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**Datasheet for the decision
of 23 October 2007**

Case Number: T 1588/05 - 3.3.06

Application Number: 00307516.5

Publication Number: 1080766

IPC: B01D 3/14

Language of the proceedings: EN

Title of invention:

Process for the separation of multicomponent mixtures

Applicant:

AIR PRODUCTS AND CHEMICALS, INC.

Opponent:

-

Headword:

Multicomponent mixtures/AIR PRODUCTS AND CHEMICALS

Relevant legal provisions:

EPC Art. 54, 56

Keyword:

"Novelty : yes"

"Inventive step (yes): teaching of prior art not leading to
claimed subject-matter"

Decisions cited:

-

Catchword:

-



Case Number: T 1588/05 - 3.3.06

D E C I S I O N
of the Technical Board of Appeal 3.3.06
of 23 October 2007

Appellant:

AIR PRODUCTS AND CHEMICALS, INC.
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Representative:

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Decision under appeal:

Decision of the Examining Division of the
European Patent Office posted 27 July 2005
refusing European application No. 00307516.5
pursuant to Article 97(1) EPC.

Composition of the Board:

Chairman: P.-P. Bracke
Members: L. Li Voti
A. Pignatelli

Summary of Facts and Submissions

I. This appeal lies from the decision of the Examining Division to refuse European patent application No. 00 307 516.5, relating to a process for the separation of multicomponent mixtures.

II. In its decision, the Examining Division, referring to documents

- (1): US-A-4306944;
- (2): NL-A-282051;
- (3): EP-A-0780147;
- (4): US-A-5970742; and
- (5): US-A-4460396.

found *inter alia* that

- the claimed subject-matter complied with the requirements of Articles 84 and 123(2) EPC;

- document (5) disclosed a process for the distillation of a multicomponent fluid containing at least three components of different volatility into at least three product streams (14, Ea and Ey) by means of a distillation system including two distillation columns, each of them having at least two distillation sections;

- this process comprised the steps of feeding the multicomponent fluid into the first column at a feed location between two distillation sections; separating in the first column at least a portion of the most volatile component (light impurities) and at least a portion of the least volatile component (ethane) from

the other components to provide a product stream 14 rich in the most volatile component and a product stream Ea rich in the least volatile component; transferring from the first to the second column by means of one-way communications both a mixture stream Ey (high purity ethylene) 15,28 containing a component of intermediate volatility (ethylene) and lean in the least volatile component and a mixture stream L containing a component of intermediate volatility (ethylene) and lean in the most volatile component; withdrawing from the second column a product stream Ey rich in said component of intermediate volatility; separating the same components in the respective distillation section adjacent the bottom of each column; removing all said product streams 14, Ea and Ey from the distillation system;

- therefore, the subject-matter of claim 1 according to any of the then pending requests lacked novelty in the light of the disclosure of document (5);

- moreover, the claimed subject-matter lacked an inventive step in the light of the teaching of document (4) taken alone or in combination with the other cited prior art documents.

III. An appeal was filed against this decision by the Applicant (Appellant).

Oral proceedings before the Board were held on 23 October 2007. During oral proceedings the Appellant submitted an amended set of 29 claims to be considered as main request and maintained the two sets of claims

according to the first and second auxiliary requests filed previously in writing.

IV. The set of claims according to the main request contains independent claims 1, 27 and 28 reading, respectively, as follows:

"1. A process for distillation of a multicomponent fluid containing at least three components, each component having a different volatility, into at least three product streams wherein one or more product streams are rich in the most volatile component, one or more product streams are rich in the least volatile component, and one or more product streams are rich in a component of intermediate volatility, said process using a distillation system including a first distillation column and a second distillation column each having at least two distillation sections and comprising the steps of:
feeding the multicomponent fluid into the first column at a feed location between two of the distillation sections thereof;
separating at least a portion of the most volatile component and/or at least a portion of the least volatile component from the other components of the multicomponent fluid in the first column to provide a product stream rich in the most volatile component and/or a product streams rich in the least volatile component;
transferring from the first column to the second column both a first mixture stream containing a component of intermediate volatility and the most volatile component and lean in the least volatile component and a second mixture stream containing a component of intermediate

volatility and the least volatile component and lean in the most volatile component; and withdrawing from the second column a product stream rich in a component of intermediate volatility; characterised in that at least one of said first and/or second mixture streams transfers is a one-way communication and (i) a respective distillation section adjacent the top of each of the first and second distillation columns each perform substantially the same separation of the same components to provide respective product streams rich in the most volatile component at the tops of the first and second distillation columns with a product stream rich in the least volatile component being withdrawn from the bottom of at least one column of the distillation system and/or (ii) a respective distillation section adjacent the bottom of each of the first and second distillation columns each perform substantially the same separation of the same components to provide respective product streams rich in the least volatile component at the bottoms of the first and second distillation columns with a product stream rich in the most volatile component being withdrawn from the top of at least one column of the distillation system; all said product streams being removed from the distillation system."

"27. An apparatus for distillation of a multicomponent fluid containing at least three components of different volatilities by a process as defined in Claim 1, said apparatus comprising:

a distillation column system comprising a first distillation column (110 Fig. 9; 110, Fig. 12; 110, Fig. 13; 110, Fig. 15; 610, Fig. 16; 710, Fig. 17; 710,

Fig. 18; 110, Fig. 19) having at least two distillation sections (1,2; 1,2; 1,2; 1,2; 1,2; 3,4; 3,4; 1,2) and a second distillation column (120; 120; 120; 120; 620; 720; 720; 120) having at least two distillation sections (3,4; 3,4; 3,4; 3,4; 3,4; 1X,10; 1X,10; 3,4); conduit means (100) for feeding the multicomponent fluid into the first column (110; 110; 110; 110; 610; 710; 710; 110) at a feed location between said two distillation sections thereof;

conduit means (968; 1268; 1368; 1568; 668; 1768; 768; 1368) for withdrawing from the first column (110; 110; 110; 110; 610; 710; 710; 110) and removing from the distillation column system a product stream rich in the most volatile component;

conduit means (938; 1238; 1338; 1538; 1638; 1738; 1738; 1338) for transferring from the first column to the second column in a one-way communication a mixture stream containing a component of intermediate volatility and lean in the least volatile component;

conduit means (122; 122; 1322; 127; 1622; 1722; 1722; 1322) for transferring from the first column to the second column a mixture stream containing a component of intermediate volatility and lean in the most volatile component;

conduit means (168; 168; 168; 168; 1668; 768; 768; 168) for withdrawing from the second column and removing from the distillation column system a product stream rich in the most volatile component;

conduit means (188; 188; 188 & 1388; 1588; 188, 688 & 1688; 188, 788 & 1788; 188, 788, 1788 & 1888; 188 & 1388) for removing from the distillation column system at least one product stream rich in the least volatile component; and

conduit means (180; 180; 180; 180; 180 & 660; 660 & 780; 660, 780, 1860 & 1880; 180) for withdrawing from an intermediate location of the second column and removing from the distillation column system at least one product stream rich in a component of intermediate volatility."

"28. An apparatus for distillation of a multicomponent fluid containing at least three components of different volatilities by a process as defined in Claim 1, said apparatus comprising:

a distillation column system comprising a first distillation column (110 Fig. 10; 110, Fig. 11; 110, Fig. 13; 110, Fig. 14; 610, Fig. 16; 710, Fig. 17; 710, Fig. 18; 110, Fig. 19) having at least two distillation sections (1,2; 1,2; 1,2; 1,2; 1,2; 3,4; 3,4; 1,2) and a second distillation column (120; 120; 120; 120; 620; 720; 720; 120) having at least two distillation sections (3,4; 3,4; 3,4; 5,6; 3,4; 1X,10; 1X,10; 3,4); conduit means (100) for feeding the multicomponent fluid into the first column (110; 110; 110; 110; 610; 710; 710; 110) at a feed location between said two distillation sections thereof;

conduit means (1088; 1188; 1388; 1488; 688; 1788; 1788; 1388) for withdrawing from the first column and removing from the distillation column system a product stream rich in the least volatile component;

conduit means (1022; 1122; 1322; 1422; 1622; 1722; 1722; 1322) for transferring from the first column to the second column in a one-way communication a mixture stream containing a component of intermediate volatility and lean in the most volatile component;

conduit means (188; 188; 188; 188; 1688; 788; 788; 188) for withdrawing from the second column and removing

from the distillation column system a product stream rich in the least volatile component;
conduit means (168; 168; 168 & 1368; 1468; 168, 668 & 1668; 168, 768 & 1768; 168, 768, 1768 & 1868; 168 & 1368) for removing from the distillation column system at least one product stream rich in the most volatile component;
conduit means (180; 180; 180; 180; 180 & 660; 660 & 780; 660, 780, 1860 & 1880; 180) for withdrawing from an intermediate location of the second column and removing from the distillation column system at least one product stream rich in a component of intermediate volatility; and
conduit means (1039; 132; 1338; 137; 1638; 1738; 1738; 1338) for transferring a mixture stream containing a component of intermediate volatility and lean in the least volatile component from said first column to said second column."

The dependent claims 2 to 26 relate to particular embodiments of the claimed process and claim 29 to a particular embodiment of the apparatus of claim 28.

- V. As regards the novelty of the claimed subject-matter, the Appellant submitted in writing and orally *inter alia* that
- the E_y stream transferred from the first to the second column in the process of document (5), though containing a component of intermediate volatility (ethylene) and being lean in the least volatile component (ethane), did not contain the most volatile component which had been completely removed from the top of the first column as product stream 14; therefore, the process disclosed in document (5) did not contain

all the features of that of claim 1 according to the main request;

- moreover, the apparatus disclosed in document (5) had no conduit means for withdrawing a product rich in a component of intermediate volatility from an intermediate section of the second column but only conduit means for withdrawing product streams from both the top and the bottom of the second column; therefore, the subject-matter of claims 27 and 28 was novel over the cited prior art.

As regards inventive step the Appellant submitted that

- the closest prior art could not be represented by document (4), since it had not been published before the allowable priority date of the present application, but a suitable starting point for the evaluation of inventive step could instead be represented by document (3), relating to a fully thermal coupled column system for the separation of multicomponent fluids;

- starting from the teaching of document (3), it would not have been obvious to the skilled person to modify the distillation column system described therein with the expectation of maintaining similar significant benefits in terms of reduced energy consumption as it had been achieved by means of the distillation column system used in the present application;

- therefore, the claimed subject-matter involved an inventive step over the teaching of the cited prior art.

- VI. The Appellant requests that the decision of first instance be set aside and that a patent be granted on the basis of the claims submitted during the oral proceedings before the Board (main request) or, in the alternative, on the basis of the claims according to the first auxiliary or second auxiliary request.

Reasons for the Decision

1. *Main request*

1.1 Articles 84 and 123(2) EPC

The Board is satisfied that the claims according to the main request comply with the requirements of Articles 84 and 123(2) EPC.

1.2 Novelty

- 1.2.1 The process of claim 1 according to the main request requires "transferring from the first column to the second column... a first mixture stream containing a component of intermediate volatility and the most volatile component and lean in the least volatile component".

As found in the decision under appeal, document (5) discloses a process for the distillation of a multicomponent fluid containing at least three components of different volatility into at least three product streams (14, Ea and Ey) requiring *inter alia* transferring from the first to the second column by means of a one-way communication a stream Ey (high

purity ethylene) 15,28 containing a component of intermediate volatility (ethylene) and lean in the least volatile component (see column 3, lines 51 to 62; column 4, lines 52 to 55; column 5, lines 40 to 42; figure 1 of document (5) and point II above).

However, said stream Ey does not contain any longer the most volatile component since all components having lower boiling points than ethylene are completely removed from the top of the first column (see column 2, lines 3 to 8 and column 8, lines 41 to 45).

Therefore, the process of document (5) does not disclose transferring from the first column to the second column a mixture stream containing a component of intermediate volatility, lean in the least volatile component and comprising the most volatile component as required in claim 1 according to the main request.

Therefore, the Board concludes that the subject-matters of claim 1 and of the dependent claims 2 to 26 are novel over the disclosure of document (5).

- 1.2.2 Both independent claims 27 and 28 according to the main request require that the claimed apparatus has "conduit means for withdrawing from an intermediate location of the second column and removing from the distillation column system at least one product stream rich in a component of intermediate volatility".

Since the second column of the apparatus disclosed in document (5) has conduit means for withdrawing product streams at the top and at the bottom of the column only (see figures 1 and 2), the disclosed apparatus does not

contain any conduit means for withdrawing a product stream from an intermediate location of the second column and removing it from the distillation column system.

Therefore, the Board concludes that the subject-matters of claims 27 and 28 and of dependent claim 29 are also novel over the disclosure of document (5).

1.2.3 The Board thus is satisfied that the subject-matter claimed is novel over the cited prior art.

1.3 Inventive step

1.3.1 The present application relates to the field of distillation of multicomponent fluid mixtures (see paragraph 1 of the published application document, to which is referred to hereinafter).

As explained in the description, in order to separate multicomponent mixtures having at least three components into almost pure components, at least two distillation columns are needed; moreover, there existed five well known distillation processes in the prior art: direct sequence, indirect sequence, side rectifier, side stripper and fully thermal coupled columns, wherein the fully thermal coupled column system required the least amount of heat duty but had not been widely commercially applied because of operating problems (see paragraph 2).

In particular, the arrangement of fully thermal coupled column systems required at least two two-way communications between the first and the second column;

therefore, this system needed a careful control of the pressure profiles in each distillation column over the whole operating range and presented operating difficulty associated with the transfer of all the vapour streams, especially for plants requiring wide ranges of variation of flow rates and operating parameters (see column 2, lines 24 to 29; 36 to 38 and column 2, line 55 to column 3, line 4 and column 6, line 49 to column 7, line 2; column 26, lines 38 to 44).

Therefore, the technical problem underlying the present invention is reported in the description of the present application as the provision of alternative column arrangements with higher operating flexibility than the known fully thermal coupled column systems while maintaining similar low heat demand (see column 3, lines 1 to 4 and column 7, lines 3 to 6).

- 1.3.2 The department of first instance found that the claimed subject-matter lacked an inventive step in the light of the teaching of document (4) (see point II above).

The Board notes that document (4) was published on 26 October 1999, i.e. after the allowable priority date of the present application of 3 September 1999.

Therefore, document (4) is not a document representing prior art under Article 54(2) EPC and it has to be disregarded in evaluating the inventive step of the claimed subject-matter (see Article 56 EPC).

- 1.3.3 Document (5), published in 1984, relates to a thermo-coupled distillation system for separating purified ethylene from a multicomponent mixture, which method

allows a considerable reduction of the energy consumption (column 1, lines 43 to 50).

Document (3), published in 1996, describes a method for optimizing the control of the operation of thermally coupled columns for the separation of multicomponent fluids in a manner that would be more commercially applicable (page 3, lines 3 to 30 and claim 1).

The Board thus agrees with the Appellant that document (3), dealing with a similar technical problem as that described in the present application, relating to a process of more general applicability than that of document (5) and published much closer to the priority date of the present application than document (5), is to be selected as the most suitable starting document for the evaluation of inventive step.

- 1.3.4 By considering figures 2 and 3 of document (3), the process disclosed in this document relates to a distillation system **comprising only two two-ways transfers** from the first column to the second column and thus differing from that of claim 1 according to the main request insofar as **it does not comprise at least one one-way transfer** from the first column to the second column of a mixture stream containing a component of intermediate volatility and the most volatile component and being lean in the least volatile component or of a mixture stream containing a component of intermediate volatility and the least volatile component and being lean in the most volatile component; moreover, the distillation system used according to the teaching of document (3) does not contain a respective distillation section adjacent the top of each of the

first and second distillation columns each performing substantially the same separation of the same components to provide respective product streams rich in the most volatile component at the tops of the first and second distillation columns with a product stream rich in the least volatile component being withdrawn from the bottom of at least one column of the distillation system or a respective distillation section adjacent the bottom of each of the first and second distillation columns each performing substantially the same separation of the same components to provide respective product streams rich in the least volatile component at the bottoms of the first and second distillation columns with a product stream rich in the most volatile component being withdrawn from the top of at least one column of the distillation system.

The Board has no reason to doubt that the claimed process successfully solved the underlying technical problem mentioned hereinabove, as stated in the present application (see column 26, line 52 to column 27, line 7).

- 1.3.5 The Board notes that document (3) teaches a specific method for optimizing the energetic control of a thermally coupled column system for the separation of multicomponent fluids by controlling its operative parameters in a manner that would be more commercially applicable (see claim 1 and page 3, lines 38 to 48) and does not contain any suggestion which would have prompted the skilled person to modify the constructional characteristics of thermally coupled column systems having two two-way transfers of mixture

streams between the first and the second column for reducing their operational difficulty and lack of flexibility while maintaining their low heat demand.

Document (5) discloses a thermally coupled column system different from that of document (3), which system, adapted for the separation of high purity ethylene, comprises two one-way communications between the first and the second column and includes the separation of the same components in the respective distillation section adjacent the bottom of each column (see figures 1 and 2 and point II above).

In particular, document (5) teaches how to reduce the energy consumption in the separation of high purity ethylene by selecting the operation pressure of the two columns and by recovering energy through heat exchange of portion of the reflux fluids (see column 1, line 51 to column 2, line 36), for example, by using the reflux of the intermediate product ethylene withdrawn from the top of the second column as part of the heating circuit of the reboiler associated with the first fractionation column (see column 5, lines 15 to 39).

The Board thus finds that document (5) relates to a very specific distillation column system optimized for the separation of pure ethylene only by recovering energy through heat exchange of the reflux fluids, which system does not appear to have high operating flexibility.

Therefore, the skilled person, starting from the teaching of document (3) and faced with the technical problem of providing alternative column arrangements

with higher operating flexibility than the known fully thermal coupled column systems while maintaining similar low heat demand, would not have been led to modify the system of document (3) by including features of a system of not general applicability and of not high flexibility as that disclosed in the much older document (5).

- 1.3.6 Furthermore, the Board finds that documents (1) and (2), both of them much older than document (3) relate to distillation systems containing arrangements of columns and separation sections very different from that of document (3) and of the subject-matter of claim 1 according to the main request (see document (1), figures 2 and 3 and document (2), figures 1 to 4).

Therefore, the skilled person would have not found any suggestion in the prior art that the replacement of at least one of the two-way communications between the first and the second column of the system disclosed in document (3) with a one-way communication combined with the separation of at least the most volatile or the least volatile product from the tops or bottoms, respectively, of both the first and second distillation columns would allow to operate a system as disclosed in document (3) with higher flexibility whilst maintaining a similar low heat demand.

Therefore, the Board concludes that the subject-matters of claim 1 and of dependent claims 2 to 26 involve an inventive step.

1.3.7 Since the process claim 1 involves an inventive step, any novel apparatus suitable for carrying out such a process also involve an inventive step on the same grounds.

Therefore, the subject-matters of claims 27 to 29 involve *mutatis mutandis* an inventive step.

2. Since the claims according to the main request comply with the requirements of the EPC, there is no need to discuss the auxiliary requests.

Order

For these reasons it is decided that:

1. The decision under appeal is set aside.
2. The case is remitted to the first instance with the order to grant a patent on the basis of claims 1 to 29 according to the main request filed during the oral proceedings before the Board and a description to be adapted.

The Registrar:

The Chairman:

G. Rauh

P.-P. Bracke