CLAIMS

1. A method of producing liquefied natural gas (LNG) from a natural gas stream, the method comprising:

removing heavy hydrocarbons from the natural gas stream in a first separator to thereby generate a separated natural gas stream and a separator bottom stream;

using the separated natural gas stream as a coolant in a heat exchanger to thereby generate a pretreated natural gas stream;

compressing and cooling the pretreated natural gas stream to form a chilled pretreated natural gas stream;

recycling a portion of the chilled pretreated natural gas stream as a recycle stream to exchange heat, in the heat exchanger, with the separated natural gas stream, thereby generating a cooled recycle stream;

wherein the recycle stream is introduced to the heat exchanger separately from any other streams;

reducing a temperature and a pressure of the cooled recycle stream, and then conveying all of the cooled recycle stream to a fourth separator;

wherein all of the separated natural gas stream and all of the natural gas stream bypass the fourth separator;

separating the cooled recycle stream into a gaseous separator overhead stream and a reflux stream;

directing the reflux stream to a top portion of the first separator; and

liquefying the chilled pretreated natural gas stream to form LNG.

2. The method of claim 1, wherein liquefying the chilled pretreated natural gas stream is performed in one of

one or more single mixed refrigerant (SMR) liquefaction units,

at least three parallel SMR liquefaction units, and

one or more expander-based liquefaction modules comprising

one or more nitrogen gas expander-based liquefaction modules or

one or more feed gas expander-based liquefaction modules.

3. The method of claim 1 or claim 2, further comprising:

separating liquids from the separator bottom stream in a second separator to form an

overhead stream;

cooling the overhead stream and separating liquids therefrom in a third separator to form a gas product stream; and

combining at least a part of the gas product stream with the pretreated natural gas stream upstream of the at least one compressor.

4. The method of any one of claims 1-3, wherein compressing and cooling the pretreated natural gas stream comprises:

compressing the pretreated natural gas stream in at least one compressor to a pressure of at least 1,500 psia to form a compressed natural gas stream;

cooling the compressed natural gas stream to form a cooled compressed natural gas stream; and

expanding, in at least one work producing natural gas expander, the cooled compressed natural gas stream to a pressure that is less than 2,000 psia and no greater than the pressure to which the at least one compressor compresses the pretreated natural gas stream, to thereby form the chilled pretreated natural gas stream.

5. The method of claim 4, wherein (a) the heat exchanger is a first heat exchanger, and wherein cooling the compressed natural gas stream comprises cooling the compressed natural gas stream in a second heat exchanger that exchanges heat with an ambient environment; and/or (b) wherein the at least one compressor comprises at least two serially arranged compressors, and wherein one of the at least two serially arranged compressors is driven by the work producing natural gas expander.

6. The method of any one of claims 1-5, further comprising:

combining the gaseous separator overhead stream with a column overhead stream upstream of the heat exchanger.

7. The method of any one of claims 1-6, further comprising:

directing the gaseous separator overhead stream to the heat exchanger; and

after passing through the heat exchanger, combining the gaseous separator overhead stream with the pretreated natural gas stream.

8. The method of any one of claims 1-7, further comprising:

cooling a portion of the natural gas stream in the heat exchanger to generate a cooled natural gas stream; and

combining the cooled natural gas stream with the natural gas stream upstream of the first separator.

9. An apparatus for the liquefaction of a natural gas stream, comprising:

a first heat exchanger that cools at least a portion of the natural gas stream to generate a cooled natural gas stream, said portion of the natural gas stream combined with the natural gas stream;

a first separation device configured to remove heavy hydrocarbons from the natural gas stream to thereby generate a separated natural gas stream and a separator bottom stream, wherein the separated natural gas stream is directed to the first heat exchanger to act as a coolant therein, thereby generating a pretreated natural gas stream;

a compression and cooling unit that compresses and cools the pretreated natural gas stream to form a chilled pretreated natural gas stream;

wherein a portion of the chilled pretreated natural gas stream is recycled to the first heat exchanger as a recycle stream to exchange heat with one or more process streams comprising at least one of the portion of the natural gas stream and the separated natural gas stream, thereby generating a cooled recycle stream;

wherein the recycle stream is introduced to the first heat exchanger separately from any other streams;

a temperature and pressure reducing device configured to reduce a temperature and a pressure of the cooled recycle stream;

a fourth separation device that separates the cooled recycle stream into a gaseous separator overhead stream and a reflux stream, and wherein the reflux stream is directed to a top portion of the first separation device;

wherein all of the separated natural gas stream and all of the natural gas stream bypass the fourth separation device; and

at least one liquefaction unit configured to liquefy the chilled pretreated natural gas stream.

10. The apparatus of claim 9, wherein the at least one liquefaction unit comprises

one or more single mixed refrigerant (SMR) liquefaction units,

at least three parallel SMR liquefaction units, or

one or more expander-based liquefaction modules comprising

one or more nitrogen gas expander-based liquefaction modules or

one or more feed gas expander-based liquefaction modules.