cause wear to the grinding chamber as the gas streams, carrying pulverized particles, impacts the grinding chamber.

(04) It is known that wear in the conventional jet mill is responsible for limiting the size of the conventional jet mill. As the size (e.g., length, width, and/or radius) of the conventional jet mill increases, the volume of the process material that could pass through the jet mill may increase roughly by a magnitude corresponding to a cube of the size increase, and the surface of the grinding chamber may increase roughly by a magnitude corresponding to a square of the size increase. For example, if the size of the conventional jet mill is doubled, the volume of the process material that could pass through the jet mill may increase as much as by eight times and the wearable surface may only increase as much as by four times. The amount of wear in the conventional jet mill may be proportional to the amount of the process material and thus takes on the level of exponential increase of the process material. Accordingly, the exponential increase of potential wear may be much faster than the increase of wearable surface of the grinding chamber when the size of the conventional jet mill increases. This geometric wear limitation may limit scaling-up of the conventional jet mill. A conventional jet mill typically has an upper size limit of approximately one meter or about forty-two inches.

SUMMARY

(05) The present disclosure relates to a reactor with a wear resistance design to reduce wear in the reactor in which materials are comminuted via tensive forces resulting from shockwaves induced within a chamber of the reactor. The reactor in accordance with the disclosure may be less constrained from being scaled up as compared to conventional air-flow pulverization devices such as a jet mill. The

reduce or control the wear caused by drag as the processed material travels in a long flight path before exiting. In some implementations, the shape of the chamber may be configured to have the continuously decreasing radius of the substantially circular cross-section is shaped as a cone, a hemisphere, or a horn-shape. This may advantageously limit the wear in the reactor in certain areas.

(13) These and other features and characteristics of the present technology, as well as the methods of operation and functions of the related elements of structure and the combination of parts and economies of manufacture, will become more apparent upon consideration of the following description and the appended claims with reference to the accompanying drawings, all of which form a part of this specification, wherein like reference numerals designate corresponding parts in the various figures. It is to be expressly understood, however, that the drawings are for the purpose of illustration and description only and are not intended as a definition of the limits of the invention. As used in the specification and in the claims, the singular form of "a", "an", and "the" include plural referents unless the context clearly dictates otherwise.

(13a) In one aspect of the present disclosure, there is provided a reactor configured to facilitate chemical reactions, and/or comminution therein using shockwaves created in a supersonic gaseous vortex, the reactor being further configured to resist wear caused by the chemical reactions, and/or comminution, the reactor comprising:

a rigid chamber having a substantially circular cross-section centered on a longitudinal axis that is normal to the cross-section;

a first gas inlet configured to introduce a high-velocity stream of gas into the chamber, the first gas inlet being disposed and arranged so as to effectuate a vortex of the stream of gas circulating within the chamber, the vortex rotating at a supersonic speed about the longitudinal axis of the chamber;

a material inlet configured to introduce a material to be processed into the chamber, the material inlet being disposed proximal to the first gas inlet, the material being processed within the chamber by nonabrasive mechanisms facilitated by shockwaves within the chamber;

an outlet configured to emit the gas and processed material from the chamber; and

a first replaceable wear part configured to protect an inner surface of the chamber, the first replaceable wear part corresponding to the first gas inlet such that the first replaceable wear part being disposed at a first portion of the inner surface of the chamber, wherein a first end of the first wear part is adapted to contact processed material particles at the first portion of the inner surface of the chamber;

wherein processing of the material within the chamber causes a wear impact to the first portion of the inner surface of the chamber due to the stream of gas introduced by the first gas inlet;

wherein the first wear part includes a cylindrical rod configured to rotate about a longitudinal axis of the cylindrical rod, the rod being disposed such that a first end of the rod forms a portion of or the entire first end of the wear part; and

wherein the first replaceable wear part is electronically isolated from the rest of the reactor.

(13b) In another aspect of the present disclosure, there is provided a reactor configured to facilitate chemical reactions, and/or comminution therein using shockwaves created in a supersonic gaseous vortex, the reactor being further configured to resist wear caused by the chemical reactions, and/or comminution, the reactor comprising:

a rigid chamber having a substantially circular cross-section centered on a longitudinal axis that is normal to the cross-section;

a first gas inlet configured to introduce a high-velocity stream of gas into the chamber, the first gas inlet being disposed and arranged so as to effectuate a vortex

of the stream of gas circulating within the chamber, the vortex rotating at a supersonic speed about the longitudinal axis of the chamber;

a material inlet configured to introduce a material to be processed into the chamber, the material inlet being disposed proximal to the first gas inlet, the material being processed within the chamber by nonabrasive mechanisms facilitated by shockwaves within the chamber;

an outlet configured to emit the gas and processed material from the chamber; and

a first replaceable wear part configured to protect an inner surface of the chamber, the first replaceable wear part corresponding to the first gas inlet such that the first replaceable wear part being disposed at a first portion of the inner surface of the chamber, wherein a first end of the first wear part is adapted to contact processed material particles at the first portion of the inner surface of the chamber;

wherein processing of the material within the chamber causes a wear impact to the first portion of the inner surface of the chamber due to the stream of gas introduced by the first gas inlet;

wherein the first replaceable wear part is further configured such that the first replaceable wear part is continuously fed into the chamber.

(13c) In a further aspect of the present disclosure, there is provided a reactor configured to facilitate chemical reactions, and/or comminution therein using shockwaves created in a supersonic gaseous vortex, the reactor being further configured to resist wear caused by the chemical reactions, and/or comminution, the reactor comprising:

a rigid chamber having a substantially circular cross-section centered on a longitudinal axis that is normal to the cross-section;

a first gas inlet configured to introduce a high-velocity stream of gas into the chamber, the first gas inlet being disposed and arranged so as to effectuate a vortex of the stream of gas circulating within the chamber, the vortex rotating at a supersonic speed about the longitudinal axis of the chamber;

a material inlet configured to introduce a material to be processed into the chamber, the material inlet being disposed proximal to the first gas inlet, the material being processed within the chamber by nonabrasive mechanisms facilitated by shockwaves within the chamber;

an outlet configured to emit the gas and processed material from the chamber; and

a first replaceable wear part configured to protect an inner surface of the chamber, the first replaceable wear part corresponding to the first gas inlet such that the first replaceable wear part being disposed at a first portion of the inner surface of the chamber, wherein a first end of the first wear part is adapted to contact processed material particles at the first portion of the inner surface of the chamber;

wherein processing of the material within the chamber causes a wear impact to the first portion of the inner surface of the chamber due to the stream of gas introduced by the first gas inlet;

wherein the first replaceable wear part is further configured such that another replaceable wear part can be coupled to a second end of the first replaceable wear part for continuous feed into the chamber, the second end being opposite of the first end of the first replaceable wear part.

BRIEF DESCRIPTION OF THE DRAWINGS

(14) FIG. 1 illustrates a top view of a reactor, in accordance with one or more implementations.

(15) FIG. 2 illustrates a side view of the reactor, in accordance with one or more implementations.

(16) FIG. 3 illustrates one example of first replaceable wear part of the reactor shown in FIGS. 1 and 2 in a detailed view.

What is claimed is:

1. A reactor configured to facilitate chemical reactions, and/or comminution therein using shockwaves created in a supersonic gaseous vortex, the reactor being further configured to resist wear caused by the chemical reactions, and/or comminution, the reactor comprising:

a rigid chamber having a substantially circular cross-section centered on a longitudinal axis that is normal to the cross-section;

a first gas inlet configured to introduce a high-velocity stream of gas into the chamber, the first gas inlet being disposed and arranged so as to effectuate a vortex of the stream of gas circulating within the chamber, the vortex rotating at a supersonic speed about the longitudinal axis of the chamber;

a material inlet configured to introduce a material to be processed into the chamber, the material inlet being disposed proximal to the first gas inlet, the material being processed within the chamber by nonabrasive mechanisms facilitated by shockwaves within the chamber;

an outlet configured to emit the gas and processed material from the chamber; and

a first replaceable wear part configured to protect an inner surface of the chamber, the first replaceable wear part corresponding to the first gas inlet such that the first replaceable wear part being disposed at a first portion of the inner surface of the chamber, wherein a first end of the first wear part is adapted to contact processed material particles at the first portion of the inner surface of the chamber;

wherein processing of the material within the chamber causes a wear impact to the first portion of the inner surface of the chamber due to the stream of gas introduced by the first gas inlet;

wherein the first wear part includes a cylindrical rod configured to rotate about a longitudinal axis of the cylindrical rod, the rod being disposed such that a first end of the rod forms a portion of or the entire first end of the wear part; and

wherein the first replaceable wear part is electronically isolated from the rest of the reactor.

2. The reactor of claim 1, wherein the rod includes a catalytic material to enhance a throughput of the reactor.

3. The reactor of claim 2, wherein the catalytic material includes platinum, and/or palladium.

4. The reactor of claim 1, wherein the first replaceable wear part is made of tungsten carbide, titanium carbide, or titanium nitride, and/or diamond.

5. The reactor of claim 1, further comprising a second gas inlet configured to introduce a gas flow into the chamber, the second gas inlet being disposed proximal to the first gas inlet such that the gas flow introduced by the second gas inlet alters the direction of the gas flow introduced by the first gas inlet.

6. The reactor of claim 1, wherein a portion of the chamber, having a continuously decreasing radius of the substantially circular cross-section, is shaped as a cone, a hemisphere, or a horn-shape.

7. The reactor of claim 1, wherein the reactor has a throughput value range from 10 kilos per hour to one thousand tons per hour.

8. A reactor configured to facilitate chemical reactions, and/or comminution therein using shockwaves created in a supersonic gaseous vortex, the reactor being further configured to resist wear caused by the chemical reactions, and/or comminution, the reactor comprising:

a rigid chamber having a substantially circular cross-section centered on a longitudinal axis that is normal to the cross-section;

a first gas inlet configured to introduce a high-velocity stream of gas into the chamber, the first gas inlet being disposed and arranged so as to effectuate a vortex of the stream of gas circulating within the chamber, the vortex rotating at a supersonic speed about the longitudinal axis of the chamber;

a material inlet configured to introduce a material to be processed into the chamber, the material inlet being disposed proximal to the first gas inlet, the material being processed within the chamber by nonabrasive mechanisms facilitated by shockwaves within the chamber;

an outlet configured to emit the gas and processed material from the chamber; and

a first replaceable wear part configured to protect an inner surface of the chamber, the first replaceable wear part corresponding to the first gas inlet such that the first replaceable wear part being disposed at a first portion of the inner surface of the chamber, wherein a first end of the first wear part is adapted to contact processed material particles at the first portion of the inner surface of the chamber;

wherein processing of the material within the chamber causes a wear impact to the first portion of the inner surface of the chamber due to the stream of gas introduced by the first gas inlet;

wherein the first replaceable wear part is further configured such that the first replaceable wear part is continuously fed into the chamber.

9. The reactor of claim 8, wherein the first replaceable wear part is made of tungsten carbide, titanium carbide, or titanium nitride, and/or diamond.

10. The reactor of claim 8, wherein the first portion of the inner surface of the chamber is located opposite to the first gas inlet within the chamber.

11. The reactor of claim 8, further comprising a second gas inlet configured to introduce a gas flow into the chamber, the second gas inlet being disposed proximal to the first gas inlet such that the gas flow introduced by the second gas inlet alters the direction of the gas flow introduced by the first gas inlet.

12. The reactor of claim 11, wherein the second gas inlet is disposed such that the gas flow introduced by the second gas inlet introduces eddy current, and/or interface current to vary the shockwaves within the chamber.

13. The reactor of claim 12, wherein the inlet nozzle is configured to emit shockwaves in the stream of gas emitted from the inlet nozzle.

14. The reactor of claim 8, wherein the chamber is configured such that the inner surface of the chamber comprises pockets adapted to pack processed material particles into the inner surface of the chamber.

15. The reactor of claim 8, wherein the first gas inlet includes an inlet nozzle disposed within the first gas inlet, the inlet nozzle being configured to emit the stream of gas at a supersonic speed.

16. The reactor of claim 8, wherein a portion of the chamber, having a continuously decreasing radius of the substantially circular cross-section, is shaped as a cone, a hemisphere, or a horn-shape.

17. The reactor of claim 8, further comprising:

a third gas inlet configured introduce a high-velocity stream of gas into the chamber, the third gas inlet being disposed and arranged so as to effectuate a vortex of the stream of gas circulating within the chamber, the vortex rotating at a supersonic speed about the longitudinal axis of the chamber;

a fourth gas inlet configured to introduce a gas flow into the chamber, the fourth gas inlet being disposed proximal to the third gas inlet such that the gas flow introduced by the fourth gas inlet alters the direction of the gas flow introduced by the third gas inlet;

a second replaceable wear part configured to protect the inner surface of the chamber, the second replaceable wear part corresponding to the third gas inlet such that the second replaceable wear part is disposed at a second portion of the inner surface of the chamber, wherein first end of the second wear part is adapted to contact processed material particles at the second portion of the inner surface of the chamber; and, wherein processing of the material within the chamber causes a wear impact to the second portion of the inner surface of the chamber due to the stream of gas introduced by the third gas inlet.

18. The reactor of claim 8, wherein the reactor has a throughput value range from 10 kilos per hour to one thousand tons per hour.

19. The reactor of claim 8, wherein:

the first wear part includes a cylindrical rod configured to rotate about a longitudinal axis of the cylindrical rod, the rod being disposed such that a first end of the rod forms a portion of or the entire first end of the wear part; and

the rod includes a catalytic material to enhance a throughput of the reactor.

20. A reactor configured to facilitate chemical reactions, and/or comminution therein using shockwaves created in a supersonic gaseous vortex, the reactor being further configured to resist wear caused by the chemical reactions, and/or comminution, the reactor comprising:

a rigid chamber having a substantially circular cross-section centered on a longitudinal axis that is normal to the cross-section;

a first gas inlet configured to introduce a high-velocity stream of gas into the chamber, the first gas inlet being disposed and arranged so as to effectuate a vortex of the stream of gas circulating within the chamber, the vortex rotating at a supersonic speed about the longitudinal axis of the chamber;

a material inlet configured to introduce a material to be processed into the chamber, the material inlet being disposed proximal to the first gas inlet, the material being processed within the chamber by nonabrasive mechanisms facilitated by shockwaves within the chamber;

an outlet configured to emit the gas and processed material from the chamber; and

a first replaceable wear part configured to protect an inner surface of the chamber, the first replaceable wear part corresponding to the first gas inlet such that the first replaceable wear part being disposed at a first portion of the inner surface of the chamber, wherein a first end of the first wear part is adapted to contact processed material particles at the first portion of the inner surface of the chamber;

wherein processing of the material within the chamber causes a wear impact to the first portion of the inner surface of the chamber due to the stream of gas introduced by the first gas inlet;

wherein the first replaceable wear part is further configured such that another replaceable wear part can be coupled to a second end of the first replaceable wear part for continuous feed into the chamber, the second end being opposite of the first end of the first replaceable wear part.