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**Datasheet for the decision
of 5 May 2010**

Case Number: T 1448/07 - 3.3.06

Application Number: 02002051.7

Publication Number: 1230967

IPC: B01D 53/047

Language of the proceedings: EN

Title of invention:

High purity oxygen production by pressure swing adsorption

Patentee:

AIR PRODUCTS AND CHEMICALS, INC.

Opponent:

Praxair, Inc.

Headword:

High purity oxygen production/AIR PRODUCTS

Relevant legal provisions:

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Relevant legal provisions (EPC 1973):

EPC Art. 54(1)(2), 56

Keyword:

"Novelty - main request (yes)"

"Inventive step - main request (yes)"

Decisions cited:

-

Catchword:

-



Case Number: T 1448/07 - 3.3.06

D E C I S I O N
of the Technical Board of Appeal 3.3.06
of 5 May 2010

Appellant:
(Opponent)

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Respondent:
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Decision under appeal:

Interlocutory decision of the Opposition
Division of the European Patent Office posted
19 July 2007 concerning maintenance of European
patent No. 1230967 in amended form.

Composition of the Board:

Chairman: P.-P. Bracke
Members: E. Bendl
U. Tronser

Summary of Facts and Submissions

I. The appeal is against the decision of the Opposition Division to maintain the European patent 1 230 967 in amended form.

II. In opposition procedure the Opponent objected to lack of novelty and inventive step. The Opposition Division decided inter alia to maintain the patent on the basis of the then pending third auxiliary request. In the course of the opposition procedure among others the following documents were cited:

D1 = EP-A-0 761 282

D4 = JP-A-10-152305 & D4a & D4b (English translations of D4)

III. The set of claims as maintained by the Opposition Division contains a total of twelve claims, of which the only independent Claim 1 reads as follows:

"1. A cyclic pressure swing adsorption process for the recovery of oxygen at greater than 97% purity from a feed gas comprising oxygen, nitrogen, and argon, with a combined forward flow stage which comprises:

(a) passing the feed gas into a first adsorption zone containing an adsorbent selective for the adsorption of nitrogen over oxygen and argon, and withdrawing therefrom a nitrogen-depleted intermediate gas;

(b) passing the nitrogen-depleted intermediate gas into a second adsorption zone containing an adsorbent which is selective for the adsorption of nitrogen over argon and selective for the adsorption of argon over oxygen;

(c) withdrawing an oxygen-enriched product gas from the second adsorption zone; and

(d) terminating the passing of feed gas into the first adsorption zone and withdrawing an oxygen-enriched depressurization gas from the second adsorption zone in the same flow direction as (c);

wherein nitrogen breakthrough from the first adsorption zone occurs and nitrogen is adsorbed in the second adsorption zone after nitrogen breakthrough,

wherein the oxygen-enriched product gas contains more than 97 vol% oxygen, and wherein the adsorbent in the first adsorption zone comprises one or more adsorbents selected from the group consisting of NaX, CaX, CaA, LiNaKX, LiZnX, wherein X represents an X zeolite with a Si/Al ratio of between about 1.0 and about 1.25,

wherein the concentration of nitrogen in the nitrogen-depleted intermediate gas withdrawn from the first adsorption zone after nitrogen breakthrough is between 0.5 vol% and the nitrogen concentration in the feed gas entering the first adsorption zone."

IV. The Opponent, now Appellant, filed on 24 August 2007 an appeal against the decision of the Opposition Division; the appeal fee was paid simultaneously. The grounds of appeal were filed on 22 November 2007. The Appellant argued that the requirements of novelty and inventive step still were not met.

V. The Proprietor, now Respondent, disputed Appellant's objections and argued that the main request in the appeal phase, which is identical with the set of claims maintained by the Opposition Division, met the requirements of the EPC.

VI. Appellant's main arguments were as follows:

Novelty - main request

- All features of Claim 1 of the patent-in-suit apart from the nitrogen breakthrough and the amount of nitrogen flowing from the first to the second phase, are directly derivable from D1;

- the latter two features are implicitly disclosed in D1 and can be calculated based on the fact that "substantially all" nitrogen is removed in the first phase and "substantially all" argon is removed in the second phase;

Inventive step - main request

- D1, the closest state of the art, does not exclude nitrogen breakthrough;

- even if assuming that nitrogen breakthrough has not been disclosed in D1, the patent-in-suit does not show any effect achieved by this difference, the objective problem is therefore the provision of an alternative;

- the person skilled in the art, as a matter of principle, would aim at optimizing the yield of oxygen; nitrogen breakthrough into the second adsorption phase would be the obvious solution.

VII. Respondent's main arguments were as follows:

Novelty - main request

- The description of the patent-in-suit defines, that the "nitrogen breakthrough" is synonymous with an increase of nitrogen concentration;

- Appellant's calculation of the alleged breakthrough in D1 is based on wrong assumptions and is not directly and unambiguously derivable from this document.

Inventive step - main request

- The effect caused by the nitrogen breakthrough is shown in Table 1 of the patent-in-suit;

- prior art does not give any hint to use the second adsorption zone comprising an expensive adsorbent for binding nitrogen.

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

The Respondent requested that the appeal be dismissed or that the patent be maintained on the basis of one of the auxiliary requests 1 to 3 submitted with the letter dated 04 April 2010.

Reasons for the Decision

1. Novelty - Main request

1.1 The Appellant objected to lack of novelty of Claim 1 of the patent-in-suit with regard to document D1. He argued that the only features which possibly could not directly be derived from the disclosure of D1, were the nitrogen breakthrough and the concentration of nitrogen in the nitrogen-depleted intermediate gas withdrawn from the first adsorption zone after nitrogen

breakthrough. According to the Appellant these features are implicitly disclosed in D1.

1.2 The Appellant stated that the removal of "substantially all" of the nitrogen in the first bed and "substantially all" of the argon in the second bed, as described in D1, column 3, lines 18-30, led to the conclusion, that a nitrogen breakthrough of at least 0.5 vol% nitrogen takes place. However, this point of view cannot be shared by the Board.

1.2.1 Claim 1 of the patent-in-suit contains the feature that a nitrogen breakthrough from the first zone occurs. Paragraph [0034] of the corresponding description defines the meaning of the said term "nitrogen breakthrough": "the leading edge of a nitrogen adsorption mass transfer zone or a nitrogen desorption mass transfer zone reaches the end of the first adsorbent layer and nitrogen passes into the second adsorbent layer. [...] After breakthrough, the concentration of nitrogen in the gas leaving the first adsorbent layer **will increase**" (emphasis added).

1.2.2 This increase is to be distinguished from a **constant** nitrogen stream from the first into the second zone as described in paragraph [0036] of the patent-in-suit: "the initial nitrogen concentration in the gas leaving the first adsorbent layer during the adsorption step typically is relatively constant at a low level, for example below about 0.5 vol%".

1.2.3 Thus, two cases of transfer of nitrogen into the second phase during the adsorption step can occur:

- i) a constant stream of nitrogen entering the second zone, with a rather low nitrogen concentration and
- ii) at nitrogen breakthrough a nitrogen concentration of between 0.5 vol% and the nitrogen concentration in the feed gas entering the first adsorption zone, which is associated with an increase in nitrogen content.

1.2.4 Starting from a final purity of the effluent gas stream of 99 vol% oxygen, as described in D1, the Appellant concluded that the 1 vol% gas other than oxygen must be argon. According to this calculation, the removal of argon in the purified gas amounts to 77 vol%. The Appellant further concluded, that the meaning of "substantially all" must be identical when describing the removal of nitrogen and therefore means that only 77 vol% nitrogen are removed from the feed gas in the first adsorption phase. Given the resulting transfer of nitrogen from the first to the second phase, he further concluded, that nitrogen breakthrough with a nitrogen gas stream of more than 0.5 vol% between the two phases occurs.

1.2.5 However, no basis for this literal interpretation of the term "substantially all" in connection with the removal of nitrogen and argon can be found in D1. As was emphasized by the Respondent, the adsorption depends heavily on processing conditions and the selectivity of the adsorbents used. No proof was submitted that the two adsorbents used in D1 would

exactly leave identical percentages of non-adsorbed nitrogen and argon in the gas stream. Furthermore, even the composition of the feed air is not defined in D1.

1.2.6 In addition, even if it could be assumed that nitrogen enters from the first to the second phase in amounts of more than 0.5 vol%, no proof of an **increase** of the nitrogen concentration, as required by feature ii) cited in paragraph 1.2.3 above, has been filed.

1.2.7 Thus, there is **no direct and unambiguous disclosure** in D1, that nitrogen breakthrough takes place and that the concentration after breakthrough is at least 0.5 vol%.

1.3 Novelty of Claim 1 vis-à-vis D1 is given.

2. Inventive step - Main request

According to the problem and solution approach, which is used by the Boards of Appeal of the European Patent Office in order to decide on the question of inventive step, it has to be determined which technical problem the object of a patent objectively solves vis-à-vis the closest prior art document. It also has to be determined whether or not the solution proposed to overcome this problem is obvious in the light of the available prior art disclosures.

2.1 Both parties agreed on D1 being the closest state of the art.

Taking into account that the process according to Claim 1 refers to pressure swing adsorption (PSA) for the recovery of oxygen at greater than 97 vol% purity,

the Board does not see any reason to deviate from this starting point.

D1 describes a PSA process for producing oxygen of a purity up to 99 vol% by means of a single pressure vessel comprising a first layer of zeolite adsorbing preferably nitrogen and a second layer adsorbing preferably argon.

- 2.2 As pointed out above, D1 differs from the patent-in-suit by the absence of any disclosure of a nitrogen breakthrough. The Respondent argued that an effect based on this difference could be derived from Table 1 of Example 2 of the patent-in-suit. This table shows the results of three tests, two of them using feed gases containing nitrogen and resulting in nitrogen breakthrough, whereas, due to the absence of nitrogen, in the third test breakthrough does not occur.

Allegedly based on the nitrogen breakthrough, improved relative oxygen productivities are shown for the nitrogen containing tests in Table 1.

- 2.2.1 It is established practice of the Boards of Appeal, that, if comparative tests are chosen to demonstrate an inventive step on the basis of an improved effect, the nature of the comparison with the closest state of the art must be such that the said effect is convincingly shown to have its origin in the distinguishing feature of the invention and alleged but unsupported advantages cannot be taken into consideration in respect of the determination of the problem underlying the application.

2.2.2 In the present case the comparative test of Table 1 differs from the tests according to the invention of the patent-in-suit in the presence of nitrogen in the feed gas, the occurrence of a nitrogen breakthrough and varying percentages of the individual gases contained in the feed gas.

2.2.3 Thus, the tests differ in several features at once. In addition it has also been admitted by the Respondent in the oral proceedings, that minor amounts of nitrogen constantly passing from the first to the second zone might have some further influence on the results achieved. Since this only occurs in nitrogen containing feed gas streams, this represents a further difference to the comparative test not containing nitrogen.

2.2.4 The available tests are therefore not suitable to undoubtedly demonstrate that the alleged effect has its origin in the distinguishing feature. The objective problem solved vis-à-vis D1 thus is the provision of an **alternative process** for producing oxygen with a purity of at least 97 vol%.

2.3 As the solution to this problem the Respondent has proposed the method according to Claim 1 of the main request.

2.4 The Appellant has objected, that the range of the nitrogen concentration breaking into the second phase is very broad and that it would therefore be "meaningless with regard to inventive step". However, no proof was submitted by the Appellant that the objective problem has not been solved.

2.5 Using the problem and solution approach it finally has to be decided whether the proposed solution was obvious.

2.5.1 Document D1 does not give any indication for a nitrogen breakthrough. On the contrary, column 2, lines 23-25 of D1 refer explicitly to "a first bed of zeolite for adsorbing nitrogen and a second bed of zeolite for adsorbing argon". It can therefore not be concluded that nitrogen adsorption takes place in the second bed too.

2.5.2 Also the passage in column 3, lines 25-30 of D1, stating that "substantially all the nitrogen is adsorbed leaving an oxygen rich gas stream but with some argon to pass through the non-adsorbent layer 10 to reach the second bed 12 where substantially all the argon is adsorbed leaving a product gas of up to 99% by volume of oxygen" does not point towards nitrogen being adsorbed in the second layer (see the reasoning in paragraphs 1.2.5 and 1.2.6 above).

2.5.3 Also D4, referred to by the Appellant, does not give any hint towards the breakthrough of nitrogen.

D4 relates to a method of improving the oxygen yield and oxygen concentration in a method of obtaining an oxygen concentration of 95% or more. One embodiment comprises two adsorbent layers, but also in this case nitrogen breakthrough cannot be derived.

Paragraph 22 of documents D4a and D4b describes the gas adsorbed in the second adsorption layer in detail. However, it cannot be derived from this passage or the

remaining text of D4a or D4b, that gases other than oxygen and argon enter the second phase.

2.5.4 With regard to Appellant's argument that the person skilled in the art would use the entire length of the first zone of the adsorption column to increase the yield, no hint can be found in D1 or D4 in this respect. Given the fact that the skilled person was well aware of the much higher costs associated with the second adsorbent compared to the first adsorbent (see paragraph [24] of D4a and D4b), it can hardly be concluded that it was for the skilled person obvious to cause a nitrogen breakthrough. D4a and D4b rather teach in paragraph [24] to use not too much of the second adsorbent in order to keep the costs down.

2.6 Thus, neither D1, nor D4 or their combination, give a hint to use nitrogen breakthrough to increase oxygen yield and purity. Claim 1 of the main request of the patent-in-suit is consequently based on an inventive step.

This finding applies also to the dependent Claims 2 to 12, which relate to specific embodiments of Claim 1.

Order

For these reasons it is decided that:

The appeal is dismissed.

The Registrar

The Chairman

G. Rauh

P.-P. Bracke