second, narrower portion, and being suitable to receive a biochar carbon catalyst bed; wherein the upper plenum section has at least one or more gas exit ports; wherein a gas inlet system is disposed around said lower double bed section to provide oxidizing gas agent generated by an oxygen absorber system (such as a low cost oxygen (LCO) absorber system) into said lower double bed section through one or more intake ports in said lower section; and a plurality of inlets or tuyeres where plasma arc torches are mounted in said lower section to enhance the heat of oxidation generated from the said biochar carbon catalyst bed and said biogenic hydrocarbon waste material to create an operating temperature of 3000 to 5000 degrees Celsius. The integrated oxygen absorber system is designed to provide oxidizing agents in the form of atmospheric pressured oxygen enriched air, oxygen or steam to generate an autothermal exothermic oxidation of the biogenic hydrocarbon waste materials, introduced into the reactor.

[0018a] In one aspect, the present disclosure provides an apparatus for one stage plasma-enhanced gasification of biogenic hydrocarbon waste material comprising: (a) a geometrically designed shaped reactor having an upper plenum section and a lower double bed section, said lower double bed section comprising a first, wider portion connected by a frustoconical transition to a second, narrower portion, and being suitable to receive a proprietary biochar carbon catalyst bed; (b) said upper plenum section having at least one gas exit port; (c) a plurality of inlets for said biogenic hydrocarbon waste material from a plurality of directions located at the upper part of said lower double bed section for introducing said material into said upper portion of said lower double bed section; (d) a gas inlet system disposed around said lower double bed section to provide oxidizing gas agent generated by an integrated oxygen absorber system into said lower double bed section through one or more intake ports in said lower double bed section; and (e) a plurality of inlets or tuyeres where plasma arc torches are mounted in said lower double bed section to enhance the heat of oxidation generated from the biochar carbon catalyst bed and said biogenic hydrocarbon waste material to create an operating temperature of 3000 to 5000 degrees Celsius; wherein the integrated oxygen absorber system provides oxidizing agents in the form of atmospheric pressured oxygen enriched air, oxygen or steam to generate an autothermal exothermic oxidation of the biogenic hydrocarbon waste materials.

[0019] In previous examples of the gasifier system as described in U.S. Pat. No. 6,987,792, oxygen was provided by a secondary source, such as an over the fence supplier, at very high costs. In certain previous examples, oxygen was provided by a dedicated air-separation unit using cryogenic technology, a methodology which again was significantly costly resulting

in high energy consumption. In general, because the step of supplying oxygen was separate from the overall process, the additional steps required in sourcing the oxygen, introducing it into the system, monitoring and managing the operational aspects of this process, resulted in inefficiencies as well as elevated costs. In an effort to eliminate the aforementioned deficiencies, and in an effort to create streamlined, cost-effective and operationally superior systems and processes, the novel disclosure as described herein provides the unique feature which comprises the integration of an oxygen absorption mechanism into the gasifier.

[0020] The step of introducing oxygen from a separate source/location into the plasma gasification system is one that was described in previous patents and publications and routinely implemented in analogous devices. However, no prior art references, or systems disclosed or suggested the feature of actually integrating an oxygen absorption system directly into the gasifier. The concept of integrating an oxygen absorption system was neither envisioned nor reduced to practice until the creation of the disclosure as discussed herein. As such the features described herein are both novel and unobvious.

[0021] As described above, significant advantages are achieved by integrating an oxygen absorption system into the described plasma-based gasifier. First the integrated feature allows for oxygen to be produced at low pressure, requires minimal manual or

[0026a] In another aspect, the present disclosure provides a method for the conversion of organic material by one stage atmospheric plasma enhanced gasification, said method comprising the use of the apparatus and: providing a catalyst bed primarily composed of a biochar material comprising dense solid carbon and ash in a lower double bed section of a reactor; providing one or more successive quantities of said biogenic hydrocarbon waste material from a plurality of directions into an upper part of a lower double bed section of a reactor, said upper plenum section having at least one gas exit port connected to an induction fan, said material forming a bed atop said biochar carbon catalyst bed; providing enhanced heating of said biochar carbon catalyst bed and said biogenic hydrocarbon waste material bed using a plurality of plasma arc torches mounted in said lower double bed section; and introducing into said lower double bed section a gaseous oxidant generated from the integrated oxygen absorber system at atmospheric pressure.

CLAIMS

1. An apparatus for one stage plasma-enhanced gasification of biogenic hydrocarbon waste material comprising:

(a) a geometrically designed shaped reactor having an upper plenum section and a lower double bed section, said lower double bed section comprising a first, wider portion connected by a frustoconical transition to a second, narrower portion, and being suitable to receive a proprietary biochar carbon catalyst bed;

(b) said upper plenum section having at least one gas exit port;

(c) a plurality of inlets for said biogenic hydrocarbon waste material from a plurality of directions located at the upper part of said lower double bed section for introducing said material into said upper portion of said lower double bed section;

(d) a gas inlet system disposed around said lower double bed section to provide oxidizing gas agent generated by an integrated oxygen absorber system into said lower double bed section through one or more intake ports in said lower double bed section;

(e) a plurality of inlets or tuyeres where plasma arc torches are mounted in said lower double bed section to enhance the heat of oxidation generated from the biochar carbon catalyst bed and said biogenic hydrocarbon waste material to create an operating temperature of 3000 to 5000 degrees Celsius;

wherein the integrated oxygen absorber system provides oxidizing agents in the form of atmospheric pressured oxygen enriched air, oxygen or steam to generate an autothermal exothermic oxidation of the biogenic hydrocarbon waste materials.

2. An apparatus according to claim 1, further comprising: a material delivery system to provide said material to said reactor through said plurality of intake ports, said delivery system comprising: a receptacle to receive said material, a shredding and compacting unit disposed to accept said material from said receptacle and to shred and compact said material, and a transfer unit to deliver said shredded and compacted material to said reactor.

3. An apparatus according to claim 2 wherein said material comprises biomass material and biogenic hydrocarbon waste materials.

4. An apparatus according to claim 3 wherein said biomass and biogenic hydrocarbon waste material comprises the non-fossilized and biodegradable organic material originating from products, by-products and residues of plants, municipal solid waste, agriculture waste, and forestry waste.

5. An apparatus according to claim 1, wherein said biochar catalyst bed is 0.5-10 meters, 1-5 meters or 1 meter in height.

6. An apparatus according to claim 2, further comprising a plurality of sensors disposed throughout said reactor to sense one or more of: a height of said biochar catalyst bed, a height of a bed of said material, a temperature of said reactor, a flow rate of gas in said reactor, and a temperature of a gas exhausted from said reactor through said exhaust port.

7. An apparatus according to claim 1, wherein said lower double bed section has one or more tap holes at a bottom thereof in order to tap the molten lava created by the inert materials inside the feedstocks mixed with flux materials containing silica and calcium oxide.

8. A method for the conversion of organic material by one stage atmospheric plasma enhanced gasification, said method comprising the use of the apparatus of Claim 1 and:

providing a catalyst bed primarily composed of a biochar material comprising dense solid carbon and ash in a lower double bed section of a reactor;

providing one or more successive quantities of said biogenic hydrocarbon waste material from a plurality of directions into an upper part of a lower double bed section of a reactor, said upper plenum section having at least one gas exit port connected to an induction fan, said material forming a bed atop said biochar carbon catalyst bed;

providing enhanced heating of said biochar carbon catalyst bed and said biogenic hydrocarbon waste material bed using a plurality of plasma arc torches mounted in said lower double bed section;

and introducing into said lower double bed section a gaseous oxidant generated from the integrated oxygen absorber system at atmospheric pressure.

9. The method according to claim 8 wherein said catalyst bed comprises biochar carbon materials with density and porosity characteristics.

10. The method according to claim 8, wherein said gaseous oxidant generated by the integrated oxygen absorber system comprises oxygen-enriched air or oxygen or steam.

11. The method according to claim 10, wherein said oxygen-enriched air comprises at least 80% (v/v) of oxygen.

12. The method according to claim 10, wherein said oxygen-enriched air comprises at least 95% (v/v) of oxygen.

13. The method according to claim 8, wherein the temperature in the biochar carbon catalyst bed in the lower double bed section is greater than 3000°C.