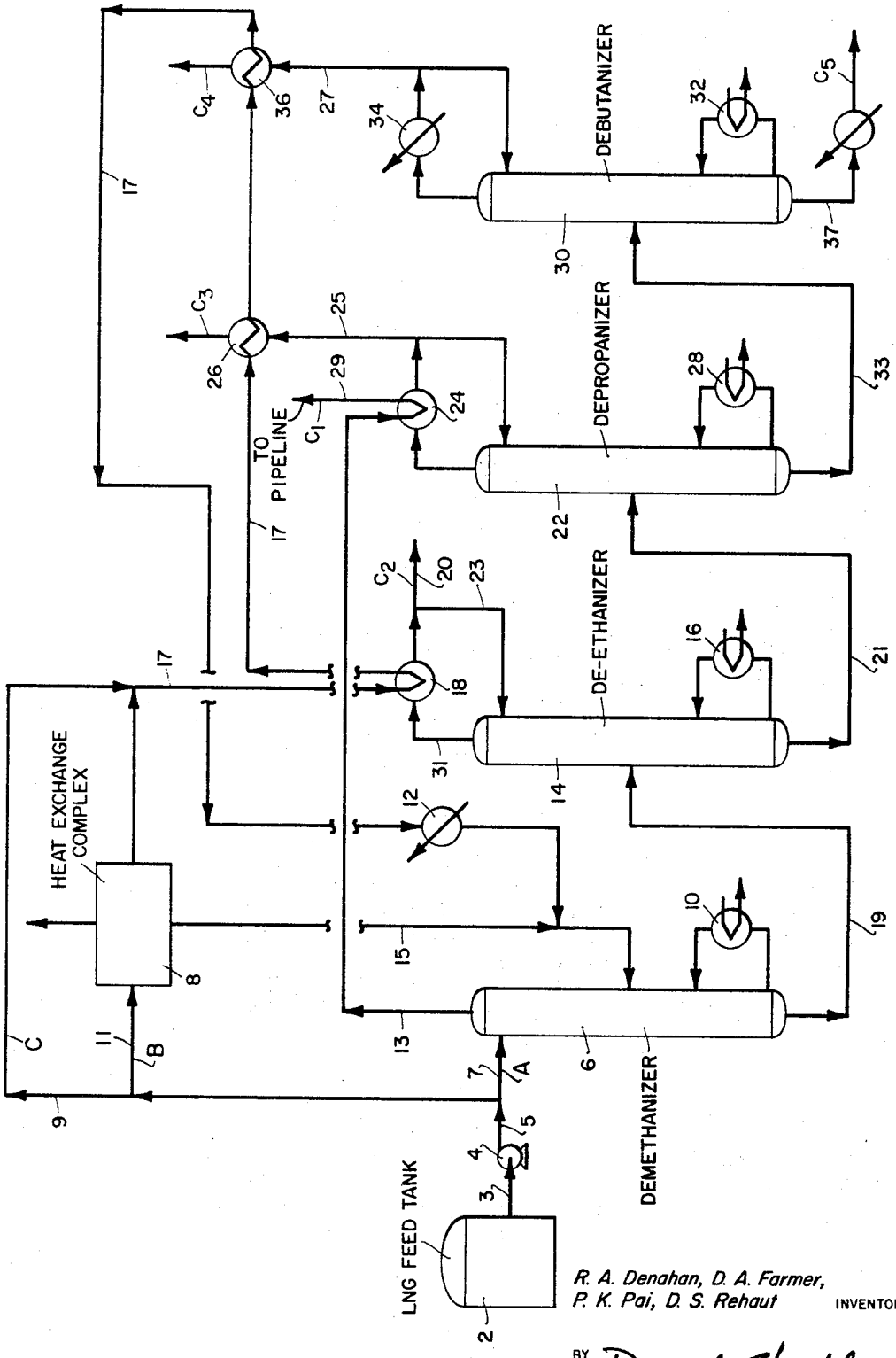
Oct. 15, 1968 R. A. DENAHAN ET AL 3,405,530

REGASIFICATION AND SEPARATION OF LIQUEFIED NATURAL GAS

Filed Sept. 23, 1966



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United States Patent Office 3,405,530 Patented Oct. 15, 1968

3,405,530

REGASIFICATION AND SEPARATION OF LIQUEFIED NATURAL GAS

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Filed Sept. 23, 1966, Ser. No. 581,550
6 Claims. (Cl. 62—28)

ABSTRACT OF THE DISCLOSURE

A method for regasification and fractionation of liquefied natural gas in which a portion of the liquefied natural gas enters the top section of a fractionating column while a second portion of cold liquefied natural gas provides refrigeration for other process streams before being introduced into a middle section of the fractionating column.

The present invention relates generally to a method of processing a liquefied gas mixture. More particularly, the invention relates to a process wherein liquefied natural gas is regasified to a product at temperatures and pressures suitable for normal distribution through a pipeline.

Natural gas is often available in areas remote to where it will be ultimately used. Quite often the source of this fuel is separated from the point of utilization by some large body of water and it then becomes necessary to effect bulk transfer of the natural gas by large tankers. Under these circumstances economics demand that the natural gas be liquefied so as to greatly reduce its volume and that it be transported at substantially atmospheric pressures. Under these conditions, the liquefied natural gas, hereinafter referred to as LNG, is at a temperature in the range of —258° F. This temperature represents the boiling point for methane at atmospheric pressure. It is to be pointed out, however, that natural gas often has small amounts of higher boiling heavier hydrocarbons such as ethane, propane, butane and the like and these will vary the boiling range of the LNG so that it usually falls somewhere between —240° and —258° F.

As the LNG arrives at the point of use it is of course in liquefied form and consequently it becomes necessary to regasify it before it may be used as a fuel. Also, the ethane and other higher molecular weight components that are present in the LNG are valuable as feed stock for the production of various petrochemicals and for the manufacture of liquefied petroleum gas. It is therefore desirable to separate these various components prior to sending the lighter gases, i.e., the lean gases, that will remain, to the fuel distribution system.

In a conventional distillation process for this type of separation it is usual to provide a fractionating tower, the vapors from the top of the tower being partially condensed in a heat exchanger. The liquid thus formed is separated and collected in a drum and a portion of it is returned to the tower by means of pumps. This returned liquid or as it is often called, the reflux, washes the ethane and heavier components out of the entering feed stock. Because of the extremely low temperatures inherent in LNG processing, the heat exchanger, the drum, the pumps and other associated equipment must be fabricated from expensive materials. In addition, the reflux that could be economically produced in this manner would contain a high proportion of ethane and would be limited in its ability to wash ethane out of the entering LNG mixture.

In contrast, the present invention provides a method for achieving a higher recovery of ethane from the LNG mixture than can economically be achieved by the conventional means discussed above. In addition, the process of the present invention removes the need for some costly exchangers, drums, pumps and other auxiliary equipment associated with the conventional process. These desirable improvements are accomplished by utilizing some of the entering LNG as the reflux to the column. At the cryogenic temperatures used in this process the components of the LNG that are heavier than ethane have a very low volatility and are not significantly vaporized into the lean gas. Because of the presence of these heavier components, this reflux liquid has a lower ethane content than can be economically achieved by the conventional means. This results in a greatly improved separation of ethane from the lean gas as compared to the ethane separation achieved in the conventional manner.

In the process of the invention the LNG feed stream is pressurized and a portion of it is passed directly into the top region of a fractionation column. The remainder of the feed is then heat exchanged with other process streams whereby it provides refrigeration duty and is subsequently partially vaporized and heated to approximately —40° F. This partially vaporized stream is returned as feed to the fractionation column where the ethane and heavier components are recovered as the bottoms product. This bottoms product is then further fractionated to recover the ethane and heavier components.

The vapors withdrawn from the top of the column, which are mostly methane, are also utilized to provide refrigeration duty to another process heat exchanger. During this heat exchange these vapors are heated to a temperature suitable for normal pipeline distribution.

Accordingly, an important object of this invention is to facilitate the regasification of LNG so that it is at suitable pressure and temperature conditions for delivery and use as a fuel.

Another important object of this invention is to provide efficient means for selectively recovering ethane from a liquefied natural gas feed stream.

Still another object of the invention is to provide efficient means for separating the various heavier hydrocarbons which may be present in the LNG as received from the tankers.

Yet another object of the present invention is to make efficient use of the refrigeration potential of the cold LNG.

Other objects and a fuller understanding of the invention may be had by referring to the following description and claims taken in conjunction with the accompanying drawing.

In the figure, a flow diagram illustrates a process according to the present invention is given.

Referring to the figure in detail, reference character **2** designates a stationary insulated storage tank which receives the LNG at atmospheric pressure from the tanker (not shown). The LNG in tank **2** will normally have a temperature of about —240° to —260° F. The LNG from tank **2** is fed through line **3** to a suitable pump **4**. The pump **4** increases the pressure of the LNG feed stock to approximately 650 p.s.i.g. The pressurized LNG stream discharged through line **5** from pump **4** is split into several streams. The first fraction designated A, representing approximately 30% of the total feed stream enters the top region of a demethanizer **6** through the line **7**. Demethanizer **6** is operated at a pressure of approximately 510 p.s.i.g. and is provided with a reboiler **10**. The second feed fraction designated B is passed through a heat exchange complex **8** whereby it provides the refrigeration duty for cooling external process streams (not shown). Heat exchange complex **8** can represent a part of a wholly separate operation such as an ethylene plant, for ex-

ample. Upon exiting from heat exchanger complex **8** this fraction is split into two lines, **15** and **17**.

The remaining fraction of feed, designated C is passed through line **9**, bypassing the heat exchanger complex **8**. It is then reunited with one of the fractions exiting from heat exchanger complex **8** in line 17. This recombined stream is then passed in heat exchange relationship with the vapors from a de-ethanizer **14**, to provide the de-ethanizer reflux **23**. This stream then passes through heat exchangers **26** and **36** where it cools propane stream **25** and butane stream **27** obtained from depropanizer **22** and debutanizer **30** respectively. The stream continues through line **17** and is further heated by heater **12** before being recombined with stream **15** and fed into the central portion of demethanizer **6**.

The vapors mostly methane, leaving the top of demethanizer **6** through the line **13** are passed through heat exchanger **24** where they cool the vapors leaving the top of depropanizer **22** and thus provide the reflux for this column. After exiting from heat exchanger **24**, the methane rich vapors are at approximately +40° F. and a suitable pressure for passage directly to the fuel distribution system (not shown) via the line **29**.

The bottoms product leaving demethanizer **6** through the line **19** is conducted to de-ethanizer **14** which is operated at a pressure of approximately 235 p.s.i.g. Heat is supplied to de-ethanizer **14** by reboiler **16**. A portion of the vapor leaving de-ethanizer **14** through the line **31** are condensed in heat exchanger **18** and refluxed via line **23** back into column **14**. The remaining portion, mostly ethane is withdrawn through line **20**.

The bottoms product leaving de-ethanizer **14** is conducted through the line **21** to depropanizer **22**. Depropanizer **22** is operated at a pressure of approximately 190 p.s.i.g. and is provided with a reboiler **28**. The propane rich vapors leaving the top of depropanizer **22** are condensed in heat exchanger **24** and a part of the condensed stream is recycled to depropanizer **22** with the remainder being withdrawn via line **25**. Prior to passing to the propane storage facilities (not shown) this stream is cooled to approximately −45° F. in heat exchanger **26**.

The bottoms product from depropanizer **22** passes through the line **33** to debutanizer **30**. This column is operated at a pressure of approximately 85 p.s.i.g. and is also provided with a reboiler **32**. The butane rich vapors leaving the top of debutanizer **30** are condensed in heat exchanger **34** and a part of the condensate is recycled as reflux to column **30**. The remainder of the condensate is withdrawn via the line **27** and through heat exchanger **36** where the butane condensate is cooled to approximately +25° F. before being sent to storage. The bottoms product from debutanizer **30** consisting of C_5 residuals is withdrawn through line **37** and passes through heat exchanger **38** prior to being stored.

It is to be understood that the foregoing arrangement can be modified in various details and need not necessarily be restricted to the processing of natural gas per se. The flow sheet and description is only given for the purposes of illustrating more clearly how the invention may be performed. Moreover, the operating percentages, temperatures and pressures specified herein above can be varied considerably for given mixtures. Accordingly, reference should be made to the following appended claims in determining the full scope of the invention.

What is claimed is:

1. A process for regasifying liquefied natural gas comprising the following steps in combination:

(a) separating the liquefied natural gas into a plurality of side streams;

(b) passing a first side stream of said plurality of streams to a distillation column;

(c) passing a second side stream through a heat exchange means whereby said second side stream is heated;

(d) recombining a first portion of the heated second side stream with the remainder of said plurality of streams;

(e) utilizing the recombined stream resulting from step (d) for providing refrigeration to other process streams; and

(f) combining said recombined stream with the previously uncombined portion of said second stream and passing this newly combined stream into the middle region of said distillation column.

2. The process of claim **1** wherein at least a portion of said heat exchange means resides in a plant which produces ethylene.

3. The process of claim **1** further characterized in that vapors, comprising mostly methane, are withdrawn from the top of said distillation column, said vapors being passed in heat exchange relationship with other process streams whereby said vapors are heated to a temperature suitable for pipeline distribution.

4. The process of claim **3** further characterized in that the vapors from the top of said distillation column are utilized to provide refrigeration for obtaining reflux streams in a depropanizer.

5. A process for regasifying liquefied natural gas whereby a product is obtained at pressures and temperatures suitable for pipeline distribution comprising the following steps in combination:

(a) pressurizing a liquefied natural gas stream,

(b) separating said liquefied natural gas stream into three side streams,

(c) passing a first side stream into the upper region of a demethanizer,

(d) passing a second side stream through a heat exchange complex whereby said second side stream provides refrigeration duty to said heat exchange complex and is thereby heated,

(e) recombining the third side stream with a first portion of the heated second side stream,

(f) utilizing this recombined stream for providing the refrigeration for obtaining reflux streams in a fractional separation by distillation and condensation of the hydrocarbons present in said liquefied natural gas stream,

(g) combining said recombined stream with the previously uncombined portion of said second side stream and passing this newly combined stream into the middle region of said demethanizer,

(h) withdrawing the vapors from the top of said demethanizer,

(i) passing said vapors in heat exchange relationship with other process streams whereby said vapors are heated to a temperature suitable for pipeline distribution.

6. The process of claim **1** wherein at least a part of said heat exchanger complex resides in a plant producing ethylene.

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