SUMMARY

[0006] The present application presents innovations for improved performance in enabling one or both of (1) more thorough gasification of particulate feed material and (2) minimization of the occurrence of unreacted molten particles of feed material exiting a reactor vessel along with syngas and being deposited on an inner wall of external ductwork from a vessel outlet.

[0007] In part, the present disclosure~~invention~~ resides in providing a plasma gasifier, and a process for operating a plasma gasifier, for purposes such as waste conversion to syngas, by including one or both of the following techniques. While it is generally the case that PGRs can take advantage of the following techniques individually, there can be preference for their use in combination.

Particularly when used in combination, opportunities for greater output of syngas with good qualities from a wider variety of feed material compositions can be enhanced.

[0008] One technique is to provide an arrangement of quench fluid inlets in an upper part (such as the roof) of a top section of the reactor vessel and injecting a fluid such as, but not limited to, water, steam, or a mix of water and steam, to cool soft or molten bits of unreacted feed material sufficiently to minimize the number of them exiting the reactor vessel that are likely to be deposited on the inside of external ductwork. The arrangement of quench fluid inlets (sometimes referred to herein as a quench system (or partial quench system)) is best combined with a reactor vessel having an additional volume (referred as a quench zone) that allows for the volume of expanding fluids from the quench fluid inlets so as to minimize any adverse effects on flow of syngas from a freeboard region below the quench zone to syngas outlets. In prior practices the ductwork from syngas outlets has often been subject to a build up of deposited material and a quench system with good performance inside a duct is difficult to build.

[0011] Specific, but not the only , embodiments of the present disclosure~~inventions~~ herein may combine, in a reactor vessel having the above-mentioned conical characteristics, a bottom section (which may be cylindrical) with a carbonaceous bed (of coke or as presented in the companion application) and plasma nozzles, a middle section (conical) with a plurality (e.g., two or three) of lateral feed ports to feed process material onto or just above the carbonaceous bed with good distribution over the interior of the middle section, a top section above the middle section that has both a freeboard region (with a conical configuration that may be less angular than the middle section) and, above the freeboard region, a quench zone (that may have a cylindrical configuration) in which injected fluid at least partially quenches (i.e., hardens or makes less soft) solid bits of matter rising with gaseous reaction products from below to one or more outlet ports at or near the top of the quench zone.

[0011a] In an aspect, there is provided a plasma gasifier comprising: a refractory-lined reactor vessel including, a bottom section configured to contain a carbonaceous bed, a middle section configured to contain 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 further includes one or more syngas outlets configured to be connected with external ductwork and, a plurality of quench fluid inlets located in the roof adjacent to the syngas outlet and configured to inject a mix of steam and water into the quench zone.

[0011b] In another aspect, there is provided 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; 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.

[0012] The following description and drawing will help in understanding these innovations and their various embodiments and variations.

BRIEF DESCRIPTIONS OF THE DRAWINGS

[0013] Figs. 1 and 2 are, respectively, an elevation view and a top plan view of an example of a plasma gasifier;

[0014] Figs. 3 and 4 are pictorials of examples of product gas and quench fluid flows in a reactor; and

[0015] Figs. 5-8 are examples, in elevational cross-section, of gasifiers with feed ports below the top surface of a feed bed.

FURTHER DESCRIPTION OF EMBODIMENTS

[0016] Figs. 1 and 2 show one example of a plasma gasifier that has both a syngas quench system and feed ports introducing feed material into a middle section of the gasifier reactor vessel.