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**D E C I S I O N**  
of 11 January 1996

**Case Number:** T 0379/93 - 3.3.2

**Application Number:** 83102890.7

**Publication Number:** 0089691

**IPC:** B01J 8/24

**Language of the proceedings:** EN

**Title of invention:**

Continuous process for the production of polymer in a fluidized bed reactor

**Patentee:**

UNION CARBIDE CORPORATION

**Opponent:**

- (01) BASF Aktiengesellschaft  
(02) BP Chemicals Limited

**Headword:**

Fluidized bed polymerisation/UNION CARBIDE

**Relevant legal provisions:**

EPC Art. 54, 56, 83, 112(1)

**Keyword:**

- "Novelty - yes"  
"Inventive step - yes"  
"Sufficiency of disclosure - yes"  
"Questions to the Enlarged Board - no"

**Decisions cited:**

T 0019/81

**Catchword:**

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Case Number: T 0379/93 - 3.3.2

DECISION  
of the Technical Board of Appeal 3.3.2  
of 11 January 1996

Appellant: BASF Aktiengesellschaft  
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Representative: -

Appellant: BP Chemicals Limited  
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Decision under appeal: Decision of the Opposition Division of the  
European Patent Office posted 9 March 1993  
rejecting the oppositions filed against European  
patent No. 0 089 691 pursuant to Article 102(2)  
EPC.

Composition of the Board:

Chairman: P. A. M. Lançon  
Members: G. J. Wassenaar  
R. E. Teschemacher

### Summary of Facts and Submissions

- I. European patent No. 0 039 691 was granted with 17 claims in response to European patent application No. 83 102 890.7.
- II. Notices of opposition were filed by the Appellants 01 and 02. Revocation of the patent in its entirety was requested on the grounds of lack of novelty, lack of inventive step and insufficient disclosure (Articles 52, 54, 56, 83, 100(a) and 100(b) EPC).

Forty documents were cited during the opposition proceedings of which the following remain relevant for this decision:

- (1) DE-C-1 013 870
- (2) DE-B-1 071 338
- (3) DE-B-1 745 114
- (12) EP-A-0 003 228
- (13) US-A-3 595 840
- (15) EP-A-0 004 645
- (16) GB-A-1 226 659
- (18) EP-A-0 021 605
- (19) EP-A-0 050 477
- (28) Perry and Chilton, Chem. Eng. Handbook 5th ed.  
page 20-73
- (30) US-A-4 564 605
- (35) Declaration of Mr Bernard

III. The Opposition Division rejected the opposition and maintained the patent in the form as granted.

Claim 1 as granted reads as follows:

"1. A continuous process for the production of polymer in a fluidized bed reactor from one or more fluid monomers by continuously passing a gaseous stream through said reactor in the presence of catalyst under reactive conditions, withdrawing polymeric product and unreacted fluids, cooling said unreacted fluids and returning said cooled fluids into said reactor together with sufficient additional monomers to replace those monomers polymerized and withdrawn as product, which comprises: cooling part or all of said unreacted fluids to form a two-phase mixture of gas and entrained liquid below the dew point and reintroducing said two-phase mixture into said reactor."

IV. In their statements of the grounds of appeal, the Appellants maintained the grounds for opposition and submitted further evidence in support of their submission that the introduction of liquid into fluidized bed polymerisation reactors was known in the art.

Novelty was attacked on the basis of (12) by Appellant 01 and on the basis of (18) by Appellant 02. Appellant 01 argued essentially that although (12) did not explicitly disclose all the features of claim 1 it nevertheless disclosed possible process conditions which would inherently comprise a process having all the features of present claim 1 (page 4, lines 26 to 34). Appellant 02 argued essentially that (18) disclosed all the elements of the process of claim 1 and that the fact

that the same document pointed to the dangers and disadvantages of such a process did not make the claimed process novel.

He further argued that should a satisfactory performance of the process of the patent in suit require special means not disclosed in document (18), then such means were not disclosed in the patent specification either, so that the invention could not be carried out by a person skilled in the art.

Inventive step was attacked on the basis of (15) or (18) in combination with (1) by Appellant 01 and on the basis of (15) in combination with (1), (12) and (28) by Appellant 02.

- V. The Respondent refuted the arguments of the Appellants and submitted further evidence in support of his submission that the warning in (18) to avoid condensation in the recycle stream of a fluidized bed reactor was based on a real prejudice.
- VI. Oral proceedings took place on 11 January 1996 at the end of which the decision as ordered was given.
- VII. The Appellants requested that the decision under appeal be set aside and that the patent be revoked in its entirety.  
Appellant 01 alternatively requested that the question on what conditions a prejudice may be accepted be referred to the Enlarged Board of Appeal should the Board not follow decision T 19/81 (OJ EPO 1982, 51).

Appellant G2 alternatively requested that the following question be referred to the Board of Appeal:

- If all the elements of an alleged invention claimed in a patent are disclosed in a document published before the priority date, and the document indicated that the alleged invention could be performed but should not be since there would be an unsatisfactory aspect to such performance, then does the alleged invention lack novelty?

The Respondent requested that the appeals be dismissed.

#### **Reasons for the Decision**

1. The appeal is admissible.
2. *Sufficiency of disclosure*

The question of sufficiency should be decided upon taking into consideration the information given in the patent specification as interpreted by the skilled man.

If the teaching in a patent specification is not in agreement with, or even contradictory to the teaching of a specific prior art document, it cannot be concluded that the teaching in the patent is insufficient. It is also possible that the prior art teaching was based on incorrect presumptions.

Since the patent specification contains comparative examples in agreement with claim 1 which were not contested, it must be concluded that the invention as claimed could be performed by the skilled man.

3. Novelty

3.1 The process of claim 1 comprises the following four steps:

- (i) continuously passing a monomer containing gas stream through a fluid bed reactor in the presence of a catalyst,
- (ii) withdrawing product and unreacted fluids from the reactor,
- (iii) cooling said unreacted fluids to a temperature below the dew point to form a two phase mixture of gas and entrained liquid, and
- (iv) reintroducing said two phase mixture into the reactor together with fresh monomer.

3.2 Document (12) discloses continuous polymerisation processes in at least two reactors, whereby in the first reactor the polymerisation takes place in liquid dispersion. The last reactor is a gas phase reactor and may comprise the above mentioned steps (i) and (ii). The unreacted fluids from the gas phase reactor may be cooled below the dew point, in which case the liquid is separated and the remaining gas is reintroduced into the fluid bed reactor as illustrated by example 3.

According to Appellant 01, document (12) also discloses on page 4, lines 26 to 34, as an alternative, the partial condensation of the withdrawn unreacted fluid followed by reintroduction of the partly condensed fluid into the reactor, which would imply the forming of a two phase mixture and the reintroduction of such a mixture into the reactor.

The Board cannot accept this view for the following reasons.

What is condensed or partly condensed according to the said passage on page 4 is the dispersant agent present from the earlier polymerisation step in the liquid phase. Mentioning that the dispersant agent can be optionally wholly or partly condensed and wholly or partly reintroduced into the gas phase reactor is more likely to mean, in line with the examples, that if no condensation takes place the dispersion medium is completely recirculated and if partial condensation takes place only the non condensed part of the dispersant is recirculated as illustrated by the examples. In any case there is no unambiguous disclosure that a two phase mixture of gas and entrained liquid is formed and reintroduced into a fluid bed reactor. Therefore, (12) does not destroy the novelty of the process of claim 1.

3.3 Document (18) also discloses steps (i) and (ii) in a continuous polymerisation process. It mentions explicitly that condensation of higher monomers ( $C_5 - C_8$  comonomers) in the recycle stream should be avoided by maintaining the temperature thereof above the dew point of the gas mixture (page 5, lines 15 to 19 and page 22, lines 8 to 22). In the discussion of the prior art in the introduction of (18) it is indicated that the use of higher comonomers in the copolymerisation with ethylene improves the quality of the product but has the disadvantage that the higher comonomers tend to condense out in the reactor system which would lead to the following specified problems:

- the production of sticky or tacky polymers which are difficult to handle and process,



- the plugging of the gas distribution plate used in such fluid bed reactors,
- the fouling of sensing elements inserted into the reactor system for the purpose of monitoring and controlling the reaction conditions, and
- reactor temperature control problems due to heat capacity variations (page 3, lines 1 to 21).

According to Appellant 02, these problems would only indicate that the product obtained by allowing condensation would not be of optimum quality and that the process in the presence of condensate would be more difficult to control. It would not imply that it was impossible to perform a continuous polymerisation process with condensate of higher monomers formed and kept in the recycle stream so that the condensed mode process of present claim 1 would lack novelty.

- 3.4 In the Board's view, however, novelty would only be destroyed if the continuous operation in the condensed mode as claimed in the patent in suit were unambiguously disclosed in (18) as a feasible option. The indication in (18) that C<sub>5</sub> to C<sub>9</sub> comonomers tend to condense out and the warning against the consequences of such a condensation is not equal to the description of an operational process as disclosed and claimed in the patent in suit. Document (18) discloses in this respect only that condensation in the reactor system should be avoided and also some reasons on which this warning is based, but there is no indication that a continuous operation in the condensed mode was a feasible option.

Therefore, (18) does not destroy the novelty of the process of claim 1.

Since neither any of the other citations discloses a process comprising in combination all the features of granted claim 1, its subject matter is considered to be novel.

4. *Inventive step*

4.1 The document representing the closest prior art is generally the document relating to the same technical subject matter and disclosing the greatest amount of common essential features. If there is more than one document fulfilling this requirement, one should generally choose the one which represents the latest development. On the basis of these general considerations, the Board regards (18) as the closest prior art. Furthermore, as shown in point 3.3 above, (18) already addresses problems in relation with the use of higher olefin comonomers such as used in the patent in suit.

Although the Appellants chose to take (15) as the closest prior art, they accepted that (15) and (18) were equally viable alternatives as the starting point for analysing inventive step.

Document (18) discloses a continuous fluid bed polymerisation process for making ethylene-based polymers, comprising the above mentioned steps (i) and (ii) and as a further essential feature a specified relationship between  $C_2$  and higher olefin comonomers.

According to the introduction of the present patent specification a major problem with prior art polymerisation processes is the removal of heat developed by the polymerisation reaction. It forms, in fact, the primary limitation on the reaction rate or Space Time Yield (STY).

This technical problem has been known for a long time for polymerisation reactors and has been discussed in several prior art documents (see (1) column 2, line 48 to column 3, line 2 and (16) page 2, lines 53 to 86). For fluid bed reactors it has further been known that the cooling must be performed smoothly in order to maintain a uniform temperature gradient in the fluid bed. Uncontrolled temperature variations due to inappropriate cooling might lead to agglomeration and even complete shut down of the reactor (see (3), column 2, lines 10 to column 3, line 4 and column 4, line 52 to column 5, line 18).

- 4.2 Starting from (18), the technical problem underlying the invention can be seen in providing a continuous process for the production of polymer in a fluidised bed reactor with improved Space Time Yield.

According to claim 1, this problem is solved by cooling the recycle stream below the dew point to form a two-phase mixture of gas and entrained liquid and reintroducing said two-phase mixture into said reactor (steps (iii) and (iv) mentioned above).

The patent specification contains comparative examples 1, 1a, 2 and 2a, whereby examples 1 and 2 have been performed in the condensed mode according to the invention, whereas examples 1a and 2a have been carried out under essentially identical operating conditions differing only in cooling the recycle stream above the dew point according to (18) with adapted catalyst injection. The STY of example 1 turned out to be 2.5 times that of example 1a and the STY of example 2 was 1.7 times that of example 2a.

The Board is, therefore, satisfied that the process of claim 1 actually solves the said problem.

4.3 It remains therefore to be decided if the present solution was obvious in view of the available prior art.

As already indicated under point 3.3 above, (18) warns against cooling of the recycle stream below the dew point, so that it clearly points away from the solution as now claimed.

As emphasized by the Appellants, the cooling effect of evaporating liquid to control the temperature in polymerisation reactors has been applied for a long time. Document (1), published in January 1957, discloses the introduction of a compressed gas into a polymerisation reactor, which partly condenses in the reactor because of the cooling effect of adiabatic decompression, followed by evaporation of the condensate by the heat of the polymerisation reaction. It specifically discloses that in this way the STY can be improved (column 2, line 53 to column 3, line 2). The reactor is not a fluid bed reactor but a simple container whereby unreacted gas and formed polymer are removed through the same exit. Document (2), published in December 1959, discloses the same cooling principle applied in a stirred bed reactor.

The use of fluidized bed reactors with a cooled recycle stream for polymerisation processes was known for more than 10 years before the priority date of the patent in suit. The earliest document disclosing such a process mentioned in these proceedings is (13), which was published in July 1971. It discloses a vinyl monomer polymerisation in a fluid bed reactor, whereby unreacted monomer gas is recycled as fluidisation gas. Part of the recycle stream may optionally be condensed. The liquid is then introduced **separately** from the fluidizing gas stream to control the temperature of the fluid bed reactor (column 5, lines 39 to 43).

The partial condensation of the recycle stream and the use of the condensed liquid for additional cooling of the fluid bed has also been known in the olefin polymerisation; see (3), column 5, lines 5 to 10, column 7, lines 26 to 28, column 9, lines 55 to 58. However no prior art document has been cited disclosing the cooling of a fluid bed by introducing a two phase mixture formed from the recycle stream into the fluid bed.

4.4 According to Appellant 01, combining the teaching of (1) with (18) to solve the problem was obvious. He argued that this combination implied that a mixture of gas and liquid is introduced into the fluid bed.

It has, however, not been shown that adiabatic cooling as taught by (1), has been applied to fluid bed polymerisation. The great pressure differentials necessary for obtaining condensation by adiabatic decompression and the temperature shock associated therewith, seem to be difficult to match with the requirements for stable fluid bed conditions such as a smooth pressure gradient and a uniform temperature profile. The latter condition being necessary to avoid agglomeration of the polymer particles, which may lead to complete shut-down of the reactor (see point 4.1). Moreover its combination would require a compression step which would very much complicate the standard fluid bed polymerisation process of (18) and would in fact result in a process not covered by present claim 1 as interpreted in view of the description and drawing.

The Board, therefore, regards the combination of (1) and (18) to be non-obvious.

4.5 According to Appellant 02 the invention was the result of an obvious combination of the teachings of (12) with the fluid bed processes of (18). Since in the understanding of the Board (12) does not teach the introduction of a liquid from the recycle stream into the gas phase reactor (point 3.2 above) the Board cannot agree with this argumentation.

4.6 Appellant 02 further argued that the Respondent was the first who made experiments with fluid bed polymerisation of ethylene in the presence of  $C_5 - C_8$  comonomers so that he was also the first who had to deal with the condensate which is almost inevitable if the recycle stream is cooled. Knowing from general textbooks such as (28) that a volatile liquid can be added to a fluid bed for cooling purposes, the easiest way to deal with the condensate would be to keep it in the recycle stream and to return it together with the gas into the fluid bed, thereby obtaining the process as now claimed. The warning against condensation in (18) would not refrain the skilled man from trying this obvious way of integrating condensed liquid into the process.

The Board cannot agree with this argumentation either. The Respondent was indeed the first who was confronted with the problem of possible condensation in the reactor system of higher monomers in the copolymerization with ethylene. In the same document (18), where this problem was discussed for the first time, however, the solution to integrate condensed liquid was rejected because it was thought it disrupted the process in an unacceptable way. After the publication of (18) the condensed mode could not, in the Board's view, be considered as a serious alternative, let alone an obvious alternative, unless there is evidence that the skilled man would not take the warning against the condensed mode seriously. Such evidence is not available. On the contrary, in the

prior art documents disclosing the use of liquid obtained by partly condensation of the recycle stream for cooling the fluid bed, such as (3) and (13) the liquid is introduced separately from the fluidizing gas. Textbook (28) likewise only discloses the injection of a liquid in a fluid bed. Moreover, document (19), in the name of Mitsui Petrochemical Industries, which was published after the priority date but before the publication date of the patent in suit, and relating to the fluid bed polymerisation of ethylene copolymers, also warned against the introduction of recycle gas containing liquid into the fluid bed and required explicitly that the gaseous recycle stream is cooled to a temperature at which the mixture is not liquified (page 3, lines 13 to 34, page 10, lines 1 to 8 and claim 1). Later publications by several authors relating to the fluid bed copolymerization of ethylene with higher monomers confirm the concern about the condensation of the higher monomers in the recycle stream. Document (30) in the name of Appellant 02, published in January 1986 but having a priority date of November 1983, i.e. only two months after the publication date of the application on which the patent in suit is based, discloses that possible condensations of higher olefins in the copolymerisation medium are to be feared, as these are prejudicial to good exploitation of a gas-phase polymerisation process (column 1, lines 51 to 58). Appellant 02's submission based on (35) that "copolymerisation medium" should be read as limited to the fluid bed wherein the polymerisation takes place so that there is no warning against condensation in the recycle stream, is not convincing. Condensation of the higher monomers can only take place if they were originally present in gas form. Since the hottest part in the polymerisation process is the fluid bed, there is never any danger of condensation taking place in the fluid bed. The only place where condensation may occur

is in the cooling section, i.e. in the recycle stream. In the Board's view the warning in (30) against condensation in the polymerisation medium should be interpreted as a warning not to cool the recycle stream below the dew point of the gas mixture.

The Board, therefore, concludes that the substantiated warning against the condensed mode in (18) which seemed plausible when read in isolation was not in contradiction to the opinion of other persons skilled in the art at the priority date of the patent in suit. Hence, it was to be expected that a skilled person at the filing date took the warning against the condensed mode seriously. The subject matter of claim 1, therefore, does not follow in an obvious manner from the cited prior art.

4.7 The outcome of the inventive step analyses would not be any different if (15) were taken as a starting point, as preferred by the Appellants. Document (15) discloses the same process steps (i) and (ii) as (18). Although reference was made in (15) to the copolymerisation of higher monomers, possible condensation problems were not discussed. There is no disclosure of cooling the recycle stream below the dew point of the gas mixture. The technical problem would be the same as starting from (18). Since (15) does not disclose condensation of any kind, it could not lead towards the solution of present claim 1.

4.8 Prior art citations not discussed above are more remote from the subject matter of claim 1 and cannot provide the skilled man with any incentive to provide the claimed solution of the above mentioned technical problem. For these reasons, the subject matter of claim 1 involves an inventive step within the meaning of Article 56 EPC.



The remaining claims 2 to 17 are dependent upon claim 1. Novelty and inventive step should be acknowledged for the same reasons as given for claim 1.

5. The questions which the Appellants requested be referred to the Enlarged Board of Appeal do not affect this decision for the following reasons.

5.1 The question proposed by Appellant 01:

As indicated above, non-obviousness was essentially based on the absence of any incentive in the prior art towards finding the solution as now claimed. The question of the prejudice essentially raised in relation with (18) was not decisive in this case. Inventive step has not been based on a prejudice which would have made an otherwise obvious solution inventive. Rather, inventive step was based on the lack of an incentive to modify the solution disclosed in (18) by integrating condensed liquid into the process. Furthermore, even if the Board had based this decision on a prejudice it would not have been based on unsubstantiated assertions in a single document without further corroboration (see point 4.6 above) so that this decision is not contradictory to T 19/81 (see points 5.2, 5.3 of the reasons). In fact, this decision supports the earlier decision.

5.2 The question proposed by Appellant 02:

As indicated under point 3.3, (18) does not disclose that a continuous fluid bed polymerisation process could be performed in the condensed mode if some disadvantages were accepted. The answer to the question is, therefore, irrelevant for this decision. Moreover the question is dependent upon the meaning of "all the elements of an

invention", which is related to the factual circumstances in a particular case, and is not an important point of law.

Therefore, the Board has not followed the requests of the Appellants to refer the said questions to the Enlarged Board of Appeal (Article 112(1)(a) EPC).

**Order**

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

The appeals are dismissed.

The Registrar:



P. Martorana

The Chairman:



P. A. M. Lançon

*Te 13.3.*

*HW 13/3/96*