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# (54) IMPROVEMENT OF C3+ RECOVERY

(57) A method for producing a stream enriched in hydrocarbons containing three or more carbon atoms from a feed gas stream, comprising:
a) separating an at least partially condensed feed gas comprising hydrocarbons containing three or more carbon atoms (108) in a phase separator (109), thereby producing a liquid stream rich in hydrocarbons containing three or more carbon atoms (110), and a vapor stream lean in hydrocarbons containing three or more carbon atoms (111),
b) heating the liquid stream rich in hydrocarbons containing three or more carbon atoms (110) and introducing the heated stream (123) into separator drum (112), thereby producing an overhead stream enriched in hydrocarbons containing no more than 3 carbon atoms (113), and a liquid product stream enriched in hydrocarbons containing three or more carbon atoms (114),
c) warming the vapor stream lean in hydrocarbons containing three or more carbon atoms (111) to ambient temperature, then separating the ambient temperature stream in a membrane unit (115), thereby producing a permeate stream (116) and a retentate stream (117),
d) cooling the retentate stream (117) and expanding the cooled retentate stream (202), combining the cooled, expanded retentate stream (204) with the overhead stream overhead stream enriched in hydrocarbons containing no more than 3 carbon atoms (113),
e) warming the combined stream (205), then exporting as a fuel gas stream (206).
f) combining the permeate stream (116) with the feed gas stream (101).

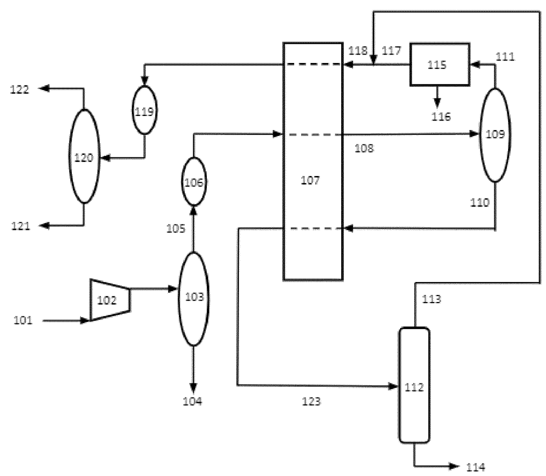


Figure 1

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(52) Cooperative Patent Classification (CPC): (Cont.)
F25J 2210/04; F25J 2230/30; F25J 2270/04;
F25J 2270/12; F25J 2270/60

## Description

### Background

**[0001]** Off-gases or natural gas contain various components like NGLs (C3+ components) which can be monetized separately. Most traditional plants remove NGLs via cryogenic plants but those technologies usually are very expensive and consume a lot of power required by external refrigeration cycles. A less costly technology that can be used to concentrate NGLs is membrane technology.

**[0002]** Membranes with ability to separate light ends from C2+/C3+ hydrocarbons already exist but their performance limits their application in less economical systems where CAPEX or OPEX are usually prohibitive. An example of such system, which can be considered as state-of-the art, is illustrated in Figure 1.

**[0003]** Feed gas stream 101 is compressed in feed compressor 102, then introduced into first phase separator 103. The compressed feed gas stream may be cooled in a heat exchanger (not shown) prior to admission into first phase separator 103. First phase separator 103 produces first condensate stream 104 and damp gas stream 105. Damp gas stream 105 is then introduced into first dehydration unit 106.

**[0004]** The dehydrated gas stream is cooled in heat exchanger 107, wherein it forms at least partially condensed stream 108. At least partially condensed stream is then introduced into second phase separator 109. Second phase separator 109 produces C3+ rich liqud stream 110 and C3+ lean gas stream 111. C3+ rich liquid stream 110 is then warmed in heat exchanger 107, producing warmed C3+ rich liquid stream 123. Warmed C3+ rich liquid stream 123 is then introduced into separator drum 112. Separator drum 112 may be a flash drum or a distillation column.

**[0005]** Separator drum 112 produces overhead gas stream 113 which is enriched in methane, and C3+ liquid product stream 114. C3+ lean gas stream 111 then enters membrane separator 115, thereby producing permeate stream 116 and retentate stream 117. Permeate stream 116 may be combined with feed gas stream 101 (not shown). Retentate stream 117 then combined with overhead gas stream 113, thus producing first combined stream 118. First combined stream 118 is heated in heat exchanger 107 then dried in second dehydration unit 119. Dried retentate stream is then introduced into third phase separator 120. Third phase separator 120 produces second condensate stream 121 and fuel gas stream 122.

**[0006]** There is a need in the industry for a process optimized for propylene recovery

### Element Numbers

**[0007]**

101 = feed gas stream
102 = feed compressor
103 = first phase separator
104 = first condensate stream
105 = damp gas stream
106 = first dehydration unit
107 = heat exchanger
108 = at least partially condensed stream
109 = second phase separator
110 = C3+ rich liquid stream
111 = C3+ lean gas stream
112 = separator drum
113 = overhead stream enriched in hydrocarbons containing no more than 3 carbon atoms (from distillation column)
114 = C3+ liquid product stream (from distillation column): stream enriched in HC containing three or more carbon atoms
115 = membrane separator
116 = permeate stream
117 = retentate stream
118 = first combined stream
119 = second dehydration unit
120 = third phase separator
121 = second condensate stream
122 = fuel gas stream
123 = warmed C3+ rich liquid stream
201 = warmed C3+ lean gas stream
202 = cooled retentate stream
203 = first JT valve
204 = expanded retentate stream
205 = second combined stream
206 = fuel gas stream
207 = second JT valve
208 = partially condensed stream (from second JT valve)
209 = compressed dehydrated gas stream
301 = third combined stream
302 = fourth phase separator
303 = C3+ depleted gas stream
304 = C3+ further enriched liquid stream
305 = expander
306 = expanded stream
307 = warmed C3+ rich liquid stream
308 = combined C3+ lean gas stream
400 = external refrigeration system (optional)

### Description of Embodiments

**[0008]** Illustrative embodiments of the invention are described below. While the invention is susceptible to various modifications and alternative forms, specific embodiments thereof have been shown by way of example in the drawings and are herein described in detail. It should be understood, however, that the description herein of specific embodiments is not intended to limit the invention to the particular forms disclosed, but on the contrary, the intention is to cover all modifications, equivalents, and alternatives falling within the spirit and scope of the invention as defined by the appended claims.

**[0009]** It will of course be appreciated that in the development of any such actual embodiment, numerous implementation-specific decisions must be made to achieve the developer's specific goals, such as compliance with system-related and business-related constraints, which will vary from one implementation to another. Moreover, it will be appreciated that such a development effort might be complex and time-consuming, but would nevertheless be a routine undertaking for those of ordinary skill in the art having the benefit of this disclosure.

**[0010]** As used herein, the term "ambient temperature" is defined as the temperature of the surrounding air. Ambient temperature may be defined as between 32 and 150 F. Ambient temperature may be defined as between 32 and 100 F. Ambient temperature may be defined as between 50 and 80 F. Ambient temperature may be defined as between 65 and 75 F.

**[0011]** Turning to Figure 2, feed gas stream 101 is compressed in feed compressor 102, then introduced into first phase separator 103. The compressed feed gas stream may be cooled in a heat exchanger (not shown) prior to admission into first phase separator 103. First phase separator 103 produces first condensate stream 104 and damp gas stream 105. First condensate stream 104 comprises condensed water. Damp gas stream 105 is then introduced into dehydration unit 106. Dehydration 106 is necessary to avoid freezing and hydrate formation in the cold part of the process. Unless the moisture content in the feed gas stream is sufficiently low, in which case first phase separator 103 is not required. Dehydration unit 106 is shown downstream of first phase separator 103 (which is the preferable location) but may be upstream of first phase separator 103. Dehydration unit 106 may be upstream of feed compressor 102, downstream of compressor 102, or at a point between stages. These variations are not shown in the figure in the interest of maintaining clarity, but the skilled artisan would recognize these placements.

**[0012]** Compressed, dehydrated gas stream 209 is then cooled in heat exchanger 107, wherein it forms partially condensed cooled stream 108. Stream 108 is then introduced into second phase separator 109, which produces C3+ rich liquid stream 110 and C3+ lean gas stream 111.

**[0013]** Although represented as a single unit, heat exchanger 107 may consist of two or more thermally separate heat exchangers as the design permits (not shown). One or more of these heat exchangers may be of the brazed aluminum design. One or more of these heat exchangers may be of the shell and tube design.

**[0014]** In one embodiment, stream 108 is expanded to a lower pressure across second JT expansion valve 207 to produce partially condensed stream 208, which is then introduced into phase separator 109. In this embodiment, cooled stream 108 need not be partially condensed.

C3+ rich liquid stream 110 is warmed in heat exchanger 107, thus producing warmed C3+ rich liquid stream 123. Warmed C3+ rich liquid stream 123 is then introduced into separator drum 112. Separator drum 112 may be a flash drum or a distillation column. Separator drum 112 produces overhead gas stream 113 which is enriched in hydrocarbons containing no more than 3 carbon atoms, and C3+ liquid product stream 114.

C3+ lean gas stream 111 is then warmed in heat exchanger 107, thus producing warmed C3+ lean gas stream 201. Warmed C3+ lean gas stream 201 is at approximately ambient temperature. Warmed C3+ lean gas stream 201 then enters membrane separator 115, thereby producing permeate stream 116 and retentate stream 117. Permeate stream 116 may be combined with feed gas stream 101 (not shown) to increase the recovery of C3+ hydrocarbons in C3+ product stream 114. In one embodiment, feed 101 is available at high pressure. In that case, permeate 116 pressure would be increased through dedicated compressor (not shown).

**[0015]** The flux and selectivity vectors are better known for membranes at ambient temperature. In another embodiment, the possibility to bypass the heat exchanger if membrane separator 115 is to be operated at sub-ambient temperatures allows fine tuning of the required selectivities between components and the off-gas composition.

**[0016]** Retentate stream 117 is cooled in heat exchanger 107, thus producing cooled retentate stream 202. Cooled retentate stream 202 is expanded across first JT valve 203, thus producing expanded retentate stream 204. Expanded retentate stream 204 is then combined with overhead stream enriched in hydrocarbons containing no more than 3 carbon atoms 113 (after expansion to pressure of stream 204 / not shown), thereby producing a second combined stream 205, which provides cold to the end of heat exchanger 107. Second combined stream 205 is then warmed up to ambient temperature in heat exchanger 107 thus producing fuel gas stream 206. At least a portion of fuel gas stream 206 may be used for the regeneration of driers 106 (not shown).

**[0017]** Turning to Figure 3 feed gas stream 101 is compressed in feed compressor 102, then introduced into first phase separator 103. The compressed feed gas stream may be cooled in a heat exchanger (not shown) prior to admission into first phase separator 103. First phase separator 103 produces first condensate stream 104 and damp gas stream 105.

**[0018]** Damp gas stream 105 is then introduced into dehydration unit 106. Dehydration is necessary to avoid freezing and hydrate formation in the cold part of the process unless the moisture content in the feed gas stream is sufficiently low, in which case the first separator 103 is not required.

**[0019]** Dehydration unit 106 is shown downstream of first phase separator 103 but may be upstream of first phase separator 103. Dehydration unit 106 may be upstream of feed compressor 102, downstream of compressor 102, or at a point between stages. These variations are not shown in the figure in the interest of maintaining clarity, but the skilled artisan would recognize these placements.

**[0020]** Compressed, dehydrated gas stream 209 is then cooled in heat exchanger 107, wherein it forms partially condensed cooled stream 108. Stream 108 is then introduced into second phase separator 109, which produces C3+ rich liquid stream 110 and C3+ lean gas stream 111.

**[0021]** Although represented as a single unit, heat exchanger 107 may consist of two or more thermally separate heat exchangers as the design permits (not shown). One or more of these heat exchangers may be of the brazed aluminum design. One or more of these heat exchangers may be of the shell and tube design.

**[0022]** In one embodiment, stream 108 is expanded to a lower pressure across second JT expansion valve 207 to produce partially condensed stream 208, which is then introduced into phase separator 109. In this embodiment, cooled stream 108 need not be partially condensed. C3+ rich liquid stream 110 is then warmed in heat exchanger 107, thus forming warmed C3+ rich liquid stream 307. Warmed C3+ rich liquid stream 307 is then combined with C3+further enriched liquid stream 304 (below), thus forming combined C3+ lean gas stream 308. Combined C3+ lean gas stream 308 is then introduced into separator drum 112. Separator drum 112 may be a flash drum or a distillation column. Distillation column 112 produces overhead gas stream 113 which is enriched in hydrocarbons containing no more than 3 carbon atoms, and C3+ liquid product stream 114. The light ends in overhead gas stream 113 may comprise C2+ hydrocarbons. In one embodiment, overhead gas stream 113 is combined with fuel gas stream 206 (below)

**[0023]** In another embodiment, C3+ lean gas stream 111 is expanded through first JT valve 203 thus producing partially condensed stream 111b. Partially condensed stream 111b is combined with overhead stream enriched in hydrocarbons containing no more than 3 carbon atoms 113 (after expansion at pressure of stream 111b / not shown), thus forming third combined stream 301. Third combined stream 301 is then introduced into fourth phase separator 302. Fourth phase separator 302 produces C3+ further enriched liquid stream 304 and C3+ depleted gas stream 303. C3+ depleted gas stream 303 is then introduced into expander 305, thus producing expanded stream 306

**[0024]** Power generated by expander 305 may be used to at least partially drive the feed compressor 102, thus reducing the power consumption and increasing the overall efficiency of the process.

**[0025]** Expanded stream 306 is then warmed in heat exchanger 107 thus producing fuel gas stream 206. Expanded stream 306 may be at a temperature of approximately -88C and may be heated up to approximately ambient temperature in heat exchanger 107. This addition of refrigeration into heat exchanger 107 thus allows the compressed feed gas to reach even lower temperatures before its expansion into second phase separator 109, which results in a higher net NGL recovery rate. At least a portion of fuel gas stream 206 may be used for the regeneration of driers 106 (not shown).

**[0026]** In one embodiment external refrigeration cycle 400 may be included to add at least a portion of the required refrigeration. External refrigeration cycle 400 may be a propane cycle.

**[0027]** In most traditional processes for the recovery of NGL's (C2+ or C3+) from natural gas, the feed gas is precooled in the main heat exchanger and the condensed liquids are separated in a "cold separator". The remaining gas is expanded in a turbine, whereas the liquids are expanded across a valve. Both expanded streams are typically fed to an absorption or distillation column. This concept is not well suited for the case under consideration (low pressure refinery off-gas, rich in hydrogen, with moderate to high amounts of C3-C4). Herein, the turbine is used indirectly for reaching lower temperatures at the NGL separation stage, by expanding a product (fuel gas) and using it as cooling medium in the exchange line. This scheme is able to reach higher C3 recovery rates with lower energy consumption as compared to the previously described alternatives.

## Claims

**1.** A method for producing a stream enriched in hydrocarbons containing three or more carbon atoms from a feed gas stream, comprising:

a) separating an at least partially condensed feed gas comprising hydrocarbons containing three or more carbon atoms (108) in a phase separator (109), thereby producing a liquid stream rich in hydrocarbons containing three or more carbon atoms (110), and a vapor stream lean in hydrocarbons containing three or more carbon atoms (111),

b) heating the liquid stream rich in hydrocarbons containing three or more carbon atoms (110) and introducing the heated stream (123) into separator drum (112), thereby producing an overhead stream enriched in hydrocarbons containing no more than 3 carbon atoms (113), and a liquid product stream enriched in hydrocarbons containing three or more carbon atoms (114),

c) warming the vapor stream lean in hydrocarbons containing three or more carbon atoms (111) to ambient temperature, then separating the ambient temperature stream in a membrane unit (115), thereby producing a permeate stream (116) and a retentate stream (117),

d) cooling the retentate stream (117) and expanding the cooled retentate stream (202), combining the cooled, expanded retentate stream

(204) with the overhead stream overhead stream enriched in hydrocarbons containing no more than 3 carbon atoms (113),

e) warming the combined stream (205), then exporting as a fuel gas stream (206).

f) combining the permeate stream (116) with the feed gas stream (101).

**2.** The method of claim 1, wherein separator drum comprises a deethanizer column, and the overhead stream enriched in hydrocarbons containing no more than 3 carbon atoms (113) is mixed with fuel gas stream (206).

**3.** The method of claim 1 or 2, further comprising step a1) dehydrating a damp feed gas stream, cooling the dehydrated feed gas stream, and optionally expanding the cooled, dehydrated feed gas stream to produce the at least partially condensed feed gas comprising hydrocarbons containing three or more carbon atoms (108) prior to step a).

**4.** The method of claim 1 or 2, further comprising step a2) compressing a feed gas stream (101) and phase separating the compressed feed gas stream, thereby producing the damp feed gas stream (105) and a condensate stream (104), prior to step a1).

**5.** The method of claims 1 through 4, wherein at least two of the cooling in steps a1), b) and d), and the warming in steps c) and e) occur in the same heat exchanger (107).

**6.** The method of claim 5, wherein additional refrigeration is provided to the heat exchanger (107).

**7.** A method for producing a stream enriched in hydrocarbons containing three or more carbon atoms from a feed gas stream, comprising:

a) separating an at least partially condensed feed gas comprising hydrocarbons containing three or more carbon atoms (108) in a first phase separator (109), thereby producing a liquid stream rich in hydrocarbons containing three or more carbon atoms (110), and a vapor stream lean in hydrocarbons containing three or more carbon atoms (111),

b) expanding the vapor stream lean in hydrocarbons containing three or more carbon atoms (111) and combining the expanded vapor stream with an overhead stream enriched in hydrocarbons containing no more than 3 carbon atoms (113), to produce a combined vapor stream (301),

a) introducing the combined vapor stream (301) into a second phase separator (302), thereby producing a liquid stream further enriched in hydrocarbons containing three or more carbon atoms (304) and a gas stream depleted in hydrocarbons containing three or more carbon atoms (303),

b) heating the liquid stream rich in hydrocarbons containing three or more carbon atoms (110) and combining the heated stream (307) with the liquid stream further enriched in hydrocarbons containing three or more carbon atoms (304) and introducing the combined stream (308) in a separator drum (112), thereby producing the overhead stream enriched in hydrocarbons containing no more than 3 carbon atoms (113), and a liquid product stream enriched in hydrocarbons containing three or more carbon atoms (114),

a) expanding the gas stream depleted in hydrocarbons containing three or more carbon atoms (303), warming the expanded gas stream (306) and then exporting as a fuel gas stream (206)

**8.** The method of claim 7, wherein separator drum comprises a deethanizer column, and the overhead stream enriched in hydrocarbons containing no more than 3 carbon atoms (113) is mixed with fuel gas stream (301).

**9.** The method of claim 7 or 8, further comprising step a1) dehydrating a damp feed gas stream, cooling the dehydrated feed gas stream, and optionally expanding the cooled, dehydrated feed gas stream to produce the at least partially condensed feed gas comprising hydrocarbons containing three or more carbon atoms (108) prior to step a).

**10.** The method of claim 7 or 8, further comprising step a2) compressing a feed gas stream (101) and phase separating the compressed feed gas stream, thereby producing the damp feed gas stream (105) and a condensate stream (104).

**11.** The method of claims 7 through 9, wherein at least two of the cooling in steps a1), b) and d), and the warming in steps c) and e) occur in the same heat exchanger (107).

**12.** The method of claim 11, wherein additional refrigeration is provided to the heat exchanger (107).

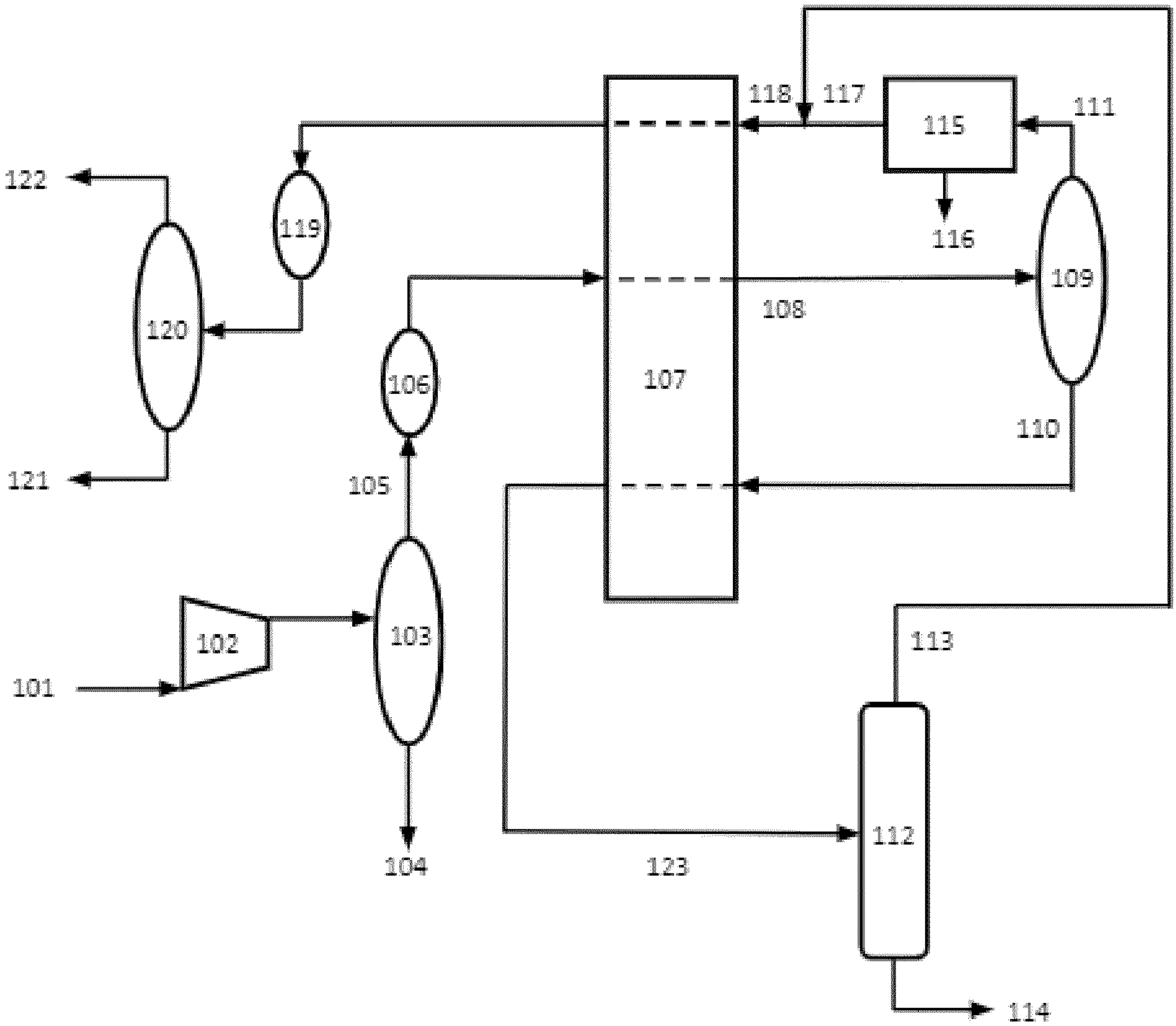
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**Figure 1**

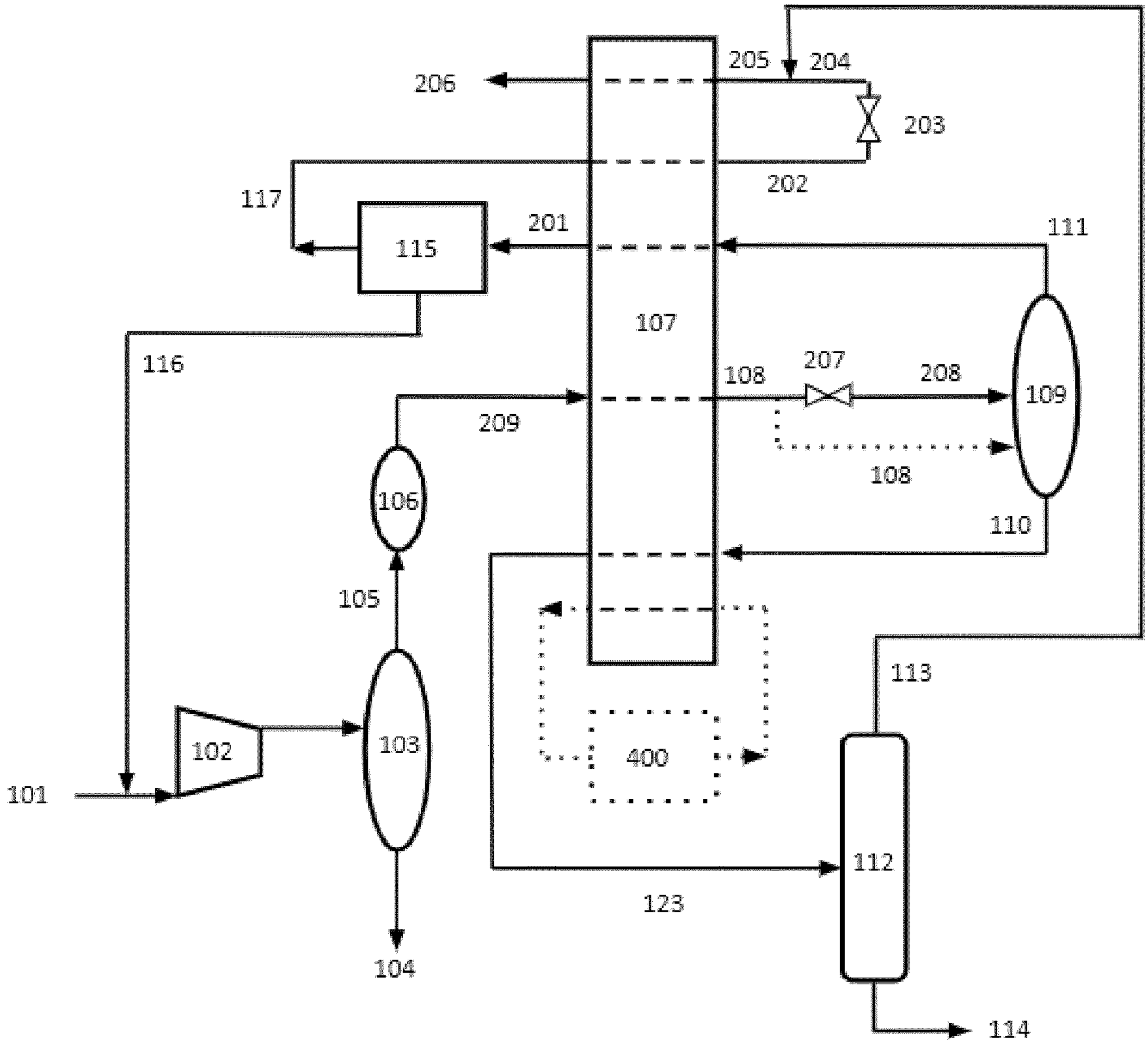
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Figure 2

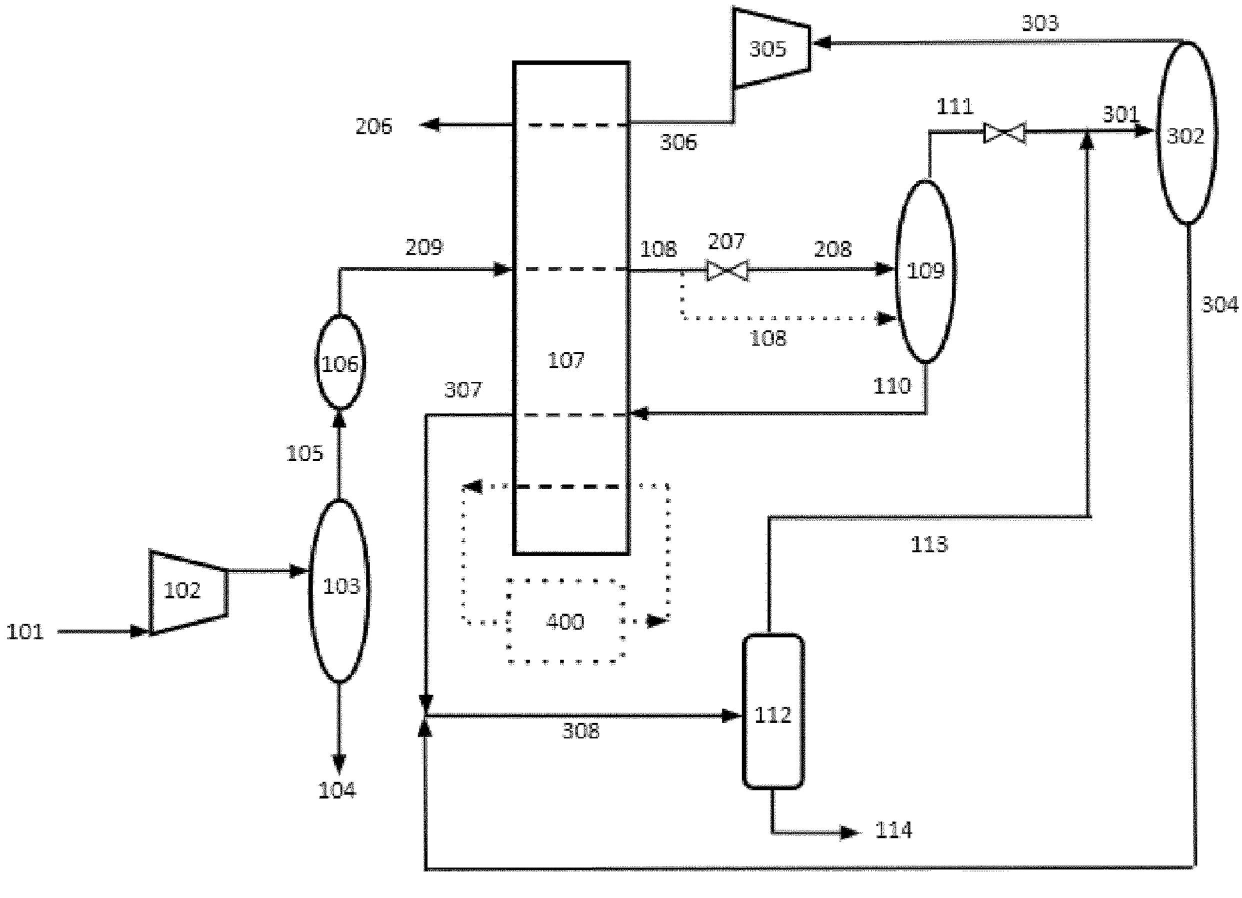
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Figure 3

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# EUROPEAN SEARCH REPORT

Application Number
EP 20 20 7964

## DOCUMENTS CONSIDERED TO BE RELEVANT

| Category | Citation of document with indication, where appropriate, of relevant passages | Relevant to claim | CLASSIFICATION OF THE APPLICATION (IPC) |
|---|---|---|---|
| X | US 2020/308494 A1 (FOLLACA V; MARTY P; RAVENTOS M; TERRIEN P) 1 October 2020 (2020-10-01) * figures 1,9 * | 1-6 | INV. F25J3/00 |
| X | WO 2016/156691 A1 (AIR LIQUIDE [FR]) 6 October 2016 (2016-10-06) * figure 2 * | 1-6 | |
| A | DE 10 2005 010054 A1 (LINDE AG [DE]) 7 September 2006 (2006-09-07) * figure 1 * | 1-6 | |
| A | WO 2016/092178 A1 (AIR LIQUIDE [FR]) 16 June 2016 (2016-06-16) * figures 1,2 * | 1-6 | |
| A | US 5 421 167 A (VERMA VIJENDER K [US]) 6 June 1995 (1995-06-06) * figure 2 * | 1-6 | |

TECHNICAL FIELDS SEARCHED (IPC)

F25J

~~The present search report has been drawn up for all claims~~

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| Place of search | Date of completion of the search | Examiner |
|---|---|---|
| Munich | 10 May 2021 | Schopfer, Georg |

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)

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Application Number
EP 20 20 7964

## CLAIMS INCURRING FEES

The present European patent application comprised at the time of filing claims for which payment was due.

☐ Only part of the claims have been paid within the prescribed time limit. The present European search report has been drawn up for those claims for which no payment was due and for those claims for which claims fees have been paid, namely claim(s):

☐ No claims fees have been paid within the prescribed time limit. The present European search report has been drawn up for those claims for which no payment was due.

## LACK OF UNITY OF INVENTION

The Search Division considers that the present European patent application does not comply with the requirements of unity of invention and relates to several inventions or groups of inventions, namely:

see sheet B

☐ All further search fees have been paid within the fixed time limit. The present European search report has been drawn up for all claims.

☐ As all searchable claims could be searched without effort justifying an additional fee, the Search Division did not invite payment of any additional fee.

☐ Only part of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the inventions in respect of which search fees have been paid, namely claims:

☒ None of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the invention first mentioned in the claims, namely claims:

1-6

☐ The present supplementary European search report has been drawn up for those parts of the European patent application which relate to the invention first mentioned in the claims (Rule 164 (1) EPC).

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# LACK OF UNITY OF INVENTION SHEET B

Application Number
EP 20 20 7964

The Search Division considers that the present European patent application does not comply with the requirements of unity of invention and relates to several inventions or groups of inventions, namely:

1. claims: 1-6

   C3+ separation by cryogenic separation and membrane separation

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2. claims: 7-12

   multi-stage phase separation and rectification

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# ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 20 20 7964

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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10-05-2021

| Patent document cited in search report | Publication date | Patent family member(s) | Publication date |
|---|---|---|---|
| US 2020308494 A1 | 01-10-2020 | US 2020308494 A1 | 01-10-2020 |
| | | WO 2020198588 A2 | 01-10-2020 |
| WO 2016156691 A1 | 06-10-2016 | FR 3034509 A1 | 07-10-2016 |
| | | WO 2016156691 A1 | 06-10-2016 |
| DE 102005010054 A1 | 07-09-2006 | AU 2006220067 A1 | 08-09-2006 |
| | | DE 102005010054 A1 | 07-09-2006 |
| | | US 2009013718 A1 | 15-01-2009 |
| | | WO 2006092266 A1 | 08-09-2006 |
| WO 2016092178 A1 | 16-06-2016 | BR 112017012414 A2 | 02-01-2018 |
| | | FR 3030026 A1 | 17-06-2016 |
| | | US 2017363351 A1 | 21-12-2017 |
| | | WO 2016092178 A1 | 16-06-2016 |
| US 5421167 A | 06-06-1995 | CA 2145013 A1 | 02-10-1995 |
| | | EP 0675190 A2 | 04-10-1995 |
| | | JP 3724840 B2 | 07-12-2005 |
| | | JP H08302360 A | 19-11-1996 |
| | | KR 950032027 A | 20-12-1995 |
| | | US 5421167 A | 06-06-1995 |

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82