Currently proposed replacement refrigerants for HFC-134a include HFC-152a, pure hydrocarbons such as butane or propane, or "natural" refrigerants such as CO_2. Many of these suggested replacements are toxic, flammable, and/or have low energy efficiency. Therefore, new alternative refrigerants are being sought.

The object of the present invention is to provide novel refrigerant compositions and heat transfer fluid compositions that provide unique characteristics to meet the demands of low or zero ozone depletion potential and lower global warming potential as compared to current refrigerants.

SUMMARY

The present disclosure relates to a composition comprising HFC-1225ye and at least one compound selected from the group consisting of:
HFC-1234ze, HFC-1234yf, HFC-1234ye, HFC-1243zf, HFC-32, HFC-125, HFC-134, HFC-134a, HFC-143a, HFC-152a, HFC-161, HFC-227ea, HFC-236ea, HFC-236fa, HFC-245fa, HFC-365mfc, propane, n-butane, isobutane, 2-methylbutane, n-pentane, cyclopentane, dimethylether, CF_3SCF_3, CO_2 and CF_3I.

In one aspect, there is provided an azeotropic or near-azeotropic composition comprising HFC-1234yf and HFC-32.

The present disclosure further relates to a composition comprising HFC-1234ze and at least one compound selected from the group consisting of: HFC-1234yf, HFC-1234ye, HFC-1243zf, HFC-32, HFC-125, HFC-134, HFC-134a, HFC-143a, HFC-152a, HFC-161, HFC-227ea, HFC-236ea, HFC-236fa, HFC-245fa, HFC-365mfc, propane, n-butane, isobutane, 2-methylbutane, n-pentane, cyclopentane, dimethylether, CF_3SCF_3, CO_2 and CF_3I.

The present disclosure further relates to a composition comprising HFC-1234yf and at least one compound selected from the group consisting of: HFC-1234ye, HFC-1243zf, HFC-32, HFC-125, HFC-134, HFC-134a, HFC-143a, HFC-152a, HFC-161, HFC-227ea, HFC-236ea, HFC-236fa, HFC-245fa, HFC-365mfc, propane, n-butane, isobutane, 2-methylbutane, n-pentane, cyclopentane, dimethylether, CF_3SCF_3, CO_2 and CF_3I.

The present disclosure further relates to a composition comprising HFC-1234ye and at least one compound selected from the group consisting of: HFC-1243zf, HFC-32, HFC-125, HFC-134, HFC-134a, HFC-143a, HFC-152a, HFC-161, HFC-227ea, HFC-236ea, HFC-236fa, HFC-245fa, HFC-365mfc, propane, n-butane, isobutane, 2-methylbutane, n-pentane, cyclopentane, dimethylether, CF_3SCF_3, CO_2 and CF_3I.

The present disclosure further relates to a composition comprising HFC-1243zf and at least one compound selected from the group consisting of: HFC-32, HFC-125, HFC-134, HFC-134a, HFC-143a, HFC-152a, HFC-161, HFC-227ea, HFC-236ea, HFC-236fa, HFC-245fa, HFC-365mfc, propane, n-butane, isobutane, 2-methylbutane, n-pentane, cyclopentane, dimethylether, CF_3SCF_3, CO_2 and CF_3I.

The present disclosure further relates to a composition comprising:

(a) at least one lubricant selected from the group consisting of polyol esters, polyalkylene glycol, polyvinyl ethers, mineral oils, alkylbenzenes, synthetic paraffins, synthetic napthenes, and poly(alpha)olefins; and

(b) a composition selected from the group consisting of:

about 1 weight percent to about 99 weight percent HFC-1225ye and about 99 weight percent to about 1 weight percent HFC-152a;

about 1 weight percent to about 99 weight percent HFC-1225ye and about 99 weight percent to about 1 weight percent HFC-1234yf;

about 1 weight percent to about 99 weight percent HFC-1225ye and about 99 weight percent to about 1 weight percent trans-HFC-1234ze;

about 1 weight percent to about 99 weight percent HFC-1225ye and about 99 weight percent to about 1 weight percent HFC-1243zf;

about 1 weight percent to about 99 weight percent trans-HFC-1234ze and about 99 weight percent to about 1 weight percent HFC-134a;

about 1 weight percent to about 99 weight percent trans-HFC-1234ze and about 99 weight percent to about 1 weight percent HFC-152a;

about 1 weight percent to about 99 weight percent trans-HFC-1234ze and about 99 weight percent to about 1 weight percent HFC-227ea; and

about 1 weight percent to about 99 weight percent trans-HFC-1234ze and about 99 weight percent to about 1 weight percent CF_3I.

The present disclosure further relates to a composition comprising:

a) a refrigerant or heat transfer fluid composition selected from the group consisting of:

about 1 weight percent to about 99 weight percent HFC-1225ye and about 99 weight percent to about 1 weight percent HFC-152a;

about 1 weight percent to about 99 weight percent HFC-1225ye and about 99 weight percent to about 1 weight percent HFC-1234yf;

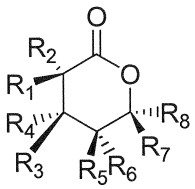
about 1 weight percent to about 99 weight percent HFC-1225ye and about 99 weight percent to about 1 weight percent trans-HFC-1234ze;

about 1 weight percent to about 99 weight percent HFC-1225ye and about 99 weight percent to about 1 weight percent HFC-1243zf;

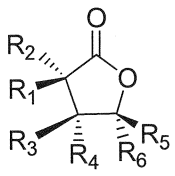
about 1 weight percent to about 99 weight percent trans-HFC-1234ze and about 99 weight percent to about 1 weight percent HFC-134a;

about 1 weight percent to about 99 weight percent trans-HFC-1234ze and about 99 weight percent to about 1 weight percent HFC-152a;

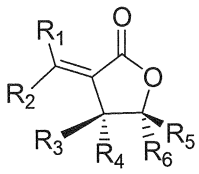
about 1 weight percent to about 99 weight percent trans-HFC-1234ze and about 99 weight percent to about 1 weight percent HFC-227ea; and



[B]



[C]



[D]

wherein, R_1 through R_8 are independently selected from hydrogen, linear, branched, cyclic, bicyclic, saturated and unsaturated hydrocarbyl radicals; and the molecular weight is from about 100 to about 300 atomic mass units; and

x) esters represented by the general formula $R^1CO_2R^2$, wherein R^1 and R^2 are independently selected from linear and cyclic, saturated and unsaturated, alkyl and aryl radicals; and wherein said esters have a molecular weight of from about 80 to about 550 atomic mass units.

The present disclosure further relates to a composition comprising:

(a) at least one ultra-violet fluorescent dye selected from the group consisting of naphthalimides, perylenes, coumarins, anthracenes, phenanthracenes, xanthenes, thioxanthenes, naphthoxanthenes, fluoresceins, derivatives of said dye and combinations thereof; and

(b) a composition selected from the group consisting of:

about 1 weight percent to about 99 weight percent HFC-1225ye and about 99 weight percent to about 1 weight percent HFC-152a;

about 1 weight percent to about 99 weight percent HFC-1225ye and about 99 weight percent to about 1 weight percent HFC-1234yf;

about 1 weight percent to about 99 weight percent HFC-1225ye and about 99 weight percent to about 1 weight percent trans-HFC-1234ze;

about 1 weight percent to about 99 weight percent HFC-1225ye and about 99 weight percent to about 1 weight percent HFC-1243zf;

about 1 weight percent to about 99 weight percent trans-HFC-1234ze and about 99 weight percent to about 1 weight percent HFC-134a;

about 1 weight percent to about 99 weight percent trans-HFC-1234ze and about 99 weight percent to about 1 weight percent HFC-152a;

about 1 weight percent to about 99 weight percent trans-HFC-1234ze and about 99 weight percent to about 1 weight percent HFC-227ea; and

about 1 weight percent to about 99 weight percent trans-HFC-1234ze and about 99 weight percent to about 1 weight percent CF_3I.

The present disclosure further relates to a method of solubilizing a refrigerant or heat transfer fluid composition in a refrigeration lubricant selected from the group consisting of mineral oils, alkylbenzenes, synthetic paraffins, synthetic napthenes, and poly(alpha)olefins, wherein said method comprises contacting said lubricant with said refrigerant or heat transfer fluid composition in the presence of an effective amount of a compatibilizer, wherein said refrigerant or heat transfer fluid comprises a composition selected from the group consisting of:

about 1 weight percent to about 99 weight percent HFC-1225ye and about 99 weight percent to about 1 weight percent HFC-152a;

about 1 weight percent to about 99 weight percent HFC-1225ye and about 99 weight percent to about 1 weight percent HFC-1234yf;

about 1 weight percent to about 99 weight percent HFC-1225ye and about 99 weight percent to about 1 weight percent trans-HFC-1234ze;

about 1 weight percent to about 99 weight percent HFC-1225ye and about 99 weight percent to about 1 weight percent HFC-1243zf;

about 1 weight percent to about 99 weight percent trans-HFC-1234ze and about 99 weight percent to about 1 weight percent HFC-134a;

wherein, R_1 through R_8 are independently selected from hydrogen, linear, branched, cyclic, bicyclic, saturated and unsaturated hydrocarbyl radicals; and the molecular weight is from about 100 to about 300 atomic mass units; and

j) esters represented by the general formula $R^1CO_2R^2$, wherein R^1 and R^2 are independently selected from linear and cyclic, saturated and unsaturated, alkyl and aryl radicals; and wherein said esters have a molecular weight of from about 80 to about 550 atomic mass units.

The present disclosure further relates to a method for replacing a high GWP refrigerant in a refrigeration, air-conditioning, or heat pump apparatus, wherein said high GWP refrigerant is selected from the group consisting of R134a, R22, R123, R11, R245fa, R114, R236fa, R124, R12, R410A, R407C, R417A, R422A, R507A, R502, and R404A, said method comprising providing a composition selected from the group consisting of:

about 1 weight percent to about 99 weight percent HFC-1225ye and about 99 weight percent to about 1 weight percent HFC-152a;

about 1 weight percent to about 99 weight percent HFC-1225ye and about 99 weight percent to about 1 weight percent HFC-1234yf;

about 1 weight percent to about 99 weight percent HFC-1225ye and about 99 weight percent to about 1 weight percent trans-HFC-1234ze;

about 1 weight percent to about 99 weight percent HFC-1225ye and about 99 weight percent to about 1 weight percent HFC-1243zf;

about 1 weight percent to about 99 weight percent trans-HFC-1234ze and about 99 weight percent to about 1 weight percent HFC-134a;

about 1 weight percent to about 99 weight percent trans-HFC-1234ze and about 99 weight percent to about 1 weight percent HFC-152a;

about 1 weight percent to about 99 weight percent trans-HFC-1234ze and about 99 weight percent to about 1 weight percent HFC-227ea; and

about 1 weight percent to about 99 weight percent trans-HFC-1234ze and about 99 weight percent to about 1 weight percent CF_3I;

to said refrigeration, air-conditioning, or heat pump apparatus that uses, used or designed to use said high GWP refrigerant.

The present disclosure further relates to a method for early detection of a refrigerant leak in a refrigeration, air-conditioning or heat pump apparatus said method comprising using a non-azeotropic composition in said apparatus, and monitoring for a reduction in cooling performance.

In another aspect, there is provided a method of producing cooling, said method comprising: evaporating said composition as disclosed herein in the vicinity of a body to be cooled and thereafter condensing said composition.

In yet another aspect, there is provided a method of producing heat, said method comprising: condensing said composition as disclosed herein in the vicinity of a body to be heated and thereafter evaporating said composition.

In a further aspect, there is provided a method for detecting the composition as disclosed herein in a compression refrigeration, air conditioning, or heat pump apparatus, said method comprising providing said composition to said apparatus, and providing a suitable means for detecting said composition at a leak point or in the vicinity of said apparatus.

In another aspect, there is provided a method for improving oil-return to the compressor in a compression refrigeration, air-conditioning or heat pump apparatus, said method comprising using the composition as disclosed herein in said apparatus.

In another aspect, there is provided a method for replacing a high GWP refrigerant in a refrigeration, air-conditioning, or heat pump apparatus, wherein said high GWP refrigerant is selected from the group consisting of R134a, R22, R123, R11, R245fa, R114, R236fa, R124, R12, R410A, R407C, R417A, R422A, R507A, R502, and R404A, said method comprising providing the composition as disclosed herein to said

refrigeration, air-conditioning, or heat pump apparatus that uses, used or is designed to use said high GWP refrigerant.

In yet another aspect, there is provided a method of using the composition as disclosed herein as a heat transfer fluid composition, said process comprising transporting said composition from a heat source to a heat sink.

In a further aspect, there is provided a refrigeration, air-conditioning, or heat pump apparatus containing a composition as disclosed herein.

In another aspect, there is provided a foam blowing agent comprising the composition as disclosed herein.

In another aspect, there is provided a method of forming a foam comprising: (a) adding to a foamable composition the composition as disclosed herein; and (b) reacting the foamable composition under conditions effective to form a foam.

In yet another aspect, there is provided a sprayable composition comprising the composition as disclosed herein.

In a further aspect, there is provided a process for producing aerosol products comprising the step of adding a composition as disclosed herein to active ingredients in an aerosol container, wherein said composition functions as a propellant.

DETAILED DESCRIPTION OF THE INVENTION

The present invention relates to compositions comprising at least one fluoroolefin. The compositions of the present invention further comprise at least one additional component that may be a second fluoroolefin, hydrofluorocarbon (HFC), hydrocarbon, dimethyl ether, bis(trifluoromethyl)sulfide, CF_3I, or CO_2. The fluoroolefin compounds and other components of the present inventive compositions are listed in Table 1.

TABLE 1

Compound	Chemical name	Chemical formula
HFC-1225ye	1,2,3,3,3-pentafluoropropene	$CF_3CF=CHF$
HFC-1234ze	1,3,3,3-tetrafluoropropene	$CF_3CH=CHF$
HFC-1234yf	2,3,3,3-tetrafluoropropene	$CF_3CF=CH_2$
HFC-1234ye	1,2,3,3-tetrafluoropropene	$CHF_2CF=CHF$

HFC-1243zf	3,3,3-trifluoropropene	$CF_3CH=CH_2$
HFC-32	difluoromethane	CH_2F_2
HFC-125	pentafluoroethane	CF_3CHF_2
HFC-134	1,1,2,2-tetrafluoroethane	CHF_2CHF_2
HFC-134a	1,1,1,2-tetrafluoroethane	CH_2FCF_3
HFC-143a	1,1,1-trifluoroethane	CH_3CF_3
HFC-152a	1,1-difluoroethane	CHF_2CH_3

CLAIMS

What is claimed is:

1. An azeotropic or near-azeotropic composition comprising HFC-1234yf and HFC-32.

2. The composition of claim 1 comprising a composition selected from the group consisting of:

about 1 weight percent to about 57 weight percent HFC-1234yf and about 99 weight percent to about 43 weight percent HFC-32;

about 1 weight percent to about 98 weight percent HFC-32, about 1 weight percent to about 98 weight percent HFC-125, and about 1 weight percent to about 55 weight percent HFC-1234yf;

about 1 weight percent to about 50 weight percent HFC-1234yf, about 1 weight percent to about 98 weight percent HFC-32 and about 1 weight percent to about 98 weight percent HFC-143a; and

about 1 weight percent to about 40 weight percent HFC-1234yf, about 59 weight percent to about 98 weight percent HFC-32 and about 1 weight percent to about 30 weight percent isobutane.

3. The composition of claim 1 or 2 comprising an azeotropic composition selected from the group consisting of:

7.4 weight percent HFC-1234yf and 92.6 weight percent HFC-32 having a vapor pressure of about 49.2 psia (339 kPa) at a temperature of about -25 °C;

3.9 weight percent HFC-1234yf, 74.3 weight percent HFC-32, and 21.8 weight percent HFC-143a having a vapor pressure of about 50.0 psia (345 kPa) at a temperature of about -25 °C; and

1.1 weight percent HFC-1234yf, 92.1 weight percent HFC-32 and 6.8 weight percent isobutane having a vapor pressure of about 50.0 psia (345 kPa) at a temperature of about -25 °C.

4. The composition as in any of claims 1-3, further comprising a lubricant selected from the group consisting of polyol esters, polyalkylene glycols, polyvinyl ethers, mineral oil, alkylbenzenes, synthetic paraffins, synthetic napthenes, and poly(alpha)olefins.

5. The composition as in any of claims 1-4, further comprising a tracer selected from the group consisting of hydrofluorocarbons, deuterated hydrocarbons, deuterated hydrofluorocarbons, perfluorocarbons, fluoroethers, brominated compounds, iodated compounds, alcohols, aldehydes, ketones, nitrous oxide (N_2O) and combinations thereof.

6. The composition as in any of claims 1-4, further comprising a compatibilizer selected from the group consisting of:

a) polyoxyalkylene glycol ethers represented by the formula $R^1[(OR^2)_xOR^3]_y$, wherein: x is an integer from 1 to 3; y is an integer from 1 to 4; R^1 is selected from hydrogen and aliphatic hydrocarbon radicals having 1 to 6 carbon atoms and y bonding sites; R^2 is selected from aliphatic hydrocarbylene radicals having from 2 to 4 carbon atoms; R^3 is selected from hydrogen, and aliphatic and alicyclic hydrocarbon radicals having from 1 to 6 carbon atoms; at least one of R^1 and R^3 is selected from said hydrocarbon radicals; and wherein said polyoxyalkylene glycol ethers have a molecular weight of from about 100 to about 300 atomic mass units;

b) amides represented by the formulae $R^1C(O)NR^2R^3$ and cyclo-$[R^4CON(R^5)-]$, wherein R^1, R^2, R^3 and R^5 are independently selected from aliphatic and alicyclic hydrocarbon radicals having from 1 to 12 carbon atoms, and at most one aromatic radical having from 6 to 12 carbon atoms; R^4 is selected from aliphatic hydrocarbylene radicals having from 3 to 12 carbon atoms; and wherein said amides have a molecular weight of from about 100 to about 300 atomic mass units;

c) ketones represented by the formula $R^1C(O)R^2$, wherein R^1 and R^2 are independently selected from aliphatic, alicyclic and aryl hydrocarbon radicals having from 1 to 12 carbon atoms, and wherein said ketones have a molecular weight of from about 70 to about 300 atomic mass units;

d) nitriles represented by the formula R^1CN, wherein R^1 is selected from aliphatic, alicyclic or aryl hydrocarbon radicals having from 5 to 12 carbon atoms, and wherein said nitriles have a molecular weight of from about 90 to about 200 atomic mass units;

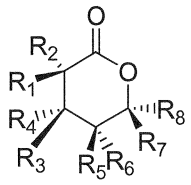
e) chlorocarbons represented by the formula RCl_x, wherein; x is 1 or 2; R is selected from aliphatic and alicyclic hydrocarbon radicals having from 1 to 12 carbon atoms; and wherein said chlorocarbons have a molecular weight of from about 100 to about 200 atomic mass units;

f) aryl ethers represented by the formula R^1OR^2, wherein: R^1 is selected from aryl hydrocarbon radicals having from 6 to 12 carbon atoms; R^2 is selected from aliphatic hydrocarbon radicals having from 1 to 4 carbon atoms; and wherein said aryl ethers have a molecular weight of from about 100 to about 150 atomic mass units;

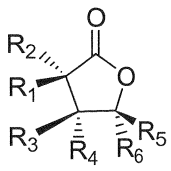
g) 1,1,1-trifluoroalkanes represented by the formula CF_3R^1, wherein R^1 is selected from aliphatic and alicyclic hydrocarbon radicals having from about 5 to about 15 carbon atoms;

h) fluoroethers represented by the formula $R^1OCF_2CF_2H$, wherein R^1 is selected from aliphatic, alicyclic, and aromatic hydrocarbon radicals having from about 5 to about 15 carbon atoms; or wherein said fluoroethers are derived from fluoroolefins and polyols, wherein said fluoroolefins are of the type $CF_2=CXY$, wherein X is hydrogen, chlorine or fluorine, and Y is chlorine, fluorine, CF_3 or OR_f, wherein R_f is CF_3, C_2F_5, or C_3F_7; and said polyols are linear or branched, wherein said linear polyols are of the type $HOCH_2(CHOH)_x(CRR')_yCH_2OH$, wherein R and R' are hydrogen, CH_3 or C_2H_5, x is an integer from 0-4, y is an integer from 0-3 and z is either zero or 1, and said branched polyols are of the type $C(OH)_t(R)_u(CH_2OH)_v[(CH_2)_mCH_2OH]_w$, wherein R may be hydrogen, CH_3 or C_2H_5, m is an integer from 0 to 3, t and u are 0 or 1, v and w are integers from 0 to 4, and also wherein t + u + v + w = 4; and

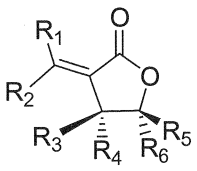
i) lactones represented by structures [B], [C], and [D]:



[B]



[C]



[D]

wherein, R_1 through R_8 are independently selected from hydrogen, linear, branched, cyclic, bicyclic, saturated and unsaturated hydrocarbyl radicals; and the molecular weight is from about 100 to about 300 atomic mass units; and

j) esters represented by the general formula $R^1CO_2R^2$, wherein R^1 and R^2 are independently selected from linear and cyclic, saturated and unsaturated, alkyl and

aryl radicals; and wherein said esters have a molecular weight of from about 80 to about 550 atomic mass units.

7. The composition any of claims 1-5, further comprising at least one ultra-violet fluorescent dye selected from the group consisting of naphthalimides, perylenes, coumarins, anthracenes, phenanthracenes, xanthenes, thioxanthenes, naphthoxanthenes, fluoresceins, derivatives of said dye and combinations thereof.

8. The composition of claim 7, further comprising at least one solubilizing agent selected from the group consisting of hydrocarbons, dimethylether, polyoxyalkylene glycol ethers, amides, ketones, nitriles, chlorocarbons, esters, lactones, aryl ethers, hydrofluoroethers, and 1,1,1-trifluoroalkanes.

9. The composition of any of claims 1-8, further comprising a stabilizer, water scavenger, or odor masking agent.

10. The composition of claim 9, wherein said stabilizer is selected from the group consisting of nitromethane, hindered phenols, hydroxylamines, thiols, phosphites and lactones.

11. A method of producing cooling, said method comprising: evaporating said composition of any of claims 1-3 in the vicinity of a body to be cooled and thereafter condensing said composition.

12. A method of producing heat, said method comprising: condensing said composition of any of claims 1-3 in the vicinity of a body to be heated and thereafter evaporating said composition.

13. A method for detecting the composition of any of claims 7-8 in a compression refrigeration, air conditioning, or heat pump apparatus, said method comprising providing said composition to said apparatus, and providing a suitable means for detecting said composition at a leak point or in the vicinity of said apparatus.

14. A method for improving oil-return to the compressor in a compression refrigeration, air-conditioning or heat pump apparatus, said method comprising using the composition of claim 6 in said apparatus.

15. A method for replacing a high GWP refrigerant in a refrigeration, air-conditioning, or heat pump apparatus, wherein said high GWP refrigerant is selected from the group consisting of R134a, R22, R123, R11, R245fa, R114, R236fa, R124, R12, R410A, R407C, R417A, R422A, R507A, R502, and R404A, said method comprising providing the composition of any of claims 1-3 to said refrigeration, air-conditioning, or heat pump apparatus that uses, used or is designed to use said high GWP refrigerant.

16. A method of using the composition of any of claims 1-3 as a heat transfer fluid composition, said process comprising transporting said composition from a heat source to a heat sink.

17. A refrigeration, air-conditioning, or heat pump apparatus containing a composition as claimed in any one of claims 1-10.

18. The refrigeration, air-conditioning, or heat pump apparatus of claim 17 comprising a mobile air-conditioning apparatus.

19. A foam blowing agent comprising the composition of any of claims 1-3.

20. A method of forming a foam comprising:

(a) adding to a foamable composition the composition of any of claims 1-3; and

(b) reacting the foamable composition under conditions effective to form a foam.

21. A sprayable composition comprising the composition of any of claims 1-3.

22. A process for producing aerosol products comprising the step of adding a composition of any of claims 1-3 to active ingredients in an aerosol container, wherein said composition functions as a propellant.