SUMMARY OF THE DISCLOSURE

[0004a] According to a first aspect of the present invention, there is provided a shell and tube heat exchanger comprising:

an elongated cylindrical shell that defines a longitudinal axis for the heat exchanger and an internal chamber, the elongated cylindrical shell having two diametrically opposed feed gas inlets and at least one feed gas outlet formed in an outer wall for allowing a feed gas to enter and exit the internal chamber;

at least one tube sheet associated with an end of the elongated cylindrical shell;

a plurality of circular baffles longitudinally spaced apart within the internal chamber of the elongated cylindrical shell for redirecting feed gas flow within the internal chamber;

a tube bundle which includes a plurality of tubes for allowing effluent gas to traverse from an inlet plenum through the internal chamber of the elongated cylindrical shell to an outlet plenum; and

a first cylindrical shroud distributor arranged and configured to direct feed gas flow from the two diametrically opposed feed gas inlets into the internal chamber proximate the at least one tube sheet, the first cylindrical shroud distributor having a cylindrical outer surface parallel to the longitudinal axis of the elongated cylindrical shell and an upstream edge that is angled obliquely relative to the longitudinal axis for distributing the flow of feed gas wherein the upstream edge is disposed symmetrically across a plane bisecting the elongated cylindrical shell evenly between the two diametrically opposed feed gas inlets.

[0004b] According to a second aspect of the present invention, there is provided a shell and tube heat exchanger comprising:

an elongated cylindrical shell that defines a longitudinal axis for the heat exchanger and an internal chamber, the elongated cylindrical shell having two diametrically opposed feed gas inlets and at least one feed gas outlet formed in an outer wall for allowing a feed gas to enter and exit the internal chamber;

at least one tube sheet associated with an end of the elongated cylindrical shell;

a plurality of circular baffles longitudinally spaced apart within the internal chamber of the elongated cylindrical shell for redirecting feed gas flow within the internal chamber, the plurality of circular baffles including shield style baffles and wing style baffles and each baffle includes a circumferential seal;

a tube bundle which includes a plurality of tubes for allowing effluent gas to traverse from an inlet plenum through the internal chamber of the elongated cylindrical shell to an outlet plenum; and

a first cylindrical shroud distributor arranged and configured to direct feed gas flow from the two diametrically opposed feed gas inlets into the internal chamber proximate the at least one tube sheet, the first cylindrical shroud distributor having a cylindrical outer surface parallel to the longitudinal axis of the elongated cylindrical shell and an upstream edge that is angled obliquely relative to the longitudinal axis for distributing the flow of feed gas wherein the upstream edge is disposed symmetrically across a plane bisecting the elongated cylindrical shell evenly between the two diametrically opposed feed gas inlets.

[0004c] According to a third aspect of the present invention, there is provided a shell and tube heat exchanger comprising:

an elongated cylindrical shell that defines a longitudinal axis for the heat exchanger and an internal chamber, the elongated cylindrical shell having two diametrically opposed feed gas inlets and at least one feed gas outlet formed in an outer wall for allowing a feed gas to enter and exit the internal chamber;

at least one tube sheet associated with an end of the elongated cylindrical shell;

a plurality of circular baffles longitudinally spaced apart within the internal chamber of the elongated cylindrical shell for redirecting feed gas flow within the internal chamber, the plurality of circular baffles including a flexible circumferential seal extending towards the elongated cylindrical shell;

a tube bundle which includes a plurality of tubes for allowing effluent gas to traverse from an inlet plenum through the internal chamber of the elongated cylindrical shell to an outlet plenum; and

a first cylindrical shroud distributor arranged and configured to direct feed gas flow from the two diametrically opposed feed gas inlets into the internal chamber proximate the at least one tube sheet, the first cylindrical shroud distributor having a cylindrical outer surface parallel to the longitudinal axis of the elongated cylindrical shell and an upstream edge that is angled obliquely relative to the longitudinal axis for distributing the flow of feed gas wherein the upstream edge is disposed symmetrically across a plane bisecting the elongated cylindrical shell evenly between the two diametrically opposed feed gas inlets.

[0005] The present disclosure is directed to heat exchanger constructions with improved heat exchange effectiveness. A first embodiment of the present disclosure is a shell and tube

heat exchanger that includes, inter alia, an elongated cylindrical shell that defines a longitudinal axis for the heat exchanger and an internal chamber. The shell has at least one feed gas inlet and feed gas outlet formed in an outer wall for allowing a feed gas to enter and exit the internal chamber. In certain constructions, the shell includes two or more feed gas inlets and two or more feed gas outlets.

[0006] At least one tube sheet is associated with an end of the elongated shell and a plurality of circular baffles are longitudinally spaced apart within the internal chamber of the shell for redirecting feed gas flow within the internal chamber. In certain constructions, a circumferential seal is associated with each of the plurality of baffles.

[0007] A tube bundle is provided which includes a plurality of tubes for allowing effluent gas to traverse from an inlet plenum through the internal chamber of the shell to an outlet plenum. The heat exchanger further includes a first shroud distributor that is arranged and configured to direct feed gas flow from the feed gas inlet into the internal chamber proximate the at least one tube sheet. The first shroud distributor has at least one angled cut formed in an end thereof for distributing the flow of feed gas.

[0008] In certain embodiments of the present invention, two feed gas inlets and two feed gas outlets are formed in the outer wall of the shell. Preferably, in such constructions, the first shroud distributor has two angled cuts formed in an end thereof for distributing the flow of feed gas. In certain constructions the angled cuts are positioned 180 degrees apart.

[0009] It is envisioned that the at least one shroud distributor can include at least one circular baffle. In a preferred embodiment, the shroud distributor includes a donut style

What is Claimed is:

1. A shell and tube heat exchanger comprising:

an elongated cylindrical shell that defines a longitudinal axis for the heat exchanger and an internal chamber, the elongated cylindrical shell having two diametrically opposed feed gas inlets and at least one feed gas outlet formed in an outer wall for allowing a feed gas to enter and exit the internal chamber;

at least one tube sheet associated with an end of the elongated cylindrical shell;

a plurality of circular baffles longitudinally spaced apart within the internal chamber of the elongated cylindrical shell for redirecting feed gas flow within the internal chamber;

a tube bundle which includes a plurality of tubes for allowing effluent gas to traverse from an inlet plenum through the internal chamber of the elongated cylindrical shell to an outlet plenum; and

a first cylindrical shroud distributor arranged and configured to direct feed gas flow from the two diametrically opposed feed gas inlets into the internal chamber proximate the at least one tube sheet, the first cylindrical shroud distributor having a cylindrical outer surface parallel to the longitudinal axis of the elongated cylindrical shell and an upstream edge that is angled obliquely relative to the longitudinal axis for distributing the flow of feed gas wherein the upstream edge is disposed symmetrically across a plane bisecting the elongated cylindrical shell evenly between the two diametrically opposed feed gas inlets.

2. The heat exchanger as recited in claim 1, wherein two feed gas outlets are formed diametrically opposite one another in the outer wall of the elongated cylindrical shell.

3. The heat exchanger as recited in claim 1, wherein the first cylindrical shroud distributor includes a first circular baffle separate from the plurality of circular baffles longitudinally spaced apart within the interior chamber of the elongated cylindrical shell.

4. The heat exchanger as recited in claim 3, wherein the first circular baffle of the first cylindrical shroud distributor

is a donut style baffle having a central window area.

5. The heat exchanger as recited in claim 4, wherein the first cylindrical shroud distributor further includes a second shield style baffle separate from the plurality of circular baffles longitudinally spaced apart within the interior chamber of the elongated cylindrical shell, the second shield style baffle having a circumferential sealing element.

6. The heat exchanger as recited in claim 1, wherein the upstream edge that is angled obliquely relative to the longitudinal axis is formed at an angle of 10-30 degrees relative to the longitudinal axis of the elongated cylindrical shell.

7. The heat exchanger as recited in claim 1, further including a second cylindrical shroud distributor having a cylindrical outer surface parallel to the longitudinal axis of the elongated cylindrical shell and a downstream edge that is angled obliquely relative to the longitudinal axis configured to direct feed gas flow from the internal chamber to the feed gas outlet wherein the downstream edge is disposed symmetrically across a plane bisecting the elongated cylindrical shell evenly between the two diametrically opposed feed gas outlets.

8. The heat exchanger as recited in claim 1, wherein the plurality of circular baffles includes both shield style baffles and wing style baffles which are arranged in alternating pattern.

9. The heat exchanger as recited in claim 1, wherein a circumferential seal is associated with each of the plurality of circular baffles.

10. The heat exchanger as recited in claim 9, wherein the circumferential seal of each of the plurality of circular baffles and the first circular baffle of the first cylindrical shroud distributor includes a flexible element which extends towards the elongated cylindrical shell.

11. The heat exchanger as recited in claim 10, wherein separate flexible elements are provided on both sides of each of the plurality of circular baffles longitudinally spaced apart within the internal chamber of the elongated cylindrical shell and the first circular baffle of the first distributor.

12. The heat exchanger as recited in claim 1, wherein the plurality of circular baffles includes at least one shield style baffle formed by cutting two diametrically opposed windows into a baffle plate.

13. The heat exchanger as recited in claim 1, wherein the plurality of circular baffles includes at least one wing style baffle formed by cutting a single window into a baffle plate.

14. The heat exchanger as recited in claim 1, wherein the plurality of circular baffles includes a donut style baffle formed by cutting a circular window into a baffle plate.

15. A shell and tube heat exchanger comprising:

an elongated cylindrical shell that defines a longitudinal axis for the heat exchanger and an internal chamber, the elongated cylindrical shell having two diametrically opposed feed gas inlets and at least one feed gas outlet formed in an outer wall for allowing a feed gas to enter and exit the internal chamber;

at least one tube sheet associated with an end of the elongated cylindrical shell;

a plurality of circular baffles longitudinally spaced apart within the internal chamber of the elongated cylindrical shell for redirecting feed gas flow within the internal chamber, the plurality of circular baffles including shield style baffles and wing style baffles and each baffle includes a circumferential seal;

a tube bundle which includes a plurality of tubes for allowing effluent gas to traverse from an inlet plenum through the internal chamber of the elongated cylindrical shell to an outlet plenum; and

a first cylindrical shroud distributor arranged and configured to direct feed gas flow from the two diametrically opposed feed gas inlets into the internal chamber proximate the at least one tube sheet, the first cylindrical shroud distributor having a cylindrical outer surface parallel to the longitudinal axis of the elongated cylindrical shell and an upstream edge that is angled obliquely relative to the longitudinal axis

for distributing the flow of feed gas wherein the upstream edge is disposed symmetrically across a plane bisecting the elongated cylindrical shell evenly between the two diametrically opposed feed gas inlets.

16. The heat exchanger as recited in claim 15, wherein the first cylindrical shroud distributor includes a first circular baffle separate from the plurality of circular baffles longitudinally spaced apart within the interior chamber of the elongated cylindrical shell.

17. The heat exchanger as recited in claim 16, wherein the first circular baffle of the first cylindrical shroud distributor is a donut style baffle having a central window area.

18. The heat exchanger as recited in claim 17, wherein the first cylindrical shroud distributor further includes a second shield style baffle separate from the plurality of circular baffles longitudinally spaced apart within the interior chamber of the elongated cylindrical shell, the second shield style baffle having a circumferential sealing element.

19. The heat exchanger as recited in claim 15, wherein the upstream edge that is angled obliquely relative to the longitudinal axis is formed at an angle of 10-30 degrees relative to the longitudinal axis of the elongated cylindrical shell.

20. The heat exchanger as recited in claim 15, wherein the plurality of shield style baffles and wing style baffles are arranged in alternating pattern.

21. The heat exchanger as recited in claim 15, wherein the circumferential seal of each of the plurality of circular baffles longitudinally spaced apart within the internal chamber of the elongated cylindrical shell includes a flexible element which extends towards the elongated cylindrical shell.

22. The heat exchanger as recited in claim 21, wherein the flexible element is provided on both sides of each of the plurality of circular baffles.

23. The heat exchanger as recited in claim 15, wherein the shield style baffles are formed by cutting two diametrically opposed windows into a baffle plate.

24. The heat exchanger as recited in claim 15, wherein the wing style baffles are formed by cutting a single window into a baffle plate.

25. The heat exchanger as recited in claim 15, wherein the donut style baffles are formed by cutting a circular window into a baffle plate.

26. A shell and tube heat exchanger comprising:

an elongated cylindrical shell that defines a longitudinal axis for the heat exchanger and an internal chamber, the elongated cylindrical shell having two diametrically opposed feed gas inlets and at least one feed gas outlet formed in an outer wall for allowing a feed gas to enter and exit the internal chamber;

at least one tube sheet associated with an end of the elongated cylindrical shell;

a plurality of circular baffles longitudinally spaced apart within the internal chamber of the elongated cylindrical shell for redirecting feed gas flow within the internal chamber, the plurality of circular baffles including a flexible circumferential seal extending towards the elongated cylindrical shell;

a tube bundle which includes a plurality of tubes for allowing effluent gas to traverse from an inlet plenum through the internal chamber of the elongated cylindrical shell to an outlet plenum; and

a first cylindrical shroud distributor arranged and configured to direct feed gas flow from the two diametrically opposed feed gas inlets into the internal chamber proximate the at least one tube sheet, the first cylindrical shroud

distributor having a cylindrical outer surface parallel to the longitudinal axis of the elongated cylindrical shell and an upstream edge that is angled obliquely relative to the longitudinal axis for distributing the flow of feed gas wherein the upstream edge is disposed symmetrically across a plane bisecting the elongated cylindrical shell evenly between the two diametrically opposed feed gas inlets.

27. The heat exchanger as recited in claim 21, wherein separate flexible elements are provided on both sides of each of the plurality of circular baffles longitudinally spaced apart within the internal chamber of the elongated cylindrical shell.

28. The heat exchanger as recited in claim 21, wherein the flexible element of each circumferential seal of each of the plurality of circular baffles is made from stainless steel.