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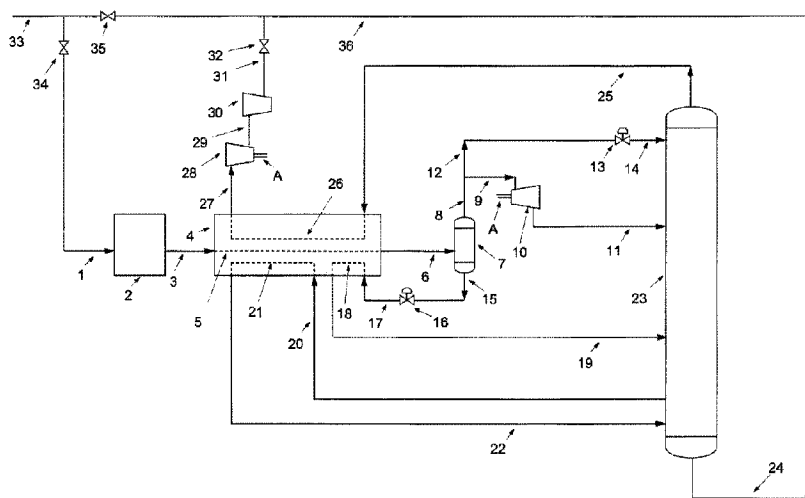
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(54) Titre : PROCÉDE DE PRODUCTION DE GAZ NATUREL LIQUEFIE

(54) Title: A METHOD TO PRODUCE LNG



(57) Abrégé/Abstract:

A method to produce LNG at straddle plants. In contrast to known methods, there is provided a slipstream of a high pressure, pre-treated, pre-cooled natural gas stream to a straddle LNG plant section. The slipstream is further cooled, and processed in a high pressure column to a methane content of 85% or 85 plus by mole. The processed stream is further treated to remove carbon dioxide. The de-carbonated high pressure stream is further cooled in a heat exchanger by a counter-current vapour fraction of the expanded gas before entering an expander apparatus. The processed, treated and cooled gas is expanded into a separator. The produced LNG fraction is pumped to storage. A portion of the LNG fraction is used as a reflux stream to the high pressure column. The cold vapour fraction from the separator flows through counter-current heat exchangers, giving up its coolth energy before being recompressed into the high pressure transmission gas pipeline.

ABSTRACT OF THE DISCLOSURE

A method to produce LNG at straddle plants. In contrast to known methods, there is provided a slipstream of a high pressure, pre-treated, pre-cooled natural gas stream to a straddle LNG
5 plant section. The slipstream is further cooled, and processed in a high pressure column to a methane content of 85% or 85 plus by mole. The processed stream is further treated to remove carbon dioxide. The de-carbonated high pressure stream is further cooled in a heat exchanger by a counter-current vapour fraction of the expanded gas before entering an expander apparatus. The processed, treated and cooled gas is expanded into a separator. The
10 produced LNG fraction is pumped to storage. A portion of the LNG fraction is used as a reflux stream to the high pressure column. The cold vapour fraction from the separator flows through counter-current heat exchangers, giving up its coolth energy before being re-compressed into the high pressure transmission gas pipeline.

TITLE OF THE INVENTION:

A method to produce LNG

5 FIELD OF THE INVENTION

The present invention relates to a method to liquefy natural gas. The method was developed with straddle plants in mind, but has broader application.

BACKGROUND OF THE INVENTION

10 Canadian Patent Application 2,763,081 (Lourenco et al) entitled "Method to Product Liquefied Natural Gas (LNG) at Midstream Natural Gas Liquids (NGLs) Recover Plants" describes a process addition to straddle plants which are used to recover natural gas liquids (NGL's). The described process allows these plants, in addition to producing NGL's, to also efficiently produce liquid natural gas (LNG).

15

There will hereinafter be described an alternative to the method described in the 2,763,081 patent application. The method can be used wherever high pressure gas flows and supporting infrastructure exists to deal with the process streams, such as at straddle plants.

20 SUMMARY OF THE INVENTION

There is provided a method to produce Liquid Natural Gas (LNG). A first step involves passing a dewatered natural gas stream at pressures of between 700 psig and 1200 psig through one or more heat exchangers to pre-cool the natural gas stream. A second step involves passing the pre-cooled natural gas stream through a gas column where natural gas
25 liquid fractions and natural gas fractions are separated. A third step involves passing the natural gas fractions at pressures of between 700 psig and 1200 psig through a gas treatment unit to remove carbon dioxide gas. A fourth step involves passing the de-carbonized natural gas fractions at pressures of between 700 psig and 1200 psig through one or more heat exchangers to pre-cool the de-carbonized natural gas fractions. A fifth step involves passing
30 the de-carbonized natural gas fractions at pressures of between 700 psig and 1200 psig through a gas expansion apparatus where pressure of the de-carbonized natural gas fractions is lowered to a pressure of less than 100 psig. A sixth step involves passing the de-carbonized

natural gas fractions at a pressure of less than 100 psig through a separator where the de-carbonized natural gas fractions are separated into an LNG stream and a natural gas stream at a pressure of less than 100 psig.

- 5 Where there is a high pressure stream of natural gas (ie at pressures in a range of 700 psig to 1200 psig) that can be tapped, the above method can operate without external power inputs, resulting in substantial savings in both capital and operating costs.

The input temperature of a high pressure stream of natural gas is relatively constant.

- 10 This means that once steady state is achieved, the ratio of cold gas vapour is constant relative to a flow rate of the natural gas. A high pressure LNG pump can be used to divert a reflux stream from the LNG stream to the gas column in order to maintain desired operating conditions.

15 BRIEF DESCRIPTION OF THE DRAWINGS

- These and other features of the invention will become more apparent from the following description in which reference is made to the appended drawings, the drawings are for the purpose of illustration only and are not intended to in any way limit the scope of the invention to the particular embodiment or embodiments shown, wherein:

FIG. 1 labelled as **PRIOR ART** is a schematic diagram of a typical straddle plant equipped with a gas pre-treatment, heat exchangers (cold box), an expander-compressor and a main compressor for re-compression to transmission pipeline.

- FIG. 2** is a schematic diagram of a typical straddle pant with the addition of a LNG production unit facility equipped with an alternate cooling, processing and treating medium and compression of the recycled vapour fraction.

FIG. 3 is a schematic diagram of a typical straddle pant with the addition of a LNG production unit facility equipped with A JT (Joules Thompson) valve in lieu of a gas expander.

- 30 **FIG. 4** is a schematic diagram of a typical straddle pant with the addition of a LNG production unit facility equipped with an additional heat exchanger to extract more cooling from the straddle plant and improve LNG production.

DESCRIPTION OF A PRIOR ART STRADDLE PLANT

LNG is produced from a natural gas that has been cooled to a cryogenic condition to condense methane, the natural gas main component. A temperature of approximately -
5 160 C is required to produce and keep natural gas in a liquid state at standard atmospheric pressure. Liquefaction reduces the volume of natural gas by approximately 600 times thus making it more economical to transport over great distances versus traditional pipelines. At present LNG is primarily transported across continents thus making it available throughout the world. LNG is also produced in small scale liquefaction plants to supply
10 peak shaving demands, as well as to make available natural gas to regions that need it but where it is not economical or technically feasible to build pipelines.

The differences in liquefaction selection processes for large versus small LNG plants are; for large plants the main criteria is minimization of capital cost whereas the minimization of energy consumption is left as a second objective. These two objectives
15 can also go together; thus an optimization of the efficiency of the plant may involve a reduction in the investment of the equipment. On the other hand, a higher efficiency can result in an increase in LNG production, so the efficiency factor has a significant impact on the plant economics. In small to medium LNG plants, it is not the efficiency, but other factors such as simplicity, modularization, ease of maintenance, operation and installation
20 that have an higher criteria when selecting a liquefaction technology. The direct consequence of these different selection criteria is that liquefaction technologies for small to medium scale applications are not the same as the ones that are used in large LNG plants.

The two main groups of liquefaction technologies are the mixed refrigerant
25 technologies and expansion based technologies. The mixed refrigerant technologies are “condensing type” processes, where the refrigerant used for the liquefaction makes use of its latent heat of vaporization to cool the natural gas. The expansion based technologies are processes where the refrigerant is always in gas phase and only makes use of its sensible heat to cool the natural gas.

The following mixed refrigerant technologies are the most representative processes in the industry: PRICO (Poly Refrigerated Integrated Cycle Operation) is licensed by Black and Veatch and it consists of one cycle of mixed refrigerant (a mixture of methane, ethane, propane, butane, nitrogen and sometimes isopentane), the advantages claimed by the licensor are operating flexibility, modular design and reduced refrigerant inventory.

The AP-M (Air Products) is licensed by APCI, is a single mixed refrigerant that is vaporized at two different levels of pressure. The dual pressure cycle is more efficient than the single pressure cycle, resulting in smaller heat exchangers and compressor. The LiMuM (Linde Multistage Mixed Refrigerant) is licensed by Linde and consists of a spiral wound heat exchanger and one 3-stage single mixed refrigeration loop for the pre-cooling, liquefaction and sub-cooling of the natural gas. This process allows for high capacity throughput. PCMR (Pre-cooled Mixed Refrigerant) is licensed by Kryopak and consists of a pre-cooling stage (ammonia or propane cycle) followed by a single mixed refrigerant cycle, where the mixed refrigerant is a mixture of nitrogen, methane, ethane, propane and butanes, this process is used primarily in small plants. OSMR (Optimized Single Mixed Refrigerant) is licensed by LNG Limited, the process is a single mixed refrigerant process complemented with a standard package ammonia absorption process. The utilization of an ammonia process improves the efficiency of the process and an increase in LNG output compared to traditional single mixed refrigerant processes. In all of the above mixed refrigerant technologies, the main differences between them are the composition of the mixed refrigerant (although the refrigerants are the same ie; nitrogen, methane, ethane, etc...), the metallurgy of the heat exchangers, the orientation of the equipment and the operations set points. In all the mixed refrigerants processes the objective of innovation is to increase efficiency, reducing capital and operating costs.

The expansion based technologies have various processes based on the use of nitrogen as a refrigerant to liquefy natural gas, the N₂ expansion cycle. Some of these processes use a single cycle, others use a dual expansion cycle and in other cases a pre-cooling cycle is added to improve efficiency. Several licensors ie; APCI, Hamworthy, BHP Petroleum Pty, Mustang Engineering and Kanfa Oregon offer the N₂ expansion cycles processes, they differ by proprietary process arrangement. In all these processes the cooling is provided by an external refrigeration plant using nitrogen expanders. The

Niche LNG process is licensed by CB&I Lummus, consists of two cycles: one cycle uses methane as a refrigerant and the other uses nitrogen. The methane provides cooling at moderate and warm levels while the nitrogen cycle provides refrigeration at the lowest temperature level. The OCX process is licensed by Mustang Engineering and is based on the use of the inlet gas as a refrigerant in an open refrigerant cycle with turbo-expanders, there are variations such as OCX-R which adds a closed loop propane refrigerant to the OCX process and OCX-Angle which incorporates LPG recovery.

As demonstrated, presently there are many variations and processes to liquefy LNG. All of the processes operate based on the expansion of low boiling fluids be it through expanders or JT valves, be it closed or open cycle, the difference between them is in the process efficiencies which result in lower capital and operating costs per unit of LNG produced.

A straddle plant is a natural gas processing plant constructed near a transmission pipeline downstream from the fields where the natural gas in the pipeline has been produced. Also called an "on-line" plant. The straddle plant removes natural gas liquids, the C_2^+ gas fractions, from the transmission natural gas stream. This is done by first pre-treating the gas stream, pre-cooling it and then reducing the transmission gas high pressure stream in a range of 700 to 1200 psig, typically about 1000 psig, through a gas expander to pressures typically about 325 psig, to cool, condense and separate the C_2^+ gas fractions in a distillation column. The bottoms of the distillation column exit the plant as the recovered natural gas liquids (NGL's). The distillation column overhead stream, primarily C_2^- gas fractions, are pre-heated in a countercurrent heat exchange by the straddle plant pre-treated feed gas stream and re-compressed in two steps back to the same transmission pipeline gas pressure. The major operating cost of these straddle plants are the re-compression costs. The re-compression is typically done in two steps. The first step is done through a booster compressor, which typically is a direct drive compressor connected to the gas expander, the energy recovered by expanding the gas from the transmission gas pipeline high pressure is directly used to compress the distillation gas overhead stream from distillation column pressure to an intermediate gas pressure, typically from 450 to

550 psig. The main re-compressor then compresses this intermediate pressure to transmission pipeline pressure. The economics of a straddle plant are based on the quantities and revenues of natural gas liquids produced against the re-compression and maintenance costs.

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Referring to **FIG. 1**, a pressurized pipeline natural gas stream 33 is routed to a straddle plant through valve 34. Valve 35, allows the transmission gas pipeline to bypass the straddle plant. High pressure gas stream 1 enters the straddle plant and is first pre-treated in unit 2 to remove the water content. The de-watered stream 3 is then routed to cold box 4 where it is pre-cooled in coil 5 by counter current gas streams in series, first by gas coil 21, then gas coil 26 and finally gas coil 18. The high pressure, pre-cooled gas stream 6 enters separator 7 where the liquids and gaseous fractions are separated. The liquid fraction is routed through stream 15 to expansion valve 16, where the pressure is reduced to column 23 pressure, this pressure expansion generates more cooling energy and the now expanded and cooler gas is routed through stream 17 to coil 18 in the cold box, pre-cooling the high pressure gas stream in coil 5. The now warmer stream 19 enters distillation column 23 for NGL recovery. The gaseous fraction exits separator 7, through stream 8 which divides into two streams, 9 and 12. Stream 9 enters expander compressor 10 where the high pressure gas is expanded to column 23 pressure, generating torque in shaft A, which drives booster compressor 28 and, the colder gas stream exits the expander-compressor 10 through stream 11 into column 23 for NGL's recovery. The gaseous stream 12 is routed through expansion valve 13, where the high pressure gas is expanded to column 23 pressure and the cooler expanded gas enters column 23 through stream 14 as a reflux stream to control column 23 overhead temperature and distillation. The recovered NGL's exit column 23 through line 24. The stripped gas exits column 23 through stream 25 and is pre-heated in the cold box through coil 26. The warmer gas stream 27 enters booster compressor 28 which is connected through shaft A to the expander 10, thus recovering the mechanical work produced by the expander and boosting stream 27 pressure to stream 29. The boosted pressure stream 29 enters main compressor 30, where the pressure is increased to transmission pipeline pressure and routed through stream 31, through straddle plant block valve 32 and into pipeline gas distribution

stream 36.

The above described process in FIG. 1 is the operation of a traditional straddle plant, there are various straddle plant modes of operation to improve the recovery of the NGL's, in all cases the objective is to produce NGL's.

5

Referring to **FIG. 2**, the difference from Fig.1, is the addition of a LNG production section to a conventional straddle plant which as described above its main objective is to produce NGL's. A pressurized pipeline natural gas stream 33 is routed to a straddle plant through valve 34. Valve 35, allows the transmission gas pipeline to bypass the straddle plant.

- 10 High pressure gas stream 1 enters the straddle plant and is first pre-treated in unit 2 to remove the water content. The de-watered stream 3 is then routed to cold box 4 where it is pre-cooled in coil 5 by counter current gas streams in series, first by gas coil 21, then gas coil 59, gas coil 26 and finally gas coil 18. The high pressure, pre-cooled gas stream 6 enters separator 7 where the liquids and gaseous fractions are separated. The liquid fraction is routed through
15 stream 15 to expansion valve 16, where the pressure is reduced to column 23 pressure, this pressure expansion generates more coolth and the now expanded and cooler gas is routed through stream 17 to coil 18 in the cold box, pre-cooling the high pressure gas stream in coil 5. The now warmer stream 19 enters distillation column 23 for NGL recovery. The gaseous fraction exits separator 7, through stream 8 which divides into two streams, 9 and 37. Stream
20 9 enters expander-compressor 10 where the high pressure gas is expanded to column 23 pressure, generating torque in shaft A, which drives booster compressor 28 and, the colder gas stream exits expander-compressor 10 through stream 11 into column 23 for NGL's recovery. The recovered NGL's exit column 23 through line 24. The stripped gas exits column 23 through stream 25 and is pre-heated in the cold box through coil 26. The warmer gas stream
25 27 mixes with LNG plant section gas stream 62 before entering booster compressor 28.

The high pressure gaseous stream 37 is the LNG section feed stream, it is routed through heat exchanger 38 where it is further cooled, the colder stream 39 enters column 40 where the methane concentration of stream 43 is controlled. The high pressure liquid fraction 41 is expanded through valve 42 to distillation column 23 pressure as a reflux stream to control
30 distillation column overhead temperature of stream 25. The methane content controlled stream 43 is routed to gas treatment unit 44 to remove the carbon dioxide content in this stream to less than 50 ppm. The de-carbonated stream 45 enters heat exchanger 46 where it is

further cooled by gaseous cold stream 56. The high pressure, de-carbonated, and further cooled stream 47 enters expander-compressor 48, where it is expanded to pressures from 0-100 psig, with 10 psig being the preferred operating pressure, the expanded stream 49 enters separator 50, where the liquid fraction LNG is separated from the gaseous fraction. The torque energy generated by expander 48 is recovered and transferred by shaft B to booster compressor 61 shaft B.

The LNG stream 51 enters LNG pump 52 and is split into streams 53 and 54. LNG stream 53 is routed to storage. LNG stream 54 is routed to high pressure pump 55 where the pressure is increased to column 40 pressure, the LNG flowrate is added to control column overhead temperature, stream 43 and hence the concentration of methane to 85% or greater than 85% by mole. The cold gaseous stream 56 exits separator 50 and is routed to heat exchanger 46, the warmer gaseous stream 57 is further heated in heat exchanger 38, exiting it through stream 58 into cold box coil 59 where it is further heated before entering booster compressor 61 through line 60. Compressor 61 is powered by torque energy recovered in expander 48 through shaft B. The boosted pressure gaseous stream 62 mixes with stream 27 and the mixed stream 63 enters booster compressor 28 where the pressure is further boosted to stream 29. Compressor 28 is powered by torque energy recovered in expander 10 through shaft A. Stream 29 gas enters main compressor 30 where the pressure is increased to transmission pipeline pressure 36, exiting the compressor through stream 31 and straddle plant block valve 32.

The proposed invention addresses both large and small plants in which process simplicity and ease of operation are the main components. The invention eliminates the need for refrigeration cycle plants and the use of proprietary mixed refrigerants. By simplifying the process it reduces capital, maintenance and operations costs. In the preferred method, a pre-treated, pre-cooled high pressure natural gas stream is further cooled in a counter-current second heat exchanger with produced cold LNG vapor, treated to a methane content specification, then de-carbonated, further cooled in a primary heat exchanger and then expanded through a gas expander. The gas expander produces torque and therefore shaft power that can be converted into mechanical compression power or electricity. In the preferred application the shaft power is used for compression. The expanded gas produces a gaseous and a liquid stream. The gaseous stream is routed to the transmission pipeline

first by pre-heating it with inlet feed gas stream and then recompressed to the transmission gas pipeline. The liquid stream, LNG is split into two streams, LNG to storage and LNG for a column reflux. The LNG reflux stream is pressurized to column pressure to control the methane content of the LNG production stream. The bottoms of the column are then
5 sent to the distillation column for the recovery of NGL's. The objective of the invention is to provide the ability for a straddle plant to improve its economics by generating LNG in addition to NGL's. In addition, the ratio of NGL's produced in this mode of operation to gas from the straddle plant to gas transmission pipeline is increased.

10 A main feature of this invention is the simplicity of the process which eliminates the conventional use of external refrigeration systems for LNG production. Another feature of the invention is the flexibility of the process to meet various operating conditions since the ratio of LNG production is proportional to the cold gaseous stream generated and returned to the transmission gas pipeline. The invention also provides for a significant savings in energy
15 when compared to other LNG processes since the process produces its own refrigeration needs. The proposed invention can be used in any straddle plant size.

Variations:

It should be noted that the motive force generated by the expanders can be
20 connected to a power generator to produce electricity versus a connected gas compressor as proposed.

Referring to **FIG. 3**, the main difference from Fig.s 2 and 3, is the use of a JT expansion valve 65 in lieu of an expander-compressor. The use of a JT valve versus an
25 expander is an alternative mode of LNG production at a lower capital cost but resulting in a lower production of LNG.

Referring to **FIG. 4**, the main difference from Fig.s 2, 3, and 4 is the addition of a heat exchanger 66, where stream 37 recovers more coolth energy from stream 25, before being
30 further cooled by the in heat exchanger 38. This added feature allows for an increment in LNG production due to an higher recovery of cryogenic energy versus Fig 2.

In this patent document, the word "comprising" is used in its non-limiting sense to mean that items following the word are included, but items not specifically mentioned are not excluded. A reference to an element by the indefinite article "a" does not exclude the possibility that more than one of the element is present, unless the context clearly requires that
5 there be one and only one of the elements.

The scope of the claims should not be limited by the preferred embodiments set forth in the examples, but should be given a broad purposive interpretation consistent with the description as a whole.

What is Claimed is:

1. A method to produce Liquid Natural Gas (LNG), comprising:
 - 5 passing a dewatered natural gas stream at pressures of between 700 psig and 1200 psig through one or more heat exchangers to pre-cool the natural gas stream;
 - passing the pre-cooled natural gas stream through a gas column where natural gas liquid fractions and natural gas fractions are separated;
 - passing the natural gas fractions at pressures of between 700 psig and 1200 psig
 - 10 through a gas treatment unit to remove carbon dioxide gas;
 - passing the de-carbonized natural gas fractions at pressures of between 700 psig and 1200 psig through one or more heat exchangers to pre-cool the de-carbonized natural gas fractions;
 - passing the de-carbonized natural gas fractions at pressures of between 700 psig and
 - 15 1200 psig through a gas expansion apparatus where pressure of the de-carbonized natural gas fractions is lowered to a pressure of less than 100 psig; and
 - passing the de-carbonized natural gas fractions at a pressure of less than 100 psig through a separator where the de-carbonized natural gas fractions are separated into an LNG stream and a natural gas stream at a pressure of less than 100 psig.
 - 20
2. The method of Claim 1, wherein a high pressure LNG pump is used to divert a reflux stream from the LNG stream to the gas column.
3. A method to produce LNG using an LNG plant feed stream, the LNG plant feed
 - 25 stream comprising a high pressure, pre-treated, pre-cooled natural gas stream from a straddle plant the method comprising:
 - cooling the LNG plant feed stream in at least one heat exchanger;
 - passing the cooled LNG plant feed stream through a gas column downstream of the at least one heat exchanger to obtain a liquid stream and a high pressure vapour stream;
 - 30 removing carbon dioxide gas from the high-pressure vapour stream of the gas column using a gas treatment unit downstream of the gas column;
 - cooling the high pressure vapour stream in one or more heat exchangers downstream

of the gas treatment unit to produce a high pressure, cooled, de-carbonated stream;

expanding the high-pressure, cooled, de-carbonated stream in a gas expansion apparatus to produce a low pressure cold mixed phase stream;

providing an LNG separator downstream of the gas expansion apparatus to separate
5 the cold mixed phase stream into an LNG stream and a natural gas stream; and

providing a high pressure LNG pump for pumping a portion of the LNG stream to the gas column as a reflux stream.

4. The method of Claim 3, wherein the gas expansion apparatus is a JT valve or a gas
10 expander turbine.

5. The method of Claim 3, wherein cooling in the one or more exchangers is provide by the natural gas stream from the LNG separator.

6. The method of Claim 3, wherein the reflux stream to the gas column controls a
15 methane concentration of overhead stream of the gas column.

7. The method of Claim 3, wherein the gas column produces a bottom stream that is
20 routed to a distillation column as a distillation column reflux and for NGL recovery.

8. The method of claim 3, wherein the gas treatment unit removes the carbon dioxide content in an overhead stream of the gas column to a concentration of less than 50 ppm.

9. The method of claim 3, wherein the vapour stream downstream of the gas treatment
25 unit is cooled by the natural gas stream from the LNG separator before entering the expansion apparatus.

10. The method of Claim 4, wherein the gas column produces a bottoms stream that is a
30 mixture of NGLs from the LNG plant feed stream, carbon dioxide and methane.

11. The method of claim 3, further comprising a straddle plant feed gas stream that feeds

a distillation column, and wherein the LNG plant feed stream is obtained by diverting a portion of the straddle plant feed gas stream upstream of the distillation column.

12. The method of claim 11, wherein the NGLs from the gas column are expanded and injected into the distillation column as a distillation column reflux stream.

13. A straddle plant LNG section for producing LNG, comprising:
 a LNG plant feed line supplying high-pressure, pre-treated, pre-cooled natural gas stream from a straddle plant;
 10 a first heat exchanger connected to the LNG plant feed line, the LNG plant feed line being connected to a cooling passage within the heat exchanger that cools the natural gas stream;
 a gas column downstream of the heat exchanger that receives the cooled natural gas stream, the gas column separating the natural gas stream into an overhead vapour stream and
 15 a bottom liquid stream;
 a gas treatment unit that receives the overhead vapour stream downstream of the gas column, the gas treatment unit removing carbon dioxide from the vapour line to produce a de-carbonated stream;
 a second heat exchanger that receives the de-carbonated stream downstream of the
 20 gas treatment unit, the second heat exchanger cooling the de-carbonated stream to produce a cooled, de-carbonated stream;
 a gas expansion apparatus that receives the cooled, de-carbonated stream, the gas expansion apparatus expanding the cooled, de-carbonated stream to produce a cold mixed phase stream;
 25 a LNG separator downstream of the gas expansion apparatus that receives the cold mixed phase stream and separated the cold mixed phase into a LNG stream outlet and a natural gas stream outlet; and
 a compressor connected to the natural gas stream outlet, the compressor re-compressing a natural gas stream from the natural gas stream outlet;
 30 a reflux line connected between the LNG stream outlet and the gas column;
 a high pressure LNG pump on the reflux line, the high pressure LNG pump pumping a portion of a LNG stream from the LNG stream outlet to the gas column.

14. The straddle plant LNG section of Claim 13, further comprising a LNG storage line and a LNG storage pump that transports a further portion of the LNG stream to a storage vessel.

5

15. A method to produce Liquid Natural Gas (LNG) from a dewatered natural gas stream, the method comprising:

cooling the dewatered natural gas stream in at least one heat exchanger, the dewatered natural gas stream being at a pressure of between 700 psig and 1200 psig;

10 removing natural gas liquids (NGLs) from the cooled, dewatered natural gas stream using a gas column downstream of the at least one heat exchanger;

removing carbon dioxide gas from a vapour stream of the gas column using a gas treatment unit downstream of the gas column, the vapour stream being at a pressure of between 700 psig and 1200 psig;

15 cooling the vapour stream using one or more heat exchangers downstream of the gas treatment unit to produce a cooled, de-carbonated stream at a pressure of between 700 psig and 1200 psig;

expanding the cooled, de-carbonated vapour stream in a gas expansion apparatus, wherein the pressure of the cooled, de-carbonated is lowered to less than 100 psig; and

20 providing an LNG separator downstream of the gas expansion apparatus to separate the expanded, cooled, de-carbonated stream into an LNG stream and a natural gas stream, the LNG stream and the natural gas stream being at a pressure of less than 100 psig.

16. The method of Claim 1, wherein a high pressure LNG pump is used to divert a reflux stream from the LNG stream to the gas column.

25

PRIOR ART FIG 1

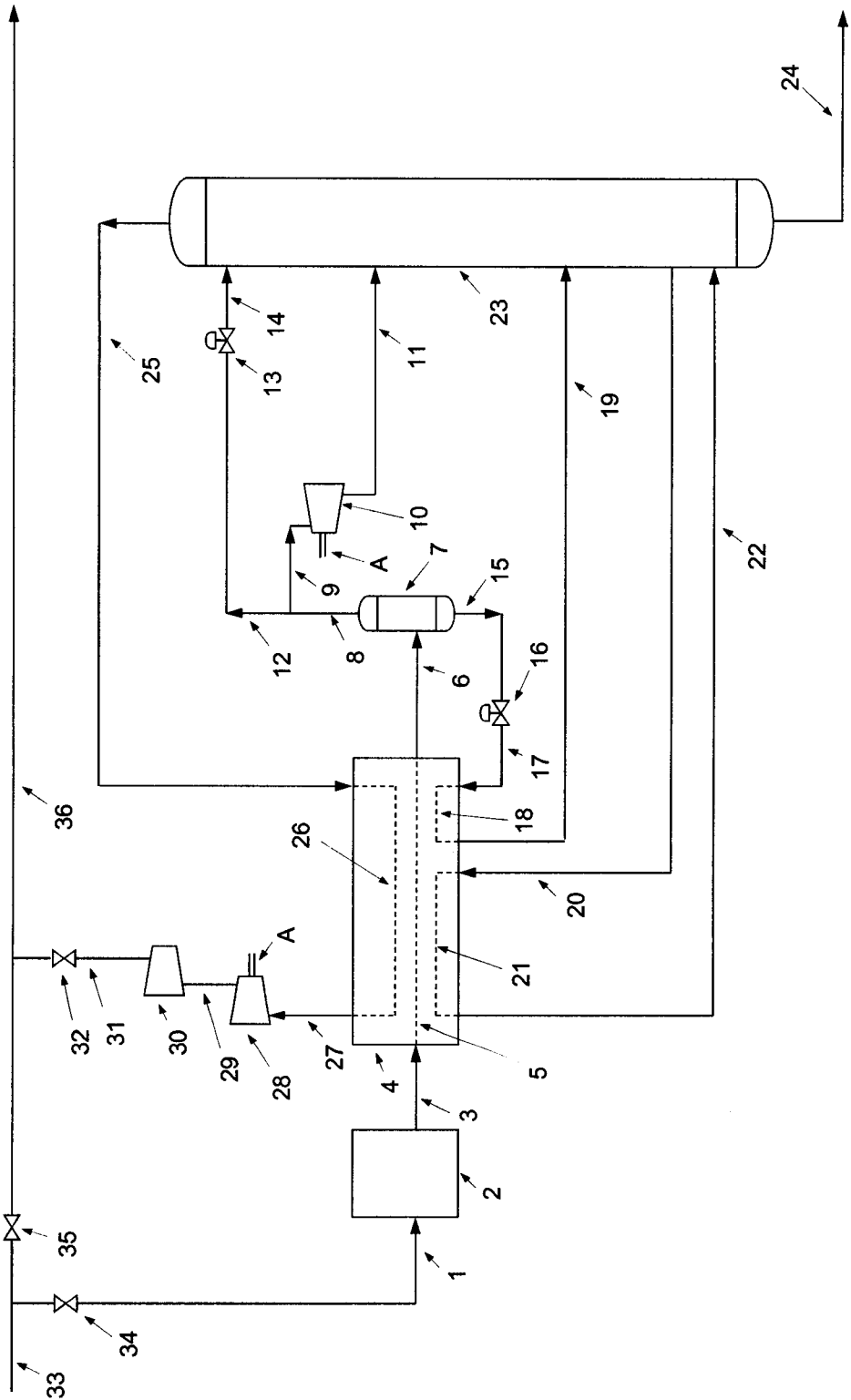


FIG 2

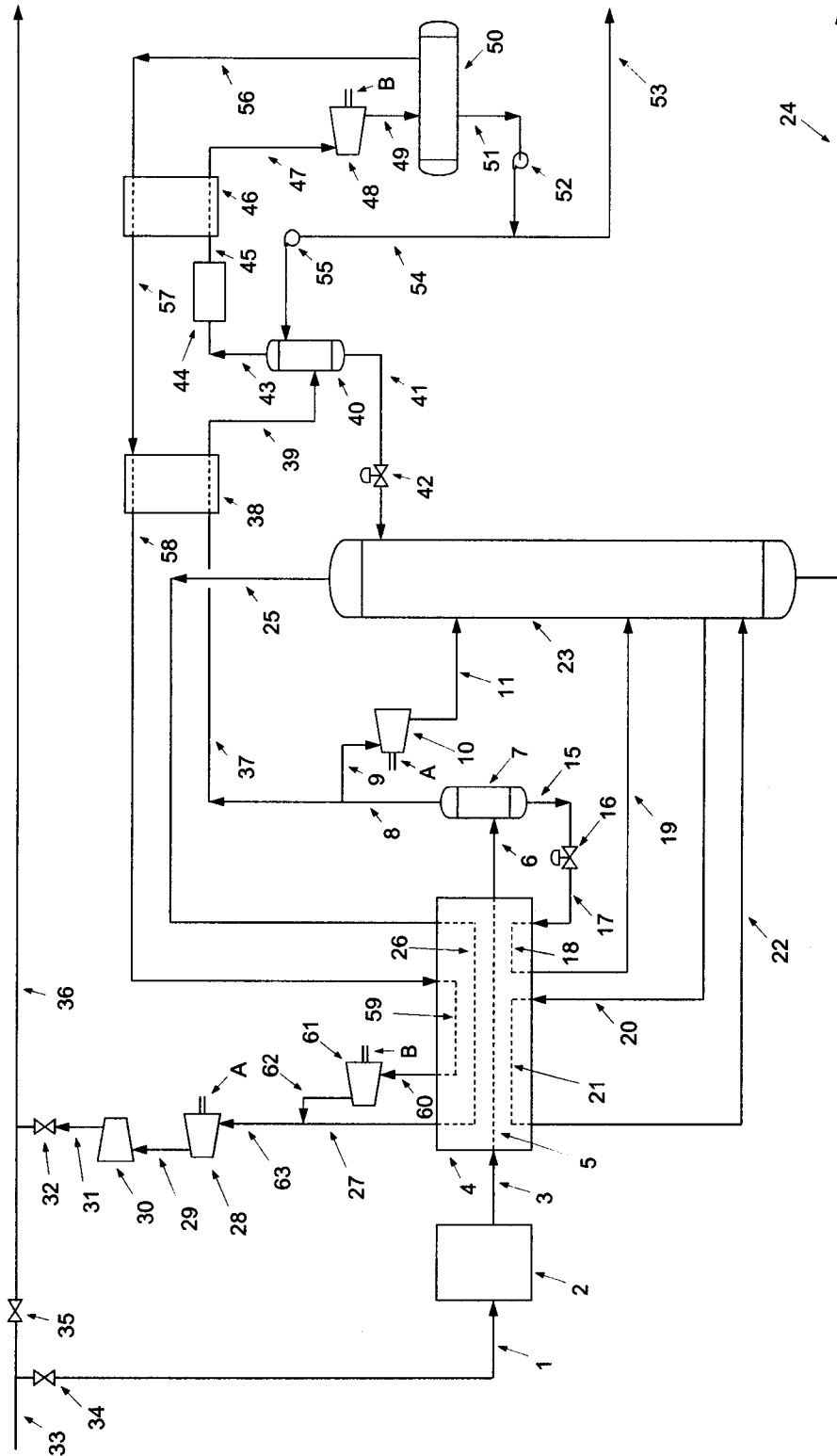


FIG 3

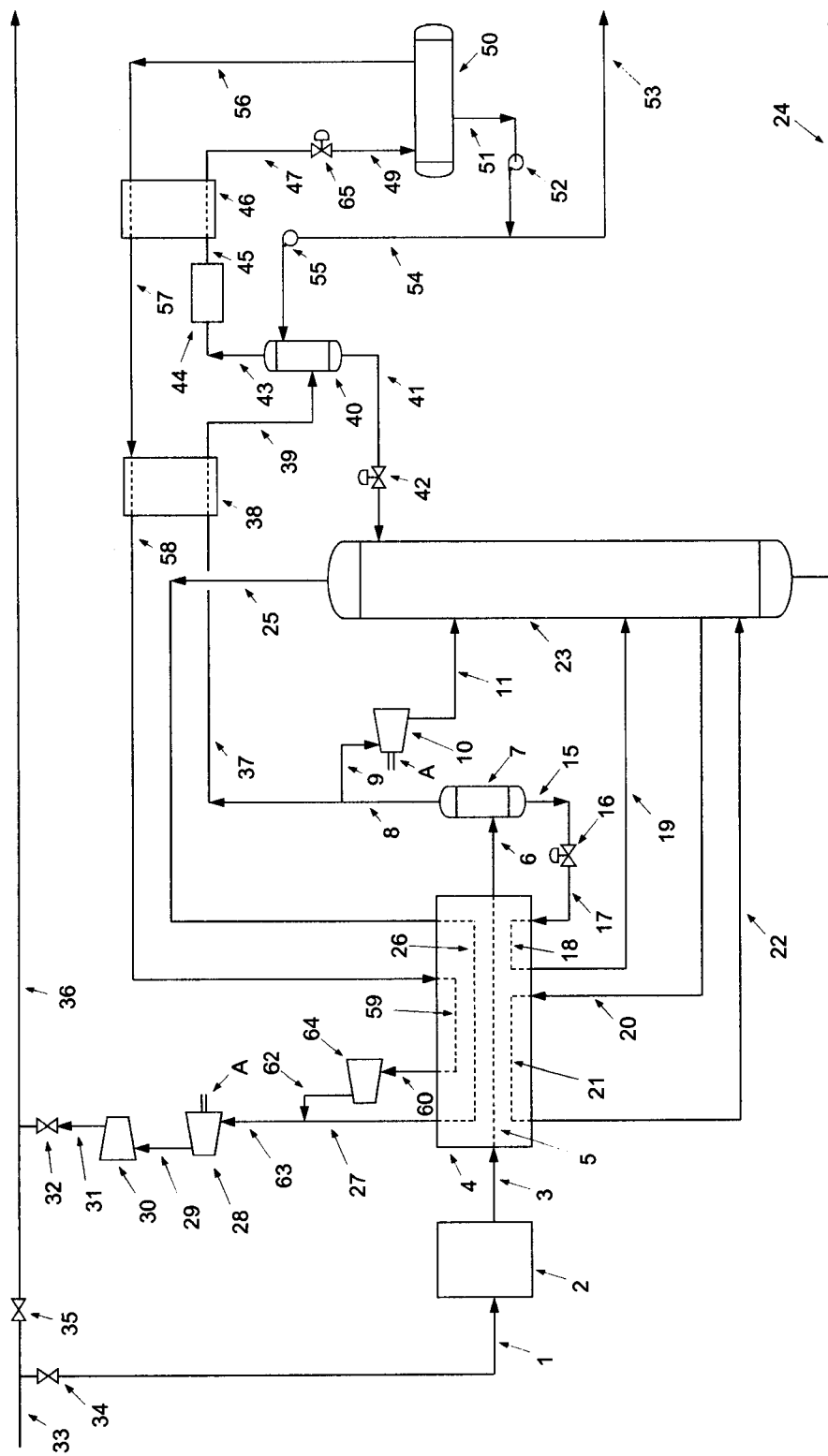


FIG 4

