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(54) **PRESSURIZED GASIFICATION PROCESS**

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(57) **ABSTRACT**

A continuous waste to energy partial oxidation gasification system and process is accomplished with high pressure.

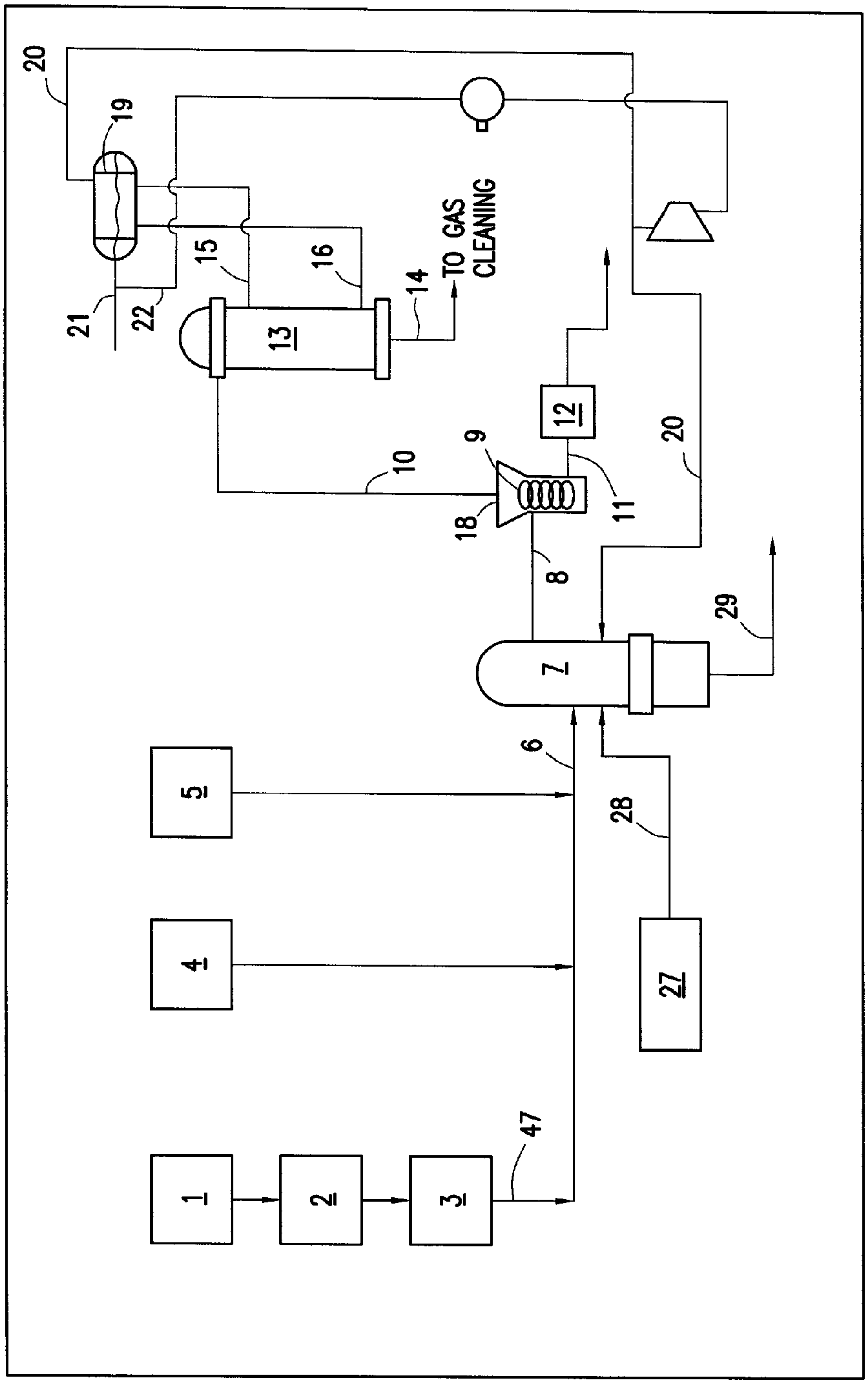
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FIG. 1A

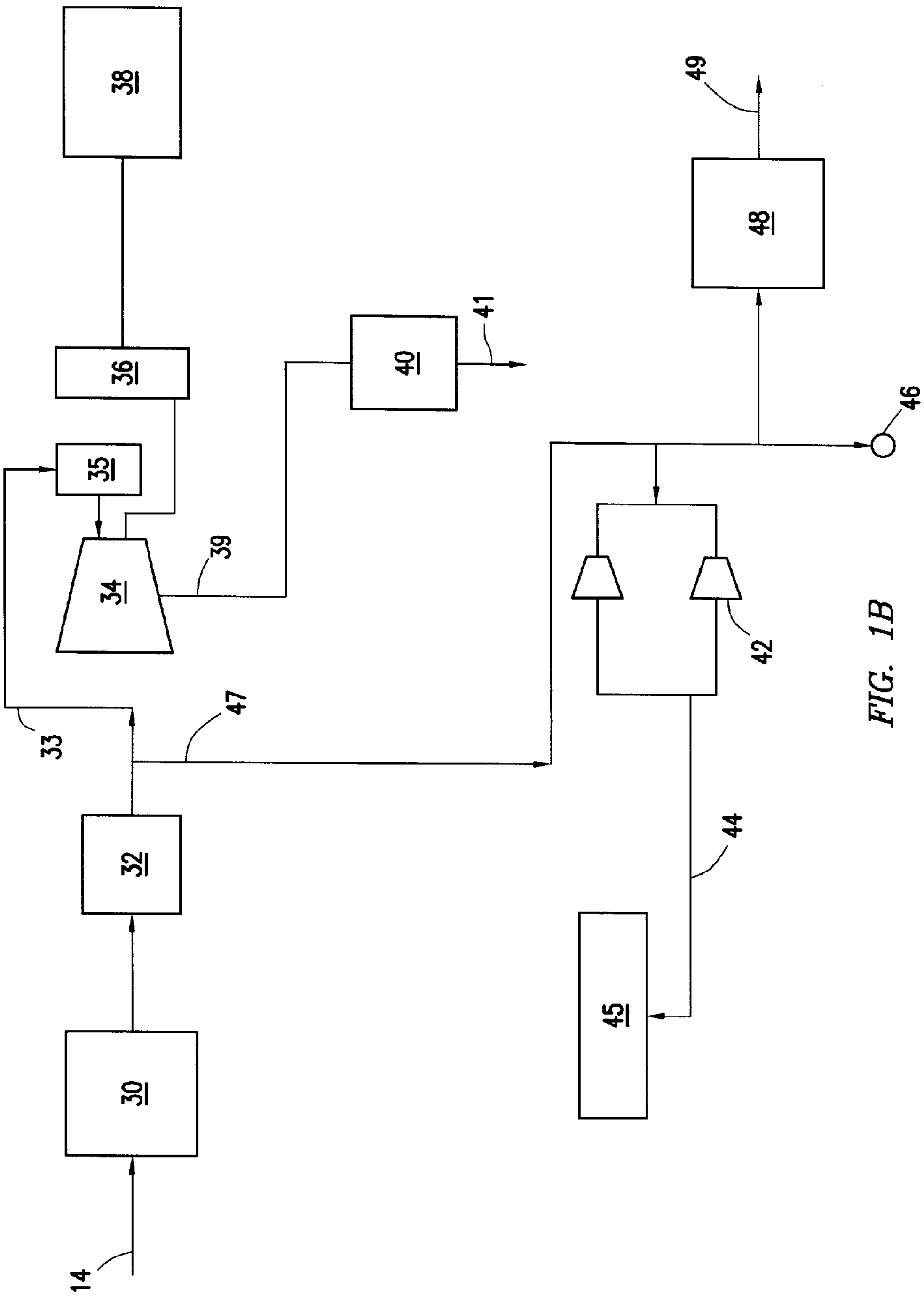


FIG. 1B

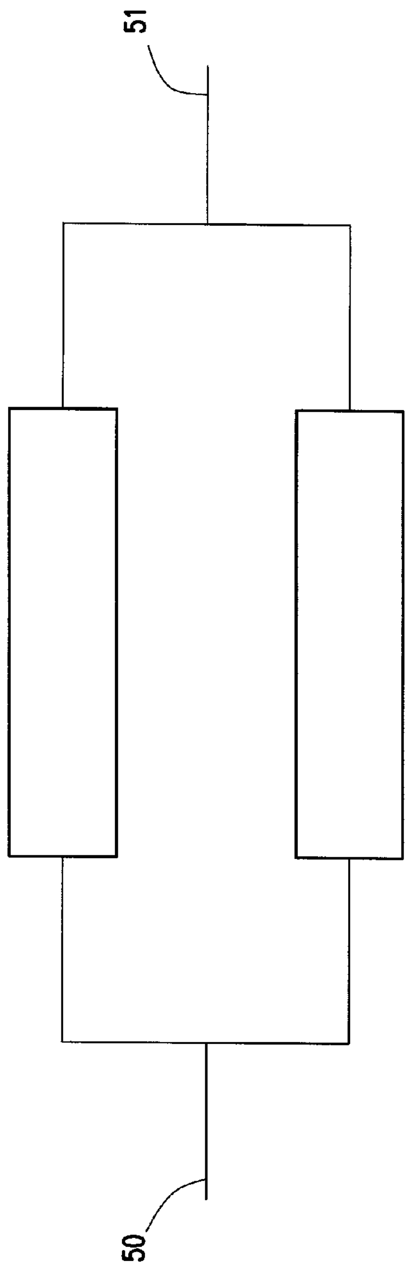


FIG. 2A

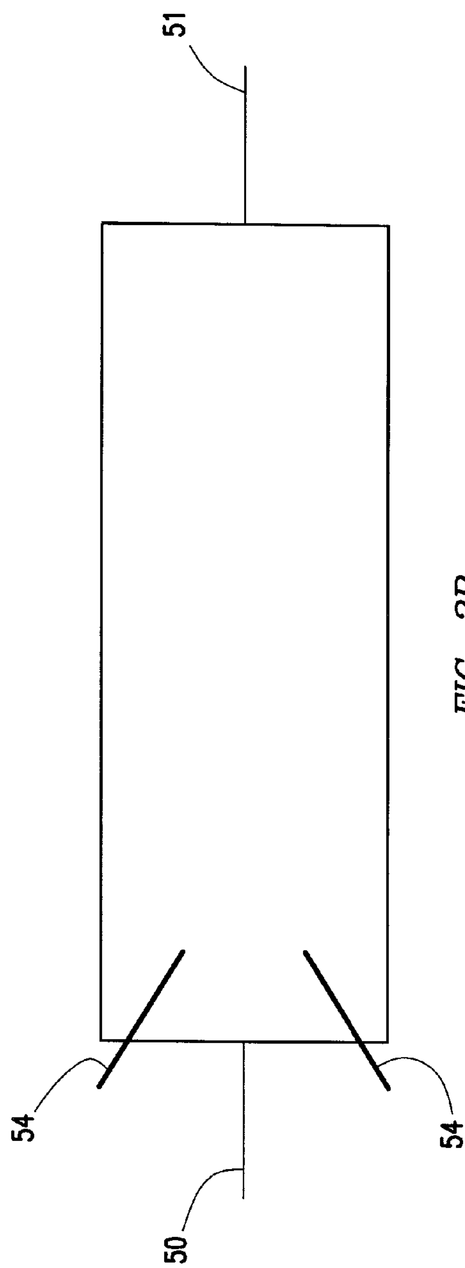


FIG. 2B

# PRESSURIZED GASIFICATION PROCESS

## CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application is a non-provisional application which claims priority from U.S. provisional application No. 61/759,193 filed Jan. 31, 2013

## FIELD OF THE DISCLOSURE

[0002] The disclosure is in the field of cogeneration technologies producing power, chemicals, or synthetic fuels from solid, liquid, or gaseous carbonaceous waste. More particularly, the disclosure relates to continuous, high pressure gasification process of waste for the purpose of generating electrical power, fuels, and/or chemicals.

## BACKGROUND OF THE DISCLOSURE

[0003] Gasification processes are often used to convert carbonaceous solids through their partial oxidation into the gas stream containing hydrogen and carbon monoxide as its major useful components. This gas is generally referred to as synthesis gas or "syngas." The resulting syngas may be used for the generation of electrical power, fuels, and/or chemicals. Production of power from syngas is potentially more efficient than solid fuel because syngas may be directly burned in gas engines. Moreover, syngas may be used to produce hydrogen, methanol, other chemicals, and synthetic fuels often manufactured from natural gas or crude oil.

## SUMMARY

[0004] The present disclosure provides a system for an waste gasification system comprising a gasifier reactor, wherein said reactor has an operating pressure of from 200 to 850 psig and an operating temperature of from 2000 to 5000° F., and wherein said system has a large-scale capacity for power generation.

[0005] The present disclosure also provides a system for an waste gasification system comprising: (a) a gasifier reactor, wherein said reactor has an operating pressure of from 200 to 850 psig and an operating temperature of from 2000 to 5000° F.; and (b) a steam reformer, wherein said system has a large-scale capacity for power generation.

[0006] The present disclosure further provides a process for waste gasification comprising: (a) separating and blending hydrocarbon feedstock; (b) feeding said feedstock to a gasifier reactor, wherein said reactor has an operating pressure from 200 to 850 psig and an operating temperature of from 2000 to 5000° F.; (c) producing synthesis gas in said gasifier reactor; (d) quenching said synthesis gas; (e) cleaning said synthesis gas; and (f) generating large-scale power capacity with said synthesis gas.

[0007] The general description and the following detailed description are exemplary and explanatory only and are not restrictive of the disclosure, as defined in the appended claims. Other aspects of the disclosure will be apparent to those skilled in the art in view of the detailed description of the disclosure as provided herein.

## BRIEF DESCRIPTION OF THE DRAWINGS

[0008] The summary and the detailed description are further understood when read in conjunction with the appended drawings. For the purpose of illustrating the present disclosure, there are shown in the drawings exemplary embodiments of said disclosure; however, the disclosure is not limited to the specific methods, compositions, and devices disclosed. In addition, the drawings are not necessarily drawn to scale. In the drawings:

[0009] FIG. **1**A is a depiction of a continuous, high pressure waste to energy ("WTE") partial oxidation gasification process consistent with at least one embodiment of the present disclosure.

[0010] FIG. **1**B is a further depiction of a continuous, high pressure WTE partial oxidation gasification process consistent with at least one embodiment of the present disclosure.

[0011] FIG. **2**A is a depiction of a continuous high pressure WTE partial oxidation process consistent with at least one embodiment of the present disclosure.

[0012] FIG. **2**B is a depiction of a continuous high pressure WTE partial oxidation process consistent with at least one embodiment of the present disclosure.

## DETAILED DESCRIPTION

[0013] The present disclosure may be understood more readily by reference to the following detailed description, taken in connection with the accompanying figures, which form a part of this disclosure. It is to be understood that this disclosure is not limited to the specific devices, methods, applications, conditions or parameters described and/or shown herein, and that the terminology used herein is for the purpose of describing particular embodiments by way of example only and is not intended to be limiting of the present disclosure. Also, as used in the specification, including the appended claims, the singular forms "a," "an," and "the" include the plural, and reference to a particular numerical value includes at least that particular value, unless the context clearly dictates otherwise. The term "plurality," as used herein, means more than one. When a range of values is expressed, another embodiment includes from the one particular value and/or to the other particular value. Similarly, when values are expressed as approximations, by use of the antecedent "about," it will be understood that the particular value forms another embodiment. All ranges are inclusive and combinable.

[0014] It is to be appreciated that certain features of the present disclosure which are, for clarity, described herein in the context of separate embodiments, may also be provided in combination in a single embodiment. Conversely, various features of the present disclosure that are, for brevity, described in the context of a single embodiment, may also be provided separately or in any subcombination.

[0015] Further, references to values stated in ranges include each and every value within that range. In embodiments of the present disclosure, the process comprises a high pressure continuous feed gasification process for feedstock in an entrained or fluidized bed gasification system. As used herein, a partial oxidation reactor can also be referred to as a "gasification reactor," a "gasifier," or simply a "reactor," and these terms are used equivalently and interchangeably.

[0016] In one embodiment of the present disclosure the gasification process includes a high pressure gasifier that has an operating pressure of from 200 to 850 psig, alternatively from 300 to 700 psig, alternatively from 300 to 500 psig, or alternatively from 300 to 400 psig. The operating temperature of the gasifier is from 2000 to 5000° F., alternatively from 2500 to 4500 ° F., or alternatively from 3000 to 4000° F.

**[0017]** The gasifier may be a flexible feed gasifier, allowing use of multiple fuel sources, including, but not limited to, hydrocarbons, sewage cake, electronic waste, hazardous materials, and drilling fluids. The available feedstock may contain foreign bodies, such as stones, scrap metals, etc. In certain embodiments, a collection area beneath the gasifier may include a grinder for the evacuation of such foreign bodies. Buildup of foreign bodies inside of the gasifier may be minimized.

**[0018]** In certain embodiment, the gasifier's mechanical integrity is controlled by instantaneous thermal wall imagery with an automatic spray wash for the purpose of ensuring reactor containment. Thermal wall allows for a range of process tasks, such as increasing efficiency in automated environments, detecting leaks in malfunctioning equipment, and conducting preventive maintenance.

**[0019]** In certain other embodiments, the process includes a feed and separation system. The feed and separation system may separate the carbonaceous materials from the non-carbonaceous materials prior to sending the feed to the reactor. A high pressure feedstock shredder may be used to prepare the feed for further processing in the high pressure reactor.

**[0020]** A stabilizer feed balancer may be used in some embodiments to achieve a pre-determined energy content of the feed within pre-determined limits. The stabilizer feed balancer may include a slip-stream feed. The slip-stream fee may include hydrocarbon species. In other embodiments, the process may include a sensor suite and integrated sensor fusion architecture for allowing real-time control and monitoring of feedstock and process reaction kinetics. The sensor suite and integrated sensor fusion architecture may include dynamic reconfigurable hardware/software architecture for process optimization and stabilization.

**[0021]** In yet another embodiment, the process includes a high pressure plasma/hydrogen reformer. The high pressure plasma/hydrogen reformer may be in addition to the above-stated process equipment and parameters. The high pressure plasma/hydrogen reformer may increase operation efficiency and output. When two or more gasifier reactors are used in conjunction with a reformer, the reactors may be sequenced either in parallel or series. The reformer of the present disclosure may feature real-time optical analysis and measurement of high temperature and high pressure gas analysis, and may be controllable via a distributed control system.

**[0022]** Process

**[0023]** Referring to FIG. **1**A, gasifier's **7** feed stream **6** may be a combination of municipal solid waste ("MSW"), coal, or various other waste streams. Prior to entering feed stream **6**, feedstock **1** may be processed through separator **2**, and grinder and blender **3** to form blended stream **47**. Liquid stream **4** and gas stream **5** may combine with blended stream **47** to form feed stream **6**. Gasifier **7** may also have two additional feed streams, which may consist of air or oxygen **28** and/or steam **20**.

**[0024]** After entering gasifier **7**, feedstock **47** may undergo gasification in which fixed carbon and organic volatiles are partially oxidized to form syngas. In some embodiments, the operating pressures for the gasifier **7** may be from 200 to 850 psig, from 300 to 700 psig, from 300 to 500 psig, or from 300 to 400 psig. In some embodiments, the operating temperature of gasifier **7** may be from 2000 to 5000° F., from 2500 to 4500° F., or from 3000 to 4000° F. The resultant synthesis gas ("syngas") **8** exiting the gasifier **7** may be analyzed to ensure proper stoichiometric composition by an in-process analyzer **18**. The syngas may then flow to cyclone separator **9**, wherein solid impurities, including but not limited to fly ash, are separated from syngas **8**. Solid impurities form stream **11** that may be removed from the system and may then be, for example, sent to bag house **12**. Syngas stream **10** exiting cyclone separator **9** may then enter quench column **13** at a temperature ranging from about 1800 to about 2000° F. After exiting quench column **13**, syngas **14** flows to heavy metal separator **30** and chlorine sulfur separator **32** (FIG. **1**B).

**[0025]** In some embodiments, syngas stream **33** exiting the sulfur separator **32** may then be s split into two streams **33** and **47**. Syngas stream **33** may then flows to combustion chamber **47** connected to gas turbine **34**. Gas turbine **34** may, for example, power gearbox **36** which may in turn supply power to generator **38**. The waste heat exhaust stream **39** exiting gas turbine **34** may flow to heat recovery steam generator **40**, wherein exiting stream **41** is vented to atmosphere after scrubbing and cleaning.

**[0026]** Syngas stream **47** may be fed to turbo expander **42**, with residuals going to flare stack **46**. Syngas stream **44** exiting turbo expander **42** may be fed to boiler **45** to generate steam for the balance of plant operation. In some embodiments, syngas stream **47** may also be fed into Fischer Tropes process **48** to, for example, create liquid fuels and/or chemicals **49**. In some embodiments, a high pressure reformer may be included downstream. The reformer may utilize plasma or hydrogen torch technology (FIG. **2**A and FIG. **2**B). Such embodiments are multi-pass processes, and may allow for either parallel (FIG. **2**A) or series (FIG. **2**B) sequenced plasma or hydrogen compartmentalized reactor chambers. In such embodiments, the syngas may enter the reformer after sulfur separation. The gas **51** exiting the reformer may be recycled to the gasifier **7**. In some embodiments, as depicted in FIG. **2**B, syngas stream **50** may be fed to reformer **52**, at which one or more plasma or hydrogen torches **54** may cause syngas stream **50** to pass through the flame front created thereby, and exiting as syngas stream **51**.

**[0027]** These embodiments of the disclosed process may allow for a plasma gasification process in which a hydrogen torch may be utilized in conjunction with high pressure. The operating pressure may be from 200 to 850 psig, from 300 to 700 psig, from 300 to 500 psig, or from 300 to 400 psig. The operating temperature of the gasifier may be from 2000 to 5000° F., from 2500 to 4500° F., or from 3000 to 4000° F.

**[0028]** When ranges are used herein for physical properties, such as molecular weight or chemical properties, such as chemical formula, all combinations, and subcombinations of ranges for specific embodiments therein are intended to be included.

**[0029]** Those skilled in the art will appreciate that numerous changes and modifications can be made to the preferred embodiments of the present disclosure and that such changes and modifications can be made without departing from the spirit of said disclosure. It is, therefore, intended that the appended claims cover all such equivalent variations as fall within the true spirit and scope of said disclosure.

What is claimed is:

**1**. An energy gasification system comprising a gasifier reactor, wherein said reactor has an operating pressure of from 200 to 850 psig and an operating temperature of from 2000 to 5000° F.

**2**. The system of claim **1**, wherein the operating pressure of the reactor is from 300 to 500 psig.

**3**. The system of claim **1**, wherein the operating temperature of the reactor is from 3000 to 4000° F.

**4**. The system of claim **1**, wherein the reactor has instantaneous thermal wall imagery.

**5**. The system of claim **1**, further comprising a feed processing and separation system.

**6**. The system of claim **1**, further comprising a high pressure feedstock shredder.

**7**. The system of claim **1**, further comprising a stabilizer feed balancer, wherein the balancer is comprised of an automatic hydrocarbon slip-stream feed.

**8**. The system of claim **1**, further comprising an advanced sensor system.

**9**. The system of claim **1**, having waste feed capacity of from 1500 to 4000 tons/day.

**10**. The system of claim **1**, wherein said gasifier reactor is a high pressure, flexible feed reactor.

**11**. The system of claim **10**, wherein the reactor feed may comprise hydrocarbons, sewage cake, electronic waste, hazardous materials, and drilling fluids.

**12**. An energy gasification system comprising:

a gasifier reactor, wherein said reactor has an operating pressure of from 200 to 850 psig and an operating temperature of from 2000 to 5000° F.; and

a steam reformer.

**13**. The system of claim **12**, wherein the operating pressure of the reactor is from 300 to 500 psig.

**14**. The system of claim **12**, wherein the operating temperature of the reactor is from 3000 to 4000° F.

**15**. The system of claim **12**, wherein the reactor has instantaneous thermal wall imagery.

**16**. The system of claim **12**, further comprising an automated feed and separation system.

**17**. The system of claim **12**, further comprising a high pressure feedstock shredder.

**18**. The system of claim **12**, further comprising a stabilizer feed balancer, wherein said balancer includes an automatic hydrocarbon slip-stream feed.

**19**. The system of claim **12**, further comprising an advanced sensor system.

**20**. The system of claim **12**, having waste feed capacity of from 1500 to 4000 tons/day.

**21**. The system of claim **12**, wherein said reactor is a high pressure, flexible feed reactor.

**22**. The system of claim **21**, wherein the reactor's feed may comprise hydrocarbons, sewage cake, electronic waste, hazardous materials, and drilling fluids.

**23**. The system of claim **12**, wherein said reformer is a high pressure plasma or hydrogen torch reformer.

**24**. The system of claim **23**, wherein the reformer has parallel sequenced plasma or hydrogen torch compartmentalized reactor chambers.

**25**. The system of claim **23**, wherein the reformer has series sequenced plasma or hydrogen torch compartmentalized reactor chambers.

**26**. An energy gasification process comprising:

separating and blending hydrocarbon feedstock;

feeding said feedstock to a gasifier reactor, wherein said reactor has an operating pressure of from 200 to 850 psig and an operating temperature of from 2000 to 5000° F.;

producing synthesis gas in said gasifier reactor;

quenching said synthesis gas;

cleaning said synthesis gas; and

generating power with the synthesis gas.

**27**. The energy gasification process of claim **26**, further comprising:

feeding the synthesis gas to a steam reformer.

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