

Internal distribution code:

- (A) [] Publication in OJ
(B) [] To Chairmen and Members
(C) [X] To Chairmen

D E C I S I O N
of 29 August 1994

Case Number: T 0084/93

Application Number: 89907898.4

Publication Number: 0381720

IPC: F25J 3/00

Language of the proceedings: EN

Title of invention:

Low pressure noncryogenic processing for ethylene recovery

Applicant:

AVANCED EXTRACTION TECHNOLOGIES

Opponent:

-

Headword:

-

Relevant legal norms:

EPC Art. 56

Keyword:

"Inventive step - yes after disclaiming amendment"

Decisions cited:

T 0433/86, T 0170/87

Catchword:

-



Case Number: T 0084/93 - 3.4.2

D E C I S I O N
of the Technical Board of Appeal 3.4.2
of 29 August 1994

Appellant:

ADVANCED EXTRACTION TECHNOLOGIES
No. 2, Northpoint Drive
Suite 820
Houston, TX 77060 (US)

Representative:

Dost, Wolfgang, Dr.rer.nat., Dipl.-Chem.
Patent- und Rechtsanwälte
Bardehle, Pagenberg, Dost, Altenburg,
Frohwitter, Geissler & Partner
Postfach 86 06 20
D-81633 München (DE)

Decision under appeal:

Decision of the Examining Division of the European
Patent Office dated 20 August 1992 refusing
European patent application No. 89 907 898.4
pursuant to Article 97(1) EPC.

Composition of the Board:

Chairman: C. Black
Members: C. G. F. Biggio
M. Lewenton

Summary of Facts and Submissions

- I. European patent application no. 89 907 898.4, based on international application no. PCT/US89/02708 (publication nos. EP-A-0 381 720 and WO 89/12794 respectively) was refused by decision of the Examining Division on the ground that the subject-matter of the claims under consideration did not involve an inventive step having regard to the disclosure in the documents US-A-4 035 167 (hereinafter Starks) and US-A-4 695 672 (hereinafter Bunting).
- II. The present appeal lies against this decision.
- III. In response to a communication from the Board accompanying a summons to oral proceedings, the Appellant submitted an amended Claim 1 and expressed the opinion that in view of the amendment, the need for oral proceedings might be obviated. It was acknowledged that consequential amendment to the remainder of the specification would be necessary.
- IV. In a communication dated 21 June 1994, the Board cancelled the oral proceedings and proposed a wording of Claim 1 containing further amendments. The Appellant approved the amended claim in a communication dated 30 June 1994.
- V. The Appellant is accordingly requesting in effect that the decision under appeal be set aside and the case remitted to the Examining Division with the order to grant a patent on the basis of Claim 1 as proposed by the Board in its communication dated 21 June 1994, with consequential amendment to bring the description into conformity with the amended Claim 1 and to supplement the non-metric units by metric or SI units.

VI. Claim 1 now under consideration reads as follows:

"A process for non-cryogenic recovery of an ethylene plus product stream from a hydrocarbon gas feed stream comprising ethylene in an amount of at least 5 mol%, methane and components selected from the group of hydrogen, nitrogen, carbon monoxide, ethane, heavier saturated and unsaturated hydrocarbons and mixtures thereof which comprises:

- A) introducing said hydrocarbon gas feed stream into the midsection of an extractor-stripper column having a reboiler,

- B) counter-currently contacting said hydrocarbon gas feed stream in said extractor-stripper column with a lean physical solvent to produce an overhead stream containing at least methane and an ethylene rich solvent bottoms stream, said lean physical solvent selected from the group consisting of:
 - 1) paraffinic solvents having molecular weights ranging from 75 to 140 and UOP characterization factors ranging from 12.0 to 13.5, said factors being independent of the aromatic content of said paraffinic solvents,

 - 2) naphthenic solvents having molecular weights ranging from 75 to 130 and UOP characterization factors ranging from 10.5 to 12.0, said factors being independent of the aromatic content of said naphthenic solvents,

 - 3) benzene, toluene, C₈-C₁₀ aromatic compounds having methyl, ethyl or propyl aliphatic groups specifically constituting a subgroup of o-xylene, m-xylene, p-xylene, hemimellitene,

pseudocumene, mesitylene, cumene, o-ethyltoluene, m-ethyltoluene, p-ethyltoluene, n-propylbenzene, isopropylbenzene, indane, durene, isodurene, prehnitene, crude xylenes, toluene transalkylation reaction effluents, extracted C₉ naphtha reformates, C₉ heart cuts of said reformates which are enriched in C₉ alkylbenzenes, C₇-C₉ alkyl aromatics, and mixtures thereof;

and

- 4) dialkyl ethers of polyalkylene glycol, N-methyl pyrrolidone, dimethylformamide, propylene carbonate, sulfolene and glycol triacetate,

- C) regenerating the ethylene rich solvent in a distillation column equipped with at least one reflux condenser and at least one reboiler to produce ethylene plus product as an overhead product stream and said lean physical solvent as a bottoms stream,

wherein said extractor-stripper column with said reboiler is operated under selected conditions to achieve a methane content of the final fractionated ethylene product ranging from chemical grade ethylene having less than 5 mol% methane to polymer grade ethylene having between 10 and 400 ppm methane by weight,

said selected operating conditions including

- a. a flow rate of said lean physical solvent selected in proportion to the flow rate of said hydrocarbon gas feed stream,

- b. a temperature of said lean physical solvent entering the top of said extractor-stripper column in the range of -12.2°C ($+10^{\circ}\text{F}$) and -40°C (-40°F),
- c. a pressure within said extractor-stripper column in the range of 446×10^3 Pa (50 psig) to 2860×10^3 Pa (400 psig),

said process being carried out in the absence of recycling part of said overhead product stream to said extractor-stripper column."

In feature B3, the Board has corrected the spelling of alkylbenzenes.

Claims 2 to 5 received 29 December 1992 remain appendant to Claim 1.

VII. The Appellant argues that neither Starks nor Bunting discloses all of the features of Claim 1 and in particular Bunting does not mention recovery of ethylene. Starks discloses moderate extraction efficiency and moderate demethanisation, and Bunting discloses high extraction efficiency but again moderate demethanisation. The average skilled person, seeking high extraction efficiency and high purity as regards methane content would therefore not be led to combine the teachings of the two documents. With the disclaimer the distinction between the claimed process and the cited documents is made even clearer.

Reasons for the Decision

1. The appeal is admissible.
2. Claim 1 filed with the grounds for the appeal has been amended as compared with Claim 1 originally filed in such a way that the requirements of Article 123(2) EPC are met. The Appellant has explained on pages 2 and 3 of the grounds for the appeal the basis for the various amendments and the Board can accept this. Briefly, the wording of the present Claim 1 reads closely on to the embodiment illustrated in Figure 8 and described on page 40, line 18 to page 47, line 2 of the description. As regards the substitution of the term "extractor-stripper" for "demethanizing-absorber", it is apparent from page 44, lines 28 and 29 that these are synonymous.
3. As regards clarity, section C of Claim 1 defines the process in terms of the result to be achieved. The Board accepts that the claim is as clear as possible in this respect, in particular that feature Ca could not be defined more precisely since the flow rates will depend on the dimensions of the column and that this should present no difficulty in interpretation for the average skilled chemical engineer.

The further amendments incorporated into Claim 1 now under consideration are by way of clarification, that is, to make clear that "at least 5 mol%" applied only to ethylene, or to supplement the units psig by pascals, or to introduce what will subsequently be shown to be an allowable disclaimer.

4. The Examining Division found that the subject-matter of Claim 1 then under consideration was novel and the Board can agree with this finding in respect of the amended Claim 1 which is of somewhat narrower scope. In any case novelty will be apparent from the discussion of inventive step.
5. For the evaluation of inventive step, Starks is considered to be the more appropriate prior art since it discloses a process for the recovery of ethylene, whereas Bunting does not mention ethylene.
6. Starks discloses a process, clearly non-cryogenic, for recovering ethylene and ethane from a gas stream containing these together with methane and other possible impurities. Starks in its introduction refers to the recovery of ethane and ethylene from gas streams containing 1 to 2 volume percent of these (column 1, lines 14 to 17), though this may be increased somewhat (lines 19 to 21) and in the detailed description, amounts of about 0.05 to about 15 volume percent, preferably about 0.1 to about 3 volume percent are disclosed. The process comprises contacting the gas stream with a solvent in at least one multistage absorption column at a temperature in the range of about -30°C to about $+50^{\circ}\text{C}$ and a pressure in the range of about 3 to about 140 atmospheres (column 2, lines 49 to 55). The temperature range and pressure range required by Claim 1 respectively lie within and overlap the lower end of these ranges. The solvent may be cyclohexane (column 2, lines 3 and 31), which falls within the scope of the solvents required by Claim 1 in feature B2 and is specifically mentioned in Claim 5. The ethylene and ethane are recovered from the rich solvent by release of pressure or by heating (paragraph bridging columns 2 and 3).

7. The subject-matter of Claim 1 differs from the disclosure in Starks mainly in that the gas stream is introduced into the mid-section of an extractor-stripper column equipped with a reboiler and counter-currently contacted therein with lean solvent and in that the ethylene-rich solvent is regenerated in a distillation column equipped with at least one reflux condenser and at least one reboiler. At least to this extent the subject-matter of Claim 1 is novel.

8. A further feature of Claim 1 is that the extractor-stripper column is operated under selected conditions to achieve a methane content of the final fractionated ethylene product ranging from chemical grade ethylene having less than 5 mol% methane to polymer grade ethylene having between 10 and 400 ppm methane by weight, these selected operating conditions being flow rate, temperature and pressure as set out in features a, b and c (see paragraph VI above). The Examining Division, on page 3 of the appealed decision, concluded that since the temperature and pressure ranges overlapped with those disclosed in Starks, and since in Starks the range of flow of the solvent stream is selected in proportion to the rate of flow of the feed stream, citing in this respect column 2, lines 39 to 44 and 51 to 55 (the Board would add column 4, lines 2 to 8), then, in effect, the average skilled person, carrying out the teaching of Starks would carry out just such a selection of operating conditions as is required by Claim 1. The Board however can agree with the Appellant that Starks does not disclose that the selection of operating conditions can result in a product having a maximum methane content of 5 mol percent. A computer simulation of the Starks process was submitted by the Applicant during the examination proceedings (letter dated 6 July 1992), and the presented data showed that the rich solvent contained

8.6% methane, 2% ethylene and 2% ethane. Therefore on separation of the solvent, an ethylene plus product will contain 68% methane, 15.6% ethylene and 16.4% ethane. In the absence of evidence to the contrary, the Board concludes that no amount of adjusting and balancing the operating conditions of the Starks process will achieve a product with a maximum methane content of 5 mole percent, let alone as little as 204 ppm as is possible with the claimed process (see table VI). The feature relating to the selected operating conditions is therefore also not disclosed in Starks, because the operating conditions disclosed in Starks are not such that a product having a maximum methane content of 5 mol percent is obtainable. The Board can therefore agree with the statement (seven and six lines from foot of page 4 of the grounds) that Starks gives only moderate demethanization.

The Board however cannot agree with the statement in the same sentence that Starks gives only moderate efficiency. Column 4, lines 9 and 10 of Starks says that more than 90% of the ethane and ethylene are removed (page 5, line 8 of the grounds says only 90%). It is true that 90% of the combined ethylene and ethane could represent 80% ethylene and 100% ethane but this is surmise. More importantly, from the above-mentioned simulation data an ethylene recovery of 93.8% (21.1 gm mol/hr in the rich solvent, 22.5 gm mol/hr in the feed) can be calculated. This does not seem to be "only moderate efficiency", and the significance will be explained later.

9. Starting from Starks the problem which is the basis of the application in suit can be seen as the provision of a process for extracting ethylene at high efficiency from a feed stream such that the product is of improved purity as regards methane content. This problem is

solved by the combination of features of Claim 1, that is selection of solvent from a defined group, use of an extractor-stripper column equipped with a reboiler, regeneration in a distillation column equipped with a reboiler and selection within specified limits of operating conditions, as is evidenced by the description with reference to Figure 8, in particular Table VI, at least as regards the use of n-heptane as solvent.

10. The question to be answered therefore is whether the said combination of features is obvious or not.

11. Now Bunting discloses many of the features of Claim 1, as is readily apparent by comparing Figure 1 thereof with Figure 8 of the patent in suit. In particular the feed stream is introduced into the mid-section of extractor-stripper column 13 having reboiler 15, and regeneration of the rich solvent is by means of distillation column 23 equipped with reflux 32 and reboiler 25 (see column 9, line 54 to column 10, line 18). The most apparent difference is that in Bunting there is provided a line 36 for recycling part of the product stream to the feed inlet. This does not appear to the Board to be "a completely different form of operation of the extractor stripper column" as argued by the Appellant (page 7 of the grounds for the appeal) but a further feature added to a known process. This known process and apparatus is described in detail in Bunting, column 2, line 63 to column 6, line 51, that is Bunting is disclosing both a process and apparatus using recycling and a process and apparatus not using recycling. The disclosure being sufficiently detailed in the latter case, it appears unnecessary to look at the corresponding US application Nos. 784 566 and 808 463 (column 2, lines 64, 65, no year stated).

12. Bunting also discloses many of the solvents used in the application in suit, both in the discussion of the prior art, column 3, line 62 to column 6, line 10 and in the examples of the claimed process, column 12, lines 21 to 31, and also in Claims 4 to 12. The Appellant's argumentation in this respect (page 7, first complete paragraph) that no specific solvents are taught for the process claimed cannot be followed.

13. It is true that Bunting does not mention ethylene recovery. However the average skilled person knows from Starks that ethylene and ethane are extracted together, and it could therefore be argued that he would expect a process known for ethane recovery also to be applicable to ethylene recovery.

14. Bunting appears to be aiming at a minimum ethane recovery of 80% (4 mols/hr) and maximum methane recovery of 0.2 mols/hr (paragraph bridging columns 10 and 11), so that the maximum desired methane content can be calculated to be 5 mol% as is required by Claim 1 of the patent in suit. It can moreover be calculated from the computer simulation according to Example 1, which omits the recycling step referred to above, that methane content is 9 mol% for an ethane recovery of 44%, from Example 2 (partial recycling), that methane content is 5.3 mol% for an ethane recovery of 75% and from Example 3 (increased recycling) that methane content is 4% for an ethane recovery of 96%.

15. Accordingly the statement on page 6 of the grounds that Bunting shows only moderate demethanisation is not completely correct, though it is true that Example 1 which does not use the recycling feature to which Bunting is directed yields a product with poor ethane recovery and a higher methane content than is sought by the application in suit.

16. The position is therefore that Starks discloses moderate demethanisation and high extraction efficiency (of ethylene and/or ethane). Bunting discloses improved demethanisation as compared with Starks and even higher extraction efficiency (of ethane), as long as the recycling feature is employed. For the person of average skill in the art seeking to achieve the object of the invention as set out in paragraph 9 above there is an indication here to combine the teaching of the two documents and in doing so he would arrive in the Board's view at the subject-matter of Claim 1 as was submitted with the grounds for the appeal, because its wording did not exclude the recycling feature. The Board notes in this respect that the pressure range required by Claim 1 at least abuts that disclosed in Bunting and while the temperature of 40°F disclosed in Bunting is outside the range required by Claim 1, page 44 of the description in the application in suit discloses that 40°F is a suitable temperature and there is no evidence that anything inventive is to be seen in the narrower range.
17. There is of course no incentive to combine the teaching of Sparks with that of Example 1 of Bunting because of the low extraction efficiency and low purity as regards methane disclosed therein. In these circumstances the Board deems it appropriate to distinguish the subject-matter of Claim 1 from that arguably derivable from a combination of the teaching of Sparks with the teaching of Bunting as a whole by means of a disclaimer which excludes from the subject-matter of the claim that part of the result of the said combination which would require recycling. This is a case where, as distinct from the situation discussed in decision T 170/87 (OJ EPO 1989, 441) the subject-matter of the claim incorporating the disclaimer can be held to be non-obvious. It is true that there is no explicit basis in the application documents for the said exclusion. In the

Board's opinion however in the particular circumstances of the present case, the same considerations apply as in the case of a disclaimer imparting novelty, that is to say, it is not necessary for there to be such a basis for the exclusion (see for example decision T 433/86). In any case the disclaimer is wholly consistent with the description of the invention. Figure 8, although schematic, is very detailed, as is the corresponding description, and in the Board's view if the recycling disclosed in Bunting had been contemplated, this would have been mentioned or shown in Figure 8.

18. An indication pointing away from a combination of Sparks and Bunting, while not persuasive in itself as regards non-obviousness of Claim 1 without the disclaimer, is worth mentioning. This is that while Starks mentions cyclohexane as solvent and this is embraced by Claim 1, cyclohexane is not mentioned in Bunting. Starks rather singles out methylpyrrolidone and dimethylformamide as being unsuitable for the disclosed process, whereas these are referred to in Bunting, column 12, line 26 as being suitable solvents. It is clear therefore that the criteria for solvent selection in Starks and Bunting are different.
19. The Board accepts that the very high extraction efficiencies and purities achievable by the claimed process are nowhere suggested in the prior art and that these are obtained without the need for the recycling step disclosed in Bunting. Moreover a further downstream demethanisation process is not required.
20. Accordingly the subject-matter of Claim 1 is seen as involving an inventive step.

21. As recognised by the Appellant, the remainder of the specification requires substantial revision to bring the description into conformity with the amended claim and also to supplement the non-metric units with units permitted by Rule 35(12) EPC. To this end the Board makes use of its power under Article 111(1) EPC to remit the case to the Examining Division.

Order

For these reasons it is decided that:

1. The decision under appeal is set aside.
2. The case is remitted to the Examining Division with the order to grant a patent on the basis of Claim 1 as set out in paragraph VI above, with a description to be adapted to the amended Claim 1, and non-metric units supplemented by units permitted by Rule 35(12) in the description and dependent claims.

The Registrar:

The Chairman:

P. Martorana

C. Black

