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D E C I S I O N
of 25 April 2001

Case Number: T 0113/97 - 3.3.5

Application Number: 91303287.6

Publication Number: 0453202

IPC: B01D 53/04

Language of the proceedings: EN

Title of invention:
Pre-purification of air for separation

Patentee:
THE BOC GROUP, INC.

Opponent:
Linde Aktiengesellschaft, Wiesbaden

Headword:
Air purification/BOC

Relevant legal provisions:
EPC Art. 56

Keyword:
"Inventive step - no, obvious solution of a technical problem"

Decisions cited:
-

Catchword:
-



Case Number: T 0113/97 - 3.3.5

D E C I S I O N
of the Technical Board of Appeal 3.3.5
of 25 April 2001

Appellant: THE BOC GROUP, INC.
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Respondent: Linde Aktiengesellschaft, Wiesbaden
(Opponent) Zentrale Patentabteilung
D-82049 Höllriegelskreuth (DE)

Representative: -

Decision under appeal: Decision of the Opposition Division of the
European Patent Office posted 29 November 1996
revoking European patent No. 0 453 202 pursuant
to Article 102(1) EPC.

Composition of the Board:

Chairman: R. K. Spangenberg
Members: G. J. Wassenaar
M. B. Günzel

Summary of Facts and Submissions

- I. The appeal is from the decision of the Opposition Division to revoke European patent No. 0 453 202, which was granted in response to European patent application No. 91 303 287.6.

It was held that the process according to claim 1 lacked an inventive step within the meaning of Article 56 EPC. Reference was made, inter alia, to the following prior art document:

D2: EP-A-0 232 840.

- II. In reply to the statement of the grounds of appeal, the respondent cited the following prior art document:

D6: JP-A-63 107720.

The respondent also provided an English translation of D6. References in this decision to D6 refer to the English translation.

- III. With a letter dated 30 May 2000 the appellant submitted three amended sets of claims as main request and first and second auxiliary request, and provided four comparative examples. Reference was made to the following textbook publication:

D7: "Heatless fractionation of gases over solid adsorbents", by C. W. Skarstrom, in Recent Developments in Separation Science, Vol II, edited by N.N. Li, CRC Press (1972), pages 95-106.

With a letter dated 23 March 2001 a new main request was submitted together with amendments to the description to adapt the description to the amended claims.

Claim 1 of the main request reads as follows:

"A pressure swing adsorption process for the removal from air of water vapour and carbon dioxide impurities comprising, in cyclic sequence:

- (a) introducing air under pressure into a first adsorptive bed thereby to remove said impurities therefrom;
- (b) at the conclusion of the removal step, ceasing introduction of air and venting said bed;
- (c) introducing into said bed a purge gas free of said impurities to remove adsorbed impurities therefrom; and
- (d) repressurising said bed, wherein said bed operates out of phase with a second bed so that one of them is producing product gas by step (a) while the other is being regenerated by steps (b) and (c) and said beds contain an initial layer of activated alumina with any remainder comprising a layer of a suitable zeolite to adsorb any residual water vapour and/or any residual carbon dioxide, wherein the layer of activated alumina comprises from 70% to 100% of the total bed volume, whereby the activated alumina acts as the sole or predominant adsorbent of carbon dioxide, characterised in that all the adsorbent particles in the beds are between 0.4 mm and 1.8 mm in size, and said bed is repressurised by backfilling with product gas containing less than 1.0 ppm (by volume) of carbon dioxide and 0.1 ppm (by volume)

of water vapour."

Claim 1 of the first auxiliary request differed therefrom in that the layer of activated alumina forms 100% of the total bed volume.

Claim 1 of the second auxiliary request differed from claim 1 of the first auxiliary request in that the purge gas referred to in feature c) is nitrogen-enriched waste or product gas from a cryogenic air separation unit.

IV. During oral proceedings, which took place on 25 April 2001, novelty of the claims on file was not disputed. The only issue discussed during oral proceedings was inventive step.

V. The appellant's arguments with respect to inventive step of the process according to claim 1 of the main request can be summarized as follows:

The closest prior art was D6 disclosing the use of alumina as sole adsorbent in a pressure swing adsorption process (PSA) for removing carbon dioxide and water vapour from air before cryogenic separation thereof. It was, however, evident to the skilled person that the reduction of carbon dioxide and water vapour indicated in the only example of D6 could not be obtained with the amount of purge gas used therein. In this respect reference was made to D7. The unworkable example made the technological teaching of D6 not credible so that a skilled person would not take D6 as a starting point for further development. Thus, although repressurisation by product gas was in itself known from D2, it was not obvious to combine it with

the teaching of D6. The use of an adsorbent with a particle size as now claimed was not disclosed in the art. The skilled person would not have expected a substantial improvement of the adsorption properties by using smaller particles than those indicated in D6. Since the use of smaller particles had clearly also some disadvantages, the skilled person would not have considered the use of adsorbent particles of the size as now claimed. As testified by the comparative examples, under the claimed operation conditions, the adsorbent productivity and adsorbent specific product, turned out to be surprisingly higher than the skilled person could have expected. No additional arguments were submitted in respect of the auxiliary requests.

VI. The respondent's arguments can be summarized as follows.

The clear general teaching of D6 was not invalidated by the presence of a possibly non-realistic example. D6 was silent about repressurisation, but it was obvious to repressurise with product gas as disclosed in D2. The skilled person knew about the advantages and disadvantages of using smaller particles. The size of 2 to 4 mm mentioned in D6 was generally used in PSA processes but a smaller size as now claimed was not unusual in the art. Depending on the local circumstances of the whole cryogenic air separation process, of which the claimed process forms a part, the skilled person was free to make more effective use of the adsorbent by taking smaller particles at the cost of a higher pressure drop over the absorption bed. This option did not require any inventive skill.

VII. The appellant requested that the decision under appeal

be set aside and that the patent be maintained with the claims according to the main request filed with the letter dated 23 March 2001 and a description to be amended as proposed in the same letter, or alternatively with the claims according to the first or second auxiliary requests filed with the letter dated 30 May 2000 and correspondingly amended descriptions as proposed in the letter dated 23 March 2001.

The respondent requested that the appeal be dismissed.

Reasons for the Decision

1. The only issue to be decided is inventive step. It is undisputed that D6 represents the closest prior art and that the process according to claim 1 of the main request differs therefrom only in that the adsorption bed is repressurised with the product gas containing 1.0 ppm carbon dioxide and 0.1 ppm water vapour, and in that the size of the adsorption particles in the beds is between 0.4 and 1.8 mm.

2. According to the patent in suit means are provided for effectively removing water vapour and carbon dioxide from air in terms of power consumption and vent gas loss (page 3, lines 20 to 1). There is, however, no evidence on file that power consumption and vent gas loss are reduced with respect to the process according to D6. From the comparative examples filed during the appeal proceedings it can be derived that the performance of the adsorption beds in terms of adsorbent specific product and adsorbent productivity (F/W) is improved. This was not contested by the respondent. On that basis the Board accepts that the

problem underlying the invention was to provide a PSA process with improved adsorbent productivity (feed volume divided by the adsorbent weight required for a carbon dioxide concentration of 1 ppm). This problem is solved by repressurising the adsorption bed with product gas and using an adsorption particle size between 0.4 and 1.8 mm as indicated in claim 1. It is thus to be decided whether it was obvious to the skilled person to solve this problem by the said features.

3. In its general teaching D6 is silent about repressurisation. In the example illustrated by the figure, feed air seems to have been used for repressurisation. Repressurisation by the product gas in a PSA process is, however, known in the art (D2, claim 1, feature (d)). D2 does not explicitly mention the purpose of this feature, but it is evident to the skilled person that starting the adsorption cycle with a clean bed as the result of filling it first with a clean gas, allows more feed gas to pass the bed before the off gas reaches the contamination level of 1 ppm carbon dioxide. Repressurisation by the product gas is thus an obvious way for improving the adsorbent productivity.
4. The Board cannot accept the appellant's argument that the skilled person would not consider any modification of D6 because its teaching is not credible. The Board does not dispute that the operating conditions mentioned in the example of D6 are not suitable to produce air with the indicated low amounts of carbon dioxide and water vapour on a steady state basis. This does, however, not mean that a skilled person would reject its general teaching. Based on his general

knowledge that for continuous separation of impurities in a gas stream by PSA the purge backwash volume should exceed the feed volume (D7, page 96, left hand column, principle 3) the skilled person would immediately recognize that for obtaining the results mentioned in the example on a steady state basis the amount of purge gas should be substantially increased. The general teaching of D6, ie to use activated alumina as the sole adsorbent in a PSA process for removing carbon dioxide and water vapour from air to a level of 2 ppm or below, remains, however, unaffected by the obvious mistake in the example. Starting from this general teaching the skilled person would not hesitate to apply additional measures known in the art for improving the adsorbent productivity such as repressurising the bed by the product gas with the aim of further improving the process.

5. According to D6 activated alumina widely commercially available in numerous grades can be used (page 4, right hand column). A specific particle size is not required. In the example activated alumina with a particle size from 2 to 4 mm has been used. As acknowledged in the patent in suit it is well known to a person skilled in the art that smaller particles of adsorbent have smaller mass transfer zones which result in a more effective use of the bed in terms of its equilibrium capacity (page 4, lines 42 to 43). Thus, the skilled person expects that by reducing the particle size of the adsorbent the productivity of the adsorbent can be improved. The skilled person faced with the above-mentioned problem, therefore, would consider a particle size reduction. Since he is also aware of the disadvantages of particle size reduction, such as increased pressure drop, he will first try a relatively

small size reduction. The small size reduction as now claimed, from 2 mm to 1.8 mm, is thus an obvious choice for a person skilled in the art trying to solve the above mentioned problem.

6. The appellant's argument that the general knowledge of the advantages of reduced particle size, referred to in the patent in suit, only related to zeolites, is not convincing. In the patent in suit the effect of reduced particle size is clearly presented as a general effect for both zeolites and alumina adsorbents (page 4, line 42 to page 5, line 1). The effect of smaller mass transfer zones results from the interaction between the surface of the adsorbent and the surrounding gasses. Although the effects may be larger for one type of adsorbent than for others, the skilled person will expect that the direction of these effects is the same for all adsorbents.

7. The appellant's argument that the increase in adsorbent productivity by using smaller adsorbent particles is surprisingly higher than the skilled person would have expected and that, without knowing this surprising increase in performance, the skilled person would not have considered the claimed particle size, is also not convincing. According to the comparative examples (experiments 2 and 4) submitted during the appeal proceedings the adsorbent productivity F/W increases from 6.9 to 8.5 (23%) when the average adsorbent size is reduced from 3.0 to 1.5 mm (50%). It is questionable whether such an increase is substantially larger than a skilled person would have expected. Moreover, the appellant's argument only makes sense if the improvement in performance of the adsorbent does not result in the expected deterioration of other relevant

process conditions, otherwise the appellant simply confirms the skilled person's expectation. Since the appellant has neither shown that the improvement in performance is surprisingly higher than could be expected, nor that disadvantages, such as increased pressure drop, are smaller than could be expected, the said argument must fail.

8. D6 does not disclose that the product gas contains less than 1.0 ppm of carbon dioxide and 0.1 ppm of water vapour. As explained above, the amount of 0.2 ppm of carbon dioxide mentioned in the example is unrealistic for a steady state situation under the indicated conditions. The amount of less than 2 ppm for both impurities mentioned in D6 is realistic and the skilled person knows how to reduce the impurity levels. It belongs to the common general knowledge in the art that the purity of air treated by a PSA process depends on the height of the absorption bed, the swing period and the purge ratio (see D7, page 99). Virtually any purity can be obtained if the absorption bed is high enough, the purge ratio is large enough and the swing period is short enough. Thus no inventive step can be seen in producing air with the claimed impurity levels.

9. For these reasons, the subject-matter of claim 1 according to the main request does not involve an inventive step within the meaning of Article 56 EPC. The additional features mentioned in claims 1 of the auxiliary requests are all disclosed in D6 (see the example). This is not in dispute. Consequently the auxiliary requests must fail for the same reasons.

Order

For these reasons it is decided that:

The appeal is dismissed.

The Registrar:

The Chairman:

G. Rau

R. Spangenberg