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Case Number: T 1631/09 - 3.3.06

Application Number: 01130247.8

Publication Number: 1219337

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Language of the proceedings: EN

Title of invention:
Hydrogen production by pressure swing adsorption using a layered absorbent bed

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:
Hydrogen production by PSA/AIR PRODUCTS

Relevant legal provisions:
-

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

Keyword:
"Inventive step: yes"

Decisions cited:
-

Catchword:
-

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Case Number: T 1631/09 **-** 3.3.06

D E C I S I O N
of the Technical Board of Appeal 3.3.06
of 20 April 2012

Appellant: (Patent Proprietor)	AIR PRODUCTS AND CHEMICALS. INC. 7201 Hamilton Boulevard Allentown, PA 18195—1501 (US)
Representative:	Sommer, Andrea Westendorp / Sommer Uhlandstrasse 2 D-80336 München (DE)
Respondent I: (Opponent I)	L'AIR LIQUIDE, SOCIETE ANONYME POUR L'ETUDE ET L'EXPLOITATION DES PROCEDES GEORGES CLAUDE 75, Quai d'Orsay F-75007 Paris (FR)
Representative:	Beroud, Amandine L'AIR LIQUIDE S.A. Direction de la Propriété Intellectuelle 75 Quai d'Orsay FR-75321 Paris Cedex 07 (FR)
Respondent II: (Opponent II)	Linde AG Abraham—Lincoln-Strasse 21 D-65189 Wiesbaden (DE)
Representative:	Zahn, Christoph Linde AG Patente und Marken Dr -Carl-von-Linde—Strasse 6-14 D-82049 Pullach (DE)
Decision under appeal:	**Decision of the Opposition Division of the European Patent Office posted 4 May 2009 revoking European patent No. 1219337 pursuant to Article 101(3)(b) EPC.**

Composition of the Board:

Chairman: P.-P. Bracke
Members: P. Ammendola
U. Tronser

Summary of Facts and Submissions

I. This appeal is from the decision of the Opposition Division to revoke European patent No. 1 219 337 concerning the production of hydrogen by pressure swing adsorption (hereinafter PSA) using a three-layer adsorbent bed.

II. The claims of the European patent as granted were as originally filed. In particular, claims 1, 13 and 27 read as follows:

"*1. A pressure swing adsorption apparatus comprising at least one bed containing at least three layers:*

a feed-end layer containing a feed-end adsorbent having a first surface area sufficiently small to separate a heavy hydrocarbon having at least six carbons from a light hydrocarbon having less than six carbons, wherein said first surface area is too small to substantially separate methane from hydrogen;
a product-end layer containing a product-end adsorbent having a second surface area sufficiently large to separate methane from hydrogen; and
an intermediate layer containing an intermediate adsorbent having an intermediate surface area intermediate to said first surface area and said second surface area."

"*13. A process for providing purified hydrogen, said process comprising:*

providing an apparatus according to claim 1;
feeding into a feed end of said apparatus a feed gas mixture containing hydrogen and heavy hydrocarbons having at least six carbons; and
recovering from a product end of said apparatus a product gas containing at least 95% hydrogen."

"*27. The process of claim 13, wherein said feed-end adsorbent occupies 2% to 20% of a total length of said at least one bed, said intermediate adsorbent occupies 25% to 40% of said total length, and said product-end adsorbent occupies 40% to 73% of said total length.*"

The granted claims 2 to 12 defined preferred embodiments of the apparatus of claim 1, whereas the remaining granted claims defined preferred embodiments of the process of claim 13.

III. The grant of the patent-in-suit had been opposed by two Opponents, *inter alia*, on the grounds of Articles 100(a) EPC 1973 (novelty and inventive step). They referred to, *inter alia*, the documents:

(1) = Chlendi, M. and Tondeur, D., *Gas.Sep.Purif.*, (1995) 9(4) 231-242;

and

(6) = Malek, A. and Farooq, S., *AIChE Journal*, (1998) 44(9) 1985-1992.

IV. During the opposition proceedings the Patent Proprietor had filed, *inter alia*, a set of fourteen claims labelled as 1st Auxiliary Request.

Claim 1 of this 1st Auxiliary Request read:

"*1. A process for providing purified hydrogen, said process comprising:*

providing a pressure swing adsorption apparatus comprising at least one bed containing at least three layers:

a feed-end layer containing a feed-end adsorbent having a first surface area sufficiently small to separate a heavy hydrocarbon having at least six carbons from a light hydrocarbon having less than six carbons, wherein said first surface area is too small to substantially separate methane from hydrogen;
a product-end layer containing a product-end adsorbent having a second surface area sufficiently large to separate methane from hydrogen; and
an intermediate layer containing an intermediate adsorbent having an intermediate surface area intermediate to said first surface area and said second surface area,

and wherein said feed-end adsorbent occupies 2% to 20% of a total length of said at least one bed, said intermediate adsorbent occupies 25% to 40% of said total length, and said product-end adsorbent occupies 40% to 73% of said total length,

feeding into a feed end of said apparatus a feed gas mixture containing hydrogen and heavy hydrocarbons having at least six carbons; and recovering from a product end of said apparatus a product gas containing at least 95% hydrogen."

The remaining claims 2 to 14 of this request defined preferred embodiments of the process of claim 1.

The Opposition Division, after having refused the higher ranking requests of the Patent Proprietor, considered that the above-cited claim 1 of the 1st Auxiliary request corresponded to claim 27 as originally filed and granted (see above section II of the Facts and Submissions) and that its subject-matter was novel. However, the process of this claim was found obvious for a skilled person that aimed at recovering hydrogen from cracked gas mixtures containing traces of hydrocarbons with at least six carbon atoms (hereinafter **H2/C6+ mixtures**) and that started from the teaching in document (6) to use a three-layered bed comprising activated alumina, silica gel and activated carbon (hereinafter this embodiment of the prior art is indicated as the **ASC bed of document (6)**). In particular, the Opposition Division considered that the skilled person would have arrived at the subject-matter of claim 1 of this request by simply adjusting the

relative fill fractions for the three layers of the ASC bed of document (6) so as to optimize the separation for any given feed composition.

Hence, the Opposition Division concluded that, even taking into account the amendments made by the Patent Proprietor during the opposition proceedings, the patent-in-suit did not fulfil the requirements of the EPC.

V. The Patent Proprietor (hereinafter Appellant) lodged an appeal against this decision (notice of appeal and appeal fee received at the EPO on 3 July 2009, grounds of appeal received at the EPO on 14 September 2009). It filed with the grounds of appeal a set of twenty-one claims labelled as Main Request as well as a diagram labelled as "D17" reporting simulation data.

Claim 1 of the Main Request reads:

"*1. Use of a pressure swing adsorption apparatus for the production of hydrogen from cracked gas streams containing at least C_6 hydrocarbons comprising at least one bed containing at least three layers:*

a feed-end layer containing a feed-end adsorbent having a first surface area sufficiently small to separate a heavy hydrocarbon having at least six carbons from a light hydrocarbon having less than six carbons, wherein said first surface area is too small to substantially separate methane from hydrogen;

a product-end layer containing a product-end adsorbent having a second surface area sufficiently large to separate methane from hydrogen; and
an intermediate layer containing an intermediate adsorbent having an intermediate surface area intermediate to said first surface area and said second surface area, and

wherein said feed-end adsorbent occupies 2% to 20% of a total length of said at least one bed, said intermediate adsorbent occupies 25% to 40% of said total length, and said product-end adsorbent occupies 40% to 73% of said total length."

Claims 2 to 7 are directed to preferred embodiments of the "*apparatus*" (sic) defined in claim 1.

Claim 8 reads:

"*8. A process for providing purified hydrogen from cracked gas streams containing at least C_6 hydrocarbons, said process comprising:*

providing an apparatus as defined in the use of claim 1; and feeding into a feed end of said apparatus a feed gas mixture containing hydrogen and heavy hydrocarbons having at least six carbons; and recovering from a product end of said apparatus a product gas containing at least 95% hydrogen."

The remaining claims 9 to 21 of this request are a renumbered version of the claims 2 to 14 of the 1st Auxiliary Request considered by the Opposition Division.

Opponent I (hereinafter Respondent I) replied disputing the compliance of this request with Articles 84 and 56 EPC. In particular clarity objections were directed to the manifest lack of consistency between the "*use*" claim 1 and the "*apparatus*" claims 2 to 7, as well as to the fact that claim 8 referred to an "*apparatus as defined in claim 1*" even though claim 1 defined a "*use*".

Opponent II (hereinafter Respondent II) in its reply only disputed the presence of an inventive step for the subject-matter of the Main Request filed with the grounds of appeal.

VI. In a letter dated 15 March 2012, also containing further simulation data, the Appellant filed as Main Request a set of twenty-one amended claims differing from the previous Main Request (i.e. that filed with the grounds of appeal) only in that the claims 2 to 7 had been amended to define preferred embodiments of the "*use*" of claim 1 and in that in claim 8 the wording "*an apparatus as defined in claim 1*" had been amended into "*an apparatus as defined in the use of claim 1*".

VII. Oral proceedings took place on 20 April 2012.

The Appellant requested that the decision under appeal be set aside and the patent be maintained on the basis of a **New Main Request** filed at the oral proceedings.

The Respondents requested that the appeal be dismissed.

Claims 1 of the New Main Request only differs from that of the corresponding claim of the Main Request filed with letter of 15 March 2012 (and, thus, also from the identically worded claim 1 filed with the grounds of appeal) in that the final wording reading:

" *second surface area, and*

wherein said feed-end adsorbent occupies 2% to 20% of a total length of said at least one bed, said intermediate adsorbent occupies 25% to 40% of said total length, and said product-end adsorbent occupies 40% to 73% of said total length."

has been replaced by:

" *second surface area,*

wherein said feed-end adsorbent occupies 2% to 20% of a total length of said at least one bed, said intermediate adsorbent occupies 25% to 40% of said total length, and said product-end adsorbent occupies 40% to 73% of said total length, and

recovering from a product end of said apparatus a product gas containing at least 95% hydrogen."

Claims 2 to 15 of the New Main Request are respectively identical to the corresponding claims filed with letter of 15 March 2012.

VIII. The Appellant's arguments presented in writing and orally may be summarised as follows:

The New Main Request, similarly to the two Main Requests previously filed in the appeal proceedings (i.e. those enclosed to the grounds of appeal and to the letter of 15 March 2012), defined by means of use and process claims substantially the same subject-matter of the process claims of the 1st Auxiliary Request refused by the Opposition Division. Hence, the New Main Request represented no substantial change of the Appellant's case and could not possibly have taken by surprise the Respondents. Thus, the New Main Request was admissible even if filed at the oral proceedings.

In the opinion of the Appellant, the simulation data provided with the grounds of appeal as well as those described in the letter of 15 March 2012 proved that the subject-matter of the claims of the New Main Request resulted in optimal recovery of hydrogen from H2/C6+ mixtures even when the composition of the feed gas varied over a wide range. The objections as to the correctness of these data only raised by Respondent II at the hearing, were to be rejected by the Board as belated. Moreover, they were deprived of any supporting evidence.

Hence, it had been proved that the ASC bed with the fill fractions indicated in claim 1 or 8 of the New

Main Request was optimized for recovering hydrogen from H2/C6+ mixtures.

The Appellant rejected the Respondents' argument that the claimed subject-matter resulted from the conventional optimizations - also by means of well-known computer simulations - of the fill fractions in the ASC beds, by stressing that:

i) contrary to the unsupported allegations of Respondent II as to an allegedly already conventional use of ASC beds in PSA processes, document (6) was the only citation mentioning the use of this kind of three-layer beds for hydrogen purification;

ii) the Respondents had provided no evidence as to the existence in the prior art of the adsorption data required for carrying out a reliable simulation, in particular no evidence of available reliable data for predicting the adsorption by activated alumina under PSA conditions of the heavy hydrocarbons possibly present in H2/C6+ mixtures;

iii) the Respondents had provided no evidence as to the nature and the reliability of the simulation programs possibly existing in the prior art;

and

iv) the Respondents had provided no evidence that by using any of such (allegedly already existing) simulation programs and adsorption data the skilled person would have arrived at the fill fraction ranges

found to be optimal by the inventors of the patent-in-suit.

In any case a skilled person aiming at a process optimized for recovering hydrogen from H2/C6+ mixtures would not have started from the ASC bed of document (6), because this embodiment of the prior art was only disclosed as suitable for purifying hydrogen from mixtures additionally containing water and light hydrocarbons or no hydrocarbons at all. Nor would this disclosure render predictable any substantial contribution of the activated alumina to the adsorption of C6+ hydrocarbons.

The Appellant conceded that the skilled person aiming at solving the posed technical problem could have started from the general teaching in document (6) as to the use of a two-layer bed made of silica gel and activated carbon (hereinafter **the SC bed of document (6)**), but concluded that neither this citation nor the remaining available prior-art would have motivated the skilled person to increase the fill fraction of the silica gel layer (hereinafter **S layer**) above the 24,5 % level disclosed in the sole example of SC bed specifically disclosed in document (6) while simultaneously adding an activated alumina layer (hereinafter **A layer**), i.e. thereby inevitably also substantially reducing the fill fraction of the activated carbon layer (hereinafter **C layer**). In the opinion of the Appellant the skilled person would in no case consider obvious to reduce the fill fraction of the C layer, as this latter was the adsorbent required for removing the most abundant impurity, i.e. methane.

IX. The Respondents' arguments may be summarised as follows:

The Respondent I acknowledged that the Appellant's Main Request filed with the grounds of appeal, although apparently deriving from a change of category of granted "*apparatus*" claims into "*use*" claims, was nevertheless fundamentally not different from the 1st Auxiliary Request (only comprising "*process*" claims) refused by the Opposition Division. Hence, this Party considered that also the subject-matter of the present process (and use) claims lacked of inventive step for substantially the same reasons indicated in the decision under appeal in respect of the then pending 1st Auxiliary Request. In particular, the claimed subject-matter just resulted from the routine optimization of the fill fractions of the three layers present in the ASC bed of document (6), in view of the specific composition of the H2/C6+ mixtures to be used as feed.

Substantially the same reasoning was submitted by Respondent II, who however additionally argued at the oral proceedings that the use of ASC beds for producing hydrogen would be well established in the prior art and that adsorption data and simulation programs were available to the skilled person and conventionally used to calculate the fill ratios for PSA beds. Hence, the claimed uses and processes were just the result of conventional optimization by means of well-known computer simulations of the layer fill fractions in the already conventional ASC beds, so as to take into account the specific impurity contents of the H2/C6+ mixtures.

At the oral proceedings Respondent II also disputed the correctness and the sufficiency of the simulation data reported in the letters filed by the Appellant in the appeal proceedings.

Finally, Respondent II also argued at the hearing that the claimed subject-matter according to the New Main Request was obvious even if the skilled person would have started from the SC bed embodiment of document (6), as defined in its more general form at page 1992 of this citation (left column, lines 9 to 26). To arrive at the subject-matter claimed in the New Main Request only required the skilled person to take into account the additional teaching e.g. at page 232 of document (1) (left column, lines 14 to 24), as to the use in PSA processes of an initial A layer to adsorb condensibles.

Reasons for the decision

Appellant's New Main Request

1. Admissibility of the request at the oral proceedings.

The Appellant has filed its final request at the oral proceedings before the Board (see above section VII of the Facts and Submissions).

As correctly observed by the Appellant and undisputed by the Respondent II (present at the hearing), this request corresponds to a sequence of use and process claims whose subject-matter is substantially equivalent to that of the process claims of the 1st Auxiliary

Request refused by the Opposition Division (see above section IV of the Facts and Submissions) as well as to the subject-matter of the use and process claims of the Main Request filed with the grounds of appeal (see above section VI of the Facts and Submissions). It may be stressed that also Respondent I has acknowledged in its written submissions that the subject-matter of the combination of use and process claims forming the Main Request filed with the grounds of appeal was not different from that of the process claims forming the 1st Auxiliary Request refused by the Opposition Division.

The Board notes, in particular, that the New Main Request apparently only differs from the Main Request filed with the grounds of appeal:

a) in the additional indication in claim 1 of the New Main Request of the hydrogen content in the product gas, so as to render the "*use*" according to this claim substantially equivalent to the "*process*" of claim 1 of the 1st Auxiliary Request refused by the Opposition Division and, thus, also substantially equivalent to the "*process*" of claim 27 as originally filed and granted (and, hence, also to the "*process*" of claim 8 of the same New Main Request),

and

b) in the amendment of claims 2 to 7 (from "*apparatus*" claims) into "*use*" claims that define preferring embodiments of the "*use*" of claim 1 (i.e. the amendments necessary at removing the apparent errors in the wording of these claims objected to by the

Respondent I in its reply to the grounds of appeal), as well as in the additional self-explanatory clarification that the apparatus to be provided in the process of claim 8 is as defined "*in the use*" of claim 1.

Hence, the Board concludes that the filing of this request at the hearing does not amount to any substantial change of the Appellant's case in respect of the set of claims of the 1st Auxiliary Request refused by the Opposition Division and of that filed with the grounds of appeal.

Therefore, the Board decides to admit the New Main Request into the appeal proceedings.

2. The Board notes that none of the clarity objections initially raised by Respondent I (against the set of claims of Main Request filed with the grounds of appeal) is still applicable to the present New Main Request. In particular, the objection according to which there would be an inconsistency in the fact that claim 8 of the Main Request filed with the grounds of appeal referred to an "*apparatus*" as defined in claim 1 although claim 1 defined a "*use*" is rendered irrelevant already because of the clarification added in claim 8 of the New Main Request that the apparatus to be provided in the claimed process is as defined "*in the use*" of claim 1. Hence, the Board is satisfied that the set of claims of the New Main Request complies with Article 84 EPC (1973).

3. Also in view of the above considerations the Board comes to the conclusion that the claims of this request comply with Articles 123(2) and (3) EPC as well.

No argument to the contrary has been presented by Respondent II at the hearing and none of the objections submitted in writing by the Respondent I is relevant in these respects. Hence, no further details need to be given on the reasons of this finding.

4. The Board is also satisfied that the subject-matter of the claims of this request is novel.

Since at the oral proceedings the Respondent II has withdrawn the novelty objection raised (for the first time) at the beginning of the hearing, and since the Respondent I has raised in writing no novelty objection against the set of claims filed with the grounds of appeal (whose subject-matter encompasses that of the claims of the present New Main Request), no further details need to be given in this respect as well.

5. Inventive step: claim 1

5.1 This claim is directed to the use of a PSA apparatus for the conversion of H2/C6+ mixtures into (gaseous) hydrogen with at least 95% purity, whereby the apparatus contains a feed-end adsorbent layer (e.g. an A layer) with a surface area sufficiently small to separate hydrocarbons with at least six carbons from lighter hydrocarbon, an intermediate layer (e.g. a S layer) with an intermediate surface area and a product-end adsorbent layer (e.g. a C layer) with a surface area sufficiently large to separate methane from

hydrogen. The claim requires the fill fractions of the feed-end layer, the intermediate layer and the product-end layer to be, respectively, 2% to 20%, 25% to 40% and 40% to 73% of the total bed length.

5.2 The patent-in-suit addresses the technical problem of optimizing the recovering of hydrogen from H2/C6+ mixtures (see the paragraphs [0001], [0005], [0011] and [0014]).

5.2.1 The Board notes that document (6) is acknowledged as relevant prior art in paragraph [0010] of the patent-in-suit and addresses, *inter alia*, the same technical problem as the patent-in-suit. Indeed, even though this citation does not explicitly mention the presence of hydrocarbons with at least six carbon atoms in the gas feed used in the specific simulations and experiments reported therein, it nevertheless acknowledges the presence in refinery fuel gas of traces of higher molecular weight hydrocarbons "*such as butane and aromatics*" (emphasis added by the Board) capable of irreversibly degrading the adsorbent capacity of the C layer (see in document (6), page 1985, the paragraph bridging the two columns, emphasis added by the Board) and gives in the upper part of the left column of page 1992 the general teaching on SC beds, by stating:

"*As discussed earlier, butane adsorption on activated carbon is almost irreversible … Thus, a proper way of operating the H_2-PSA system for treatment of refinery fuel gas is to ensure the containment of the butane (and of other heavier molecular weight hydrocarbons) within the silica gel section and the methane front (and, hence, the other hydrocarbon components) within*

the activated carbon section." (emphasis added by the Board).

The only specific example in document (6) providing information as to the fill fraction of the layers in a SC bed is that depicted in Figure 1, wherein the S layer constitutes 24.5% of the bed length.

5.2.2 The Opposition Division and Respondent I have instead considered more relevant for the assessment of inventive step another disclosure also contained in document (6), i.e. that referring to the simulation of an industrial system operated in Singapore and based on a three-layer ASC bed.

However, the Board notes that this disclosure relates to the purification of hydrogen from mixtures **not** containing heavy hydrocarbons, as apparent from the disclosure at page 1989, lines 2 to 21, that:

"*The … PSA process in operation at a refinery in Singapore utilizes three different adsorbents, namely, activated alumina, silica gel, and activated carbon. The activated alumina layer is used essentially to remove water … Hydrocarbon constituents in the feed streams other than C_1-C_4 are ignored in this study since they are present in trace amounts, if at all*." (emphasis added by the Board).

Hence, the ASC bed appears only disclosed in document (6) in connection with a simulation made under the assumption that hydrocarbons with more than four carbon atoms were likely to be totally absent in the industrial process taking place at Singapore.

Thus, the ASC bed of document (6) does **not** address the same technical problem addressed in the patent-in-suit and, therefore, represents a less relevant prior art for the skilled reader of this citation as a whole.

5.2.3 Accordingly, the Board concludes that the above-identified general teaching on SC beds of document (6), exemplified in a SC bed wherein the S layer constitutes 24.5% thereof, represents a more reasonable starting point for the assessment of inventive step.

5.3 As to the problem credibly solved by the use of present claim 1 vis-à-vis this prior art, the Board notes that the Respondent I has not disputed in its written submissions the Appellant's written statements (in the grounds of appeal and in the letter of 15 March 2012) that the provided simulation data demonstrated over a wide range of feed compositions the results already reported in the patent examples as to a maximized recovery of hydrogen from H2/C6+ mixtures. The essence of the reasoning of Respondent I is rather that the fill fractions of the ASC apparatus of the patent-in-suit are just the result of a conventional adaptation of the fill fractions of the adsorption layers (in the ASC bed of document (6)) depending on the quantities of the components of the feed mixture that need to be removed. Hence, the arguments presented by this Party certainly do not imply that the claimed subject-matter provides results that are appreciably worse than those provided e.g. by the SC bed of the prior art with a S layer of 24.5%.

At the oral proceedings Respondent II has disputed for the first time the sufficiency of these simulation data. However, this objection of Respondent II implies at most that some of the beds according to the claimed use are not optimal for certain possible compositions of the H2/C6+ mixtures. Since the same reasoning would necessarily apply also to any reduction into practice of the general teaching on SC beds provided in document (6) (inclusive of the actually exemplified SC bed with 24.5% S layer) it is apparent that also the Respondent II's objection does not imply that the claimed subject-matter provides worse results than the SC bed of departure.

Hence, the Respondents' lines of argument appears to explicitly or implicitly acknowledge that the use of the three-layer apparatus with the fill factions indicated in claim 1 of the New Main Request may at least represent **an alternative to the SC bed of the prior art.**

The Board has therefore found unnecessary to arrive at a conclusion as to whether the simulation data provided by the Appellant are or not sufficient at rendering credible that the claimed use is specifically optimized for H2/C6+ mixtures and, thus, superior to the prior art of departure. Indeed, even if it is assumed, for the sake of an argument in favour of the Respondents, that the claimed subject-matter only represents an alternative to the prior art, still the available evidence is found by the Board, for the reasons indicated here below, manifestly insufficient at rendering credible that it would have been obvious for

the skilled person to arrive at the claimed subject-matter.

5.3.1 As a matter of fact, the skilled person searching for an alternative to the SC bed of document (6) for purifying H2/C6+ mixtures would only arrive in an obvious manner to the presently claimed subject-matter in the presence of some indications that an A layer could be at least as effective as the S layer in reversibly adsorbing at least some of the heavy and light hydrocarbons (other than methane) expected in cracking gas mixtures.

However, no such suggestion is contained in any of the available citations.

In particular, whereas document (6) explicitly states that the S layer is apt at reversibly adsorbing butane or higher hydrocarbons, the same is not disclosed for the A layer in any of the cited documents.

The Board wishes to stress that the explicit instruction contained in document (1) as to the fact that an A layer is as suitable as a S layer for adsorbing "*condensibles*" (see in document (1), page 232, left column, lines 14 to 24, reading "*Typically, the first layer to be percolated by feed gas is* ***alumina or silica gel****, and this adsorbs essentially water and condensibles, the second layer is active carbon and adsorbs hydrocarbons, …*" emphasis added by the Board) does not appear to necessarily refer to condensibles that are also "*hydrocarbons*", as these latter are explicitly stated in the same passage to be adsorbed by the active carbon.

Hence, the skilled person would have expected that the use of an additional A layer, as that present in the ASC bed also disclosed in the same document (6), would inevitably result in a decrease in the capacity of the SC bed in reversibly adsorbing hydrocarbon impurities.

Under these circumstances the person skilled in the art, who is searching for an alternative to the SC bed for purifying feed mixtures containing C6+ impurities, would have no reason to (partially or completely) replace any of the two layers already present therein by an A layer.

5.3.2 The Board considers it appropriate to stress that the Respondent II has provided no evidence in support of its allegation, disputed by the Appellant, that ASC bed were already conventionally used in the prior art for PSA purification of cracked gas mixtures containing heavy hydrocarbons.

Nor has Respondent II provided any evidence in support of its allegation, disputed by the Appellant, that already the adsorption data known to the skilled persons would have rendered apparent that an A layer could be at least as efficient as a S layer in reversibly adsorbing any of the hydrocarbon impurities normally present in H2/C6+ mixtures.

Under these circumstances the Board concludes that the citations provided by the Respondents do not render credible that the skilled person would have explored (either by means of experiments or computer simulations) the possibility of using an ASC bed in

replacement of the SC bed used in document (6) for H2/C6+ mixtures.

Accordingly, the subject-matter of claim 1 of the New Main Request has not been proved to be obvious in view of the available prior art and, thus, is found to comply with Article 56 EPC (1973).

6. Inventive step: claims 2 to 15.

Claims 2 to 7 of the New Main Request define preferred embodiments of the use of claim 1. Hence, their subject-matter is found to comply with Article 56 EPC (1973) for the same reasons indicated above for claim 1.

The process of claim 8 of the New Main Request is substantially the same as the use described in claim 1. Hence the reasons indicated above for finding this latter to comply with Article 56 EPC (1973) apply similarly to claim 8, as well as to claims 9 to 15 which define preferred embodiments of the process of claim 8.

Order

For these reasons it is decided that:

1. The decision under appeal is set aside.

2. The case is remitted to the department of the first instance with the order to maintain the patent on the basis of the New Main Request submitted during oral proceedings and a description to be adapted and Figures 1, 2 and 3 as granted.

The Registrar: The Chairman:

D. Magliano P.-P. Bracke