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Datasheet for the decision of 29 January 2016

Case Number: T 1403/12 - 3.2.03

Application Number: 06127190.4

Publication Number: 1939564

IPC: F25J1/02

Language of the proceedings: EN

Title of invention:
Process to obtain liquefied natural gas

Applicant:
Repsol, S.A.

Headword:

Relevant legal provisions:
EPC Art. 56, 111(1)
EPC R. 115(2)
RPBA Art. 12(4)

Keyword:

Inventive step - (no)
Appeal decision -
remittal to the department of first instance (no)
Summons to oral proceedings -
continuation of proceedings without duly summoned party
Late-filed request -
request could have been filed in first instance proceedings (yes)

Decisions cited:

Catchword:

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Case Number: T 1403/12 - 3.2.03

D E C I S I O N
of Technical Board of Appeal 3.2.03
of 29 January 2016

Appellant: (Applicant)	Repsol, S.A. C/Méndez Álvaro, 44 28045 Madrid (ES)
Representative:	Pons Ariño, Angel Pons Patentes y Marcas Internacional, S.L. Glorieta Rubén Dario 4 28010 Madrid (ES)
Decision under appeal:	**Decision of the Examining Division of the European Patent Office posted on 20 March 2012 refusing European patent application No. 06127190.4 pursuant to Article 97(2) EPC.**

Composition of the Board:

Chairman	G. Ashley
Members:	C. Donnelly
	E. Kossonakou

Summary of Facts and Submissions

I. The appeal lies from the decision of the examining division to refuse the European patent application.

II. The applicant (hereinafter: the "appellant") filed an appeal against this decision in due form and time. It requested that the contested decision be set aside and that a patent be granted on the basis of the main request filed with the grounds of appeal, or alternatively, on the basis of one of the first to fourth auxiliary requests also filed with the grounds, or that the application be remitted to a different examining division for further prosecution.

The appellant also made an auxiliary request for oral proceedings.

III. The board informed the appellant of its provisional opinion in a communication pursuant to Articles 15(1) and 17(2) RPBA, dated 26 October 2015. In particular, it indicated that EP 1 092 931 A1 (D4) appeared to be very relevant to the question of inventive step for all the requests, and that the admissibility of the auxiliary requests would require discussion in view of Article 12(4) RPBA.

IV. By letter of 26 January 2016 the appellant simply informed the board that it would not be attending the oral proceedings scheduled for 29 January 2016. Oral proceedings were duly held on 29 January 2016 in the absence of the appellant (Rule 115(2) EPC).

V. State of the art

The examining division cited the following documents during the examination procedure.

D1: US 2004/083756 A1;
D2: US-A-5931 021;
D3: FR-A-1 542 232;
D4: EP 1 092 931 A1;
D5: W.R. True: "Reducing scale, increasing flexibility are targets of new LNG designs", Oil and Gas Journal, 6 December 1999, pages 54 to 61;
D6: D. Harrold: "Design a turnkey floating LNG facility", Hydrocarbon Processing, July 2004, pages 47 to 51;
D7: DE 12 68 161 B;
D8: W. Bach "Offshore Erdgasverflüssigung mit Stickstoffkälte - Prozeßauslegung und Vergleich von Gewickelten Rohr- und Plattenwärmetauschern", Linde Berichte aus Technik und Wissenschaft 1990, no.64, Wiesbaden, DE.

VI. Independent claim 1 according to the main request reads:

"A system of production of Liquefied Natural Gas (LNG) comprising:

- an offshore mobile structure, and
- a natural gas liquefaction plant installed on the offshore mobile structure using air as a refrigerant which comprises:

at least one compressor (105,107,109) where the air (12) is compressed to obtain a compressed air stream (18),

at least one expander (112, 113) where a cooled compressed air stream (19) is expanded to obtain a (sic) expanded air stream (24,25)
at least one heat exchanger (100, 120, 101) where the natural gas stream (2,5) is cooled with an end-flash gas stream (9,10) and with the expanded air stream (24,25) to obtain a cooled liquid natural gas (6),
an expansion device (102) where the cooled natural gas (6) is expanded to obtain an expanded cooled natural gas (7), and
an end flash vessel (103) where the expanded cooled natural gas (7) is separated in liquefied natural gas LNG (8)and in the end-flash gas (9), being used as a fuel gas within the system."

Independent claim 10 of the main request reads:

"A method of production of liquefied natural gas (LNG), which comprises the following steps being performed on an offshore mobile structure:
a. taking air (12) as refrigerant fluid of the natural gas stream,
b. compressing the air (12) to obtain a compressed air stream (18);
c. cooling the compressed air (18) to obtain a cooled compressed air stream (19);
d. expanding said cooled air stream (19) to obtain an expanded air stream (24,25);
e. passing an end-flash gas stream and the expanded air stream (24,25) through a heat exchanger (101) for cooling the natural gas stream (2,5) to obtain a cooled liquid natural gas (6)
f. expanding the cooled liquid natural gas (6) to obtain an expanded natural gas (7) and separating said expanded natural gas in liquid (LNG) (8) and the end flash gas (9),

g. the end-flash gas being used as a fuel gas."

First auxiliary request

Claim 1 according to the first auxiliary request reads:

"A movable system for liquefying natural gas comprising a barge or a ship provided with a natural gas liquefaction plant comprising:
at least one compressor (105, 107, 109) where a refrigerant (12) is compressed to obtain a compressed refrigerant stream (18),
at least one expander (112, 113) where a cooled compressed refrigerant stream (19) is expanded to obtain an expanded refrigerant stream (24, 25),
at least one heat exchanger (100, 120, 101) where the natural gas stream (2, 5) is cooled with at least the expanded refrigerant stream (24, 25) to obtain a cooled liquid natural gas (6),
an expansion device (102) where the cooled natural gas (6) is expanded to obtain an expanded cooled natural gas (7),
characterized in that

the plant further comprises an end-flash vessel (103) where the expanded cooled natural gas (7) is separated in liquefied natural gas LNG (8) and in an end-flash gas stream (9) and wherein the heat exchanger (100, 120, 101) is further provided with the end flash gas stream (9) to obtain the cooled liquid natural gas (6), said end-flash gas being used as a fuel gas within the plant, and in that the refrigerant is air."

Second auxiliary request

The amended claim 1 is based on claim 1 of the first auxiliary request, but also includes the feature:

"and in that the refrigerant is air continuously taken from the environment at atmospheric conditions in an open cycle or having a point for making-up air from the environment in a closed cycle, the plant further comprising a treating plant to remove CO_2 and water from said air taken from the environment."

Third auxiliary request

The amended claim 1 is based on claim 1 of the second auxiliary request and comprises the additional features of:

"a first heat exchanger (100) for the pre-cooling of the compressed refrigerant stream (18) and the natural gas stream (2) which comprises:
an inlet for the compressed refrigerant stream (18),
an inlet for the natural gas stream (2),
an inlet for the end-flash gas stream (10) and an inlet for refrigeration stream (25) emerging from a second heat exchanger (101),
an outlet for cooled compressed refrigerant (19),
an outlet for a refrigerant stream (12) which is further connected to the compressor (105,107,109) in the closed refrigeration cycle or with the atmosphere (26) in the open refrigeration cycle,
one second heat exchanger (101) where the natural gas stream is cooled with the end-flash gas stream (9) and with the expanded refrigerant stream (24) providing

enough cooling to liquefy the natural gas stream to obtain a cooled liquid natural gas (6)."

Fourth auxiliary request

Claim 1 of the fourth auxiliary request reads:

"A system of production of Liquefied Natural Gas (LNG) comprising:

- an offshore mobile structure, and
- a natural gas liquefaction plant installed on the offshore mobile structure which comprises an open or a closed air (12) refrigerant cycle wherein in the open cycle the air (12') is continuously taken from the environment at atmospheric conditions and in the closed cycle has a point for making-up air from the environment, the air refrigerant cycle comprising a treating plant (C) to remove CO_2 and water from the air taken from the environment,
the plant also comprising:
at least one compressor (105,107,109) where said air (12) is compressed to obtain a compressed air stream (18),
at least one expander (112, 113) where a cooled compressed air stream (19) is expanded to obtain a (sic) expanded air stream (24,25),
a first heat exchanger (100) for the pre-cooling of the compressed air stream (18) and the natural gas stream (2) which comprises:
an inlet for the compressed air stream (18),
an inlet for the natural gas stream (2),
an inlet for the end-flash gas stream (10) and an inlet for air refrigeration stream (25) emerging from a second heat exchanger (101),
an outlet for the cooled compressed air (19),

an outlet for an air stream (12) which is further connected to the compressor (105,107,109) in the closed refrigeration cycle or with the atmosphere (26) in the open refrigeration cycle,
one second heat exchanger (101) where the natural gas stream (5) is cooled with an end-flash gas stream (9) and with the expanded air stream (24) providing enough cooling to liquefy the natural gas stream to obtain a cooled liquid natural gas (6),
an expansion device (102) where the cooled natural gas (6) is expanded to obtain an expanded cooled natural gas (7), and
an end flash vessel (103) where the expanded cooled natural gas (7) is separated in liquefied natural gas LNG (8)and in the end-flash gas (9), being used as a fuel gas within the system."

Corresponding amendments have been made to the independent method claims of each request.

VII. Appellant's case, main request

Starting out from D1 or D3, the subject-matter of claim 1 according to the main request not only differs in that:

(i) the system is installed on an offshore mobile structure, and;
(ii) the system further comprises an end-flash vessel for separating the expanded cooled natural gas in liquid natural gas (LNG) and an end-flash gas, wherein the latter is used to cool the natural gas stream in the at least one heat exchanger and the fuel gas being used as fuel gas within the system,

but also in that:

(iii) the refrigerant is atmospheric air (instead of nitrogen or oxygen as disclosed in D1 or liquefied air as disclosed in D3).

The objective technical problem according to the appellant is therefore how to produce LNG on an offshore mobile structure with a refrigerant not produced on board and not depending on any external source of energy, i.e. how to produce LNG on an offshore mobile structure in a self-sufficient way.

The three distinguishing features identified above all contribute to solving this problem in a synergistic fashion, and the examining division was incorrect to argue that each feature could be handled separately when assessing inventive step.

Further, the examining division failed to provide any evidence that using the flash gas both for cooling the natural gas and as a fuel is well known in the art.

First auxiliary request

The amended claim is directed to a movable system for liquefying natural gas comprising a barge or ship provided with a natural gas liquefaction plant instead of claiming a system of LNG production comprising an offshore mobile structure.

This amendment clarifies the technical problem of producing LNG on a movable structure, which is self-sufficient in terms of refrigerant.

Second auxiliary request

The amendment makes it clear that the refrigerant air is taken from the environment.

Third auxiliary request

The additional features define that in order to achieve a self-sufficient movable structure, a pre-cooling of the natural gas stream and air stream is made by the countercurrent passage of air refrigerant stream and of the flash gas. This also leads to a warming of the flash gas which is then in an optimum condition for use as a fuel gas.

Fourth auxiliary request

This request is essentially a combination of the second and third auxiliary requests.

Reasons for the Decision

1. Remarks concerning the contested decision

1.1 During the oral proceedings held on 8 December 2011, the examining division understood that the appellant had requested a decision "according to the state of file". Accordingly, it issued the minutes on 29 December 2011 and then referred to these by way of the EPO Form 2061 for communicating a decision according to the state of the file. Although this is an unusual procedure, since the immediate issue of a conventional decision would have been the straightforward manner in which to bring

the proceedings to an end, the appellant has not raised any objections in this respect.

1.2 Further, from the minutes, which essentially form the reasoning for the decision, it can be established that the examining division considered that the subject-matter of the new main request filed during the oral proceedings of 8 December 2011 (corresponding to the main request in these appeal proceedings) lacked an inventive step taking D1 or D3 as the closest prior art in combination with D5, D6 or D8, which all disclose floating natural gas liquefaction systems, and D7 which shows cold recovery from flash gas; or, alternatively, with D5 as the closest prior art and in combination with D1 to D3.

2. Relevance of the prior art

2.1 The board accepts the appellant's point of view that D1 relates to a different type of cooling installation than that of the application, namely one using a classic double column arrangement in which the actual cooling of the natural gas is done in the main heat exchanger by nitrogen and oxygen streams which have been separated out from the feed air in the double column.

2.2 The board also agrees with the appellant that D2 explicitly states that flash gas is to be avoided (see column 1, lines 56 to 57).

2.3 D3 discloses a system which partly relies on using the "cold" already stored in a shipment of either liquid nitrogen or liquid air which is sent to the natural gas production site where it is used to produce LNG which is then shipped back in the same vessel. The "cold" in the LNG is then used in turn in the production of the liquid

nitrogen or air when it is vaporised at the point of sale. Nevertheless, the arrangement shown in figure 8 of D3 employs a similar cascade arrangement of compressors, intercoolers and expanders to produce cold. However, as pointed out by the appellant, there is no mention of using the flash gas in cooling the natural gas stream or as a fuel, as is required by the present invention.

2.4 D5 describes various arrangements for liquefying natural gas on offshore platforms. However, although there is a reference to the flash gas being used for cooling on page 60, 3rd column, paragraphs 2 to 4, the appellant is correct in indicating that what is used as a fuel gas is not any end-flash gas, but an extraction from the medium pressure level of the natural gas stream (see page 60, 3rd column, paragraph 1, opening sentence "At a medium pressure level, a fuel gas stream is taken for turbines or engine drivers").

2.5 Although D7 mentions the flash gas being used for cooling the natural gas stream, it uses a methane compression expansion cycle to provide the additional cooling and does not mention fuel gas.

2.6 D4 was not mentioned by the examining division during the oral proceedings. However, it is the only document cited in the European search report which discloses flash gas being used both to cool the natural gas stream (in heat exchanger 128) and as a fuel (see in particular figure 1, column. 10, lines 11 to 32; also infra, point 3.1). For this reason, the board considers that the skilled person would consider this document to be highly relevant and to form the most promising starting point for assessing inventive step. This assessment also addresses the appellant's argument that the examining division failed to provide any evidence that using the

flash gas both for cooling the natural gas and as a fuel is well known in the art.

3. Main request, inventive step, Article 56 EPC

3.1 D4 discloses:

a system of production of Liquefied Natural Gas (LNG) comprising:

- a natural gas liquefaction plant using a gas as a refrigerant which comprises:

at least one compressor (168) where the gas is compressed to obtain a compressed gas stream (162),
at least one expander (166) where a cooled compressed gas stream (162) is expanded to obtain an expanded air stream (130),
at least one heat exchanger (128) where the natural gas stream (126) is cooled with an end-flash gas stream (138) and with the expanded air stream (130) to obtain a cooled liquid natural gas (132),
an expansion device (134) where the cooled natural gas is expanded to obtain an expanded cooled natural gas, and
an end flash vessel (136) where the expanded cooled natural gas is separated in liquefied natural gas LNG and in the end-flash gas (138) being used as a fuel gas within the system (see column 10, lines 29 to 32).

3.2 The system of claim 1 differs from D4 in that:

(i) it is installed on an offshore mobile structure; and
(ii) the gas used in the gas expander cycle is air.

3.3 The technical effect of these features is to provide a mobile LNG installation which uses a readily available refrigerant even in remote locations.

The objective technical problem can therefore be defined as one of how to provide LNG production facilities to exploit gas reserves in remote locations.

3.4 Faced with this problem the skilled person is taught by, for example, D5 that LNG production facilities can be placed on offshore mobile structures such that they may be transported to remote locations (see in particular page 54, middle column, lines 1 to 11).

3.5 As regards feature (ii), D4 itself states at column 8, lines 17 to 21 that "The gas stream to be work expanded in the gas expander cycle can be a pure component or a mixture of components; examples include a pure nitrogen stream or a mixture of nitrogen with other gases such as methane". Although not explicitly mentioned, this specification includes air. The advantages and disadvantages of using air in an expander gas cycle are well known in the art; furthermore the skilled person is aware that air is in plentiful supply, even at remote locations and can be used in gas expander cycles after standard treatment in conventional equipment to remove impurities.

3.6 It would therefore be obvious for the skilled person faced with the above objective technical problem to install the LNG equipment known from D4 on an offshore mobile structure and use air as the gas in the gas expander cycle.

Consequently, the subject-matter of claim 1 of the main request lacks an inventive step.

4. Admissibility of auxiliary requests, Article 12(4) RPBA

4.1 The appellant was specifically asked by the examining division whether it wished to file further requests (see minutes of the oral proceedings, page 4, lines 4 to 15). The examining division even went as far as suggesting that a claim, essentially comprising the subject-matter of the present second auxiliary request, be filed. However, this offer was declined. Faced with this situation the board sees no reason to admit auxiliary requests 1 and 2, since the appellant did not avail itself of the opportunity to file them before the examining division although it was clearly in the position to do so (Article 12(4) RPBA).

4.2 As regards auxiliary requests 3 and 4, the board accepts that their subject-matter is more restricted than that of auxiliary requests 1 and 2 and as such they represent further fall-back positions which the appellant could not have been expected to file earlier. Consequently, these requests are to be taken into consideration.

5. Third and fourth auxiliary requests, inventive step

5.1 In its communication pursuant to Articles 15(1) and 17(2) RPBA, the board set out the reasons why it considered D4 to be very relevant to the question of inventive step for all requests. Despite this, the appellant has made no submissions in writing with respect to D4, and elected not to attend the oral proceedings to make its case. In view of this, the board considers it appropriate to exercise its power under Article 111(1) EPC to carry out substantive examination of these requests in order to bring the case to an expedient conclusion.

5.2 In the installation of D4 the initial cooling of the natural gas is carried out by a mixed component refrigerant cycle, which is utilized in an optimum temperature range which maximises efficiency (see D4, Abstract). Hence, the natural gas stream does not need to pass through the first heat exchanger since its temperature has already been reduced to -100 °C by the mixed component cycle. However, the skilled person wishing to simplify the installation of D4 would see it as obvious to go back to a basic system and carry out all the cooling in the gas expander circuit, in which case the specification of the particular inlet and outlet streams of the first and second heat exchangers, as claimed in the third auxiliary request, would inevitably follow.

5.3 The subject-matter of the fourth auxiliary request is essentially a combination of that of the second and third auxiliary requests.

As reasoned above with respect to the main request, the use of air as the refrigerant in the gas expander refrigeration circuit of D4 would be obvious for the skilled person. Once this decision has been taken, it is also obvious that the most readily available source of air is the environment, and that this air must undergo a suitable treatment to remove CO_2 and water which would otherwise cause problems with the correct functioning of the installation at lower temperatures.

Thus, the subject-matter of claim 1 according to either the third or fourth auxiliary requests does not involve an inventive step in view of the heat exchanger arrangements shown in D4 and the skilled person's general knowledge.

6. Remittal to the examining division

Since the board has dealt with all the appellant's requests using its powers under Article 111(1) EPC there is no need to remit the case to the examining division.

Order

For these reasons it is decided that:

The appeal is dismissed.

The Registrar: The Chairman:

C. Spira G. Ashley

Decision electronically authenticated