Summary

One embodiment of the present invention is a unique reducing gas generator. Another embodiment is a unique method for generating a reducing gas. Other embodiments include apparatuses, systems, devices, hardware, methods, and combinations for generating reducing gas. Further embodiments, forms, features, aspects, benefits, and advantages of the present application will become apparent from the description and figures provided herewith.

In one aspect, there is provided a reducing gas generator, comprising:

an oxidant system configured to generate from air an oxidant having a variable oxygen content, and configured to provide an oxygen content of the oxidant at a selected value greater than that of ambient atmospheric air;

the oxidant system including a first merging chamber configured to receive an oxygen-rich gas and a nitrogen-rich gas, and a valve controlling an amount of the nitrogen-rich gas received in the first merging chamber for mixing with the oxygen-rich gas, such that the oxidant is discharged from the first merging chamber with the oxygen content at the selected value;

a second merging chamber in fluid communication with the oxidant system and a source of a hydrocarbon fuel, wherein the second merging chamber is configured to receive the hydrocarbon fuel and the oxidant and to discharge a feed stream containing both the hydrocarbon fuel and the oxidant; and

a reformer in fluid communication with the second merging chamber and including a catalytic reactor, wherein the reformer is configured to receive the feed

stream from the second merging chamber, to reform the feed stream into a reducing gas, and to discharge the reducing gas;

a temperature sensor positioned downstream of an inlet to the reformer so as to measure at least one of a temperature of catalyst in the catalytic reactor and a temperature of reducing gas output by the catalytic reactor; and

a control system in communication with the temperature sensor, the control system being programmed to control a flow rate of the feed stream and to control both the oxygen content of the oxidant, via controlling the valve responsive to signals from the temperature sensor, and an oxidant/fuel ratio of the feed stream to maintain a predetermined control temperature while achieving a desired flammables content of the reducing gas output by the reducing gas generator, wherein the desired flammables content is in the range of approximately 45% to 80% by volume.

In another aspect, there is provided a reducing gas generator, comprising:

an oxidant system configured to provide an 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;

the oxidant system further including a first merging chamber configured to receive an oxygen-rich gas and a nitrogen-rich gas, and a valve controlling an amount of the nitrogen-rich gas received in the first merging chamber for mixing with the oxygen-rich gas, such that the oxidant is provided from the first merging chamber with the oxygen content at the selected value;

a second merging chamber in fluid communication with the first merging chamber and a source of a hydrocarbon fuel, so as to discharge a feed stream containing both the hydrocarbon fuel and the oxidant;

a reformer including a catalytic reactor, and being configured to receive the feed stream, to reform the oxidant and fuel into a reducing gas, and to discharge the reducing gas;

a temperature sensor positioned downstream of an inlet to the reformer so as to measure at least one of a temperature of catalyst in the catalytic reactor and a temperature of reducing gas output by the catalytic reactor; and

a control system in communication with the temperature sensor, the control system being programmed to control a flow rate of the feed stream, and to control both the oxygen content of the oxidant, via controlling the valve responsive to signals from the temperature sensor, and an oxidant/fuel ratio of the feed stream to maintain a predetermined control temperature while achieving a desired flammables content of the reducing gas output by the reducing gas generator; wherein the desired flammables content is in the range of approximately 45% to 80% by volume.