ABSTRACT

A process and system is provided for separating a feed gas stream containing methane, at least one C2 component, at least one C3 component, and optionally heavier components, into a volatile gas stream containing a major portion of the methane and at least one C2 component and a less volatile stream containing a major portion of the at least one C3 and heavier components. The feed stream is cooled, at least partially condensed, and fed to a fractionation column wherein the feed stream is separated into an overhead vapor stream comprising primarily the lighter components of the feed stream and a bottoms liquid stream comprising primarily the heavier components of the feed stream. The introduction of a reboiler onto the fractionation column assists in removing co-absorbed C2 and lighter components from the fractionation column bottoms thereby facilitating more efficient operation of a downstream deethanizer column. Addition of residue recycle can further supplement recovery of desired components.
METHODS AND SYSTEMS FOR RECOVERING LIQUEFIED PETROLEUM GAS FROM NATURAL GAS

RELATED APPLICATION

[0001] This application claims the benefit of U.S. Provisional Patent Application No. 61/360,753, filed Jul. 1, 2010, which is incorporated by reference herein in its entirety.

BACKGROUND OF THE INVENTION

[0002] 1. Field of the Invention
[0003] The present invention is directed toward processes and systems for recovering liquefied petroleum gas (LPG) from a hydrocarbon gas stream, especially a natural gas stream or a refinery gas stream. Particularly, the processes and systems described herein may be utilized to enhance LPG recovery, particularly when processing higher pressure or leaner feed streams thereby providing broader applicability compared to previous processes.

[0004] 2. Description of the Prior Art
[0005] Natural gas comprises primarily methane, but can also include varying amounts of heavy hydrocarbon components such as ethane, propane, butane, and pentane, for example. It is well known that natural gas streams can be separated into their respective component parts. Such processes involve a combination of chilling, expansion, distillation and/or like operations to separate methane and ethane from C3 and heavier hydrocarbon components. Typically the separation made is of methane and ethane from propane and heavier components. If economically desirable, the ethane could also be recovered and similarly, it is desirable in many instances to further fractionate the recovered C3 (or alternatively C2) and heavier components.

[0006] One process that has been devised for separating a natural gas stream into light and heavy component streams is shown in U.S. Pat. No. 5,771,712, incorporated by reference herein in its entirety. The '712 Patent demonstrates a typical process wherein an overhead stream from a deethanizer is passed into heat exchange with an exit stream from an absorber to cool the overhead stream from the deethanizer to a temperature at which it is partially liquefied. This partially liquefied stream is then introduced into the absorber wherein the liquid portion of the stream passes downwardly through the absorber to contact a gaseous stream passing upwardly through the absorber. While this processing system has been effective to separate C3 and lighter components from C4 and heavier components, it is relatively inefficient when processing lower pressure feed gas streams. It is also relatively inefficient when processing rich feed gas streams with respect to their C3 and heavier content. It is particularly ineffective when large amounts of very light gases, such as hydrogen, may be present in the feed gas stream charged to the process. Hydrogen in gaseous streams recovered from refinery operations, which may be desirably separated in such processes, is not uncommon. While the occurrence of hydrogen in significant quantities in natural gas is rare, the presence of hydrogen in similar streams from refinery operations is common.

[0007] U.S. Pat. No. 6,405,561 discloses a process for recovering C3 and heavier components from low-pressure natural gas or refinery gas streams. The '561 patent teaches the improvement of cooling and partially condensing a deethanizer overhead gas stream to produce a deethanizer liquid stream that is further cooled and directed into an upper portion of a separator/absorber, which separates the inlet feed stream into a liquid bottoms stream comprising primarily C4 and heavier components and an overhead gas stream comprising primarily C2 and lighter components. The process of the '561 patent is particularly effective for treatment of feed gas streams at lower pressure that contain substantial amounts of very light components, including hydrogen that is often found in refinery applications. The process of the '561 patent is also effective for treatment of feed gas streams rich with respect to recoverable C3 and heavier components.

[0008] However, as feed gas pressure increases, or if feed gas streams with higher quantities of C2 and lighter components are used, the process of the '561 patent becomes less effective due to co-adsorption of these lighter components in the separator/absorber bottoms stream. As a result, these lighter components tend to reduce the temperature required to partially condense the deethanizer overhead gas stream. Thus, the refrigerant medium used in this condensation operation must be changed from propane to a colder, more horsepower-intensive refrigeration media. As a result, the investment in equipment and operating cost is increased substantially.

SUMMARY OF THE INVENTION

[0009] In one embodiment of the present invention, there is provided a process for separating a feed gas stream containing methane, at least one C3 component, and at least one C4 component into a volatile gas stream containing a major portion of the methane and at least one C4 component and a less volatile stream containing a major portion of at least one C3 component. The process comprises first cooling the feed gas stream to a temperature sufficient to condense the majority of the at least one C3 component in the feed gas stream to produce a cooled feed stream. The cooled feed stream is introduced into a separator vessel to separate the cooled feed stream into a separator gas stream and a separator liquid stream. At least a portion of both of the separator gas and liquid streams from the separator vessel is introduced into a fractionation column to produce a fractionation column bottoms product and a fractionation column overhead gas stream. The fractionation column bottoms product is introduced into a deethanizer tower which produces a deethanizer bottoms stream comprising a majority of the at least one C3 component and a deethanizer overhead gas stream.

[0010] In another embodiment of the present invention, there is provided a process for separating a feed gas stream containing methane, at least one C3 component, and at least one C4 component into a volatile gas stream containing a major portion of the methane and at least one C4 component and a less volatile stream containing a major portion of the at least one C3 component. The process comprises cooling the feed gas stream to a temperature sufficient to condense the majority of the at least one C3 component therein to produce a cooled feed stream. The cooled feed stream is passed to a fractionation column to produce a liquid fractionation column bottoms product and a fractionation column overhead residue gas stream. The fractionation column including a reboiler operable to vaporize at least a portion of the fractionation column liquid which is taken from the bottom or near the bottom of the column. The vaporized portion is then reintroduced into the fractionation column. The fractionation column bottoms product is introduced into a deethanizer tower which produces a deethanizer bottoms stream comprising a majority of the at least one C3 component and a deetha-
alyzer overhead gas stream. The deethanizer overhead gas stream is cooled and at least partially condensed thereby producing a deethanizer liquid reflux stream and a deethanizer residue gas stream. Optionally, the deethanizer residue gas stream is combined with at least a portion of the overhead residue gas stream to form a combined residue gas stream. At least a portion of the combined residue gas stream is compressed and cooled to produce a residue gas reflux stream. The residue gas reflux stream is introduced into the fractionation column.

In a further embodiment of the present invention, there is provided a process for separating a feed gas stream containing methane, at least one C₂ component, and at least one C₃ component into a volatile gas stream containing a major portion of the methane and at least one C₂ component and a less volatile stream containing a major portion of the at least one C₃ component. The process comprises cooling the feed gas stream to a temperature sufficient to condense the majority of the at least one C₃ component in the feed gas stream to produce a cooled feed stream. The cooled feed stream is passed to a fractionation column to produce a liquid fractionation column bottoms product and a fractionation column overhead residue gas stream. The fractionation column bottoms product is introduced into a deethanizer tower, which produces a deethanizer bottoms stream comprising a major portion of the at least one C₂ component and a deethanizer overhead gas stream. The deethanizer overhead gas stream is cooled and at least partially condensed thereby producing a deethanizer liquid reflux stream and a deethanizer residue gas stream. At least a portion of the fractionation column overhead residue gas stream is compressed and cooled to produce a residue gas reflux stream. The residue gas reflux stream is then introduced into the fractionation column.

In yet another embodiment of the present invention, there is provided a system for separating a feed gas stream containing methane, at least one C₂ component, and at least one C₃ component into a volatile gas stream containing a major portion of the methane and at least one C₂ component and a less volatile stream containing a major portion of the at least one C₃ component. The system comprises a feed stream heat exchanger configured to cool the feed gas stream to a temperature sufficient to condense the majority of the at least one C₃ component in the feed gas stream to produce a cooled feed stream. A separator vessel is located downstream from the feed stream heat exchanger and configured to separate the cooled feed stream into a separator gas stream and a separator liquid stream. A fractionation column is located downstream from the separator vessel and configured to receive at least a portion of both the separator gas and liquid streams and produce a fractionation column bottoms product and a fractionation column overhead residue gas stream. A deethanizer tower is located downstream from the fractionation column bottoms product and to produce a deethanizer bottoms stream comprising a majority of the at least one C₂ component and a deethanizer overhead gas stream.

In still another embodiment of the present invention, there is provided a system for separating a feed gas stream containing methane, at least one C₂ component, and at least one C₃ component into a volatile gas stream containing a major portion of the methane and at least one C₂ component and a less volatile stream containing a major portion of the at least one C₃ component. The system comprises a feed stream heat exchanger configured to cool the feed gas stream to a temperature sufficient to condense the majority of the at least one C₃ component therein to produce a cooled feed stream. A fractionation column is located downstream from the feed stream heat exchanger and is configured to receive the cooled feed stream and produce a fractionation column bottoms product and a fractionation column overhead residue gas stream. The fractionation column includes a reboiler configured to vaporize at least a portion of the fractionation column liquid and reintroduce the vaporized fractionation column liquid back into the fractionation column. A deethanizer tower is located downstream from the fractionation column and configured to receive at least another portion of the fractionation column bottoms product and produce a deethanizer bottoms stream comprising a majority of the at least one C₂ component and a deethanizer overhead gas stream. A deethanizer separation vessel is located downstream from the deethanizer heat exchanger and is configured to separate the cooled deethanizer overhead gas stream into a deethanizer liquid reflux stream and a deethanizer residue gas stream. Optionally, the system further includes a conduit configured to merge at least a portion of the deethanizer residue gas stream with at least a portion of the fractionation column overhead residue gas stream to form a combined residue gas stream. A residue gas heat exchanger is provided and configured to condense at least a portion of the combined residue stream to form a residue gas reflux stream. Conduit is configured to deliver at least a portion of the residue gas reflux stream from the gas condensation unit to the fractionation column.

In even a further embodiment, there is provided a system for separating a feed gas stream containing methane, at least one C₂ component, and at least one C₃ component into a volatile gas stream containing a major portion of the methane and at least one C₂ component and a less volatile stream containing a major portion of the at least one C₃ component. The system comprises a feed stream heat exchanger configured to cool the feed gas stream to a temperature sufficient to condense the majority of the at least one C₃ component in the feed gas stream to produce a cooled feed stream. A fractionation column is located downstream from the feed stream heat exchanger and is configured to produce the cooled feed stream and produce a fractionation column bottoms product and a fractionation column overhead residue gas stream. A deethanizer tower is located downstream from the fractionation column and configured to receive at least a portion of the fractionation column bottoms product and produce a deethanizer bottoms stream comprising a major portion of the at least one C₂ component and a deethanizer overhead gas stream. A deethanizer heat exchanger is provided and configured to receive and cool the deethanizer overhead gas stream. A deethanizer separation vessel is provided and configured to separate the cooled deethanizer overhead gas stream into a deethanizer liquid reflux stream and a deethanizer residue gas stream. Conduit is provided and configured to deliver at least a portion of the deethanizer liquid reflux stream to the fractionation column.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic diagram of a process according to one embodiment of the present invention; and

FIG. 2 is a schematic diagram of a process according to another embodiment of the present invention.
DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0017] Turning to FIG. 1, an embodiment of the present invention is shown that is particularly adapted for the recovery of C3 and heavier components from a hydrocarbon-containing gas stream, such as a natural gas or refinery gas stream. In particular embodiments, the inlet feed gas stream 10 comprises methane, at least one C2 component, at least one C3 component, and optionally heavier components. In still other embodiments, inlet feed gas stream 10 comprises methane as the predominant component, with C2, C3, and heavier components being present in lesser amounts. In refinery applications, the feed may also contain significant quantities of lightier components such as hydrogen. Particularly, in certain applications, the feed stream may comprise as much as 10%, or even as much as 50%, hydrogen.

[0018] The present invention exhibits the flexibility to accommodate a wide variety of feed pressures. In one embodiment, the feed stream 10 can be supplied at a pressure of at least 300 psi, or particularly, between about 350 psi to about 700 psi. Typically, feed stream 10 will be supplied at a temperature that is above the condensation point for the C3 components present therein; therefore, feed stream will need to be cooled in order to condense these components. In this embodiment, feed gas stream 10 is passed through a heat exchanger 12 where it is cooled to a temperature sufficient to condense the majority of the at least one C3 component in the feed gas stream to produce a cooled gas feed stream. Note, the use of the word “gas” in the term “cooled gas feed stream” should not be taken as implying that the entirety of the stream is present in the gaseous state. Certain components, particularly the heavier components may be present as liquids. The cooling streams used in heat exchanger 12 are discussed in greater detail below. It will be understood that the heat exchange function shown schematically in heat exchanger 12 may be accomplished in a single or a plurality of heat exchange vessels.

[0019] The cooled inlet gas is passed via a line or conduit 14 to a separation vessel 16 where it is separated into a vapor stream 18 and a bottoms stream 20. Vapor stream 18 is directed toward an expander 22 to reduce the pressure of and further cool the stream. The expanded vapor stream is passed via a line 24 to a fractionation column 26 containing one or more theoretical stages of mass transfer. In certain embodiments, the fractionation column 26 is a conventional distillation column containing a plurality of vertically spaced trays, one or more packed beds, or some combination of trays and packing.

[0020] The bottoms stream 20 recovered from separation vessel 16 contains primarily C3 and heavier components, although the bottoms stream 20 will also contain quantities of lighter materials. As explained further below, ultimately these lighter components will be separated from the C3 and heavier components in subsequent processing steps. In order to maximize the efficiency of these subsequent processing steps, the present embodiment seeks to control the levels of C2 and lighter components contained in the liquid, predominantly C3 stream that will be further processed. Thus, bottoms stream 20 is also passed to fractionation column 26. Generally, bottoms stream 20 is introduced into fractionation column 26 below the introduction point for the expanded vapor stream carried by line 24, although the arrangement of the introduction points for the various streams fed to fractionation column 26 can be varied as deemed appropriate. This step of introducing bottoms stream 20 into fractionation column 26 provides an opportunity for the lighter materials co-absorbed in liquid bottoms stream 20 to be separated therefrom. Fractionation column 26 is equipped with an optional reboiler 28 to assist with separation of the C2 and lighter components from the bottoms of the fractionation column. A portion of the fractionation column liquids taken from the bottom or near the bottom of column 26 are directed to reboiler 28 and at least partially vaporized and then reintroduced into the fractionation column 26. Accordingly, as the liquid stream exiting fractionation column 26 contains fewer C3 or lighter components, it has higher condensation temperature than the stream 20. This permits a propane refrigerant, or similar refrigerant, to be used to condense the overhead stream from a deethanizer 36, which is discussed in greater detail below. Otherwise, if the bottoms product from fractionation column 26 contained a higher level of C2 or lighter components, a colder and therefore more expensive refrigeration system would need to be employed.

[0021] In fractionation column 26, a liquid bottoms stream comprising primarily C3 and heavier components plus some light components is recovered via a line 30 and a pump 32 and pumped via a line 34 to heat exchanger 12 where it is used to cool the inlet gas stream in line 10. The stream in line 34 is then passed to a deethanizer 36. In deethanizer 36 the stream from line 34 is separated by conventional distillation techniques as well known to the art for deethanizers into an overhead vapor stream 38 and a bottoms stream 40. Deethanizer 36 also comprises a conventional reboiler 42. The stream recovered from deethanizer 36 through line 40 comprises primarily C3 and heavier components. An overhead stream is recovered from the deethanizer via line 38, which is rich in C2 and lighter components and is passed to a heat exchanger 44 where it is partially condensed and then through a line 46 to a separator 48. From separator 48, a liquid stream is withdrawn via line 50 and passed to a pump 52 from which a portion of the liquid stream is passed via a line 54 into an upper portion of deethanizer 36 as a reflux. The vapor stream recovered from separator 48 is passed via a line 56.

[0022] Deethanizer 36 is maintained at a higher pressure than fractionation column 26. The increased pressure for deethanizer 36 is supplied by pump 32 and maintained by a valve 57 disposed in line 56. In certain embodiments, the pressure in deethanizer 36 is at least 25 psi, or at least 100 psi, or at least 200 psi greater than the pressure in fractionation column 26.

[0023] A second portion of the liquid stream from separator 48 is passed via a line 58, through a heat exchanger 60, and into an upper portion of fractionation column 26. An overhead vapor stream recovered from the upper portion of fractionation column 26 is passed via a line 62, through heat exchanger 66 and then combined with the stream in line 56. It is noted that the stream carried by line 56 is flashed across valve 57. The combined stream contains a residue gas that comprises a major portion of the C3 and lighter components from the inlet gas feed stream. This stream is passed via line 64 through heat exchanger 12 so as to provide cooling for feed stream 10. Alternatively, stream 56 and stream 62 can be passed separately through heat exchanger 12 such that stream 56, which contains a significant quantity of C2 components, would be available for internal use thus reducing the C2 content of the residue gas.

[0024] The cooling to heat exchanger 12 provided by the materials carried by lines 34 and 64 can be supplemented by
a refrigerant, such as propane, supplied to heat exchanger 12 by line 76. Next, the residue gas carried by line 64 is passed through a compressor 66. The residue gas exits compressor 66 via line 68. Optionally, a portion of the residue gas carried by line 68 is passed via a line 70 to a heat exchanger 72 where it is cooled and condensed. In the embodiment illustrated, the chilled portion of residue gas exiting heat exchanger 72 is refluxed to the top of fractionation column 26. The other portion of residue gas from line 68 is withdrawn from the system via line 74. In those embodiments in which streams 56 and 62 are not combined and an additional reflux is desired for column 26, a portion of the contents of stream 62 are compressed, condensed and refluxed to the column.

In an illustrative embodiment of the process shown in FIG. 1, a dehydrated gas stream is charged to the process at 340 psia and 114°F. The gas stream is cooled in heat exchanger 12 to a temperature of -66°F and 330 psia and charged to separation vessel 16. In separation vessel 16, gaseous overhead stream 18 is produced and passed through expander 22 and is carried by line 24 at -99°F and 150 psia to fractionation column 26. The liquid stream recovered via line 20 at -1.5°F and 145 psia and directed through pump 32 where its pressure is increased to 360 psia. The stream carried by line 34 is used to provide refrigeration to heat exchanger 12 and then directed to deethanizer 36 at a temperature of 74°F and 355 psia.

Deethanizer 36, a bottoms liquid stream composed primarily of C3 and heavier components is recovered via line 40 at a temperature of 173°F and 350 psia. The vapor stream recovered via line 56 is at a temperature of 24°F at 335 psia. In the current simulation, the vapor stream recovered via line 56 was withdrawn from the system and used as fuel gas. However, as illustrated in FIG. 1, this stream can be flashed across valve 57 and combined with the gas carried by line 62. A liquid reflux stream carried by line 58 is withdrawn from the deethanizer at a temperature of 24°F and 335 psia. This stream is cooled, expanded, and refluxed to fractionation column 26 at -11°F and 145 psia.

The overhead vapor from fractionation column 26 carried by line 62 is at a temperature of -117°F and a pressure of 140 psia and is heat exchanged with the stream carried by line 58 and emerges from heat exchanger 60 at -99°F and 135 psia and directed to heat exchanger 12 via line 64. This residue gas stream exits heat exchanger 12 at 95°F and 125 psia and is directed toward compressor 66 (in this simulation a series of compressor stages with intercooling) where it is boosted to 1265 psia and its temperature raised to 115°F. A portion of this compressed stream is withdrawn via line 70, cooled and condensed by heat exchanger 72 and refluxed to fractionation column 26 at a temperature of -112°F and pressure of 1255 psia.

While specific temperatures have been referred to in connection with the embodiment illustrated in FIG. 1, it should be understood that a wide range of temperature and pressure variations are possible within the scope of the present invention. Such temperature and pressure variations are readily determined by those skilled in the art based upon the composition of the specific feed streams, the desired recoveries and the like within the scope of the processes disclosed above.

FIG. 2 illustrates another embodiment of a process in accordance with the present invention. Note, when applicable, the same reference numerals used in the description of FIG. 1 have been used to identify comparable lines or equipment. In the process of FIG. 2, the inlet gas stream is charged to the process via a line 10. The inlet feed gas is cooled in a heat exchanger 12 and thereafter passed via a line 14 to a heat exchanger 15 where it is further cooled to a selected temperature and passed via line 17 to a fractionation column 26 containing one or more theoretical stages of mass transfer. Fractionation column 26 is equipped with a reboiler 28 to assist with separation of the C2 and lighter components from the bottoms of the fractionation column. A portion of the tower liquid from fractionation column 26 is directed to reboiler 28 and at least partially vaporized and then reintroduced into the bottom of fractionation column 26.

In fractionation column 26, a liquid bottoms product comprising primarily C3 and heavier components plus some light components is recovered via a line 30 and a pump 32 and pumped via a line 34 to heat exchanger 12 where it is used to cool the inlet gas stream in line 10. The stream in line 34 is then passed via a deethanizer 36. In deethanizer 36 the stream from line 34 is separated by conventional distillation techniques into an overhead vapor stream 38 and a bottoms steam 40. A conventional reboiler 42 is shown for withdrawing a portion of the deethanizer tower liquid, at least partially vaporizing the withdrawn portion, and returning the at least partially vaporized steam back to deethanizer 36. The steam recovered from deethanizer 36 through line 40 comprises primarily C2 and heavier components. An overhead steam is recovered from the deethanizer via line 38, which is rich in C2 and lighter components and is passed to a heat exchanger 44 where it is at least partially condensed and then through a line 46 to a separator 48. From separator 48, a liquid steam is withdrawn via a line 50 and passed to a pump 52 from which a portion of the liquid steam is passed via a line 54 into an upper portion of deethanizer 36 as a reflux. The vapor stream recovered from separator 48 is passed via a line 56 and through an expansion valve 57. The vapor stream is then combined with the residue gas from line 62 and directed toward a compressor 66 via line 64.

A second portion of the liquid stream from separator 48 is passed via a line 58 and a heat exchanger 60 into an upper portion of fractionation column 26. An overhead vapor stream recovered from the upper portion of fractionation column 26 is passed via a line 62 through heat exchanger 60 to combination with the stream in line 26. The combined stream carried by line 64 contains a major portion of the C2 and lighter components from the inlet gas feed stream. As noted above, the stream in line 64 is compressed by compressor 66 and passed into line 68. A portion of the compressed residue gas carried by line 68 is passed via a line 70 to a heat exchanger 72 where it is cooled and condensed. In the embodiment illustrated, the condensed portion of residue gas exiting heat exchanger 72 is refluxed to the top of fractionation column 26. The other portion of residue gas from line 68 is withdrawn from the system via line 74.

It is noted that, as discussed above with respect to FIG. 1, in certain embodiments, streams 56 and 62 may be kept separate. When an additional reflux is desired for column 26, a slip stream of the material carried by line 62 can be compressed, condensed, and refluxed to the column. It is also noted that for any embodiment discussed above, it is within the scope of the present invention for the residue gas reflux carried by line 70 to be used without equipping fractionation column 26 with a reboiler 28.

While the present invention has been described by reference to certain of its preferred embodiments, it is
respectfully pointed out that the embodiments described are illustrative rather than limiting in nature and that many variations and modifications are possible within the scope of the present invention.

We claim:

1. A process for separating a feed gas stream containing methane, at least one C2 component, and at least one C3 component into a volatile gas stream containing a major portion of the methane and at least one C2 component and a less volatile stream containing a major portion of the at least one C3 component, the process comprising:
   a) cooling the feed gas stream to a temperature sufficient to condense the majority of the at least one C3 component in the feed gas stream to produce a cooled feed stream;
   b) introducing the cooled feed stream into a separator vessel to separate the cooled feed stream into a separator gas stream and a separator liquid stream;
   c) introducing at least a portion of both of the separator gas and liquid streams from the separator vessel into a fractionation column to produce a fractionation column bottoms product and a fractionation column overhead residue gas stream;
   d) introducing the fractionation column bottoms product into a deethanizer tower and producing a deethanizer bottoms stream comprising a majority of the at least one C2 component and a deethanizer overhead gas stream;
   e) cooling and at least partially condensing the deethanizer overhead gas stream thereby producing a deethanizer liquid reflux stream and a deethanizer residue gas stream; and
   f) introducing at least a portion of the deethanizer liquid reflux stream into the fractionation column.

2. The process according to claim 1, wherein the fractionation column further includes a reboiler operable to vaporize at least a portion of a fractionation column liquid, the vaporized fractionation column liquid being reintroduced into the fractionation column.

3. The process according to claim 1, further comprising:
   g) combining the fractionation column overhead residue gas stream with at least a portion of the deethanizer residue gas stream to form a combined residue gas stream;
   h) compressing and cooling at least a portion of the combined residue gas stream to produce a residue gas reflux stream; and
   i) introducing the residue gas reflux stream into the fractionation column.

4. The process according to claim 1, wherein the process further comprises:
   g) compressing and cooling at least a portion of the fractionation column overhead residue gas stream to produce a residue gas reflux stream; and
   h) introducing the residue gas reflux stream into the fractionation column.

5. A process for separating a feed gas stream containing methane, at least one C2 component, and at least one C3 component into a volatile gas stream containing a major portion of the methane and at least one C2 component and a less volatile stream containing a major portion of the at least one C3 component, the process comprising:
   a) cooling the feed gas stream to a temperature sufficient to condense the majority of the at least one C3 component in the feed gas stream to produce a cooled feed stream;
   b) passing the cooled feed stream to a fractionation column to produce a liquid fractionation column bottoms product and a fractionation column overhead residue gas stream, the fractionation column including a reboiler operable to vaporize at least a portion of a fractionation column liquid, the vaporized fractionation column liquid being reintroduced into the fractionation column;
   c) introducing the fractionation column bottoms product into a deethanizer tower and producing a deethanizer bottoms stream comprising a majority of the at least one C2 component and a deethanizer overhead gas stream;
   d) cooling and at least partially condensing the deethanizer overhead gas stream thereby producing a deethanizer liquid reflux stream and a deethanizer residue gas stream; and
   e) introducing at least a portion of the deethanizer liquid reflux stream into the fractionation column.

6. The process according to claim 5, wherein the process further comprises:
   f) compressing and cooling at least a portion of the fractionation column overhead residue gas stream to produce a residue gas reflux stream; and
   g) introducing the residue gas reflux stream into the fractionation column.

7. The process according to claim 6, wherein prior to step (b) introducing the cooled feed stream into a separator vessel to separate the cooled feed stream into a separator gas stream and a separator liquid stream.

8. The process according to claim 6, wherein the process further comprises, prior to step (f), combining at least a portion of the deethanizer residue gas stream with the at least a portion of the fractionation column overhead gas residue stream.

9. The process according to claim 9, wherein prior to step (b) introducing the cooled feed stream into a separator vessel to separate the cooled feed stream into a separator gas stream and a separator liquid stream.

10. A process for separating a feed gas stream containing methane, at least one C2 component, and at least one C3 component into a volatile gas stream containing a major portion of the methane and at least one C2 component and a less volatile stream containing a major portion of the at least one C3 component, the process comprising:
    a) cooling the feed gas stream to a temperature sufficient to condense the majority of the at least one C3 component in the feed gas stream to produce a cooled feed stream;
    b) passing the cooled feed stream to a fractionation column to produce a liquid fractionation column bottoms product and a fractionation column overhead residue gas stream, the fractionation column including a reboiler operable to vaporize at least a portion of a fractionation column liquid, the vaporized fractionation column liquid being reintroduced into the fractionation column;
    c) introducing the fractionation column bottoms product into a deethanizer tower and producing a deethanizer bottoms stream comprising a majority of the at least one C2 component and a deethanizer overhead gas stream;
    d) cooling and at least partially condensing the deethanizer overhead gas stream thereby producing a deethanizer liquid reflux stream and a deethanizer residue gas stream; and
    e) introducing at least a portion of the deethanizer liquid reflux stream into the fractionation column;
    f) compressing and cooling at least a portion of the fractionation column overhead residue gas stream to produce a residue gas reflux stream; and
    g) introducing the residue gas reflux stream into the fractionation column.
g) introducing the residue gas reflux stream into the fractionation column.

11. The process according to claim 10, wherein prior to step (f), at least a portion of the deethanizer overhead gas stream is combined with the fractionation column overhead residue gas stream.

12. A system for separating a feed gas stream containing methane, at least one C₂ component, and at least one C₃ component into a volatile gas stream containing a major portion of the methane and at least one C₂ component and a less volatile stream containing a major portion of the at least one C₃ component, the system comprising:
   a) a feed stream heat exchanger configured to cool the feed gas stream to a temperature sufficient to condense the majority of the at least one C₃ component in the feed gas stream to produce a cooled feed stream;
   b) a separator vessel configured to separate the cooled feed stream into a separator gas stream and a separator liquid stream;
   c) a fractionation column located downstream from the separator vessel and configured to receive at least a portion of both the separator gas and liquid streams and produce a fractionation column bottoms product and a fractionation column overhead residue gas stream;
   d) a deethanizer tower located downstream from the separator vessel and configured to receive at least a portion of the fractionation column bottoms product and produce a deethanizer bottoms stream comprising a majority of the at least one C₃ component and a deethanizer overhead gas stream;
   e) a deethanizer heat exchanger configured to receive and cool the deethanizer overhead gas stream; and
   f) a deethanizer separation vessel configured to separate the cooled deethanizer overhead gas stream into a deethanizer liquid reflux stream and a deethanizer residue gas stream.

13. The system according to claim 12, wherein the fractionation column further includes a reboiler configured to vaporize at least a portion of a fractionation column liquid and reintroduce the vaporized fractionation column liquid back into the fractionation column.

14. The system according to claim 12, further comprising:
   g) conduit configured to merge at least a portion of the deethanizer residue gas stream with at least a portion of the fractionation column overhead residue gas stream to form a combined residue gas stream;
   h) a residue gas heat exchanger configured to receive at least a portion of the combined residue gas stream and to produce a residue gas reflux stream; and
   i) conduit configured to deliver at least a portion of the residue gas reflux stream from the residue gas heat exchanger to the fractionation column.

15. The system according to claim 12, further comprising:
   g) a compressor located upstream from the residue gas heat exchanger and configured to compress the combined residue gas stream.

16. A system for separating a feed gas stream containing methane, at least one C₂ component, and at least one C₃ component into a volatile gas stream containing a major portion of the methane and at least one C₂ component and a less volatile stream containing a major portion of the at least one C₃ component, the system comprising:
   a) a feed stream heat exchanger configured to cool the feed gas stream to a temperature sufficient to condense the majority of the at least one C₃ component in the feed gas stream to produce a cooled feed stream;
   b) a fractionation column configured to receive the cooled feed stream and produce a fractionation column bottoms product and a fractionation column overhead residue gas stream, the fractionation column including a reboiler configured to vaporize at least a portion of a fractionation column liquid and reintroduce the vaporized fractionation column liquid back into the fractionation column;
   c) a deethanizer tower located downstream from the fractionation column and configured to receive at least another portion of the fractionation column bottoms product and produce a deethanizer bottoms stream comprising a majority of the at least one C₃ component and a deethanizer overhead gas stream;
   d) a deethanizer heat exchanger configured to receive and cool the deethanizer overhead gas stream; and
   e) a deethanizer separation vessel configured to separate the cooled deethanizer overhead gas stream into a deethanizer liquid reflux stream and a deethanizer residue gas stream.

17. The system according to claim 16, the system further comprising:
   f) a residue gas heat exchanger configured to condense at least a portion of the fractionation column overhead residue gas stream to form a residue gas reflux stream; and
   g) conduit configured to deliver at least a portion of the residue gas reflux stream from the residue gas heat exchanger to the fractionation column.

18. The system according to claim 16, further comprising:
   f) a compressor located upstream from the residue gas heat exchanger and configured to compress the fractionation column overhead residue gas stream.

19. The system according to claim 16, further comprising:
   f) conduit configured to merge at least a portion of the deethanizer residue gas stream with at least the fractionation column overhead residue gas stream to form a combined residue gas stream.

20. A system for separating a feed gas stream containing methane, at least one C₂ component, and at least one C₃ component into a volatile gas stream containing a major portion of the methane and at least one C₂ component and a less volatile stream containing a major portion of the at least one C₃ component, the system comprising:
   a) a feed stream heat exchanger configured to cool the feed gas stream to a temperature sufficient to condense the majority of the at least one C₃ component in the feed gas stream to produce a cooled feed stream;
   b) a fractionation column configured to receive the cooled feed stream and produce a fractionation column bottoms product and a fractionation column overhead residue gas stream, the fractionation column including a reboiler configured to vaporize at least a portion of a fractionation column liquid and reintroduce the vaporized fractionation column liquid back into the fractionation column;
   c) a deethanizer tower located downstream from the fractionation column and configured to receive at least a portion of the fractionation column bottoms product and produce a deethanizer bottoms stream comprising a majority of the at least one C₃ component and a deethanizer overhead gas stream; and
   d) a deethanizer heat exchanger configured to receive and cool the deethanizer overhead gas stream;
c) a deethanizer separation vessel configured to separate the cooled deethanizer overhead gas stream into a deethanizer liquid reflux stream and a deethanizer residue gas stream;
f) conduit configured to deliver at least a portion of the deethanizer liquid reflux stream to the fractionation column;
g) a residue gas heat exchanger configured to condense at least a portion of the fractionation column overhead residue gas stream; and

h) conduit configured to deliver at least a portion of the condensed fractionation column overhead residue gas stream to the fractionation column.

21. The system according to claim 20, further comprising:
i) conduit configured to merge at least a portion of the deethanizer residue gas stream with at least the fractionation column overhead residue gas stream to form a combined residue gas stream.