CLAIMS

What is claimed is:

1. A plasma gasifier comprising:

a refractory-lined reactor vessel including, ~~during operation,~~ a bottom section ~~containing~~ configured to contain a carbonaceous bed, a middle section configured to contain ~~containing~~ a bed of deposited feed material, and a top section including a freeboard region in a lower part of the top section and a quench zone in an upper part of the top section; and

a roof over the quench zone;

wherein the top section ~~is further characterized by including~~ further includes one or more syngas outlets configured to be connected with external ductwork and, ~~an arrangement of~~

a plurality of quench fluid inlets ~~for injecting fluid~~ located in the roof adjacent to the syngas outlet and configured to inject a mix of steam and water into the quench zone.

2. The apparatus of claim 1 wherein:

the one or more syngas outlets are located in the roof.

~~3. The apparatus of claim 2 wherein:~~

~~the plurality of quench fluid inlets are located in the roof.~~

~~4.~~3. The apparatus of claim 1 wherein:

the plurality of quench fluid inlets are substantially symmetrically arranged proximate the one or more syngas outlets.

~~5.~~4. The apparatus of claim ~~4~~ 3 wherein:

the plurality of quench fluid inlets are each connected with an external supply of fluid including water, steam, or a mix of water and steam (or other fluid or fluids).

~~6.~~5. The apparatus of claim 1 wherein:

the middle section has an overall configuration of a truncated inverse cone that is wider adjacent the top section than adjacent the bottom section.

~~7.~~6. The apparatus of claim ~~6~~ 5 wherein:

the top section has an overall configuration that includes a conical part starting adjacent the middle section that has an overall configuration of a truncated cone that is wider at ~~the~~ a higher end of that ~~first~~ conical part than adjacent the middle section.

~~8.~~7. The apparatus of claim ~~7~~ 6 wherein:

the middle section cone has a larger wall angle relative to the center line of the vessel than the wall angle of the conical part of the top section.

~~9.~~8. The apparatus of claim ~~7~~ 6 wherein:

the quench zone of the top section is located in a cylindrical part between the conical part thereof and the roof.

~~10. The apparatus of claim 1 wherein:~~

~~the plurality of quench fluid inlets are each connected with an external supply of fluid including water, steam, or a mix of water and steam, and/or other fluids, that is let into the~~

~~quench zone in an amount to substantially minimize molten particles passing through the syngas outlets and being deposited within the external ductwork.~~

~~11.~~9. The apparatus of claim ~~10~~ 1 wherein:

the quench zone of the top section is contained within a cylindrical configuration that extends up from a conical part of the top section that is below the quench zone.

~~12.~~10. The apparatus of claim 1 wherein:

the middle section of the vessel has one or more feed ports extending through a lateral wall thereof.

~~13.~~11. The apparatus of claim ~~12~~ 10 wherein:

the one or more feed ports include a plurality of feed ports that extend through a lateral conical wall of the middle section and are arranged at substantially symmetrical locations around the lateral conical wall.

~~14.~~12. The apparatus of claim ~~12~~ 10 wherein:

the one ~~ore~~ or more feed ports include at least one feed port oriented at an angle up from a horizontal plane above the bed of deposited feed material.

~~15.~~13. The apparatus of claim ~~12~~ 10 wherein:

the one or more feed ports include at least one feed port located below the bed of deposited feed material's upper surface.

~~16. The apparatus of claim 12 wherein:~~

~~each of the feed ports is arranged to receive feed material in either a substantially continuous and uniform manner or in varying batch amounts~~

~~17.~~14. The apparatus of claim ~~12~~ 10 wherein:

~~the~~ at least one of the feed ports ~~include at least one~~includes a feed port arranged in combination with a feeding mechanism selected from the group consisting of a ram type feeder, a flap valve system, a lock hopper system, a discrete feeder, and a screw feeder.

~~18.~~15. The apparatus of claim 1 wherein:

the reactor vessel bottom section additionally has one or more plasma torches directed through a lateral wall into the carbonaceous bed and also has a tap hole for molten metal and slag; and

the reactor vessel is further provided with any one or more additional inlets including:

a carbon bed tuyere for gas injection in the bottom section;

a lower start-up burner port into the bottom section;

an upper start-up burner port into the top section;

one or more lower feed bed tuyeres in a lower region of the middle section adjacent the bed of feed material;

one or more upper feed bed tuyeres in an upper region of the middle section adjacent the bed of feed material; and

a gas space tuyere into the middle section above the feed bed, for use for temperature control by introduction of oxygen and/or air to cause an elevation of gas temperature to greater than 1000°C.

~~19.~~16. A process for gasification of solid feed material to produce a syngas comprising the steps of:

providing a plasma heated carbonaceous bed in a bottom section of a reactor vessel;

feeding feed material into a middle section of the reactor vessel to form a bed of deposited feed material on top of the carbonaceous bed in the bottom section;

reacting the feed material with hot gases rising from the bottom section;

forming, in the middle section, a syngas mixture containing a varying quantity of unreacted particles of the feed material;

allowing the syngas mixture to rise into a top section of the reactor vessel toward one or more syngas outlets at the top of the top section;

~~maintaining conditions in the vessel such that unreacted particles from the middle section are subjected to further reactions in a first, lower, part of the top section; and~~

at least partially quenching, by injecting water, steam , or a mixture thereof, through quench fluid inlets in a roof of the reactor vessel, in a second, upper part of the top section, at least some molten fragments among the unreacted particles of the syngas mixture so they are made sufficiently solid not to be subject to stick to walls of exterior ductwork from the syngas outlets .

~~20.~~17. The process of claim ~~19~~16 wherein:

the feeding of feed material into the middle section of the reactor vessel includes supplying feed material from one or more external feed sources through one or more feed ports of a lateral wall of the middle section of the vessel, said feed ports being located no higher than above, and proximate to, the upper surface of the bed of deposited feed material; and

the supplying of feed material through the lateral wall feed ports of the middle section and maintaining other conditions with the reactor vessel are performed in a manner to enhance reactivity of particulate matter within the feed material by proximity to the feed bed and prolonging residence time of unreacted particulate matter, promoting additional reactions thereof, before the syngas mixture reaches the outlets.

~~21.~~18. The process of claim ~~20~~ 17 wherein:

the feeding of feed material is performed a substantially continuous and uniform manner.

~~22.~~19. The process of claim ~~19~~ 16 further comprising:

replacing reacted carbonaceous material of the bottom section with additional carbonaceous material supplied through the one or more feed ports of the lateral wall of the middle section.

~~23.~~20. The process of claim ~~20~~ 17 wherein:

the feeding of feed material includes use of one or more feed ports located immediately above the bed of deposited feed material and angled upwardly to avoid excess heating by the bed reactions of feed material in the feed ports.

~~24.~~21. The process of claim ~~20~~ 17 wherein:

the feeding of feed material includes use of one or more feed ports located to feed material directly laterally into the bed of deposited feed material with substantial reaction of the feed material from said feed ports within the bed itself.

22. The apparatus of claim 1 wherein the fluid comprises:

steam and atomized water.

~~25. A plasma gasifier comprising:~~

~~a bottom section with a carbonaceous bed and one or more plasma torch inlets;~~

~~a middle section with one or more lateral feed ports for supplying feed material to form a feed bed atop the carbonaceous bed of the bottom section, said feed ports being oriented at an upward angle and located above and proximate to the feed bed upper surface.~~

26. A plasma gasifier comprising:

a bottom section with a carbonaceous bed and one or more plasma torch inlets;

a middle section with one or more lateral feed ports for supplying feed material to form a feed bed atop the carbonaceous bed of the bottom section, said feed ports including one or more feed ports located at a level below the feed bed upper surface.

27. The apparatus of claim 26 further comprising:

a cooling arrangement at each feed port at a level below the feed bed upper surface to avoid heating of feed material within the feed port to a condition blocking the feed port.

28. The apparatus of claim 26 further comprising:

a feeding mechanism at each feed port to force feed material into the feed bed.