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Datasheet for the decision of 4 July 2006

Case Number: T 0173/04 - 3.2.03

Application Number: 95301381.0

Publication Number: 0671594

IPC: F25J 3/04

Language of the proceedings: EN

Title of invention:
Atmospheric gas separation method

Patentee:
THE BOC GROUP, INC.

Opponents:
Praxair, Inc.
L'AIR LIQUIDE, Société Anonyme
LINDE AKTIENGESELLSCHAFT

Headword:
-

Relevant legal provisions:
EPC Art. 83, 56

Keyword:
"Inventive step (yes)"

Decisions cited:
-

Catchword:
-

Case Number: T 0173/04 - 3.2.03

D E C I S I O N
of the Technical Board of Appeal 3.2.03
of 4 July 2006

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Decision under appeal: **Interlocutory decision of the Opposition Division of the European Patent Office posted 12 December 2003 concerning maintenance of European patent No. 0671594 in amended form.**

Composition of the Board:

Chairman: U. Krause
Members: C. Donnelly
K. Garnett

Summary of Facts and Submissions

I. The appellants (opponent I and opponent II) lodged appeals on 22 January and 6 February respectively, against the decision of the opposition division posted on 12 December 2003 maintaining European patent No. 0 671 594 in amended form. Written statements setting out the respective grounds of appeal were filed by appellant I on 16 April 2004 and by appellant II on 22 April 2004. Both appellants made objections under Articles 100(b), Article 83 EPC and Article 100(a), Article 56 EPC.

II. The contested patent as maintained in amended form comprises four independent method claims 1-4.

Claim 1 reads as follows:

A method of cryogenically separating a mixture of atmospheric gases within a distillation column, said method comprising:
forming descending liquid and ascending vapour phases of said mixture of said atmospheric gases within the distillation column;
contacting said descending liquid and ascending vapour phases of said mixture within structured packing contained within at least one section of the distillation column so that said descending liquid phase becomes ever more concentrated in lower volatility components of said mixture as it descends through said structured packing while said vapour phase becomes ever more concentrated in higher volatility components of said mixture as it ascends through said structured packing;

said structured packing being formed of corrugated metal sheets with a specific area within a range of between $100m^2/m^3$ and $450m^2/m^3$ and flow channels oriented at an angle of 45 degrees; and
operating the column so that the said section is at a pressure of greater than two bars, a flow parameter Ψ equal to C_L/C_v, where C_v is the vapour rate of the ascending vapour phase and C_L is the liquid rate of the descending liquid phase, having a value either greater than 0.1 **or** within a flow parameter range of between 0.01 and 0.1 wherein the vapour rate is **less** than a critical vapour rate at which said section of the distillation column floods **and greater** than a minimum vapour rate equal to $\exp[-0.0485(\ln\Psi)^2-0.595 \ln \Psi - 3.176-0.00169A]$, when Ψ is within said flow parameter range and equal to $0.054e^{-0.00169A} \Psi^{-0.372}$ when Ψ is greater than 0.1, where A is the specific area of the structured packing.

Claim 2 is identical to claim 1 except that:
-said structured packing is formed of corrugated metal sheets with a specific area within a range of between **$450m^2/m^3$ and $1000m^2/m^3$**; and
the vapour rate is greater than a minimum vapour rate equal to **$\exp[-0.0485(\ln\Psi)^2-0.595 \ln \Psi -3.748-0.000421A]$**, when Ψ is within said flow parameter range and equal to **$0.0305e^{-0.000421A} \Psi^{-0.372}$** when Ψ is greater than 0.1

Claim 3 is identical to claim 1 except that:

-said structured packing is formed of corrugated metal sheets with a specific area within a range of between **$170m^2/m^3$ and $250m^2/m^3$** and the flow channels are oriented at an **angle of 30 degrees**; and the vapour rate is greater than a minimum vapour rate equal to **$\exp[-0.0485(\ln\Psi)^2-0.595 \ln \Psi -2.788-0.00236A]$,** when Ψ is within said flow parameter range and equal to **$0.0796e^{-0.00236A}\ \Psi^{-0.372}$** when Ψ is greater than 0.1

Claim 4 is identical to claim 1 except that:

-said structured packing is formed of corrugated metal sheets with a specific area within a range of between **$250m^2/m^3$ and $1000m^2/m^3$** and the flow channels are oriented at an **angle of 30 degrees;** and
the vapour rate is greater than a minimum vapour rate equal to **$\exp[-0.0485(\ln\Psi)^2-0.595 \ln \Psi -3.156-0.000893A]$,** when Ψ is within said (*flow parameter*) range and (*equal*) to **$0.05515e^{-0.000893A}\ \Psi^{-0.372.}$** when Ψ is greater than 0.1.

These claims essentially define the operating limit curves on the Souder diagram (see figure 1 of the contested patent) for four different classes of structured packing used in an air distillation column operated at more than 2bars. The equations define the minimum value of Cv whereas the maximum value is defined as that at which flooding occurs.

III. At the request of all parties oral proceedings were held on 4 July 2006. At the end of these proceedings the parties made the following requests:

Appellants I and II (Opponent I and II): that the decision under appeal be set aside and that the European Patent No. 0 672 594 be revoked.
Respondent (Patentee):that the appeals be dismissed and that the patent be upheld in the amended form approved in the decision of the opposition division.

IV. *State of the art*

In their arguments the appellants made reference ***inter alia*** to the following documents:

D1: Brochure "Separation Columns for Distillation and Absorption", Sulzer Chemtech, Nov. 1991;
D2: Brochure "Flexipac", Bulletin KFP-2, Koch Engineering Co., Inc., January 1981,
D3: "Hydraulic Performance and Efficiency of Koch Flexipac Structured Packings", McNulty et al.,Paper presented at the 1982 Annual meeting of AIChE, Los Angeles, California;
D4: EP-A-0467395;
D4a: US-A-4929399;
D5: EP-A-0516087;
D8: EP-A-0447943;
D8a: US-A-4296050;
D8b: US-A-4455339;
D15: US-A-5197296;
D16: US-A-5148680;
D23: EP-A-0321163;
D24: Article " A generalised pressure drop model for structured packings", L.Spiegel, W.Meier, ICHEME Symposium Series No. 128, pages B85 to B94, 1992
D25: Perry's Chemical Engineers' Handbook, sixth edition, 1984, pages 18-22 to 18-25;
D29: "Distillation tray fundamentals", M.J.Lockett, Cambridge University Press, 1986, page 6;
P1: "Impact of Low Pressure Drop Structure Packing on Air Distillation", R. Agrawal et al, Chem E Symposium Series No. 128, LP A125-A138, 1992;

P3: "Effect of Pressure on Structured Packing Performance", Rukovena et al., AlChE, April 1987;
P4: Brochure FLEXIPAC Structured Packing Systems, Koch Engineering Company Inc. 1991.

V. The arguments of the parties on each of the issues under consideration are summarised below.

(a) *Insufficiency of disclosure - Article100(b), Article 83 EPC.*

Appellant I

This objection was only raised as a precaution in the event that the patentee should dispute that the skilled person, at the priority date, would have been able to determine the flood point (i.e. the critical vapor rate) of the distillation column without exercising an inventive activity. In particular, it should be noted that all the independent claims specify that the vapour rate is "less than a critical vapour rate" at which the distillation column floods, but the patent specification does not disclose how this rate should be determined in practice.

Appellant II

It was agreed that in order to calculate the value of the vapour rate Cv, in addition to the specific area value and flow channel angle of the structured packing, it is also necessary to take into account the radius of curvature and the texture of the corrugated sheets making up the packing. This position is supported for example by document P3, which details a comparison of two makes of structured packing (see page 62 Intalox (R), Structured Packing 2T - Capacity Comparisons"), having the same specific surface and corrugation angle and which reveals performances differing by up to 20%. Hence, it is evident that other parameters are needed to define fully the structured packing such that a precise value of Cv can be calculated. Failing this, the skilled person would have to carry out an undue amount of experimental testing in order to determine the minimum values of Cv, as the equations specified in the contested patent cannot be relied upon.

Further, it should be noted that the independent claims do not set an upper range of pressure range. To fulfil the requirements of Article 83 EPC the skilled person must be able to carry out the invention over the whole range i.e., in the absence of an upper limit, at all pressures above 2bars. However, it is clear from the graphs filed with the letter of 22 April 2004 to support arguments concerning inventive step that, for all atmospheric gases, the claimed method cannot be used at pressures above 25bars as the Cv values calculated according to the patent specification are greater than those predicted by the theory according to D2 and D25.

Respondent

In response to appellant I:

It is not disputed that the skilled person, at the priority date, would have had the technical knowledge necessary to determine the flood point of the distillation column without exercising an inventive activity, once he had been prompted to do so.

In summary, the requirements of Article 83 EPC are met, because the skilled person can determine the flood point by experiment, but only now that the contested patent has indicated that it is worthwhile.

In response to appellant II

In air separation systems the additional parameters cited by appellant II have been found to have an insignificant effect on packing capacity. This phenomenon is attributed to the low surface tension and very low contact angles that liquid air, liquid oxygen and liquid nitrogen display, which render the need for surface texturing superfluous. The results referred to by appellant II were not obtained in an air-separation system and are thus not directly relevant.

This objection is one of clarity (Article 84 EPC) rather than of insufficiency and therefore cannot be raised during opposition proceedings anyway.

As regards appellant II's second line of reasoning, advanced for the first time in the oral proceedings, it must be remembered that the patent specification is intended to be read by a person skilled in the art. The skilled person knows that in air separation processes, pressures above 10bars are seldom encountered since the ensuing increased costs occasioned by having to build pressure vessels able to withstand such pressures cannot be offset by any gains in efficiency. Hence, the skilled person knows that the upper pressure limit which applies is that of the maximum pressure normally used in air separation processes, which is far below 25bars. Hence, the methods claimed are valid for all pressures which would be encountered in a practical air separation process. Further, the figures used by appellant II are based on purely theoretical considerations whereas the figures of the patent are based on empirical results.

(b) *Article 100(a) - Inventive step*

Appellant I

The use of structured packing formed of corrugated metal sheets with a specific area A between 250m2/m3 and 1000m2/m3 and with flow channels oriented at an angle of 45 degrees for air separation purposes was well known in the art before the priority date (see D4, page 5, line 31; D4a, column 1, lines 26 to 29; D5, column 7, lines 5 to 21). Further, document D4, in view of numerous documents such as D8 (see page 3, lines 57 and 58), also makes an implicit disclosure or at least renders obvious an operating pressure of more than 2bars. Similarly, D5 also suggests the use of structured packing in the high pressure column of a double column system (see claim 15).

The only specific measure in claim 1 of the opposed patent is the selection of the vapour rate Cv above a given minimum vapour rate, depending on the flow parameter Ψ. However, the skilled person has no choice but to select a vapour rate when operating a cryogenic air separation plant and usually this value is set in the range 50-95% of the critical vapour rate (see D4, page 5, line 33). Hence, the practical operating value of the critical vapour rate is inextricably linked to the critical vapour rate.

The skilled person knows that the critical vapour rate may be determined either by experiment or calculation.

If it is considered that at the priority date the available theoretical models would have been seen as divergent or unreliable, it then follows that the skilled person would have no choice but to carry out experimental testing in order to determine the flood point. Given that the respondent has accepted that the skilled person has the technical knowledge to find the value of the critical vapour rate by routine experimental testing, the claimed values been obtained without the need to make an inventive step.

D24 indicates that the available models were not precise and hence would have contributed to making the skilled person think that it was necessary to carry out testing. Further, P3 mentions at page 10 that tests for determining the flood point were made at 4.14 bar, which suggests that testing at these pressures was not problematical.

However, if for some reason the skilled person had been prevented or dissuaded from carrying out experimental tests, the claimed values would also have been obtained by analysis of the available theoretical models.

In particular document D3 would have been consulted which, although based on experimental data from an air/water system, is expressly stated as being applicable to other systems and pressure independent (see page 14, last two lines). D3 relates to measurements carried out using structured packing of the type "Flexipac 1 to 4" which by reference to D2 (see table 1) can be shown to comprise packing densities and channel angles falling within the claimed ranges.

By resolving the equation (5b) (see page 13) for "Flexipac 2" type packing with the appropriate data and correction terms also provided in D3, it can be shown that the resulting 80% of critical Cv curve (D3 80% flood in annex 2, letter of 14 April 2004) lies above the curve indicating the lower limit of the vapour flow rate according to claim 1.

Consequently, when applying the theory of D3 to processes described in D4 or D8 the skilled person would necessarily arrive at the process claimed in claim 1.

The same conclusions could be arrived at by using the flood point data given in D2, which deals with the structured packing mentioned in D4 and which is of the type specified in claim 1.

The skilled person would not have selected the theory according to D1 in preference to D2 or D3, since it is explicitly stated at page 4 of this document that it is not valid for pressures above 2bars and there is no indication that it can be employed for cryogenic air separation.

Document P3, cited by the respondent in particular because of the passage at page 17 stating "the maximum capacity of a structured packing decreases with an increase in absolute pressure of operation", cannot in fact be considered a prejudice against the use of structured packing at high pressures. A closer examination of this document reveals that the pressure is not kept constant (see page 11, last sentence). Since the flow parameter is proportional to the square root of the pressure (see D29, figure 1.3), this passage actually refers to the well known decrease of the critical vapour rate with increasing flow parameter (i.e. with increasing pressure).

Further, by considering figure 1 of the contested patent it can been shown that curve 1, which delimits the flood point at 2bars, corresponds to 74% of curve 3.

Appellant II

By application of the appropriate correction factors, the curves defining Cv in D2 and D25 can be used in calculations for processes with atmospheric gases as well as air/water systems. By so doing, it can be shown that in both cases even though the curves are different, increasing the pressure will lead to an increase in the Cv value at flooding, the exact value of which would have to be determined by experiment. Hence, the skilled person would have had every reason to anticipate higher values of Cv with increasing pressure.

Alternatively, considering P3, and in particular the figure on page 62, which compares the performance of two types of packing (Mellapak 250Y and INTALOX 2T), it can be shown that at the priority date the skilled person would have operated within the claimed ranges. As it is not clear at what pressure the results in the figure were obtained, it is necessary to study both high-pressure and low-pressure scenarios. If the results were obtained at high pressure, then P3 shows it was known to operate structured packing above 2bars within the range claimed. If the results were obtained at low pressure then the skilled person would still learn that by using a structured packing with a different texture it is possible to increase the Cv by 20%. Thus, by using INTALOX 2T it would still be possible to reduce the Cv to take account of the high pressure and still stay within the operating domain claimed.

A combination of the teachings of P3 with either D2 or D25 to calculate a value of Cvmax gives a result which is always higher than that predicted by the patent.

Hence, the existing theory at the time of the priority date of the contested patent would have led the skilled man to expect an increase in Cv with an increase in operating pressure in a distillation column using structured packing.

Respondent

The skilled person would not have carried out experimental testing to determine the flood point at higher pressures because he would have been put off by the high cost of the test rig in combination with minimal prospects for a favourable outcome. In order to obtain accurate results it would have been necessary to provide testing apparatus which fully simulated all aspects of high-pressure cryogenic air separation such that the errors induced by extrapolation of data from low-pressure air/water testing were eliminated. The manufacture of testing apparatus for high pressure applications has to be in conformity with exacting conditions laid down in the various pressure vessel codes (ASME IX etc.). Hence, the decision to manufacture a high-pressure cryogenic testing rig cannot be taken lightly and would not have been made without some reasonable expectation of success.

However, at the time, the expected gains to be made by employing structured packing in the high pressure column of a double-column air separation plant were much less (in the order of 2.6% if the pressure drop was entirely eliminated) than that which could be expected from their deployment in the low-pressure column (see D23, page 9, lines 30 to 40).

Consequently, the skilled person would not have carried out the tests at the priority date since all the indications were that investment in high-pressure testing apparatus would not provide the necessary return. Further, the skilled person would have believed the results predicted by the theoretical model of D1 and unwittingly operated the high pressure distillation columns fitted with structured packing at a less than optimal Cv value.

The skilled person would also not have arrived at the subject-matter of claimed methods by consideration of the available theory at the time.

P3 makes an unequivocal statement that the maximum capacity of a structured packing decreases with an increase in absolute pressure of operation (see page 17, 3rd paragraph). Appellant I's attempt to distort this clear message from P3 by applying the teaching of D29 is erroneous since D29 expressly states that it is not applicable to cryogenic air separation systems. Accordingly, the content of P3 lends considerable support to the viewpoint that the results obtained at high pressure in the respondent's cryogenic air separation test-rig are surprising.

D3 and D25 are very general studies which were not accepted as authoritative in the industry. D3 presents no data obtained from the separation of air and there is no indication that its results can be extrapolated to cryogenic air separation systems. References to D24 do little to strengthen the teaching of D3 as this document is also void of any data relating to air separation.

A comparison of P4 and D2 reveals that for the same type of structured packing (Flexipac Type 1Y) the manufacturer (Koch) revised its correlations to indicate lower flood points in 1991 (P4, figure 9c) than had been given in 1981 (D2, figure 8a). Document P4 therefore demonstrates that no great authority should be credited to D2 or D3.

In conclusion, the skilled person would not have used D2 or D3 to make theoretical calculations, but would rather have relied on the model presented in D1, as this conforms more closely with actual experimental data obtained for air separation at low pressures. The model according to D1 predicts a decrease in the flood point with increasing pressure (see annex II, letter of 12 November 2004). Thus, the skilled person at the priority date would not have calculated the true flood point, but would have arrived at an erroneous value, leading to unwitting operation of the air separation system at less than optimum conditions.

Reasons for the Decision

1. *Insufficiency of disclosure - Article 100(b), Article 83 EPC.*

The board considers that the skilled person would have possessed the technical knowledge to determine the flood point by experimental testing as indicated in the patent (see page 4, lines 28-32) and in P3 (see page 10). Appellant I does not dispute this. Whether the skilled person would have carried out the testing without first being prompted by the teaching of the patent is a matter of inventive step and is discussed below.

The board concurs with appellant II that other parts of the state of the art indicate that the texture of the structured packing can influence the operating conditions in air separation systems: see for example US-A-4929399 (D4a), in particular column 3, lines 52-66, and EP-A-516 087 (D5), which also shows a way of defining mathematically the type of texture, as well as P3, cited by appellant II. However, the claims specify equations for calculating the minimum values of Cv for all the types of structured packing falling within the range of the claim. Thus, the skilled person is in a position to calculate a value, as an equation is provided with which to do it. Whether this is a precise value is another question -it would seem that all the theoretical equations of the prior art directed at calculating Cv values involve some degree of approximation. Thus, as indicated by the respondent, this seems to be more a question of clarity. It might be possible to formulate a more precise equation to define Cv, but the respondent has chosen not to do so. However, this would not appear to change the fact that the skilled man can calculate a value for Cv according to the claims and operate the column at a vapour rate between this value and the flood point.

As regards appellant II's contention that the method of the claims must be valid for all pressures up to the critical point of the gases to be separated, the board is of the view that as the claims are directed towards a method of cryogenic air separation the conditions normally encountered in such processes apply. The skilled person knows that the practical upper pressure limit for operating such processes is far below 25bars because of the difficulties and costs associated with manufacturing and operating plant capable of withstanding such pressures.

Hence, the requirements of Article 83 EPC are met.

2. *Article 100(a) - Inventive step*

In the board's view, numerous documents (in particular D8,D15 (low pressure column operated at 25-90psi), D16 (high pressure column at 60-100psi), D5 (use of packing in high pressure column)) indicate that the use structured packing in air separation plants at pressures above 2bars was at least contemplated before the priority date. In addition, the types of structured packing specified in the claims appear to have been standard in the air separation industry and generally known in the art at the priority date (see documents D4,D5,D8,D8a,D8b). As argued by Appellant I, it is logical that the skilled person has no choice but to select an operating regime for the distillation columns in question. One of the crucial parameters which must be determined is the critical vapour rate or maximum design velocity, which is normally set at about 80% of the vapour rate at flooding (see contested patent page 4, lines 28-32 and D3, page 18, 2nd paragraph and page 21, item 4).

As explained above, there appears no doubt that the skilled man would have known at the priority date how to determine the vapour rate at flooding by experiment in a routine manner. The point under discussion therefore is whether the skilled person would have actually carried out the testing and not been put off by the prospect of low returns having regard to the high investment in the necessary testing rig.

The board is of the opinion that the construction of a test rig for simulating cryogenic air separation at pressures over 2bars cannot be dismissed as routine. The requirement for operating at higher pressures would have necessitated manufacturing according to strict construction codes (e.g. ASME VIII and IX), which would inevitably have led to higher costs through their requirements for approved welding procedures, use of qualified personnel, stringent material specifications and quality control procedures. P3, at page 10, confirms that test facilities at research institutes for high-pressure cryogenic testing were few and far between and does not mention the existence of high-pressure cryogenic testing apparatus at all. Accordingly, the board accepts that such facilities would not have been immediately available and that the construction of the necessary test-rig in-house would have required a high capital investment. Therefore it needs to be examined whether the prospects for success would have warranted this outlay.

The parties have debated at length the merits of the various theories available at the time which could possibly have been used to predict operating conditions for air separation at pressures over 2bars.

The board is in no doubt that the skilled person would have consulted P3 since this document, despite not expressly dealing with air separation, is alone in discussing the influence of pressure on the performance of structured packing and draws conclusions directly in this respect without the reader having to make calculations. One of these conclusions (see page 17, paragraph 3) is that the maximum capacity of a structured packing decreases with an increase in absolute pressure of operation. This statement is backed up by the data given in tables 2 and 3. Appellant I has argued that this statement does not mean what it appears to say as the flow parameter is proportional to the square root of the operating pressure ratio, as evidenced by D29, figure 1.3, and the mention at page 11, lines 11-13, of P3. This argument cannot be dismissed, as the respondent suggests, simply on the grounds that D29 states that "clearly inclusion of pressure on figure 1.3 is inappropriate when refrigeration is used as for demethanisers or for air distillation" since P3 is not dealing with systems involving refrigeration either.

However, appellant I's reasoning is unconvincing on account of the fact that the annotations made to figure 1 of the contested patent, filed with letter of 21 March 2005, must be erroneous as the values Cv1 and Cv2, whilst allegedly relating to different pressures, have been read off the same constant pressure line (curve 1). The same applies to the calculations made and the conclusions drawn by appellant II from document D2 at constant flow parameter made in letter of 22 April 2004.

Given this situation, the board is of the view that the skilled person would have considered the figure on page 62 of P3 which shows that the capacity or critical vapour rate decreases with increasing flow parameter. Since the flow parameter is proportional to the square root of the gas density and, therefore, the pressure, this means that the critical vapour rate decreases with pressure. In the absence of any further explanation in P3, the board considers that this is how the skilled person would understand the statement on page 17. This conclusion is also consistent with the teachings of documents D1 (figure on page 4), D2 (figure 7), D3 (figure 25) and D25 (figure 18-38).

It is also plausible that an extrapolation to higher pressures from the theory of D1 would have been made as this document deals with air separation and provided satisfactory results for such processes at lower pressures. This would also have been the easiest and most immediately available option open to the skilled person. The indication on page 4 of D1 that the theory is only applicable up to 2bars cannot be considered as a barrier, but rather as an indication to the skilled person that appropriate extrapolation is necessary.

As against this there appears to be no compelling reason why the skilled person would have consulted D2 or D3, which are in fact similar documents emanating from the same source and relating to the same type of structured packing. D3 states that test work was limited to an air/water system at near-ambient conditions and gives a general suggestion that the resulting model may be applied to other vapors and liquids at other operating conditions (see page 2, paragraph 2). Admittedly D3 draws the conclusion at page 21 that the CVCL model developed there gives good agreement for reported pressure drops in hydrocarbon systems. However, at page 17, paragraph 3, in connection with calculation of the maximum design velocity, it is stated that the results can only be treated as preliminary and much additional work is needed before applying the data to other systems and conditions. In any event, the model developed in D3 for calculating the vapour rate at flooding (equation 5b) suggests that, since the liquid ratio is practically independent of pressure, the vapour rate Cv should also be constant.

The tentative nature of the findings given in D3 is further confirmed by a comparison of P4 and D2, which reveals that for the same type of structured packing (Flexipac Type 1Y) the manufacturer (Koch) revised its correlations to indicate lower flood points in 1991 (P4, figure 9c) than had been given in 1981 (D2, figure 8a).

Similar criticisms can be aimed at D25, which also concerns a modified generalised pressure drop correlation.

Moreover, the calculations made by appellant II show that for both D2 and D25, there is only a marginal increase of 1% for the critical flooding rate as the pressure is increased from 1bar to 5bar. Given the approximate nature of these models, the skilled person would have taken these results to indicate that the Cv value is independent of pressure, which confirms the teaching of D3.

Appellant I has presented in annexes 2 to 4 of the grounds of appeal, a series of curves which show that, for three different types of structured packing, D2 and D3 predict Cv values above that of D1 at 1bar (annexes 2 and 3) and even above that predicted by the patent at 4 and 6bars. Hence, the skilled person, by the mere fact of applying the theory of D2 and D3 at 1bar and assuming pressure independence for extrapolation to higher pressures, would find himself inherently in the claimed range.

However, the influence of correction factors applied by the applicant to allow for the differences in surface tension and viscosity between water and liquid oxygen in arriving at these results is not clear.

In summary D2,D3 and D25 neither deal directly with air separation nor with the effect of high pressure on the performance of structured packing. The models presented there indicate that the Cv value is independent of pressure.

The skilled person, faced with the problem of selecting operating parameters for an air separation distillation column at pressures above 2bars, would have come to the conclusion that at best the Cv value would not change with increasing pressure but, on the basis of P3, which is the only direct study available into the effects of pressure on structured packing, would depend only on the flow parameter. In these circumstances the decision to stick with the theory according to D1, which also predicts such a relationship, would have been seen as the only way to ensure with a high degree of confidence that flooding would be avoided.

Further, although it is accepted that at the priority date, air separation distillation columns using structured packing operating at above 2bars had been suggested, neither the wherefore nor the process parameters concerning such an implementation had been disclosed. This situation must be further nuanced by the information given in D23 at page 9, lines 30-40 and P1, page A129, paragraphs 2 and 3, which explains the accepted wisdom at the time that gains in performance obtained by using structured packing in the high-pressure column will always be less than those obtained by its use in the low pressure column. Even by the use of structured packing, the pressure drop can never be totally eliminated (see P1, page A129, paragraph 2) such that the maximum possible gain in power consumption of around 2.5% is not achievable. Combined with the fact that the cost-benefit of structured packing in the low-pressure column was under scrutiny (see P1, page A129, paragraph 3) any attempts at the deployment and testing of structured packing in high pressure situations would have had to be made against a negative backdrop.

In conclusion, at the priority date of the contested patent, air separation distillation columns using structured packing operating at above 2bars had been suggested. However, the skilled person, although possessing the technical knowledge to determine the flood point experimentally, would have been deterred from so doing by the high cost of the necessary apparatus and the prospect of poor returns. The skilled person would also have been further dissuaded from carrying out testing by the fact that the available theoretical models of the period indicated that the critical Cv value to flow parameter relationship curve is independent of pressure (cf diagram on page 4 of D1; figure 7 of D2; figure 25 of D3; figures 18-38 of D25; page 62 of P3). Hence, a decrease of the critical Cv value (cf P3, p 17) with increasing pressure would be expected since the flow parameter, which is proportional to the square root of the gas density, increases. There is no available prior art suggesting that the curves would shift to higher values with increased pressure, as claimed in the independent claims for the different configurations of structured packing.

It also follows from the reasons given above that the invention would also not have been arrived at by purely theoretical considerations based on a review of all the available models. These theories have been applied and adapted with the benefit of hindsight with a view to obtaining the result disclosed in the contested patent rather than any prior conviction of their relevance for predicting the effects of increased pressure on structured packing operating parameters in cryogenic air separation at the priority date.

Order

For these reasons it is decided that:

The appeals are dismissed.

Registrar:	Chairman:
U. Bultmann	U. Krause