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Datasheet for the decision of 2 December 2014

Case Number: T 0057/11 - 3.3.05

Application Number: 03254537.8

Publication Number: 1382375

IPC: B01D53/04

Language of the proceedings: EN

Title of invention:
Process and apparatus for treating a feed gas

Patent Proprietor:
AIR PRODUCTS AND CHEMICALS, INC.

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

Linde AG

Headword:

Relevant legal provisions:
EPC Art. 100(a), 54, 56

Keyword:
Novelty - (yes)
Inventive step - (yes)

Decisions cited:
T 0197/86

Catchword:

Beschwerdekammern
Boards of Appeal
Chambres de recours

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Case Number: T 0057/11 - 3.3.05

D E C I S I O N
of Technical Board of Appeal 3.3.05
of 2 December 2014

Appellant: (Patent Proprietor)	AIR PRODUCTS AND CHEMICALS, INC. 7201 Hamilton Boulevard Allentown, PA 18195-1501 (US)
Representative:	Beck Greener Fulwood House 12 Fulwood Place London WC1V 6HR (GB)
Respondent 1: (Opponent 1)	L AIR LIQUIDE SOCIETE ANONYME POUR L ETUDE ET L EXPLOITATION DES PROCEDES GEORGES CLAUDE 75 Quai d'Orsay 75007 PARIS (FR)
Representative:	Pittis, Olivier L'Air Liquide, S.A. Direction de la Propriété Intellectuelle 75, Quai d'Orsay 75321 Paris Cedex 07 (FR)
Respondent 2: (Opponent 2)	Linde AG Klosterhofstrasse 1 80331 München (DE)
Representative:	Zahn, Christoph Linde AG Legal Services Intellectual Property Dr.-Carl-von-Linde-Strasse 6-14 82049 Pullach (DE)
Decision under appeal:	**Decision of the Opposition Division of the European Patent Office posted on 13 December 2010 revoking European patent No. 1382375 pursuant to Article 101(3)(b) EPC.**

Composition of the Board:

Chairman	G. Raths
Members:	G. Glod
	D. Prietzel-Funk

Summary of Facts and Submissions

I. The present appeal lies from the decision of the opposition division to revoke European patent EP-B-2 046 476.

The opposition division found that the claims of the patent as granted (main request) were novel over D1, D2 and D5, but that claim 1 of the main and auxiliary requests did not involve an inventive step over D2 in combination with D1 or D3.

II. The independent claims of the patent as granted are as follows:

"*1. A thermal swing adsorption process for the reduction of the level of a component in a feed gas selected from synthetic gas, natural gas and air, comprising passing the feed gas to at least three parallel thermal swing adsorption zones, each zone containing an adsorbent and being operated in an adsorption cycle which comprises:*
a single adsorption step to remove the component from the feed gas, or to reduce the level of the component in the feed gas and in which the feed gas is fed continuously to the adsorption zone during the adsorption step, depressurisation of the adsorption zone, a thermal swing step to desorb the adsorbed component and repressurisation of the adsorption zone, wherein the adsorption cycle of each zone is phased with respect to that of the other zones so that at any point during the adsorption cycle, the number of zones in the adsorption step is greater than the number of zones not in the adsorption step."

"*21. A thermal swing adsorption apparatus comprising at* *least three adsorption vessels, a feed gas inlet assembly in fluid communication with each vessel, an outlet assembly in fluid communication with the at least three vessels being arranged in parallel paths, flow control means to permit the feed gas to pass through each vessel and to the outlet assembly, a regeneration assembly comprising a conduit in fluid communication with the outlet assembly whereby a regeneration gas is able to be passed into each vessel and a heater to heat the regeneration gas, the flow control means and the regeneration assembly being arranged so that each vessel, in use, repeatedly undergoes an adsorption cycle comprising a single adsorption step, depressurisation, a regeneration step and repressurisation and the adsorption cycle for each vessel is out of phase with the cycle for all the other vessels provided that, in use, at least two vessels are in the adsorption step at any time and the flow control means feeds the feed gas continuously to the adsorption zone during the adsorption step.*"

"*25. Use of apparatus as claimed in any one of Claims 21 to 24, in a process as defined in any one of Claims 1 to 20.*"

III. The documents cited during the opposition proceedings included the following:

D1: EP-B1-0 956 894
D2: US 5 571 309
D3: US 5 846 295
D5: Hydrocarbon Processing: "Drying Natural Gas with Alumina", March 1969, p. 103-132

IV. The patent proprietor (hereinafter: "the appellant") filed an appeal against said decision and submitted grounds for the appeal. In addition the following document was cited:

D6: US 4 964 901

V. Opponent 1 (hereinafter: "Respondent 1") replied to the statement of grounds and cited the following document:

D7: FR 2 777 477

VI. Opponent 2 (hereinafter: "Respondent 2") only referred to its submissions made during the opposition proceedings.

VII. In its communication under Article 15(1) of the Rules of Procedure of the Boards of Appeal (RPBA), the board expressed its preliminary non-binding opinion that the subject-matter of the claims as granted was novel and that, starting from D3 as closest prior art, the subject-matter of the claims as granted seemed likely to involve an inventive step.

VIII. By letter dated 5 November 2014 the appellant submitted further arguments.

IX. Oral proceedings took place on 2 December 2014. The appellant submitted a new auxiliary request.

X. The arguments of **the appellant** can be summarised as follows:

Novelty

D1 did not disclose depressurisation and repressurisation steps. The opposition division had cited paragraph [0029] of D1 and reasoned that this taught away from there being depressurisation and repressurisation steps. The respondents had not argued that this reasoning was wrong. D1 did not anticipate the subject-matter of the claims.

Inventive step

D2 was not an appropriate starting point. The three-bed scheme used in D2 was designed specifically to deal with a problem arising from the need to feed purified air to both a high pressure fractionation stage and a lower pressure fractionation stage. The opposition division was in manifest error in suggesting that the use of three beds in D2 did not arise from the need to deal with high and low pressure streams. The process according to D2 started with a feed at atmospheric pressure. The essential purpose in D2 was to generate simultaneously a low pressure output of purified gas (one bed) and a high pressure output of pressurised gas (another bed). There was no conceivable reason why the reader of D2 should take a serious look at the issue of designing a single, continuous adsorption step while eliminating the steps of generating the high and low pressure outputs that were the raison d'être of the D2 teaching.

Taking D2 alone, without hindsight use of the invention, there was no reason at all why the skilled reader would find D1 of any interest for improving D2. The aims of the two documents were thoroughly incompatible.

Unlike D2, D3 was concerned with how to purify air in a single, continuous adsorption step, which was the field of the invention. D3 had to be considered the closest prior art.

It was clear from the examples of the patent as granted that the advantage of increased air flow was obtained independently of the choice of pressure. The use of three adsorption beds enabled a shorter bed length to be used for a given flow rate or else a higher throughput to be achieved for a given bed length than would be the case using a conventional arrangement of two beds operated in alternation. The higher pressure drop during the regeneration step was not a problem since it was compensated for by adding additional gas. The fluidisation of the bed did not occur during the regeneration, since it was done counter-current to that of the feed gas when on-line. There was no evidence in the form of an example showing that this increased pressure drop during the regeneration step had a negative impact on the overall process.

D7 would not be combined with D1, since D7 was concerned with the pre-purification of air before cryogenic treatment while Dl was concerned with recovery of solvents. The regeneration task in Dl was to strip solvent off activated carbon. The system was not disclosed to be significantly pressurised. Depressurisation and repressurisation took energy and imposed costs. The skilled person would not adopt these measures without expectation of a clear benefit.

XI. The arguments of **respondent 1** can be summarised as follows:

Novelty

While teaching a TSA process, D1 implicitly taught a process comprising a depressurisation step prior to the regeneration step and a repressurisation step after the regeneration step. These two steps would be part of a classic TSA process as confirmed by paragraph [0005] of the patent as granted and by D7 (page 2, lines 3 to 23). D1 was novelty-destroying for the subject-matter of claim 1.

Inventive step

Starting from D1 the problem to be solved was to improve the process.

The solution to add a depressurisation step prior to the regeneration step and a repressurisation step after the regeneration step was obvious in view of D7.

Starting from D3 as closest prior art the problem to be solved had to be subdivided into six problems (see 2.3), as indicated in paragraph [0019] of the patent as granted. There was no evidence that any of these problems was solved. The examples of the patent as granted showed a considerable pressure drop during the regeneration step. Therefore more energy was needed for the overall process.

The examples of the patent as granted were conducted with three beds although claim 1 did not exclude a much higher number of beds. Furthermore the bed height and diameter were specific and it was not credible that the same results were obtained over the whole scope of claim 1.

The problem had to be redefined as finding an alternative process. The solution to this problem was obvious since three beds had to be considered as an arbitrary choice.

XII. Requests:

The appellant requested that the decision under appeal be set aside and that the patent be maintained on the basis of the claims according to the claims as granted, or alternatively on the basis of the claims according to the auxiliary request filed during the oral proceedings or on the basis of the auxiliary request filed with the letter dated 23 March 2011.

Respondent 1 requested that the appeal be dismissed.

Respondent 2 did not submit any requests.

Reasons for the Decision

Main request (patent as granted)

1. Article 100(a) / Article 54 EPC: novelty

1.1 D1 discloses a thermal swing adsorption process for solvent recovery characterised in that at least three adsorbers with fixed beds of activated carbon are applied and each of the beds is periodically subjected, in overlapping cycles, to a sequence of at least the following steps: a) the solvent containing air is passed to the bed where the solvent is adsorbed; b) the bed is heated in a first heating step with a hot gas coming from another bed which is being cooled; c) the bed is put on "hold" or "idle", while a further bed completes step g); d) the bed is further heated in a second heating step by hot gas in an essentially closed loop; f) the bed is cooled in a first cooling step during which the gas exiting from this bed is passed to another bed starting its heating as described in step b); g) the bed is cooled in a second, final cooling step in an essentially closed loop (D1: claim 1). D1 is silent as to the pressure at which the process is conducted. It does not disclose a depressurisation and a repressurisation step.

A reference to D7 is also not helpful for trying to close the information gap in D1 related to the (de)pressurisation steps. D7, which is not a textbook, discloses that a classical thermal swing adsorption (TSA) process for the purification of air comprises a depressurisation and a repressurisation step (D7: page 2, lines 3 to 23). The process disclosed in D1 relates to a different process, namely the recovery of solvents from air. Therefore it cannot be concluded that the process according to D1 comprises inevitably such (de)pressurisation steps. The skilled person knows that a TSA process relies on the change in adsorption capacity with temperature for a given pressure. The process of D7 is conducted at super atmospheric pressure (D7: page 2, lines 5 to 7), while the pressure of the process of D1 is unknown.

It follows that the subject-matter of claim 1 is not directly and unambiguously derivable from D1. As a consequence, the same applies to the thermal swing adsorption apparatus according to claim 21, since no flow control means, arranged as in claim 21 of the patent as granted, are present. Therefore, claim 25 relating to the use of the thermal swing adsorption apparatus according to claim 21 is also not anticipated by D1.

1.2 The board does not see any reason to deviate from the decision of the opposition division with respect to novelty vis-à-vis D5. D5 does not disclose a depressurisation and a repressurisation step. In addition, no flow control means, arranged as in claim 21 of the patent as granted, are present.

1.3 The subject-matter of the claims of the patent as granted fulfills the requirements of Article 54 EPC.

2. Article 100(a) / Article 56 EPC: inventive step

2.1 Invention

The invention concerns a thermal swing adsorption process (TSA) using at least three adsorption beds for reducing the level of a component in a feed gas to render it suitable for downstream processing (see paragraph [0001]).

2.2 Closest prior art

It is established jurisprudence that the closest prior art is normally a prior-art document disclosing subject-matter conceived for the same purpose and having the most relevant technical features in common.

Having to make a choice among D1, D2 and D3, the board takes document D3 as the most suitable starting point for assessing inventive step.

The reasons are as follows:

D1 discloses a thermal swing process for recovering solvent from air but it does not relate to a feed gas that is rendered suitable for downstream processing.

D2 relates to an adsorption process in which high and low pressure streams are introduced into the adsorbent beds to produce high and low pressure product streams (see column 1, lines 9 to 12) but it teaches away from a single adsorption step (see column 2, lines 32 to 38).

D3 is considered to be the closest prior art, since it relates to a single continuous adsorption step and has the same goal as the present invention, namely to remove a compound from feed gas that is subsequently further processed (see column 1, lines 13 to 16). It discloses a TSA process wherein, after compression, air is fed into one of two adsorbent columns or vessels, depending upon which is currently on-line and which is in its regeneration phase. The flow of gas through the column is continued until the adsorbent is so loaded with water and carbon dioxide that it is necessary for it to be regenerated. For this purpose the column is depressurised. Dry nitrogen-rich waste gas is warmed to a regeneration temperature and supplied to the downstream end of the column through which the gas passes in the reverse of the feed direction. After regeneration and repressurisation, the bed goes back on-line (see column 7, line 59 to column 8, line 12).

2.3 Problem

According to the patent as granted, the technical problem can be seen in providing a process which reduces or avoids undesirable fluid flow, bed fluidisation, unacceptable pressure drop, design complexity and difficulties in transporting large-scale apparatus (paragraph [0019]; page 3, lines 37 to 39 of the patent as granted).

2.4 Solution

As a solution to this problem the patent as granted proposes a TSA process according to claim 1 characterised in that the feed gas is passed through at least three parallel TSA zones, the number of zones in the adsorption step being greater than the number of zones not in the adsorption step.

2.5 Success of the solution

The examples of the patent as granted show a simulation of a conventional TSA cycle as disclosed in D3 for operation with two beds and two pairs of beds where the beds are alternately on-line and off-line for comparative purposes. In addition, a TSA system with three beds according to the invention was assessed.

According to established jurisprudence, where comparative tests are chosen to demonstrate an inventive step with an improved effect over a claimed area, the nature of the comparison with the closest prior art must be such that the effect is convincingly shown to have its origin in the distinguishing feature of the invention (T 197/86, Reasons 6.1.3). This requirement is met here, since only the amount of beds was changed while the other parameters were identical (e.g. adsorbent, bed diameter, bed size, pressure).

The results of the comparative tests presented in Tables 1 to 3 show that with the three-bed system according to the invention a higher air flow than in a system as known from the prior art with two beds can be achieved. The air flow in the three-bed system is similar to the conventional four-bed system. This means that one bed can be saved, which reduces the design complexity. In addition, the bed fluidisation and pressure drop when operated on line are not impacted.

Table 4 of the patent as granted shows that, for a given air flow, the process according to the invention can be conducted in a shorter bed than the process according to the prior art. This leads to the use of smaller scale beds, so the problems with transport logistics are reduced.

However, the examples also show that the pressure drop during the regeneration step is increased when operating a three-bed system as compared to a two- or four-bed system. A twofold increased pressure drop was to be expected in view of the increased air flow and regeneration flow, but the pressure drop is even more pronounced. The correction of this pressure drop is simple to achieve by adding the required amount of gas. There is no evidence on file in the form of comparative examples or simulations or calculations showing that this increased pressure drop outweighs the advantages obtained by the reduction of the number of beds.

The comparative examples were done with three beds and related to the simulation with air, but the subject-matter of claim 1 is not limited to three beds. It needs to be established whether this example is representative for the whole scope of the claim. There are no reasons and no data showing that the increase in feed gas flow obtained by the process according to the invention for air compared to a process of the prior art cannot be obtained for other feed gases. It may be that the regeneration is more difficult for different components that may be present in a different feed gas, but there is no evidence that this would lead to an overall disadvantage that could not be offset by the benefit obtained (reduction in the number of beds) by the process according to the invention.

Respondent 1 alleged that the results shown in the patent as granted would not be obtained with a high number of beds and different bed sizes. These allegations are, however, not corroborated by facts, but are only speculations. There is no convincing reason why the problem would not be solved with a higher number of beds as long as the number of zones in the adsorption step is greater than "the number of zones not in the adsorption step" as required by the wording of claim 1.

In view of the lack of convincing counter-evidence, it is accepted that the problem is solved over the whole range claimed, independently of the type and pressure of the feed gas and of the type of components in the feed gas.

2.6 Obviousness

It needs to be established whether the solution to the problem is obvious in view of the prior art.

As indicated above, **D1** discloses a thermal swing process for recovering solvent from air. It relates to the efficient use of heat during such a process (D1: paragraph [0025]). It does not belong to the same field as D3 (removing at least carbon dioxide and water from feed gas to form a purified gas for subsequent cryogenic treatment). D1 is silent on design complexity and change in air flow when going from a two-bed system to a three-bed system. Therefore, the skilled person would not consider D1 when trying to find a solution to the posed problem.

D2 relates to high and low pressure streams. D2 does not teach a single adsorption step in which the feed gas is continuously fed to the adsorption zone. Applying the teaching of D2 to D3 would lead to a process as disclosed in D2. It appears evident from D2 that the presence of a high and a low pressure stream is essential in D2 (D2: claim 1; column 1, line 65 to column 2, line 5; column 4, lines 56 to 60). Thus, D2 does not suggest a solution to the posed problem.

D3 only relates to two beds of adsorbent which can be placed on-line in substitution for one another (D3: column 6, lines 60 and 61). D3 relates to the improvement of the adsorbent (D3: claim 1), says nothing about having three adsorption zones and does not provide any suggestion aiming at a change in the number of adsorption zones.

D5 relates to the removal of liquid hydrocarbon from natural gas, which is different from D3. D5 is silent about the posed problem so that the skilled person would not consider D5 when trying to find a solution to this problem.

Neither **D6** nor **D7** discloses a three-bed system.

The prior art does not teach that three parallel thermal swing adsorption zones comprising a single adsorption step in which the feed gas is fed continuously provide advantages over two.

The solution to the posed problem is not rendered obvious by the prior art.

2.7 The same reasoning can be applied to independent apparatus claim 21 and independent use claim 25.

2.8 The subject-matter of the claims thus fulfils the requirements of Article 56 EPC.

Order

For these reasons it is decided that:

1. The decision under appeal is set aside.

2. The patent is maintained as granted.

The Registrar: The Chairman:

C. Vodz G. Raths

Decision electronically authenticated