Internal distribution code:

(A) [-] Publication in OJ
(B) [-] To Chairmen and Members
(C) [-] To Chairmen
(D) [X] No distribution

Datasheet for the decision of 12 April 2018

Case Number: T 0959/16 - 3.3.06

Application Number: 10711104.9

Publication Number: 2411119

IPC: B01D53/04, B01D53/047, B01D53/30, C01B3/56

Language of the proceedings: EN

Title of invention:
CYCLIC ADSORPTION CONTROL METHOD AND CONTROLLER

Applicant:
Praxair Technology, Inc.

Headword:
Adsorption control method/Praxair

Relevant legal provisions:
EPC Art. 52(1), 54(3), 84, 111(1), 123(2)
RPBA Art. 13

Keyword:
Late-filed new Main Request - admitted (yes) - (filed in reaction to objections raised by the Board)
Amendments - allowable (yes) - Main Request
Novelty - (yes) - Main Request
Remittal to the department of first instance - (yes) - Main Request

Decisions cited:

Catchword:

Europäisches Patentamt
European Patent Office
Office européen des brevets

Beschwerdekammern

Boards of Appeal

Chambres de recours

Boards of Appeal of the
European Patent Office
Richard-Reitzner-Allee 8
85540 Haar
GERMANY
Tel. +49 (0)89 2399-0
Fax +49 (0)89 2399-4465

Case Number: T 0959/16 - 3.3.06

D E C I S I O N
of Technical Board of Appeal 3.3.06
of 12 April 2018

Appellant: (Applicant)	Praxair Technology, Inc. 39 Old Ridgebury Road Danbury, CT 06810 (US)
Representative:	Schwan Schorer & Partner mbB Patentanwälte Bauerstrasse 22 80796 München (DE)
Decision under appeal:	**Decision of the Examining Division of the European Patent Office posted on 3 November 2015 refusing European patent application No. 10711104.9 pursuant to Article 97(2) EPC.**

Composition of the Board:

Chairman	M. Maremonti
Members:	G. Santavicca
	C. Heath

Summary of Facts and Submissions

I. The appeal lies from the decision of the Examining Division of the European Patent Office, posted on 3 November 2015, refusing European patent application No. 10 711 104.9 pursuant to Article 97(2) EPC.

II. In the decision under appeal, which is based on the Main Request (amended Claims 1-3 and originally filed Claims 4-17) filed at the oral proceedings held on 3 November 2015, the Examining Division came to the conclusion that D5 (EP 2 111 905 A1) disclosed a process as defined in Claim 1 and a system as defined in Claim 10 of the pending Main Request, which consequently were not new (Article 54(3) EPC).

III. In its statement setting out the grounds of appeal, the Appellant essentially maintained that D5 did not disclose the feature that the actual on-stream time of the bed in adsorption mode was set due to an estimation of the on-stream time based on a measurement of the adsorbate/impurity concentration somewhere in the bed. Consequently, it submitted that the subject-matter of Claims 1 and 10 was novel over D5.

IV. In a communication in preparation for oral proceedings, the Board raised objections under Articles 84 and 123(2) EPC against the claims of the Main Request then pending, but considered the process of Claim 1 and the control system of Claim 10 to be novel over the disclosure of D5. The Board also indicated that it would be inclined to remit the case back to the Examining Division if a clearly allowable claim request was filed in reaction to the communication.

V. With its reply, dated 19 March 2018, the Appellant filed a new Main Request and First to Fifth Auxiliary Requests, allegedly addressing the objections raised by the Board in its communication.

VI. Oral proceedings were held on 12 April 2018. After a discussion of the claims (all pending claim requests) in respect of added subject matter under Article 123(2) EPC, the Appellant submitted a new set of claims entitled "Main Request of April 12, 2018" and withdrew all other claim requests. The issue of remittal was also briefly debated.

VII. The appellant finally requested that the decision under appeal be set aside and that a patent be granted on the basis of Claims 1 to 15 of the Main Request filed at 10:50 during the oral proceedings before the Board.

VIII. Claims 1 and 10 according to said Main Request filed at 10:50 on 12 April 2018 respectively read as follows:

"*1. A method of controlling an adsorbent bed unit comprising:*

measuring an adsorbent bed concentration of an impurity within an adsorbent bed of the adsorbent bed unit, the adsorbent bed adsorbing the impurity from a feed stream fed into the adsorbent bed, thereby to produce a product stream containing a product concentration of the impurity no greater than a targeted product concentration;

the adsorbent bed unit being operated in accordance with a cycle during which the feed stream is fed to the adsorbent bed and thereafter, the adsorbent within the adsorbent bed is regenerated through

desorption of the impurity, the cycle incorporating a feed cycle time during which the feed stream is introduced into the adsorbent bed, the impurity is adsorbed and the product stream is produced;

controlling the product concentration within the product stream by manipulating the feed cycle time employed within the adsorbed bed unit by a product purity controller responsive to data referable to the adsorbent bed concentration which calculates a control parameter that will set the feed cycle time employed within the adsorbent bed unit so that the adsorbent bed concentration is controlled by the control parameter to approach the targeted adsorbent bed concentration that will maintain the product concentration at a level no greater than the targeted product concentration, the control parameter being calculated so that the feed cycle time will decrease as the adsorbent bed concentration increases and will increase as the adsorbent bed concentration decreases;

wherein an adsorbent bed controller responsive to the control parameter calculated by the product purity controller controls valves within a flow circuit of the adsorbent bed unit such that the adsorbent bed unit is operated in accordance with the cycle during which the feed stream is fed to the adsorbent bed during the feed cycle time and thereafter, the adsorbent within the adsorbent bed is regenerated through desorption of the impurity; and

the adsorbent bed concentration being measured within the adsorbent bed, at a location thereof, at which the adsorbent bed concentration will change before the product concentration of the impurity within the product stream changes in response to a disturbance

so that controlling the adsorbent bed concentration to maintain the adsorbent bed concentration at the targeted adsorbent bed concentration will also maintain the product concentration of the impurity within the product stream at level no greater than the targeted product concentration."

"*10. A control system for an adsorbent bed unit comprising:*

a sampling portal located within an adsorbent bed of an adsorbent bed unit for sampling an adsorbent bed concentration of an impurity within the adsorbent bed, the adsorbent bed adsorbing the impurity from a feed stream fed into the adsorbent bed during a feed cycle time, thereby to produce a product stream containing a product concentration of the impurity no greater than a targeted product concentration;

a gas analyzer operatively associated with the sampling portal and configured to generate data referable to the adsorbent bed concentration;

a product purity controller responsive to the data and configured to calculate a control parameter that will set the feed cycle time employed within the adsorbent bed unit so that the adsorbent bed concentration will be controlled by the control parameter to approach a targeted adsorbent bed concentration that will maintain the product concentration of the impurity at the level no greater than the targeted product concentration, the control parameter calculated so that the feed cycle time decreases as the adsorbent bed concentration increases and increases as the adsorbent bed concentration

decreases;

the sampling portal being situated at a location of the adsorbent bed at which the adsorbent bed concentration will change before the product concentration of the impurity within the product stream changes in response to a disturbance so that controlling the adsorbent bed concentration to approach the targeted adsorbent bed concentration will also maintain the product concentration of the impurity within the product stream at a level no greater than the targeted product concentration; and

an adsorbent bed controller responsive to the control parameter calculated by the product purity controller and controlling valves within a flow circuit of the adsorbent bed unit such that the adsorbent bed unit is operated in accordance with a cycle during which the feed stream is fed to the adsorbent bed during the feed cycle time and thereafter, the adsorbent within the adsorbent bed is regenerated through desorption of the impurity."

Dependent Claims 2-9 and 11-15 respectively concern particular embodiments of the process according to Claim 1 and of the control system defined in Claim 10.

IX. The arguments of the Appellant of relevance for the present decision can be summarised as follows:

The final Main Request was filed in reaction to the objections raised respectively in the Board's communication and during the oral proceedings. It addressed/overcame all of the objections raised by the Board. Thus, it was admissible and clearly allowable.

The claimed subject-matter was novel over D5, as also acknowledged by the Board in its communication.

As inventive step had not yet been dealt with, the Appellant had no objections against a remittal to the Examining Division for further prosecution.

Reasons for the Decision

Main Request

Admissibility

1. The claims at issue were filed in response to and clearly overcome all of the Board's objections.

1.1 Hence, the Board decided to admit them into the proceedings despite their late filing (Article 13 RPBA).

Amendments – formal allowability

2. Article 84 EPC - Clarity and support by the description

2.1 The objected to inconsistency resulting from the amended feature "*the feed cycle time being ~~manipulated~~* ***calculated*** *so that ..*", raised in the Board's communication against Claim 1 according to the previous Main Request, is no longer present in Claim 1 at issue (see Point VIII, *supra*).

2.2 The Board holds that Claim 1 at issue now clearly expresses that the feed cycle time is manipulated by a product purity controller which calculates a control

parameter for setting the feed cycle time within the adsorbent, in line with the description.

2.3 Claims 1 and 10 at issue only use terms of art, described more particularly in the description, which are not objectionable under Article 84 EPC.

2.4 Hence, Claims 1 and 10 at issue are clear and supported by the description (Article 84 EPC).

3. Article 123(2) EPC

3.1 The claims at issue are not objectionable under Article 123(2) EPC, as they are fairly based on the application as filed, as follows:

3.2 Compared to Claim 1 as originally filed, Claim 1 at issue comprises the following additional features:

(1) "*by a product purity controller responsive to data referable to the adsorbent bed concentration which calculates a control parameter that will set the feed cycle time employed within the adsorbent bed unit*";

(2) "*is controlled by the control parameter to approach the*";

(3), "*the control parameter being calculated*"; and

(4) "*wherein an adsorbent bed controller responsive to the control parameter calculated by the product purity controller controls valves within a flow circuit of the adsorbent bed unit such that the adsorbent bed unit is operated in accordance with the cycle during which the feed stream is fed to the adsorbent bed during the feed cycle time and thereafter, the adsorbent within the*

adsorbent bed is regenerated through desorption of the impurity".

3.2.1 These added features are almost *verbatim* disclosed in paragraphs [0017] (features (1) to (3)) and [0018] (feature (4)) of the application as originally filed, which concern the most general disclosure of the process of use of the claimed control system, which are thus applicable to all of the embodiments of the invention as claimed, as also apparent from paragraphs [0012] (penultimate and last sentence), [0013] (first sentence) and [0015] (first and third sentence).

3.2.2 Hence, the process defined in Claim 1 at issue is directly and unambiguously disclosed in the application as originally filed.

3.3 Claim 10 at issue is identical to Claim 10 as originally filed.

3.4 Dependent Claims 2, 3, 4 and 5 correspond to original Claims 2 to 5 apart from the deletion of the features now added to/defined in Claim 1 at issue.
Dependent Claims 6 to 9 have the same wording of originally filed Claims 6 to 9.
Dependent Claims 11 and 12 are identical to originally filed Claims 11 and 12, respectively. Claim 13 is identical to the combination of originally filed Claims 13 and 14. Claim 14 is identical to Claim 15 as originally filed. Claim 15 is identical to the combination of Claims 16 and 17 as originally filed.

3.5 Therefore, the Board holds that the amended claims fulfil the requirements of Article 123(2) EPC.

Main Request - Novelty - Claim 1

4. Main Request - Novelty over D5 - Claim 1

4.1 D5, filed on 17 April 2009, but claiming the priority date of a national application filed on 21 April 2008, was published on 28 October 2009, i.e. after the priority date (25 March 2009) but before the filing date (12 March 2010) of the application at issue.

4.1.1 The content of D5 is identical to the content of its priority application, so that D5 enjoys its priority date as its effective filing date (Article 89 EPC).

4.1.2 The content of the application at issue is identical to the content of its priority application. Thus, all of the disclosed embodiments of the application at issue enjoy the priority date.

4.1.3 Consequently, D5 discloses prior art only opposable to the novelty of the claimed subject-matter under Article 54(3) EPC.

4.2 D5 (Claim 1) (underlining by the Board) discloses a cyclical swing adsorption process in which one adsorber bed is in an on-stream mode, during which adsorbate is adsorbed from a feed gas mixture passing through the bed, while another adsorber bed is in regeneration mode, during which the adsorbed adsorbate is desorbed from the bed, and said beds alternate between said modes, wherein
- the (actual) time required to complete the on-stream mode is determined by the total amount of the adsorbate in the feed gas mixture fed to the bed during said mode,
- the concentration of the adsorbate in the feed gas

mixture is monitored during said on-stream mode and the (remaining) time required to complete the on-stream mode predicted from said monitored concentration,
- and at least one regeneration mode operating condition is modified in response to changes in said (remaining) predicted time
whereby the regeneration mode is completed at the same time as the concurrent on-stream mode.

From this general disclosure of D5 the Board understands that the actual on-stream time of the adsorber is only a function of the total amount of adsorbate that reaches it and can be adsorbed by its bed (capacity), whilst the prediction (an estimation) of the on-stream time serves the purpose of controlling the regeneration time of the off-stream bed.

4.2.1 According to a preferred mode of D5 (Claim 2), the (given) time for completion of the on-stream mode is based on a datum concentration of the adsorbate in the feed gas mixture, and the predicted time for completion changes only when the monitored concentration exceeds said datum concentration to the extent that the predicated time exceeds said (given) time.

The Board understands from this preferred disclosure of D5 that its method includes the indication of any shortening of the estimated on-stream time arising from the concentration of the adsorbate in the feed gas stream exceeding the datum one. The latter concentration (datum) is the one on the basis of which the on-stream time was calculated, and is an assumed value (400 ppm in Claim 4) based on typical practice (Examples, page 9, paragraph [0055]). This serves the purpose of being able to run the adsorption system with a much longer on-stream time during most of the time

when the concentration remains the datum one. This understanding is in line with the disclosure of paragraphs [0022] (in particular last sentence) and [0026] of D5).

4.2.2 According to the detailed disclosure of the control method of D5 (paragraphs [0026], [0047], [0052] and [0053], respectively),

- "The present invention provides control of a swing adsorption system so that the system can be operated under optimal conditions for the normal concentration of adsorbate in the feed gas but the regenerated bed made available for use more quickly than normal to accommodate for a reduced on-stream time resultant from increased adsorbate concentration above the normal level. This is achieved by continuous or continual determination of adsorbate concentration of the feed gas, calculating from the resultant data an estimate of the on-stream time that will be achieved and automatically varying the purge flow or other operational parameters for the bed being regenerated so that it will have reached the required level of regeneration when the on-stream bed is saturated";

- "A flow controller 32 is provided in the purge gas feed 27 to measure and control the flow of purge gas to the inlet 22. The flow controller 32 receives a control signal from a processor 33, which provides also a control signal to a heat sequencer 34 for controlling the heating of the purge gas. A carbon dioxide sensor 35 located downstream of the separator 3 provides input to the processor 33 proportional to the carbon dioxide concentration in the cleaned air feed to the adsorber beds."

- "The processor 33 estimates from the carbon dioxide concentration data from sensor 35 the time required to complete the on-stream step. If the estimated on-stream time decreases, the process controls the flow controller to increase the purge flow, and optionally the heater temperature and/or heater operational time, so that the heat pulse is pushed through the off-stream bed quicker and the bed cooled quicker so that it is fully regenerated in time to go back on-line. If the conditions change such that the estimated on-stream time increases, then the processor reduces the purge flow, and optionally the heater temperature and/or heater operational time, saving energy.", and

- "The present invention significantly improves efficiency by measuring adsorbate concentration in the feed gas entering the on-stream bed and processes the resultant information to control the purge flow to the off-stream bed.",

From this further disclosure of D5, the Board understands that the continuously **measured** parameter is the concentration of the target impurity in the feed stream (to the on-stream bed), which is input into a processor that **calculates** an estimated on-stream time (remaining time until bed saturation), and, in response to an increase/decrease of the estimated on-stream time, an operating condition of the **purge** flow (to the **off-stream bed**) is **controlled**, so that any mismatch between on-stream time and regeneration time is effectively prevented, while saving energy.

4.2.3 It follows from the above analysis that none of the embodiments directly and unambiguously defined in the claims or illustrated in the examples of D5 discloses the feature of Claim 1 at issue

"*measuring an adsorbent bed concentration of an impurity within an adsorbent bed of the adsorbent bed unit, the adsorbent bed adsorbing the impurity from a feed stream fed into the adsorbent bed*".

4.3 However, as also acknowledged in the decision under appeal, D5 (paragraphs [0030], [0031] and [0043]) also mentions variants wherein the concentration of the adsorbate is not (only) monitored by measurement in the feed gas mixture upstream the on-stream adsorber but can be monitored by measurement
- also in the on-stream adsorber bed, or
- only in the on-stream adsorber bed.

4.3.1 Although D5 discloses that the measure carried out within the adsorbent would permit a more accurate estimation of the on-stream time, it nevertheless stresses that,
- suitably the outlet concentration of adsorbate is used to verify the correctness of the estimation of the on-stream time and that no adsorbate exits in the bed,
- hence the measurement at the outlet can be used to feed back to the on-stream time estimator software for making corrections to the **predictions**.

It is not apparent to the Board from this particular disclosure of D5 that the measurement in the on-stream bed, or close to its outlet, is for controlling the actual on-stream time of the on-stream bed adsorber.

4.3.2 Indeed, D5 (paragraph [0032]) directly and unambiguously discloses that any such measured change in adsorbate concentration activates, in response thereto, a modification of at least one regeneration mode operating condition such as:
- the flow rate of the purge gas, and/or

- the temperature of that gas, and/or
- the regeneration heating time for TSA, or the
- shortening of the PSA cycle time to gain capacity.

4.4 It follows from the above analysis of the particular embodiments of D5 in which the concentration of the adsorbate is also or only measured in the on-stream adsorber (or close to its outlet) that, also in these particular embodiments of D5, the monitored/measured operating condition is the concentration of the adsorbate in the (feed/bed) gas stream and in response to a change in the datum concentration in the gas stream (upstream and/or in the on-stream bed), (at least one of the mentioned conditions affecting) the regeneration time (of the off-stream bed) is manipulated (i.e. controlled), so that it matches the completion time of the on-stream adsorption step of the on-stream adsorber. The feed cycle time (i.e. the actual on-stream time) of the on-stream adsorber (which according to D5 is still only determined by the total amount of impurity arriving at the on-stream adsorbent bed) is thereby not controlled.

4.5 Therefore, for the Board, D5 at least does not directly and unambiguously discloses the following features of Claim 1 at issue:

"*controlling the product concentration within the product stream by manipulating the feed cycle time employed within the adsorbent bed unit by a product purity controller responsive to data referable to the adsorbent bed concentration which calculates a control parameter that will set the feed cycle time employed within the adsorbent bed unit so that the adsorbent bed concentration is controlled by the control parameter to approach the targeted adsorbent bed concentration that*

will maintain the product concentration at a level no greater than the targeted product concentration, the control parameter being calculated so that the feed cycle time will decrease as the adsorbent bed concentration increases and will increase as the adsorbent bed concentration decreases".

4.6 In other words, D5, discloses a control of the actual **regeneration** cycle time of the **off-stream bed**, so that on-stream and regeneration times (each running in a different bed) are matched (see paragraph [0028] of D5) (hence, a control among a plurality of bed cycles), on the basis of an **estimated** time, possibly calculated from the adsorbate concentration within or at the outlet of the on-stream bed. However, D5 does not disclose a method as claimed, which instead concerns the control of the **actual feed** cycle time of the **on-stream adsorber** on the basis of the adsorbate concentration continuously measured within the on-stream bed (a control within the same bed cycle), in order to lengthen the adsorption cycle as much as possible, in order to increase the production rate of the on-stream adsorber.

4.7 Therefore, for the Board, D5 does not directly and unambiguously disclose a method of controlling an adsorbent bed unit as defined in Claim 1 at issue. The subject-matter of Claim 1 at issue is thus novel over D5 (Articles 52(1) and 54(3) EPC).

Main Request - Novelty - Claim 10

5. As regards the novelty of apparatus Claim 10, not acknowledged in the decision under appeal, the Board notes the following:

5.1 D5 (Claim 11) discloses a cyclical swing adsorption apparatus for carrying out its process, the apparatus including:
- a control circuit for maintaining one bed in an on-stream mode for a time determined by total amount of adsorbate in the feed gas mixture fed to the bed during said mode,
- a total adsorber sensor for measuring the total amount of the adsorbate in the feed gas mixture fed to the bed during the on-stream mode, thereby determining the (actual) duration of the on-stream mode (see also page 5, lines 1-2),
- a concentration monitor for monitoring the concentration of the adsorbate in the feed gas mixture during said on-stream mode, and
- a processor for predicting, from said monitored concentration, the (remaining) time required to complete the on-stream mode,
said control circuit modifying at least one regeneration mode operating condition in response to changes in said predicted time whereby the regeneration mode is completed at the same time as the concurrent on-stream mode.

5.2 None of the apparatus embodiments defined in the claims or illustrated in the examples of D5 directly and unambiguously discloses the feature of Claim 10 at issue
"*a sampling portal located within an adsorbent bed unit for sampling an adsorbent bed concentration of an impurity within the adsorbent bed, ...*".

5.3 If this feature were considered to be implicit from the disclosure on paragraph [0030] of D5, mentioning the option of measuring the concentration of the adsorbate in the on-stream bed, then D5 nevertheless does not

disclose the features

"*a gas analyzer operatively associated with the sampling portal and configured to generate data referable to the adsorbent bed concentration*",

let alone the features

"*a product purity controller responsive to the data and configured to calculate a control parameter that will set the feed cycle time employed within the adsorbent bed unit so that the adsorbent bed concentration will be controlled by the control parameter to approach a targeted bed concentration that will maintain the product concentration of the impurity at the level no greater than the targeted product concentration, ...* ".

5.4 Thus, also the claimed control system as defined in Claim 10 at issue is not disclosed by D5, and is consequently novel over D5 (Articles 52(1) and 54(3) EPC).

Remittal

6. The Main Request is admissible into the proceedings (Article 13 RPBA) and its claimed subject-matter complies with the requirements of Articles 84 and 123(2) EPC, and is also novel over the disclosure of D5.

6.1 However, outstanding patentability requirements such as inventive step have not been dealt with in the decision under appeal, so that there is no decision to review in this respect.

6.2 Therefore, the Board (has) decided to remit the case back to the Examining Division for further prosecution (Article 111(1) EPC).

Order

For these reasons it is decided that:

1. The decision under appeal is set aside.

2. The case is remitted to the Examining Division for further prosecution.

The Registrar: The Chairman:

D. Magliano M. Maremonti

Decision electronically authenticated