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Datasheet for the decision of 16 October 2012

Case Number: T 1384/10 - 3.3.06

Application Number: 07117595.4

Publication Number: 1917994

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Language of the proceedings: EN

Title of invention:
Performance stability in rapid cycle pressure swing adsorption systems

Applicant:
Air Products and Chemicals, Inc.

Headword:
Rapid cycle pressure swing adsorption process/AIR PRODUCTS AND CHEMICALS

Relevant legal provisions (EPC 1973):
EPC Art. 56

Keyword:
"Inventive step: no"

Decisions cited:
-

Catchword:
-

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Case Number: T 1384/10 - 3.3.06

D E C I S I O N
of the Technical Board of Appeal 3.3.06
of 16 October 2012

Appellant: (Applicant)
Air Products and Chemicals, Inc.
7201 Hamilton Boulevard
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Representative:
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Decision under appeal:
Decision of the Examining Division of the European Patent Office posted 12 January 2010 refusing European patent application No. 07117595.4 pursuant to Article 97(2) EPC.

Composition of the Board:

Chairman: P.-P. Bracke
Members: G. Dischinger-Höppler
U. Tronser

Summary of Facts and Submissions

I. This appeal is from the decision of the Examining Division to refuse the European patent application No. 07 117 595.4 entitled "performance stability in rapid cycle pressure swing adsorption systems".

II. The decision was based on the grounds of Article 123(2) EPC for introducing subject-matter which extends beyond the content of the application as filed and - in an obiter dictum - on the grounds of Article 56 EPC for lack of inventive step in view of the disclosure of documents

D1 EP-A-0 391 718;

D2 WO-A-03/092817 and

D3 US-A-2002/0014159.

III. The Applicant (hereinafter Appellant) filed an appeal against this decision and argued that the amendment was admissible since the deleted feature was erroneous and in contradiction with the other teaching of the application. Further, the claimed process differed from that disclosed in Example 1 of document D1 by various features including the using of activated alumina in the first adsorber layer. As shown in the examples of the application in suit, these features provided an unexpected decrease of deactivation of the adsorbent when applied to small portable adsorber systems. Since none of the cited prior art documents suggested these features for solving the technical problem of providing

an improved PSA process, the claimed subject-matter was not obvious.

IV. In a communication, the Board of Appeal drew attention to problems under Articles 123(2) EPC. The Board further indicated that the effects shown in the application in suit seemed not derivable from the distinguishing features. Therefore, the technical problem actually solved in view of document D1 appeared to consist in providing an alternative process. However, solving this problem by the distinguishing features appeared obvious in view of the prior art.

V. In a response dated 5 October 2012, the Appellant addressed the objections under Articles 123(2) and 56 EPC and filed an amended set of 11 claims. Claim 1 reads as follows:

"1. A pressure swing adsorption process operated in a repeating cycle for the production of oxygen comprising

(a) providing at least one cylindrical adsorber vessel having a feed end and a product end, wherein the vessel comprises a first layer of activated alumina adjacent the feed end and a second layer of adsorbent material disposed between the first layer and the product end, wherein the depth of the first layer is between 10% and 40% of the total bed height, and the depth of the first layer is between 0.7 cm and 13 cm, and the ratio of the total depth of the first and second layers to the inside diameter of the adsorber vessel is between 1.8 and 6.0, wherein the adsorbent in the first layer forms a cylindrical bed having a radius r, the adsorbent in the first layer is selective for the adsorption of water from a mixture comprising water,

oxygen, and nitrogen; the adsorbent in the second layer is selective for the adsorption of nitrogen from a mixture comprising oxygen and nitrogen;

(b) introducing a pressurized feed gas comprising at least oxygen, nitrogen and water into the feed end of the adsorber vessel passing the gas successfully through the first and second layers, wherein the superficial contact time of the pressurized feed gas in the first layer is between 0.08 and 0.50 sec.;

(c) withdrawing a product gas enriched in oxygen from the product end of the adsorber vessel, wherein the flow rate of the product gas enriched in oxygen is between 6.67 x 10^{-6} m^3/s and 5.83 x 10^{-5} m^3/s (between 0.4 and 3.5 standard liters per minute);

(d) a depressurization step in which gas is withdrawn from the feed end of the adsorber vessel to regenerate the adsorbent material in the first and second layers; and

(e) a repressurization step in which the adsorber vessel is pressurized by introducing one or more repressurization gases into the adsorber vessel, and wherein the duration of the feed step is between 0.75 seconds and 30 seconds."

VI. At the oral proceedings held before the Board on 16 October 2012, the Appellant's attention was drawn to the fact that none of the examples contained in the application in suit disclosed a production rate of 0.4 to 3.5 standard liters per minute as required in the amended version of the claims. Therefore, any technical effects derivable from the examples appeared irrelevant for the claimed process.

VII. The Appellant submitted three pages of calculation and in essence the following arguments:

– It was shown by the calculation that example 5 of the application as filed was covered by Claim 1.

– Due to the low production rate claimed, a skilled person would combine in Claim 1 the 10% of the total bed height with 0.7 cm and the 40% with 13 cm for calculating the adsorbent vessel diameter. Hence, he would know that the claimed subject-matter related to a small portable oxygen concentrator having an inside diameter of between 1.17 and 18.06 cm which operates near isothermally. Therefore, the claimed subject-matter differed from document D1 by using activated alumina in the first layer of a smaller, portable oxygen concentrator which operates more isothermally at a lower flow rate of enriched product gas and at a superficial contact time also in line with a portable oxygen concentrator.

– Examples 1 and 2 of the application were representative for the process of document D1. While not being strictly according to the invention, Examples 3 and 4 of the application were not meaningless but to be taken as an indication that in view of document D1 the technical problem of lowering deactivation rates in a small oxygen concentrator without decreasing the product purity over time is solved by the claimed process.

– This effect was surprising since it was known that the adsorption affinity and capacity was much higher for NaX molecular sieve than for activated alumina.

– However, none of the cited prior art documents gave an incentive to solve this technical problem by the means claimed.

– The same applied if the technical problem actually solved by the claimed subject-matter in view of document D1 was considered to consist merely in providing an alternative process.

VIII. The Appellant requested that the decision under appeal be set aside and that a patent be granted on the basis of the request filed with the letter dated 5 October 2012.

Reasons for the Decision

1. *Amendments and novelty*

The Board is satisfied that the claims as amended fulfil the requirements of Article 123(2) EPC and that the subject-matter disclosed therein is sufficiently disclosed (Article 83 EPC) and not anticipated by the cited prior art (Article 54 EPC).

Since the appeal fails for the reasons of lack of inventive step, there is no reason to give further details. The same applies to the question of whether the claims fulfil the requirements under Article 84 EPC.

2. *Inventive Step*

2.1 The application in suit relates to a process for recovering oxygen by removing impurities, in particular water, from a feed gas comprising oxygen, nitrogen and water, during operation of a small, portable, rapid cycle pressure swing adsorption (PSA) oxygen concentrator (paragraphs 1 to 3 of the application as filed).

2.2 According to the Case Law of the Boards of Appeal of the European Patent Office (see I.D.3.1), a suitable starting point for the assessment of inventive step is normally a prior art document disclosing subject-matter conceived for the same or a similar purpose as the claimed invention.

2.3 The state of the art disclosed in document D1 - chosen by the Appellant as the closest prior art - qualifies as a starting point for the assessment of inventive step since it relates to a process for removing moisture and other contaminants from moist air by using a cylindrical PSA oxygen concentrator which is operated in rapid cycles, namely at an absorption time per cycle of 0.4 min (24 sec) and at a purge time per cycle of 0.333 min (20 sec) (page 3, lines 15 to 23 and Table B) which is within the total cycle duration of 6 to 60 seconds according to the application (page 2, line 49 and present Claim 3).

2.4 Document D1 specifically discloses a PSA process operated at a flow rate of oxygen enriched product gas of 106 standard liters per minute (3.75 scfm) in a

cylindrical adsorber vessel having a feed end and a product end, comprising a first adsorption layer of 13X molecular sieve selective for the adsorption of water and other impurities adjacent the feed end and a second layer of adsorbent material selective for the adsorption of nitrogen disposed between the first layer and the product end. The vessel has an inside diameter, hence a maximum bed diameter, of 26.98 cm, a depth of the first layer of 15.24 cm (0.5 ft) and a depth of the second layer of 121.92 cm (4.0 ft). The depth of the first layer is thus 11% of the total bed height (examples, Tables A and B, page 5, line 30 to page 6, line 4).

2.5 In the Appellant's view the claimed process differs from that of document D1 essentially by

- using in the first adsorption layer activated alumina instead of molecular sieve,
- using an oxygen concentrator which operates more isothermally and wherein the depths of the first and second layers as well as the inside diameter of the adsorber vessel are smaller,
- operating at a lower flow rate of oxygen enriched product gas and
- operating at a particular superficial contact time in the first adsorption layer.

Further, the Appellant argued that it was shown in Examples 3 and 4 that using activated alumina instead of zeolite molecular sieve (as in Example 2) in combination with the contact time improved the process performance in a small portable oxygen concentrator. The improvement consisted in that deactivation rates were decreased. This was unexpected since zeolite

molecular sieve had a much higher affinity for water than activated alumina and showed no deactivation of the adsorbent or reduction in oxygen purity if used in a large oxygen concentrator as in Example 1. The unexpected effect was plausible also in view of document D1 since the process disclosed therein was representative for Examples 1 and 2 of the application. The claimed process was based on an inventive step, since the available prior art did not hint towards the subject-matter of Claim 1.

2.6 Even if it was accepted in the Appellant's favour that the claimed process differs from that of document D1 by the features listed above (point 2.5), the Board is not convinced by these arguments.

The effects shown in Examples 3 and 4 when compared with Examples 1 and 2 are not relevant for the claimed process since they are operated at a production rate of only 0.022 to 0.05 liters per minute and not according to the process of Claim 1 where a production rate of 0.4 to 3.5 standard liters per minute is required. Hence in Examples 3 and 4 the production rate is 20 to 70 times lower than required. However, the inside diameter of the vessel of Claim 1 may be as low as 1.17 cm which is about half of that according to Examples 3 and 4, while the minimum total bed height is comparable, namely 6.7 cm in the examples and 7 cm according to Claim 1 (see also point IV above). In addition, according to Claim 1, the depth of the first layer may be as low as 10% of the total bed height whereas it is 30% or 40% in the examples.

Accordingly, Claim 1 covers a process operated at a throughput which is at least 20 times higher than in Examples 3 and 4 while using an alumina layer much smaller in height and diameter than according to Examples 3 and 4. The Appellant did not provide anything to show credibly that under such circumstances a lower deactivation rate is obtained when compared with a process (as in Example 2) where NaX molecular sieve is used instead of activated alumina.

This fact cannot be changed, even on assuming in the Appellant's favour that Example 5 was in accordance with Claim 1 since no evidence allows the conclusion that the same effect as in Examples 3 and 4 is achieved if the process is operated at the calculated production of 0.5 to 1.15 l/min rate in the larger vessel of Example 5, namely with a bed diameter of 5.3 cm (2.1 inches) and a bed height of 8.6 cm (3.4 inches), with 25% of the bed being alumina.

The same applies in view of document D1 because the process disclosed therein is operated in an adsorber vessel much larger than in Example 5 but considerably smaller than in Example 1 of the application.

2.7 According to the so-called problem-solution approach used by the Boards of Appeal for the assessment of inventive step (see Case Law of the Boards of Appeal of the European Patent Office I.D.2), the technical problem actually solved by the claimed invention in comparison with the disclosure of document D1 must be considered therefore to consist in providing an alternative PSA process for recovering oxygen by removing impurities from a feed gas comprising oxygen,

nitrogen and water. In view of the above considerations, the Board accepts that this technical problem was credibly solved by the provision of the claimed process.

2.8 It remains to be decided whether it was obvious for someone skilled in the art to modify the process of document D1 by the distinguishing features listed in point 2.5 above in the reasonable expectation of solving the above stated technical problem of providing just an alternative process.

2.9 Document D1 does not suggest a specific alternative process. However, it discloses that activated alumina, along with clays, silica gels and molecular sieves, is a common type of inorganic water adsorbent suitable for the claimed process. The suitability of activated alumina for this purpose is corroborated by documents D2 and D3 which both relate to an oxygen concentrator performing a PSA process and using activated alumina for water adsorption (see document D2, Claims 28 to 35, amended version, and page 11, paragraph 56; document D3, page 1, paragraph 2 and page 5, paragraph 54). Hence, using in a PSA oxygen concentrator activated alumina instead of molecular sieve for removing water from air is well-known in the art.

Further, the using of activated alumina especially in a small oxygen concentrator is obvious in the light of document D2 which relates to "truly" portable oxygen concentrator systems weighing only 2 to 15 pounds (Claim 32, amended version, and page 5, paragraph 17). As acknowledged in the application in suit (page 8, paragraph 34), small concentrator systems, in

particular systems with small bed diameters, inevitably operate more isothermally than larger systems.

Hence, it is at the disposal of a skilled person to select the height of the beds and the diameter in accordance with circumstances.

The same applies to the flow rate of product gas and the superficial contact time since there is no reason to consider the claimed values unusual. On the contrary, the values of both parameters have to be adapted to the size and shape of the concentrator as also argued by the Appellant (point VI above).

3. Therefore, the features distinguishing the claimed process from that of document D1 are, in the Board's judgment, all options at the disposal of someone skilled in the art. The selection of any of those features, either alone or in combination, in order to provide an alternative process to that disclosed in document D1, is therefore, obvious.

4. For all these reasons, the Board concludes that the claimed subject-matter is not based on an inventive step as required by Article 52(1) EPC in combination with Article 56 EPC.

Order

For these reasons it is decided that:

The appeal is dismissed.

The Registrar: The Chairman:

D. Magliano P.P. Bracke