CLAIMS

1. A method for separating a feed stream in a distillation tower comprising:

providing a distillation tower comprising a stripper section and a controlled freeze zone section, wherein the controlled freeze zone section comprises a lower section and an upper section, and wherein the controlled freeze zone section comprises a melt tray assembly in the lower section of the controlled freeze zone section;

introducing a feed stream into one of the stripper section and the controlled freeze zone section of the distillation tower, the feed stream comprising a hydrocarbon and a contaminant;

separating the feed stream in the stripper section into an enriched contaminant bottom liquid stream, comprising the contaminant, and a freezing zone vapor stream, comprising the hydrocarbon, at a temperature and pressure at which no solid forms;

contacting the freezing zone vapor stream in the controlled freeze zone section with a freezing zone liquid stream, comprising the hydrocarbon, at a temperature and pressure at which a solid, comprising the contaminant, and a hydrocarbon-enriched vapor stream, comprising the hydrocarbon, form;

directly applying heat to a controlled freeze zone vertical wall of the controlled freeze zone section with a heating mechanism coupled to at least one of a controlled freeze zone internal surface of the controlled freeze zone vertical wall and a controlled freeze zone external surface of the controlled freeze zone vertical wall, wherein the heating mechanism is coupled to the controlled freeze zone vertical wall above the melt tray assembly; and

at least one of destabilizing and preventing adhesion of the solid to the controlled freeze zone vertical wall with the heating mechanism.

2. The method of claim 1, wherein applying heat includes heating separate sections of the controlled freeze zone vertical wall with the heating mechanism.

3. The method of claim 1, wherein applying heat includes heating the upper section of the controlled freeze zone section.

4. The method of claim 1, wherein the heating mechanism comprises one of (a) a coil containing a fluid and (b) an electrical conductor.

5. The method of claim 1, further comprising detecting a temperature of the heating mechanism with a temperature sensor that is adjacent to the heating mechanism and coupled to at least one of the controlled freeze zone internal surface and the controlled freeze zone external surface.

6. The method of claim 1, further comprising melting or vaporizing the solid in the upper section of the controlled freeze zone section.

7. The method of claim 6, wherein the lower section of the controlled freeze zone section directly abuts and is separate from the upper section of the controlled freeze zone section and wherein the upper section of the controlled freeze zone section directly abuts and is separate from the lower section of the controlled freeze zone section.

8. The method of claim 1, further comprising producing the freezing zone liquid stream in a rectifier section of the distillation tower at a temperature and pressure at which substantially no solid forms.

9. The method of claim 8, wherein the distillation tower further comprises a rectifier section, and wherein at least one of the stripping section, the controlled freeze zone section, and the rectifier section are in a first vessel and another of the at least one of the stripping section, the controlled freeze zone section, and the rectifier section are in a second vessel that is separate from the first vessel.

10. A distillation tower that separates a contaminant in a feed stream from a hydrocarbon in the feed stream, the distillation tower comprising:

a stripper section constructed and arranged to separate a feed stream, comprising a contaminant and a hydrocarbon, into an enriched contaminant bottom liquid stream, comprising the contaminant, and a freezing zone vapor stream, comprising the

hydrocarbon, at a temperature and pressure at which no solids form; and

a controlled freeze zone section constructed and arranged to receive the freezing zone vapor stream from the stripper section and to contact the freezing zone vapor stream with a freezing zone liquid stream at a temperature and pressure at which a solid, comprising the contaminant, is formed;

wherein the controlled freeze zone section comprises a lower section and an upper section, where the upper section directly abuts and is separate from the lower section, and wherein the controlled freeze zone section further comprises:

a melt tray assembly in the lower section of the controlled freeze zone section that is constructed and arranged to melt a solid, comprising the contaminant, formed in the controlled freeze zone section;

a heating mechanism coupled to at least one of a controlled freeze zone internal surface of a controlled freeze zone vertical wall of the controlled freeze zone section and a controlled freeze zone external surface of the controlled freeze zone vertical wall that at least one of destabilizes and prevents adhesion of the solid to the controlled freeze zone vertical wall, wherein the heating mechanism is above the melt tray assembly and is in the upper section of the controlled freeze zone section.

11. The distillation tower of claim 10, wherein the heating mechanism comprises one of (a) a coil containing a fluid and (b) an electrical conductor, and wherein the distillation tower further comprises a temperature sensor adjacent to the heating mechanism and coupled to the controlled freeze zone internal surface or the controlled freeze zone external surface.

12. The distillation tower of claim 10, wherein the heating mechanism extends around an internal circumference of the controlled freeze zone internal surface or an external circumference of the controlled freeze zone external surface.

13. The distillation tower of claim 10, wherein the heating mechanism comprises a plurality of heating mechanisms, wherein each of the heating mechanisms is coupled to one of the controlled freeze zone internal surface and the controlled freeze zone external surface.

14. The distillation tower of claim 10, wherein the heating mechanism comprises a plurality of heating mechanisms and wherein at least one of the plurality of heating mechanisms is connected to another one of the plurality of heating mechanism.

15. The distillation tower of claim 10, further comprising a rectifier section constructed and arranged to operate at a temperature and pressure at which substantially no solid forms.

16. The distillation tower of claim 15, wherein at least one of the stripping section, the controlled freeze zone section, and the rectifier section are in a first vessel and another of the at least one of the stripping section, the controlled freeze zone section, and the rectifier section are in a second vessel that is separate from the first vessel.

17. The distillation tower of claim 16, wherein the stripping section and the controlled freeze zone section are in the first vessel and the rectifier section is in the second vessel that is separate from the first vessel.

18. A method for producing hydrocarbons comprising:

extracting a feed stream comprising a hydrocarbon and a contaminant from a reservoir;

introducing the feed stream into one of a stripper section and a controlled freeze zone section of a distillation tower;

separating the feed stream in the stripper section into an enriched contaminant bottom liquid stream, comprising the contaminant, and a freezing zone vapor stream, comprising the hydrocarbon, at a temperature and pressure at which no solid forms;

contacting the freezing zone vapor stream in the controlled freeze zone section with a freezing zone liquid stream, comprising the hydrocarbon, at a temperature and pressure at which the freezing zone vapor stream forms a solid, comprising the contaminant, and a hydrocarbon-enriched vapor stream, comprising the hydrocarbon;

accumulating at least a portion of the freezing zone liquid stream in a melt tray assembly in the controlled freeze zone section;

directly applying heat to a controlled freeze zone vertical wall of the controlled freeze zone section with a heating mechanism coupled to at least one of a controlled freeze zone internal surface of the controlled freeze zone vertical wall and a controlled freeze zone external surface of the controlled freeze zone vertical wall, wherein the heating mechanism is coupled to the controlled freeze zone vertical wall above the melt tray assembly;

at least one of destabilizing and preventing adhesion of the solid to the controlled freeze zone vertical wall with the heating mechanism;

removing the hydrocarbon-enriched vapor stream from the distillation tower; and

producing the hydrocarbon-enriched vapor stream extracted from the distillation tower.

19. The method of claim 18, wherein the heating mechanism comprises a plurality of heating mechanism and wherein applying heat includes heating separate sections of the controlled freeze zone vertical wall with the heating mechanisms.

20. The method of claim 18, wherein applying heat includes heating the upper section of the controlled freeze zone section.

21. The method of claim 18, wherein the heating mechanism comprises one of (a) a coil containing a fluid and (b) an electrical conductor.

22. The method of claim 18, further comprising detecting a temperature of the heating mechanism with a temperature sensor that is adjacent to the heating mechanism and coupled to at least one of the controlled freeze zone internal surface and the controlled freeze zone external surface.

23. The method of claim 18, further comprising melting or vaporizing the solid in at least one of a lower section of the controlled freeze zone section and an upper section of the controlled freeze zone section.

24. The method of claim 23, wherein applying heat includes heating the at least one of the lower section and the upper section of the controlled freeze zone section, wherein the lower section directly abuts and is separate from the upper section of the controlled freeze zone section and wherein the upper section directly abuts and is separate from the lower section of the controlled freeze zone section.

25. The method of claim 18, further comprising producing the freezing zone liquid stream in a rectifier section of the distillation tower at a temperature and pressure at which substantially no solid forms.

26. The method of claim 25, wherein at least one of the stripping section, the controlled freeze zone section and the rectifier section are in a first vessel and another of the at least one of the stripping section, the controlled freeze zone section and the rectifier section are in a second vessel that is separate from the first vessel.