BESCHWERDEKAMMERN DES EUROPÄISCHEN PATENTAMTS

BOARDS OF APPEAL OF THE EUROPEAN PATENT OFFICE

CHAMBRES DE RECOURS DE L'OFFICE EUROPEEN DES BREVETS

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File No.: T 0145/93 - 3.4.2

Application No.: 85 200 843.2

Publication No.: 0 168 073

Classification: BO1D 53/04, BO1D 53/26

Title of invention: Method for heat and mass exchange operations

D E C I S I O N
of 10 November 1993

Applicant: Lavie, Ram, *et al*

Proprietor of the patent: -

Opponent: -

Headword: Art. 56 EPC

EPC:

Keyword: "inventive step: (after amendments) yes"

Headnote
Catchwords

Europäisches Patentamt | European Patent Office | Office européen des brevets

Beschwerdekammern | Boards of Appeal | Chambres de recours

Case Number: T 0145/93 - 3.4.2

D E C I S I O N
of the Technical Board of Appeal 3.4.2
of 10 November 1993

Appellant: Lavie, Ram
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Decision under appeal: **Decision of the Examining Division of the European Patent Office dated 25 September 1992 refusing European patent application No. 85 200 843.2 pursuant to Article 97(1) EPC.**

Composition of the Board:

Chairman: E. Turrini
Members: M. Chomentowski
B.J. Schachenmann

Summary of Facts and Submissions

I. European patent application No.85200843.2 (publication No.0168073) was refused by the Examining division on the grounds that the submitted Claim 1 was not inventive having regard to

D1 = DE-A-2 460 515

and the general technical knowledge of the person skilled in the art. The Examining Division took the view that the process of D1 for removing gaseous impurities from hydrogen comprises two adsorption/desorption beds wherein there is also some heating/cooling accompanying the adsorption/desorption of impurities; thus, as the submitted method, the process of **D1** is also for carrying out **HME (heat and mass exchange)** operations between two feed streams containing at least two components and differing in temperature; moreover, the only feature which distinguishes the submitted method from the known process is that the temperature of the cooled and enriched product stream is at a lower temperature than that of the heated and diluted product stream; however, it is not clear that this feature is related to any advantage of the method and, moreover, it appears to be a feature which is automatically obtained if short adsorption/desorption cycles are applied.

II. The Appellants (Applicants) lodged an appeal against this decision.

III. In a communication, the Board informed the Appellants that the new main claim submitted with the statement of grounds of appeal appeared to contain additional subject-matter, to lack clarity and to lack an inventive step, but that a new amended main claim annexed to the

communication could be allowable if accompanied with adapted description and drawings as well as further technical explanations for better specifying those features distinguishing the method of the claimed invention from the prior art.

IV. In a letter dated 27 August 1993, the Appellants filed a new main claim identical with the one proposed by the Board, new pages 3 and 4 of the description; moreover, they filed a new description page 9 which could be used for providing amendments and mentioned that original dependent Claim 8 and the embodiment illustrated by Fig.3, i.e. page 7a, lines 6, 7 and page 9, lines 7 through 17, could be deleted, if required. Technical explanations for the claimed method were annexed to the letter. The Appellants requested that the decision under appeal be set aside and that a patent be granted on the basis of the submitted patent application documents.

V. Claim 1 reads as follows: "1. A method for carrying out heat and mass exchange operations between two feed streams, each stream containing at least two components, with the two feed streams differing in temperature by at least 30°C and in composition such that the hot stream is rich in some component(s) of interest and yields a product at a colder temperature which is enriched in the component(s) of interest, while the cold lean feed stream is lean in the same component(s) and yields a product at a hotter temperature which is diluted in the component(s) of interest, and the two feed streams being introduced in a reactor containing a reagent, the equilibrium concentration of which reagent at the conditions of the cold stream being higher than that prevailing at the conditions of the hot feed stream, wherein said heat and mass exchange operations are carried out in at least one pair of adsorption beds which are thermally insulated from their enclosures and

are simultaneous and countercurrent, and the reagent is capable of preferentially retaining one or more components, the retaining power of the reagent being higher at lower temperatures than at higher temperatures, the temperature of the cooled and enriched product stream being at a lower temperature than that of the heated and diluted product stream, thus enabling the use of the thermodynamic work potential supplied by the transfer of heat between the two streams to drive the process in the desired direction thereby having both mass and heat exchange in the adsorption beds; and feeding the hot rich feed stream into a first end of the reactor and extracting the resulting cooled and enriched product stream from the second end of the reactor; and feeding the cold lean feed stream into the second end of the reactor and extracting the resulting heated and diluted product stream from the first end of the reactor." The further claims, which correspond to Claims 2 to 7 and 9 to 16 as originally filed, are dependent claims.

VI. The Appellants submitted the following arguments in support of their requests: In the presently claimed method, each little element of adsorbent undergoes over a full cycle of adsorption/desorption a well ordered set of process steps consisting of - heat exchange with a hot concentrated stream, thereby raising the temperature of the adsorbent and simultaneously releasing solute in said stream, and heat exchange with a cold dilute stream, thereby reducing its temperature by transferring said heat to the cold stream and simultaneously adsorbing solute. Since in the process of Fig.1 of **D1**, except for negligible heating or cooling due to adsorption or desorption, there is no specific heating/cooling on purpose in the adsorption/desorption beds and the heating and cooling steps of the gas circulating in the beds is provided in external heat

exchangers, there is no indication which would make the presently claimed method obvious to the skilled person.

Reasons for the Decision

1. The appeal is admissible.

2. *Procedural issues*

2.1 In their letter dated 27 August 1993, the Appellants, instead of commenting on the objections raised by the Board with regard to the embodiment of Fig.3, merely stated that dependent Claim 8 and the embodiment of fig.3 including the corresponding passages of the description could be deleted. The Board concludes therefrom that the Appellants do not intend to maintain said parts of their application and that the mentioned amendments have been incorporated into their main request. The Board is therefore satisfied that it can be decided on the European patent application on the basis of said text wherein said embodiment of Fig.3 has been deleted and which has been agreed by the Appellants (Art.113(2) EPC).

2.2 The present application differs from the application as filed in that the features of the claimed method have been more clearly defined in the context of the original disclosure, obvious errors have been corrected and, moreover, the embodiment illustrated by original Fig.3 has been deleted. It is to be noted that the embodiment of page 9, lines 18 and 19, wherein the reagent is in the form of a moving solid bed, is based on the disclosure in the combination of the original Claims 9, 7, 5 and 1 to 3, which were not related with the fluid reagent circulating in the corresponding stages in the two series of fluid-fluid contactors disclosed in

original Claims 4 and 8. It is also to be noted that the feature of page 10, lines 1 to 3, that the reagent is a liquid material, is based on original Claims 4 and 1. Therefore, the European patent application has not been amended in such a way that it contains subject- matter which extends beyond the content of the application as filed (Art.123(2) EPC).

3. *Clarity*

3.1 For the reasons mentioned in the preceding paragraph, the embodiments of the invention comprising a moving bed or a fluid reagent are consistent with the claims resulting from the cited original claims. The Board is satisfied that, since moreover the terminology in the claims is uniform and since the essential features of the invention, in particular that the heat and mass exchange (HME) is a simultaneous operation which occurs in the adsorption beds, are adequately mentioned in the main claim, the requirements pursuant to Article 84 and Rule 29(3) EPC are met.

4. *Novelty*

4.1 **D1** is the closest prior art document. The method known from D1 (see column 2, lines 6 to 68; column 3, line 8 to column 4, line 42; Fig.1) is for carrying out purification of hydrogen (H_2) by removing gaseous impurities, and in particular CH_4, from a fluid; the method is for carrying out **mass exchange** operations between two feed streams (circulating in conduits (24) and (30)), each stream containing at least two components (principally H_2 and CH_4), because the impurities retained in the adsorption bed when it is at low temperature (for instance bed (31) at -178°C) are desorbed and carried away when said adsorption bed is at high temperature during the next phase of the cycle,

i.e. in the state mentioned for bed (26). Indeed, in the known method **heat exchange** operations are carried out between the two fluid streams because the fluid circulating in conduit (24) is heated between about -180°C at the head output of washing column (6) to about -148°C at the entrance of adsorption bed (26), said heating taking place in particular in heat exchanger (25) by the other fluid circulating in conduit (27); said other fluid in conduit (27) is cooled in particular in said same heat exchanger (25) (between about -148°C at the output of adsorption bed (26) and -180°C in the separating device (28)).

However, no information concerning **heat transfer** between the fluid streams and the adsorption beds (26, 31) is derivable from D1 in relation with the embodiment illustrated by Fig.1. In particular, the first feed stream circulating in conduit (24) enters into the (desorption) bed (26) at -148°C; there is no indication that it should be cooled in said (desorption) bed (26), but it is specified that said stream is **then cooled** in the heat exchangers (25) and (22) to a temperature of -180°C; this indicates that if some cooling has taken place within the (desorption) bed (26), it is insufficient and must be completed in external heat exchangers. Moreover, since the cooled stream (in conduit (27)) which later circulates as the second feed stream in the conduit (30) passes through the separating device (28) which is at about -180°C and arrives at the entrance of **(adsorption) bed (31) which works at about -178°C,** there is no indication that said fluid stream should be heated by passing through the (adsorption) bed (31). These considerations relate to the normal working conditions of the system as they are indicated in **D1** in relation with Fig.1, and the question arises about the **initial conditions** of the system with a freshly desorbed bed ready for adsorption and a freshly adsorbed bed ready for desorption. One operation mode could be that

the two beds (26) and (31) are directly exchanged and thus for instance the (warm) bed (31) (at about -148°C) is cooled by the fluid stream circulating in conduit (30) and which is at about -180°C. However, there are indications in D1 (see column 2, lines 11 to 51) that this is not the case; for instance, it is specified that the cold gas can by no means be directly provided for desorption of a bed which has completed adsorption before and said cold gas is **first heated before** it is provided for desorption of a charged bed; the result is a sufficient temperature difference in relation with the original temperature of the cold gas and consequently and simultaneously a quick desorption and primarily a much better desorbed bed than with a cold gas. In the same manner the gas directed (for adsorption) to the freshly desorbed bed is **cooled before** reaching said bed. Another indication that in the sense of D1 the gas to be submitted to an operation in a bed must be first brought to a temperature near that of the operating bed can be derived from the teaching relating to the embodiment illustrated by Fig.2 of D1 (see column 2, lines 52 to 68 and column 4, lines 43 to 60), whereby before arriving at the adsorbing bed (31) which has been regenerated before, the gas in conduit (30) is first passed through the bed (35) (which has been regenerated before and is thus warm), said gas being thus heated and **then cooled in heat exchanger (22)**; this particular process is done for increasing the effectiveness of the method and for minimizing the variations in the composition of the product gas stream; although it also results in the cooling of an adsorption bed, however this **cooling** is specified as being **before its working period** and it relies upon a **third bed and a heat exchanger added to the system of Fig.1**, i.e another type of system. Therefore, it is derivable from D1 that the adsorption/desorption beds (26, 31) of Fig.1 work at their working temperature and receive gas at said same

working temperature; how the beds having been freshly desorbed/adsorbed are brought to their working temperature in the new cycle is not specified in D1 and could be by some other warming/cooling step before putting the beds at work in said new cycle. Thus, there is no heat exchange on purpose in the adsorption/desorption beds of Fig. 1 of **D1**. Moreover, since the enriched product stream leaving the (desorption) bed (26), which it has entered at a temperature of -148°C, will have to be cooled in the heat exchangers (25, 22), there is no indication in D1 that said product should be cooled in the bed (26) at a temperature lower than that of the diluted product stream leaving the (adsorption) bed (31) at a temperature of -178°C. This is also an indication of no thermal step on purpose in the beds. In this respect, the Appellant's argument that in the system of Fig.1 of D1 the heat related with adsorption/desorption in the adsorption/desorption beds is negligible as compared with the heat exchange in the heat exchangers is credible because according to the calculations mentioned in said statement adsorption/desorption heat would cause a temperature rise/drop in the order of 1°C whereas heat exchange in the heat exchangers causes temperature rise/drop of approximately 30°C (between -180°C or 178°C and 148°C); moreover, heat related to adsorption/desorption is not derivable from D1. Therefore, the method of D1 is not a method for carrying out heat and mass exchange operations between two feed streams in the sense of the present application and, thus, the subject-matter of Claim 1 is novel in the sense of Article 54 EPC.

5. *Inventive step*

5.1 Since the method of D1 is not a method for carrying out heat and mass exchange operations between two feed

streams in the sense of the present application, the known method has not the benefits of advantageous energy utilization and of compactness of the equipment mentioned in the present application (see page 2, lines 14 to 21). Indeed, in the known method the external heat exchangers (12, 18, 22, 25) as well as the pipes leading to and from the adsorbers/desorbers (26, 31) can result in heat loss and do not allow to control the process within the adsorber/desorber beds by utilizing the thermodynamic work potential from the different temperatures in the system.

5.2 As credibly argued by the Appellant with reference to further submitted technical information, the presently claimed method solves these problems by taking advantage of the heat and mass exchange within each of the adsorption/desorption beds; in particular, the feature that the temperature of the cooled and enriched product stream is at a lower temperature than that of the heated and diluted product stream enables the use of the thermodynamic work potential supplied by the transfer of heat between the two streams to drive the process in the desired direction thereby having both mass and heat exchange.

5.3 As mentioned here above, another method for carrying out purification of hydrogen (H2) by removing gaseous impurities, and in particular CH4, from a fluid, is also known from D1 (see column 4, lines 43 to 60; Fig.2); said other method is carried out in a system having three adsorption/desorption beds (26, 31, 35), whereby the supplementary adsorber (35) is cooled by flowing gas at low temperature; however, the gas thus heated by the contact with adsorption bed (35) is then cooled in an heat exchanger (22) before being lead to the adsorber (31). Thus, this other known method does not dispose of the external heat exchangers; it does not contain either

any step of heating an absorber/desorber by the gas circulating without the interposition of a heat exchanger. Therefore, it does not provide any incitation to the skilled person for in particular disposing of the heat exchangers and, thus, does not lead to the presently claimed method.

5.4 The other documents of the available prior art are less relevant and were not mentioned during the examination procedure.

5.5 Thus, since having regard to the prior art the subject-matter of present Claim 1 is not obvious to a person skilled in the art, it involves an inventive step in the sense of Article 56 EPC.

5.6 Therefore, Claim 1 is allowable (Art.52(1) EPC).

5.7. The further claims are also allowable due to their dependence from Claim 1. 6. Therefore, since the application and the invention to which it relates meet the requirements of the Convention, a patent may be granted (Art.97(2) EPC).

Order

For these reasons, it is decided that:

1. The decision under appeal is set aside.

2. The case is remitted to the first instance with the order to grant a patent on the basis of the following documents:

Description: pages 1, 2, 5 to 7, 7a, 8, and 10 to 16 as originally filed; page 3, 4 and 9 filed with Appellants'letter dated 27 August 1993, with deletion of the text of page 7a, lines 6, 7 and page 9, lines 7 through 17, according to request in same letter; with amendments on page 12, line 15, column 4, (1.25 in place of 6.25) and on page 13, line 19 (-20 in place of 30), in accordance with Appellants'letter dated 22 August 1989;

Claims: No. 1 filed with Appellant's letter dated 27 August 1993; Nos. 2 to 7 and Nos. 8 to 15, renumbered from Claims 9 to 16 as originally filed and with the last six claims being referenced to Claims 1 to 9, in accordance with the request in same letter;

Drawings: Sheet 1/4 (Fig.1 and 2) renumbered from Sheet 1/5 filed with Appellants'letter dated 22 August 1989; Sheets 2/4 to 4/4, renumbered from Sheets 3/5 to 5/5 as originally filed with Fig.4a, 4b, 5a, 5b and 6 renumbered 3a, 3b, 4a, 4b and 5.

The Registrar: The Chairman:

P.Martorana E.Turrini

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