Claims

1. A method comprising:

feeding a feed gas comprising methane (CH_4) and carbon dioxide (CO_2) to a cryogenic distillation column during start-up of the cryogenic distillation column;

producing an acid gas rich bottom stream and a freeze zone vapor stream;

flowing the freeze zone vapor stream into a freezing section of the cryogenic distillation column, wherein the freeze zone vapor stream exits the cryogenic distillation column as an overhead stream, and wherein the overhead stream has a temperature and a CO_2 concentration;

heating the overhead stream via a heating component to form a heated overhead stream to reduce or prevent solidification of the CO_2 in the overhead stream;

regulating an amount of heat emitted by the heating component via a control system, wherein the control system maintains a temperature margin of the heated overhead stream using a measured temperature as an input into a control scheme, wherein the temperature margin is a temperature difference between the temperature of the overhead stream and a temperature at which CO_2 solidification would occur in the overhead stream given the CO_2 concentration of the overhead stream;

flowing the heated overhead stream into a heat exchanger, wherein the heated overhead stream substantially reduces or prevents solidification of CO_2 in the heat exchanger;

after flowing the heated overhead stream into the heat exchanger, compressing the heated overhead stream via an overhead compressor to produce a high-pressure vapor; and

reducing pressure of the high-pressure vapor to produce a liquid-vapor stream at an inlet of the cryogenic distillation column, wherein the liquid-vapor stream is introduced into the cryogenic distillation column as a refluxing spray.

2. The method of claim 1, wherein the heating of the overhead stream comprises raising a temperature of the overhead stream by 0.5 °F to 10 °F.

3. The method of claim 1 or 2, comprising measuring a temperature of the heated overhead stream at an inlet of the heat exchanger.

4. The method of any one of claims 1 to 3, comprising reducing a temperature of the high-pressure vapor to produce the liquid-vapor stream at the inlet of the cryogenic distillation column.

5. The method of any one of claims 1 to 4, comprising recycling the overhead stream in the cryogenic distillation column, wherein the overhead stream enters a cooling cycle comprising compression, heat exchange, and reduction in pressure and temperature in the recycle.

6. The method of any one of claims 1 to 5, comprising recycling the overhead stream in the cryogenic distillation column until a concentration of the CO_2 is lowered to a non-solidifying range.

7. The method of any one of claims 1 to 6, comprising diverting the overhead stream to a reflux accumulator after a non-solidifying range for the CO_2 is reached.

8. The method of any one of claims 1 to 7, wherein heating the overhead stream via the heating component comprises disposing an inline heater in a flow line of the overhead stream, wherein the inline heater is disposed upstream of the heat exchanger.

9. The method of any one of claims 1 to 7, wherein heating the overhead stream via the heating component comprises disposing heat tracing on a flow line of the overhead stream, wherein the heating tracing is disposed upstream of the heat exchanger.

10. The method of any one of claims 1 to 7, wherein heating the overhead stream via the heating component comprises blending a slipstream of discharge from the overhead compressor into the overhead stream.

11. The method of any one of claims 1 to 7, wherein heating the overhead stream via the heating component comprises diverting a portion of the overhead stream to an external heat exchanger to form a heated diverted portion and blending the heated diverted portion into the overhead stream.

12. A cryogenic distillation system comprising:

a cryogenic distillation column to:

receive a feed gas comprising methane (CH_4) and carbon dioxide (CO_2) that flows into the cryogenic distillation column; and

discharge a freeze zone vapor stream as an overhead stream, wherein the overhead stream has a temperature and a CO_2 concentration;

a heating component configured to heat the overhead stream to produce a heated overhead stream to reduce or prevent solidification of the CO_2 in the overhead stream;

a control system to regulate an amount of heat provided via the heating component to the overhead stream, wherein the control system uses a measured temperature as an

input to a control scheme to maintain a temperature margin of the heated overhead stream, wherein the temperature margin is a temperature difference between the temperature of the overhead stream and a temperature at which CO_2 solidification would occur in the overhead stream given the CO_2 concentration of the overhead stream;

a heat exchanger configured to receive the heated overhead stream, wherein the heating element reduces or prevents solidification of CO_2 in the heat exchanger;

a compressor to compress the heated overhead stream to produce a high-pressure vapor, wherein the heated overhead stream being compressed is the heated overhead stream coming from the heat exchanger; and

a Joule-Thomson (J-T) valve to receive the high-pressure vapor, wherein a pressure and a temperature of the high-pressure vapor is reduced to produce a liquid-vapor stream exiting the J-T valve, wherein the liquid-vapor stream is introduced into the cryogenic distillation column.

13. The cryogenic distillation system of claim 12, wherein the heating component comprises an inline heater.

14. The cryogenic distillation system of claim 12, wherein the heating component comprises heat tracing.

15. The cryogenic distillation system of claim 12, wherein the heating component comprises an external heat exchanger.

16. The cryogenic distillation system of claim 12, wherein the heating component comprises a slipstream from the overhead compressor.

17. The cryogenic distillation system of claim 12, wherein the heating component comprises a pipe tee and a recycle line to receive a slipstream from the overhead compressor.

18. The cryogenic distillation system of any one of claims 12 to 17, comprising a temperature sensor to measure the temperature of the heated overhead stream at an inlet of the heat exchanger.

19. The cryogenic distillation system of any one of claims 12 to 18, wherein the control system uses a real-time computation of the temperature margin as input into the control scheme to maintain the temperature margin of the heated overhead stream.

20. A method comprising:

feeding a feed gas comprising carbon dioxide (CO_2) and methane (CH_4) into a cryogenic

distillation column during start-up;

producing an acid gas rich bottom stream and a freeze zone vapor stream in the cryogenic distillation column;

flowing the freeze zone vapor stream into a freezing section of the cryogenic distillation column, wherein the freeze zone vapor stream exits the cryogenic distillation column as an overhead stream, and wherein the overhead stream has a temperature and a CO_2 concentration;

heating the overhead stream via a heating component to form a heated overhead stream;

regulating an amount of heat emitted by the heating component via a control system, wherein the control system uses a measured temperature as an input into a control scheme to maintain a temperature margin of the heated overhead stream, wherein the temperature margin is a temperature difference between the temperature of the overhead stream and a temperature at which CO_2 solidification would occur in the overhead stream given the CO_2 concentration of the overhead stream;

flowing the heated overhead stream into a heat exchanger, wherein solidification of the CO_2 in the heat exchanger is substantially reduced or prevented;

after flowing the heated overhead stream into the heat exchanger, compressing the heated overhead stream via an overhead compressor to produce a high-pressure vapor, wherein the heated overhead stream is compressed to a pressure beyond solidification conditions for CO_2;

reducing pressure and temperature of the high-pressure vapor via a Joule-Thomson (J-T) valve to produce a liquid-vapor stream;

flowing the liquid-vapor stream into the cryogenic distillation column, wherein the liquid-vapor stream is introduced into the cryogenic distillation column to lower a concentration of the CO_2 in the overhead stream;

cycling the liquid-vapor stream in the cryogenic distillation column, wherein the cycling comprises a cooling cycle comprising compression, heat exchange, and reduction in pressure and temperature; and

continuously recycling the liquid-vapor stream in the cryogenic distillation column until a concentration of the CO_2 in the liquid-vapor stream is lowered to a non-solidifying range.

21. The method of claim 20, wherein the control system uses a real-time computation of the temperature margin as input into the control scheme to maintain the temperature margin of the heated overhead stream.