Claims

1. A method of natural gas liquefaction comprising at least two nitrogen refrigerant streams, each stream undergoing a cycle of compression, cooling, expansion and heating, during which each of the nitrogen streams is expanded to a different pressure other than for the others of the at least two nitrogen streams, and, the heating occurs in one or more heat exchangers;
the expanded nitrogen streams being in a heat exchanging relationship with a stream of the natural gas and with the one or more compressed nitrogen streams in at least one of said one or more heat exchangers, wherein at least one expanded nitrogen stream is compressed as a side stream in a stage of a main nitrogen compressor so as to combine the compressed side stream with another compressed nitrogen stream after passing said nitrogen compressor stage.

2. A method according to claim 1 wherein the main nitrogen compressor comprises at least two compressor stages.

3. A method according to claim 2 wherein the nitrogen compressor unit comprises at least two compressors coupled on a common drive shaft.

4. A method according to claim 1 or 2 or3 wherein the compressed nitrogen stream is divided over at least two parallel placed expanders to different pressure levels.

5. A method according to claim 4 wherein each expander is connected over a common drive shaft to a compressor for compressing a nitrogen flow.

6. A method according to claim 5 wherein each compressor connected to the respective expander receives and compresses a part of the nitrogen stream that is compressed by the main nitrogen compressor.

7. A method according to claim 5 wherein at least one compressor connected to the respective expander receives and compresses at least a part of the nitrogen stream that passed the heat exchanger.

8. A method according to any preceding claim, wherein the main nitrogen compressor is gas turbine driven or electric motor driven or steam turbine driven.

9. A method according to any preceding claim, wherein the expansion comprises a high pressure, a intermediate pressure and a low pressure expansion stage in a respective expander.

10. A method according to any preceding claim, wherein the main nitrogen compressor comprises three compressor stages and receives two side streams with different pressures.

11. A method according to claim 10 wherein the three compressors are coupled on a common drive shaft

12. A method according to any preceding claim, wherein two of the three parallel placed expanders are turbo-expanders and the third expander is a Joule-Thompson valve.

13. A natural gas liquefaction apparatus comprising a heat exchanger system of one or more heat exchangers for placing the natural gas in a heat exchanging relationship with multiple nitrogen refrigerant streams; at least two compressors for compressing a first and an at least second nitrogen refrigerant stream; a first expander for expanding the first nitrogen stream to a first pressure and at least a second expander for expanding the at least second nitrogen stream to an at least second, lower pressure than the first pressure, wherein the apparatus further comprises a main nitrogen compressor with at least two compressor stages, each compressor stage being arranged for receiving an associated nitrogen stream, and each nitrogen stream having a different pressure other than the other of the at least two nitrogen streams, one nitrogen stream being a side stream which will be combined with the other nitrogen stream.

14. Apparatus according to claim 13, wherein the one nitrogen stream is combined with the other nitrogen stream after passing the compressor stage associated with the one nitrogen stream before entry of the other nitrogen stream into the compressor stage associated with the other nitrogen stream.

15. Apparatus according to claim 13 or 14 wherein the main nitrogen compressor comprises at least two compressors coupled on a common drive shaft.

16. Apparatus according to any one of claims 13 – 15 wherein the compressed nitrogen stream is divided over at least two parallel placed expanders to different pressure levels.

17. Apparatus according to claim 15 wherein each expander is connected over a common drive shaft to a compressor arranged for compressing a nitrogen flow.

18. Apparatus according to claim 17 wherein each compressor receives and compresses a part of the nitrogen stream that is compressed by the main nitrogen compressor.

19. Apparatus according to claim 15 wherein at least one compressor receives and compresses at least a part of the nitrogen stream that passed the heat exchanger system before it flows to the main nitrogen compressor.

20. Apparatus according to any one of preceding claims 14-19, wherein the main nitrogen compressor unit is gas turbine driven or electric motor driven or steam turbine driven.

21. Apparatus according to any one of preceding claims 14-20,wherein the first and at least second expander comprise a high pressure, a intermediate pressure and a low pressure expansion stage in a respective expander.

22. Apparatus according to any one of preceding claims 14 - 21, wherein the main nitrogen compressor comprises three compressors and receives two side streams with different pressures.

23. Apparatus according to claim 22, wherein two of the three parallel placed expanders are turbo-expanders and the third expander is a Joule-Thompson valve.

Claims

1. A method of natural gas liquefaction comprising at least two nitrogen refrigerant streams, each stream undergoing a cycle of compression, cooling, expansion and heating, during which each of the nitrogen streams is expanded to a different pressure other than for the others of the at least two nitrogen streams, and, the heating occurs in one or more heat exchangers;
the expanded nitrogen streams being in a heat exchanging relationship with a stream of the natural gas and with the one or more compressed nitrogen streams in at least one of said one or more heat exchangers, wherein at least one expanded nitrogen stream is compressed as a side stream in a stage of a main nitrogen compressor comprising at least two compressor stages, a first compressor stage (22) and a second compressor stage (23), wherein an outlet of the first compressor stage (22) is coupled to an inlet of the second compressor stage (23) in such a way that the compressor outlet stream from a low pressure turbo expander (L) after being pressurized in the first compressor stage (22) is added to a compressor outlet stream from a high pressure turbo expander (H) before the inlet of the second compressor stage (23) so as to combine the compressed side stream with another compressed nitrogen stream after passing said nitrogen compressor stage.

2. A method according to claim 1, wherein the nitrogen compressor unit comprises at least two compressors coupled on a common drive shaft.

3. A method according to claim 1 or 2, wherein the compressed nitrogen stream is divided over at least two parallel placed expanders to different pressure levels.

4. A method according to claim 3, wherein each expander is connected over a common drive shaft to a compressor for compressing a nitrogen flow.

5. A method according to any one of the preceding claims, wherein the main nitrogen compressor is gas turbine driven or electric motor driven or steam turbine driven.

6. A method according to any one of the preceding claims, wherein the expansion comprises a high pressure, an intermediate pressure and a low pressure expansion stage in a respective expander.

7. A method according to any one of the preceding claims, wherein the main nitrogen compressor comprises three compressor stages and receives two side streams with different pressures.

8. A method according to claim 7, wherein the three compressors are coupled on a common drive shaft.

9. A method according to any one of the preceding claims, wherein two of the three parallel placed expanders are turbo-expanders and the third expander is a Joule-Thompson valve.

10. A natural gas liquefaction apparatus comprising a heat exchanger system of one or more heat exchangers for placing the natural gas in a heat exchanging relationship with multiple nitrogen refrigerant streams; at least two compressors for compressing a first and an at least second nitrogen refrigerant stream; a first expander for expanding the first nitrogen stream to a first pressure and at least a second expander for expanding the at least second nitrogen stream to an at least second, lower pressure than the first pressure, wherein the apparatus further comprises a main nitrogen compressor with at least two compressor stages, each compressor stage being arranged for receiving an associated nitrogen stream, wherein an outlet of a first compressor stage (22) is coupled to an inlet of a second compressor stage (23) in such a way that the compressor outlet stream from a low pressure turbo expander (L) after being pressurized in the first compressor stage (22) is added to a compressor outlet stream from a high pressure turbo expander (H) before the inlet of the second compressor stage (23) and wherein each nitrogen stream has a different pressure other than the other of the at least two nitrogen streams, one nitrogen stream being a side stream which will be combined with the other nitrogen stream.

11. Apparatus according to claim 10, wherein the one nitrogen stream is combined with the other nitrogen stream after passing the compressor stage associated with the one nitrogen stream before entry of the other nitrogen stream into the compressor stage associated with the other nitrogen stream.

12. Apparatus according to claim 10 or 11, wherein the main nitrogen compressor comprises at least two compressors coupled on a common drive shaft.

13. Apparatus according to any one of claims 10 – 12 wherein the compressed nitrogen stream is divided over at least two parallel placed expanders to different pressure levels.

14. Apparatus according to claim 12, wherein each expander is connected over a common drive shaft to a compressor arranged for compressing a nitrogen flow.

15. Apparatus according to claim 14, wherein at least one compressor receives and compresses at least a part of the nitrogen stream that passed the heat exchanger system before it flows to the main nitrogen compressor.

16. Apparatus according to any one of the preceding claims 11-15, wherein the main nitrogen compressor unit is gas turbine driven or electric motor driven or steam turbine driven.

17. Apparatus according to any one of the preceding claims 11-16, wherein the first and at least second expander comprise a high pressure, a intermediate pressure and a low pressure expansion stage in a respective expander.

18. Apparatus according to any one of the preceding claims 11 - 17, wherein the main nitrogen compressor comprises three compressors and receives two side streams with different pressures.

19. Apparatus according to claim 18, wherein two of the three parallel placed expanders are turbo-expanders and the third expander is a Joule-Thompson valve.