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**Datasheet for the decision
of 2 May 2018**

Case Number: T 0639/14 - 3.3.09

Application Number: 08356055.7

Publication Number: 2105457

IPC: C08J9/20, C08J9/14, C08L25/04,
C08F12/08

Language of the proceedings: EN

Title of invention:
Process for the preparation of expandable polystyrene

Patent Proprietor:
ARKEMA FRANCE

Opponent:
Akzo Nobel Chemicals International B.V.

Headword:

Relevant legal provisions:
EPC Art. 56

Keyword:
Inventive step - main request (yes)

Decisions cited:

T 0344/89, T 0767/02

Catchword:



Beschwerdekammern

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Chambres de recours

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Case Number: T 0639/14 - 3.3.09

D E C I S I O N
of Technical Board of Appeal 3.3.09
of 2 May 2018

Appellant: Akzo Nobel Chemicals International B.V.
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Representative: Akzo Nobel Chemicals IP Group
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Respondent: ARKEMA FRANCE
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Decision under appeal: **Interlocutory decision of the Opposition
Division of the European Patent Office posted on
22 January 2014 concerning maintenance of the
European Patent No. 2105457 in amended form.**

Composition of the Board:

Chairman W. Sieber
Members: F. Rinaldi
E. Kossonakou

Summary of Facts and Submissions

- I. This decision concerns the appeal filed by the opponent against the interlocutory decision of the opposition division that European patent No. 2 105 457 as amended met the requirements of the EPC.
- II. With the notice of opposition the opponent had requested revocation of the patent based on Article 100(a) EPC for lack of novelty and lack of inventive step.

The documents submitted during the opposition proceedings were:

- D1: US 6,608,150 B1
- D2: R.-D. Klodt et al., "Particle Foam Based on Expandable Polystyrene (EPS)"; in Modern Styrenic Polymers: Polystyrenes and Styrenic Copolymers (J. Scheirs and D.B. Priddy, eds.), John Wiley & Sons Ltd., 2003, Chapter 9, pp. 165-201
- D3: FR 1 310 106.

- III. In the appealed decision, the fifth auxiliary request was found to be allowable. Claim 1 of this request reads as follows:

"1. Process for the preparation of expandable polystyrene comprising the following steps:

- i°) heating an aqueous suspension comprising styrene monomer and at least one organic peroxide initiator of formula (I) 1-alkoxy-1-t-alkylperoxy-cyclohexane in which the alkoxy group contains 1

to 4 carbon atoms, the t-alkyl group contains 4 to 12 carbon atoms, and the cyclohexane ring may optionally be substituted with 1 to 3 alkyl groups each, independently having 1 to 3 carbon atoms, at a temperature ranging from 100°C to 120°C, - ii°) adding a blowing agent being pentane during step i°)."

As to inventive step, the subject-matter of claim 1 of the fifth auxiliary request involved an inventive step over D1 alone or in combination with D2 or D3.

- IV. In its statement setting out the grounds of appeal, the opponent (in the following "appellant") requested that the decision of the opposition division be set aside and that the patent be revoked. It *inter alia* raised an objection of added subject-matter against dependent claim 13 of the claim set found allowable by the opposition division.
- V. In its reply, the patent proprietor (in the following "respondent") submitted a main request and four auxiliary requests.
- VI. Claim 1 of the main request is identical in wording to claim 1 of the fifth auxiliary request, which was found allowable by the opposition division (see point III above). The only difference between the two requests is that in the main request the dependency in claim 13 has been amended to overcome the appellant's objection of added subject-matter.
- VII. The appellant provided further arguments with the letter dated 23 March 2018.

- VIII. The respondent provided further arguments with the letter dated 30 March 2018, including the re-filed main request and six auxiliary requests. The latter are not pertinent to the present decision.
- IX. Oral proceedings took place on 2 May 2018.
- X. The appellant's arguments regarding the main request which are pertinent for the present decision can be summarised as follows:
- The closest prior art D1 disclosed in example 11 the polymerisation of styrene using two peroxides, including a peroxide as required by claim 1, namely 1-alkoxy-1-t-alkylperoxycyclohexane. The addition of a blowing agent was not mentioned in example 11. Since, however, the whole teaching of D1 was about expandable polystyrene, a blowing agent such as pentane must have been added after the polymerisation in example 11 in order to render the polystyrene expandable. Thus, the process of claim 1 of the main request differed from the process of example 11 in that pentane (*i.e.* the blowing agent) was added during the heating step. However, D1 taught to add the blowing agent during the polymerisation process (column 1, line 55 to 57). In addition, common general knowledge as described in D2 taught to add the blowing agent during the polymerisation (e.g. Fig. 9.3). Moreover, pentane was by far the most frequently used blowing agent. In view of these aspects, the invention was obvious.
 - Regarding the technical problem, the appellant contested that the ambitious problem of obtaining expandable polystyrene having a high molecular

weight while keeping the amount of residual styrene monomers low was derivable from the opposed patent. In fact, it was known, as stated in the opposed patent, that the addition of blowing agent during polymerisation reduced the molecular weight. Moreover, there was no indication in the opposed patent that pentane was responsible for obtaining the effects addressed in the technical problem. Finally, the combination of an initiator as required by claim 1 and the pentane did not provide a synergistic effect.

- A comparison of example 11 of D1 with the examples of the opposed patent showed that the ambitious technical problem was not solved.

XI. The respondent's arguments regarding the main request which are pertinent for the present decision can be summarised as follows:

- The general teaching of D1, rather than example 11 of D1, was the appropriate starting point for the assessment of inventive step. The selection of a specific class of peroxide initiator, namely 1-alkoxy-1-t-alkylperoxycyclohexane, in combination with a specific alkane (pentane) made it possible to obtain expandable polystyrene having a high molecular mass while keeping the amount of residual styrene monomers low. This had been demonstrated with the comparative tests filed on 30 April 2013. Thus, the technical problem was to provide a simple process for preparing expandable polystyrene having a high molecular mass while keeping the amount of residual styrene monomers low.

- The said technical problem was derivable from the opposed patent. The provision of an expandable polymer having a high molecular mass was described in paragraph [0012], and in paragraph [0003] it was stated that a low concentration of residual monomer was desirable. The examples confirmed that these effects were obtained using pentane as the blowing agent, and the comparative examples confirmed that the initiator of the invention provided a contribution in solving the technical problem.
- The examples of the opposed patent and example 11 of D1 were not comparable.

XII. The appellant requests that the decision of the opposition division be set aside and that the patent be revoked.

XIII. The respondent requests that the patent be maintained in amended form based on the main request or, if the main request is found to be not allowable, that the case be remitted to the opposition division for consideration of the auxiliary requests.

Reasons for the Decision

1. Amendments - Article 123(2) EPC

The main request differs from the fifth auxiliary request found allowable by the opposition division only in that the dependency of claim 13 of the main request was amended so that it was dependent solely on

claim 12. This amendment overcomes the appellant's objection to the amended dependency ("according to any one of claims 1 to 12") of claim 13 of the fifth auxiliary request held allowable by the opposition division (Article 123(2) and Rule 80 EPC). The appellant has not raised any objection to the main request with respect to added subject-matter. The board is also satisfied that the amendment complies with the requirements of Article 123(2) EPC.

2. Inventive step

2.1 The remaining issue in the appeal proceedings concerns inventive step. The appellant raised inventive step attacks in view of D1 alone and of D1 in combination with D2.

2.2 Closest prior art

2.2.1 In the same way as the patent, D1 refers to processes for the polymerisation of expandable styrene polymers, generically designated as EPS (e.g. column 1, lines 10 to 11; claim 11). It is an objective of D1 to produce EPS at accelerated conversion rates. The specific organic peroxide initiators used allow to obtain EPS resins with molecular weights suitable for typical EPS applications (column 3, lines 5 to 13). D1 can therefore be considered to represent the closest prior art. This is also common ground between the parties.

2.2.2 More precisely, D1 relates to the use of peroxide-based initiators in the production of expandable polystyrene which allow an effective conversion within an acceptable period of time (column 1, lines 20 to 24). According to D1, "intermediate" temperature peroxides with a one hour half-life temperature of from 101

to 111°C enhance conversion rates (column 4, lines 56 to 59). D1 discloses various such intermediate temperature peroxides, including 1-alkoxy-1-t-alkylperoxycyclohexane, where the t-alkyl group contains 4 to 8 and the alkoxy group 1 to 8 carbon atoms (column 5, lines 32 to 39). As an example of this type of peroxide initiator, 1-methoxy-1-t-amyperoxycyclohexane (TAPMC) is mentioned (column 5, lines 46 to 47).

In order to render the polystyrene beads obtained by the polymerisation process expandable, the addition of a blowing agent is required. This agent is typically a low molecular weight alkane such as butane, 2-methylbutane, pentane and cyclohexane (column 1, lines 49 to 53). Blowing agents can be added before or at any time during the polymerisation (column 7, lines 25 to 26), but also after the polymerisation process, in a second step, following isolation of the polymer beads (column 1, lines 57 to 59).

In example 11, one of the polymerisation initiators used is TAPMC, which falls within the scope of claim 1 of the main request. In fact, TAPMC is the only peroxide initiator of claim 1 exemplified in the opposed patent (column 3, lines 24 to 26 and examples of the invention 2, 3 and 4).

The addition of a blowing agent is not mentioned in example 11 of D1. Since, however, the whole teaching of D1 is directed to the production of EPS, the appellant argued that example 11 described the first part of the polymerisation process and that the blowing agent was added in a second step, after polymerisation of the styrene monomer.

2.2.3 A first contested point was precisely what part of D1 constitutes the closest prior art. The appellant's view was that example 11 of D1 (which uses TAPMC as an initiator) was the closest prior art, whereas the respondent considered the general disclosure of D1 (directed to "intermediate" temperature peroxides) to be the appropriate starting point for the assessment of inventive step.

2.2.4 Claim 1 of the main request relates to a process wherein the blowing agent *pentane* is added *during* the polymerisation step. In light of this, the board considers that the selection of example 11 as the closest prior art is the result of an *ex post facto* analysis, because the disclosure of this example is described within the context of a two-step process not covered by claim 1 of the main request. Thus, the board agrees with the respondent that the skilled person would rather start from the generic disclosure of D1, which leaves various possibilities for selecting (i) the initiator (which may or may not be a 1-alkoxy-1-t-alkylperoxycyclohexane), (ii) the point in time for the addition of the blowing agent, and (iii) the type of blowing agent.

2.2.5 Nevertheless, for the sake of argument and in the appellant's favour, the board will start in the following from example 11 of D1 for the assessment of inventive step.

2.3 The objective technical problem

2.3.1 The technical problem to be solved was a matter of dispute between the parties:

- The appellant saw the technical problem in the provision of an alternative process for making EPS.
- The respondent's view was that the technical problem resides in the provision of a simple process for obtaining EPS having a high molecular weight while keeping the amount of residual styrene monomers low.

2.3.2 In this respect, the tests submitted by the respondent with letter dated 30 April 2013 and referred to in the appeal proceedings are of relevance. In these tests, the respondent carried out the same process as disclosed in example 2 of the opposed patent, except that instead of pentane (C5) as the blowing agent, hexane (C6) or butane (C4) was used. The results were as follows:

	Molecular weight	Residual styrene content
Example 2 of opposed patent (C5)	226000	700 ppm
Comparative example (C6)	173000	1650 ppm
Comparative example (C4)	183000	1380 ppm

It follows from these tests that if butane or hexane is added as a blowing agent during polymerisation - instead of pentane as required by claim 1 - the molecular weight of the resulting expandable polystyrene is reduced and the amount of residual styrene increased. In this context, the board notes

that according to paragraph [0014] of the opposed patent, EPS preferably has a molecular weight of above 190,000 g/mol. Molecular weights above this value are achieved when pentane is used as the blowing agent, as demonstrated by the invention examples 2 to 4.

2.3.3 In view of these tests, the objective technical problem cannot be regarded as the provision of an alternative process, as asserted by the appellant, but rather as the provision of a simple process that leads to polystyrene with high molecular weight and low residual styrene content. Clearly, in view of what is stated above, the objective technical problem is solved.

2.4 The appellant's remaining counter-arguments regarding the formulation of the objective technical problem do not convince the board:

2.4.1 The appellant argued that the technical problem proposed by the respondent was not derivable from the opposed patent. In the light of paragraphs [0007] to [0009], it was evident that the presence of pentane or flame retardants caused a decrease in the molecular weight of the polystyrene. Rather than being the solution to a technical problem, the presence of pentane was the source of disadvantages regarding the molecular weight. The effects the respondent relied upon to demonstrate an inventive contribution were reported for the first time in tests which it filed in April 2013.

2.4.2 The board cannot agree.

Firstly, both the molecular weight of the expandable polystyrene and the amount of residual monomer obtained are two important results of the process of the

invention. These results are consistently highlighted in invention examples 2 to 4 and in comparative examples 5 to 7 of the opposed patent, as can be seen from paragraphs [0050], [0054], [0057], [0062], [0064] and [0066].

Secondly, the skilled person would understand from paragraph [0012] that the opposed patent aims at simultaneously providing the following:

- (a) accelerating the preparation of expandable polystyrene,
- (b) using a blowing agent during the polymerisation, and
- (c) obtaining polystyrene having a particularly high molecular weight.

In this context, it is worth noting that the blowing agent consistently used in invention examples 2 to 4 is pentane, which is the preferred blowing agent described in the opposed patent (see paragraph [0039]).

Thirdly, it is also derivable from the opposed patent that a low concentration of residual monomer is desirable (see paragraph [0003]).

In short, the board is convinced that the technical problem proposed by the respondent is straightforwardly derivable from the opposed patent. For this reason, decisions T 344/89 and T 767/02 - both relating to an unallowable reformulation of the technical problem - do not support the appellant's case. The tests filed in April 2013 simply represent additional evidence, but they do not alter the technical problem derivable from the opposed patent.

- 2.4.3 In its written submissions, the appellant compared the molecular weight of the polystyrene obtained in example 11 of D1 (278,000) with the polystyrene obtained in example 2 of the opposed patent (226,000). Similarly, the content of the residual monomer was lower in example 11 of D1 as compared to example 2 of the opposed patent. Therefore, the appellant concluded that the technical problem suggested by the appellant was not solved over D1.
- 2.4.4 This argument is not convincing. Although the same peroxide initiator is used in both example 11 of D1 and example 2 of the opposed patent, these examples are not comparable, since no blowing agent, let alone pentane, is present during the polymerisation in example 11 of D1.
- 2.5 Obviousness
- 2.5.1 It remains to be decided whether, in view of the available prior art, it would have been obvious for the skilled person to solve the objective technical problem as defined above by the means claimed.
- 2.5.2 There is no indication in D1 itself that pentane should be used as the blowing agent in order to solve the objective technical problem. More precisely, starting from example 11 of D1 (which already discloses the initiator TAPMC), the skilled person may have chosen to add the blowing agent *during* the polymerisation process in order to simplify the manufacturing process, in line with the disclosure of D1, column 1, line 55 to 57. But the skilled person had no indication from the teaching of D1 to specifically select pentane as the blowing agent with the expectation to improve the molecular weight and the residual monomer content of the obtained

EPC. There is no teaching whatsoever in D1 in this direction. In fact, according to D1, all blowing agents are interchangeable, so that there is no reason to choose a specific blowing agent instead of another with the aim of improving the molecular weight of the expandable polystyrene.

- 2.5.3 As regards the combination of D1 with D2, the latter is a textbook which discloses pentane as a blowing agent for styrene polymerisation. The appellant argued that D2 demonstrated that pentane was the most commonly used blowing agent. Therefore, the skilled person would also use pentane in the process of example 11 of D1 during the styrene polymerisation. However, this alone does not compel the skilled person to use pentane as the blowing agent. Such an approach appears to be tainted by hindsight. On the contrary, what needs to be decided at this juncture is whether the skilled person had any indication to use pentane and not other blowing agents equally suggested in D1 for solving the objective technical problem.

On this point, however, D2 contains no indication that pentane would optimise the molecular weight and residual monomer content in the EPS production. There is simply no pointer for the solution in D2 either.

To be complete, D3 (page 2, left column, last paragraph) confirms that many blowing agents (including e.g. heptane) are known in the art, but there is no teaching that one of the blowing agents, and in particular pentane, would improve the molecular weight and residual monomer content in the EPS production.

2.5.4 The board notes that precisely this issue was a point in the opposition division's reasoning (see reasons for the decision, point 5.2):

"Neither D2 nor D3, however, give any incentive to use pentane for improving the Mw build up of the polystyrene or for obtaining low residual monomer contents.

The Opponent has not submitted any evidence or literature that said technical effects were expectable from the prior art or general knowledge."

In the appeal proceedings too, the appellant has not provided any evidence demonstrating the (improved) influence of pentane on the molecular weight and/or residual monomer content in the production of EPS. Thus, the board sees no reason for reversing the appealed decision.

2.5.5 Also, the board cannot accept the appellant's argument that no "synergy" or "link" has been demonstrated for the combination of the features of claim 1. On the contrary, the respondent's experiments show that pentane has a technical effect. Whether or not there is also a synergistic effect between the initiator and the pentane is therefore not relevant in the present case.

2.5.6 Finally, the appellant argued that any effect associated with the selection of pentane was a bonus effect, because the skilled person would have selected pentane in view of D2 anyway as the blowing agent. This argument is not convincing. As already explained above, the advantageous effect could not be expected from the teaching of the prior art documents. Furthermore, there

is no lack of alternatives that would place the skilled person into the notorious "one-way-street" situation: both the closest prior art D1 and D3 suggest various equally suited blowing agents.

2.5.7 Thus, the subject-matter of claim 1 involves an inventive step, Article 56 EPC. The same applies to claims 2 to 13 which are all dependent on claim 1.

3. Description

The description was adapted during the oral proceedings before the opposition division. In the board's view, the so amended description was correctly adapted. The parties agreed that no further modification was necessary.

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 in the following version:
 - claims 1 to 13 of the main request request filed with letter dated 30 March 2018; and
 - description pages 2 to 5 filed during oral proceedings before the opposition division on 11 December 2013.

The Registrar:

The Chairman:



M. Cañueto Carbajo

W. Sieber

Decision electronically authenticated