface area of fibrils or fibrids is considered to be particularly high (more than 1 $m^2/g$; see Claim 1) in comparison with fibres or filaments. Therefore, the thermoplastic fibrids and fibrils of document (1) differ, in the Board's judgment, considerably in respect of their external structure from the staple fibers used in the patent in suit.

Contrary to the Appellant's argument, document (3) concerns a self-supporting preform layer. Document (3) seeks to avoid loss of strength in a glass fiber mat after several foldings by the addition of thermoplastic fibers, such as polyester fibers (page 2, lines 23 to 32). The advantageous mechanical properties of the mixed fiber mats are said to be suitable for reinforcement of plastics (page 3, lines 13 to 15).

Similarly, according to the description of the patent in suit, the preforms shall be suitable for the production of glass fiber reinforced thermoplastic resin composites (page 1, lines 3 to 5). The Board does not see an essential difference between these respective purposes. Moreover, the indication of a use aimed at could only amount to a distinguishing feature if it has to be understood as the **functional** definition of a **technical** feature. The Appellant did not provide any evidence that it was generally accepted in the art that the term "preform" implies particular properties (technical features) of the material concerned.

The fiber mats disclosed in document (3) are, moreover, composed of the same kind of fibers as the preforms according to the patent in suit and are bonded with the intention to provide very good strength properties (see

page 1, lines 7 to 11, page 4, lines 1 to 2, Example 1, Claims 1 and 11 and page 5, lines 16 to 26). It is, therefore, beyond any doubt that the products of document (3) have sufficient strength to be self-supporting.

The Board considers, therefore, that document (3) represents the closest prior art.

3.3 Technical problem

Document (3) is silent about any pH of the aqueous dispersion, let alone any adaptation of the pH to low or high values. It is further silent about any addition of dispersing aids. Nor can any such requirements be deduced from the context of document (3). Although composite production from the wet-laid fibre webs is not disclosed in document (3), it must be concluded that the drawbacks mentioned in the patent in suit in respect with high or low pH and dispersion aid additives are actually overcome if the preforms are produced in accordance with the process of document (3).

In view of the closest prior art, the technical problem underlying the patent in suit is, therefore, the provision of a further preform and of a method for producing the same, whilst avoiding the above drawbacks (see point 3.1).

3.4 Inventive step

3.4.1 Main request

According to Claim 1 it is proposed to solve this problem by a method which **comprises** dispersing in neutral water the thermoplastic and glass fibres under agitation such that a homogenous filamentary slurry is

formed, which is then fed to a screen to form a layer, the latter being dewatered, dried, heated so as to thermally bond the thermoplastic fibres, and finally cooled to give a self-supporting preform layer.

From the examples of the patent in suit it can be seen that in the preforms resulting from this claimed method, the glass fibres are highly dispersed in intimate admixture with the thermoplastic fibres and that these preforms can be converted into glass fibre reinforced thermoplastic composites of high uniformity and good tensile and flexural properties. It is, therefore, credible, that the above defined technical problem has been solved by the subject-matter of Claim 1.

In the Appellant's opinion, the wording of the claims excludes the presence of a separate binder and the use of a milling equipment for dispersion of the fibers into individual filaments as disclosed in document (3) (see page 2, lines 27 to 38 and page 3, lines 22 to 26).

However, according to the common practice of the Boards of Appeal, the term "**comprising**" is to be understood as "**including**" or "**comprehending**", rather than "**consisting of**". Therefore, the method of Claim 1 which "**comprises**" several process steps is not, in the Board's judgment, limited to the steps enumerated. Consequently, the claimed process may, inter alia, also "**comprise**" the addition of further additives such as separate binders. Likewise, the process may **comprise** a step for splitting the fiber bundles into monofilaments by treatment with grinding tools customary in the paper industry, such as a Jordan mill (document (3), page 3, lines 22 to 26).

In this context it should be noted that in document (3) the only purpose of the action of such a milling or grinding device is for splitting the fiber bundles. Nothing suggests that, at the same time, a shortening of the fibers would necessarily occur.

As indicated in point 3 above, document (3) fails to teach that the glass fibers include a surface sizing comprising a coupling agent and a film-forming agent as proposed by the process of Claim 1 and the product of Claim 7. For the reasons set out above, this feature is considered to be the only difference between the claimed subject-matter and the teaching of document (3).

No arguments have been submitted by the Appellant to sustain a particular unexpected effect related to a surface sizing, nor is such an effect evident from the patent in suit. On the contrary, it is known from documents (4) and (5) (see in document (4), page 96; in document (5), page 3, "sizes") that it is common practice in the art of manufacturing glass fibers to apply a sizing comprising a film forming agent to protect the glass and a coupling agent to assist adhesion between the glass/resin interface (see patent in suit, page 3, lines 51 to 54). Someone skilled in the art trying to rework the process of document (3) would, therefore, be prompted by documents (4) and (5) to use glass fibers having such a surface size, thereby arriving in an obvious manner at the subject-matter of Claim 1 bearing in mind that the latter does not exclude the addition of a separate binder and a milling step.

For these reasons, the Board concludes that the subject-matter of Claim 1 of the main request does not involve an inventive step.

3.4.2 Auxiliary request

Claim 1 is limited to a process **consisting** of the steps as listed to form a self-supporting preform layer. Likewise, Claim 7 (valid only for the designated contracting states except ES) is restricted to a self-supporting preform layer **consisting** of 10 to 70 percent by weight of said glass fibers, randomly arrayed in the plane of the layer, intimately mixed with 90 to 30 percent by weight of said thermoplastic fibers, and wherein the fibers are substantially dispersed as individual filaments.

Therefore, these claims exclude the addition or presence of further components. They exclude in particular the addition of components other than fibers or any step transferring the fibers into non-fibrous form.

It remains to be decided whether or not the proposed solution to the problem underlying the patent in suit was obvious in the light of the cited prior art.

Document (3), i.e. the closest prior art, requires the addition of a separate binder in an amount of at least 5% wt based on the weight of the resulting web containing up to 50% wt of thermoplastic fibres, either by spraying it onto the fibres or by adding it to suspension in a form that, upon removal of water, it remains on the screen together with the fibres in the mat formed (see page 2, lines 32 to 38 and page 5, lines 2 to 13).

The Board agrees with the Respondent's argument that according the English translation of document (3), the binding agent can, inter alia, be added in the form of filaments (see page 5, lines 10 to 15). In the German translation of document (3), however, no such

filamentary form of the binder is mentioned (see page 4, last full paragraph of the German translation). Due to this conflict of evidence arising from these contradicting translations (none of them being certified), a conflict on a point of decisive importance, any disclosure of binder filaments in document (3) must be ignored.

The board has taken into account that the binder used in document (3) may be the same component (e.g. polyester of polyurethane; see page 4, lines 24 to 26) as is used in the present patent as a film-forming agent contained in the sizing on the surface of the glass fibers (see page 3, line 52). However, the amount of such a sizing is at most 1% based on the weight of the glass fibre (see document (4), page 96), which corresponds to below 1% wt based on the total of fibres present in the preform layer and, hence, to a considerably smaller quantity when compared with the minimum amount of 5% wt in accordance with document (3). There is not hint in document (3) suggesting that alternatively the binder could be omitted or at least be considerably reduced. Thus, document (3), on its own, does not render obvious the solution to the existing technical problem as claimed.

Document (1), which also aims at the production of articles made of glass fiber reinforced thermoplastic polymers wherein the glass fibres are homogenously dispersed throughout the whole product (page 4, last paragraph) does not, in fact, use any additional binding agent. It requires, however, as a mandatory feature that the thermoplastic material is in the form of fibrils or fibrids having a large surface area of at least 1 $m^2/g$ (Claim 1, page 1, lines 8 to 14) which upon heat treatment are either only dried or totally melted such that the fibrids can no longer be identified. It does neither hint at a possible substitution of the

fibrils or fibrids by thermoplastic fibres or filaments nor suggest to apply heat in a manner to bond the fibrids, however, without destroying their form. Someone skilled in the art would, therefore, not conclude from document (1) that replacement of the said thermoplastic fibrids or fibrils by fibers or filaments would be a feasible way to provide a self-supporting preform consisting merely of fibers.

4. The Board is, therefore, satisfied that none of the cited prior art documents, either individually or in combination, renders obvious the claimed solution of the existing technical problem, and concludes that the subject-matter of the method of Claim 1 (for all designated contracting states), the preform layer of Claim 7 (for all designated contracting states except ES) as well as of the composite of Claim 13 (for all designated contracting states except ES) involves an inventive step within the meaning of Articles 52(1) and 56 EPC.

Patentability of the dependent Claims 2 to 6 (for all designated contracting states) and 8 to 12 (for all designated contracting states except ES) is derived from that of the respective independent claims.

**Order**

**For these reasons it is decided that:**

1. The decision under appeal is set aside.

2. The case is remitted to the Opposition Division with the order to maintain the patent with the claims set out in auxiliary request 'IV' and after any consequential amendment of the description.

The Registrar: The Chairman:

G. Rauh P. Krasa