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**Datasheet for the decision  
of 16 June 2011**

**Case Number:** T 0335/09 - 3.3.06

**Application Number:** 01300664.8

**Publication Number:** 1226860

**IPC:** B01D 53/04

**Language of the proceedings:** EN

**Title of invention:**

Method of operating a thermal swing adsorption system and  
corresponding apparatus

**Patentee:**

AIR PRODUCTS AND CHEMICALS, INC.

**Opponent:**

L'AIR LIQUIDE, SOCIETE ANONYME POUR L'ETUDE ET L'EXPLOITATION  
DES PROCEDES GEORGES CLAUDE

**Headword:**

Adsorption method/AIR PRODUCTS

**Relevant legal provisions:**

EPC Art. 54(3)

**Relevant legal provisions (EPC 1973):**

EPC Art. 56

**Keyword:**

"Novelty: yes"

"Inventive step: yes - claimed feature not disclosed in the  
prior art"

**Decisions cited:**

-

**Catchword:**

-



Case Number: T 0335/09 - 3.3.06

**D E C I S I O N**  
of the Technical Board of Appeal 3.3.06  
of -

**Appellant:** L'AIR LIQUIDE, SOCIETE ANONYME POUR L'ETUDE ET  
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**Decision under appeal:** Interlocutory decision of the Opposition  
Division of the European Patent Office posted  
15 December 2008 concerning maintenance of  
European patent No. 1226860 in amended form.

**Composition of the Board:**

**Chairman:** P.-P. Bracke  
**Members:** P. Ammendola  
U. Tronser

## Summary of Facts and Submissions

I. This appeal is from the interlocutory decision of the Opposition Division concerning the maintenance in amended form of European patent No. 1 226 860 according to the then pending third auxiliary request of the Patent Proprietor.

II. The Opponent had sought revocation of the patent in suit on the grounds of, *inter alia*, lack of novelty and lack of inventive step (Article 100(a) in combination with Articles 54(3) EPC and 56 EPC 1973). During the opposition proceedings reference had been made to documents

(1)= EP-A-1 080 773 (as prior art under Article 54(3) EPC),

(2)= EP-A-0 449 576

and

(3)= FR-A-2 127 112.

The Patent Proprietor had filed as third auxiliary request a set of 22 claims (hereinafter the claims as maintained) identical to claims 1 to 22 as originally granted.

III. Claim 1 **as maintained** reads:

"1. *A method of operating a thermal swing adsorption process in which water and carbon dioxide are removed by adsorption onto at least one adsorbent,*

*which comprises determining directly or indirectly one or more parameters relating to the water content of a feed gas comprising water and carbon dioxide, said method comprising passing said feed gas through a first portion of adsorbent in a bed 15, 15' for removing water and a second portion in a bed 16, 16' for removing carbon dioxide, selecting process conditions for regeneration of the at least one adsorbent in the thermal swing adsorption process and passing regenerating gas through a valve 30 to flow through a heater 28 and through the second portion of the adsorbent in the bed 16, 16' such that the heat wave passes through said second portion of the adsorbent, closing said valve 30 and opening a second valve 31 such that the flow of regenerating gas is not heated and passes into the second adsorbent and displaces the heat pulse further through said first portion of adsorbent to desorb water from a portion thereof under pressure swing adsorption regeneration conditions based on said parameters, and modifying the regeneration process conditions to accord with the selected process conditions for regeneration such that adsorbed water and carbon dioxide is desorbed thereby regenerating the at least one adsorbent."*

Claims 2 to 11 as maintained define preferred embodiments of the method of claim 1.

Claim 12 as maintained reads:

"12. A method for the reduction of the level of carbon dioxide and water in a feed gas comprising,

*passing the feed gas to an adsorption zone containing an adsorbent, contacting the gas with said adsorbent so as to remove water and carbon dioxide from the gas and passing the gas depleted in water and carbon dioxide to a cryogenic separation process in which at least one of the components of the gas depleted in carbon dioxide and water is recovered, wherein the adsorbent is regenerated by heating after adsorption according to pre-determined regeneration conditions said method comprising determining directly or indirectly one or more parameters relating to the water content of a feed gas prior to contact with the adsorbent, passing said feed gas through a first portion of adsorbent in a bed 15, 15' for removing water and a second portion in a bed 16, 16' for removing carbon dioxide, selecting process conditions for regeneration of the at least one adsorbent in response to the said one or more parameters and modifying the regeneration process conditions to accord with the selected process conditions for regeneration, passing regenerating gas through a valve 30 to flow through a heater 28 and through the second portion of the adsorbent in the bed 16, 16' such that a heat wave passes through said second portion of the adsorbent, and in accordance with the selected process conditions closing said valve 30 and opening a second valve 31 such that the flow of regenerating gas is not heated and passes into the second adsorbent and displaces the heat pulse further through said first portion of adsorbent to desorb water from a portion thereof under pressure swing adsorption regeneration conditions."*

Claims 13 to 22 as maintained define preferred embodiments of the method of claim 12.

- IV. The Opposition Division found that the subject-matter of these claims was novel, *inter alia*, because document (1) did not disclose a thermal swing adsorption (hereinafter TSA) process wherein part of the step of regeneration of the adsorbent was carried out under pressure swing adsorption (hereinafter PSA) conditions.

As to the issue of inventive step, the TSA process disclosed in document (2) was considered to represent the closest prior art. The Opposition Division found that the subject-matter of claims 1 to 22 as maintained was based on an inventive step vis-à-vis this prior art, *inter alia*, because neither document (2) nor document (3) contained any information which would incite the person skilled in the art to adjust the process conditions for regeneration on the basis of a parameter relating to the actual water content of the gas feed.

- V. The Opponent (hereinafter Appellant) lodged an appeal against this decision and filed with the grounds of appeal document

(4)= "Adsorption purification for air separation units", M.Grenier *et al.*, in "*Cryogenic Processes and Equipment - 1984*", pages 143 to 148.

The Board summoned the Parties to oral proceedings to be held on 16 June 2011.

With a letter of 9 May 2011 the Appellant announced its absence at the forthcoming oral proceedings.

The Patent Proprietor (hereinafter Respondent) filed with letter of 10 June 2011 three sets of amended claims respectively labelled as auxiliary requests 1 to 3.

Oral proceedings were held as scheduled in the announced absence of the duly summoned Appellant.

VI. The Appellant argued in writing in essence as follows.

The wording "*under pressure swing adsorption conditions*" in claim 1 as maintained had no clear significance because - contrary to the conventional meaning of these words which implied no variation of temperature - the claim associated the PSA conditions to the displacement of a heat pulse from the second to the first portion of the adsorbent. Hence, the sole clear implication of the definition of the step of water desorption in the method of claim 1 was that during such step the counter-current stream of regenerating gas was unheated.

In the opinion of the Appellant document (1) already required to determine the actual water content of the gas feed and, thus, to just apply the amount of energy strictly needed for each regeneration cycle as defined by the formula described in paragraphs [0088] and [0089]. This citation also explicitly suggested at column 10, lines 43 to 48, the possibility of changing the temperature of the regenerating gas and that the heat available for regeneration corresponded to the



difference between the heat entering the system and the heat leaving the system. Hence, it was apparent to the skilled reader of document (1) that if the heat available for the regeneration had been already introduced during the desorption of carbon dioxide, then it was necessary to stop heating the regenerating gas during the subsequent desorption of water. Hence, all the features of the method of claim 1 as maintained were already present in the process disclosed in this citation.

As to the issue of inventive step, the Appellant argued that the subject-matter of claim 1 only differed from the prior art process disclosed in document (2) in that the former used a stream of cold regenerating gas during the water desorption. Hence, this prior art represented the closest state of the art and the sole technical problem possibly solved by the claimed method was just that of minimizing the energy consumption in the prior art process.

However, document (2) already emphasized the need of using just the amount of heat strictly necessary for regenerating the adsorbent and taught to stop heating the regenerating gas once that sufficient heat had been introduced into the adsorbent. In other words, document (2) itself would prompt the skilled person to keep the heating of the regenerating gas as short as possible and, thus, to arrive at the claimed subject-matter.

Additionally, the displacement of the heat pulse within the adsorbent when interrupting the heating of the regenerating gas would be common general knowledge of

the skilled person and was also explicitly described in document (3).

Moreover, also document (4) demonstrated that it was generally known to obtain energy savings by minimizing the amount of heat utilized during the regeneration step. In order to obtain this reduction the sole possibility was to introduce just the needed amount of heat by means of hot regenerating gas and then to cut off the heating before that the heat front had reached the first portion of the adsorbent.

Thus, it would be apparent that the subject-matter claimed would just be an optimization of the process of document (2) already evident in view of the overall teaching of this citation as well as in view of the content of document (3) and/or (4).

The above arguments as to the lack of novelty and of inventive step of the subject-matter of claim 1 as maintained would equally apply to the subject-matter of claim 12 as maintained, since the latter only differed from the former for the additional requirement that the gas deprived of water and carbon dioxide was finally passed to a cryogenic separation process, i.e. for an additional step also explicitly disclosed in each of documents (1) and (2).

VII. The Respondent disputed in writing and orally these objections by stressing *inter alia* that the claimed process was an hybrid process in which water was desorbed under PSA conditions and, thus, required to use during the regeneration an amount of hot regenerating gas that was less than that necessary for

completely regenerating the adsorbent under TSA conditions.

On the contrary, the processes of document (1) was a TSA process in which the amount of heat at least sufficient at desorbing completely the adsorbed water and carbon dioxide under TSA conditions was introduced as hot regenerating gas. The heat balance modification vaguely mentioned in column 10 of this citation only suggested the appropriate setting of the temperature of the hot regenerating gas and, thus, would not imply, in general, any change of such temperature during the regeneration or, more particularly, the instruction of discontinuing completely the heating of the regenerating gas before that the heat wave had reached the first portion of the adsorbent. Accordingly, the relevant technical instruction of document (1) would not imply any introduction of cold regenerating gas way through the regeneration.

As to the issue of inventive step, the Respondent stressed, *inter alia*, that also the process of document (2) was a TSA process and that this citation was silent as to the possibility of minimizing the amount of energy necessary for regeneration by adjusting the regeneration conditions, inclusive of the complete shut off of the heating of the regenerating gas during the water desorption, in view of the actual water content of the feed gas to be purified. Indeed, in the prior art the setting of the air purification process conditions was conventionally made on the basis of the most adverse ambient conditions. Thus, also the concept of "sufficient" heat used in document (2) referred to such worse feed conditions.

Finally, the other documents referred to by the Appellant were also silent as to the possibility of adjusting the conditions of regeneration to the water content of the actual feed to be purified.

Already for these reasons, the subject-matter of claims 1 and 12 as maintained could not possibly result in an obvious manner from the available prior art.

VIII. The Appellant requested in writing that the decision under appeal be set aside and the patent be revoked.

The Respondent requested that the appeal be dismissed or the patent be maintained on the basis of one of the auxiliary requests 1 to 3 submitted with the letter dated 10 June 2011.

## **Reasons for the decision**

### *Respondent's main request (claims as maintained)*

#### 1. Interpretation of claim 1 as maintained

Claim 1 as maintained (see above section III of the Facts and Submissions) defines a method for operating a TSA process to purify a feed gas from the water and the carbon dioxide contained therein, by passing this gas through two portions of at least one adsorbent, whereby the first portion removes water and the second removes the carbon dioxide. The regeneration of the adsorbent is then obtained by flowing counter-current a regenerating gas that is initially heated, so as to

produce a heat wave passing through the second portion of the adsorbent, and then unheated, so as to displace the heat pulse in the first portion, to produce desorption of adsorbed water under PSA regeneration conditions. The claim also requires to set the regeneration conditions on the basis of previously determined parameters relating to the water content of the feed gas.

The Appellant has disputed the clarity of the requirement of PSA regeneration conditions during the step of water desorption in the claimed method and, thus, equated the definition of this step to just the instruction to use unheated regenerating gas (see the last sentence on page 1 of the letter of the Appellant dated 9 May 2011).

Hence, even in the restrictive interpretation of the Appellant, claim 1 as maintained at least clearly requires **to discontinue the heating of the regenerating gas when the heat wave has not yet reached the end of the adsorbent**, i.e. when at least part of the water to be desorbed is still adsorbed onto the first portion of the adsorbent.

Since the Appellant's objections fail for the reasons indicated here below already in respect of such restrictive interpretation of claim 1, it has turned out unnecessary for the Board to further investigate which other clear technical features, if any, could possibly correspond to the requirement of PSA regeneration conditions during water desorption.

2. Claim 1 as maintained: novelty (Article 54(3) EPC)
  - 2.1 The Appellant has only contested the novelty of the subject-matter of this claim on the basis of document (1) (which undisputedly is prior art under Article 54(3) EPC).
  - 2.2 The Board finds that at least the requirement of claim 1 to discontinue the heating of the regenerating gas while the heat wave has not yet reached the end of the first portion of the adsorbent is neither explicitly described nor necessarily implied in the passages of document (1) referred to by the Appellant (i.e. the description of example 1 at column 10, lines 43 to 48, in combination with claim 1 and the overall teaching of this citation as embodied in the formula of paragraphs [0088] and [0089]) or in any other portion of this citation.

In particular, the above-identified description at column 10 of document (1), after mentioning in general the possibility of modifying the entrance/exit thermal balance of the adsorbent as one of the alternatives for adapting the purification process of this citation to the actually present atmospheric conditions, simply adds the information that a change of the regeneration temperature results in a modification of the temperature profile at the exit of the system and that the heat available for desorption corresponds to the difference between the heat entering the system and the heat exiting the system.

Therefore, the disclosure of this portion of document (1) acknowledges the possibility that heat may **exit** the

system and, thus, be lost. Accordingly, it can also reasonably be interpreted as proposed by the Respondent, i.e. as the instruction to adjust to the actual atmospheric conditions the (constant) temperature value at which the regenerating gas must be **heated throughout the whole regeneration process** (i.e. also during the water desorption).

Similarly, also the formula of paragraphs [0088] and [0089] of document (1) instructs the skilled reader to determine the energy necessary for the regeneration step of the TSA process disclosed in this citation by taking into account the actual atmospheric conditions as well as the **heat losses** (see " $Q_s$ " in the formula of paragraph [0089]).

Hence, the teaching of document (1) does not appear to explicitly provide or necessarily imply the unambiguous instruction to discontinue completely the heating of the regenerating gas when the heat wave has not yet reached the end of the adsorbent.

Accordingly, the Appellant's argument as to the lack of novelty of the subject-matter of claim 1 as maintained in view of this prior art is found unconvincing.

3. Claim 1 as maintained: inventive step (Article 56 EPC 1973)

The Appellant has not contested the energy-saving effect of the claimed method but has maintained that the claimed method is just an optimization of the process of document (2), optimization that would be obvious in view of the teachings in this document taken

alone or in view of its combination with the disclosure of document (3) and/or of document (4).

The Board notes however that, even if one arbitrarily assumes in favour of the Appellant:

a) that the TSA process of document (2) represents a reasonable starting point for the assessment of inventive step and that the technical problem objectively solved by the subject-matter of claim 1 as maintained vis-à-vis this prior art process, is just the optimization of this latter;

and

b) that the skilled reader of document (2), (3) and/or (4) finds in these citations the instruction to introduce just the minimum amount of heat required for regenerating the adsorbent or any other instruction inevitably implying to introduce cold regenerating gas during the desorption of water,

still neither document (2) *per se*, nor its combination with document (3) or with document (4) explicitly discloses or necessarily implies the feature of the method of claim 1 as maintained to adjust the conditions of the regeneration step to the actual water content of the specific gas feed to be purified.

It is also relevant in this respect, that the Appellant has not disputed the rightness of the statements given e.g. in paragraphs [0015] and [0056] of the patent-in-suit and in the written submissions of the Respondent, as to the fact that in the prior art the setting of the



air purification process conditions was conventionally made on the basis of the most adverse atmospheric conditions. Hence, the Board has no reason for presuming that it was already conventional in the relevant technical field to minimize the energy costs by adjusting of the regeneration conditions to the actual water content of the gas feed.

Already for these reasons the Board finds that the Appellant has not succeeded in rendering credible that the subject-matter of claim 1 as maintained is obvious in view of the prior art. Thus, the Board concludes that the subject-matter of this claim complies also with the requirements of Article 56 EPC 1973.

4. Novelty and inventive step of the remaining claims 2 to 22 as maintained.

The same reasoning given above at points 1 and 2 for rejecting the Appellant's arguments against the novelty and the presence of an inventive step for the subject-matter of claim 1 as maintained, applies to the substantially identical objections raised by the Appellant in respect of the subject-matter of claim 12 as maintained, which only differs from that of claim 1 for the additional indication that the purified gas is sent to a process of cryogenic separation.

The same applies to the subject-matter of the claims 2 to 11 and of the claims 13 to 22 defining preferred embodiments of the method of claim 1 and of that of claim 12, respectively.

**Order**

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

The appeal is dismissed.

The Registrar:

The Chairman:

D. Magliano

P.-P. Bracke