CLAIMS:

1. A refrigerated cargo container comprising:

a cargo container;

a refrigeration unit; and

a plurality of refrigerant tubes in fluid communication with the refrigeration unit and extending along a roof of the cargo container, the plurality of refrigeration tubes configured to convey refrigerant there through and cool an interior of the cargo container via natural convection and/or thermal radiation.

2. The refrigerated cargo container of Claim 1, wherein the plurality of refrigerant tubes extends along an inner roof panel of the cargo container.

3. The refrigerated cargo container of Claim 2, wherein the inner roof panel is contoured to increase surface area.

4. The refrigerated cargo container of Claim 3, wherein the inner roof panel has a sinusoidal cross-section.

5. The refrigerated cargo container of Claim 2, wherein the inner roof panel includes a plurality of channels, each channel receptive of a refrigerant tube of the plurality of refrigerant tubes.

6. The refrigerated cargo container of Claim 1, wherein the plurality of refrigerant tubes are disposed at an angle nonparallel to horizontal.

7. The refrigerated cargo container of Claim 6, wherein disposing the plurality of refrigerant tubes at an angle nonparallel to horizontal directs condensate in a selected direction.

8. The refrigerated cargo container of Claim 7, wherein the plurality of refrigerant tubes are disposed to direct condensate toward a first end of the cargo container.

9. The refrigerated cargo container of Claim 1, wherein the plurality of refrigerant tubes extend from a header.

10. The refrigerated cargo container of Claim 1, wherein the refrigeration unit comprises:

a compressor;

a condenser in fluid communication with the compressor; and

an expansion valve in fluid communication with the condenser.

11. The refrigerated cargo container of Claim 10, wherein the plurality of refrigerant tubes are in fluid communication with the expansion valve and in fluid communication with the compressor.

12. The refrigerated cargo container of Claim 1, further comprising one or more refrigerant tubes extending along one or more sidewalls of the cargo container.

13. A method of cooling a cargo in a cargo container comprising:

flowing a refrigerant through a plurality of refrigerant tubes disposed at a roof of the cargo container;

transferring thermal energy from container air in the container to the refrigerant thereby cooling the container air;

circulating the container air via natural convection toward the cargo thereby cooling the cargo via thermal energy transfer to the container air; and

recirculating the container air toward the plurality of refrigerant tubes.

14. The method of Claim 13, further comprising transferring thermal energy between the plurality of refrigerant tubes and the cargo via thermal radiation.

15. The method of Claim 13, further comprising:

flowing the refrigerant from the refrigerant tubes through a compressor;

flowing the refrigerant from the compressor through a condenser;

flowing the refrigerant from the condenser through an expansion valve; and

flowing the refrigerant from the expansion valve into the plurality of refrigerant tubes.

16. The method of Claim 15, further comprising flowing the refrigerant from the expansion valve through a header and into the plurality of refrigerant tubes.

17. The method of Claim 13, further comprising flowing a volume of fresh air into the cargo container via a fan.

18. The method of Claim 17, wherein the fan is a condenser fan.

19. The method of Claim 13, further comprising flowing refrigerant through a plurality of refrigerant tubes disposed at one or more sidewalls of the cargo container.

20. The method of Claim 13, further comprising directing condensate toward a selected location in the cargo container.

21. The method of Claim 20, wherein the direction of condensate is achieved via:

disposing the plurality of refrigerant tubes at an angle nonparallel to horizontal; and

flowing the condensate toward the selected location via gravity.

22. A method of heating a cargo in a cargo container comprising:

heating a flow of refrigerant disposed in a plurality of tubes;

flowing the flow of refrigerant through the plurality of tubes at the cargo container;

transferring thermal energy from flow of refrigerant to container air in the container thereby heating the container air;

circulating the container air via natural convection toward the cargo thereby heating the cargo via thermal energy transfer from the container air; and

recirculating the container air toward the plurality of tubes.

23. The method of Claim 22, further comprising transferring thermal energy between the plurality of refrigerant tubes and the cargo via thermal radiation.

24. The method of Claim 22, further comprising:

flowing the refrigerant from the refrigerant tubes through a compressor;

flowing the refrigerant from the compressor through a condenser;

flowing the refrigerant from the condenser through an expansion valve; and

flowing the refrigerant from the expansion valve into the plurality of refrigerant tubes.

25. The method of Claim 24, further comprising flowing the refrigerant from the expansion valve through a header and into the plurality of refrigerant tubes.

26. The method of Claim 22, further comprising flowing a volume of fresh air into the cargo container via a fan.

27. The method of Claim 26, wherein the fan is a condenser fan.

28. The method of Claim 22, further comprising flowing refrigerant through a plurality of refrigerant tubes disposed at one or more sidewalls of the cargo container.

29. The method of Claim 22, further comprising directing condensate toward a selected location in the cargo container.

30. The method of Claim 29, wherein the direction of condensate is achieved via:

disposing the plurality of refrigerant tubes at an angle nonparallel to horizontal; and

flowing the condensate toward the selected location via gravity.

Claims

1. A refrigerated cargo container (10) comprising:

a cargo container (10);

a refrigeration unit (14); and

a plurality of refrigerant tubes (32) in fluid communication with the refrigeration unit (14) and extending along a roof (30) of the cargo container (10), the plurality of refrigeration tubes (32) configured to convey refrigerant there through and cool an interior of the cargo container (10) via natural convection and/or thermal radiation.

2. The refrigerated cargo container (10) of Claim 1, wherein the plurality of refrigerant tubes (32) extends along an inner roof panel (46) of the cargo container (10).

3. The refrigerated cargo container (10) of claim 2, wherein the inner roof panel (46) is contoured to increase surface area, wherein the inner roof panel (46) in particular has sinusoidal cross-section.

4. The refrigerated cargo container (10) of Claim 2, wherein the inner roof panel (46) includes a plurality of channels (52), each channel (52) receptive of a refrigerant tube of the plurality of refrigerant tubes (32).

5. The refrigerated cargo container (10) of Claim 1, wherein the plurality of refrigerant tubes (32) are disposed at an angle nonparallel to horizontal.

6. The refrigerated cargo container (10) of Claim 1, wherein the plurality of refrigerant tubes (32) extend from a header (38).

7. The refrigerated cargo container (10) of Claim 1, wherein the refrigeration unit (14) comprises:

a compressor (16);

a condenser (18) in fluid communication with the compressor (16); and

an expansion valve (20) in fluid communication with the condenser (18) ,

and wherein the plurality of refrigerant tubes (32) are in fluid communication with the expansion valve (20) and in fluid communication with the compressor (16).

8. The refrigerated cargo container (10) of Claim 1, further comprising one or more refrigerant tubes (32) extending along one or more sidewalls (26) of the cargo container (10).

9. A method of cooling a cargo (12) in a cargo container (10) comprising:

flowing a refrigerant from a refrigeration unit (14) located at the cargo container (10) through a plurality of refrigerant tubes (32) disposed at a roof (30) of the cargo container (10);

transferring thermal energy from container air in the container (10) to the refrigerant thereby cooling the container air;

circulating the container air via natural convection toward the cargo (12) thereby cooling the cargo (12) via thermal energy transfer to the container air; and

recirculating the container air toward the refrigeration unit (14).

10. A method of heating a cargo (12) in a cargo container (10) comprising:

heating a flow of refrigerant disposed in a plurality of tubes (32);

flowing the flow of refrigerant through the plurality of tubes (32) at the cargo container (10);

transferring thermal energy from flow of refrigerant to container air in the container thereby heating the container air;

circulating the container air via natural convection toward the cargo (12) thereby heating the cargo (12) via thermal energy transfer from the container air; and

recirculating the container air toward the plurality of tubes (32).

11. The method of claim 9 or 10, further comprising transferring thermal energy between the plurality of refrigerant tubes (32) and the cargo (12) via thermal radiation.

12. The method of claim 9 or 10, further comprising:

flowing the refrigerant from the refrigerant tubes (32) through a compressor (16);

flowing the refrigerant from the compresser (16) through a condenser (18);

flowing the refrigerant from the condenser (18) through an expansion valve (20); and

flowing the refrigerant from the expansion valve (20) into the plurality of refrigerant tubes (32).

13. The method of Claim 12, further comprising flowing the refrigerant from the expansion valve (20) through a header (38) and into the plurality of refrigerant tubes (32).

14. The method of Claim 9 or 10, further comprising flowing a volume of fresh air into the cargo container (10) via a fan (44) ,
Wherein the fan (44) in particular is a condenser fan (44).

15. The method of Claim 9 or 10, further comprising flowing refrigerant through a plurality of refrigerant tubes (32) disposed at one or more sidewalls (26) of the cargo container (10) ,
and/or further comprising directing condensate toward a selected location in the cargo container (10).