CLAIMS

~~**What is claimed is:**~~

~~1. A method for producing liquefied natural gas (LNG) from a natural gas stream having a nitrogen concentration of greater than 1 mol%, comprising:~~

~~at an LNG liquefaction facility, receiving at least one liquid nitrogen (LIN) stream, the at least one LIN stream being produced at a different geographic location from the LNG liquefaction facility;~~

~~liquefying a natural gas stream by indirect heat exchange with a nitrogen vent stream to form a pressurized LNG stream, where the pressurized LNG stream has a nitrogen concentration of greater than 1 mol%;~~

~~directing the pressurized LNG stream to one or more stages of a column to produce an LNG stream and the nitrogen vent stream, wherein the column has upper stages and lower stages; and~~

~~directing one or more LIN streams to one or more upper stages of the column.~~

~~2. The method of claim 1, further comprising:~~

~~prior to directing the pressurized LNG stream to one or more stages of the column, separating the pressurized LNG stream into an LNG vapor stream and an LNG liquid stream, where the LNG vapor stream has a nitrogen concentration greater than the nitrogen concentration of the pressurized LNG stream and the LNG liquid stream has a nitrogen concentration less than the nitrogen concentration of the pressurized LNG stream;~~

~~wherein directing the pressurized LNG stream to one or more stages of the column comprises~~

~~directing the LNG liquid stream to one of the upper stages of the column; and~~

~~directing the LNG vapor stream to one of the lower stages of the column.~~

~~3. The method of claims 1 or 2, wherein the column is one of a fractionation column, a distillation column, or an absorption column.~~

~~4. The method of any one of claims 1-3, wherein a natural gas stream is directed to one of~~

~~the lower stages of the column, wherein the natural gas stream has a lower pressure than the pressurized LNG stream.~~

~~5. The method of claim 4, wherein the natural gas stream comprises boil-off gas from LNG storage tanks.~~

~~6. The method of claim 4, wherein the natural gas stream comprises boil-off gas from storage tanks on an LNG carrier ship.~~

~~7. The method of claim 4, further comprising compressing the natural gas stream prior to being directed to the column.~~

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

~~indirectly exchanging heat between the nitrogen vent stream and the natural gas stream to form a warmed nitrogen vent stream.~~

~~9. The method of any one of claims 1-8, wherein the LNG stream has a nitrogen concentration of less than 1 mol%.~~

~~10. The method of any one of claims 1-9, wherein the nitrogen vent stream has a methane concentration of less than 0.1 mol%.~~

~~11. The method of any one of claims 1-10, further comprising:~~

~~expanding the pressurized LNG stream within a liquid hydraulic turbine prior to being directed to the column.~~

~~12~~1. A method for producing liquefied natural gas (LNG) from a natural gas stream having a nitrogen concentration of greater than 1 mol%, where the method comprises:

at an LNG liquefaction facility, receiving a first liquefied nitrogen (LIN) stream and a second LIN stream, the first and second LIN streams being produced at a different geographical location than the LNG liquefaction facility;

liquefying the natural gas stream by indirect heat exchange with a nitrogen vent stream and the second liquefied nitrogen stream to form a pressurized LNG stream, where the pressurized LNG stream has a nitrogen concentration of greater than 1 mol%;

directing the pressurized LNG stream to a jet pump, and using the pressurized LNG stream as a motive fluid for the jet pump;

mixing the pressurized LNG stream and a lower pressure natural gas stream in the jet pump to produce a two-phase LNG stream, wherein the lower pressure natural gas stream has a pressure that is lower than a pressure of the pressurized LNG stream;

separating the two-phase LNG stream into an LNG vapor stream and an LNG liquid stream;

directing the LNG liquid stream to one or more stages of a column;

directing the LNG vapor stream to one or more lower stages of the column;

directing the first liquefied nitrogen stream to one or more upper stages of the column; and

producing an LNG stream and the nitrogen vent stream from the column.

~~13~~2. The method of claim ~~12~~1, wherein the column is one of a fractionation column, a distillation column, or an absorption column.

~~14~~3. The method of claim ~~12~~-1 or claim ~~13~~2, wherein the lower pressure natural gas stream comprises boil-off gas extracted from LNG storage tanks.

~~15~~4. The method of claim ~~12~~-1 or claim ~~13~~2, wherein the lower pressure natural gas stream comprises boil-off gas extracted from LNG during storage or unloading operations from an LNG carrier ship.

~~16~~5. The method of any one of claims ~~12-15~~1 to 4, further comprising compressing the lower pressure natural gas stream prior to being directed to the column.

~~17~~6. The method of any one of claims ~~12-16~~1 to 5, further comprising:

indirectly exchanging heat between the nitrogen vent stream and the natural gas stream to form a warmed nitrogen vent stream.

~~18~~7. The method of any one of claims ~~12-17~~1 to 6, wherein the LNG stream has a nitrogen molar concentration of less than 1 mol%.

~~19~~8. The method of any one of claims ~~12-18~~1 to 7, wherein the nitrogen vent stream has a methane molar concentration of less than 0.1 mol%.

~~20~~9. A method for producing liquefied natural gas (LNG) from a natural gas stream having a nitrogen concentration of greater than 1 mol%, where the method comprises:

at an LNG liquefaction facility, receiving one or more liquefied nitrogen (LIN) streams, the one or more LIN streams being produced at a different geographical location than the LNG liquefaction facility;

at least partially liquefying the natural gas stream by indirect heat exchange with a nitrogen vent stream ~~and the second liquefied nitrogen stream~~ to form a pressurized LNG stream, where the pressurized LNG stream has a nitrogen concentration of greater than 1 mol%;

directing the pressurized LNG stream to a separation vessel to produce an LNG vapor stream and an LNG liquid stream;

directing the LNG vapor stream to a jet pump, and using the LNG vapor stream as a motive fluid for the jet pump;

mixing the LNG vapor stream and a first lower pressure natural gas stream in the jet pump to produce a second lower pressure gas stream, wherein each of the first and second lower pressure natural gas streams have a pressure that is lower than a pressure of the pressurized LNG stream;

directing the LNG liquid stream to one or more stages of a column;

directing the second lower pressure natural gas stream to one or more lower stages of the column;

directing the one or more LIN streams to one or more upper stages of the column; and

producing an LNG stream and the nitrogen vent stream from the column.

~~21~~10. The method of claim ~~20~~9, wherein the LNG stream has a nitrogen molar concentration of less than 1 mol%.

~~22~~11. The method of claim ~~20~~ 9 or claim ~~21~~10, wherein the nitrogen vent stream has a methane molar concentration of less than 0.1 mol%.

~~23~~12. The method of any one of claims ~~20-22~~9 to 11, wherein the column is one of a fractionation column, a distillation column, or an absorption column.

~~24~~13. The method of any one of claims ~~20-23~~9 to 12, wherein the lower pressure natural gas stream comprises boil-off gas extracted from LNG storage tanks.

~~25~~14. The method of any one of claims ~~20-24~~9 to 13, wherein the lower pressure natural gas stream comprises boil-off gas extracted from LNG during storage or unloading operations from an LNG carrier ship.

~~26. A method for producing liquefied natural gas (LNG) from a natural gas stream having a nitrogen concentration of greater than 1 mol%, where the method comprises:~~

~~at an LNG liquefaction facility, receiving a first liquefied nitrogen (LIN) stream and a second LIN stream, the first and second LIN streams being produced at a different geographical location than the LNG liquefaction facility;~~

~~liquefying the natural gas stream by indirect heat exchange with a nitrogen vent stream and the second liquefied nitrogen stream to form a pressurized LNG stream, where the pressurized LNG stream has a nitrogen concentration of greater than 1 mol%;~~

~~directing the pressurized LNG stream to one or more stages of a column;~~

~~directing a lower pressure natural gas stream to one or more lower stages of the column, wherein the lower pressure natural gas stream has a pressure that is lower than a pressure of the pressurized LNG stream;~~

~~directing the first liquefied nitrogen stream to one or more upper stages of the column; and~~

~~producing an LNG stream and the nitrogen vent stream from the column.~~

~~27. The method of claim 26, wherein liquefying the natural gas stream by indirect heat exchange with a nitrogen vent stream and the second liquefied nitrogen stream is accomplished in a heat exchanger, the method further comprising:~~

~~forming a first warm gas refrigerant stream from the second liquid nitrogen stream after the second liquid nitrogen stream passes through the heat exchanger;~~

~~expanding the first warm gas refrigerant stream to form a first cold gas refrigerant stream; and~~

~~directing the first cold gas refrigerant stream through the heat exchanger to liquefy the natural gas stream.~~

~~28. The method of claim 27, further comprising:~~

~~forming a second warm gas refrigerant stream from the first cold gas refrigerant stream after the first cold gas refrigerant stream passes through the heat exchanger;~~

~~compressing and cooling the second warm gas refrigerant stream to form a compressed refrigerant stream;~~

~~in a second heat exchanger, exchanging heat between the second warm gas refrigerant stream and the compressed refrigerant stream;~~

~~expanding the compressed refrigerant stream to form a second cold gas refrigerant stream; and~~

~~directing the second cold gas refrigerant stream through the heat exchanger to liquefy the natural gas stream.~~

~~29. The method of any one of claims 26-28, wherein the LNG stream has a nitrogen molar concentration of less than 1 mol%.~~

~~30. The method of any one of claims 26-29, wherein the nitrogen vent stream has a methane molar concentration of less than 0.1 mol%.~~

~~31. The method of any one of claims 26-30, wherein the column is one of a fractionation column, a distillation column, or an absorption column.~~

~~32. The method of any one of claims 26-31, wherein the lower pressure natural gas stream comprises boil-off gas extracted from LNG storage tanks.~~

~~33. The method of any one of claims 26-31, wherein the lower pressure natural gas stream comprises boil off gas extracted from LNG during storage or unloading operations from an LNG carrier ship.~~