Claims

What is claimed is:

1. A reducing gas generator, comprising:

a merging chamber configured to receive an oxidant, a recycle gas and a hydrocarbon fuel and discharge a feed stream including the oxidant, the recycle gas and the hydrocarbon fuel;

a recycle pump in fluid communication with the merging chamber and configured to pressurize a flow of the recycle gas and discharge the pressurized flow into the merging chamber;

a reformer in fluid communication with the merging chamber and configured to receive the feed stream and to reform the feed stream to yield a reducing gas; and

a junction operable to receive a portion of the reducing gas and direct a portion of the reducing gas to the recycle pump as the recycle gas.

2. The reducing gas generator of claim 1, further comprising a cooler configured to reduce the temperature of the reducing gas discharged by the reformer, wherein the junction is operable to receive cooled reducing gas from the cooler.

3. The reducing gas generator of claim 2, wherein the cooler is a heat exchanger.

4. The reducing gas generator of claim 2, wherein the cooler includes an injector configured to inject a coolant into the reducing gas.

5. The reducing gas generator of claim 4, wherein the coolant includes at least one of steam and atomized water.

6. The reducing gas generator of claim 4, wherein the coolant is nitrogen.

7. The reducing gas generator of claim 1, wherein the recycle pump is a compressor.

8. The reducing gas generator of claim 7, wherein the recycle pump is an ejector.

9. The reducing gas generator of claim 1, further comprising a valve configured to discharge reducing gas from the reducing gas generator.

10. The reducing gas generator of claim 1, further comprising an oxidant system configured to provide the oxidant, and configured to provide an oxygen content of the oxidant having a value that exceeds the oxygen content of ambient atmospheric air, wherein the oxidant system is configured to provide the oxidant without the use of stored oxygen.

11. The reducing gas generator of claim 10, wherein the oxidant system is also configured to provide an oxygen content of the oxidant having a value that is less than the oxygen content of ambient atmospheric air

12. The reducing gas generator of claim 1, further comprising an oxidant system configured to provide the oxidant, and configured to provide an oxygen content of the oxidant having a value that is less than the oxygen content of ambient atmospheric air, wherein the oxidant system is configured to provide the oxidant without the use of stored oxygen

13. A method of generating a reducing gas, comprising:

receiving an oxidant, a recycle gas and a hydrocarbon fuel;

discharging a feed stream including the oxidant, the recycle gas and the hydrocarbon fuel;

reforming the feed stream to yield a reducing gas; and

extracting a portion of the reducing gas to form the recycle gas.

14. The method of claim 13, further comprising reducing the temperature of the reducing gas prior to extracting the recycle gas.

15. The method of claim 14, further comprising using a heat exchange to reduce the temperature of the reducing gas.

16. The method of claim 13, further comprising reducing the temperature of the recycle gas after extraction from the reducing gas.

17. The method of claim 16, wherein the temperature of the recycle gas is reduced by injecting a coolant into the recycle gas.

18. The method of claim 17, wherein the coolant is at least one of steam and atomized water.

19. The method of claim 17, wherein the coolant is nitrogen gas.

20. The method of claim 13, further comprising supplying the oxidant with an oxygen content greater than that of ambient air without using stored oxygen.

21. The method of claim 13, further comprising supplying the oxidant with an oxygen content less than that of ambient air without using stored oxygen.

Claims

1. A reducing gas generator, comprising:

a merging chamber configured to receive an oxidant, a recycle gas and a hydrocarbon fuel and discharge a feed stream including the oxidant, the recycle gas and the hydrocarbon fuel;

a first conduit having a first outlet opening to the merging chamber, for conveying the oxidant into the merging chamber;

a second conduit having a second outlet opening to the merging chamber, for conveying the recycle gas into the merging chamber;

a third conduit having a third outlet opening to the merging chamber, for conveying the hydrocarbon fuel into the merging chamber;

a recycle pump in direct fluid communication with the merging chamber and positioned within the second conduit, and the recycle pump being configured to pressurize a flow of the recycle gas through the second conduit, and to discharge the pressurized flow through the second outlet into the merging chamber such that a flow of the oxidant, a flow of the hydrocarbon fuel, and the pressurized flow of the recycle gas are merged therein to form the feed stream;

a catalytic reformer including a catalyst and being in fluid communication with the merging chamber and configured to receive the feed stream and to reform the feed stream to yield a reducing gas; and

a junction operable to receive a portion of the reducing gas and direct a portion of the reducing gas to the recycle pump as the recycle gas.

2. The reducing gas generator of claim 1, further comprising a cooler configured to reduce the temperature of the reducing gas discharged by the reformer, wherein the junction is operable to receive cooled reducing gas from the cooler.

3. The reducing gas generator of claim 2, wherein the cooler is a heat exchanger.

4. The reducing gas generator of claim 2, wherein the cooler includes an injector configured to inject a coolant into the reducing gas.

5. The reducing gas generator of claim 4, wherein the coolant includes at least one of steam and atomized water.

6. The reducing gas generator of claim 4, wherein the coolant is nitrogen.

7. The reducing gas generator of claim 1, wherein the recycle pump is a compressor.

8. The reducing gas generator of claim 7, wherein the recycle pump is an ejector.

9. The reducing gas generator of claim 1, further comprising a valve configured to discharge reducing gas from the reducing gas generator.

10. The reducing gas generator of claim 1, further comprising an oxidant system configured to provide the oxidant, and configured to provide an oxygen content of the oxidant having a value that exceeds the oxygen content of ambient atmospheric air, wherein the oxidant system is configured to provide the oxidant without the use of stored oxygen.

11. The reducing gas generator of claim 10, wherein the oxidant system is also configured to provide an oxygen content of the oxidant having a value that is less than the oxygen content of ambient atmospheric air.

12. The reducing gas generator of claim 1, further comprising an oxidant system configured to provide the oxidant, and configured to provide an oxygen content of the oxidant having a value that is less than the oxygen content of ambient atmospheric air, wherein the oxidant system is configured to provide the oxidant without the use of stored oxygen.