CLAIMS

What is claimed is:

1. An integrated system, comprising:

a gas turbine system having a combustion chamber configured to stoichiometrically combust a compressed oxidant and a fuel in the presence of a compressed recycle exhaust gas, wherein the compressed recycle exhaust gas serves to moderate a temperature of combustion in the combustion chamber, and the combustion chamber directs a discharge to an expander configured to generate a gaseous exhaust stream and at least partially drive a main compressor;

an exhaust gas recirculation system having at least one integrated cooling unit, wherein the at least one integrated cooling unit cools the gaseous exhaust before injection into the main compressor to generate the compressed recycle exhaust gas; and

a CO_2 separator fluidly coupled to the compressed recycle exhaust gas via a purge stream and configured to discharge a residual stream consisting primarily of nitrogen-rich gas to be expanded in a gas expander and generate a nitrogen exhaust gas, wherein the nitrogen exhaust gas is injected into the at least one integrated cooling unit to cool the gaseous exhaust.

2. The system of claim 1, further comprising at least one additional cooling unit, wherein the additional cooling unit is fluidly coupled to the at least one integrated cooling unit, and wherein the additional cooling unit cools the gaseous exhaust to a temperature of about 105 °F.

3. The system of claim 1, further comprising a residual cooling unit fluidly coupled to the residual stream and configured to reduce the temperature of the residual stream and extract condensed water therefrom.

4. The system of claim 3, wherein the at least one integrated cooling unit is an evaporative cooling unit comprising:

a first column configured to receive the nitrogen exhaust gas and a cool water supply, wherein the nitrogen exhaust gas evaporates a portion of the cool water supply to cool the cool water supply and generate a cooled water discharge; and

a second column configured to receive the cooled water discharge and the gaseous exhaust, wherein interaction between the cooled water discharge and the gaseous exhaust cools the gaseous exhaust.

5. The system of claim 4, wherein the at least one integrated cooling unit reduces the temperature of the pressurized recycle stream to below about 100 °F.

6. The system of claim 4, wherein cooled water is pressurized with a pump before being introduced into the second column.

7. The system of claim 4, wherein the second column is further configured to condense and extract an amount of water from the pressurized recycle stream.

8. The system of claim 1, further comprising a heat exchanger fluidly coupled to the purge stream and configured to reduce the temperature of the purge stream prior to being introduced into the CO_2 separator.

9. The system of claim 1, further comprising a boost compressor adapted to increase the pressure of the gaseous exhaust stream to a pressure between about 17 psia and about 21 psia before injection into the main compressor.

10. A method of generating power, comprising:

stoichiometrically combusting a compressed oxidant and a fuel in a combustion chamber and in the presence of a compressed recycle exhaust gas, thereby generating a discharge stream, wherein the compressed recycle exhaust gas acts as a diluent configured to moderate the temperature of the discharge stream;

expanding the discharge stream in an expander to at least partially drive a main compressor and generate a gaseous exhaust stream;

directing the gaseous exhaust stream into at least one integrated cooling unit;

cooling the gaseous exhaust stream in the at least one integrated cooling unit before injecting the gaseous exhaust stream into the main compressor to generate the compressed recycle exhaust gas;

directing a portion of the compressed recycle exhaust gas to a CO_2 separator via a purge stream, the CO_2 separator being configured to discharge a residual stream consisting primarily of nitrogen-rich gas to be expanded in a gas expander and generate a nitrogen exhaust gas; and

injecting the nitrogen exhaust gas into the at least one integrated cooling unit to cool the gaseous exhaust stream.

11. The method of claim 10, further comprising cooling the pressurized recycle gas in at least one pre-cooling unit disposed before a final integrated cooling unit to a temperature of about 105 °F, wherein the at least one pre-cooling unit is fluidly coupled to the final integrated cooling unit.

12. The method of claim 10, further comprising:

cooling the residual stream with a residual cooling unit fluidly coupled to the CO_2 separator; and

extracting condensed water from the residual stream.

13. The method of claim 12, further comprising:

receiving the nitrogen exhaust gas and a cool water supply in a first column of the at least one integrated cooling unit;

evaporating a portion of the cool water supply to cool the cool water supply and generate a cooled water discharge;

receiving the cooled water discharge and the gaseous exhaust stream in a second column of the at least one integrated cooling unit;

cooling the gaseous exhaust stream to a temperature below about 100°F with the cooled water discharge.

14. The method of claim 13, further comprising pressurizing the cooled water discharge with a pump before being introduced into the second column.

15. The method of claim 13, further comprising condensing and extracting an amount of water from the pressurized recycle stream in the second column.

16. The method of claim 10, further comprising reducing the temperature of the purge stream in a heat exchanger fluidly coupled to the purge stream and configured to reduce the temperature of the purge stream prior to being introduced into the CO_2 separator.

17. A combined-cycle power generation system, comprising:

a combustion chamber configured to stoichiometrically combust a compressed oxidant and a fuel in the presence of a compressed recycle exhaust gas, wherein the combustion chamber directs a discharge to an expander configured to generate a gaseous exhaust stream and drive a main compressor;

an evaporative cooling tower having a first column and a second column, wherein the second column is configured to receive and cool the gaseous exhaust stream before being compressed in the main compressor to generate the compressed recycle exhaust gas; and

a CO_2 separator fluidly coupled to the compressed recycle exhaust gas via a purge stream and configured to discharge a residual stream consisting primarily of nitrogen-rich gas to be expanded in a gas expander and generate a nitrogen exhaust gas, wherein the nitrogen exhaust gas is injected into the first column to evaporate and cool a cooling water supply to discharge a cooled water, and wherein the cooled water is injected into the second column to cool the gaseous exhaust stream.

18. The system of claim 17, further comprising a condenser fluidly coupled to the residual stream and configured to reduce the temperature of the residual stream and extract condensed water therefrom.

19. The system of claim 17, wherein evaporative cooling tower further comprises a pump configured pressurize the cooled water and inject the cooled water into the second column in order to cool the pressurized recycle gas.

20. The system of claim 19, wherein the second column is a direct contact cooler.

21. The system of claim 20, wherein the second column is a multi-stage direct contact cooler.

CLAIMS

1. An integrated system, comprising:

a gas turbine system having a combustion chamber configured to stoichiometrically combust a compressed oxidant and a fuel in the presence of a compressed recycle exhaust gas, wherein the compressed recycle exhaust gas serves to moderate a temperature of combustion in the combustion chamber, and the combustion chamber directs a discharge to an expander configured to generate a gaseous exhaust stream and at least partially drive a main compressor;

an exhaust gas recirculation system having at least one integrated cooling unit, wherein the at least one integrated cooling unit cools the gaseous exhaust before injection into the main compressor to generate the compressed recycle exhaust gas; and

a CO_2 separator fluidly coupled to the compressed recycle exhaust gas via a purge stream and configured to discharge a residual stream consisting primarily of nitrogen-rich gas to be expanded in a gas expander and generate a nitrogen exhaust gas, wherein the nitrogen exhaust gas is injected into the at least one integrated cooling unit to cool the gaseous exhaust.

2. The system of claim 1, further comprising at least one additional cooling unit, wherein the additional cooling unit is fluidly coupled to the at least one integrated cooling unit, and wherein the additional cooling unit cools the gaseous exhaust to a temperature of about 105 °F.

3. The system of claim 1, further comprising a residual cooling unit fluidly coupled to the residual stream and configured to reduce the temperature of the residual stream and extract condensed water therefrom.

4. The system of claim 3, wherein the at least one integrated cooling unit is an evaporative cooling unit comprising:

a first column configured to receive the nitrogen exhaust gas and a cool water supply, wherein the nitrogen exhaust gas evaporates a portion of the cool water supply to cool the cool water supply and generate a cooled water discharge; and

a second column configured to receive the cooled water discharge and the gaseous exhaust, wherein interaction between the cooled water discharge and the gaseous exhaust cools the gaseous exhaust.

5. The system of claim 4, wherein the at least one integrated cooling unit reduces the temperature of the pressurized recycle stream to below about 100 °F.

6. The system of claim 4, wherein cooled water is pressurized with a pump before being introduced into the second column.

7. The system of claim 4, wherein the second column is further configured to condense and extract an amount of water from the pressurized recycle stream.

8. The system of claim 1, further comprising a heat exchanger fluidly coupled to the purge stream and configured to reduce the temperature of the purge stream prior to being introduced into the CO_2 separator.

9. The system of claim 1, further comprising a boost compressor adapted to increase the pressure of the gaseous exhaust stream to a pressure between about 17 psia and about 21 psia before injection into the main compressor.

10. A method of generating power, comprising:

stoichiometrically combusting a compressed oxidant and a fuel in a combustion chamber and in the presence of a compressed recycle exhaust gas, thereby generating a discharge stream, wherein the compressed recycle exhaust gas acts as a diluent configured to moderate the temperature of the discharge stream;

expanding the discharge stream in an expander to at least partially drive a main compressor and generate a gaseous exhaust stream;

directing the gaseous exhaust stream into at least one integrated cooling unit;

cooling the gaseous exhaust stream in the at least one integrated cooling unit before injecting the gaseous exhaust stream into the main compressor to generate the compressed recycle exhaust gas;

directing a portion of the compressed recycle exhaust gas to a CO_2 separator via a purge stream, the CO_2 separator being configured to discharge a residual stream consisting primarily of nitrogen-rich gas to be expanded in a gas expander and generate a nitrogen exhaust gas; and

injecting the nitrogen exhaust gas into the at least one integrated cooling unit to cool the gaseous exhaust stream.

11. The method of claim 10, further comprising cooling the pressurized recycle gas in at least one pre-cooling unit disposed before a final integrated cooling unit to a temperature of about 105 °F, wherein the at least one pre-cooling unit is fluidly coupled to the final integrated cooling unit.

12. The method of claim 10, further comprising:

cooling the residual stream with a residual cooling unit fluidly coupled to the CO_2 separator; and

extracting condensed water from the residual stream.

13. The method of claim 12, further comprising:

receiving the nitrogen exhaust gas and a cool water supply in a first column of the at least one integrated cooling unit;

evaporating a portion of the cool water supply to cool the cool water supply and generate a cooled water discharge;

receiving the cooled water discharge and the gaseous exhaust stream in a second column of the at least one integrated cooling unit;

cooling the gaseous exhaust stream to a temperature below about 100°F with the cooled water discharge.

14. The method of claim 13, further comprising pressurizing the cooled water discharge with a pump before being introduced into the second column.

15. The method of claim 13, further comprising condensing and extracting an amount of water from the pressurized recycle stream in the second column.

16. The method of claim 10, further comprising reducing the temperature of the purge stream in a heat exchanger fluidly coupled to the purge stream and configured to reduce the temperature of the purge stream prior to being introduced into the CO_2 separator.

17. A combined-cycle power generation system, comprising:

a combustion chamber configured to stoichiometrically combust a compressed oxidant and a fuel in the presence of a compressed recycle exhaust gas, wherein the combustion chamber directs a discharge to an expander configured to generate a gaseous exhaust stream and drive a main compressor;

an evaporative cooling tower having a first column and a second column, wherein the second column is configured to receive and cool the gaseous exhaust stream before being compressed in the main compressor to generate the compressed recycle exhaust gas; and

a CO_2 separator fluidly coupled to the compressed recycle exhaust gas via a purge stream and configured to discharge a residual stream consisting primarily of nitrogen-rich gas to be expanded in a gas expander and generate a nitrogen exhaust gas, wherein the nitrogen exhaust gas is injected into the first column to evaporate and cool a cooling water supply to discharge a cooled water, and wherein the cooled water is injected into the second column to cool the gaseous exhaust stream.

18. The system of claim 17, further comprising a condenser fluidly coupled to the residual stream and configured to reduce the temperature of the residual stream and extract condensed water therefrom.

19. The system of claim 17, wherein evaporative cooling tower further comprises a pump configured pressurize the cooled water and inject the cooled water into the second column in order to cool the pressurized recycle gas.

20. The system of claim 19, wherein the second column is a direct contact cooler.

21. The system of claim 20, wherein the second column is a multi-stage direct contact cooler.