

## CLAIMS

What is claimed:

1. A feed injector, comprising:
  - a body having an outer wall and an inner wall;
  - a first conduit formed between the outer wall and the inner wall, the first conduit configured to receive a atomizing gas;
  - a second conduit formed by the inner wall, the second conduit configured to receive a liquid, wherein the first conduit and the second conduit are separated by the inner wall;
  - a mixing chamber at an outlet of the first conduit and an outlet of the second conduit, wherein the atomizing gas from the first conduit and the liquid from the second conduit hit and/or mix together in the mixing chamber to form liquid droplets and a mixture of the atomizing gas and the liquid;
  - a flow cone having a first end in the second conduit and a second end in the mixing chamber;
  - an annular path between the inner wall of the second conduit and an outer surface of the flow cone forms a liquid pathway to the outlet of the second conduit, wherein the outlet of the second conduit is form by a gap between an end of the inner wall and the second end of the flow cone,
  - wherein a protrusion at the second end of the flow cone is angled from a central axis of the feed injector at an angle from 0 to 90 degrees; and
  - a discharge channel at an end of the mixing chamber opposite the flow cone.
2. The feed injector of claim 1, further comprising a plurality of vanes on a portion of the outside wall of the flow cone.
3. The feed injector of claim 2, wherein the plurality of vanes are configured to change a direction of the liquid in the liquid pathway.

4. The feed injector of claim 1, further comprising one or more impingement plates extend a length from the outer wall towards the central axis within the mixing chamber.
5. The feed injector of claim 4, wherein the one or more walls are angled at an angle from the outer wall, and the angle is equal to the angle of the gap.
6. The feed injector of claim 1, wherein the outer surface of the flow cone is angled to have the liquid pathway get progressively smaller from the first end of the flow cone to the second end of the flow cone.
7. The feed injector of claim 1, wherein the angle of the protrusion is in the range from 30 to 90 degrees.
8. The feed injector of claim 1, wherein the angle of the protrusion is from 45 to 75 degrees.
9. The feed injector of claim 1, wherein the atomizing gas is steam.
10. The feed injector of claim 1, wherein the liquid is a hydrocarbon.
11. The feed injector of claim 1, further comprising an inlet of the second conduit provided at an end opposite of the discharge channel.
12. The feed injector of claim 11, further comprising an inlet of the first conduit provided between the inlet of the second conduit and the discharge channel.
13. The feed injector of claim 12, wherein the inlet of the first conduit is perpendicular to the central axis and the inlet of the second conduit is parallel to the central axis.
14. The feed injector of claim 1, wherein the outer wall, the inner wall, the first conduit, and the second conduit are coaxial to the central axis.
15. The feed injector of claim 1, wherein the outlet of the first conduit is angled to form an angle of attack for the atomizing gas between 0 to 90 degrees.
16. A fluid catalytic cracking unit, comprising:

a vertically disposed riser reactor;  
a regenerator fluidly coupled to and configured to provide a catalyst or hot particles to the vertically disposed riser reactor;  
one or more feed injectors disposed in the vertically disposed riser reactor, the feed injectors comprising:  
a body having an outer wall and an inner wall;  
a first conduit formed between the outer wall and the inner wall, the first conduit configured to receive an atomizing gas;  
a second conduit formed by the inner wall, the second conduit configured to receive a liquid feed, wherein the first conduit and the second conduit are separated by the inner wall;  
a mixing chamber at an outlet of the first conduit and an outlet of the second conduit, wherein the atomizing gas from the first conduit and the liquid from the second conduit mix together in the mixing chamber to form liquid droplets and a mixture of the atomizing gas and the liquid;  
a flow cone having a first end in the second conduit and a second end in the mixing chamber;  
an annular path between the inner wall of the second conduit and an outer surface of the flow cone forming a liquid pathway to the outlet of the second conduit, wherein the outlet of the second conduit is formed by a gap between an end of the inner wall and the second end of the flow cone,  
wherein a protrusion at the second end of the flow cone is angled from a central axis of the feed injector at an angle from 0 to 90 degrees; and  
a discharge channel at an end of the mixing chamber opposite the flow cone,  
wherein the liquid droplets and the mixture of the atomizing gas and the liquid enter the vertically disposed riser reactor through the discharge channel of the one or more feed injectors.

17. The fluid catalytic cracking unit of claim 16, wherein the one or more feed injectors are disposed proximate a bottom of the vertically disposed riser reactor.

18. A method, comprising:

- flowing an atomizing gas through a first conduit of a feed injector;
- flowing a liquid through a second conduit of the feed injector, wherein the first conduit and the second conduit are separated by a wall within the feed injector;
- directing the liquid through a liquid pathway formed by an annular path between the wall and an outer surface of a flow cone within the feed injector, wherein the liquid travels from a first end of the flow cone in the second conduit to a second end the flow cone in a mixing chamber of the feed injector;
- exiting the liquid into the mixing chamber through an outlet of the second conduit formed a gap between an end of the wall and the second end of the flow cone,
- distributing the liquid into the mixing chamber with a protrusion at the second end of the flow cone angled from a central axis of the feed injector at an angle from 0 to 90 degrees;
- exiting the atomizing gas into the mixing chamber through an outlet of the first conduit;
- combining the liquid from the second conduit and the atomizing gas from the first conduit in the mixing chamber to form liquid droplets resulting in a mixture of the atomizing gas and the liquid droplets; and
- discharging the mixture of the atomizing gas and the liquid droplets through a discharge channel of the feed injector at an end of the mixing chamber opposite the flow cone.
19. The method of claim 18, further comprising changing a direction of the liquid flow in the liquid pathway with a plurality of vanes on a portion of the outer surface of the flow cone.
20. The method of claim 18, further comprising pre-mixing a portion of the atomizing gas with the liquid within the second conduit upstream of the flow cone.