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D E C I S I O N
of 10 November 2004

Case Number: T 0299/00 - 3.3.5

Application Number: 95100967.9

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Title of invention:

VSA adsorption process with continuous operation

Applicant:

AIR PRODUCTS AND CHEMICALS, INC.

Opponent:

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Headword:

-

Relevant legal provisions:

EPC Art. 56, 123(2)

Keyword:

"Amendments - added subject-matter (no)"
"Inventive step - (yes)"
"Exclusion of hindsight"

Decisions cited:

-

Catchword:

-



Case Number: T 0299/00 - 3.3.5

D E C I S I O N
of the Technical Board of Appeal 3.3.5
of 10 November 2004

Appellant: AIR PRODUCTS AND CHEMICALS, INC.
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Representative: Marx, Lothar, Dr.
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Decision under appeal: Decision of the Examining Division of the
European Patent Office posted 2 November 1999
refusing European application No. 95100967.9
pursuant to Article 97(1) EPC.

Composition of the Board:

Chairwoman: M. M. Eberhard
Members: A. T. Liu
J. H. Van Moer

Summary of Facts and Submissions

I. The appeal was lodged against the decision of the Examining Division refusing patent application No. 95 100 967.9 concerning a VSA adsorption process with continuous operation.

II. The examining division held that the subject-matter of claim 1 on file did not imply an inventive step in view of the documents:

D1: US-A-5,122,164

D2: US-A-4,781,735

III. Observations regarding the significance of the technical features differentiating the claimed process from that of D1 were filed with the statement of the grounds of appeal and by letter dated 6 December 2002.

IV. With the letter dated 26 May 2004, the appellant filed a new set of claims 1 to 9 and a new page 5 of the description. Claim 1 read as follows:

"1. A vacuum swing adsorption process for selectively separating a more strongly adsorbable component from a less strongly adsorbable component of a feed gas mixture in a plurality of adsorption beds containing an adsorbent selective for the more strongly adsorbable component, comprising the steps of:

(a) introducing a feed gas mixture at an elevated pressure higher than ambient containing said more strongly adsorbable component and said less

strongly adsorbable component into an inlet of a first adsorption bed containing said adsorbent selective for the more strongly adsorbable component and adsorbing the more strongly adsorbable component on the adsorbent while the less strongly adsorbable component passes through said first bed unadsorbed as a product and as a source of purge gas for a bed of said plurality of adsorption beds undergoing purge of step (d) and continuing until the adsorption front of said more strongly adsorbable component approaches an outlet of said first bed and terminating the introduction of said feed gas mixture;

- (b) following the termination of the introduction of said feed gas mixture into said first bed, cocurrently depressurizing said first bed to a lower pressure to remove a cocurrent depressurization gas from said first bed and passing said cocurrent depressurization gas to an outlet of a bed of said plurality of adsorption beds at lower pressure undergoing repressurizing of step (e) to at least partially pressure equalize the two beds, while countercurrently depressurizing said first bed by connection to a source of vacuum;
- (c) countercurrently evacuating said first bed under vacuum conditions to remove said more strongly adsorbable component;
- (d) countercurrently purging said first bed with a portion of the less strongly adsorbable component from a bed of said plurality of adsorption beds

undergoing step (a) to remove additional more strongly adsorbable component from said first bed;

- (e) simultaneously repressurizing said first bed with ambient pressure feed gas mixture, elevated pressure feed gas mixture and said cocurrent depressurization gas from a bed of said plurality of adsorption beds undergoing the cocurrent depressurization of step (b);
- (f) further repressurizing said first bed with elevated pressure feed gas mixture; and
- (g) performing steps (a) through (f) in each of said plurality of adsorption beds in a phased sequence."

V. The appellant's arguments may be summarised as follows:

- With respect to the closest prior art according to D1, the problem to be solved is to achieve lower costs of production by making it possible to operate the rotating machinery, the feed blower and vacuum pump, continuously.
- The solution offered in claim 1 is a process in which the pressure equalisation / repressurisation step (e) of the first bed is carried out using simultaneously ambient pressure feed gas, elevated pressure feed gas mixture and depressurisation gas emanating from another bed of the plurality of adsorption beds and the further repressurisation step (f) of the first bed is carried out using elevated pressure feed gas mixture.

- D1 does not mention the present technical problem or its solution. The objection of lack of inventive step is based on hindsight.
- VI. The appellant requested that the decision under appeal be set aside and that a patent be granted on the basis of claims 1 to 9 as submitted with the letter dated 26 May 2004. Oral proceedings were requested as an auxiliary request.

Reasons for the Decision

1. *Amendments*

- 1.1 Present claim 1 corresponds to claim 1 as originally filed , with the difference that it specifies, in the preamble, that the process is a "vacuum swing adsorption process". It also contains the amendments in step a) wherein the original feature "elevated pressure" has been amended to read "elevated pressure higher than ambient" and in step e) wherein the original feature "repressurizing" now reads "simultaneously repressurizing". These amendments are based on the original description at page 1, line 6; page 10, line 32 and page 11, lines 14 to 18, respectively.

The text of present claim 2 is a clearer and more concise reformulation of the text of original claim 2.

Claims 3 to 8 correspond to claims 3 to 8 as originally filed. Claim 9 corresponds to original claim 10, with

the essential difference that the pressure values are also expressed in SI-units.

The amendments at pages 1 and 3 to 5 of the description are in accordance with the present claims. On pages 6 to 11, 13 and 14 of the description, the appropriate SI-units have been introduced.

Consequently, the amendments satisfy the requirements of Article 123(2) EPC.

2. *Novelty*

2.1 Claim 1 (see also point IV above) is directed to a vacuum swing adsorption (VSA) process comprising the following sequence of steps:

- (a) an adsorption step
- (b) a cocurrent depressurisation step
- (c) a countercurrent evacuation step
- (d) a countercurrent purge step
- (e) a pressure equalisation step combined with a partial repressurisation and
- (f) a final repressurisation step

2.2 The process as claimed is novel since none of the documents on file discloses a vacuum swing adsorption process comprising the above step (e) using simultaneously ambient pressure feed gas, elevated

pressure feed gas mixture and depressurisation gas emanating from another bed of the plurality of adsorption beds and step (f) using elevated pressure feed gas mixture.

3. *Inventive step*

3.1 The Board can accept that the closest prior art is represented by D1 which is directed to a PSA process for producing an oxygen enriched product stream from a feed gas containing at least oxygen and nitrogen using two adsorption columns. This process aims *inter alia* at minimizing cost and maintaining simplicity of operation (column 1, lines 9 to 12 and lines 42 to 46, and claim 1). In this process, feed gas is introduced into the inlet of the first column and the oxygen enriched gas product is recovered from the outlet and introduced to the product reservoir. A portion of the recovered product gas is used for purging the second column which is simultaneously undergoing a desorption and evacuation of the nitrogen rich gas. Product gas from the outlet of the first column (which is at an initially high pressure) is continued to be introduced into the outlet of the second column until the pressure is substantially equal in both columns while withdrawing gas from the inlet of the first column through a vacuum pump. The second bed is then repressurised using oxygen enriched gas taken from the product reservoir while continuing to withdraw gas from the inlet of the first column. In the next step, the feed gas is introduced into the inlet of the second column for nitrogen adsorption and recovery of the oxygen enriched product gas in the product reservoir. A portion of the oxygen enriched product gas is used for

purging the first column which is simultaneously undergoing a desorption and evacuation of the nitrogen rich gas. Product gas from the second column is introduced into the outlet of the first column to substantially equalize the pressure in the columns while withdrawing gas from the second column through the vacuum pump. After this equalisation step, product gas contained within the product reservoir is introduced into the outlet of the first column to backfill it while continuing to withdraw gas from the inlet of the second column. The preceding steps are cyclically repeated (claim 1, description column 3, line 38 to column 5, line 36; Figures 2A-2F).

- 3.2 The Board can accept that, with respect to D1, the technical problem to be solved is the provision of a process allowing the production of oxygen at lower costs.
- 3.3 To solve the above stated technical problem, claim 1 proposes a process in which the pressure equalisation using depressurisation gas from a bed undergoing a depressurisation is carried out simultaneously with the repressurisation using ambient and elevated pressure feed gas, followed by a final repressurisation using elevated pressure feed gas (steps (e) and (f) of claim 1). In the process of D1, the repressurisation is exclusively achieved by using oxygen enriched product gas from the product reservoir, in a separate step subsequent to the pressure equalisation (see point 3.1 above and D1, in particular Figures 2A/2B and 2D/2E; Figures 3A/3B and 3E/3F; Figures 4B/4C and 4G/4H).

3.4 Whilst the process of D1 uses the more valuable oxygen enriched product gas for repressurisation, the claimed process uses ambient feed gas and elevated pressure feed gas for the repressurisation in step (e). As pointed out by the appellant, the use of ambient feed gas in this step contributes to the reduction of the production costs. Further, by using elevated pressure feed gas for repressurisation both during the pressure equalising step (e) and the repressurisation step (f), the present process keeps the feed blower continuously in use, avoiding its shutdown or idling. It is thus plausible that the claimed process results in a more efficient use of the rotating machinery (the vacuum pump and the feed blower), which leads to a further reduction of production costs (page 10, line 29 to page 11, line 25 and page 14, lines 16 to 29). It is therefore credible that the technical problem indicated in point 3.2 above is solved by the process of claim 1. The question is whether the proposed solution is derivable from the available prior art.

3.5 As is stated in D1, the process disclosed therein achieves a power saving by continuous or nearly continuous utilisation of the vacuum pump. In the embodiment of Figure 2, the vacuum pump runs continuously to withdraw gas alternately from one or the other of the two columns (column 1, lines 47 to 64 and column 5, lines 32 to 36). However, it is expressly indicated that, in the equalisation step 1 (Figure 2A) the inlet of column A is completely closed and the inlet of column B is only open for gas to be withdrawn to the vacuum pump (column 3, lines 38 to 49). While pressure equalisation takes place in step 4 (Figure 2D), the reverse occurs, i.e. the inlet of column A is open

for withdrawing gas through the vacuum pump and the inlet of column B is completely closed (column 4, lines 44 to 56). The inlet of column A (or column B) is thus only opened to admit pressurised feed stream into the adsorption column for producing oxygen enriched gas after this column has been repressurised with product gas from the product reservoir (column 4, lines 11 to 14 and column 5, lines 1 to 11). The Board can therefore follow the appellant's argument that D1 does not disclose or suggest the possibility of using the feed blower continuously or using elevated pressure feed gas for repressurisation.

3.6 D2, which is also cited in the decision under appeal, is particularly directed to a PSA process for producing oxygen enriched gas having a low nitrogen content. To this end, the process makes particular use of three adsorption columns (column 2, lines 36 to 47). Without the benefit of hindsight, it is not apparent to the Board why the skilled person should turn to D2 in order to solve the present technical problem with respect to D1. Even if he would have done so for some reason, there is no pointer in either of these documents allowing a combination of these processes in such a way as to arrive at the claimed process. A combination of these processes is all the more dubitable since D1 expressly seeks to simplify prior art three-bed processes by providing a process requiring only two adsorption beds (see D1, column 1, lines 47 to 50).

3.7 As is established above, although D1 also tackles the technical problem of minimising costs, it does not suggest a process as defined in claim 1, either by itself or in combination with D2. The other available

documents do not disclose or suggest a process comprising the combination of steps (e) and (f) according to claim 1. As a consequence, the Board is of the view that the subject-matter of claim 1 implies an inventive step, Article 56 EPC.

Dependent claims 2 to 9 are directed to preferred embodiments of the process of claim 1; their object is therefore also new and inventive. The description has been correctly adapted to the claims on file.

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 with the following documents:
 - claims 1 to 9 filed with the letter of 26 May 2004
 - description pages 1 to 4 and 6 to 15 filed with the Grounds of Appeal dated 24 February 2000,
 - description page 5 filed with the letter of 26 May 2004.
 - drawing sheet 1/1 as originally filed

The Registrar:

The Chairman:

A. Wallrodt

M. Eberhard