CLAIMS

1. A distillation tower for separating a feed stream, the distillation tower comprising:

a controlled freeze zone section having a controlled freeze zone upper section and a controlled freeze zone lower section below the controlled freeze zone upper section, wherein the controlled freeze zone section is constructed and arranged to form a solid from a feed stream, wherein the controlled freeze zone section comprises:

(a) a spray assembly in the controlled freeze zone upper section;

(b) a melt tray assembly in the controlled freeze zone lower section; and

(c) a feed stream distribution mechanism between the spray assembly and the melt tray assembly,

wherein the feed stream comprises a liquid portion and a vapour portion;

wherein the feed stream distribution mechanism is constructed and arranged to uniformly distribute at least a portion of the feed stream in the controlled freeze zone section;

wherein the feed stream distribution mechanism comprises a pipe header having a plurality of orifices, that are distributed in pairs along a lower half of the pipe header, and wherein the upper half of the pipe header does not comprise orifices;

wherein the feed stream distribution mechanism is configured such that the plurality of orifices are angled downward towards the controlled freeze zone lower section and such that the pairs of orifices operate to direct the feed stream vapour portion downward when the feed stream vapour portion first exits the orifices and then direct the feed stream vapour portion upwards along the outer surface of the lower half of the pipe header towards the spray assembly; and

wherein the feed stream distribution mechanism operates to direct the liquid feed stream portion of the feed stream downward toward the melt tray assembly.

2. The distillation tower of claim 1, wherein the feed stream distribution mechanism is separate and distinct from the spray assembly and the melt tray assembly.

3. The distillation tower of claim 1 or 2, wherein the pipe header is one of H-shaped and X-shaped.

4. The distillation tower of claim 1 or 2, wherein the pipe header includes a first pipe and a second pipe that intersects the first pipe.

5. The distillation tower of claim 4,

wherein the controlled freeze zone section includes a controlled freeze zone wall,

wherein the first pipe extends from a first location of the controlled freeze zone wall to a second location of the controlled freeze zone wall, and

wherein the second pipe extends from a third location of the controlled freeze zone wall to a fourth location of the controlled freeze zone wall.

6. The distillation tower of claim 1, wherein the pipe header includes:

a first pipe,

a second pipe that intersects the first pipe,

a third pipe that intersects the second pipe, and

a fourth pipe that intersects the second pipe and is parallel to the third pipe.

7. The distillation tower of claim 6,

wherein the controlled freeze zone section includes a controlled freeze zone wall, and

wherein the first pipe extends from the controlled freeze zone wall to the second pipe.

8. The distillation tower of any one of claims 1 to 7, wherein the distillation tower further comprises an inlet channel that extends from the controlled freeze zone section and transports the feed stream into the controlled freeze zone section.

9. The distillation tower of claim 8,

wherein the feed stream comprises a hydrocarbon and a contaminant, and

wherein the feed stream contains less than or equal to 20% contaminant when transported into the controlled freeze zone section from the inlet channel.

10. A method of separating a feed stream in a distillation tower, the method comprising:

directly introducing a feed stream, wherein the feed stream comprises a vapour portion and a liquid portion, into a distillation tower via a controlled freeze zone section of the distillation tower;

operating the controlled freeze zone section at a temperature and pressure at which the feed stream forms a solid in the controlled freeze zone section;

uniformly distributing the feed stream introduced into the controlled freeze zone section with

a feed stream distribution mechanism that is below a spray assembly of the controlled freeze zone section and is above a melt tray assembly of the controlled freeze zone section; and

forming a solid from the feed stream in the controlled freeze zone section;

wherein the feed stream distribution mechanism comprises a pipe header having a plurality of orifices that are distributed in pairs along a length of the lower half of the pipe header and wherein the upper half of the pipe header does not comprise orifices;

wherein the feed stream distribution mechanism is configured such that the plurality of orifices are angled downwards towards the controlled freeze zone lower section and such that the pairs of orifices operate to direct the feed stream vapour portion downward when the feed stream vapour portion first exits the orifices and then direct the feed stream vapour portion upwards along the outer surface of the lower half of the pipe header towards the spray assembly; wherein the feed stream distribution mechanism operates to direct the liquid feed stream portion downward toward the melt tray assembly; and

wherein the temperature of the feed stream that flows through the feed stream distribution mechanism is warmer than the solid that forms in the controlled freeze zone section.

11. The method of claim 10, further comprising separating the vapour feed stream portion from the liquid feed stream portion before uniformly distributing the vapour feed stream portion and the liquid feed stream portion.

12. The method of claim 10, further comprising producing a hydrocarbon from the feed stream.

13. The method of claim 10, wherein the temperature of the feed stream within the feed stream distribution mechanism acts to prevent the formation of solids on the outer surface of the feed stream distribution mechanism.

14. The distillation tower of claim 1, wherein the feed stream distribution mechanism has a shape that minimizes the cross-section of the feed stream distribution along a lateral axis of the controlled freeze zone section.

15. The distillation tower of claim 1, wherein the distribution of the vapor phase through the orifices of the feed stream distribution mechanism and around the outer surface of the pipe header acts to prevent the formation of solids on the outer surface of the feed stream distribution mechanism.

16. The method of claim 10, wherein the distribution of the vapor phase through the orifices of the feed stream distribution mechanism and around the outer surface of the pipe header acts to prevent the formation of solids on the outer surface of the feed stream distribution mechanism.