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**Datasheet for the decision
of 23 July 2010**

Case Number: T 1300/07 - 3.3.05

Application Number: 01946803.2

Publication Number: 1251951

IPC: B01J 8/02

Language of the proceedings: EN

Title of invention:
Chemical reactor with heat exchanger

Patentee:
Meggitt (U.K.) Limited

Opponent:
Lang, Christian

Headword:
Chemical reactor/MEGGIT (U.K.) Ltd.

Relevant legal provisions:
EPC Art. 54, 56
EPC R. 139

Relevant legal provisions (EPC 1973):

-

Keyword:
"Novelty, inventive step (main request) - yes"

Decisions cited:

-

Catchword:

-



Case Number: T 1300/07 - 3.3.05

D E C I S I O N
of the Technical Board of Appeal 3.3.05
of 23 July 2010

Appellant I: Lang, Christian
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Decision under appeal: Interlocutory decision of the Opposition
Division of the European Patent Office posted
24 May 2007 concerning maintenance of European
patent No. 1251951 in amended form.

Composition of the Board:

Chairman: E. Wäckerlin
Members: H. Engl
H. Preglau

Summary of Facts and Submissions

I. The present appeals are from the interlocutory decision of the opposition division posted on 24 May 2007 to maintain European patent EP-B-1 251 951 in amended form.

II. The following documents were *inter alia* cited in the opposition proceedings:

D1: David Reay, "*Learning from experiences with compact heat exchangers*", June 1999, Cadett Analysis Series 25, Sittard, pages 32-42, 85-86, 98, 141-142, XI-XII

D3: WO-A-97 21 064

D4: DE-A-43 13 723

D5: Tony Johnston, "*Miniaturized heat exchangers for chemical processing*", *The Chemical Engineer*, December 1986, pages 36-38

D10: DE-A-197 41 645

III. The opposition division rejected the patentee's main request, as the proposed amendments to claims 1 and 12 did not meet the requirements of Article 123(2) EPC. However, the claims of the auxiliary request, filed during oral proceedings, were found to meet the requirements of the EPC. The opposition division held that document D3 did not disclose a combined multistage heat exchanger/reactor as defined in claim 1. Starting from D3 as the closest prior art, the technical problem consisted in modifying the design of the catalytic reactor to improve the heat exchange. Starting from D4, the technical problem was seen in improving the integration of the heat exchangers into the catalytic reactor. There was no incentive in any document to use

heat exchangers of the printed circuit heat exchanger (PCHE) type placed between successive catalytic beds or reaction zones, in order to solve the problem posed.

- IV. The appeal of appellant I (opponent) was filed by letter dated 7 July 2007; the statement of grounds of appeal was filed under cover of letter dated 1 October 2007.
- V. The appeal of appellant II (patentee) was filed by letter dated 3 August 2007 and the statement of grounds of appeal was filed under cover of letter dated 2 October 2007. Appellant II requested that the patent be maintained on the basis of the claims filed during opposition proceedings with letter of 1 May 2007 as the main request, or in the alternative, that the patent be maintained on the basis of the claims of the first auxiliary request, upheld by the opposition division.
- VI. Further submissions of appellant II were received by letter dated 19 February 2008.
- Second and third auxiliary requests were put on record with letter dated 23 June 2010.
- VII. Additional submissions of appellant I were received by letter dated 16 July 2010.
- VIII. Oral proceedings took place on 23 July 2010. Appellant II filed a new main request. The independent claims read as follows:

Main request:

"1. A reactor comprising a reaction zone and in series therewith heat exchange means of the plate type in operative contact with the reaction zone so as to receive reactants for heat exchange purposes, wherein the heat exchange means is of the printed circuit heat exchanger type (PCHE) namely, panels formed from a plurality of superposed metal plates wherein fluid flow channels have been formed, according to a pre-determined pattern, said channel bearing plates being aligned during superposition to define discrete heat exchange pathways for fluids and diffusion bonded together, wherein a plurality of reaction zones are arranged in succession having a heat exchange panel arranged between successive zones, the design being such that the contact face area of the panels is similar to the contact face area of the reaction zones."

"12. A process for conversion of a fluid reactant in a reactor comprising a reaction zone and in series therewith heat exchange means of the printed circuit heat exchanger (PCHE) type in operative contact with said reaction zone, and having discrete fluid pathways for heat exchange between fluids at differing temperatures whilst avoiding mixing of the fluids, the said process comprising, providing the appropriate fluid reactant species to be converted in the reaction zone within the reactor and at a predetermined stage of reaction introducing at least a portion of the fluid reactant species into a reactant fluid pathway within said heat exchange means, and also introducing an auxiliary fluid at a temperature differing from that

of the fluid reactant species into another fluid pathway within said heat exchange means and juxtaposed to the first whereby the discrete nature of the respective pathways permits indirect heat exchange between the fluid reactant species, said process being optionally repeated in successive stages, wherein a plurality of reaction zones are arranged in succession having a heat exchange panel arranged between successive zones, the design being such that the contact face area of the panels is similar to the contact face area of the reaction zone."

"14. An apparatus for controlling the temperature profile of a reactant fluid in the presence of a catalyst during an endothermic or exothermic chemical reaction, comprising a reactor having reactant fluid inlet means and reactant fluid outlet means; catalytic beds being provided therebetween, spaced apart by a printed circuit heat exchanger (PCHE); said heat exchanger comprising heat exchanging fluid inlet means, heat exchanging fluid outlet means, a first channel or set of channels for passage of the heat exchanging fluid, and a second channel or set of channels in communication with the adjacent catalytic beds to allow passage of the reactant fluid from one catalytic bed to the next, said second channel or set of channels not being in communication with the reactant fluid, wherein multiple heat exchangers are provided, between adjacent catalytic beds, the design being such that the contact face area of the exchangers is similar to the contact face area of the catalytic beds."

"18. A process for indirectly controlling the temperature profile of a reaction fluid in the presence of a catalyst during an endothermic or exothermic chemical reaction, comprising passing a reactant fluid from a reactant fluid inlet means in a reactor to a first catalytic bed before passing said reactant fluid through a first channel or set of channels in a printed circuit heat exchanger (PCHE) and subsequently passing said fluid to a further catalytic bed; passing a heat exchanging fluid from a heat exchanging inlet means to a heat exchanging outlet means through a second channel or set of channels in the said printed circuit heat exchanger (PCHE); and exchanging heat between the heat exchanging fluid and the reactant fluid whilst passing same through the said printed circuit heat exchanger (PCHE), the products of the reaction finally leaving the catalytic bed being passed to a reaction fluid outlet means, wherein the heat exchanger is between the catalytic beds and that the contact face area of the heat exchanger is similar to the contact face area of the catalytic beds."

IX. The arguments of appellant I may be summarised as follows:

The corrections in claims 12 and 15 in the version maintained by the opposition division contravened Rule 88 EPC 1973 and should not, therefore, have been allowed.

Furthermore, the claims suffered from clarity problems ("*indefinite wording*") rendering it impossible to determine the scope of protection.

Claim 1 was anticipated by D3 which disclosed a reactor having an alternate arrangement of catalyst beds and heat exchange panels.

In the alternative, it was argued that the claimed subject matter lacked an inventive step having regard to D3, it being obvious to arrange catalytic beds and heat exchanger plates in the claimed manner.

In addition, the claimed invention was obvious having regard to D4 in combination with D5. The latter document suggested replacing the conventional heat exchangers of D4 by PCHEs.

X. The arguments of appellant II may be summarised as follows:

The appellant's arguments concerning clarity were rejected as being outside the scope of opposition.

The claimed subject matter was novel because D3 did not disclose catalyst beds within the context of the invention.

The claimed subject matter also involved an inventive step because there was no motivation for the skilled person to design a reactor with successive reaction zones and PCHE panels wherein the contact face of the panels was similar to the cross sectional area of the PCHE panels.

XI. Requests

Appellant I requests that the decision under appeal be set aside and that the European patent be revoked.

Appellant II requests that the decision under appeal be set aside and that the patent be maintained on the basis of the claims filed during the oral proceedings, or in the alternative, that the patent be maintained on the basis of the claims filed during oral proceedings before the opposition division as auxiliary request 1, or still further alternatively, on the basis of auxiliary requests 2 and 3 submitted with letter of 23 June 2010.

Reasons for the Decision

1. *Amendments (main request)*

- 1.1 Claim 1 is based on a combination of the features of claims 1, 7 and 8 of European patent application EP 01946803.2, published as International patent application WO-A-01/54806 (henceforth "*the application as filed*"). Furthermore, regarding the definition of the heat exchange means, the claim includes the features of claim 10 and the corresponding explanatory passage from page 11, line 28, to page 12, line 3, of the application as filed. The feature relating to "*a reaction zone and in series therewith heat exchange means*" is disclosed on page 7, lines 25 to 28, and in claim 9 of the application as filed. The feature is also clearly and unambiguously derivable from Figure 1 (see in particular reference signs 4 and 5).

Claim 12 is similarly based on claim 15 in combination with claims 7, 8, 10 and the description, page 11, line 28, to page 12, line 3, of the application as filed. Regarding the feature "*a reaction zone and in series therewith heat exchange means*" see the preceding paragraph.

Claim 14 is similarly based on claim 17 in combination with the features of claims 7, 8 and 10.

Claim 18 is based on original claim 21 in combination with the disclosure of claims 7, 8 and 10 and the description, page 11, line 28, to page 12, line 3, of the application as filed.

Dependent claims 2 to 11, 13, 15 to 17 are identical to originally filed claims 2 to 6, 9, 11 to 14, 16, 18 to 20, respectively.

The requirements of Article 123(2) EPC are thus met.

1.2 The amendments clearly limit the scope of protection conferred by the claims, compared with the claims as granted. The requirements of Article 123(3) EPC are therefore met.

2. *Article 84 EPC*

2.1 Appellant I raised the objection that the claims suffered from clarity problems ("*indefinite wording*") rendering it impossible to determine the scope of protection. Insofar as this summary objection can be understood at all, the board observes the following.

Pursuant to Article 100 EPC, objections of lack of clarity cannot be considered in opposition and opposition appeal proceedings, unless such issues arise out of amendments made to a patent. This is not the case here, at least as far as the claims of the main request are concerned (see point 1.1 above).

Therefore, the objection of appellant I under Article 84 EPC cannot be taken into account.

3. *Correction of errors - Rule 139 EPC (Rule 88 EPC 1973)*

3.1 Main request, claim 14

The amendment under dispute is the substitution of the expression "said second channel ... not being in communication with the reactant fluid" for the expression "said first channel ... not being in communication with the reactant fluid". The amendment was allowed by the opposition division under the provision of Rule 139 EPC (Rule 88 EPC 1973) (correction of an obvious error).

The board agrees that, in the light of the patent as a whole and in the context of the claim, the expression "said second channel" cannot be correct, as in such a case mixing of the heat exchange fluid with the reactant fluid could occur, which is for obvious technical reasons not feasible.

However, the proposed correction does not appear to be the only possible way of correcting the error: One could as well envisage replacing the term "reactant

fluid" by the term "heat exchange fluid", in order to correct the error.

According to Rule 139, second sentence, EPC, a correction of an error concerning the description is only allowable if it is obvious that nothing else could have been intended than what is offered as the correction. Since this condition is not met in the present case, the correction proposed during opposition proceedings cannot be allowed. Claim 14 must therefore remain in its form as granted.

4. *Novelty (main request)*

4.1 Appellant I regarded document D3 as novelty-destroying for claims 1, 12, 14 and 18 of the main request.

4.1.1 It is undisputed that document D3 discloses a heat exchanger composed of a series of disc-shaped thin heat exchange plates bonded together to form a stack (Figures 1 and 9; page 16, lines 1 to 24). In a combination heat exchanger, one or more of these plates may be coated with a catalyst (page 5, lines 23 to 25), said catalyst-bearing plates thus defining what could be termed one or more "reaction zones".

4.1.2 However, contrary to the assertions of appellant I, document D3 does not directly and unambiguously disclose a plurality of reaction zones arranged in succession having a heat exchange panel arranged between successive zones. The apparatus disclosed in D3 consists of a succession of heat exchanging stages, of which one or more may at the same time function as reaction zones due to their catalytic coating.

Similarly, in some of the heat exchanging stages further process fluids may be introduced which are to be combined within the heat exchanger (page 4, lines 12 to 18; page 5, lines 7 to 18; Figures 9 and 10). However, in these embodiments the heat exchange continues to take place even in the sections additionally functioning as "reaction zones". Therefore, in the board's view, D3 does not disclose heat exchange panels arranged between successive reaction zones, as required by claim 1 of the opposed patent.

4.1.3 The board also accepts the explanations of appellant II that D3 does not disclose heat exchange panels of the PCHE type. Printed circuit heat exchange (PCHE) panels are characterized in that the fluid channels are formed entirely in the surface of the panels (see D5, page 37, left hand column, second paragraph entitled "Printed circuit heat exchangers"; D1, pages 37, 38: Sections 2.6 to 2.6.5). In contrast, the heat exchanger disclosed in D3 is of the so-called Marbond™ type, wherein individual plates having a plurality of orifices are stacked (see D1, pages 40 to 42: Section 2.7; D3, Figures 1, 2, 3, 4A, 4B, 6A, 6B, 7A, 7B, and claim 1). It is by combining a number of these orifice-bearing plates together that a tubular passage (a channel) is formed. Therefore, the plates of D3 cannot be regarded as "channel-bearing", as required by the claims of the patent in suit.

4.1.4 In view of the above, the subject matter of claim 1 is novel having regard to D3. For the same reasons, the subject matter of independent claims 12, 14 and 18, reciting all the apparatus features of claim 1, and of

the dependent claims as well, is also novel having regard to D3.

- 4.2 No further novelty objection based on any other document has been raised. The board is also not aware of any prior art document showing all the claimed features in combination.

D5 discloses miniature heat exchangers for chemical processing of the printed circuit heat exchanger (PCHE) type. It is reported that said PCHEs can *"substitute for conventional heat exchangers, constituting miniaturized, price-competitive boilers, condensers, recuperative exchangers, and so on"*. *The heat exchanger "cores can be configured as plug flow reactors with very short residence times and tightly defined temperature profiles"* (page 38, left hand column, fourth and ninth paragraphs from top). D5 does not disclose heat exchangers wherein a plurality of reaction zones or catalytic beds are arranged in succession having a heat exchange panel arranged between successive zones or catalytic beds.

Document D10 discloses a microreactor for the liquid-phase oxidation of organic compounds. The microreactor consists of metal foils (of typically 100 micrometer thickness) having microchannels for reactant and cooling fluids. The individual foils are stacked and diffusion-bonded such that the channels of adjacent foils are perpendicular to each other. The channels of one layer may receive a reactant fluid and those of the adjacent layers a coolant fluid, thereby functioning as a cross-flow reactor/heat exchanger. Channel diameter is typically smaller than 100 micrometers. See D10,

Figure 1 and column 5, lines 7 to 17, lines 34 to 50 and lines 58 to 63. D10 thus fails to disclose PCHE panels interleaved by reaction zones.

The requirements of Article 54 EPC are thus met.

5. *Inventive step (main request)*

5.1 The opposed patent in suit is concerned with a combined multistage heat exchanger/reactor, wherein the heat exchanger units are of the PCHE type. Furthermore, the opposed patent is also concerned with a method of converting a fluid reactant under heat exchange conditions, using a multistage heat exchanger/reactor, wherein the heat exchanger units are of the PCHE type.

5.2 The closest prior art is generally selected from among documents dealing with the same technical problem and/or having the greatest structural similarity with the claimed subject matter.

5.3 D3 has the object of providing a heat exchanger with improved flexibility of design and manufacture, which may also be configured for the combination of two or more process fluids, in particular when such combination gives rise to an exothermic reaction (page 2, lines 8 to 15). As mentioned above, D3 discloses a heat exchanger composed of a series of disc-shaped thin heat exchange plates bonded together to form a stack. The fluid channels in the metal panels are created by chemical milling or etching (page 8, lines 20 to 24) and the plates are bonded together by diffusion bonding (page 9, lines 15 to 19), as in the manufacture of PCHE plates and stacks. Optionally, one

or more of the plates may be catalyst-bearing. In the combined heat exchanger/reactor, there may be several stages of cooling and combining of process fluids.

Because of these similarities with the opposed patent both in object and in structure, the parties have identified document D3 as closest prior art. The board can accept this choice.

- 5.4 Starting from document D3, the technical problem may be defined as providing an improved apparatus and process for controlling the reaction temperature within a desired range, during the operation of a chemical process. This technical problem is clearly derivable from the application as filed, for instance from page 6, line 29, to page 7, line 8.
- 5.5 As a solution to the above defined technical problem, the opposed patent proposes an apparatus and a process in accordance with claims 1, 12, 14 and 18 of the main request, respectively, characterised in that the heat exchange means are of the PCHE type and in that a plurality of reaction zones or catalytic beds are arranged in succession having a heat exchange panel arranged between successive zones or catalytic beds.
- 5.6 The effects and advantages of the claimed apparatus and process are explained in paragraphs [0073] and [0074] and in Figures 2 and 3 of the opposed patent. This has not been disputed by appellant I. In particular Figure 3 illustrates that a reactor according to the claimed invention containing multiple reaction zones with embedded PCHE heat exchange stages shows a controlled and predictable temperature profile along the length of

the reactor, in comparison with the temperature profile of a conventional tubular reactor, illustrated in Figure 2. In the conventional reactor/heat exchanger, temperature builds up considerably at the reactor inlet ("hot spot"). The reactor according to the invention (Figures 3, 4) exhibits only a gradual und predictable temperature rise, in spite of a significantly higher reactant feed ($> 100 \text{ g/Nm}^3$ of ortho-xylene, vs. $< 50 \text{ g/Nm}^3$ feed in Figure 2).

For these reasons, the board is satisfied that the above technical problem has been solved.

5.7 It remains to be decided whether the claimed solution is obvious having regard to the prior art.

5.7.1 According to the argument of appellant I, document D3 already disclosed plates in a combination heat exchanger/reactor coated with a catalyst. The skilled person would immediately understand that the catalyst coating could be applied to the surfaces of the plate shown in Figure 7A of D3, as the most logical - or indeed the only logical - location for a catalyst coating. As the discs (plates) were structurally independent, the reactor of Figure 9 of D3 also exhibited structurally independent reaction zones (discs 7A) and heat exchange zone (disc Figure 8). It was furthermore apparent that the contact faces of the disc of Figure 7A must match the contact face of the discs according to Figure 8 in order to form a cylindrical device. Therefore, the disclosure of D3 alone already suggested the claimed apparatus.

5.7.2 The board does not find these arguments convincing. As discussed above, D3 does not disclose the concept of a reactor/heat exchanger with a plurality of reaction zones arranged in succession and a heat exchange panel arranged between successive zones. Notwithstanding the passage on page 17, lines 13 to 16, of D3 stating that the heat exchanger shown in Figures 9 and 10 and the components of Figures 7A, 7B and 8 exemplify how the invention is applied in the cooling of two or more combined process fluids, the board sees no direct and unambiguous basis in D3 for identifying discs 7A as "structurally independent reaction zones" within the meaning of the opposed patent. Also the passage on page 5, lines 23 to 25, gives no detail for locating the catalyst coating precisely on discs 7A. As said discs rather form part of the heat exchanger stack, they do not form "structurally independent reaction zones". They serve the dual purpose of heat exchange and combining two process fluids (page 18, line 13 to page 21, line 2). The board is therefore not convinced by the argument of appellant I that the skilled person would arrive at the concept distinguishing the claimed invention from D3, in view of document D3 alone.

5.7.3 As mentioned before, document D3 additionally fails to disclose a heat exchanger of the PCHE type (see point 3.1.3). PCHE heat exchangers are known *per se* in the art (see D5, page 37, left hand column, second paragraph, entitled "*Printed circuit heat exchangers*"; D1, pages 37, 38: Sections 2.6 to 2.6.5). These heat exchangers consist of a multitude of individual panels as defined in claim 1 of the main request (i.e. "*panels formed from a plurality of superposed metal plates wherein fluid flow channels have been formed, according*

to a pre-determined pattern, said channel bearing plates being aligned during superposition to define discrete heat exchange pathways for fluids and diffusion bonded together") (see D1, Figures 2.13, 2.14). The skilled person - not knowing the invention - and wishing to combine PCHE heat exchangers with reaction zones would arrange PCHE units (not individual panels) as shown in D1 or D5 and connect them in a conventional manner pipe-to-pipe with the reactor unit(s). It is only in the knowledge of the opposed patent that someone of ordinary skill in the art would arrange the heat exchange panels between successive reaction zones, with their respective contact face areas matching each other. There is not even any suggestion in D3 of doing so in view of the problem posed.

- 5.7.4 In a second line of argument presented during the opposition proceedings (see letter of 10 November 2006, page 7), appellant I disputed the presence of an inventive step based on the combination of documents D4 and D5.

Document D4 is concerned with a combined reactor/heat exchanger for the production of SO₃. It is one of the objects of D4 to overcome the conventional spatial separation of reactor and heat exchanger (column 1, lines 1 to 7, 55 to 60). The apparatus shown in Figures 1 and 2 comprises several catalytic stages (K1 to K5) and several intervening heat exchange stages (W1 to W6), arranged in a common frame construction. The heat exchangers W1 to W6 are of the conventional tubular boiler type ("*Rohrkessелеlemente als Dampferzeuger*"; see column 2, lines 5 and 6).

As discussed above, D5 discloses miniature heat exchangers for chemical processing of the printed circuit heat exchanger (PCHE) type.

Starting from D4, appellant I defined the problem of the opposed patent as the production of a more compact, more efficient and cheaper reactor. According to appellant I's argument, one would arrive at an identical construction to that of the opposed patent by substituting the tubular boiler heat exchangers of D4 for the PCHEs as suggested by D5.

The board is firstly not convinced that the skilled person starting from D4 and confronted with the above defined technical problem would turn at all to document D5. The combined reactor/boiler disclosed in D4 is designed for the industrial production of sulphur trioxide in quantities of 800 tons/day; reactor length is 15 m (column 2, lines 45 to 49). In contrast, D5 expressly concerns miniaturized printed circuit heat exchangers (see caption on page 36, and page 37, Figure 3). In view of this mismatch in size and concomitant reactant throughput, the skilled person would not consider PCHEs as a viable alternative to the tubular boilers of D4.

Secondly, even assuming, in favour of appellant I, that PCHEs could be integrated into such a reactor design, neither D4 nor D5 discloses or suggests bringing the heat exchange means into operative contact with the reaction zones. Without hindsight and without the exercise of an inventive imagination, the skilled person would resort to a conventional pipe-to-pipe

connection between separate reaction zones and heat exchange units.

Lastly, there is no suggestion in D4 or D5 that the contact face area of the PCHE panels should be adjusted to the contact face area of the reaction zones or catalytic beds, as required by claims 1 and 14, respectively, of the patent in suit.

Therefore, a combination of features from D4 and D5 as relied upon by appellant I does not lead in an obvious manner to the claimed subject matter.

- 5.7.5 In the opposition proceedings, appellant I put forward a number of further inventive step arguments which were based on D3 in combination with D10 and on document D4 in combination with D10. However, appellant I did not rely on these arguments in the appeal procedure. The board limits itself therefore to briefly explaining why it does not consider these approaches involving document D10 convincing.

The content of document D10 has already been summarized above. In short, D10 discloses a microreactor consisting of metal foils (of typically 100 micrometer thickness) having microchannels for reactant and cooling fluids. The individual foils are stacked and diffusion-bonded such that the channels of adjacent foils are perpendicular to each other. The channels of one layer may receive a reactant fluid and those of the adjacent layers a coolant fluid, thus functioning as a cross-flow reactor/heat exchanger. In view of this compact structure, the board is unable to see how PCHE panels could fit into the stacked structure to give an

interleaved arrangement of heat exchange and reaction zones.

Moreover, appellant I has not put forward plausible arguments as to why the skilled person should consider replacing heat exchange substructures in D10 by PCHE units. After all, little or nothing could be gained from such a hypothetical modification, as D10 already discloses a miniaturized reactor/heat exchanger.

- 5.7.6 The board concludes from the above that the subject matter of claim 1 in accordance with the main request is based on an inventive step.
- 5.7.7 Claim 12 relates to a process for conversion of a fluid in a reactor. The claim specifies essentially the same apparatus features, in particular the plurality of reaction zones arranged in succession having printed circuit heat exchange panels in operative contact therewith, as claim 1. Therefore, the assessment of inventive step of claim 1 applies, *mutatis mutandis*, also to claim 12.
- 5.7.8 Claim 14 defines an apparatus for controlling the temperature profile of a reaction fluid in the presence of a catalyst, wherein multiple printed circuit heat exchangers (PCHE) are provided between reaction zone formed catalytic beds. This apparatus involves the same inventive concept of arranging multiple printed circuit heat exchange panels between successive reaction zones (catalytic beds), with their respective contact face areas matching each other, as claim 1.

The board disagrees with the argument of appellant I that the catalytic bed of claim 14 (and claim 18) of the opposed patent could be in the form of a fluidized catalytic bed, formed by adding a finely divided particulate catalyst to one of the process fluids before the process fluids combine, as disclosed in D3, page 6, lines 1 to 3. The board firstly does not share the interpretation of appellant I who interprets the passage of the description bridging pages 5 and 6 as relating directly to the heat exchanger shown in Figures 9 and 10 of D3. In the board's view, the description corresponding to said Figures 9 and 10 (page 18, line 13 to page 21, line 23) does not warrant such a combination. Secondly, even if the skilled person did arrive at such a combination of features disclosed individually in document D3, the result would still be patently distinct from the subject matter claimed in claims 14 and 18 of the opposed patent, for the following reasons. In case of a fluidized catalytic bed, the catalysed reaction would inevitably commence as soon as the process fluids combined, as shown in D3, Figure 9. The catalytic reaction would continue throughout the reactor, concomitant with and in parallel to the heat exchange process. Therefore, if a finely divided particulate catalyst were added to one of the process fluids A or B in the heat exchanger/reactor shown in Figure 9 of D3, no distinction could be made between heat exchange means and the catalytic beds itself. Such a design is not compatible with the wording of claim 14.

Therefore, the assessment of inventive step of claim 1 applies, *mutatis mutandis*, also to claim 14.

5.7.9 Claim 18 defines a process utilizing a combined catalytic reactor/printed circuit heat exchanger (PCHE) for indirectly controlling the temperature profile of a reaction fluid in the presence of a catalyst. According to claim 18, the heat exchange means of the PCHE type are located between the catalytic beds, and the contact face area of the heat exchange means is similar to the contact face area of the catalytic beds. As regards the inventive character of the claimed subject matter, the arguments presented above apply *mutatis mutandis*.

5.7.10 The dependent claims 2 to 11, 13, and 15 to 17 define particular embodiments of the claimed apparatus and process, respectively. These claims are based on an inventive step for the reasons discussed above.

5.8 In summary, the claims of the main request satisfy the requirements of Article 56 EPC.

5.9 Since the main request is found to be allowable, there is no need to consider the auxiliary requests.

Order

For these reasons it is decided that:

1. The decision under appeal is set aside.

2. The case is remitted to the department of first instance with the order to maintain the patent on the basis of claims 1 to 18 of the main request as filed during the oral proceedings, and a description and drawings to be adapted.

The Registrar

The Chairman

C. Vodz

E. Wäckerlin