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**Datasheet for the decision
of 4 February 2008**

Case Number: T 1858/06 - 3.3.06

Application Number: 01304974.7

Publication Number: 1166868

IPC: B01J 19/32

Language of the proceedings: EN

Title of invention:
Structured packing

Applicant:
THE BOC GROUP, INC.

Opponent:
-

Headword:
Structured packing/BOC GROUP

Relevant legal provisions:
-

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

Keyword:
"Inventive step (no): obvious to try"

Decisions cited:
-

Catchword:
-



Case Number: T 1858/06 - 3.3.06

D E C I S I O N
of the Technical Board of Appeal 3.3.06
of 4 February 2008

Appellant: THE BOC GROUP, INC.
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Representative: Wickham, Michael
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Decision under appeal: Decision of the Examining Division of the
European Patent Office posted 30 June 2006
refusing European application No. 01304974.7
pursuant to Article 97(1) EPC (1973).

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. 01 304 974.7, relating to a structured packing element.

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

(1): WO-A-97/16247 and

(2): CH-A-662515,

found, *inter alia*, that

- document (2) disclosed a structured packing element containing corrugated sheets differing from the claimed one only insofar as the angles of inclination to the horizontal of the corrugations were constant throughout the sheets;

- document (2) taught that the provision of planar members between adjacent corrugated sheets increased the packing performance;

- moreover, document (1) taught that a structured packing element comprising sheets containing corrugations having a variable angle of inclination to the horizontal and a greater angle of inclination at or in the vicinity of the interface between successive elements (hereinafter referred to as **wavy corrugations**) had a better performance because of a reduced liquid build-up at the interface between adjacent packing elements;

- therefore, it would have been obvious for the skilled person to replace the corrugated sheets used in the packing elements of document (2) with sheets containing wavy corrugations as described in document (1) in order to arrive at the same advantages taught in that document;

- therefore, the claimed subject-matter did not involve an inventive step.

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

The Board submitted its preliminary opinion in a communication dated 15 February 2007 and cited, additionally, documents

(3): US-A-4597916; and

(4): US-A-5632934.

The Appellant submitted with letter of 23 April 2007 an amended set of claims according to the auxiliary request and cited document

(5): US-A-4836836.

Oral proceedings were held on 4 February 2008.

IV. Claim 1 according to the main request reads as follows:

"1. A structured packing element comprising:
an array of vertically oriented corrugated sheets
having perforations; each of said corrugated sheets

having a top portion, a middle portion and a bottom portion, all of said portions having corrugations at an angle of inclination to the horizontal; at least some of said corrugated sheets having corrugations with angles of inclination in said middle portion that are smaller than their angles of inclination in at least one of said top and bottom portions; and one or more planar members positioned between at least one pair of adjacent corrugated sheets, and at least one outermost horizontal edge of said planar members being situated proximal to a horizontal edge of said pair of adjacent corrugated sheets."

Claim 1 according to the auxiliary request reads as follows:

"1. The use, in the cryogenic separation of a fluid mixture comprising argon and oxygen, of a structured packing element comprising:
an array of vertically oriented corrugated sheets having perforations; each of said corrugated sheets having a top portion, a middle portion and a bottom portion, all of said portions having corrugations at an angle of inclination to the horizontal; at least some of said corrugated sheets having corrugations with angles of inclination in said middle portion that are smaller than their angles of inclination in at least one of said top and bottom portions; and one or more planar members positioned between at least one pair of adjacent corrugated sheets, and at least one outermost horizontal edge of said planar members being situated proximal to a horizontal edge of said pair of adjacent corrugated sheets."

V. As regards the claims according to the main request the Appellant submitted in writing and orally *inter alia* that

- the technical problem underlying the invention consisted not only in increasing the capacity of a structured packing element but in increasing its capacity without having a significant adverse effect on the efficiency, i.e. without a significant increase in the HETP of the packing, which is the height of packing equivalent to a theoretical plate;

- the experimental results contained in the application showed that the addition of planar members into a structured packing with rectilinear corrugations increased the capacity of the packing at expense of an increased HETP whilst, surprisingly, this did not occur with a packing having wavy corrugations;

- the closest prior art was represented by document (1), dealing with a similar technical problem as in the present application and not by document (2) as used in the decision under appeal;

- in fact, document (2) related to an extraction or absorption process in which a disperse phase was brought into contact with a continuous phase and not to a rectification process wherein two continuous streams of fluids were contacted with each other as in the present application; therefore, the teaching of this document concerned a fluid behaviour which was different from that dealt with in the present application; thus, a skilled person would not have

considered its teaching in order to solve the technical problem underlying the invention;

- moreover, if a person skilled in the art would have tried to improve the structured packing of document (1), he would have been careful in carrying out any modification, as he knew that in this technical field any modification could affect the properties of the packing; in particular he would have been wary of taking measures which could lead to an improved capacity of the packing but have a detrimental effect on its efficiency or HETP;

- in particular, he would not have tried to insert the planar members used between the corrugated sheets of document (3) into the structured packing of document (1), since these planar members would have been expected to affect the interfacial properties of the packing and to have an adverse effect on the pressure drop at the interface of adjacent packing elements and on their HETP;

- moreover, document (3) did not contain any teaching that the addition of planar members between corrugated sheets would improve the capacity a structured packing; to the contrary, the teaching of document (3) was concerned in one embodiment with the use of tab regions bent outwardly from the apertures within the planar sheets positioned between corrugated sheets in order to increase the turbulence of the fluid flow and to enhance the vapour-liquid interaction; because of the increased turbulence, the skilled person would thus have expected an increased pressure drop at the

interface of the packing elements and no increase in capacity;

- therefore, the skilled person would not have found in document (3) any teaching for solving the technical problem underlying the invention;

- furthermore, document (4), concerning various alternatives for improving the performance and capacity of a structured packing used in the separation of air, taught with regard to some of these alternatives to modify the configuration of the structured packing by removing metal parts; therefore, this teaching would have led a skilled person away from adding planar members between the corrugated sheets of a structured packing.

As regards the claims according to the auxiliary request the Appellant submitted that

- the closest prior document was represented by document (4), relating also to the use of structured packing elements in the cryogenic separation of a fluid mixture comprising argon and oxygen;

- document (5) suggested that all types of structured packing could be used for this type of separation and that it was not possible to make predictions about the performance of a particular structured packing without having experimental data;

- moreover, document (4) would have led the skilled person away from adding metal parts such as planar

members between the corrugated sheets of packing element;

- even considering the teaching of documents (1) and (3), the skilled person would not have modified the structured packing disclosed in document (4) with the expectation of improving its capacity without affecting negatively its efficiency.

Therefore, the subject-matter of the claims according to the main request or to the auxiliary request involved an inventive step.

VI. With regard to the claims according to the main request the Board had submitted in writing *inter alia* that

- document (1) appeared to represent the most suitable starting point for the evaluation of inventive step;

- it appeared that it was known at the priority date of the present application, e.g. from document (3), that the insertion of planar members between corrugated sheets improved the distribution of the fluids within the packing, thereby increasing its efficiency, and did not affect its operational characteristics;

- therefore, the skilled person would have had no reason to expect that the incorporation of such planar members into a structured packing element containing corrugated sheets as in document (1) would increase the pressure drop at the interface of adjacent packing elements and would lead to an increase of the HETP;

- therefore, it appeared that the skilled person, following the teaching of the prior art, would have tried to add such planar members to the structured packing of document (1) in the attempt to increase the capacity of the packing without affecting its efficiency;

- the Appellant's discovery shown in the present application that a specific packing system similar to that of document (3) having corrugated sheets with rectilinear corrugations had, under the specific conditions used, an unexpectedly worse efficiency than that of a similar packing without the planar members inserted between the corrugated sheets, appeared to relate to a behaviour which was not known and could not be expected according to the teaching of the prior art at the priority date of the present application; therefore, this finding could not amount to a prejudice which would have prevented the skilled person from trying such planar members in the structured packing described in document (1);

- moreover, the application of structured packing elements containing corrugated sheets having wavy corrugations for the cryogenic separation of fluid mixtures comprising oxygen and argon was known from document (4);

- therefore, the subject-matter of the claims according to the main request appeared to lack an inventive step.

VII. The Appellant requests that the decision under appeal be set aside and that a patent be granted on the basis of claims 1 to 15 according to the main request

submitted with letter of 30 October 2006 or, in the alternative, on the basis of claims 1 to 14 according to the auxiliary request, submitted with letter of 23 April 2007.

Reasons for the Decision

1. *Main request*

1.1 Articles 84 EPC(1973) and 123(2) EPC

The Board is satisfied that the claims according to the main request comply with the requirements of Articles 84 EPC(1973) and 123(2) EPC.

Since the appeal fails on other grounds no further details are necessary.

1.2 Inventive step

1.2.1 The present invention regards a structured packing element which can be used in a method of cryogenic separation (see column 1, lines 3 to 6, all references hereinafter being also made to the published A2 application document).

As explained in the description, structured packing elements are widely used as mass transfer elements within distillation columns, for example for the separation of air into its components, to bring ascending vapour phases into intimate contact with descending liquid phases of mixtures to be separated.

A structured packing generally includes a series of elements made up of a number of corrugated sheets placed side by side with the corrugations of adjacent sheets criss-crossing one another. In use the liquid phase is distributed to the top of the packing and spreads out throughout it as a descending film whilst the vapour phase rises through the corrugations contacting the descending liquid film (column 1, lines 26 to 38).

According to the description, there had been many attempts in the prior art to increase the efficiency of such structured packing elements, which efficiency is correlated to the **HETP**. In particular, the lower the HETP, the more efficient the packing.

However, there was still the need of alternative designs of structured packing elements for improving their capacity without a significant sacrifice in their separation efficiency and viceversa (column 1, lines 39 to 43 and column 2, lines 3 to 6).

The technical problem underlying the invention thus is defined in the application as the provision of means for increasing the capacity of a structured packing element without having a significant adverse effect on its efficiency, i.e. without a significant increase in the HETP of the packing (column 2, lines 7 to 10).

- 1.2.2 The most suitable starting point for assessing inventive step is, according to the jurisprudence of the Boards of Appeal of the EPO, a document (if available) conceived for the same purpose or aiming at the same objectives as the claimed invention and having the most relevant technical features in common (see

Case Law of the Boards of Appeal of the EPO, 5th edition, 2006, point I.D.3.1).

Document (2), used as starting point in the decision under appeal, concerns an extraction or absorption process in which a disperse phase is brought into contact with a continuous phase and aims at improving the radial spreading of the disperse phase across the packing (page 2, left column, line 45 to page 2, right column, line 26 and page 3, left column, lines 41 to 46). This document does not mention, at least explicitly, the technical problem addressed in the present application and does not concern the contact of two continuous streams of fluids as in the separation of air explicitly mentioned in the application.

To the contrary, document (1), relating also to the use of a structured packing in distillation columns wherein a continuous ascending vapour phase is brought into intimate contact with a descending liquid phase, deals with the provision of means for increasing the capacity of a structured packing element without having a significant adverse effect on its efficiency. Therefore, this document deals explicitly with the same technical problem addressed in the present application (see page 1, lines 1 to 10 and page 2, lines 1 to 10 and 19 to 20).

Therefore, the Board, in agreement with the Appellant (see points V and VI above), takes document (1) as the most reasonable starting point for the evaluation of inventive step.

1.2.3 The structured packing elements disclosed in document (1) (see claim 1 and page 2, lines 11 to 16) differ from the subject-matter of claim 1 according to the main request only insofar as they do not comprise one or more planar members positioned between at least one pair of adjacent corrugated sheets, wherein at least one outermost horizontal edge of said planar members is situated proximal to a horizontal edge of said pair of adjacent corrugated sheets. This has not been disputed by the Appellant.

Since document (1) had already provided means for solving the technical problem addressed to in the present application (see page 2, lines 20 to 26 and page 3, lines 11 to 14), the technical problem underlying the invention can be formulated as suggested by the Appellant (see point V above) as the provision of means for further increasing the capacity of structured packing elements as described in document (1) without having a significant adverse effect on their HETP.

The present application shows in its examples that the addition of planar members between the corrugated sheets of a structured packing MELLAPACKPLUS 752Y, having wavy corrugations as the packing elements of document (1), brings about an increase of its capacity in an argon-oxygen separation without any appreciable loss in separation efficiency (see column 15, lines 35 to 43).

Therefore, the Board is satisfied that the claimed subject-matter solves the above mentioned technical problem.

1.2.4 As taught in document (1) and not contested by the Appellant, the capacity of a structured packing is governed by the behaviour of the fluids at the interface between adjacent packing elements. For instance, where liquid-vapour contact is involved, the pressure drop in the vapour phase is higher at the interface between successive packing elements than within the body of the packing. Therefore, liquid tends to build up at such interface. This liquid build up, which can bring about a loss of performance, occurs over a grater range of operating conditions the higher the liquid load (page 2, lines 1 to 10).

Moreover, even though it was known that in packing elements containing corrugated sheets having rectilinear corrugations, such as the known Sulzer packings X or Y, a decrease of the efficiency has to be expected when the angle of inclination to the horizontal of the corrugations is modified to increase capacity (see document (1), page 1, lines 16 to 29), this behaviour had already been resolved by means of sheets having wavy corrugations as used in document (1), according to which an increase in capacity can be achieved without affecting the HETP and viceversa.

1.2.5 It was known from document (3), relating to the use of structured packing elements containing corrugated sheets having rectilinear corrugations, that the insertion of planar members including a plurality of apertures therein between at least one pair of adjacent corrugated sheets, wherein the outermost horizontal edges of said planar members are situated proximal to the horizontal edges of said adjacent corrugated sheets,

improves the distribution of the fluids within the structured packing, thereby maximising its efficiency without adversely affecting its operational characteristics for adding to pressure losses therethrough and, in particular, optimizing surface area and vapour passage area and minimizing the pressure drop (see column 4, lines 7 to 18 and 40 to 54; column 4, line 65 to column 5, line 14; column 5, lines 28 to 30; column 6, lines 20 to 35 and 65 to 68; figures 1 and 2); therefore, document (3), by teaching that the addition of such planar members maximises efficiency and minimizes the pressure drop, teaches, in the Board's judgement, that the addition of such planar members improves the capacity of the packing without negatively affecting the separation efficiency, i.e. its HETP.

Moreover, even though, document (3) describes in one embodiment the use of tab regions bent outwardly from the apertures within the planar sheets positioned between corrugated sheets in order to increase the turbulence of the fluid flow and to enhance the vapour-liquid interaction, (column 4, lines 55 to 64), this embodiment of document (3) does not imply, in the Board's view, that the pressure drop at the interface between successive packing elements would necessarily be increased, as argued by the Appellant during oral proceedings, since, as already explained hereinabove, the explicit teaching of document (3) is that the introduction of the planar members with or without such additional tabs regions maximises the efficiency of the packing without adversely affecting its operational characteristics for adding to pressure losses therethrough.

Therefore, the Board cannot accept the Appellant's allegation that the teaching of document (3) does not contain any indication that the addition of such planar members improves the capacity of the packing or that the skilled person, by reading this document, would have expected, because of the increased turbulent flow of the fluids, that an increase in capacity would not be possible.

1.2.6 Furthermore, document (1) not only taught, as explained in paragraph 1.2.4 above, that the use of wavy corrugations had already resolved the problematic behaviour of packings containing sheets having rectilinear corrugations wherein a reduction of the efficiency had to be expected with an increase of capacity but also that spacer members can be introduced between adjacent sheets without affecting the characteristics of the packing (page 3, last paragraph). Therefore, the skilled person would not have expected any adverse effect by adding the planar members of document (3) to the packing of document (1).

1.2.7 Furthermore, even though document (4), relating to the increase of the performance and capacity of a structured packing in the cryogenic separation of air (see column 1, lines 9 to 12 and 36 to 42), describes some embodiments in which metal parts of the corrugated sheets have to be removed for obtaining the desired improvement (column 4, lines 40 to 44 and column 5, lines 7 to 9 and 13 to 18), it also teaches that the same improvement can be achieved by using corrugated sheets having the corrugations in the base region steeper than in the bulk region of the packing (see

column 5, lines 10 to 12; column 6, lines 16 to 19; figure 11), i.e. by means of corrugated sheets having wavy corrugations as taught in document (1).

Therefore, also the teaching of this document would not have led away the skilled person from adding planar members to a structured packing as described in document (1) in order to increase its capacity without affecting its efficiency.

1.2.8 The Board remarks also that the Appellant's discovery shown in the present application that a specific packing system similar to that of document (3) having corrugated sheets with rectilinear corrugations had, under the specific conditions used, an increased capacity but an unexpectedly worse efficiency than that of a similar packing without inserted planar members (column 15, lines 19 to 30), relates to a behaviour which was not known and could not be expected according to the teaching of the prior art at the priority date of the present application; therefore, this finding could not amount to a prejudice which would have prevented the skilled person from trying to add such planar members into the structured packing described in document (1).

1.2.9 The Board thus finds that it would have been obvious for the skilled person, in the light of the teaching of document (3) that the addition of planar members between the corrugated sheets of a structured packing element improves the capacity of the packing without affecting negatively its separating efficiency, to try to increase the capacity of the structured packing

elements of document (1) by adding thereto such planar members.

- 1.2.10 The Board concludes that the skilled person, following the teaching of the prior art, would have tried to add one or more planar members between at least one pair of adjacent corrugated sheets of the structured packing of document (1), wherein at least one outermost horizontal edge of said planar members is situated proximal to a horizontal edge of said pair of adjacent corrugated sheets, with the expectation of increasing the capacity of the packing without affecting its HETP.

Therefore, the subject-matter of claim 1 according to the main request lacks an inventive step.

2. *Auxiliary request*

- 2.1 Claim 1 according to the auxiliary request differs from that according to the main request only insofar as it relates to the use, in the cryogenic separation of a fluid mixture comprising argon and oxygen, of a structured packing element having all the characteristics of claim 1 according to the main request.

Since document (1) does not explicitly suggest that the structured packing disclosed therein can be used in a cryogenic separation and document (4) relates instead to the improvement of the performance and capacity of a structured packing used in the cryogenic separation of a fluid mixture comprising argon and oxygen (see column 1, lines 9 to 12 and 36 to 42 and claim 17), the Board considers document (4), as submitted by the

Appellant during oral proceedings, as the most suitable starting point for the evaluation of inventive step of the use claim 1 according to the auxiliary request.

Document (5), published about 8 years before document (4), is indeed a less relevant document, since it deals only in general with the use of a structured packing instead of trays in a cryogenic separation and does not deal with the improvement of the capacity of such a structured packing (see column 1, lines 28 to 57).

- 2.2 Similarly to the definition of the technical problem used with regard to claim 1 according to the main request (point 1.2.3 above), the technical problem underlying the invention can be defined, starting from document (4), as the provision of means for increasing the capacity of a structured packing element in the cryogenic separation of argon and oxygen without having a significant adverse effect on the efficiency, i.e. without a significant increase in the HETP of the packing.

As already explained hereinabove this technical problem has been convincingly solved by means of the subject-matter of claim 1.

- 2.2.1 As already explained in point 1.2.7 above, document (4) teaches that the capacity and efficiency of a structured packing which is suitable for the separation of argon and oxygen can be improved by using corrugated sheets having the corrugations in the base region steeper than in the bulk region of the packing (see column 5, lines 10 to 12; column 6, lines 16 to 19; figure 11), i.e. by means of corrugated sheets having

wavy corrugations as taught in document (1). The disclosure of this document differs from the subject-matter of claim 1 according to the auxiliary request only insofar as the used structured packing does not contain one or more planar members between at least one pair of adjacent corrugated sheets of the structured packing of document (1), wherein at least one outermost horizontal edge of said planar members is situated proximal to a horizontal edge of said pair of adjacent corrugated sheets.

- 2.3 Even though document (4) suggests, as alternatives to this specific embodiment similar to that of document (1), other embodiments wherein metal parts of the corrugated sheets are removed (see column 4, lines 40 to 44 and column 5, lines 7 to 9 and 13 to 18), this teaching would not have prevented the skilled person from trying the embodiment not requiring a removal of metal parts, i.e. the embodiment similar to the teaching of document (1).

The Board thus finds that, starting from this specific teaching of document (4) and considering the teaching of documents (1) and (3), it would have been obvious for the skilled person to try to add planar members as disclosed in document (3) between the sheets of the structured packing disclosed in document (4) and similar to that of document (1) in order to try to further improve its capacity without affecting negatively its efficiency.

The fact that, in the particular technical field of cryogenic separation, it is allegedly not possible to predict the characteristics of a packing without

experimental data, as submitted by the Appellant, is not a reason, in the Board's view, that would have prevented the skilled person to try to apply the teaching of the prior art in the attempt of improving the known subject-matter.

Therefore, the same reasoning put forward with respect to claim 1 according to the main request (see points 1.2.5 to 1.2.9 above) applies *mutatis mutandis* to claim 1 according to the auxiliary request.

2.4 Therefore, the subject-matter of claim 1 according to the auxiliary request lacks an inventive step.

Order

For these reasons it is decided that:

The appeal is dismissed.

The Registrar:

The Chairman:

G. Rauh

P.-P. Bracke