Claims

1. A circulating fluid bed reactor having a reactor wall of circular cross section about a vertical axis, a lower inlet for fluidizing gas and feed injection nozzle assemblies for a liquid heavy oil feed and atomization steam above the lower fluidizing gas inlet and around the reactor wall, the nozzle assemblies each extending through the reactor wall into the reactor with a discharge orifice within the reactor and a feed inlet for the liquid heavy oil feed at the end remote from the discharge orifice; each feed injection nozzle assembly comprising:

a premixer section to combine the liquid heavy oil feed with atomization steam to form a liquid feed/steam mixture comprising gas bubbles in liquid, the premixer section comprising successive converging and diverging zones with a plurality of radial steam inlet ports located at the entry of the converging zone;

a flow conduit section following and connected to the outlet of the premixer section, extending from the premixer section to a discharge nozzle, to convey a flow of the liquid/steam mixture created by the premixer to the discharge nozzle;

a discharge nozzle having a convergent entry following and connected to the flow conduit section to shear the liquid feed/steam mixture and create liquid feed droplets of reduced size upon exit from the discharge nozzle.

2. A circulating fluid bed reactor according to claim 1 in which the premixer section includes a central cylindrical throat section connecting the converging and diverging zones.

3. A circulating fluid bed reactor according to claim 1 in which the nozzle assembly has a flow conduit section comprising successive convergence and divergence zones to reduce the size of the gas bubbles in the liquid feed/steam mixture from the premixer.

4. A circulating fluid bed reactor according to claim 3 further comprising a disperser in which the disperser has a body comprising a central flow passage of circular cross-section and a plurality of lobes in the body, the wall of each lobe defining a segment of a hollow cone with the axes of the hollow cones intersecting

symmetrically with the central axis of the disperser to define an increasing multilobe exit passage of increasing cross-sectional area in the disperser body.

5. A fluid coking reactor according to claim 4 in which the premixer section includes a central cylindrical throat section connecting the converging and diverging zones.

6. A fluid coking reactor according to claim 5 further comprising a disperser in which the disperser has a body comprising a central flow passage of circular cross-section and a plurality of lobes in the body, the wall of each lobe defining a segment of a hollow cone with the axes of the hollow cones intersecting symmetrically with the central axis of the disperser to define an increasing multilobe exit passage of increasing cross-sectional area in the disperser body.

7. A fluid coking reactor according to claim 4 in which the nozzle body has a flow conduit section comprising successive convergence and divergence zones to reduce the size of the gas bubbles in the liquid feed/steam mixture from the premixer.

8. A fluid coking reactor according to claim 4 in which the nozzle assembly has a flow conduit section comprising tandem convergence zones separated by a diffusion zone.

9. A fluid coking reactor according to claim 4 in which the feed injection nozzles each comprise a multilobe disperser at the outlet of the discharge nozzle to generate a correspondingly shaped liquid jet plume having an increased surface area relative to a cylindrical jet.

10. A circulating fluid bed reactor according to claim 1 in which the nozzle assembly has a flow conduit section comprising tandem convergence zones separated by a diffusion zone.

11. A circulating fluid bed reactor according to claim 1 which comprises a multilobe disperser at the outlet of the discharge nozzle to generate a correspondingly shaped liquid jet plume having an increased surface area relative to a cylindrical jet.

12. A fluid coking reactor having a reactor wall of circular cross section about a vertical axis, a lower inlet for fluidizing gas and feed injection nozzle assemblies for a liquid heavy oil feed and atomization steam above the lower fluidizing gas inlet and around the reactor wall, the nozzle assemblies each extending through the reactor wall into the reactor with a discharge nozzle orifice within the reactor and an inlet for the liquid heavy oil feed at the end remote from the discharge nozzle; each feed injection nozzle assembly comprising:

a premixer section to combine the liquid heavy oil feed with atomization steam to form a liquid feed/steam mixture comprising gas bubbles in liquid, the premixer section comprising successive converging and diverging zones and a central throat section connecting the converging and diverging zones, with a plurality of radial steam inlet ports located at an entry of the converging zone;

a flow conduit section following and connected to the outlet of the premixer section, extending from the premixer section to a discharge nozzle, to convey a flow of the liquid/steam mixture created by the premixer to the discharge nozzle;

a discharge nozzle having a convergent entry following and connected to the flow conduit section to shear the liquid feed/steam mixture and create liquid feed droplets of reduced size upon exit from the discharge nozzle.

13. A fluid coking unit having a fluidized bed coking reactor which comprises:

a reaction section of circular cross section about a vertical axis and confined by a reactor wall,

a base region below the dense bed reaction section at which fluidizing gas in injected to fluidize a dense bed of finely-divided solid coke particles in the dense bed reaction section,

a plurality of heavy oil inlets located around the periphery of the reactor wall at multiple elevations above the base region,

a scrubber section above the reaction section and separated from the dense bed reaction section,

at least one cyclone at the top of the dense bed reaction section, each cyclone having an inlet for gas and coke particles exiting the reaction section, a cyclone gas outlet exhausting into the scrubber section and a cyclone dipleg for returning coke particles separated from the gas in the cyclone into the dense bed reaction section,

a stripping section at the base region of the reactor,

feed injection nozzle assemblies each extending through the reactor wall into the reactor with a discharge orifice within the reactor and an inlet for liquid heavy oil feed at the end remote from the discharge nozzle; each feed injection nozzle assembly comprising:

a premixer section to combine the liquid heavy oil feed with the atomization steam to form a liquid feed/steam mixture comprising gas bubbles in liquid, the premixer section comprising successive converging and diverging zones with a plurality of radial steam inlet ports located at an entry of the converging zone;

a flow conduit section following and connected to the outlet of the premixer section, extending from the premixer section to a discharge nozzle, to convey a flow of the liquid/steam mixture created by the premixer to the discharge nozzle;

a discharge nozzle having a convergent entry following and connected to the flow conduit section to shear the liquid feed/steam mixture and create liquid feed droplets of reduced size upon exit from the discharge nozzle.

14. A fluid coking reactor according to claim 13 in which the premixer section includes a central cylindrical throat section connecting the converging and diverging zones.

15. A fluid coking unit according to claim 13 in which the nozzle body has a flow conduit section comprising successive convergence and divergence zones to reduce the size of the gas bubbles in the liquid feed/steam mixture.

16. A fluid coking unit according to claim 13 in which the nozzle assembly has a flow conduit section comprising tandem convergence zones separated by a diffusion zone.

17. A fluid coking unit according to claim 13 in which each feed injection nozzle assembly comprise a disperser at the outlet of the discharge nozzle to generate a correspondingly shaped liquid jet plume having an increased surface area relative to a cylindrical jet, the disperser having a body comprising a central flow passage of circular cross-section and a plurality of lobes in the body, the wall of each lobe defining a segment of a hollow cone with the axes of the hollow cones intersecting symmetrically with the central axis of the disperser to define an increasing multilobe exit passage of increasing cross-sectional area in the disperser body.

18. A fluid coking unit according to claim 17 in which the disperser has a body comprising four lobes, the wall of each lobe defining a segment of a hollow cone with the axes of the hollow cones intersecting symmetrically with the central axis of the disperser to define an increasing quadrulobe exit passage of increasing cross-sectional area in the disperser body.

19. A fluid coking unit according to claim 13 in which the reactor is coupled in the unit to a burner/heater by means of coke lines comprising a cold coke transfer line to transfer coke from the bottom of the stripper to the burner/heater and a hot coke return line to bring hot coke from the burner/heater back to the reactor.

20. A fluid coking unit according to claim 17 which includes a coke gasifier section connected to the heater/burner by means of a coke transfer line.