SUMMARY

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

In a first 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 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 slag and metals from the vessel; and, the carbonaceous bed comprises a mass of particles that contain carbon and are of varied size and shape leaving voids between particles and with strength of the particles being sufficient to maintain voids between particles under pressure of process material on the bed, and the mass of particles containing carbon has at least 25% of its carbon 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 ~~invention~~ 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 ~~invention~~ 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

produce the desired slag chemistry can be added instead to the brick formula along with the carbon source. For example, one or more binders in the bricks can be selected to satisfy the requirements of those additives where cement type binders will typically provide calcium for fluxing properties while silicate binders will serve as modifiers to the slag chemistry.

[0018] In metal melting applications, where the slag chemistry is an integral part of the final metal chemistry, the brick formulation can be engineered to incorporate slag making ingredients, resulting in less need for a separate feed of those ingredients and to provide more intimate contact of those materials with the carbon reductant.

[0019] In addition to the foregoing, the present ~~invention~~ disclosure includes, either in addition to or independent of the use of the mentioned non-coke units, various other ways of constructing or operating a reactor that can contribute to a lessening of the amount of coke required for the carbon bed (as well as consuming some otherwise waste materials). These include any of the following:

[0020] --Using spent potliner material from the aluminum industry. The carbon liner of the potliner is very high in carbon content. It is joined with refractory material, such as a ceramic. Spent potliner material is a listed hazardous waste that is difficult or expensive to dispose of. By the present ~~invention~~disclosure, there are a number of ways to use the material in reactor carbon beds. The carbon can be applied as particles in the above mentioned bricks (as any other carbon containing material can) but potliner carbon material may also be used in particles or chunks that substitute for coke in the bed. The refractory part of the potliner (sometimes available from aluminum makers intermixed with the carbon liner, or separately) can be placed, in particles or chunks, either in the bricks or otherwise in the bed in addition to the carbon and be a beneficial slag additive (when used in a quantity that meets composition requirements for the reactions occurring in the bed).

[0021] -- Providing a reactor with a charge bed (or feed bed) support that is also a gas distributor and a slag screen. This support grid can be disposed horizontally across the

gasify feed materials that are uncompacted and in pieces that are diverse in size and weight. (For example, shredded biomass or municipal waste including paper products.) A higher percentage of the light weight feed material pieces can be reacted by hot gases rising up from the charge bed where the feed chutes are close to (or under) the charge bed surface to a greater extent than in prior practice in which feed chutes have been located well above the charge bed in an upper section of the reactor and where more of the lighter pieces of feed material did not descend enough to reach sufficiently hot gases for reaction. A large percentage of the lighter pieces may exit the reactor with the exhaust gas in that case. In the new arrangement, any light feed materials that do not descend directly onto the charge bed are more certain to float immediately above the charge bed and reach a high temperature from gases rising from the nearby charge bed so they are gasified. This contributes to the top gas, or syngas, production of the reactor and permits lower demands on the carbon bed, as long as the carbon bed temperature would still be sufficient to maintain molten slag flow. This arrangement can be applied, for example, and without limitation, where the reactor also has, at about the same elevation as the charge bed surface and the feed chutes, one or more gas inlets for oxygen (air) that takes part in reactions of the floating feed material and is regulated to assist in forming carbon monoxide from that feed material.

[0024] The carbon beds described in the foregoing examples are generally applicable to gasification (or vitrification) reactors with a fixed or stationary bed but are not necessarily limited thereto as they may also be applied to fluidized beds. In addition, the carbonaceous beds of other thermal reactors besides PGRs may be similarly modified to reduce coke requirements.

[0025] The foregoing is only to briefly describe some ~~aspects~~ embodiments of some examples of the ~~invention~~present disclosure.