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**Datasheet for the decision
of 17 June 2025**

Case Number: T 0725/23 - 3.3.02

Application Number: 16798415.2

Publication Number: 3368631

IPC: C09K5/04, F25J1/02

Language of the proceedings: EN

Title of invention:

METHOD USING HYDROGEN-NEON MIXTURE REFRIGERATION CYCLE FOR
LARGE-SCALE HYDROGEN COOLING AND LIQUEFACTION

Patent Proprietor:

Linde GmbH

Opponent:

L'AIR LIQUIDE, Société Anonyme
pour L'étude et L'exploitation
des procédés Georges Claude

Headword:

LINDE / HYDROGEN LIQUEFACTION

Relevant legal provisions:

EPC Art. 54, 56
RPBA 2020 Art. 12(4)

Keyword:

Main request (filed as auxiliary request 2 before the
opposition division) - admissibly raised and maintained (yes)
Main request - Novelty - (yes) - Inventive Step (yes)
Inventive step - non-obvious alternative



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Case Number: T 0725/23 - 3.3.02

D E C I S I O N
of Technical Board of Appeal 3.3.02
of 17 June 2025

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Decision under appeal:

**Interlocutory decision of the Opposition
Division of the European Patent Office posted on
28 February 2023 concerning maintenance of the
European Patent No. 3368631 in amended form.**

Composition of the Board:

Chairman S. Bertrand
Members: M. Maremonti
 M. Blasi

Summary of Facts and Submissions

I. The appeal by the opponent ("appellant") is against the interlocutory decision of the opposition division, according to which European patent No. 3 368 631 ("the patent") as amended in the form of auxiliary request 1, the claims of which were filed by letter dated 12 February 2021, and the invention to which it relates, meets the requirements of the EPC.

II. Claim 1 of auxiliary request 1 found allowable by the opposition division reads as follows:

"1. Method for liquefying a feed gas stream, said feed gas comprising hydrogen or helium, the method comprising the steps of:

- *providing a feed gas stream (11) comprising the feed gas, wherein said feed gas stream (11) has an initial temperature,*
- *precooling said feed gas stream (11) from said initial temperature to an intermediate temperature in a precooling step yielding a precooled feed gas stream (12),*
- *cooling said precooled feed gas stream (12) from said intermediate temperature to a temperature equal to or below the boiling temperature or the critical temperature of said gas,*
wherein

- *said precooled feed gas stream (12) is cooled to a first temperature in a first cooling step with a first refrigerant stream (21), wherein said first refrigerant stream (21) is expanded, thereby producing cold, and*

said cooled feed gas stream (13) is further cooled from said first temperature to said temperature equal to or below the boiling temperature or critical temperature of said gas in a second cooling step with a second refrigerant stream (31) wherein said second refrigerant stream (31) is expanded, thereby producing cold,

wherein said first refrigerant stream (21) and/or said second refrigerant stream (31) comprises or consists of a refrigerant composition comprising neon and hydrogen."

III. The opposition was based on the ground under Article 100(a) EPC in combination with Articles 54 and 56 EPC. Reference was made, *inter alia*, to the following documents:

- D1: H. Quack *et al.*, "Selection of Components for the IDEALHY Preferred Cycle for the Large Scale Liquefaction of Hydrogen", Advances in Cryogenic Engineering, AIP Conf. Proc. 1573, 2014, pages 237-44
- D4: H. Quack, "CONCEPTUAL DESIGN OF A HIGH EFFICIENCY LARGE CAPACITY HYDROGEN LIQUEFIER", Advances in Cryogenic Engineering: Proceedings of the Cryogenic Engineering Conference, vol. 47, edited by Susan Breon *et al.*, 2002, pages 255-63
- D10: H. Quack *et al.*, "Search for the Best Processes to Liquefy Hydrogen in Very Large Plants", The 12th CRYOGENICS 2012 - Dresden, Germany, pages 281-86
- D13: K. Ohlig and L. Decker, "The Latest Developments and Outlook for Hydrogen Liquefaction Technology", December 2013, found at: <https://www.researchgate.net>

- IV. The opposition division came, *inter alia*, to the following conclusion:
- The subject-matter of claim 1 of auxiliary request 1 was novel over the disclosure in document D4 and involved an inventive step in view of document D1 taken as the closest prior art.
- V. With its statement of grounds of appeal and a subsequent letter, the appellant contested the reasoning of the opposition division and submitted, *inter alia*, that the claimed subject-matter was not novel and lacked inventive step. The appellant also contested the admittance of the auxiliary requests filed by the patent proprietor ("respondent", see below).
- VI. In its reply to the appeal dated 3 November 2023, the respondent rebutted the appellant's arguments and presented its submissions in support of the request considered allowable by the opposition division (main request) and its auxiliary requests. By letter dated 14 December 2023, it filed copies of the sets of claims of auxiliary requests 1 to 4, which had been filed as auxiliary requests 2 to 5 before the opposition division.
- VII. The parties were summoned to oral proceedings as per their requests. In preparation for the oral proceedings, the board issued a communication under Article 15(1) RPBA. In that communication, the board expressed, *inter alia*, the preliminary opinion that the subject-matter of claim 1 of the request found allowable by the opposition division did not involve an inventive step.
- VIII. The respondent replied to the board's communication and submitted further arguments supporting admittance and patentability of its claim requests.

IX. Oral proceedings before the board were held by videoconference on 17 June 2025 in the presence of both parties. During the oral proceedings, the respondent withdrew the main request and auxiliary request 1 and made auxiliary request 2, the set of claims of which were filed by letter dated 14 December 2023, its main request.

X. Final requests relevant to the decision

The appellant requested that the appealed decision be set aside and that the patent be revoked. Additionally, the appellant requested that the main request, filed as auxiliary request 2 by letter dated 14 December 2023, not be admitted.

The respondent requested that the appealed decision be set aside and that the patent be maintained in amended form based on the set of claims of the main request, filed as auxiliary request 2 by letter dated 14 December 2023.

XI. As regards the parties' submissions that are relevant to the decision, reference is made to them in the reasons for the decision below.

Reasons for the Decision

Main request (filed as auxiliary request 2 by letter dated 14 December 2023) - admittance into the proceedings -
Article 12(4) RPBA

1. Claim 1 of the main request differs from claim 1 of the claim request found allowable by the opposition division (point II above) in that the feature at the end of the claim reading:

"wherein said first refrigerant stream (21) and/or said second refrigerant stream (31) comprises or consists of a refrigerant composition comprising neon and hydrogen"

is amended to read (amendments highlighted by the board):

"wherein said first refrigerant stream (21) ~~and/or said second refrigerant stream (31)~~ comprises or consists of a refrigerant composition comprising neon and hydrogen, **wherein said second refrigerant stream consists of hydrogen**".

2. The appellant requested that the main request not be admitted into the proceedings. It argued that this request had been filed late, i.e. only one week prior to oral proceedings before the opposition division, without any justification. When claim requests were filed after the final date set by the opposition division under Rule 116 EPC, these requests could be admitted only if *prima facie* allowable. This condition was not met for the current main request since the claimed subject-matter lacked novelty and inventive step.
3. The board decided that the current main request formed part of the appeal proceedings for the following reasons.
 - 3.1 The main request was filed as auxiliary request 2 before the opposition division. Since the opposition division found the then auxiliary request 1 to be allowable, the appealed decision is not based on the current main request.
 - 3.2 Under Article 12(2) RPBA, a party's appeal case shall be directed, *inter alia*, to the requests on which the decision under appeal was based. Under Article 12(4) RPBA, any part of a party's appeal case

which does not meet the requirements of Article 12(2) RPBA is to be regarded as an amendment, unless the party demonstrates that this part was admissibly raised and maintained in the proceedings leading to the decision under appeal. Any such amendment may be admitted only at the discretion of the board.

- 3.3 Therefore, if the current main request was admissibly raised and maintained before the opposition division, this request is not to be regarded as an amendment to the respondent's case within the meaning of Article 12(4) RPBA. If this is the case, the board has no discretion not to admit this request under Article 12(4) RPBA.
- 3.4 There is no doubt that the current main request was maintained before the opposition division, see e.g. the appealed decision, page 2, point XII.
- 3.5 As regards the issue of whether the request was admissibly raised, the course of events during the opposition proceedings was considered by the board:
- By summoning the parties to oral proceedings scheduled for 30 January 2023, the opposition division set 30 November 2022 as the final date for making written submissions and/or amendments under Rule 116 EPC.
 - By letter dated 23 November 2022, the appellant provided further submissions to contest patentability of the claimed subject-matter, *inter alia* in view of the disclosure in document D1.
 - By letter dated 30 November 2022, the respondent made various submissions to support patentability of the claimed subject-matter in view of the cited prior art.

- By letter dated 5 January 2023, the appellant made additional submissions contesting novelty of the claimed method.
- By letter dated 24 January 2023, the respondent filed the current main request as auxiliary request 2.

3.6 The respondent referred to its letter dated 24 January 2023 and submitted that the current main request had been filed in direct response to the submission made by the appellant for the first time in its letter dated 23 November 2022 regarding the interpretation of the first cooling step and the second cooling step as defined in the claimed method. Based on this new interpretation, the appellant had considered both cooling steps as being anticipated by D1. In particular, the respondent referred to the appellant's submission on the second page of the letter dated 23 November 2022 under "*Deuxième lecture possible de D1*". The respondent also highlighted that the letter could not have been filed much earlier in view of the need to consult the client and the Christmas break which was coming up at that time.

3.7 At the oral proceedings before the board, the appellant did not contest that its submission referred to by the respondent had been made for the first time in the letter dated 23 November 2022, nor that the current main request was a reaction thereto. Nevertheless, it argued that a reaction to this submission should have been submitted before the final date set under Rule 116 EPC, for example with the respondent's letter dated 30 November 2022 (see above).

3.8 However, the board considers that it is already debatable whether the appellant's letter dated 23 November 2022 had reached the respondent before the

final date set under Rule 116 EPC. In fact, in its letter dated 30 November 2022, the respondent did not refer to the appellant's letter dated 23 November 2022, let alone to the submission made on page 2 referred to above. Furthermore, the formulation of amendments as fallback positions always requires a certain amount of time. Thus, if the appellant's letter dated 23 November 2022 had reached the respondent before the final date set under Rule 116 EPC, it could not have been expected of the respondent to reply to the appellant's submissions made on 23 November 2022 before the final date set under Rule 116 EPC.

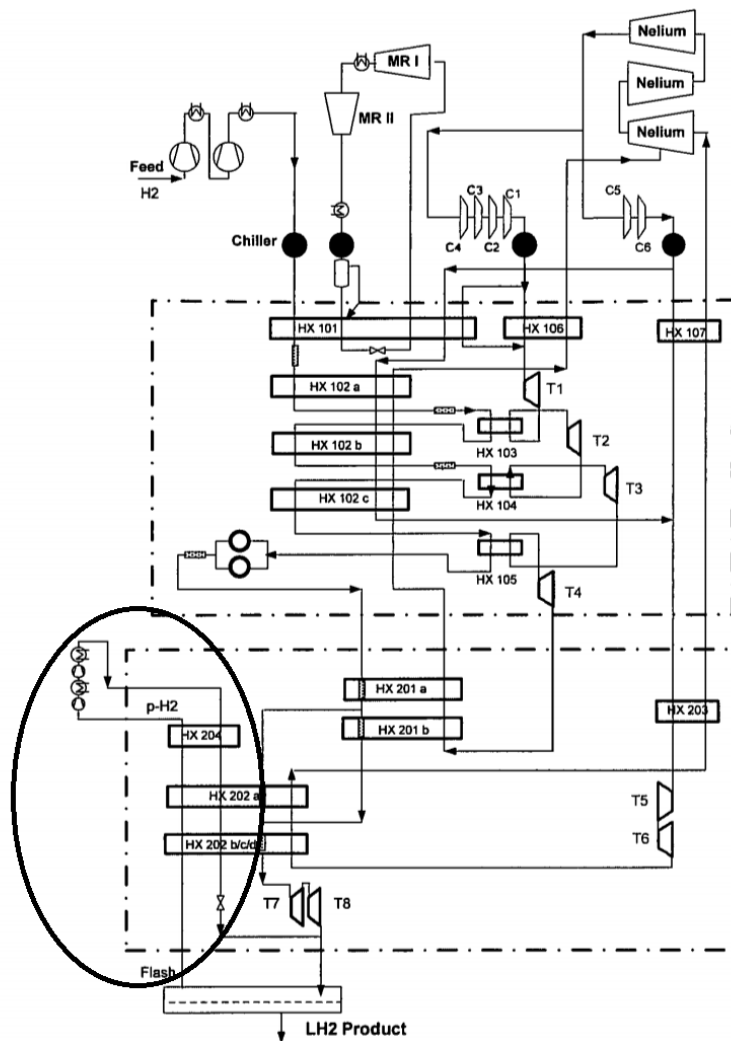
- 3.9 Moreover, the board considers that the amendment to claim 1 in the current main request represented a legitimate and serious attempt to distinguish the claimed subject-matter from the disclosure in D1 in view of the appellant's late submission referred to above (see considerations on inventive step below). Therefore, in the case at hand, the filing of the current main request in written proceedings with the letter dated 24 January 2023 was justified.
- 3.10 The board thus concluded that the opposition division should have admitted the current main request had a decision in this regard been required. Therefore the current main request was admissibly raised and maintained before the opposition division and the board had no discretion not to admit this request (Article 12(4) RPBA).

Main request (filed as auxiliary request 2 by letter dated 14 December 2023) - claim 1 - novelty under Article 54 EPC

4. The appellant argued that the subject-matter of claim 1 of the main request was not novel over the disclosures in both D1 and D4.

Document D1

5. Document D1 discloses (abstract, pages 237 to 240, figure 1) a method for liquefying a feed gas stream containing hydrogen. Reference is made to figure 1 of D1 reproduced below (circle in the figure inserted by the board):



The feed gas is pre-cooled in the heat exchanger HX 101 with a main refrigerant (MR), thus producing a pre-cooled feed stream. This pre-cooled feed stream is cooled to a first non-specified temperature in a first cooling step carried out in heat exchangers HX 102a, HX 103, HX 102b, HX 104, HX 102c, HX 105, HX 201a and HX 201b with a first refrigerant stream (see "Neelium"

stream passing through compressors C1 to C4), which is expanded in turbines T1 to T4, thereby producing the cold needed for the first cooling step. The cooled feed stream is further cooled from the first temperature to a temperature of about 26.8 K (second bullet point on page 237), i.e. below the critical point of hydrogen (33 K), in a second cooling step carried out in heat exchangers HX 202a and HX 202b/c/d with a second refrigerant stream (see "Neliium" stream passing through compressors C5 and C6), which is expanded in turbines T5 and T6, thereby producing the cold needed for the second cooling step. As regards the composition of the "Neliium" refrigerant stream, D1 discloses (page 239) that a mixture of 75% helium and 25% neon ("Neliium 25") is used. The liquefied feed stream is finally expanded in turbines T7 and T8 so to obtain the liquefied hydrogen product ("LH2 Product"). According to D1 (third bullet point at top of page 239), the outlet stream of turbine T8 contains a certain amount of flash hydrogen gas, which is warmed up to ambient temperature, compressed, cooled, condensed and throttled into the storage dewar (see also the encircled loop in figure 1 above).

- 5.1 The appellant argued that D1 disclosed in table 1 on page 239 three equivalent alternative refrigerants to be used as first refrigerant stream in all the heat exchangers HX 102a, HX 103, HX 102b, HX 104, HX 102c, HX 105, HX 201a, HX 201b, HX 202a and HX 202b/c/d. These equivalent refrigerants were helium-neon, hydrogen-neon and hydrogen-helium-neon mixtures. The selection of a hydrogen-neon mixture as required by claim 1 of the main request from this single list did not confer novelty. Moreover, D1 disclosed a second refrigerant stream consisting of hydrogen. This stream originated from the flash gas at the outlet of turbine T8. Indeed, this flash gas was compressed, cooled and

then expanded through a valve (see encircled loop in figure 1 above), thereby producing cold as required of the second refrigerant stream by claim 1 of the main request. Therefore D1 disclosed all the features of claim 1 of the main request in combination.

5.2 The board disagrees for the following reasons.

5.2.1 Contrary to the appellant's view, D1 does not disclose three equivalent refrigerant mixtures. In fact, having examined advantages and disadvantages of hydrogen, helium and neon as cryogenic refrigerants below 60 K (see table 1 on page 239 of D1), D1 states that the Nelium 25 mixture (see above) was chosen as the refrigerant to be used in the above-mentioned method. No mixture of hydrogen and neon is disclosed in D1 as being used as a refrigerant in a method for liquefying a hydrogen-containing feed stream.

5.2.2 The appellant further argued that, on the basis of the information in table 1 of D1, the skilled person would have seriously contemplated replacing helium with hydrogen in the refrigerant mixture of D1. However, this argument concerns the issue of inventive step of the claimed method and is not relevant for alleging lack of novelty, as the latter requires direct and unambiguous disclosure of all the claimed features in combination.

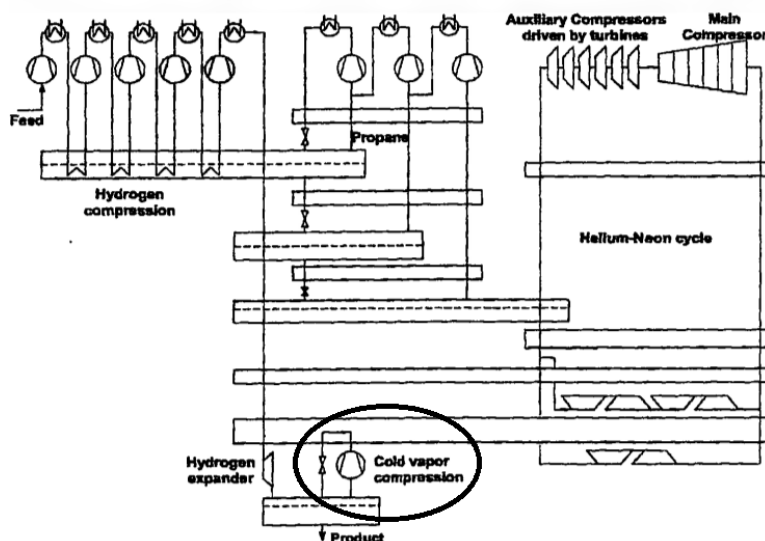
5.2.3 Moreover, as explained above, the Nelium 25 mixture is used in the method of D1 as both the first and second refrigerant streams within the meaning of claim 1 of the main request. In fact, the only sensible reading of claim 1 is that the cold produced by the expansion of the first and second refrigerant streams is used to perform the first and second cooling steps as defined in the claimed method. The board concurs with the respondent's view that the flash hydrogen gas

originating after the expansion in turbine T8 cannot represent the second refrigerant stream as defined in claim 1 of the main request. As argued by the respondent, this flash gas is merely condensed in the loop illustrated in the circle in figure 1 of D1 above. Even if the expansion of this condensed gas through the valve downstream from heat exchanger HX 202 b/c/d produces cold, this cold is not used to cool the feed gas as required by claim 1 of the main request.

5.3 Therefore the board concluded that the subject-matter of claim 1 of the main request is novel over the disclosure in D1.

Document D4

6. D4 discloses (abstract, pages 257 to 260, figure 7 on page 263) a method for liquefying a feed gas stream containing hydrogen as illustrated by figure 7 reproduced below (circle in the figure inserted by the board):



The feed gas is precooled to 220 K using a propane vapour compression refrigerator, thus producing a precooled feed stream (first paragraph of page 259 of D4). This precooled feed stream is cooled to 73 K

(second paragraph of page 259 of D4) in a first cooling step with a first refrigerant stream, which is expanded in four turbines (figure 7, right-hand side, bottom), thereby producing the cold needed for the first cooling step. The cooled feed stream is further cooled to 25 K (second heading on page 259 of D4), i.e. below the critical point of hydrogen (33 K), in a second cooling step with a second refrigerant stream, which is expanded in two turbines (figure 7, right-hand side, bottom, below the above-mentioned four turbines), thereby producing the cold needed for the second cooling step. As regards the composition of the first and second refrigerant streams, D4 discloses (page 259, second paragraph and last full paragraph) that a mixture of helium and neon is used for both the first and second cooling steps. The liquefied feed stream is finally expanded in a hydrogen expander (figure 7, left-hand side, bottom). According to D4 (page 260 under "*Cooling from 25 K to the storage condition*"), this expansion produces a certain amount of flash hydrogen gas which is compressed by a cold compressor to a pressure level from which it can be condensed by the helium cycle. At the outlet of this condenser the hydrogen is throttled (see encircled loop in figure 7 above).

- 6.1 In analogy to its line of argument in view of D1, the appellant submitted that on page 259 D4 disclosed a list of equivalent refrigerants to be used for the first cooling step. The selection of a hydrogen-neon mixture as required by claim 1 of the main request from this single list did not confer novelty. Moreover, D4 disclosed a second refrigerant stream consisting of hydrogen. This stream originated from the flash gas at the outlet of the hydrogen expander. Indeed, this flash gas was subject to cold compression and then expanded through a valve (see the encircled loop in figure 7

above), thereby producing cold as required of the second refrigerant stream by claim 1 of the main request.

6.2 This line of argument is not convincing.

6.2.1 As submitted by the respondent, contrary to the appellant's view, D4 does not disclose hydrogen-containing mixtures to be used as refrigerants. On the contrary, on page 259, having discussed possible refrigerant gases, D4 states that a helium-neon mixture was chosen as the refrigerant to be used in the above-mentioned method. No mixture of hydrogen and neon is disclosed in D4, let alone as a mixture used in a method for liquefying a hydrogen-containing feed stream. As regards the appellant's argument that the skilled person would have seriously contemplated replacing helium with hydrogen in the refrigerant mixture of D4, the same observations by the board made above in respect of D1 apply.

6.2.2 Moreover, as set out above, a helium-neon mixture is used in the method of D4 as both first and second refrigerant streams within the meaning of claim 1 of the main request. The board concurs with the respondent's view that the flash hydrogen gas originating after the expansion in the hydrogen expander does not represent the second refrigerant stream as defined in claim 1 of the main request. As argued by the respondent, this flash gas is merely condensed in the loop illustrated in the circle in figure 7 of D4 above. Even if the expansion of this condensed gas through the valve downstream of the cold vapour compression produces cold, this cold is not used to cool the feed gas as required by claim 1 of the main request.

6.3 Therefore the board concluded that the subject-matter of claim 1 of the main request is novel over the disclosure in D4.

Main request (filed as auxiliary request 2 by letter dated 14 December 2023) - claim 1 - inventive step under Article 56 EPC

7. Closest prior art

The appellant raised inventive-step objections against the subject-matter of claim 1 of the main request in view of either D1 or D4 as the closest prior art. For the disclosures in D1 and D4, reference is made to the considerations on novelty set out above.

Starting from D1

8. Distinguishing features

8.1 The appellant argued that the sole possible distinguishing feature of the claimed method over D1 was that the first refrigerant stream comprised or consisted of a composition comprising neon and hydrogen. Indeed, as already submitted for its novelty objection, the appellant argued that the flash gas originating at the outlet of turbine T8 (figure 1 of D1) consisted of hydrogen and represented the second refrigerant stream as required by the claimed method.

8.2 However, for the reasons set out above in respect of novelty, the flash gas originating at the outlet of turbine T8 of D1 is not a refrigerant stream within the meaning of claim 1 of the main request. It follows that, as submitted by the respondent, the claimed method differs from D1 in that

- the first refrigerant stream comprises or consists of a composition comprising neon and hydrogen, and
- the second refrigerant stream consists of hydrogen.

In fact, as explained above, the method of D1 uses a mixture of helium and neon as both first and second refrigerant streams.

9. Objective technical problem

9.1 The appellant submitted that no technical effect was associated with the distinguishing features mentioned above. Therefore the objective technical problem was the provision of an alternative method for liquefying a feed gas comprising hydrogen.

9.2 In the appellant's favour, the board accepts this formulation of the objective technical problem.

10. Obviousness of the claimed solution

10.1 The appellant argued that D1 disclosed on page 239 that hydrogen, helium, neon and their mixtures might alternatively be used as refrigerants for liquefying hydrogen. Therefore the choice of a hydrogen-neon mixture for the first refrigerant stream and pure hydrogen for the second refrigerant stream constituted an obvious alternative for the skilled person in view of D1 alone. Moreover, the same disclosure as in D1 was found in document D10, see page 284, first bullet point under point 5 and fifth bullet point under point 6. Document D13 disclosed the liquefaction of hydrogen by using pure hydrogen as the refrigerant, see figure 3. Under the paragraph "*Future Developments*" of D13, it was particularly stated that neon should be avoided since it could freeze out due to its boiling point of 42 K. In view of these disclosures, it had to be concluded that the subject-matter of claim 1 of the main request lacked inventive step.

10.2 The board disagrees.

- 10.2.1 As set out above, D1 on page 239 (table 1), having discussed advantages and disadvantages of hydrogen, helium and neon as refrigerants below 60 K, discloses that the choice is a mixture of 75% helium with 25% neon. This refrigerant mixture is used as first and second refrigerant streams within the meaning of claim 1 of the main request. The alternative of using two separate refrigerant streams is not disclosed in D1, let alone a second refrigerant stream consisting of hydrogen.
- 10.2.2 The same disclosure is found in document D10 under points 5 and 6 on pages 284 and 285. In fact, here too a discussion is held about advantages and disadvantages of hydrogen, helium and neon as refrigerants. D10 concludes (page 285, paragraph following figure 3) that "*[i]t is not yet clear, whether the refrigerant in the low temperature cooling loop will be pure helium or a mixture of helium and neon. This depends on the available technology for the main turbo compressor. Pure helium requires very high circumferential speeds of the compressor blades. The addition of the neon would make this task easier.*" Thus D10 too suggests a single helium-neon refrigerant mixture, specifically teaching away from using separate refrigerant streams, let alone a pure hydrogen stream as the second refrigerant stream as required by claim 1 of the main request.
- 10.2.3 As submitted by the respondent, D13, under "*CURRENT TECHNOLOGY*", discloses that hydrogen can be liquefied by using either a pure helium Brayton cycle (figure 2 of D13) or a pure hydrogen Claude cycle (figure 3 of D13). The possibility of using two different refrigerant streams as defined in the claimed method is not disclosed. Under "*FUTURE DEVELOPMENTS*", D13 suggests that improvements could be achieved by

shifting to more-efficient turbocompressors. However, according to D13, this solution can be adopted only by adding a component, e.g. neon, to hydrogen. This solution would require an adjustment of the refrigeration loop at its cold end to prevent neon freeze-out. Therefore, contrary to the appellant's view, and as argued by the respondent, D13 teaches away from using pure hydrogen at the cold end of the refrigerant cycle; in contrast thereto, it suggests using a hydrogen-neon mixture and ensuring that possible freeze-out of neon is avoided.

- 10.2.4 Therefore the board concluded that, starting from D1, neither one of D1, D10 or D13 suggests the claimed alternative of using the two separate refrigerant streams as defined in claim 1 of the main request.

Starting from D4

11. Distinguishing features

- 11.1 The appellant argued that the sole possible distinguishing feature of the claimed method over D4 was that the first refrigerant stream comprised or consisted of a composition comprising neon and hydrogen.

- 11.1.1 In a first line of argument, and as already submitted for its novelty objection (see above), the appellant argued that the flash gas originating at the outlet of the hydrogen expander (figure 7 of D4) consisted of hydrogen and represented the second refrigerant stream as required by the claimed method.

- 11.1.2 However, for the reasons set out above in respect of novelty, the flash gas originating at the outlet of the hydrogen expander of D4 is not a refrigerant stream within the meaning of claim 1 of the main request.

11.1.3 In a second line of argument, the appellant referred to page 259 of D4, distinguishing a first cooling step from 300 to 73 K and a second cooling step from 73 to 25 K. These two steps corresponded to the first and second cooling steps as required by the claimed method. The appellant submitted that, for the second cooling step, the use of pure hydrogen was disclosed as a possible alternative to be selected from a single list.

11.1.4 This line of argument is not convincing either. As submitted by the respondent, on page 259, D4, having stated that for the cooling step from 300 to 73 K one had the choice between mixtures of nitrogen, neon, hydrogen or helium as refrigerant, states that the classical solution would be to use nitrogen; however, a helium-neon mixture was opted for. As regards the cooling from 73 to 25 K, D4 discloses on page 259 that "*one has the choice between neon, hydrogen and helium as the refrigerant*". However, having examined advantages and disadvantages, the choice was again a helium-neon mixture. Thus D4 does not disclose the use of two different refrigerant streams in a method for the liquefaction of hydrogen, let alone a second refrigerant stream consisting of hydrogen as required by the claimed method.

11.2 It follows that, as submitted by the respondent, the claimed method differs from D4 in that

- the first refrigerant stream comprises or consists of a composition comprising neon and hydrogen, and
- the second refrigerant stream consists of hydrogen.

12. Objective technical problem

12.1 The appellant submitted that no technical effect was associated with the distinguishing features mentioned above. Therefore the objective technical problem was

the provision of an alternative method for liquefying a feed gas comprising hydrogen.

- 12.2 In the appellant's favour, the board accepts this formulation of the objective technical problem.
13. Obviousness of the claimed solution
- 13.1 The appellant argued that using a hydrogen-neon mixture for the first refrigerant stream and pure hydrogen for the second refrigerant stream merely represented an obvious choice among alternatives disclosed in D4 as all being equivalent to each other. Alternatively, the claimed solution would have been obvious to the skilled person from D13. In this respect, the arguments were the same as when starting from D1 (see above).
- 13.2 The board disagrees. As noted above, D4 does not present hydrogen, helium, neon and their mixtures as equivalent refrigerants for the liquefaction of hydrogen. In contrast, having examined advantages and disadvantages, D4 discloses (second paragraph under "COOLING FROM 300 TO 73 K") using a helium-neon mixture for the cooling from 220 to 73 K. Moreover, it states (third paragraph under "COOLING FROM 73 TO 25 K") that for the cooling between 73 and 25 K "*it turns out that the optimum lies somewhere between helium and neon. Our strategy is to do the process design on the basis of helium as the refrigerant. Then some of the helium is replaced by neon until the turbocompressor and the expander/compressors are satisfied*". Therefore D4 proposes the use of a helium-neon mixture as both the first and second refrigerant streams within the meaning of claim 1 of the main request. As regards D13, the same observations by the board as set out above in respect of D1 as the closest prior art apply *mutatis mutandis*.

13.3 Therefore the board concluded that, starting from D4, neither D4 nor D13 suggests the claimed alternative of using the two separate refrigerant streams as defined in claim 1 of the main request.

14. For these reasons, the board concluded that the subject-matter of claim 1 of the main request involves an inventive step within the meaning of Article 56 EPC.

Conclusion

15. Since no other objections were raised against the main request by the appellant, the board concluded that the main request is allowable.

Order

For these reasons it is decided that:

1. The decision under appeal is set aside.
2. The case is remitted to the opposition division with the order to maintain the patent in amended form with claims 1 to 14 of the main request, filed as auxiliary request 2 with the letter dated 14 December 2023, and a description and drawings possibly adapted thereto.

The Registrar:

The Chairman:



U. Bultmann

S. Bertrand

Decision electronically authenticated