[0007] In another embodiment, the present disclosure provides an apparatus including a tuyere chamber, a plasma torch configured to produce a superheated gas and to direct the superheated gas into the tuyere chamber in an axial direction, and a shroud gas inlet assembly including a passage encircling the plasma torch and an opening around the plasma torch for injecting a shroud gas around the super-heated gas. In another aspect, the present disclosure provides an apparatus comprising: a tuyere chamber; a plasma torch configured to produce a superheated gas and to direct the superheated gas into the tuyere chamber in an axial direction; and a shroud gas inlet assembly including a passage encircling the plasma torch and a first annular opening around the plasma torch configured to inject a shroud gas in an axial direction around the super-heated gas, wherein the shroud gas inlet assembly further includes: a spiral passage configured to inject shroud gas through a second annular opening in a tangential direction adjacent to a wall of the tuyere.

[0008] In another embodiment, the present disclosure provides an apparatus including a tuyere chamber, a plasma torch configured to produce a superheated gas and to direct the superheated gas into the tuyere chamber in an axial direction, and a shroud gas inlet assembly including a passage encircling the plasma torch and a plurality of blades around the plasma torch for injecting a shroud gas around the super-heated gas. In another ~~aspect~~embodiment, the present disclosure provides an apparatus comprising: a tuyere chamber; a plasma torch configured to produce a superheated gas and to direct the superheated gas into the tuyere chamber in an axial direction; and a shroud gas inlet assembly including an annular passage encircling the plasma torch and a plurality of blades positioned in the annular passage around the plasma torch for injecting a shroud gas around the super-heated gas.

[0009] In another embodiment, the present disclosure provides an apparatus including a tuyere chamber configured to be positioned adjacent to a plasma torch, a plurality of gas injection nozzles positioned adjacent to a wall of the tuyere chamber for the purpose of the injection of shroud gas, and wherein the gas injection nozzles direct the shroud gas in a tangential direction to cause the shroud gas to spiral along the wall of the tuyere chamber. In another aspect, the present disclosure provides an apparatus comprising: a tuyere chamber configured to be positioned adjacent to a plasma torch; a shroud gas inlet assembly between the plasma torch and the tuyere chamber configured to direct shroud gas flow either axially or tangentially or both along the wall of the chamber, thereby protecting the chamber wall from superheated gas; a plurality of gas injection nozzles positioned ~~adjacent to~~ within a wall of the tuyere chamber for the purpose of the injection of shroud gas, the plurality of gas injection nozzles being located at a position that is axially displaced from both an end of plasma torch and an end of the tuyere chamber; and wherein the gas injection nozzles direct the shroud gas in a tangential direction to cause the shroud gas to spiral along the wall of the chamber.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] FIG. 1 is an elevation view, partially in section, of an example of a plasma gasification reactor.

[0011] FIG. 2 is a schematic cross-sectional view of a plasma torch and an associated tuyere.

[0012] FIG. 3 is a schematic exploded view, partially in section, of a tuyere and shroud gas inlet assembly.

[0013] FIG. 4 is a schematic cross-sectional view of a portion of a tuyere and shroud gas inlet assembly.

[0014] FIG. 5 is a schematic cross-sectional view of the shroud gas inlet assembly of FIG. 4.

[0015] FIG. 6 is a schematic cross-sectional view of a portion of a tuyere and shroud gas inlet assembly.

[0016] FIG. 7 is a schematic cross-sectional view of the shroud gas spiral inlet assembly of FIG. 6, taken along line 7-7.

[0017] FIGs. 8 through 15 are schematic cross-sectional views of various tuyere and shroud gas inlet assemblies.

[0018] FIG. 16 is a schematic exploded view, partially in section, of a tuyere and shroud gas inlet assembly.

[0019] FIG. 17 is a cross-sectional view of a portion of a tuyere with multiple shroud gas nozzles.

[0020] FIG. 18 is a cross-sectional view of the tuyere of FIG. 17 taken along line 18-18.

a tuyere chamber;

a plasma torch configured to produce a superheated gas and to direct the superheated gas into the tuyere chamber in an axial direction; and

a shroud gas inlet assembly including a passage encircling the plasma torch and a first annular opening around the plasma torch configured to inject a shroud gas in an axial direction around the super-heated gas, wherein the shroud gas inlet assembly further includes:

a spiral passage configured to inject shroud gas through a second annular opening in a tangential direction adjacent to a wall of the tuyere.

10. The apparatus of claim 9, wherein the shroud gas inlet assembly includes:

a first plenum coupled to a side of the shroud gas inlet assembly passage to direct shroud gas into the shroud gas inlet assembly passage in a direction toward the plasma torch; and

the first annular opening is formed between the plasma torch and a flange.

11. The apparatus of claim 9, wherein the shroud gas inlet assembly includes:

a first plenum coupled to the shroud gas inlet assembly passage to direct shroud gas into the shroud gas inlet assembly passage in a direction tangential to the plasma torch; and

the second annular opening is formed between a side of the shroud gas inlet assembly passage and a flange.

12. The apparatus of claim 9, wherein the shroud gas inlet assembly passage has a spiral shape, and the opening is formed between the plasma torch and a flange.

13. The apparatus of claim 9, wherein the shroud gas inlet assembly passage has a spiral shape, and the opening is formed between a side of the shroud gas inlet assembly passage and a flange.

14. The apparatus of claim 9, wherein the shroud gas comprises one or more of:

steam, CO_2, or other gases that participate in reactions with carbon within a gasifier or furnace.

15. ~~An~~ The apparatus of claim 9, further comprising:

~~a tuyere chamber;~~

~~a plasma torch configured to produce a superheated gas and to direct the superheated gas into the tuyere chamber in an axial direction; and~~

~~a shroud gas inlet assembly including an annular passage encircling the plasma torch and~~ a plurality of blades positioned in the first annular opening or the second annular opening ~~passage around the plasma torch for injecting a shroud gas around the super-heated gas.~~

16. The apparatus of claim 15, wherein the shroud gas comprises one or more of:

steam, CO_2, or other gases that participate in reactions with carbon within a gasifier or furnace.

17. An apparatus comprising:

a tuyere chamber configured to be positioned adjacent to a plasma torch;

a shroud gas inlet assembly between the plasma torch and the tuyere chamber configured to direct shroud gas flow either axially or tangentially or both along the wall of the chamber, thereby protecting the chamber wall from superheated gas;

a plurality of gas injection nozzles positioned ~~adjacent to~~within a wall of the tuyere chamber for the purpose of the injection of shroud gas, the plurality of gas injection nozzles being located at a position that is axially displaced from both an end of plasma torch and an end of the tuyere chamber; and

wherein the gas injection nozzles direct the shroud gas in a tangential direction to cause the shroud gas to spiral along the wall of the chamber.

~~18. The apparatus of claim 17, further comprising:~~

~~a shroud gas inlet assembly between the plasma torch and the tuyere chamber configured to direct shroud gas flow either axially or tangentially or both along the wall of the chamber, thereby protecting the chamber wall from superheated gas.~~

~~19~~18. The apparatus of claim ~~18~~17, wherein the shroud gas inlet assembly comprises:

two passages;

wherein a first one of the passages is configured to direct shroud gas flow axially and parallel to a plasma plume flow, and a second one of the passages is configured to direct flow tangentially, spiraling along the wall of the tubular mixing chamber.

~~20~~19. The apparatus of claim 17, wherein the shroud gas comprises one or more of:

steam, CO_2, or other gases that participate in reactions with carbon within a gasifier or furnace.