CLAIMS

What is claimed is:

1. An integrated power generation system, comprising:

a gas turbine system comprising a combustion chamber configured to combust a compressed oxidant and a fuel in the presence of a compressed recycle stream to generate a discharge stream that is expanded in an expander, thereby generating a gaseous exhaust stream;

an exhaust gas recirculation system comprising a boost compressor and one or more cooling units fluidly coupled to the boost compressor, the boost compressor being configured to receive and increase the pressure of the gaseous exhaust stream and the one or more cooling units being configured to cool the gaseous exhaust stream and provide a cooled recycle gas to the main compressor, wherein the main compressor compresses the cooled recycle gas and generates the compressed recycle stream;

a purge stream fluidly coupled to the compressed recycle stream having a heat exchanger configured to reduce the temperature of the purge stream and generate a cooled purge stream; and

a CO_2 separation system fluidly coupled to the heat exchanger, the CO_2 separation system comprising:

an absorption column configured to receive the cooled purge stream and absorb CO_2 from the cooled purge stream with a potassium carbonate solvent to generate a nitrogen-rich residual stream and a bicarbonate solvent solution;

a solvent stripping section configured to receive the bicarbonate solvent solution and strip volatile components from the bicarbonate solvent solution with a stripping vapor; and

a regeneration column fluidly coupled to the stripping section configured to receive and boil the bicarbonate solvent solution to remove CO_2 and water therefrom, producing a regenerated potassium carbonate solvent to be recycled to the absorption column.

2. The system of claim 1, wherein the solvent stripping section is incorporated as additional stages in the absorption column.

3. The system of claim 1, wherein the solvent stripping section is a column separate from the absorption column configured to generate a first stream comprising the stripping vapor and the volatile components stripped from the bicarbonate solvent solution and a second stream comprising the bicarbonate solvent solution.

4. The system of claim 3, wherein the stripping vapor comprises nitrogen, argon, steam, or a combination thereof.

5. The system of claim 1, further comprising a first valve fluidly coupled to the solvent stripping section and configured to flash the bicarbonate solvent solution to a near-atmospheric pressure before the bicarbonate solvent solution enters the regeneration column.

6. The system of claim 5, wherein the first valve is a hydraulic turbine configured to generate power.

7. The system of claim 1, further comprising a reboiler fluidly coupled to the regeneration column and configured to receive and heat a portion of the regenerated potassium carbonate solvent and produce a heated regenerated potassium carbonate solvent.

8. The system of claim 7, wherein the reboiler is configured to recycle the heated regenerated potassium carbonate solvent to the regeneration column to produce steam.

9. The system of claim 1, further comprising a condenser fluidly coupled to the regeneration column configured to receive the CO_2 and water removed from the bicarbonate solvent solution and separate the water from the CO_2.

10. The system of claim 9, wherein a portion of the water separated from the CO_2 is pumped back to the regeneration column to create steam.

11. The system of claim 1, wherein the combustion chamber is configured to stoichiometrically combust the compressed oxidant and the fuel in the presence of the compressed recycle stream.

12. The system of claim 1, wherein the compressed recycle stream acts as a diluent configured to moderate the temperature of the discharge stream.

13. An integrated power generation system, comprising:

a gas turbine system comprising a combustion chamber configured to combust a compressed oxidant and a fuel in the presence of a compressed recycle stream to generate a discharge stream that is expanded in an expander, thereby generating a gaseous exhaust stream;

an exhaust gas recirculation system comprising a boost compressor and one or more cooling units fluidly coupled to the boost compressor, the boost compressor being configured to receive and increase the pressure of the gaseous exhaust stream and the one or more cooling units being configured to cool the gaseous exhaust stream and provide a cooled recycle gas to the main compressor, wherein the main compressor compresses the cooled recycle gas and generates the compressed recycle stream;

a purge stream fluidly coupled to the compressed recycle stream having a heat exchanger configured to reduce the temperature of the purge stream and generate a cooled purge stream; and

a CO_2 separation system fluidly coupled to the heat exchanger, the CO_2 separation system comprising:

an absorption column configured to receive the cooled purge stream and absorb CO_2 from the cooled purge stream with a potassium carbonate solvent to generate a nitrogen-rich residual stream and a bicarbonate solvent solution;

a first valve fluidly coupled to the absorption column configured to flash the bicarbonate solvent solution to a pressure sufficient to separate volatile components from the bicarbonate solvent solution, thereby generating a dual phase reduced-pressure solvent solution having a gaseous phase comprising the volatile components and a liquid phase comprising the bicarbonate solvent solution;

a flash vessel fluidly coupled to the first valve configured to receive the reduced-pressure solvent solution and remove the gaseous phase of the reduced-pressure solvent solution from the liquid phase of the reduced-pressure solvent solution;

a second valve fluidly coupled to the flash vessel configured to receive the liquid phase of the reduced-pressure solvent solution and flash the liquid phase to a near-atmospheric pressure, thereby generating a near-atmospheric bicarbonate solvent solution; and

a regeneration column fluidly coupled to the second valve configured to receive and boil the near-atmospheric bicarbonate solvent solution to remove CO_2 and water therefrom, producing a regenerated potassium carbonate solvent to be recycled to the absorption column.

14. The system of claim 13, wherein the first valve is configured to flash the bicarbonate solvent solution to a pressure such that the gaseous phase of the bicarbonate solvent solution comprises less than 1.0 mol% carbon dioxide.

15. The system of claim 14, wherein the first valve is configured to flash the bicarbonate solvent solution to a pressure such that at least 98 mol% of the total carbon dioxide in the bicarbonate solvent solution remains in the liquid phase of the reduced-pressure solvent solution.

16. The system of claim 13, further comprising a reboiler fluidly coupled to the regeneration column and configured to receive and heat a portion of the regenerated potassium carbonate solvent and produce a heated regenerated potassium carbonate solvent.

17. The system of claim 16, wherein the reboiler is configured to recycle the heated regenerated potassium carbonate solvent to the regeneration column to produce steam.

18. The system of claim 13, further comprising a condenser fluidly coupled to the regeneration column configured to receive the CO_2 and water removed from the bicarbonate solvent solution and separate the water from the CO_2.

19. The system of claim 18, wherein a portion of the water separated from the CO_2 is pumped back to the regeneration column to create steam.

20. The system of claim 13, wherein at least a portion of the gaseous phase of the reduced-pressure solution removed from the flash vessel is recycled to the exhaust gas recirculation system.

21. The system of claim 20, wherein the at least a portion of the gaseous phase of the reduced-pressure solution recycled to the exhaust gas recirculation system is combined with the cooled recycle gas provided to the main compressor.

22. The system of claim 13, wherein the combustion chamber is configured to stoichiometrically combust the compressed oxidant and the fuel in the presence of the compressed recycle stream.

23. The system of claim 13, wherein the compressed recycle stream acts as a diluent configured to moderate the temperature of the discharge stream.

24. The system of claim 13, wherein one or both of the first and second valves is a hydraulic turbine configured to generate power.

25. A method for generating power, comprising:

combusting a compressed oxidant and a fuel in a combustion chamber and in the presence of a compressed recycle stream, thereby generating a discharge stream, and expanding the discharge stream to generate a gaseous exhaust stream;

increasing the pressure of the gaseous exhaust stream and cooling the gaseous exhaust stream to generate a cooled recycle gas that is compressed to generate the compressed recycle stream;

cooling a purge stream fluidly coupled to compressed recycle stream to generate a cooled purge stream;

directing the cooled purge stream to an absorption column and absorbing CO_2 from the cooled purge stream with a potassium carbonate solvent;

discharging a nitrogen-rich residual stream and a bicarbonate solvent solution from the absorption column;

stripping volatile components from the bicarbonate solvent solution with a stripping vapor;

boiling the bicarbonate solvent solution in a regeneration column to remove CO_2 and water therefrom, generating a regenerated potassium carbonate solvent; and

recycling the regenerated potassium carbonate solvent to the absorption column.

26. The method of claim 25, wherein the stripping vapor comprises nitrogen, argon, steam, or a combination thereof.

27. The method of claim 25, further comprising flashing the bicarbonate solvent solution through a valve to a near-atmospheric pressure before boiling the bicarbonate solution in the regeneration column.

28. The method of claim 27, wherein the valve is a hydraulic turbine configured to generate power.

29. The method of claim 25, further comprising receiving the CO_2 and water removed from the bicarbonate solvent solution in a condenser fluidly coupled to the regeneration column and separating the water from the CO_2.

30. The method of claim 29, wherein a portion of the water separated from the CO_2 in the condenser is directed to the regeneration column to create steam.

31. The method of claim 25, wherein the compressed oxidant and the fuel are combusted in the presence of a compressed recycle stream under stoichiometric conditions.

32. The method of claim 25, wherein the compressed recycle stream moderates the temperature of the discharge stream.

33. A method for generating power, comprising:

combusting a compressed oxidant and a fuel in a combustion chamber and in the presence of a compressed recycle stream, thereby generating a discharge stream, and expanding the discharge stream to generate a gaseous exhaust stream;

increasing the pressure of the gaseous exhaust stream and cooling the gaseous exhaust stream to generate a cooled recycle gas that is compressed to generate the compressed recycle stream;

cooling a purge stream fluidly coupled to compressed recycle stream to generate a cooled purge stream;

directing the cooled purge stream to an absorption column and absorbing CO_2 from the cooled purge stream with a potassium carbonate solvent;

discharging a nitrogen-rich residual stream and a bicarbonate solvent solution from the absorption column;

flashing the bicarbonate solvent solution to a pressure sufficient to separate volatile components from the bicarbonate solvent solution, generating a dual phase reduced-pressure solvent solution having a gaseous phase comprising the volatile components and a liquid phase comprising the bicarbonate solvent solution;

separating the gaseous phase of the reduced-pressure solvent solution from the liquid phase of the reduced-pressure solution;

flashing the liquid phase of the reduced-pressure solvent solution to a near-atmospheric pressure to generate a near-atmospheric solvent solution;

boiling the near-atmospheric solvent solution in a regeneration column to remove CO_2 and water therefrom, thereby generating a regenerated potassium carbonate solvent; and

recycling the regenerated potassium carbonate solvent to the absorption column.

34. The method of claim 33, wherein the bicarbonate solution is flashed to a pressure such that the gaseous phase of the reduced-pressure solvent solution comprises less than 1.0 mol%

CO_2.

35. The method of claim 34, wherein the bicarbonate solution is flashed to a pressure such that at least 98 mol% of the total CO_2 in the bicarbonate solvent solution remains in the liquid phase of the reduced-pressure solvent solution.

36. The method of claim 33, further comprising receiving the CO_2 and water removed from the near-atmospheric solvent solution in a condenser fluidly coupled to the regeneration column and separating the water from the CO_2.

37. The method of claim 36, wherein a portion of the water separated from the CO_2 in the condenser is directed to the regeneration column to create steam.

38. The method of claim 33, wherein at least a portion of the gaseous phase of the reduced-pressure solvent solution is recycled and combined with the cooled recycle gas.

39. The method of claim 33, wherein the compressed oxidant and the fuel are combusted in the presence of a compressed recycle stream under stoichiometric conditions.

40. The method of claim 33, wherein the compressed recycle stream moderates the temperature of the discharge stream.

CLAIMS

1. An integrated power generation system, comprising:

a gas turbine system comprising a combustion chamber configured to combust a compressed oxidant and a fuel in the presence of a compressed recycle stream to generate a discharge stream that is expanded in an expander, thereby generating a gaseous exhaust stream;

an exhaust gas recirculation system comprising a boost compressor and one or more cooling units fluidly coupled to the boost compressor, the boost compressor being configured to receive and increase the pressure of the gaseous exhaust stream and the one or more cooling units being configured to cool the gaseous exhaust stream and provide a cooled recycle gas to the main compressor, wherein the main compressor compresses the cooled recycle gas and generates the compressed recycle stream;

a purge stream fluidly coupled to the compressed recycle stream having a heat exchanger configured to reduce the temperature of the purge stream and generate a cooled purge stream; and

a CO_2 separation system fluidly coupled to the heat exchanger, the CO_2 separation system comprising:

an absorption column configured to receive the cooled purge stream and absorb CO_2 from the cooled purge stream with a potassium carbonate solvent to generate a nitrogen-rich residual stream and a bicarbonate solvent solution;

a solvent stripping section configured to receive the bicarbonate solvent solution, strip volatile components from the bicarbonate solvent solution with a stripping vapour, and keep essentially all of the CO_2 in the bicarbonate solvent solution; and

a regeneration column fluidly coupled to the stripping section configured to receive and boil the bicarbonate solvent solution to remove CO_2 and water therefrom, producing a regenerated potassium carbonate solvent to be recycled to the absorption column.

2. The system of claim 1, wherein the solvent stripping section is incorporated as additional stages in the absorption column.

3. The system of claim 1, wherein the solvent stripping section is a column separate from the absorption column configured to generate a first stream comprising the stripping vapor and the volatile components stripped from the bicarbonate solvent solution and a second stream comprising the bicarbonate solvent solution.

4. The system of claim 3, wherein the stripping vapor comprises nitrogen, argon, steam, or a combination thereof.

5. The system of claim 1, further comprising a first valve fluidly coupled to the solvent stripping section and configured to flash the bicarbonate solvent solution to a near-atmospheric pressure before the bicarbonate solvent solution enters the regeneration column.

6. The system of claim 5, wherein the first valve is a hydraulic turbine configured to generate power.

7. An integrated power generation system, comprising:

a gas turbine system comprising a combustion chamber configured to combust a compressed oxidant and a fuel in the presence of a compressed recycle stream to generate a discharge stream that is expanded in an expander, thereby generating a gaseous exhaust stream;

an exhaust gas recirculation system comprising a boost compressor and one or more cooling units fluidly coupled to the boost compressor, the boost compressor being configured to receive and increase the pressure of the gaseous exhaust stream and the one or more cooling units being configured to cool the gaseous exhaust stream and provide a cooled recycle gas to the main compressor, wherein the main compressor compresses the cooled recycle gas and generates the compressed recycle stream;

a purge stream fluidly coupled to the compressed recycle stream having a heat exchanger configured to reduce the temperature of the purge stream and generate a cooled purge stream; and

a CO_2 separation system fluidly coupled to the heat exchanger, the CO_2 separation system comprising:

an absorption column configured to receive the cooled purge stream and absorb CO_2 from the cooled purge stream with a potassium carbonate solvent to generate a nitrogen-rich residual stream and a bicarbonate solvent solution;

a first valve fluidly coupled to the absorption column configured to flash the bicarbonate solvent solution to a pressure sufficient to separate volatile components from the bicarbonate solvent solution and keep essentially all of the CO_2 in the bicarbonate solvent solution, thereby generating a dual phase reduced-pressure solvent solution having a gaseous phase comprising the volatile components and a liquid phase comprising the bicarbonate solvent solution;

a flash vessel fluidly coupled to the first valve configured to receive the reduced-pressure solvent solution and remove the gaseous phase of the reduced-pressure solvent solution from the liquid phase of the reduced-pressure solvent solution;

a second valve fluidly coupled to the flash vessel configured to receive the liquid phase of the reduced-pressure solvent solution and flash the liquid phase to a near-atmospheric pressure, thereby generating a near-atmospheric bicarbonate solvent solution; and

a regeneration column fluidly coupled to the second valve configured to receive and boil the near-atmospheric bicarbonate solvent solution to remove CO_2 and water therefrom, producing a regenerated potassium carbonate solvent to be recycled to the absorption column.

8. The system of claim 7, wherein the first valve is configured to flash the bicarbonate solvent solution to a pressure such that the gaseous phase of the bicarbonate solvent solution comprises less than 1.0 mol% carbon dioxide.

9. The system of claim 8, wherein the first valve is configured to flash the bicarbonate solvent solution to a pressure such that at least 98 mol% of the total carbon dioxide in the bicarbonate solvent solution remains in the liquid phase of the reduced-pressure solvent solution.

10. The system of any one of claims 1 to 7, further comprising a reboiler fluidly coupled to the regeneration column and configured to receive and heat a portion

of the regenerated potassium carbonate solvent and produce a heated regenerated potassium carbonate solvent.

11. The system of claim 10, wherein the reboiler is configured to recycle the heated regenerated potassium carbonate solvent to the regeneration column to produce steam.

12. The system of any one of claims 1 to 7, further comprising a condenser fluidly coupled to the regeneration column configured to receive the CO_2 and water removed from the bicarbonate solvent solution and separate the water from the CO_2.

13. The system of claim 12, wherein a portion of the water separated from the CO_2 is pumped back to the regeneration column to create steam.

14. The system of claim 7, wherein at least a portion of the gaseous phase of the reduced-pressure solution removed from the flash vessel is recycled to the exhaust gas recirculation system.

15. The system of claim 14, wherein the at least a portion of the gaseous phase of the reduced-pressure solution recycled to the exhaust gas recirculation system is combined with the cooled recycle gas provided to the main compressor.

16. The system of any one of claims 1 to 7, wherein the combustion chamber is configured to stoichiometrically combust the compressed oxidant and the fuel in the presence of the compressed recycle stream.

17. The system of any one of claims 1 to 7, wherein the compressed recycle stream acts as a diluent configured to moderate the temperature of the discharge stream.

18. The system of claim 7, wherein one or both of the first and second valves is a hydraulic turbine configured to generate power.

19. A method for generating power, comprising:

combusting a compressed oxidant and a fuel in a combustion chamber and in the presence of a compressed recycle stream, thereby generating a

discharge stream, and expanding the discharge stream to generate a gaseous exhaust stream;

increasing the pressure of the gaseous exhaust stream and cooling the gaseous exhaust stream to generate a cooled recycle gas that is compressed to generate the compressed recycle stream;

cooling a purge stream fluidly coupled to compressed recycle stream to generate a cooled purge stream;

directing the cooled purge stream to an absorption column and absorbing CO_2 from the cooled purge stream with a potassium carbonate solvent;

discharging a nitrogen-rich residual stream and a bicarbonate solvent solution from the absorption column;

stripping volatile components from the bicarbonate solvent solution with a stripping vapour while keeping essentially all of the CO_2 in the bicarbonate solvent solution;

boiling the bicarbonate solvent solution in a regeneration column to remove CO_2 and water therefrom, generating a regenerated potassium carbonate solvent; and

recycling the regenerated potassium carbonate solvent to the absorption column.

20. The method of claim 19, wherein the stripping vapor comprises nitrogen, argon, steam, or a combination thereof.

21. The method of claim 19, further comprising flashing the bicarbonate solvent solution through a valve to a near-atmospheric pressure before boiling the bicarbonate solution in the regeneration column.

22. The method of claim 21, wherein the valve is a hydraulic turbine configured to generate power.

23. A method for generating power, comprising:

combusting a compressed oxidant and a fuel in a combustion chamber and in the presence of a compressed recycle stream, thereby generating a discharge stream, and expanding the discharge stream to generate a gaseous exhaust stream;

increasing the pressure of the gaseous exhaust stream and cooling the gaseous exhaust stream to generate a cooled recycle gas that is compressed to generate the compressed recycle stream;

cooling a purge stream fluidly coupled to compressed recycle stream to generate a cooled purge stream;

directing the cooled purge stream to an absorption column and absorbing CO_2 from the cooled purge stream with a potassium carbonate solvent;

discharging a nitrogen-rich residual stream and a bicarbonate solvent solution from the absorption column;

flashing the bicarbonate solvent solution to a pressure sufficient to separate volatile components from the bicarbonate solvent solution while keeping essentially all of the CO_2 in the bicarbonate solvent solution, generating a dual phase reduced-pressure solvent solution having a gaseous phase comprising the volatile components and a liquid phase comprising the bicarbonate solvent solution;

separating the gaseous phase of the reduced-pressure solvent solution from the liquid phase of the reduced-pressure solution;

flashing the liquid phase of the reduced-pressure solvent solution to a near-atmospheric pressure to generate a near-atmospheric solvent solution;

boiling the near-atmospheric solvent solution in a regeneration column to remove CO_2 and water therefrom, thereby generating a regenerated potassium carbonate solvent; and

recycling the regenerated potassium carbonate solvent to the absorption column.

24. The method of claim 23, wherein the bicarbonate solution is flashed to a pressure such that the gaseous phase of the reduced-pressure solvent solution comprises less than 1.0 mol% CO_2.

25. The method of claim 24, wherein the bicarbonate solution is flashed to a pressure such that at least 98 mol% of the total CO_2 in the bicarbonate solvent solution remains in the liquid phase of the reduced-pressure solvent solution.

26. The method of any one of claims 19 to 23, further comprising receiving the CO_2 and water removed from the near-atmospheric solvent solution in a condenser fluidly coupled to the regeneration column and separating the water from the CO_2.

27. The method of claim 26, wherein a portion of the water separated from the CO_2 in the condenser is directed to the regeneration column to create steam.

28. The method of claim 23, wherein at least a portion of the gaseous phase of the reduced-pressure solvent solution is recycled and combined with the cooled recycle gas.

29. The method of any one of claims 19 to 23, wherein the compressed oxidant and the fuel are combusted in the presence of a compressed recycle stream under stoichiometric conditions.

30. The method of any one of claims 19 to 23, wherein the compressed recycle stream moderates the temperature of the discharge stream.