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(54) **SYSTEM AND METHOD FOR OPERATING A
GASIFIER**

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(57) **ABSTRACT**

A gasifier includes a combustion chamber and a pressure vessel surrounding the combustion chamber, wherein the pressure vessel includes an inner surface. A controller adjusts a pressure inside the pressure vessel so that a dew point temperature of corrosive compounds produced in the combustion chamber is less than a temperature of the inner surface of the pressure vessel. A method for operating a gasifier includes adjusting a pressure inside a pressure vessel surrounding the gasifier so that a dew point temperature of a corrosive compound is less than a temperature of an inner wall of the pressure vessel.

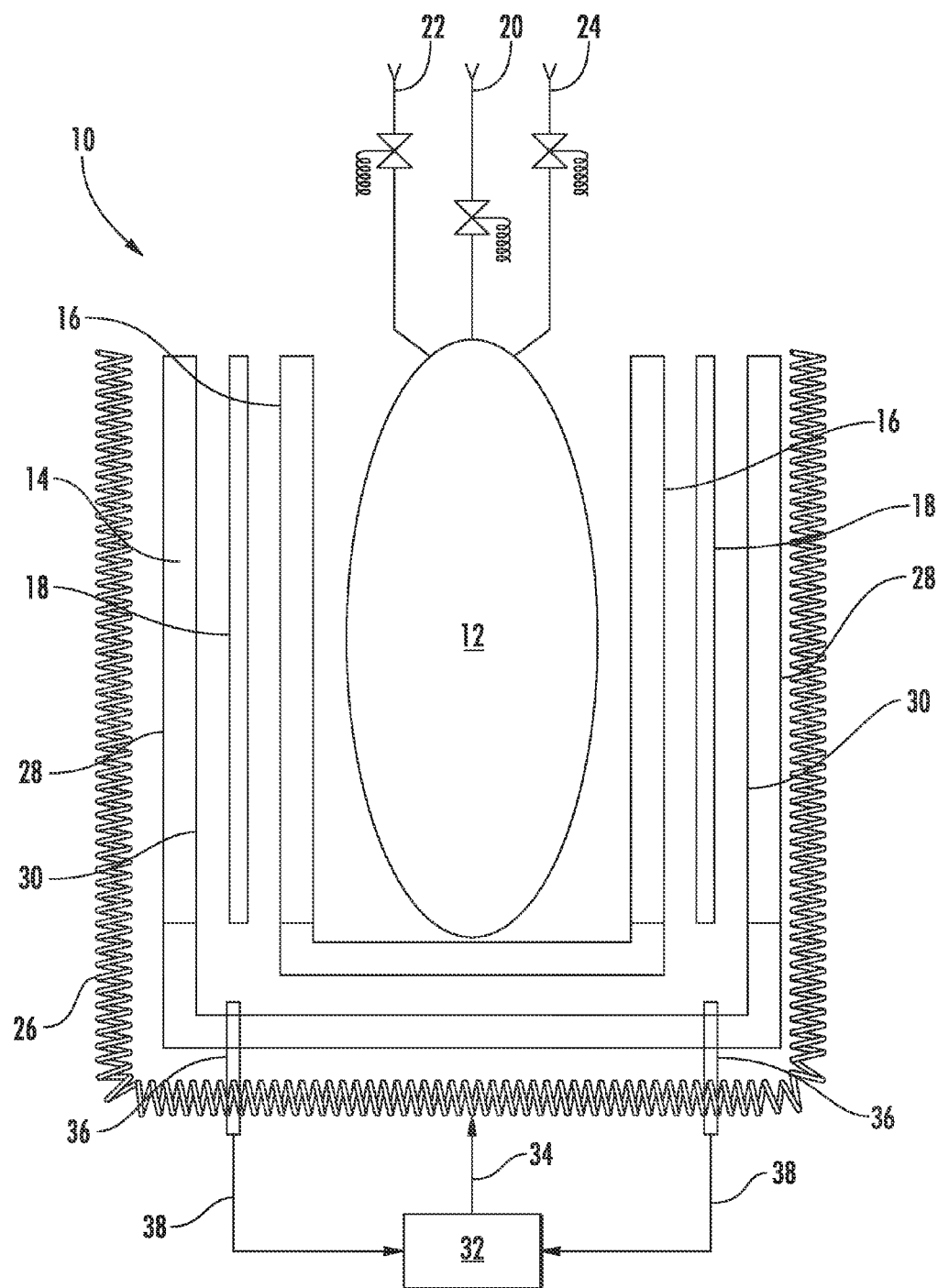


FIGURE 1

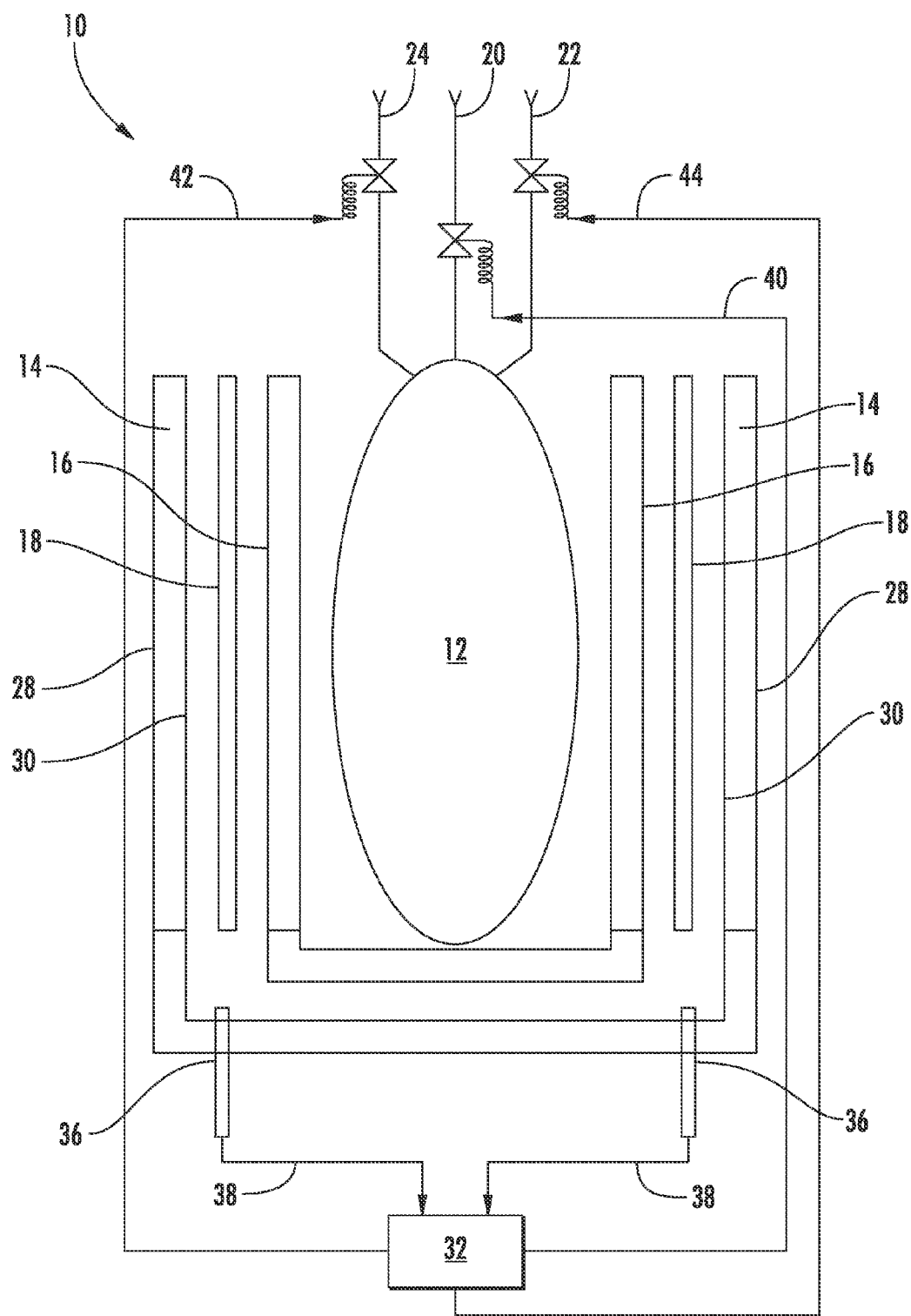


FIGURE 2

SYSTEM AND METHOD FOR OPERATING A GASIFIER

FIELD OF THE INVENTION

[0001] The present invention generally involves a system and method for operating a gasifier. Specific embodiments of the present invention may include a controller that adjusts conditions in the gasifier to reduce corrosion.

BACKGROUND OF THE INVENTION

[0002] An Integrated Gasification Combined Cycle (IGCC) is known in the art for converting petroleum coke or coal into synthetic gas which may then be supplied to a gas turbine to generate power. The synthetic gas, a clean burning fuel, may be burned directly in the gas turbine or may be processed further to produce methanol and hydrogen for combustion in the gas turbine.

[0003] The IGCC typically includes a gasifier to convert the petroleum coke or coal into the synthetic gas. The petroleum coke or coke is partially combusted with oxygen in a gasifier at a high temperature and pressure to produce the synthetic gas. The gasifier may be constructed of an insulated brick lining surrounded by a pressure resistant steel vessel. The brick lining is typically designed to withstand internal gasifier temperatures of approximately 2,500-3,000° F., while the steel vessel is typically designed to withstand an inner surface temperature of approximately 400-600° F.

[0004] The gasification process may produce highly corrosive byproducts, such as ammonium chloride. If the dew point temperature of the inner surface of the steel vessel is less than the dew point temperature of the corrosive byproducts, then the corrosive byproducts may condense on an inside surface of the steel vessel, causing aqueous corrosion on the inside surface of the steel vessel. The aqueous corrosion on the inside surface of the steel vessel is undesirable in that it may result in unplanned outages for maintenance and/or repair and ultimately reduces the useful life of the steel vessel.

[0005] Various attempts have been made to control the production and/or effects of the corrosive byproducts. For example, attempts have been made to indirectly monitor the production of the synthetic gas, and thus the production of the corrosive byproducts. Other attempts have involved costly external wind deflectors and variations in the design of the brick insulation. However, an improved system and method for controlling the gasifier would be useful in reducing corrosion caused by the corrosive byproducts.

BRIEF DESCRIPTION OF THE INVENTION

[0006] Aspects and advantages of the invention are set forth below in the following description, or may be obvious from the description, or may be learned through practice of the invention.

[0007] One embodiment of the present invention is a gasifier that includes a combustion chamber and a pressure vessel surrounding the combustion chamber, wherein the pressure vessel includes an inner surface. A controller adjusts a pressure inside the pressure vessel so that a dew point temperature of corrosive compounds produced in the combustion chamber is less than a temperature of the inner surface of the pressure vessel.

[0008] Another embodiment of the present invention is a gasifier that includes a combustion chamber and a pressure vessel surrounding the combustion chamber, wherein the

pressure vessel includes an inner surface. A controller generates at least one of a fuel signal to control a flow of fuel to the combustion chamber, an oxidant signal to control a flow of oxidant to the combustion chamber, or a diluent signal to control a flow of diluent to the combustion chamber to adjust a pressure inside the pressure vessel.

[0009] The present invention also includes a method for operating a gasifier. The method includes adjusting a pressure inside a pressure vessel surrounding the gasifier so that a dew point temperature of a corrosive compound is less than a temperature of an inner wall of the pressure vessel.

[0010] Those of ordinary skill in the art will better appreciate the features and aspects of such embodiments, and others, upon review of the specification.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] A full and enabling disclosure of the present invention, including the best mode thereof to one skilled in the art, is set forth more particularly in the remainder of the specification, including reference to the accompanying figures, in which:

[0012] FIG. 1 is a simplified cross-section of a gasifier according to one embodiment of the present invention; and

[0013] FIG. 2 is a simplified cross-section of a gasifier according to an alternate embodiment of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

[0014] Reference will now be made in detail to present embodiments of the invention, one or more examples of which are illustrated in the accompanying drawings. The detailed description uses numerical and letter designations to refer to features in the drawings. Like or similar designations in the drawings and description have been used to refer to like or similar parts of the invention.

[0015] Each example is provided by way of explanation of the invention, not limitation of the invention. In fact, it will be apparent to those skilled in the art that modifications and variations can be made in the present invention without departing from the scope or spirit thereof. For instance, features illustrated or described as part of one embodiment may be used on another embodiment to yield a still further embodiment. Thus, it is intended that the present invention covers such modifications and variations as come within the scope of the appended claims and their equivalents.

[0016] FIGS. 1 and 2 show a simplified cross-section of a gasifier 10 according to various embodiments of the present invention. As a general proposition, the gasifier 10 includes a combustion chamber 12 surrounded by a pressure vessel 14. The combustion chamber 12 provides an enclosed volume for combustion of fuel and oxygen to produce a synthetic gas. As such, the combustion chamber 12 is constructed from material capable of withstanding the maximum temperature of the combustion. For example, the combustion chamber may include a refractory insulated brick lining 16 capable of continuous exposure to temperatures of approximately 2,500-3,000° F. The pressure vessel 14 is generally constructed from steel or a steel alloy capable of containing the pressure generated by the combustion and withstanding a continuous exposure to temperatures of approximately 400-600° F. The gasifier 10 may include additional surrounding or partially surrounding layers of material that insulate, contain, or otherwise enclose the gasifier. For example, as shown in FIGS. 1

and 2, a refractory grout 18 coating between the combustion chamber 12 and the pressure vessel 14 may be used to attenuate heat between the combustion chamber 12 and the pressure vessel 14.

[0017] The gasifier 10 may further include separate or combined supplies of fuel 20, oxidants 22, and/or diluents 24 to the combustion chamber 12. The fuel generally comprises petroleum coke, coal, or another suitable product to be gasified. The oxidants generally comprise oxygen, an oxygen compound, or another chemical capable of combusting with the fuel. The diluents generally comprise nitrogen, argon, or another inert gas for diluting the oxidants prior to combustion. The supply of fuel 20, oxidants 22, and/or diluents 24 may comprise any suitable tank, piping, and/or valve system for transporting the fuel, oxidants, or diluents to the gasifier 10. The fuel, oxidants, and/or diluents combine in the combustion chamber 12 to produce the synthetic gas. In addition, the combustion produces one or more byproducts, including corrosive compounds such as ammonium chloride.

[0018] As shown in the embodiment illustrated in FIG. 1, the gasifier 10 may further include a heater 26 surrounding an outer wall 28 of the pressure vessel 14. The heater 26 may comprise any suitable system for supplying heat to the outer wall 28 of the pressure vessel 14 so that the heat penetrates through the pressure vessel 14 to increase the temperature of an inner wall 30 of the pressure vessel 14. For example, the heater 26 may comprise conductive, radiant, or convective heaters such as, for example, resistive coils, infrared heaters, heated coolant, or any suitable system known to one of ordinary skill in the art for providing heat.

[0019] The heater 26 may be manually activated or energized as needed to increase the temperature of the inner wall 30 of the pressure vessel 14. For example, measured parameters of the gasifier 10, content of the fuel, production rate of the synthetic gas, or any other operational parameter may be used to determine when to activate or energize the heater 26. In this manner, the temperature of the inner wall 30 of the pressure vessel 14 may be maintained greater than the dew point temperature of any corrosive compound produced during combustion to reduce and/or prevent condensation of the corrosive compound on the inner wall 30 of the pressure vessel 14.

[0020] As shown in FIG. 1, alternate embodiments of the present invention may also include a controller 32 connected to the heater 26. The controller 32 may send a heater signal 34 to the heater 26 to activate or energize the heater 26. For example, the controller 32 may be programmed to activate or energize the heater 26 at timed intervals, based on the measured parameters of the gasifier 10, content of the fuel, production rate of the synthetic gas, or any other operational parameter. As described herein, the technical effect of the controller 32 is to control the temperature of the inner wall 30 of the pressure vessel 14 and/or pressure inside the combustion chamber 12 and/or pressure vessel 14. The controller 32 may be a stand alone component or a sub-component included in any computer system known in the art, such as a laptop, a personal computer, a mini computer, a mainframe computer, or industrial controllers, microcontrollers, or embedded systems. The various controller and computer systems discussed herein are not limited to any particular hardware architecture or configuration. Embodiments of the systems and methods set forth herein may be implemented by one or more general-purpose or customized controllers adapted in any suitable manner to provide the desired func-

tionality. The controller 32 may be adapted to provide additional functionality, either complementary or unrelated to the present subject matter. For instance, one or more controllers may be adapted to provide the described functionality by accessing software instructions rendered in a computer-readable form. When software is used, any suitable programming, scripting, or other type of language or combinations of languages may be used to implement the teachings contained herein. However, software need not be used exclusively, or at all. For example, as will be understood by those of ordinary skill in the art without required additional detailed discussion, some systems and methods set forth and disclosed herein may also be implemented by hard-wired logic or other circuitry, including, but not limited to, application-specific circuits. Of course, various combinations of computer-executed software and hard-wired logic or other circuitry may be suitable as well.

[0021] The gasifier 10 may further include a corrosion sensor 36 between the pressure vessel 14 and the combustion chamber 12. The corrosion sensor 36 may comprise an electronic circuit that measures a voltage potential or current flow created by the presence of the corrosive compounds on the inner wall 30 of the pressure vessel 14. The corrosion sensor 36 may thus generate a corrosion signal 38 reflective of the presence and/or amount of corrosive compounds present between the pressure vessel 14 and the combustion chamber 12. The corrosion signal 38 may be manually interpreted and acted on by an operator to activate or energize the heater 26, as desired. Alternately, the corrosion sensor 36 may be connected to the controller 32 to transmit the corrosion signal 38 to the controller 32. In this manner, the controller 32 may be programmed to activate or energize the heater 26 upon receiving a predetermined corrosion signal.

[0022] One of ordinary skill in the art will readily appreciate that the gasifier 10 shown in FIG. 1 may provide a method for reducing and/or preventing corrosive compounds from condensing between the pressure vessel 14 and the combustion chamber 12. The method increases the temperature of the inner wall 30 of the pressure vessel 14 surrounding the gasifier 10. The heater 26 may thus be manually activated or energized to increase the temperature of the inner wall 30 of the pressure vessel 14 to a temperature greater than the dew point temperature of the corrosive compound. In alternate embodiments, the controller 32 may be used to automatically activate or energize the heater. In addition, the corrosion sensor 36, if present, may provide the corrosion signal 38 to the controller 32, and the controller 32 may activate or energize the heater 26 upon receiving the predetermined corrosion signal.

[0023] FIG. 2 shows the gasifier 10 according to an alternate embodiment of the present invention. The gasifier 10 again comprises the combustion chamber 12, pressure vessel 14, and supplies of fuel 20, oxidants 22, and diluents 24 as previously described with respect to the embodiment shown in FIG. 1. In this particular embodiment, however, the gasifier 10 reduces and/or prevents the condensation of corrosive compounds between the pressure vessel 14 and the combustion chamber 12 by adjusting the pressure in the combustion chamber 12 and/or pressure vessel 14. Specifically, the flow rate of the fuel, oxidants, and/or diluents may be adjusted to raise or lower the amount of combustion occurring in the combustion chamber 12, producing a corresponding increase or decrease in the pressure in the combustion chamber 12 and/or pressure vessel 14. The increase or decrease in the

pressure in the combustion chamber 12 and/or pressure vessel 14 produces a corresponding increase or decrease in the dew point temperature of any corrosive compounds, thus reducing and/or preventing the condensation of any corrosive compounds between the pressure vessel 14 and the combustion chamber 12.

[0024] Measured parameters of the gasifier 10, content of the fuel, production rate of the synthetic gas, or any other operational parameter may be used to manually adjust the flow rate of the fuel, oxidants, and/or diluents. For example, the gasification of higher energy fuel generally results in a higher pressure in the combustion chamber 12 and pressure vessel 14. This higher pressure in the combustion chamber 12 and pressure vessel 14 produces a corresponding higher dew point temperature for any corrosive compounds produced as byproducts. The higher dew point temperature for the corrosive compounds may lead to undesirable condensation of the corrosive compounds on the relatively cooler inner wall 30 of the pressure vessel 14. Therefore, the flow of fuel and/or oxidants may be decreased to reduce the pressure in the combustion chamber 14 and produce a corresponding decrease in the dew point temperature of any corrosive compounds produced as byproducts. Alternately, or in addition, the flow rate of the diluents may be increased to raise the dilution of the oxidants prior to combustion, producing a similar increase in the pressure and dew point temperature of any corrosion compounds produced as byproducts.

[0025] As shown in FIG. 2, the embodiment shown in FIG. 2 may also include the controller 32 and/or corrosion sensor 36 as previously described with respect to FIG. 1. For example, the controller 32 may be programmed to generate a fuel signal 40 to control the flow of fuel 20 to the combustion chamber 12, an oxidant signal 44 to control the flow of oxidants 22 to the combustion chamber 12, and/or a diluent signal 42 to control the flow of diluents 24 to the combustion chamber 12 to adjust the pressure inside the pressure vessel 14 and/or combustion chamber 12. The controller 32 may generate the fuel 40, oxidant 44, and/or diluent 42 signals at timed intervals, based on the measured parameters of the gasifier 10, content of the fuel, production rate of the synthetic gas, or any other operational parameter.

[0026] Alternately, or in addition, the corrosion sensor 36 may generate the corrosion signal 38 reflective of the presence and/or amount of corrosive compounds present between the pressure vessel 14 and the combustion chamber 12, as previously described with respect to FIG. 1. The corrosion signal 38 may be manually interpreted and acted on by an operator to adjust the flow of fuel 20, oxidants 22, and/or diluents 24 to raise or lower the pressure in the pressure vessel 14 and/or combustion chamber 12, as desired. Alternately, the corrosion sensor 36 may be connected to the controller 32 to transmit the corrosion signal 38 to the controller 32. In this manner, the controller 32 may be programmed to adjust the flow of fuel 20, oxidants 22, and/or diluents 24 upon receiving the predetermined corrosion signal.

[0027] One of ordinary skill in the art will readily appreciate that the gasifier 10 shown in FIG. 2 may provide a method for reducing and/or preventing corrosive compounds from condensing between the pressure vessel 14 and the combustion chamber 12. The method adjusts the pressure inside the pressure vessel 14 and/or combustion chamber 12 so that the dew point temperature of the corrosive compound is less than the temperature of the inner wall 30 of the pressure vessel 14. The pressure inside the pressure vessel 14 and/or combustion

chamber 12 may be adjusted by adjusting the flow of fuel 20, oxidants 22, and/or diluents 24. In addition, or alternately, the method may include detecting any corrosive compounds inside the pressure vessel 14 and adjusting the pressure inside the pressure vessel 14 and/or combustion chamber 12 according to the presence and/or amount of any detected corrosive compounds.

[0028] This written description uses examples to disclose the invention, including the best mode, and also to enable any person skilled in the art to practice the invention, including making and using any devices or systems and performing any incorporated methods. The patentable scope of the invention is defined by the claims, and may include other examples that occur to those skilled in the art. Such other and examples are intended to be within the scope of the claims if they include structural elements that do not differ from the literal language of the claims, or if they include equivalent structural elements with insubstantial differences from the literal languages of the claims.

What is claimed is:

1. A gasifier comprising:

- a. a combustion chamber;
- b. a pressure vessel surrounding the combustion chamber, wherein the pressure vessel includes an inner surface; and
- c. a controller, wherein the controller adjusts a pressure inside the pressure vessel so that a dew point temperature of corrosive compounds produced in the combustion chamber is less than a temperature of the inner surface of the pressure vessel.

2. The gasifier as in claim 1, wherein the controller generates a fuel signal to control a flow of fuel to the combustion chamber.

3. The gasifier as in claim 1, wherein the controller generates an oxidant signal to control a flow of oxidant to the combustion chamber.

4. The gasifier as in claim 1, wherein the controller generates a diluent signal to control a flow of diluent to the combustion chamber.

5. The gasifier as in claim 1, further comprising a heater surrounding the pressure vessel, wherein the heater increases the temperature of the inner surface of the pressure vessel.

6. The gasifier as in claim 5, wherein the controller is connected to the heater and the controller generates a heater signal to activate the heater.

7. The gasifier as in claim 1, further comprising a corrosion sensor between the pressure vessel and the combustion chamber.

8. The gasifier as in claim 7, wherein the controller is connected to the corrosion sensor and the controller generates a corrosion signal to the controller.

9. The gasifier as in claim 8, wherein the corrosion signal causes the controller to generate at least one of a fuel signal to control a flow of fuel to the combustion chamber, an oxidant signal to control a flow of oxidant to the combustion chamber, or a diluent signal to control a flow of diluent to the combustion chamber to adjust the pressure inside the pressure vessel.

10. A gasifier comprising:

- a. a combustion chamber;
- b. a pressure vessel surrounding the combustion chamber, wherein the pressure vessel includes an inner surface; and
- c. a controller, wherein the controller generates at least one of a fuel signal to control a flow of fuel to the combustion

chamber, an oxidant signal to control a flow of oxidant to the combustion chamber, or a diluent signal to control a flow of diluent to the combustion chamber to adjust a pressure inside the pressure vessel.

11. The gasifier as in claim **10**, further comprising a heater surrounding the pressure vessel, wherein the heater increases a temperature of the inner surface of the pressure vessel.

12. The gasifier as in claim **11**, wherein the controller is connected to the heater and the controller generates a heater signal to activate the heater.

13. The gasifier as in claim **10**, further comprising a corrosion sensor between the pressure vessel and the combustion chamber.

14. The gasifier as in claim **13**, wherein the controller is connected to the corrosion sensor and the corrosion sensor generates a corrosion signal to the controller.

15. The gasifier as in claim **14**, wherein the corrosion signal causes the controller to generate at least one of the fuel signal, the oxidant signal, or the diluent signal to adjust the pressure inside the pressure vessel.

16. The gasifier as in claim **14**, wherein the controller generates at least one of the fuel signal, the oxidant signal, or the diluent signal to adjust the pressure inside the pressure vessel upon receiving a predetermined corrosion signal.

17. A method for operating a gasifier comprising:

adjusting a pressure inside a pressure vessel surrounding the gasifier so that a dew point temperature of a corrosive compound is less than a temperature of an inner wall of the pressure vessel.

18. The method as in claim **17**, further comprising adjusting a flow of at least one of fuel, oxidant, or diluent to adjust the pressure inside the pressure vessel.

19. The method as in claim **17**, further comprising detecting a corrosive compound inside the pressure vessel.

20. The method as in claim **17**, further comprising increasing a temperature of the inner wall greater than the dew point temperature of the corrosive compound.

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