SUMMARY

[0010] This summary briefly characterizes some embodiments of the present disclosure. Statements made are intended to be generally informative as to examples of the present disclosure although not as definitive as the appended claims.

In ~~a first~~ one aspect, there is provided plasma gasification or vitrification reactor apparatus comprising: a reactor vessel containing a carbonaceous bed and having one or more plasma torches for establishing ~~an elevated~~ temperature of at least about 1000°C within the bed; and the reactor vessel also having one or more feed material inlets above the bed for depositing process material from outside the vessel onto the bed, one or more gas exhaust ports above the bed for exit of gaseous products from the vessel, and one or more slag ports at the bottom of the bed for exit of molten slag and metals from the vessel; ~~and,~~wherein the carbonaceous bed comprises ~~a mass of particles that contain carbon and are~~ bricks of varied size in a range of from about 5 cm to about 25 cm, and shape leaving voids between the bricks ~~particles~~ and with strength of the bricks ~~particles~~ being sufficient to maintain voids between particles under pressure of process material on the bed, wherein the bricks include carbon-containing fines and at least one of: Portland cement, potassium silicate cement, or aluminum silicate cement, with ~~and the mass of particles containing carbon has~~ at least 25% by weight of ~~its~~ the carbon-containing fines being ~~content in particles~~ other than coke ~~selected from the group consisting of wood blocks of natural wood, bricks comprising carbon-containing fines and one or more binders, and mixtures thereof~~.

~~In the second aspect, there is provided a process for forming and maintaining a carbonaceous bed with coke replacement units suitable for use in pyrolytic processes comprising the steps of: forming a plurality of non-coke units that are either or both irregularly shaped natural wood blocks and bricks comprising carbon-containing fines and one or more binders; forming an initial carbonaceous bed by a quantity of particles of coke in which at least about 25% of the carbon content of the initial bed is provided by said quantity of non-coke units and up to about 75% of the carbon content of the initial bed is provided by said quantity of particles of coke; performing a pyrolytic process with the carbonaceous bed including reacting carbon in the bed with other added process material at an elevated temperature in the bed and supplementing carbon material during the pyrolytic process by adding additional carbon material of which at least 25% of the additional carbon material is not coke.~~

In a third aspect, there is provided gasification and vitrification reactor apparatus comprising: a reactor vessel containing a carbonaceous bed and having means for establishing an elevated temperature within the bed; the reactor vessel also having one or more feed material inlets above the bed for depositing process material from outside the vessel onto the bed, one or more gas exhaust ports above the bed for exit of gaseous products from the vessel, and one or more slag ports at the bottom of the bed for exit of molten and vitreous material from the vessel; the carbonaceous bed comprises a mass of particles that contain carbon and are of varied size and shape of which at least 25% of the total carbon content of the bed is in particles selected form the group consisting of wood blocks of natural wood, bricks comprising carbon-containing fines and one or more binders, spent potliner material from aluminum processing, soot water residue from a gasification reactor, and mixtures thereof.

In a fourth aspect, there is provided a starting material for forming a carbonaceous article for use among particles of a carbonaceous bed of a thermal reactor and comprising: a composition including, in approximate weight % other than water, carbon containing particles, 40 to 95 parts, silica, 0 to 30 parts, calcium carbonate, 0 to 25 parts, fly ash 0 to 40 parts, Portland cement, 0 to 20 parts, potassium silicate cement, 0 to 20 parts, aluminum silicate cement, 0 to 20 parts, kaolin clay, 0 to 20 parts, sodium bentonite, 0 to 20 parts, calcium bentonite, 0 to 20 parts, potassium bentonite, 0 to 20 parts, sodium silicate, 0 to 20 parts aluminum hydroxide, 0 to 10 parts, nickel, 0 to 5 parts, and iron, 0 to 5 parts.

In a fifth aspect, there is provided a process for producing, with the material as defined above, units of carbonaceous material for use in a carbonaceous bed of a thermal reactor comprising the steps of: mixing the material with an amount of water to form a moldable mixture; pouring the moldable mixture into the molds of a predetermined size and shape for use in a carbonaceous bed; and allowing the moldable mixture, in the molds, to set and air dry or applying either or both heat and pressure.

[0011] The present disclosure provides, in various forms and by various processes, reactors and carbonaceous beds that require less coke than has been generally the case in the past. The carbon required can be obtained, at least in part, by carbon bearing alternatives to coke. Examples include beds that have at least about 25% (it can be significantly greater up to 100%) of the carbon content of the bed made of non-coke units that may be either, or both, wood blocks of natural wood or bricks comprising carbon-containing particles or fines and one or more binders and possibly a catalyst. Any such materials may be applied in a bed also including coke (although coke may be replaced completely in some applications). Carbon of the bed may additionally include, if desired, for example, if included in feed material to the carbonaceous bed, other non-coke materials such as raw coal (anthracite or bituminous), charcoal, or process materials including biomass (any carbon bearing materials).

[0012] Some embodiments of the present disclosure take advantage of, and make use of, carbon material resulting as waste from any of a variety of other processes (e.g., carryover from any gasification reactor, fly ash from coal fired boilers, as well as others) which contribute to lessening requirements for coke in the bed. For one thing, they may be advantageously used as particles or fines in making the above-mentioned bricks. Such waste carbon materials may also be included in the feed stock to the reactor without being formed into bricks.

[0013] In connection with the use of extraneous waste carbon materials referred to herein it is immaterial whether those carbon atoms were ever previously in any form of coke. Therefore, the examples of the beds including non-coke units such as wood blocks and bricks with carbon material generally intend that the carbon bed have such non-coke units in a range of about 25% to 100% and about zero to 75% coke (referring to quantities of carbon atoms in

CLAIMS

What is claimed is:

1. Plasma gasification or vitrification reactor apparatus comprising:

a reactor vessel containing a carbonaceous bed and having one or more plasma torches for establishing ~~an elevated~~ temperature of at least about 1000°C within the bed; and

the reactor vessel also having one or more feed material inlets above the bed for depositing process material from outside the vessel onto the bed, one or more gas exhaust ports above the bed for exit of gaseous products from the vessel, and one or more slag ports at the bottom of the bed for exit of molten slag and metals from the vessel; ~~and,~~

wherein the carbonaceous bed comprises ~~a mass of particles that contain carbon and are~~ bricks of varied size in a range of from about 5 cm to about 25 cm, and shape leaving voids between the bricks ~~particles~~ and with strength of the bricks ~~particles~~ being sufficient to maintain voids between particles under pressure of process material on the bed, ~~and the mass of particles containing carbon~~ wherein the bricks include carbon-containing fines and at least one of: Portland cement, potassium silicate cement, or aluminum silicate cement, with ~~has~~ at least 25% by weight of ~~its~~the ~~carbon content in particles~~ carbon-containing fines being other than coke ~~selected from the group consisting of wood blocks of natural wood, bricks comprising carbon-containing fines and one or more binders, and mixtures thereof~~.

2. The apparatus of claim 1 wherein:

the bricks include a flux~~particles of the carbonaceous bed that are not coke include a quantity of carbon-containing substance added to the process material from the feed material inlets above the bed or injected into the carbonaceous bed~~.

3. The apparatus of claim 2 wherein:

the flux comprises calcium~~carbon-containing substance added to the bed includes carbon fines~~.

4. The apparatus of claim 1 wherein:

the ~~bed particles other than coke comprise~~ bricks ~~of~~ include carbon-containing fines of at least about 50% by weight carbon and one or more binders.

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

~~the bed particles other than coke that contain carbon include bricks comprising quantities of carbon fines and Portland cement.~~

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

the bricks additionally comprise quantities of one or more of bentonite clay, sand, sodium silicate, fly ash, aluminum hydroxide, and one or more catalysts.

~~7.~~6. The apparatus of claim 1 wherein:

the ~~bed particles other than coke that contain carbon include bricks comprising quantities of carbon fines and one or more binders and the carbon fines in the bricks are~~ carbon-containing fines include carbon containing bits of material that have average cross-sectional dimensions of about one micron to one cm.

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

the carbon-containing~~carbon~~ fines are products of a prior gasification or combustion process and have in total weight % of carbon of at least about 50%.

~~9.~~8. The apparatus of claim 1 wherein:

the reactor vessel includes a first portion containing the carbonaceous bed and a second portion above the first portion up to the gas exhaust ports that has over at least 80% of its entire height a conical side wall configuration that expands the enclosed volume from the bottom to the top of the second portion; and

the one or more feed material inlets include a plurality of said inlets which extend through the side wall of the reactor vessel above the carbonaceous bed.

~~10.~~ 9. The apparatus of claim ~~9~~ 8 wherein:

the one or more feed material inlets are located through the side wall of the reactor vessel at a level no more than about halfway up from the very bottom of the reactor vessel and no more than about 1 m. above the top surface of process material deposited on the carbonaceous bed.

11. A process for forming and maintaining a carbonaceous bed with coke replacement units suitable for use in pyrolytic processes comprising the steps of:

forming a plurality of non-coke units that are either or both irregularly shaped natural wood blocks and bricks comprising carbon-containing fines and one or more binders;

forming an initial carbonaceous bed by a quantity of particles of coke in which at least about 25% of the carbon content of the initial bed is provided by said quantity of non-coke units and up to about 75% of the carbon content of the initial bed is provided by said quantity of particles of coke;

performing a pyrolytic process with the carbonaceous bed including reacting carbon in the bed with other added process material at an elevated temperature in the bed and supplementing carbon material during the pyrolytic process by adding additional carbon material of which at least 25% of the additional carbon material is not coke.

12. The process of claim 11 wherein:

the forming of the plurality of the non-coke units is followed by said placing in a reactor vessel without drying or charring of the units before said placing in a reactor vessel.

13. The process of claim 11 wherein:

the forming of the plurality of the non-coke units is followed by either or both of some drying and charring of the surface of at least some of the units prior to said placing in a reactor vessel.

14. The process of claim 11 wherein:

the performing of the pyrolytic process is carried out in a thermal reactor in which the elevated temperature in the bed is produced by injecting a plasma heated gas into the bed or the bed is initially activated to produce the elevated temperature by ignition of a fuel; and,

the supplementing of carbon material during the performing of the pyrolytic process includes adding carbon material along with or interspersed with added process material on top of the initial bed.

15. The process of claim 14 wherein:

the forming of the initial bed includes at least about 50% of the carbon content of the initial bed being of non-coke units and up to about 50% of the carbon content of the initial bed provided by said quantity of coke;

the initial bed is formed and maintained at a depth of up to about 2 m in the reactor vessel; and,

the process material added to the bed includes at least about 50% by weight of biomass material.

16. The process of claim 11 wherein:

the forming of a plurality of non-coke units includes forming bricks comprising carbon-containing fines and Portland cement.

17. The process of claim 16 wherein:

the forming of the bricks further comprises the addition of one or more of bentonite clay, sand, sodium silicate, fly ash, aluminum hydroxide and one or more catalysts, to the mixture of carbon containing fines and Portland cement.

18. The process of claim 16 wherein:

the forming of the bricks includes recovering and mixing with the Portland cement a quantity of carbon fines that are a non-reacted byproduct of a pyrolytic process using carbon either in the presence of or the absence of a plasma.

19. The process of claim 16 wherein:

the forming of the bricks includes recovering and mixing with the Portland cement a quantity of carbon fines that are a non-reacted byproduct of a combustion process using carbon.

20. The process of claim 14 wherein:

the supplementing of carbon material further includes the injecting of carbon-containing fines into the bed.

~~21.~~10. ~~Gasification and vitrification reactor~~The apparatus of claim 1 wherein the carbon-containing fines comprise~~comprising~~:

~~a reactor vessel containing a carbonaceous bed and having means for establishing an elevated temperature within the bed;~~

~~the reactor vessel also having one or more feed material inlets above the bed for depositing process material from outside the vessel onto the bed, one or more gas exhaust ports above the bed for exit of gaseous products from the vessel, and one or more slag ports at the bottom of the bed for exit of molten and vitreous material from the vessel;~~

~~the carbonaceous bed comprises a mass of particles that contain carbon and are of varied size and shape of which at least 25% of the total carbon content of the bed is in particles selected form the group consisting of~~

~~wood blocks of natural wood,~~

~~bricks comprising carbon-containing fines and one or more binders,~~

spent potliner material from aluminum processing, or

soot water residue from a gasification reactor,

~~and~~ or mixtures thereof.

~~22. The apparatus of claim 21 wherein:~~

~~the one or more feed material inlets are located through the side wall of the reactor vessel at a level no more than about halfway up from the very bottom of the reactor vessel and no more that about 1 m. above the top surface of process material deposited on the carbonaceous bed.~~

~~23. The apparatus of claim 21 further comprising:~~

~~additional inlets through the side wall of the reactor vessel for injection of carbon fines into the carbonaceous bed.~~

~~24. The apparatus of claim 21 wherein:~~

either or both part of the process material supplied through the feed material inlets above the carbonaceous bed and the carbon fines supplied through the additional inlets includes additional non-coke carbon material.

25. The apparatus of claim 22 wherein:

the additional non-coke carbon material comprises carbon fines that are a non-reacted product of processing carbonaceous material.

26. The apparatus of claim 23 wherein:

the non-coke material comprises material selected from the group of coal, ash, soot particulates and mixtures thereof.

27. The apparatus of claim 21 wherein:

the additional inlets include at least one inlet that is arranged to receive carbon fines from an arrangement that includes an eductor receiving a carrier gas of solids at a first pressure and a pressurized gas at the second, higher, pressure injecting solids from the first gas into the carbonaceous bed.

28. The apparatus of claim 21 further comprising:

a grid across the reactor vessel below the feed material inlets and above the carbonaceous bed, the grid having solid members that contribute to support deposited process material above the carbonaceous bed and also having openings between the solid members that allow gas flow upward from the carbonaceous bed and flow of molten and vitreous material downward to the carbonaceous bed.

29. A starting material for forming a carbonaceous article for use among particles of a carbonaceous bed of a thermal reactor and comprising:

a composition including, in approximate weight % other than water,

carbon containing particles, 40 to 95 parts,

silica, 0 to 30 parts,

calcium carbonate, 0 to 25 parts,

fly ash 0 to 40 parts,

Portland cement, 0 to 20 parts,

potassium silicate cement, 0 to 20 parts,

aluminum silicate cement, 0 to 20 parts,

kaolin clay, 0 to 20 parts,

sodium bentonite, 0 to 20 parts,

calcium bentonite, 0 to 20 parts,

potassium bentonite, 0 to 20 parts,

sodium silicate, 0 to 20 parts

aluminum hydroxide, 0 to 10 parts,

nickel, 0 to 5 parts, and

iron, 0 to 5 parts.

30. A process for producing, with the material of claim 29, units of carbonaceous material for use in a carbonaceous bed of a thermal reactor comprising the steps of:

mixing the material with an amount of water to form a moldable mixture;

pouring the moldable mixture into the molds of a predetermined size and shape for use in a carbonaceous bed; and

allowing the moldable mixture, in the molds, to set and air dry or applying either or both heat and pressure.

31. The process of claim 30 further including formation of a carbonaceous bed by including the steps of:

removing the molded units from the molds, which are shaped to provide the units with average dimensions of about 10 cm. to 25 cm. across,

introducing a quantity of the molded units into a thermal reactor to form a carbonaceous bed in which at least about 25% of the bed carbon content is carbon of the molded units.