NOZZLE/HEADER DESIGN FOR POLYSTYRENE

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims priority from U.S. Patent Application No. 15/085,464, filed on March 30, 2016.

FIELD

[0002] Embodiments of the present disclosure generally relate to fluid exchange vessels. More particularly, embodiments of the present disclosure relate to devolatilizer nozzles and methods of distributing fluid within fluid exchange vessels.

BACKGROUND

[0003] Polymer may be recovered from a polymerization reactor and fed to a devolatilizer where components such as unreacted monomer or solvent may be removed from the polymer. For example, volatiles may be removed by vacuum distillation, flash devolatization, stripping, increasing polymer surface area, or combinations thereof. The surface area of a polymer may be increased by passing the polymer through a devolatilizer nozzle, which is an arrangement of one or more flow tubes having small perforations or holes directed downward in a vessel for discharging molten polymer downward from the holes in continuous vertical strands. The polymer strands provide increased surface area for devolatilization of the polymer. As the polymer strands fall in the devolatilization vessel, the unreacted monomer and solvent are released while the polymer strands collect at the bottom of the vessel. The devolatilized polymer may then be sent to subsequent polymer processing steps.

SUMMARY

[0004] The present disclosure provides for a devolatilizer vessel. The devolatilizer vessel includes a vessel header with a plurality of alternating vessel header penetrations. The plurality of lateral flow tubes are arranged in a parallel configuration. Each lateral flow tube enters the vessel header through one of the alternating vessel header penetrations with a single vessel header penetration per lateral flow tube. Each lateral flow tube has a perforated section located within the vessel header. The perforated section has a non-circular cross-section. The non-circular cross-section has the shape of a circular sector, an elliptical sector, or an irregular quadrilateral. The non-circular cross-section has two straight sides. A third side of the non-circular cross-section is an arc. The two straight sides connect at an angle that is equal to or more than 70-76 degrees and each straight side connects with the arc at an angle that is greater than 90 degrees.

[0005] The present disclosure provides for a method. The method includes passing a molten polymer through lateral flow tubes of a vessel header of a devolatilizer vessel. The lateral flow tubes are arranged in a parallel configuration and enter the vessel header through a plurality of alternating vessel header penetrations with a single vessel header penetration per lateral flow tube. The molten polymer exits the lateral flow tubes as strands through

perforations in the lateral flow tubes within the vessel header. The lateral flow tubes have a non-circular cross-section. The non-circular cross-section has the shape of a circular sector, an elliptical sector, or an irregular quadrilateral. The non-circular cross-section has two straight sides. A third side of the non-circular cross-section is an arc. The two straight sides connect at an angle that is equal to or more than 70-76 degrees and each straight side connects with the arc at an angle that is greater than 90 degrees. The method includes obtaining devolatilized polymer.

BRIEF DESCRIPTION OF DRAWINGS

[0006] The present disclosure may be understood from the following detailed description when read with the accompanying figures.

[0007] FIG. 1A is a top plan view of a polymer melt distributor vessel header design in accordance with certain embodiments of the present disclosure.

[0008] FIG. 1B is a partial side plan view of a polymer melt distributor vessel design in accordance with certain embodiments of the present disclosure.

[0009] FIG. 2A is a partial cross-sectional view of an internal support structure along an interior wall of a vessel header in accordance with certain embodiments of the present disclosure.

[0010] FIG. 2B is a partial cross-sectional view of an alternative internal support structure along an interior wall of a vessel header in accordance with certain embodiments of the present disclosure.

[0011] FIG. 3A is a cross-sectional side view of an internal support structure in accordance with certain embodiments of the present disclosure.

[0012] FIG. 3B is a cross-sectional side view of an internal support structure in accordance with certain embodiments of the present disclosure.

[0013] FIG. 3C is a cross-sectional side view of an internal support structure in accordance with certain embodiments of the present disclosure.

[0014] FIG. 4 is a cross-sectional side view of a welded lateral flow tube connection in accordance with certain embodiments of the present disclosure.

[0015] FIG. 5 is a cross-sectional side view of an externally flanged lateral flow tube connection in accordance with certain embodiments.

[0016] FIG. 6A is a cross-sectional view of an internally flanged lateral flow tube connection in accordance with certain embodiments of the present disclosure.

[0017] FIG. 6B is a cross-sectional view of an internally flanged lateral flow tube connection in accordance with certain embodiments of the present disclosure.

[0018] FIG. 7 is a magnified cross-sectional view of a nozzle hole showing a strand angle in accordance with certain embodiments of the present disclosure.

[0019] FIG. 8 is a schematic of a nozzle hole pattern in accordance with certain embodiments of the present disclosure.

CLAIMS

What is claimed is:

1. A devolatilizer vessel comprising:

a vessel header comprising a plurality of alternating vessel header penetrations; and

a plurality of lateral flow tubes arranged in a parallel configuration, wherein each lateral flow tube enters the vessel header through one of the alternating vessel header penetrations with a single vessel header penetration per lateral flow tube, wherein each lateral flow tube comprises a perforated section located within the vessel header, the perforated section comprising a non-circular cross-section, wherein the non-circular cross-section has the shape of a circular sector, an elliptical sector, or an irregular quadrilateral, wherein the non-circular cross-section has two straight sides, wherein a third side of the non-circular cross-section is an arc, wherein the two straight sides connect at an angle that is equal to or more than 70-76 degrees, and wherein each straight side connects with the arc at an angle that is greater than 90 degrees.

2. The devolatilizer vessel of claim 1, wherein the perforations in the perforated section extend only across a portion of the two straight sides of the non-circular cross-section.

3. The devolatilizer vessel of claim 1, wherein a majority of perforations in the lateral flow tubes have a maximum strand angle of equal to or less than 65 degrees.

4. The devolatilizer vessel of claim 1, wherein the perforations in the lateral flow tubes are tapered holes.

5. The devolatilizer vessel of claim 4, wherein all or a portion of the tapered holes have a linear taper.

6. The devolatilizer vessel of claim 4, wherein all or a portion of the tapered holes are multiple internal tapered holes.

7. The devolatilizer vessel of claim 1, wherein the lateral flow tubes are in fluid communication with an external distribution manifold.

8. The devolatilizer vessel of claim 1, wherein the lateral flow tubes are formed of 304 stainless steel, AL-6XN stainless steel, or LDX 2101 stainless steel.

9. The devolatilizer vessel of claim 1, wherein the lateral flow tubes are welded into the vessel header penetrations, or wherein the lateral flow tubes are internally flanged to the vessel header penetrations, or wherein the lateral flow tubes are externally flanged to the vessel header penetrations.

10. The devolatilizer vessel of claim 9, wherein the lateral flow tubes are externally flanged to the vessel header penetrations, and wherein the external flanges are arranged in a staggered configuration.

11. The devolatilizer vessel of claim 1, further comprising internal support structure supporting each lateral flow tube within the vessel header opposite the corresponding vessel header penetration.

12. The devolatilizer vessel of claim 11, wherein the internal support structure accommodates horizontal expansion or contraction of the lateral flow tube.

13. The devolatilizer vessel of claim 11, wherein the internal support structure is a sliding cradle comprising a support rail located opposite the vessel header penetration and above the lateral flow tube and a sliding hanger connecting the support rail and the lateral flow tube.

14. The devolatilizer vessel of claim 11, wherein the internal support structure comprises a support cradle located opposite the corresponding vessel header penetration on which the lateral flow tube rests.

15. The devolatilizer vessel of claim 14, wherein the support cradle is interior to the vessel header wall, or wherein the support cradle is exterior to the vessel header wall.

16. The devolatilizer vessel of claim 14, wherein the support cradle is welded to the vessel interior.

17. The devolatilizer vessel of claim 16 wherein the support cradle is welded to the vessel interior along one or more weld arcs positioned inside the support cradle.

18. The devolatilizer vessel of claim 16, wherein the support cradle is welded to the vessel interior along one or more weld arcs positioned inside the support cradle such that a weld root spacing between the weld arcs and vessel header penetration welds is minimized.

19. The devolatilizer vessel of claim 1, wherein the lateral flow tubes are welded into the vessel header penetrations and are externally flanged to an external distribution manifold or internally flanged to the external distribution manifold.

20. The devolatilizer vessel of claim 1, wherein the lateral flow tubes are externally flanged to the vessel header penetrations and to an external distribution manifold.

21. The devolatilizer vessel of claim 1, further comprising an internal support structure supporting the lateral flow tubes within the vessel header opposite the vessel header penetrations, wherein the lateral flow tubes are welded into the vessel header penetrations and are externally flanged to an external distribution manifold, and wherein the perforated sections of the lateral flow tubes extend substantially the entire length of the lateral flow tubes from the vessel header penetrations to the internal support structure.

22. The devolatilizer vessel of claim 1, further comprising an internal support structure supporting the lateral flow tubes within the vessel header opposite the vessel header penetrations, wherein the lateral flow tubes are externally flanged to the vessel header penetrations and to an external distribution manifold, and wherein the perforated sections of the lateral flow tubes extend substantially the entire length of the lateral flow tubes from the vessel header penetrations to the internal support structure.

23. The devolatilizer vessel of claim 1, wherein the non-circular cross-section has the shape of an irregular quadrilateral.

24. A method comprising:

passing a molten polymer through lateral flow tubes of a vessel header of a devolatilizer vessel, wherein the lateral flow tubes are arranged in a parallel configuration and

enter the vessel header through a plurality of alternating vessel header penetrations with a single vessel header penetration per lateral flow tube;

wherein the molten polymer exits the lateral flow tubes as strands through perforations in the lateral flow tubes within the vessel header, and wherein the lateral flow tubes have a non-circular cross-section, and wherein the non-circular cross-section has the shape of a circular sector, an elliptical sector, or an irregular quadrilateral, wherein the non-circular cross-section has two straight sides, wherein a third side of the non-circular cross-section is an arc, wherein the two straight sides connect at an angle that is equal to or more than 70-76 degrees, and wherein each straight side connects with the arc at an angle that is greater than 90 degrees; and

obtaining devolatilized polymer from the devolatilizer vessel.

25. The method of claim 24, wherein a majority of the strands exit the perforations at a maximum strand angle of equal to or less than 52.5 degrees.

26. The method of claim 24, wherein the devolatilized polymer is polystyrene comprising equal to or less than about 1000 ppm of styrene monomer.