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(54) **TYER CARBURETION PROCESS**

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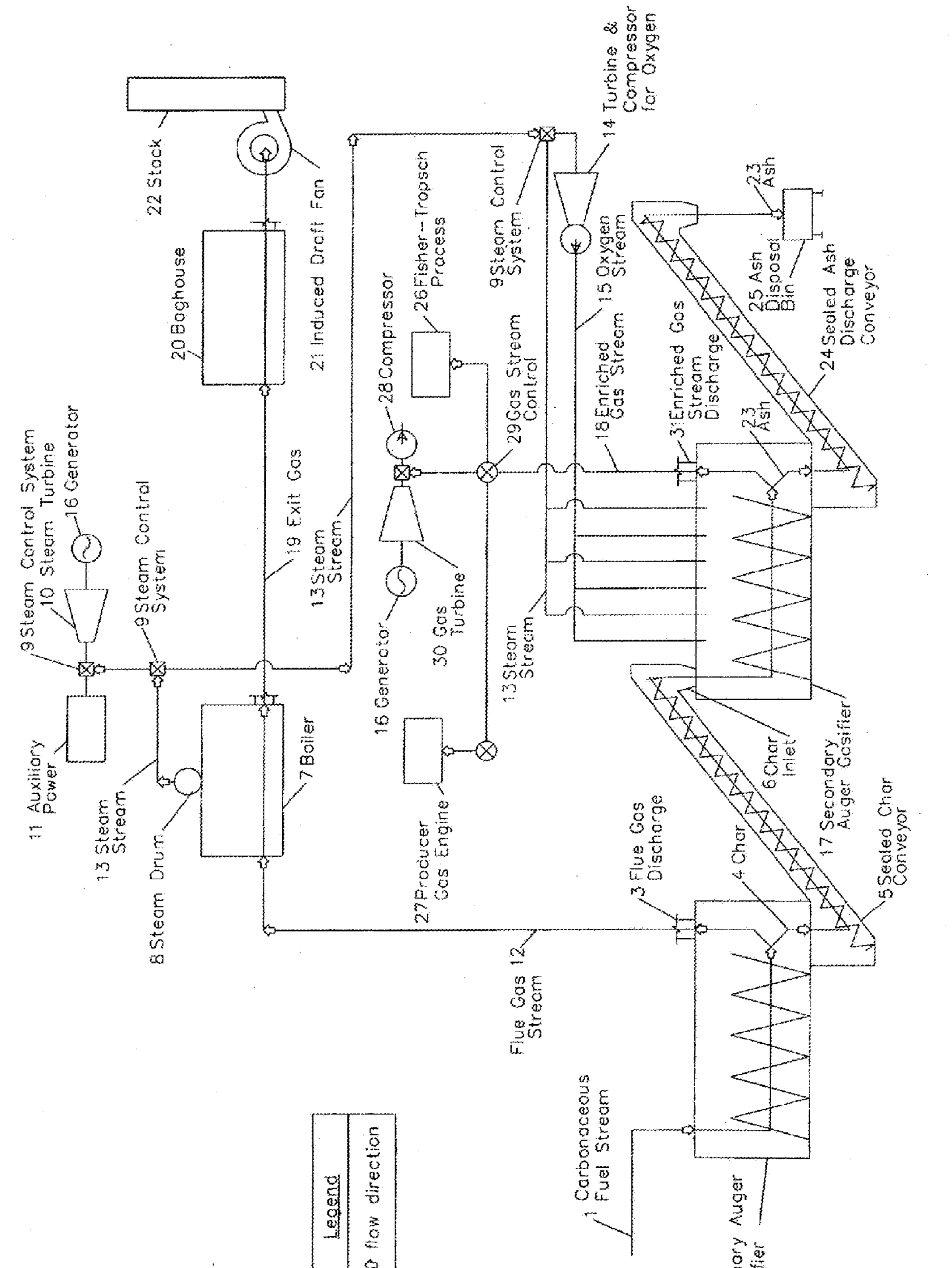
(57) **ABSTRACT**

A means for improving prior art combined cycle combustor and/or gasifiers and/or plural thermodynamic cycle gasification systems by introducing and utilizing an auger for the continuous feeding, agitation, tumbling, advancement and discharge of heterogenous carbonaceous fuel. In addition to the aforementioned improvement, I have included provisions for Fontana's water gas shift reaction utilizing refectory embedded down-tubes that convey steam and oxygen into and through the chambers fluidized bed.



Tyer Carburetion Process

Fig.# 1

TYER CARBURETION PROCESS

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims subject matter disclosed in a provisional application filed Jan. 14, 2009, Ser. No. 61/205,055 entitled "Combined Cycle Gasifier" and a non-provisional application filed Feb. 20, 2009, Ser. No. 12/378,864, entitled "Improved Auger Combustor", and is a continuation of a non-provisional application filed Jan. 19, 2010, Ser. No. 12/657,226, entitled "Tyer Carburetion Process." The benefit under 35 USC 309(e) of the United States provisional application is hereby claimed, as are the priority benefits of the other applications named, the aforementioned applications being hereby incorporated herein by reference.

BACKGROUND AND SUMMARY

[0002] The invention relates generally to fluidized bed gasifiers and to the production of gasified fuel via and/or in conjunction with the gasification of solid fuels in a fluidized bed gasifier featuring a rotating auger conveyor. More particularly, it deals with improvements to gasifiers that facilitate the continuous controlled movement and gasification of solid fuels in the combustor/gasifier; also, those gasifiers which facilitate production and enrichment of gasified fuel via and in conjunction with such combined cycle gasification system. These and other improvements taught herein are in relation to the operation of an auger gasifier(s) and/or plural thermodynamic cycle gasification systems. The use of an auger represents significant advances in technology related to the environmentally sound utilization and processing of bioenergy fuels, such as but not limited too, solid fuel for the production of energy via such fluidized bed gasifiers and plural thermodynamic cycle gasification systems.

[0003] Much of the world's energy needs have been, and continue to be, filled by hydrocarbon fuels. In the past, such fuels provided a convenient, plentiful, and inexpensive energy source. The current rising costs of such fuels and concerns over the adequacy of their supply in the future has made them a less desirable energy source and has led to an intense investigation of alternative sources of energy. The ideal alternative energy source is a fuel that is renewable, inexpensive, and plentiful, with examples of such fuels being, but not limited too, the byproducts of wood, pulp, and paper mills, household municipal solid waste (MSW), commercial refuse-derived fuel (RDF). In addition, biomass fuels are a renewable energy source because they are biological material derived from living, or recently living organisms, such as wood, waste, and alcohol fuels and are considered carbon-neutral since the C_{O2} liberated from the gasification of biomass fuels are recycled in plants. The combusted biomass fraction of RDF is used by stationary combustion operators to reduce their overall reported C_{O2} emissions.

[0004] Refuse-derived fuel (RDF) and municipal solid waste (MSW) consists largely of organic components of municipal waste such as plastics and biodegradable waste. For example, forest residues (such as dead trees, branches and tree stumps), yard clippings and wood chips may be used as biomass; however, biomass also includes plant or animal matter used for production of fibers or chemicals.

[0005] Biomass may also include biodegradable wastes that can be gasified as fuel and industrial biomass that can be grown from numerous types of plant including, such as but not limited too, miscanthus, switch grass, hemp, corn, poplar, willow, sorghum, sugarcane, and a variety of tree species, ranging from eucalyptus to oil palm, but excludes organic material such as fossil fuel substances such as coal or petroleum.

[0006] The use of such alternative energy sources is not problem-free consequently since there is reason for concern over the contents of the emissions from the combustion of such fuels as well as the environmental ramifications of acquiring and transporting the fuel and disposing the residue of combustion. Starved-air gasifiers, wherein the air supplied for gasification is controlled in order to control temperature conditions (and the rates of gasification) so as to gasify the fuel as completely as possible, have proved very useful in the utilization of such alternative energy sources while simultaneously maintaining a high degree of environmental quality in emissions. Such starved-air gasifiers are capable of gasifying various types of fuel and producing significant amounts of synthesis gas and heat that can be employed for any number of purposes including the production of process steam for use in manufacturing and in the generation of electricity by combining a plurality of thermodynamic cycles.

[0007] Unfortunately, most starved-air gasifiers, as originally developed and operated, were not entirely satisfactory in processing the gasifiable elements of the fuel at high throughput while not producing noxious emissions. This problem resulted, in part, from the use of such gasifiers to burn a wide variety of fuels, including many that were non-homogeneous, such as household municipal solid waste (MSW) and commercial refuse-derived fuel (ROF). While the pollution problem can be solved to a degree by the utilization of scrubbers and other antipollution devices, such mechanisms are very expensive and their cost may militate against the use of alternative energy sources previously described.

[0008] Many of the drawbacks of such prior art devices were overcome by the development of the auger gasifier by the inventor and others. See, U.S. Pat. No. 4,009,667 (describing the original auger gasifier utilized in the system); U.S. Pat. No. 4,315,468 (describing a control means for the system); U.S. Pat. No. 4,331,084 (describing a refuse fuel feed mechanism for the system); U.S. Pat. No. 4,331,085 (describing a flame stabilization means for the system); U.S. Pat. No. 4,332,206 (describing an afterburner for the system); U.S. Pat. No. 4,332,206 (describing a hot gas recycle mechanism for use with the system); and U.S. Pat. No. 6,349,658 (describing an auger gasifier with fluidized bed). The auger gasifier technology taught and described in the foregoing patents offers a cost-effective approach to clean, efficient gasification of biomass fuels and other prepared solid waste fuels. It employs a starved-air plural thermodynamic cycle combustion/gasification technique, ideally utilizing only starved air combustion in order to gasify solid fuel in a primary auger chamber (the "combustor" or "gasifier" chamber) prior to sending the char and flue gases on to the secondary auger gasifier.

[0009] One of the unique features within the Tyer Carburetion Process auger gasifier system is its auger. Fuel enters the primary auger gasifier at a continuous controlled rate and is shaped into a pile by the first auger flight, then pushed and tumbled through the gasifier chamber by the auger. As the auger moves the fuel through this horizontal gasifier cylinder, it stirs the material to maximize exposure for oxidation and/or gasification; this is accomplished by reversing the direction the auger is traveling and creating a void between the auger flight and the gasifying fuel then reversing the direction again thus exerting force o the char and pushing it into the un-gasified fuel. The pitch of the auger can decrease, along the path of material flow to accommodate the decrease of fuel bulk and retention time as the material gasifies. The use of an auger to convey fuel through the gasification cycle is an improvement, which results in very accurately controlled movement of fuel through the gasification chamber, in comparison to alternative rotary kiln incinerators. This ability to manage fuel-bed configuration permits control of forced-draft combustion air so as to minimize combustion and gasify nearly all the carbonaceous fuel without complete combustion taking place, thereby allowing the gasifier to operate at what is a uniformly moderate temperature from auto-ignition to desired exit gas temperature, as well as, supplying char and/or steam to the secondary auger gasifier.

[0010] The combination of fuel bed auger agitating, stirring with air injection produce precise temperature control evidencing the Tyer Carburetion Process auger gasifier system several advantages over prior technology: Reliability and clean operation; high throughput; low gasifier temperature, longer material life (refractory and auger); fully automatic control; and the ability to combust a wide variety of heterogeneous solid fuels. However, several of these advantages are further strengthened by the addition of a substrate of appropriate granular materials to act as an "air bearing" in the auger combustor/gasifier chamber, and to aid in the diffusion of gasification air through the material being burned as more fully described in U.S. Pat. No. 6,349,658.

[0011] Still, while the auger combustor/gasifier described in the foregoing patents offers a cost-effective approach to clean, efficient gasification, I have found that various innovative improvements, as further taught herein, support and facilitate its operations and of efficiency. These improvements include provision of a vertically elongated ("oblong") primary combustor/gasifier chamber with an auger that can move up and down allowing for large amounts of fuel input when necessary. This improvement, in turn, requires and/or is facilitated by provision for simultaneous elevation adjustments of the auger and bed darn to assure that fuel material is processed in degrees from the top downward without sweeping massive amounts of the fluidized bed materials towards the output end of the chamber.

[0012] Another improvement involves provision for optional independent pressurization of the primary auger gasifier and/or of the secondary auger gasifier, allowing substantial increase in the fuel processing speed through the gasifier. Because the Tyer Carburetion Process utilizes low gasification temperatures, high convection rates and radiative heat transfer, the heat, which is normally lost from the bulk bed material, is now providing to the fuel sufficient ignition energy to evaporate moisture, heat the ash and gasify the remaining fuel without significantly changing the instantaneous bed temperature. My Biomass bubbling bed operates sub-stoichiometrically, or below the ideal gas laws because all the available oxygen is used. If an increase of oxygen was allowed into the auger gasifier chamber a greater portion of the fuel would become oxidize leading to an increase of the amount of bed heat that would be released; contrary to this, lower oxygen levels have the reverse effect.

[0013] Because I can control both the duration and the direction of the auger cycles, use a lower gasification temperature, a higher convection and heat transfer rate, I can create a more efficient and cost effective system which is well adapted to meet the continuing needs of our modern technological civilization for elimination of waste, such as but not limited too, RDF & MSW while producing clean environmentally sound sources of alternative energy therefrom.

[0014] In addition to the aforementioned improvements, I have provided a provision within the Tyer Carburetion Process that allows the water gas shift reaction, first discovered by Felice Fontana in 1780, to take place. As the heated bed radiates heat into the refractory embedded down-tubes, the heat is absorbed, preheats the down-tubes carrying the steam and oxygen. This steam and oxygen is injected into and through the particle bed as the incandescent char is tumbling over bed. As the auger tumbles the char, as previously mentioned, the perimeter char falls down Into the void created by the moving auger into the center of the bed and allows the hot oxygen & steam emitted from the down-tubes to mix with the incandescent fuel thus creating the suitable environment for Fontana's water gas shift reaction to happen.

BRIEF DESCRIPTION OF THE DRAWINGS

[0015] FIG. **1** is an illustration, which facilitates an understanding of the invention of the Tyer Carburetion Process in accordance with the teachings of the invention.

ITEM # DESCRIPTION

[0016] **1**. Carbonaceous Fuel Stream
[0017] **2**. Primary Auger Gasifier
[0018] **3**. Flue Gas Discharge
[0019] **4**. Char (Char is the solid material that remains after light gases (e.g. coal gas) and tar (e.g. coal tar) have been driven-out or released from carbonaceous material, during the initial stage of combustion, which is known as carbonization, charring, devolatilization or pyrolysis.
[0020] **5**. Sealed Char Conveyor
[0021] **6**. Char Inlet
[0022] **7**. Boiler
[0023] **8**. Steam Drum
[0024] **9**. Steam Control System
[0025] **10**. Steam Turbine
[0026] **11**. Auxiliary Power
[0027] **12**. Flue Gas Stream
[0028] **13**. Steam Stream
[0029] **14**. Turbine & Compressor for Oxygen
[0030] **15**. Oxygen Stream
[0031] **16**. Generator
[0032] **17**. Secondary Auger Gasifier
[0033] **18**. Enriched Gas Stream
[0034] **19**. Exit Gas
[0035] **20**. Baghouse
[0036] **21**. Induced Draft Fan
[0037] **22**. Stack
[0038] **23**. Ash
[0039] **24**. Sealed, Ash Discharge Conveyor
[0040] **25**. Ash Disposal Bin
[0041] **26**. Fisher-Tropsch Process
[0042] **27**. Producer Gas Engine
[0043] **28**. Compressor
[0044] **29**. Gas Stream Control
[0045] **30**. Gas Turbine
[0046] **31**. Enhanced Gas Stream Discharge

EMBODIMENT ONE; DETAILED DESCRIPTION

[0047] A (I) Carbonaceous Fuel Stream, such as but not limited to, wood is introduced into the (**2**) primary auger gasifier by a means and where said fuel stream is advanced, agitated and tumbled by an auger as the fuel stream is partially gasified thus creating (**12**) flue gas stream and (**4**) Char product. The (**4**) char product is collected from the primary auger gasifier via the (**5**) sealed char conveyor and delivered through the (**6**) char inlet into the (**17**) secondary auger gasifier. As said primary auger gasifier produces the (**12**) flue gas stream that exits (**3**) the flue gas discharge, said gases are directed to the (**7**) boiler for steam production. After leaving said boiler, the (**12**) flue gas stream, now an (**19**) exit gas is directed through the (**20**) baghouse for cleaning and discharged. Concurrently, the (**13**) steam stream which exits the (**7**) boiler (**8**) steam drum and is controlled by the (**9**) Steam control system directs (**13**) steam stream to provide steam either into the (**10**) steam turbine which powers an electrical (**16**) generator and/or for (**11**) auxiliary power. When required, for the water gas shift reaction (**9**) steam control system can direct both the (**13**) steam stream into the secondary auger gasifier's down-tubes and the (**13**) steam stream into the (**14**) turbine and compressor for oxygen, which supplies the (**15**) oxygen stream for the oxygen stream down-tubes located within the (**17**) secondary auger gasifier. Within the (**17**) secondary auger gasifier, a supply of (**13**) steam stream and a supply of (**15**) oxygen stream is introduced with the said(**4**) char that as the gasification process takes place a synthesis gas known in the art as an (**18**) enriched gas stream is produced. Note: it is not necessary within this process to produce neither the oxygen nor the steam for the secondary gasification. The oxygen and steam can be supplied by other sources. Said enriched gas stream is directed to, such as but not limited to: (**27**) Producer gas engines, (**30**) Gas Turbine (**16**) generators and/or (**26**) Fisher-Tropsch process. The (**23**) ash from said secondary auger gasifier is deposited into the (**24**) sealed ash discharge conveyor and conveyed to the (**25**) ash disposal bin.

EMBODIMENT ONE; OPERATIONAL DESCRIPTION

[0048] A carbonaceous fuel stream is introduced into the primary auger gasifier, advanced, agitated and tumbled by an auger, partially gasified and creates a flue gas stream and char product. The char product is collected from the primary auger gasifier, conveyor and delivered into the secondary auger gasifier. As said primary auger gasifier produces the flue gas stream that exits the flue gas discharge from the primary auger gasifier, said gases are directed to the boiler for steam production. After leaving said boiler, the flue gas stream, now an exit gas is cleaned and discharged. Concurrently, the steam stream also exiting the boiler steam drum, controlled by the steam control system directs steam stream to provide steam either into the steam turbine, which powers an electrical generator, and/or for auxiliary power. When required, for the water gas shift reaction, steam control system can direct both the steam stream into the secondary auger gasifier's down-tubes and the steam stream into the turbine and compressor for oxygen, which supplies the oxygen stream for the oxygen stream down-tubes located within the secondary auger gasifier. Within the secondary auger gasifier, a supply of steam stream and a supply of oxygen stream are introduced with the char that as the gasification process takes place a synthesis gas known in the art as an enriched gas stream is produced. Note: it is not necessary within this process to produce neither the oxygen nor the steam for the secondary gasification. The oxygen and steam can be supplied by other sources. Said enriched gas stream is directed to, such as but not limited to: a producer gas engines, a gas turbine/generator(s) and/or a Fisher-Tropsch process. The ash from the secondary auger gasifier is deposited into a sealed ash discharge and conveyed to the ash disposal bin for removal.

ADVANTAGES

[0049] From the descriptions above, a number of advantages of embodiments of the Tyer Carburetion Process become evident:

[0050] A. The ability to convey mechanically, char through a horizontal gasification chamber by the use of an auger is more efficient then the current grate systems and offers greater control over the gasification process.

[0051] B. The ability to sequence the introduction of a plurality of oxygen streams and steam streams into a horizontal gasification chamber to produce a medium. British Thermal Unit (BTU) gas is superior over the current methods of starting and stopping the feed cycle and offers continuous feed and discharge as well as continuous water gas shift reactions.

[0052] C. The ability to manufacture a chamber with a pipe conduit embedded within the refractory takes advantage of the heat and radiative heat transfer from the bubbling bed which current prior art ignores thus wastes by discharging up the stack.

[0053] D. The ability to pre-heat both the oxygen and steam stream as it travels through the refractory embedded conduit is a great energy savings. I reuse the heat energy that exists within the Tyer carburetion process.

[0054] E. By using the oxygen and steam stream as a means to create a fluidized bed as opposed to a separate air injection system to fluidize a particulate bed is both an energy savings improvement and uses fewer components.

[0055] F. My ability to bring the oxygen and steam streams from the top of the horizontal gasification chamber down through the embedded tubes allows me to bring the blown oxygen through the bed to create water gas is also a superior novelty over the prior arts stop and start cycling. Prior art spends time and energy reheating the fuel to incandescent levels while I continuously create water gas.

[0056] G. I can control the internal temperature of the horizontal gasification chamber by blown oxygen, which allows me the novelty of heating or cooling down sections of a gasifier and/or combustor in contrast to increasing or decreasing the temperature of the gasifier as a whole, which is common among prior art.

CONCLUSION, RAMIFICATIONS AND SCOPE

[0057] Accordingly, the reader will see that the Tyer Carburetion process is an immense improvement over prior art. The Tyer carburetion process includes numerous advancements in gasification, combustion and other plural thermodynamic cycle gasification systems in addition to the water gas shift reaction environment creation. The use of an auger is a significant advancement in technology related to the environmentally sound utilization and processing of bioenergy fuels via such fluidized bed gasifiers and plural thermodynamic cycle gasification systems. My Tyer carburetion process is an improvement to gasifiers that facilitate the continuous controlled movement and gasification of solid fuels in the combustor/gasifier; also, those gasifiers that facilitate production and enrichment of gasified fuel via and in conjunction with such plural thermodynamic cycle gasification systems. The current rising costs of such petroleum fuels and concerns over the adequacy of their supply in the future has made them a less desirable energy source and has led me to an intense investigation of alternative sources of energy, which I believe I have invented herein.

1. A gasifier system, comprising:

a primary gasifier having an inlet for receiving gasifiable materials into its interior and outlets for discharging a flue gas discharge stream and char remaining after initial gasification of said gasifiable materials; and

a secondary gasifier receiving char from said primary gasifier, said secondary gasifier comprising

an elongated horizontally disposed stationary secondary gasifier chamber, said chamber having a first end with an inlet for receiving said char into its interior and a second end with outlets for discharging an enriched water gas stream produced by steam treatment of said char within the secondary gasifier chamber and ash remaining after said treatment, the horizontal position of said elongated stationary chamber defining an upper and a lower side, and

a rotatable screw conveyor extending through said secondary gasifier chamber's interior from proximate said first end to proximate said second end for moving said char therethrough, said screw conveyor comprising an axial member having two ends with a plurality of spiral flights forming a continuous helix around said axial member.

2. The gasifier system of claim **1**, wherein said primary gasifier is comprised of

an elongated horizontally disposed stationary primary gasifier chamber, said chamber having a first end with an inlet for receiving said gasifiable materials into its interior and a second end with outlets for a flue gas discharge stream and char remaining after initial gasification of said gasifiable materials, the horizontal position of said elongated stationary chamber defining an upper and a lower side, and

a rotatable screw conveyor extending through said primary gasifier chamber's interior from proximate said first end to proximate said second end for moving said gasifiable materials therethrough, said screw conveyor comprising an axial member having two ends with a plurality of spiral flights forming a continuous helix around said axial member.

3. The gasifier system of claim **1**, further comprising a boiler whereby said flue gas discharge stream is used to produce steam, which steam is used for the steam treatment of said char in the secondary gasifier chamber.

4. The gasifier system of claim **2**, further comprising a boiler whereby said flue gas discharge stream is used to produce steam, which steam is used for the steam treatment of said char in the secondary gasifier chamber.

5. The gasifier system of claim **1**, further comprising a boiler whereby said flue gas discharge stream is used to produce steam, which steam is used to power a compressor producing oxidizing gas for use in the secondary gasifier chamber.

6. The gasifier system of claim **2**, further comprising a boiler whereby said flue gas discharge stream is used to produce steam, which steam is used to power a compressor producing oxidizing gas for use in the secondary gasifier chamber.

7. The gasifier system of claim **3**, further comprising a boiler whereby said flue gas discharge stream is used to produce steam, which steam is used to power a compressor producing oxidizing gas for use in the secondary gasifier chamber.

8. The gasifier system of claim **1**, wherein said char is conveyed from the primary gasifier to the secondary gasifier via a sealed char conveyor.

9. The gasifier system of claim **2**, wherein said char is conveyed from the primary gasifier to the secondary gasifier via a sealed char conveyor.

10. The gasifier system of claim **3**, wherein said char is conveyed from the primary gasifier to the secondary gasifier via a sealed char conveyor.

11. The gasifier system of claim **4**, wherein said char is conveyed from the primary gasifier to the secondary gasifier via a sealed char conveyor.

12. The gasifier system of claim **5**, wherein said char is conveyed from the primary gasifier to the secondary gasifier via a sealed char conveyor.

13. The gasifier system of claim **6**, wherein said char is conveyed from the primary gasifier to the secondary gasifier via a sealed char conveyor.

14. The gasifier system of claim **7**, wherein said char is conveyed from the primary gasifier to the secondary gasifier via a sealed char conveyor.

15. The gasifier system of claim **7**, further comprising a steam control system controlling the distribution of steam for treatment purposes and to power said compressor.

16. The gasifier system of claim **14**, further comprising a steam control system controlling the distribution of steam for treatment purposes and to power said compressor.

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