

Claims

1. A composition comprising:
 - (i) 1,1-difluoroethene (vinylidene fluoride, R-1132a);
 - 5 (ii) difluoromethane (R-32); and
 - (iii) 2,3,3,3-tetrafluoropropene (R-1234yf).
2. A composition according to claim 1 comprising from about 1 to about 50% by weight R-1132a.
- 10 3. A composition according to claim 2 comprising from about 2 to about 50% by weight R-1132a.
4. A composition according to claim 2 comprising from about 1 to about 40% by weight R-1132a.
- 15 5. A composition according to claims 3 or 4 comprising from about 2 to about 40% by weight R-1132a.
- 20 6. A composition according to claim 4 comprising from about 1 to about 30% by weight R-1132a.
7. A composition according to claims 5 or 6 comprising from about 2 to about 30% by weight R-1132a.
- 25 8. A composition according to claims 6 or 7 comprising from about 3 to about 20% by weight R-1132a.
9. A composition according to claim 8 comprising from about 5 to about 20% by weight R-1132a.
- 30 10. A composition according to any of the preceding claims comprising from about 1 to about 99% by weight R-32.
- 35 11. A composition according to claim 10 comprising from about 2 to about 98% by weight R-32.

12. A composition according to claims 10 or 11 comprising from about 5 to about 90% by weight R-32.
13. A composition according to claim 12 comprising from about 10 to about 80% by weight R-32.
14. A composition according to claim 13 comprising from about 15 to about 70% by weight R-32.
15. A composition according to any of the preceding claims comprising from about 1 to about 99% by weight R-1234yf.
16. A composition according to claim 15 comprising from about 2 to about 98% by weight R-1234yf.
17. A composition according to claims 15 or 16 comprising from about 5 to about 90% by weight R-1234yf.
18. A composition according to claim 17 comprising from about 10 to about 75% by weight R-1234yf.
19. A composition according to claim 18 comprising from about 10 to about 65% by weight R-1234yf.
20. A composition according to Claim 1 comprising from about 1 to about 50% by weight R-1132a, from about 2 to about 97% by weight R-32, and from about 2 to about 97% by weight R-1234yf.
21. A composition according to claim 20 comprising from about 2 to about 40% by weight R-1132a, from about 4 to about 94% by weight R-32, and from about 4 to about 94% by weight R-1234yf.
22. A composition according to claim 21 comprising from about 3 to about 30% by weight R-1132a, from about 10 to about 91% by weight R-32 and from about 6 to about 87% by weight R-1234yf.

23. A composition according to claim 22 comprising from about 4 to about 25% by weight R-1132a, from about 15 to about 88% by weight R-32 and from about 8 to about 81% by weight R-1234yf.

5 24. A composition according to any of the preceding claims further comprising carbon dioxide (CO₂, R-744), optionally wherein the CO₂ is present in an amount of from about 1 to about 30% by weight, such as from about 2 to about 20% by weight.

25. A composition according to claim 24 wherein the R-1132a and CO₂ are present in
10 a combined amount of from about 2 to about 50% by weight, such as from about 2 to about 40% by weight, for instance from about 4 to about 30% by weight, e.g. from about 5 to about 20% by weight.

26. A composition according to any of the preceding claims further comprising 1,1,2-
15 trifluoroethene (R-1123), optionally wherein the R-1123 is present in an amount of from about 1 to about 30% by weight, such as from about 5 to about 20% by weight.

27. A composition according to any of claims 1 to 25, wherein the composition is substantially free of 1,1,2-trifluoroethene (R-1123).

20 28. A composition according to claim 27, wherein the composition contains no 1,1,2-trifluoroethene (R-1123).

29. A composition according to any of the preceding claims consisting essentially of
25 the stated components.

30. A composition according to any of the preceding claims, wherein the composition is less flammable than R-1132a alone.

30 31. A composition according to claim 30 wherein the composition has:

- a. a higher flammable limit'
 - b. a higher ignition energy; and/or
 - c. a lower flame velocity
- compared to R-1132a alone.

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32. A composition according to any of the preceding claims wherein the composition is non-flammable.

33. A composition according to claim 32 wherein the composition is non-flammable at ambient temperature, preferably wherein the composition is non-flammable at 60 °C.
34. A composition according to any of the preceding claims wherein the composition
5 has a volumetric refrigeration capacity that is at least 90% of that of R-410A.
35. A composition according to any of the preceding claims wherein the composition has a coefficient of performance (COP) that is equivalent or higher to that of R-410A.
- 10 36. A composition according to any of the preceding claims wherein the composition has an operating pressure in a condenser equal to or lower than that of R-32.
37. A composition according to any of the preceding claims wherein the composition has a compressor discharge temperature that is lower than that of R-32.
- 15 38. A composition according to any of the preceding claims wherein the composition has a temperature glide in an evaporator or condenser of less than about 10K, preferably less than about 5K.
- 20 39. A composition according to any of the preceding claims wherein the composition has a burning velocity of less than about 10 cm/s as measured by ASHRAE Standard 34.
40. A composition comprising a lubricant and a composition according to any of the preceding claims.
- 25 41. A composition according to claim 40, wherein the lubricant is selected from mineral oil, silicone oil, polyalkyl benzenes (PABs), polyol esters (POEs), polyalkylene glycols (PAGs), polyalkylene glycol esters (PAG esters), polyvinyl ethers (PVEs), poly (alpha-olefins) and combinations thereof, preferably wherein the lubricant is selected from PAGs
30 or POEs.
42. A composition comprising a stabiliser and a composition according to any of the preceding claims.
- 35 43. A composition according to claim 42, wherein the stabiliser is selected from diene-based compounds, phosphates, phenol compounds and epoxides, and mixtures thereof.

44. A composition comprising a flame retardant and a composition according to any of the preceding claims.

45. A composition according to claim 44, wherein the flame retardant is selected from the group consisting of tri-(2-chloroethyl)-phosphate, (chloropropyl) phosphate, tri-(2,3-dibromopropyl)-phosphate, tri-(1,3-dichloropropyl)-phosphate, diammonium phosphate, various halogenated aromatic compounds, antimony oxide, aluminium trihydrate, polyvinyl chloride, a fluorinated iodocarbon, a fluorinated bromocarbon, trifluoro iodomethane, perfluoroalkyl amines, bromo-fluoroalkyl amines and mixtures thereof.

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46. A heat transfer device containing a composition as defined in any one of claims 1 to 45.

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47. A heat transfer device according to claim 46 wherein the heat transfer device is a refrigeration device.

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48. A heat transfer device according to claim 46 or 47 wherein the heat transfer device comprises a residential or commercial air conditioning system, a heat pump or a commercial or industrial refrigeration system.

49. Use of a composition as defined in any one of claims 1 to 45 in a heat transfer device, preferably in a refrigeration device.

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50. A sprayable composition comprising material to be sprayed and a propellant comprising a composition as defined in any of claims 1 to 45.

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51. A method for cooling an article which comprises condensing a composition defined in any of claims 1 to 45 and thereafter evaporating the composition in the vicinity of the article to be cooled.

52. A method for heating an article which comprises condensing a composition as defined in any one of claims 1 to 45 in the vicinity of the article to be heated and thereafter evaporating the composition.

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53. A method for extracting a substance from biomass comprising contacting biomass with a solvent comprising a composition as defined in any of claims 1 to 45, and separating the substance from the solvent.

54. A method of cleaning an article comprising contacting the article with a solvent comprising a composition as defined in any of claims 1 to 45.
- 5 55. A method of extracting a material from an aqueous solution or from a particulate solid matrix comprising contacting the aqueous solution or the particulate solid matrix with a solvent comprising a composition as defined in any of claims 1 to 45, and separating the material from the solvent.
- 10 56. A mechanical power generation device containing a composition as defined in any of claims 1 to 45.
57. A mechanical power generating device according to claim 56 which is adapted to use a Rankine Cycle or modification thereof to generate work from heat.
- 15 58. A method of retrofitting a heat transfer device comprising the step of removing an existing heat transfer composition, and introducing a composition as defined in any one of claims 1 to 45.
- 20 59. A method of claim 58 wherein the heat transfer device is a commercial or industrial refrigeration device, a heat pump, or a residential or commercial air conditioning system.
60. A method for reducing the environmental impact arising from the operation of a product comprising an existing compound or composition, the method comprising
25 replacing at least partially the existing compound or composition with a composition as defined in any one of claims 1 to 45.
61. A method of claim 60 wherein the use of the composition of the invention results in a lower Total Equivalent Warming Impact, and/or a lower Life-Cycle Carbon Production
30 than is attained by use of the existing compound or composition.
62. A method of claim 60 or 61 carried out on a product from the fields of air-conditioning, refrigeration, heat transfer, aerosols or sprayable propellants, gaseous dielectrics, flame suppression, solvents, cleaners, topical anesthetics, and expansion applications.
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63. A method according to claim 60 or 61 wherein the product is selected from a heat transfer device, a sprayable composition, a solvent or a mechanical power generation device, preferably a heat transfer device.

5 64. A method according to claim 63 wherein the product is a heat transfer device, preferably a residential or commercial air conditioning system, a heat pump or a commercial or industrial refrigeration system.

65. A method according to any of claims 58 to 64 wherein the existing compound or
10 composition is a heat transfer composition, preferably wherein the heat transfer composition is a refrigerant selected from R-410A, R-454B, R-452B and R-32.

66. Any novel heat transfer composition substantially as hereinbefore described, optionally with reference to the examples.

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