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D E C I S I O N
of 24 June 1998

Case Number: T 0761/93 - 3.3.3

Application Number: 83109827.2

Publication Number: 0108245

IPC: C08J 9/22

Language of the proceedings: EN

Title of invention:
Process for producing pre-foamed particles of polypropylene resin

Patentee:
Japan Styrene Paper Corporation

Opponent:
BASF Aktiengesellschaft, Ludwigshafen

Headword:
-

Relevant legal provisions:
EPC Art. 56

Keyword:
"Inventive step (no) - obvious combination of known features"

Decisions cited:
-

Catchword:

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Case Number: T 0761/93 - 3.3.3

D E C I S I O N
of the Technical Board of Appeal 3.3.3
of 24 June 1998

Appellant: (Proprietor of the patent)
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Representative: -

Decision under appeal: **Decision of the Opposition Division of the European Patent Office posted 29 June 1993 revoking European patent No. 0 108 245 pursuant to Article 102(1) EPC.**

Composition of the Board:

Chairman: C. Gérardin
Members: H. Fessel
A. Lindqvist

Summary of Facts and Submissions

I. European patent No. 0 108 245 in respect of European patent application 83 109 827.2 filed on 30 September 1983 in the name of Japan Styrene Paper Corporation was granted on 23 December 1987 (cf. Bulletin 87/52) on the basis of a set of 7 claims of which the only independent Claim 1 read as follows:

"A process for producing pre-foamed particles of a polypropylene resin which comprises expanding original pre-foamed particles of a polypropylene resin, said original pre-foamed particles having the following relation

$$2 < E^{1/3} \times n^{1/2} < 45$$

wherein E is the expansion ratio of the original pre-foamed particles, and n is the number of cells per mm^2 of the cross section of the original pre-foamed particles, by (1) imparting expanding ability to the original pre-foamed particles and then heating them with a heated gas to the heat distortion temperature of the base resin of the pre-foamed particles or a higher temperature or (2) heating the original pre-foamed particles with steam to the heat distortion temperature of the base resin of the particles or a higher temperature with or without imparting expanding ability thereto, whereby pre-foamed particles having an expansion ratio higher than the original expansion ratio E are obtained."

Dependent Claims 2 to 7 related to preferred embodiments of the process of Claim 1.

II. A Notice of Opposition was filed by BASF Aktiengesellschaft on 6 September 1988. In its Statement of Grounds of Opposition filed on the same

day the Opponent alleged lack of clarity, novelty as well as sufficiency of disclosure and further considered the claimed subject-matter not to involve any inventive step.

These objections were based essentially on the following documents still relevant in appeal proceedings:

D5: JP-B-561 344 (considered in the form of its English translation);

D6: GB-A-2 002 386 and

D7: EP-A-0 053 333.

III. By its decision of 22 April 1993 issued in writing on 29 June 1993, the Opposition Division revoked the patent. That decision held the subject-matter of Claim 1 as amended during oral proceedings, which was a combination of former Claims 1 and 3, to meet the requirements of Articles 84, 123(2) and (3) as well as those of Article 54 EPC, but not to be inventive in view of the disclosure of D7 combined with that of D6.

The Opposition Division considered D7 to represent the closest prior art and the claimed process to differ from D7 in that the pre-foamed particles were foamed a second time or more before forming the foamed article. The only effect of the second expansion step was a further increase of the expansion ratio and an improvement of the properties of the foamed article. From D6 it could, however, be derived that particles difficult to be foamed in one step could be foamed in two steps, since the expanding ability was added again

to the particles in the second step. During the expansion the expansion ratio increased and consequently the number of cells decreased.

IV. On 23 August 1993 an appeal was lodged by the Appellant (Patentee) together with payment of the prescribed fee. The Statement of Grounds of Appeal was received on 8 November 1993. During oral proceedings held on 24 June 1998 the Appellant submitted a set of 6 claims identical with that filed during oral proceedings before the Opposition Division.

The only independent Claim 1 of that set of claims reads as follows:

"A process for producing foamed articles of polypropylene resins which comprises, in a first step, obtaining original pre-foamed particles by feeding polypropylene resin particles, a volatile blowing agent and a dispersing medium into a closed vessel, heating them to a temperature above a point at which the resin particles soften, thereafter opening one end of the vessel, and releasing the resin particles and the dispersing medium simultaneously into an atmosphere kept at a lower pressure than the inside of the vessel, as well as
in a second step, expanding the obtained original pre-foamed particles having the following relation

$$2 < E^{1/3} \times n^{1/2} < 45$$

wherein E is the expansion ratio of the original pre-foamed particles, and n is the number of cells per mm^2 of the cross section of the original pre-foamed particles, by

(1) imparting expanding ability to the original pre-foamed particles and then heating them with a heated gas to the heat distortion temperature of 80 to 130°C of the base resin of the pre-foamed particles or a higher temperature or

(2) heating the original pre-foamed particles with steam to the heat distortion temperature of the base resin of the particles or a higher temperature with or without imparting expanding ability thereto, whereby pre-foamed particles having an expansion ratio higher than the original expansion ratio E are obtained, and

(3) in a third step, the obtained pre-foamed particles are first aged for a predetermined period of time at room temperature and atmospheric pressure, and then further aged for a predetermined period of time under predetermined pressure using an inorganic gas, or a mixture of an inorganic gas and a volatile blowing agent, thereafter the pre-foamed particles are filled in a mold and heated with steam under pressure to form the foamed article."

Dependent Claims 2 to 6 relate to preferred embodiments of the process according to Claim 1.

V. The arguments presented in the written submissions and during oral proceedings can be summarised as follows:

(i) The Appellant agreed that D7 was to be regarded as closest prior art. He agreed that the first expansion step as well as the process features of step 3 were known per se and could no longer involve an inventive step. The claimed process differed, however, in that the second expansion step was missing and the heating to the heat distortion temperature of the base resin or a

temperature above was also missing. Moreover in Table 1 it had been demonstrated that, only by using pre-foamed particles satisfying the relation indicated in Claim 1 and further expanding them in a second step, the desired dimensional accuracy and melt adhesion could be achieved (Expansion ratio 20-25 versus 27-32).

(ii) As to the arguments used by the Opposition Division two errors were made. The first was that the expansion ratio of Example 1 of D7, e.g. E = 37.5, was based on the bulk density (note 3 in Table 2) and not on the true density as used in the patent in suit and specified on p. 3, ll. 56 to 62; expressed as true expansion ratio that figure was E = 25. The second error concerned the range of cell number argued to be in the range of 0.5 to 180 for E = 37, but in reality being in the range of 0.47 to 237 cells/mm^2 for the true value of E = 25. On that basis the figures of the true expansion rate of Examples 1 to 5 of D7 were in the range of 75 to 85 and the corresponding cell numbers were 980 to 740.

(iii) The Appellant saw the technical problem to be solved versus D7 in the improvement of dimensional stability expressed in terms of lower shrinkage. Versus D6 the expansion was said to be higher, i.e. first step E = 3-9, second step E = 13-37 in D6 versus 22 to 62 in (d) of Tab. 3. Already the expansion ratio in the first step was higher, i.e. 10 to 28 (cf. Tab. 5).

(iv) It was not proper to combine D7 with D6, since the expansion process disclosed in the latter citation concerned crosslinked polyolefin resins exclusively.

VI. The Respondent (Opponent), who had withdrawn his opposition with his letter received on 24 February 1994 and was thus no longer a party of the proceedings, did not attend the oral proceedings held on 24 June 1998. In its written submission of 16 December 1993 he disputed that the value of the cell number of Example 1 of D7 was ill founded; he also contended that the comparative examples in the patent in suit were not based on the most relevant prior art (D7) and did thus not provide any evidence for the alleged improvement. Although D6 concerned crosslinked polyolefins, nevertheless it would have been obvious to use the two step expansion process of D6 in D7 in the light of what was said on the ease of expanding and foaming of uncrosslinked polyolefins (cf. D7, p. 2, ll. 6-12).

VII. The Appellant requested that the decision under appeal be set aside and the patent be maintained on the basis of Claims 1 to 6 as submitted during oral proceedings.

Reasons for the Decision

1. The appeal is admissible.

2. The Opposition Division considered the amended claims to meet the requirements of Article 123(2) and (3) EPC. The Respondent did not raise any objection and the Board is also satisfied that these requirements are met.

2.1 In Claim 1 the features of step 1 were disclosed on p. 4, ll. 8-17 and those of step 3 on p. 7, l. 24 - p. 8, l.3 of the original files corresponding to p. 3, ll. 1-5 and p. 4, ll. 2-8 respectively of the patent specification. The range of the heat distortion temperature added to the second step was disclosed in Claim 3 of the original files (Claim 3 of the patent specification).

2.2 Nor was the scope of the claims extended since step 2 has been incorporated between the two steps of the process according to Claim 1 as granted, resulting in a restriction of the scope of protection.

3. Novelty was not disputed and the Board cannot find any reason to dispute novelty either. There is thus no need to discuss this issue in detail.

4. *Inventive step*

The patent in suit relates to a process for producing pre-foamed particles of polypropylene resin.

4.1 Such a process is disclosed in D7 which the Board, like the Appellant and the Opposition Division, regards as the closest state of the art. This citation relates to a process for producing pre-foamed particles of polypropylene resins with good adhesion between the particles, wherein substantially non crosslinked particles of polypropylene and a volatile blowing agent are dispersed in water in the presence of a dispersing agent within a closed cell, then heated to a temperature above the point at which the resin particles soften. That dispersion is then released into an atmosphere kept at lower pressure than the inside of the vessel (Claim 4 in conjunction with p. 5, ll. 31-35). Foamed articles obtained from such pre-

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foamed particles are said to have excellent heat resistance, chemical resistance and flexibility as well as mechanical strength (p. 6, ll. 6-10).

4.2 Although the patent specification does not contain an explicit comparison with this state of the art, the Board accepts in the light of the arguments presented by the Appellant during oral proceedings that the technical problem underlying the patent in suit may be defined in positive terms, e.g. it may be seen in the definition of a process giving rise to pre-foamed particles with good melt-adhesion between the particles suitable for the production of articles having improved characteristics in terms of dimensional accuracy and flexibility (patent specification p. 4, ll. 13-16).

4.3 According to the patent in suit, this problem is to be solved by, in a second step, heating to the heat distortion temperature of the base resin or above the pre-foamed particles obtained in the first step having the relation $2 < E^{1/3} \times n^{1/2} < 45$, and then further processing the resulting particles in a third step, as specified in the Claim 1.

4.4 In view of the experimental results in the patent specification, especially Examples 1, 2 and 5 versus Comparative Examples 1, 2 and 3 respectively (Tables 1, 2 and 5) the Board is satisfied that the above defined technical problem is effectively solved with the three step process defined in Claim 1.

5. It remains to be decided whether the combination of features was obvious having regard to the documents provided in opposition proceedings.

5.1 As it appears from point 4.1 above, the process taught in D7 can be regarded as a process limited to the first and third steps of the process as claimed. As such it is an attempt to overcome a common shortcoming of the pre-foaming step in all previous processes, namely the necessity to crosslink the polyolefin particles prior to pre-foaming (p. 2, ll. 6-12; p.3, ll. 27-30). There is no further embodiment mentioned, in particular nothing which may suggest a modification of the foaming step within the terms of the patent in suit. Thus D7 alone cannot render obvious the claimed subject-matter.

5.2 D6 relates to a process for producing expanded crosslinked polyolefin resin particles, which comprises first allowing particles of a crosslinked polyolefin resin containing a foaming agent to expand to an average expansion ratio of from 3 to 9 and then, after imparting expandability to the thus pre-expanded particles, further allowing said pre-expanded particles to expand to an average expansion ratio of from 13 to 37, said average expansion ratio being based on the original volume of unexpanded resin particles (Claim 5). The thus produced material is then further processed into molded articles (Claim 8 in conjunction with p. 4, ll. 22-28).

As far as the particles are concerned, this combination of primary and secondary expansions gives rise to polyolefin resin particles, which are uniform in foamed cell distribution as well as in size, and further makes it possible to produce highly expanded small particles of polyolefin resin (p. 3, ll. 4-7). Regarding the further processing, e.g. the moulding step, the 'two step expansion' process is said to be more efficient in

that it allows shortened moulding cycles and the expanded molded articles produced thereby are said to have improved quality (p. 1, ll. 45-47; p. 3, ll. 55/56; p. 4, ll. 28-37).

From that document the skilled person would thus become aware of the beneficial influence of the two step expansion on the final properties of the moulded articles.

5.3 Although the Appellant conceded during oral proceedings that at first sight it might tempting to use such a two step expansion in the process known from D7 in order to solve the technical problem, he argued that in reality a skilled person would not do so, because the two processes were disclosed in relation to fundamentally different polymers, non crosslinked polymers in D7 and crosslinked polymers in D6.

This argument cannot be accepted for the following reasons.

The first results from the technical developments as they appear in D6 and D7. D6, which is strictly limited to crosslinked polyolefins, was published on 21 February 1979. D7 published on 9 June 1982, without explicitly referring to D6, acknowledges that in the prior art it was considered necessary to crosslink polyolefin particles prior to pre-foaming, before specifying that it had now been found possible to expand polypropylene resin without crosslinking with even better results (p. 2, ll. 6-12). The difference between the two disclosures reflects thus a difference in technical development, not teachings which would be opposite in substance.

The second appears in D5 discussed in detail during oral proceedings. This document describes a process for pre-expanding polymer particles (cf. claim), whereby also (i) highly expanded homogeneous particles are obtained (p. 3, para. 3), (iii) the particles are free of any thermal adhesion to each other (p. 3, para. 4), and (iii) the expanded particles have a high closed cell ratio (p.4, para,1). The polymers said to be suitable for that process are not particularly limited provided that they are expandable when they are impregnated with volatile blowing agent and heated (p. 4, para. 2). This general condition is followed by a list of ethylene homo- and copolymers, which must be assumed to be non crosslinked, then by "polymers having a cross-linking bond formed between ethylene molecules as by an organic peroxide or irradiation with electron rays".

These considerations demonstrate that there is no fundamental difference between crosslinked and non crosslinked polyolefin in pre-foaming processing and that, consequently, there was a strong incentive at the priority date of the patent in suit to combine the teachings of D7 and D6.

5.4 The last feature to examine is the relation which the expansion ratio of the original pre-foamed particles has to satisfy, i.e. whether the range defined in claim 1 can be regarded as inventive.

This relation, which is based on the expansion ratio of the original pre-foamed particles and the number of cells per mm^2, specifies the relative importance of the primary expansion step with respect to the overall expansion process. As the discussion during oral proceedings made clear, this relation has obviously been determined empirically by means of systematic

experiments in order to define the area of best results; such an attempt of optimization of an otherwise obvious combination of process features belongs to the routine task of a skilled person for which no inventive step can be acknowledged.

Moreover, the range corresponding to these better results cannot be regarded as particularly narrow. Whether one considers the values used in the patent specification for comparative purposes, which range from 1.5 to 105 (p. 4, Tab. 1) and must thus be regarded as usual in the art, or the values calculated for D7 by the Appellant, which range between 75 and 86 (Statement of Grounds of Appeal, p. 3, point 2), it becomes apparent that the relatively broad range required in the patent in suit comprises nearly half the possible values and that the argument of a selection cannot be accepted.

5.5 It follows from these considerations that the claimed subject-matter was obvious in the light of the prior art cited and that the advantages obtained merely correspond to the expectations. Consequently it does not involve an inventive step.

6. The same conclusion applies to dependent Claims 2 to 6, which are directed to preferred embodiments of the process according to Claim 1 and thus fall with it.

Order

For these reasons it is decided that:

The appeal is dismissed.

The Registrar:

E. Görgmaier

The Chairman:

C. Gérardin