

TITLE OF THE INVENTION

METHODS AND EQUIPMENT FOR TRANSPORTING, TRANSFERRING,
STORING AND USING REFRIGERANTS

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit of priority of U.S. Provisional Application 63/527,134 filed July 17, 2023, and U.S. Provisional Application 63/565,023 filed March 14, 2024, the disclosure of each of which is incorporated herein by reference in its entirety.

FIELD OF THE INVENTION

[0002] The present invention is directed to refrigerant blending, transportation, transfer, and storage and use. In particular, the methods described herein prevent the formation of undesirable reaction products during any or all of these processes in combination.

BACKGROUND OF THE INVENTION

[0003] The fluorocarbon industry has been working for the past few decades to find replacement refrigerants for the ozone depleting chlorofluorocarbons (CFCs) and hydrochlorofluorocarbons (HCFCs) being phased out as a result of the Montreal Protocol. The solution for many applications has been the commercialization of hydrofluorocarbon (HFC) compounds for use as refrigerants, solvents, fire extinguishing agents, blowing agents and propellants. These new compounds, such as HFC refrigerants, HFC-134a and HFC-125 being the most widely used at this time, have zero ozone depletion potential (ODP) and thus are not affected by the current regulatory phase-out as a result of the Montreal Protocol. In addition to ozone depleting concerns, global warming is another environmental concern in many of these applications. HFC refrigerants such as HFC-134a and HFC-125 respectively have global warming potentials (GWP) of 1,300 and 3,170 according to the UN's IPCC Fifth Assessment Report (AR5).

[0004] This regulatory landscape is continuously evolving, taking into consideration properties beyond just ODP and GWP. More particularly, there is a need for refrigerant compositions that not only meet low ODP standards and have

low global warming potentials, but that also exhibit low or no flammability, provide superior performance in a variety of applications and which meet the standards of evolving regulations.

[0005] There is a need in this art for new refrigerants that meet evolving regulations as well as provide heat transfer and refrigerant characteristics that meet or exceed the effectiveness of conventional refrigerants.

[0006] Some fluoropropenes, particularly difluoropropenes (HCFO-1252), are such potential new refrigerants. Difluoropropenes, such as HFO-1252zf, HFO-1252yf, HFO-1252ye, HFO-1252ze and HFO-1252zc, are unsaturated hydrocarbons including one or more pairs of carbon atoms linked by double bond and are believed to be stable under typical operating conditions.

[0007] However, the unsaturated double bond provides a reactive moiety which is subject to attack by various reactive species. Thus, it is believed that difluoropropenes can exhibit degradation and/or produce unwanted by-products under certain conditions, particularly storage, handling, and transport conditions. This degradation may occur by any number of different mechanisms.

[0008] For example, under conditions of extreme temperatures and more particularly high heat (e.g., above 100°C, or above 150°C, preferably above 200°C) or in the presence of base compounds in a contaminated system that might occur expectedly or unexpectedly during storage, handling and transport, decomposition of difluoropropenes may occur by the loss of an HF molecule. Also, in the presence of other compounds in a contaminated system (e.g., excessive oxygen, oxidizing chemicals such as organic peroxide or hydroperoxide which can be present in sealants on threaded components, or radical generating compounds, among various contaminants) that might occur expectedly or unexpectedly during storage, handling and transport, difluoropropenes may oligomerize or homopolymerize.

[0009] What is therefore needed are systems and methods of transporting, transferring, storing, and using difluoropropenes which prevent the formation of possible undesirable reaction products.

SUMMARY OF THE INVENTION

[0010] Embodiment 1: A composition comprising a difluoropropene and an effective amount of at least one inhibitor, wherein preferably the difluoropropene is selected from the group consisting of 3,3-difluoropropene (HFO-1252zf, $\text{CHF}_2\text{CH}=\text{CH}_2$), 2,3-difluoropropene (HFO-1252yf, $\text{CH}_2\text{FCF}=\text{CH}_2$), 1,2-difluoropropene (HFO-1252ye, $\text{CH}_3\text{CF}=\text{CHF}$), 1,3-difluoropropene (HFO-1252ze, $\text{CH}_2\text{FCH}=\text{CHF}$) and 1,1-difluoropropene (HFO-1252zc, $\text{CH}_3\text{CH}=\text{CF}_2$), and wherein the composition is substantially free of oligomeric, homopolymers or other polymeric products.

[0011] Embodiment 2: A composition comprising a difluoropropene; one or more additional compounds selected from one of hydrofluorocarbons (HFCs), hydrochlorocarbons (HCCs), hydrofluoroolefins (HFOs), and hydrochlorofluoroolefins (HCFOs); and an effective amount of at least one inhibitor, wherein preferably the difluoropropene is selected from the group consisting of 3,3-difluoropropene (HFO-1252zf, $\text{CHF}_2\text{CH}=\text{CH}_2$), 2,3-difluoropropene (HFO-1252yf, $\text{CH}_2\text{FCF}=\text{CH}_2$), 1,2-difluoropropene (HFO-1252ye, $\text{CH}_3\text{CF}=\text{CHF}$), 1,3-difluoropropene (HFO-1252ze, $\text{CH}_2\text{FCH}=\text{CHF}$) and 1,1-difluoropropene (HFO-1252zc, $\text{CH}_3\text{CH}=\text{CF}_2$), and wherein the composition is substantially free of oligomeric, homopolymers or other polymeric products.

[0012] Embodiment 3: The composition according to any of Embodiments 1-2, individually or any combination thereof, wherein the difluoropropene is HFO-1252zc.

[0013] Embodiment 4: The composition according to any of Embodiments 1-3, individually or any combination thereof, wherein an oxygen concentration of the composition is about 0.4 vol% or less, preferably about 0.315 vol% or less, at a temperature of about 25°C.

[0014] Embodiment 5: The composition according to any of Embodiments 1-4, individually or any combination thereof, wherein the composition comprises non-absorbable gases in an amount of about 3 vol% or less, preferably about 1.5 vol% or less, at a temperature of about 25°C.

[0015] Embodiment 6: The composition according to any of Embodiments 1-5, individually or any combination thereof, wherein a moisture content of the

composition is less than about 20 ppm by weight per AHRI 700, preferably less than about 10 ppm by weight based per AHRI 700, more preferably less than about 5 ppm by weight based on AHRI 700, at a temperature of about 25°C.

[0016] Embodiment 7: The composition according to any of Embodiments 1-6, individually or any combination thereof, wherein the total acid number of the composition is between 0 and about 1 mg KOH/g, at a temperature of about 25°C.

[0017] Embodiment 8: The composition according to any of Embodiments 1-7, individually or any combination thereof, the composition further comprising an acid scavenger.

[0018] Embodiment 9: The composition according to Embodiment 8, wherein the acid scavenger is selected from the group consisting of a butyl oxide, siloxane, an activated aromatic compound, and a combination thereof.

[0019] Embodiment 10: The composition according to any of Embodiments 1-9, individually or any combination thereof, the composition further comprising a tracer.

[0020] Embodiment 11: The composition according to Embodiment 10, wherein the tracer is selected from the group consisting of hydrofluorocarbons (HFCs), deuterated hydrofluorocarbons, chlorofluorocarbons (CFCs), hydrofluorochlorocarbons (HCFCs), chlorocarbons, perfluorocarbons, fluoroethers, brominated compounds, iodated compounds, alcohols, aldehydes and ketones, nitrous oxide and combinations thereof. Alternatively, the tracer may be selected from trifluoromethane (HFC-23), dichlorodifluoromethane (CFC-12), chlorodifluoromethane HCFC-22), methyl chloride (HCC-40), chlorofluoromethane (HCFC-31), fluoroethane (HFC-161), 1,1,-difluoroethane (HFC-152a), 1,1,1-trifluoroethane (HFC-143a), chloropentafluoroethane (CFC-115), 1,2-dichloro-1,1,2,2-tetrafluoroethane (CFC-114), 1,1-dichloro-1,2,2,2-tetrafluoroethane (CFC-114a), 2-chloro-1,1,1,2-tetrafluoroethane (HCFC-124), pentafluoroethane (HFC-125), 1,1,2,2-tetrafluoroethane (HFC-134), 1,1,1,2-tetrafluoroethane (HFC-134a), 1,1,1,3,3,3-hexafluoropropane (HFC-236fa), 1,1,1,2,3,3,3-heptafluoropropane (HFC-227ea), 1,1,1,2,2,3,3-heptafluoropropane (HFC-227ea), 1,1,1,3,3-pentafluoropropane (HFC-245fa), 1,1,1,2,2-pentafluoropropane (HFC-245cb), 1,1,1,2,3-pentafluoropropane (HFC-245eb), 1,1,2,2-tetrafluoropropane (HFC-254cb), 1,1,1,2-tetrafluoropropane (HFC-254eb), 1,1,1-trifluoropropane (HFC-263fb), 1,1-

difluoro-2-chloroethylene (HCFC-1122), 2-chloro-1,1,2-trifluoroethylene (CFC-1113), 1,1,1,3,3-pentafluorobutane (HFC-365mfc), 1,1,1,2,3,4,4,5,5,5-decafluoropentane (HFC-43-10mee), 1,1,1,2,2,3,4,5,5,6,6,7,7,7-tetradecafluoroheptane, hexafluorobutadiene, 3,3,3-trifluoropropyne, iodotrifluoromethane, deuterated hydrocarbons, deuterated hydrofluorocarbons, perfluorocarbons, fluoroethers, brominated compounds, iodated compounds, alcohols, aldehydes, ketones, nitrous oxide (N₂O) and mixtures thereof.

[0021] Embodiment 12: The composition according to any of Embodiments 1-11, individually or any combination thereof, wherein the additional compounds are selected from the group consisting of C₂-C₄ alkenes selected from ethylene, propylene, butylene, allene, and cyclobutene.

[0022] Embodiment 13: The composition according to any of Embodiments 1-11, individually or any combination thereof, wherein the additional compounds are selected from the group consisting of methane, ethylene, trifluoromethane (HFC-23), fluoroethylene (HFO-1141), propane (HC-290), propylene (HO-1270), 2,3,3,3-tetrafluoropropene (HFO-1234yf), allene, C₃H₄F₂, 3-fluoro-1-propene (HFO-1261zf), 1,1,1-trifluoropropane (HFC-263fb), 1-fluoropropene (E/Z-HFO-1261ze), 2-butene, cyclobutene, 2-methyl-1-propene, 1,1-difluoropropane, 2-chloro-3,3,3-trifluoropropene (HCFO-1233xf), 3-chloropropene (HCO-1260zf), and C₃H₄FCI (HCFO-1251 isomers).

[0023] Embodiment 14: The composition according to any of Embodiments 1-11, individually or any combination thereof, wherein the additional compounds are selected from the group consisting of ethylene, trifluoromethane (HFC-23), 1,1-difluoroethene (HFO-1132a), fluoroethene (HFO-1141), 1,1,2,2,2-pentafluoroethane (HFC-125), propane (HC-290), 1,1,2-trifluoroethane (HFC-143), 2,3,3,3-tetrafluoropropene (HFO-1234yf), 1,1-difluoroethane (HFC-152a), 3-fluoro-1-propene (HFO-1261zf), 1,1,1-trifluoropropane (HFC-263fb), 1,1,1-trifluoroethane (HFC-143a), difluoropropane, chlorotrifluoropropene, pentafluorobutene (HFO-1345) and C₄H₆F₄ (HFC-374).

[0024] Embodiment 14A: The composition according to any of Embodiments 1-11, wherein the composition comprises 1,1-difluoropropene (HFO-1252zc), optionally 1-

chloro-1,1-difluoropropane (HCFC-262fc) and/or 1,1,1-trifluoropropane (HFC-263fb), and one or more additional members or compounds selected from:

- (i) methane, ethylene, trifluoromethane (HFC-23), fluoroethylene (HFO-1141), propane (HC-290), propylene (HO-1270), 2,3,3,3-tetrafluoropropane (HFO-1234yf), allene, $C_3H_4F_2$, 3-fluoro-1-propene (HFO-1261zf), 1,1,1-trifluoropropane (HFC-263fb), 1-fluoropropane (E/Z-HFO-1261ze), 2-butene, cyclobutene, 2-methyl-1-propene, 1,1-difluoropropane, 2-chloro-3,3,3-trifluoropropane (HCFO-1233xf), 3-chloropropane (HCO-1260zf), and C_3H_4FCI (HCFO-1251 isomers);
- (ii) HFO-1132a, HFC-125, HFC-143a, HFO-1225zc, HFC-152a, HFO-1252ze, HFO-1252yf, HFO-1252zf, and HFO-1252ye;
- (iii) methane, ethylene, trifluoromethane (HFC-23), fluoroethylene (HFO-1141), propane (HC-290), propylene (HO-1270), 2,3,3,3-tetrafluoropropane (HFO-1234yf), allene, $C_3H_4F_2$, 3-fluoro-1-propene (HFO-1261zf), 1-fluoropropane (E/Z-HFO-1261ze), 2-butene, cyclobutene, 2-methyl-1-propene, 1,1-difluoropropane (HFC-272fb), 2-chloro-3,3,3-trifluoropropane (HCFO-1233xf), 3-chloropropane (HCO-1260zf), and C_3H_4FCI (HCFO-1251 isomers);
- (iv) methane, ethylene, trifluoromethane (HFC-23), fluoroethylene (HFO-1141), propane (HC-290), propylene (HO-1270), 2,3,3,3-tetrafluoropropane (HFO-1234yf), allene, $C_3H_4F_2$, 3-fluoro-1-propene (HFO-1261zf), 1-fluoropropane (E/Z-HFO-1261ze), 2-butene, cyclobutene, 2-methyl-1-propene, 1,1-difluoropropane, 2-chloro-3,3,3-trifluoropropane (HCFO-1233xf), 3-chloropropane (HCO-1260zf), and C_3H_4FCI (HCFO-1251 isomers);
- (v) ethylene, trifluoromethane (HFC-23), 1,1-difluoroethene (HFO-1132a), fluoroethane (HFC-1141), 1,1,2,2,2-pentafluoroethane (HFC-125), propane (HC-290), 1,1,2-trifluoroethane (HFC-143), 2,3,3,3-tetrafluoropropane (HFO-1234yf), 1,1,1-difluoroethane (HFC-152a), 3-fluoro-1-propene (HFO-1261zf), 1-fluoropropane (E/Z-HFO-1261ze), 1,1,1-trifluoropropane (HFC-263fb), 1,1,1-trifluoroethane (HFC-143a), difluoropropane, chlorotrifluoropropane, pentafluorobutene (HFO-1345) and $C_4H_6F_4$ (HFC-374);
- (vi) ethylene, trifluoromethane (HFC-23), 1,1-difluoroethene (HFO-1132a), fluoroethylene (HFO-1141), 1,1,2,2,2-pentafluoroethane (HFC-125), propane

- (HC-290), 1,1,2-trifluoroethane (HFC-143), 2,3,3,3-tetrafluoropropene (HFO-1234yf), 1,1,1-difluoroethane (HFC-152a), 3-fluoro-1-propene (HFO-1261zf), 1-fluoropropene (E/Z-HFO-1261ze), 1,1,1-trifluoropropane (HFC-263fb), 1,1,1-trifluoroethane (HFC-143a), difluoropropane, chlorotrifluoropropene, pentafluorobutene (HFO-1345) and $C_4H_6F_4$ (HFC-374);
- (vii) trifluoromethane (HFC-23), dichloromethane (HCC-30), chlorofluoromethane (HCFC-31), methyl chloride (HCC-40), methane, 1,1,2,2,2-pentafluoroethane (HFC-125), 1,1,2-trifluoroethane (HFC-143), 1,1,1-trifluoroethane (HFC-143a), 1,1,1-difluoroethane (HFC-152a), 1,1,1,2,2-pentafluoropropane (HFC-245cb), 2-chloro-1,1,1-trifluoropropane (HCFC-253dc), 1,1,1,3-tetrafluoropropane (HFC-254fb), 1,1,1-trichloropropane (HCC-260fb), 1,1-dichloro-1-fluoropropane (HCFC-261fc), 1,1-difluoropropane (HFC-272fb), propane (HC-290), tetrafluorobutene (HFO-374), butane (HC-600), allene, 2-butene, cyclobutene, 2-methylpropene, 1-chloro-2,2-difluoroethylene (HCFO-1122), 1,2-difluoroethene (HFO-1132), 1,1-difluoroethene ((HFO-1132a), fluoroethylene (HFO-1141), ethylene (HO-1150), 2-chloro-3,3,3-trifluoropropene (HCFO-1233xf), 2,3,3,3-tetrafluoropropene (HFO-1234yf), 3-chloro-3,3-difluoropropene (HCFO-1242zf), 3,3,3-trifluoropropene (HFO-1243zf), HCFO-1251 isomer (I), HCFO-1251 isomer (II), 3-chloropropene (HCO-1260zf), 3-fluoro-1-propene (HFO-1261zf), 1-fluoropropene (E/Z-HFO-1261ze), propylene (HO-1270), pentafluorobutene (HFO-1345), and E/Z-t-BuO-CF=CH-CH₃;
- (viii) ethylene, HFC-23, HFO-1132a, propane, HFO-1234yf, HFO-1261zf, E/Z-HFO-1261ze, HFC-143a, HCFO-1233xf, and HFC-374; or
- (ix) HCFO-1233xf, HFC-152a, HFC-263fb, HFC-254fb, HFC-253dc, HFC-252dc and HCFO-1230xa.

[0025] Embodiment 15: The composition according to any of Embodiments 1-11, individually or any combination thereof, wherein the additional compounds are selected from the group consisting of trifluoromethane (HFC-23), dichloromethane (HCC-30), chlorofluoromethane (HCFC-31), methyl chloride (HCC-40), methane, 2,2-dichloro-1,1,1-trifluoroethane (HCFC-123), 1,1,2,2,2-pentafluoroethane (HFC-125), 1-chloro-1,1-difluoroethane (HCFC-142b), 1,1,2-trifluoroethane (HFC-143), 1,1,1-trifluoroethane (HFC-143a), 1-chloro-1-fluoroethane (HCFC-151a),

1,1,difluoroethane (HFC-152a), 2,2,3,3-tetrachloro-1,1,1-trifluoropropane (HCFC-223aa), 1,2,2-trichloro-1,3,3,3-tetrafluoropropane (HCFC-224aa), 1,1,1,2,3,3,3-heptafluoropropane (HFC-227ca), 1,1,1,3,3,3-hexafluoropropane (HFC-236fa), 1,1,2-trichloro-3,3-difluoropropane (HCFC-242db), 1,1,2,3-tetrachloro-1-fluoropropane (HCFC-241db), 1,2,3-trichloro-1,1-difluoropropane (HCFC-242dc), 2,3-dichloro-1,1,1-trifluoropropane (HCFC-243db), 2-chloro-1,1,1,3-tetrafluoropropane (HCFC-244db), 1,1,1,2,2-pentafluoropropane (HFC-245cb), 1,1,1,3-tetrachloropropane (HCC-250fb), 2-chloro-1,1,1-trifluoropropane (HCFC-253dc), 1,1,1,2-tetrafluoropropane (HFC-254eb), 1,1,1,3-tetrafluoropropane (HFC-254fb), 1,1-difluoropropane (HFC-272fb), propane (HC-290), butane, allene, 2-butene, cyclobutene, 2-methylpropene, 1-chloro-2,2-difluoroethylene (HCFO-1122), 1,2-difluoroethene (HFO-1132), 1,1-difluoroethene ((HFO-1132a), fluoroethene (HFO-1141), ethylene (HO-1150), propylene (HO-1270), 2-chloro-3,3,3-trifluoropropene (HCFO-1233xf), 2,3,3,3-tetrafluoropropene (HFO-1234yf), 3-chloro-3,3-difluoropropene (HCFO-1242zf), 3,3,3-trifluoropropene (HFO-1243zf), C₃H₄FCI (HCFO-1251), C₃H₄FCI (HCFO-1251), 3-chloropropene (HCO-1260zf), 3-fluoro-1-propene (HFO-1261zf), 1-fluoropropene (E/Z-HFO-1261ze), pentafluorobutene (HFO-1345), and E/Z-t-BuO-CF=CH-CH₃.

[0026] Embodiment 16: The composition according to any of Embodiments 1-11, individually or any combination thereof, wherein the additional compounds are selected from the group consisting of ethylene, HFC-23, HFO-1132a, propane, HFO-1234yf, HFO-1234ze, HFO-1261zf, E/Z-HFO-1261ze, HFC-143a, HCFO-1233xf, and HFC-374.

[0027] Embodiment 16A: The composition according to any of Embodiments 1-11, individually or in combination, wherein the composition optionally further comprises at least one of HCC-250fb and HCFO-1242zf, and wherein the additional compounds are selected from:

- (i) HCFC-262fc, HCC-250fb, HFC-263fb, HFO-1243zf, other HCFO-1252 isomers, ethane, ethylene, HFC-23, HCFC-22, HFO-1132a, propane, HFC-143a, HCFC-142b, HFO-1234yf, HFO-1234ze, HFO-1225zc, HCFO-1242zf and HCFC-252fc;

- (ii) HCC-250fb, HCFC-252fc and HCFC-262fc, and one or more additional compounds selected from HFC-263fb, HFO-1243zf, other 1252 isomers, ethane, ethylene, HFC-23, HCFC-22, HFO-1132a, propane, HFC-143a, HCFC-142b, HFO-1234yf, HFO-1234ze, HFO-1225zc, and HCFO-1242zf;
- (iii) HCC-250fb, HFC-263fb, HFO-1243zf, other 1252 isomers, ethane, ethylene, HFC-23, HCFC-22, HFO-1132a, propane, HFC-143a, HCFC-142b, HFO-1234yf, HFO-1234ze, HFO-1225zc, HCFO-1242zf and HCFC-252fc;
- (iv) HCC-250fb, HFC-263fb, HFO-1243zf, other 1252 isomers, ethane, ethylene, HFC-23, HCFC-22, HFO-1132a, propane, HFC-143a, HCFC-142b, HFO-1234yf, HFO-1234ze, HFO-1225zc and HCFO-1242zf;
- (v) HCFC-262fc, HCC-250fb, HFC-263fb, HCFO-1242zf, HFO-1252zf, HFO-1243zf and HCFC-252fc;
- (vi) HCFC-262fc, HFC-263fb, HFO-1252zf, HFO-1243zf and HCFC-252fc;
- (vii) HCFO-1242zf, HCFC-262fc, HCC-250fb, HFC-263fb, HFO-1252zf, HFO-1243zf and HCFC-252fc;
- (viii) HCC-250fb, HCFC-252fc, HCFC-262fc, HCFO-1242zf, HFC-263fb, other 1252 isomers, ethane, ethylene, HFC-23, HCFC-22, HFO-1132a, propane, HFC-143a, HCFC-142b, HFO-1234yf, HFO-1234ze, and HFO-1225zc and HFO-1243zf.

[0028] Embodiment 17: The composition of any of Embodiments 1-16A, individually or any combination thereof, wherein a total amount of the additional compounds is selected from one of about 0.5 wt.% or less, about 0.4 wt.% or less, about 0.3 wt.% or less, about 0.2 wt.% or less, and about 0.1 wt.% or less.

[0029] Embodiment 18: The composition according to any of Embodiments 1-16, individually or any combination thereof, wherein the composition further comprises at least one of HFC-263fb and HCFC-262fc.

[0030] Embodiment 19: A composition comprising a difluoropropene selected from the group consisting of HFO-1252zf, HFO-1252yf, HFO-1252ye, HFO-1252ze and HFO-1252zc, wherein at least one of:

an oxygen concentration of the composition is about 0.4 vol% or less, preferably about 0.315 vol% or less, at a temperature of about 25°C;

an amount of non-absorbable gases is about 2 vol% or less, preferably about 1.5 vol% or less, at a temperature of about 25°C; and

a moisture content of the composition is less than about 20 ppm by weight per AHRI 700, or less than about 10 ppm by weight based per AHRI 700, or less than about 5 ppm by weight based on AHRI 700, at a temperature of about 25°C.

[0031] Embodiment 20: The composition according to Embodiment 19, wherein the total acid number of the composition is between 0 and about 1 mg KOH/g, at a temperature of about 25°C.

[0032] Embodiment 21: A pressurized container filled with the composition of any of Embodiments 1-20, individually or any combination thereof.

[0033] Embodiment 21A: A storage stable refrigerant comprising a pressurized container filled with the composition of any of Embodiments 1-20.

[0034] Embodiment 22: A method for packaging a container of refrigerant, the method comprising:

providing a container suitable for holding a composition comprising HFO-1252zc;

optionally conditioning the container for receiving the composition,

sealably connecting a container to a source of the composition comprising HFO-1252zc and filling the container with the composition such that the contents of the container include at least one of:

an oxygen concentration of the composition is about 0.4 vol% or less, preferably about 0.315 vol% or less, at a temperature of about 25°C;

an amount of non-absorbable gases is about 2 vol% or less, preferably about 1.5 vol% or less, at a temperature of about 25°C; and

a moisture content of the composition is less than about 20 ppm by weight per AHRI 700, or less than about 10 ppm by weight based per AHRI 700, or less than about 5 ppm by weight based on AHRI 700, at a temperature of about 25°C.

[0035] Embodiment 23: The method according to Embodiment 22, wherein the total acid number of the composition is between 0 and about 1 mg KOH/g, at a temperature of about 25°C.

[0036] Embodiment 24: The method according to any of Embodiments 22-23, individually or any combination thereof, wherein the composition further comprises one or more additional compounds according to any of Embodiments 12-17.

[0037] Embodiment 25: The method according to any of Embodiments 22-24, individually or any combination thereof, wherein the composition further comprises at least one of HFC-263fb and HCFC-262fc.

[0038] Embodiment 26: A pressurized container filled according to the method of any of Embodiments 22-25, individually or any combination thereof.

[0039] Embodiment 26A: A storage stable refrigerant comprising a pressurized container filled according to the method of any of Embodiments 22-25.

[0040] Embodiment 27: A method comprising storing a composition comprising HFO-1252zc and one or more additional compounds in a container, the method comprising:

maintaining an oxygen concentration of about 0.4 vol% or less, preferably about 0.315 vol% or less, at a temperature of about 25°C;

maintaining an amount of non-absorbable gases to be about 2 vol% or less, preferably about 1.5 vol% or less, at a temperature of about 25°C;

maintaining a moisture content of the composition to less than about 20 ppm by weight per AHRI 700, or less than about 10 ppm by weight based per AHRI 700, or less than about 5 ppm by weight based on AHRI 700, at a temperature of about 25°C; or

maintaining a total acid number of the composition to be between 0 and about 1 mg KOH/g, at a temperature of about 25°C.

[0041] Embodiment 28: The method according to Embodiment 27, wherein the one or more additional compounds are selected according to any of Embodiments 12-17.

[0042] Embodiment 29: The method of any of Embodiments 22-25 and 27-28, individually or any combination thereof, the method further comprising monitoring at least parameter of the composition with one or more sensors, wherein the at least

one parameter is selected from the group consisting of temperature, moisture concentration, non-absorbable gas concentration, acidity and combinations thereof.

[0043] Embodiment 30: The method of Embodiment 29, wherein the method further comprises adjusting a property of the composition when monitoring of the at least one parameter determines a value that exceeds or falls below a respective threshold parameter.

[0044] Embodiment 31: The method of Embodiment 30, wherein the threshold parameter is a composition temperature of about 200°C.

[0045] Embodiment 32: The method of Embodiment 30, wherein the threshold parameter is a composition moisture concentration measured with the one or more sensors exceeds a threshold parameter of a refrigerant moisture concentration of 20 ppm by weight, per AHRI 700.

[0046] Embodiment 33: The method of Embodiment 30, wherein the threshold parameter is a non-absorbable gas concentration of 1.5 volume percent at 25°C, per AHRI 700.

[0047] Embodiment 34: The method of Embodiment 33, wherein the non-absorbable gas is oxygen.

[0048] Embodiment 35: The composition according to any of Embodiments 1-20, individually or any combination thereof, wherein the composition is free of or substantially free of Group A Fluorinated Substances.

[0049] Embodiment 36: The composition according to any of Embodiments 1-21, individually or any combination thereof, wherein degradation products of the stabilized composition are free of or substantially free of Group A Fluorinated Substances.

[0050] Embodiment 37: The composition according to any of the preceding Embodiments, further comprising at least one antioxidant.

[0051] Embodiment 38: A composition comprising a difluoropropene, an effective amount of at least one inhibitor, and at least one antioxidant, wherein preferably the difluoropropene is selected from the group consisting of 3,3-difluoropropene (HFO-1252zf, $\text{CHF}_2\text{CH}=\text{CH}_2$), 2,3-difluoropropene (HFO-1252yf, $\text{CH}_2\text{FCF}=\text{CH}_2$), 1,2-

difluoropropene (HFO-1252ye, $\text{CH}_3\text{CF}=\text{CHF}$), 1,3-difluoropropene (HFO-1252ze, $\text{CH}_2\text{FCH}=\text{CHF}$) and 1,1-difluoropropene (HFO-1252zc, $\text{CH}_3\text{CH}=\text{CF}_2$), preferably HFO-1252zc, and wherein the composition is substantially free of oligomeric, homopolymers or other polymeric products.

[0052] Embodiment 39: The composition according to any of Embodiments 37 or 38, wherein the at least one antioxidant comprises at least one member selected from the group consisting of butylated hydroxytoluene, butylated hydroxyanisole, tertiary-butylhydroquinone, gallate, 2-phenyl-2-propanol, 1-(2,4,5-trihydroxyphenyl)-1-butanone, bisphenol methane derivatives, 2,2'-methylene bis (4-methyl-6-t-butyl phenol), among other phenolics, and combinations thereof.

[0053] Embodiment 40. The composition according to any of Embodiments 37 to 39, wherein an amount of the at least one antioxidant ranges from about 0.01 to about 5,000 ppm by weight, preferably about 0.03 to about 2000 ppm, more preferably about 0.05 to about 1000 ppm.

[0054] Embodiment 41. A method of storing the composition according to any of the preceding Embodiments, the method comprising: (i) introducing the composition into a storage vessel; (ii) allowing a predetermined duration to elapse after introducing the composition into the storage vessel; (iii) measuring a content of non-absorbable gases contained in the composition after the predetermined duration has elapsed; and (iv) if the content of non-absorbable gases is greater than 5 vol%, preferably greater than 3 vol%, and more preferably greater than 1.5 vol%, dividing the composition contained in the storage vessel equally amongst at least two storage vessels, such that each storage vessel contains a portion of the composition up to about 50% of the volume of the storage vessel, and subsequently removing the non-absorbable gases until the total amount of non-absorbable gases in each storage vessel is less than 5 vol%, preferably less than 3 vol%, more preferably less than 1.5 vol%.

[0055] Embodiment 42. The method of Embodiment 41, wherein the non-absorbable gases are removed by venting.

[0056] Embodiment 43. The method of any of Embodiments 41 or 42, wherein the predetermined duration is from about 12 hours to about 24 hours.

[0057] Embodiment 44: The method of any of Embodiments 41 to 43, wherein steps (iii) and (iv) are repeated at predetermined time intervals during storage of the composition.

[0058] The various aspects and embodiments of the invention can be used alone or in combinations with each other. Other features and advantages of the present invention will be apparent from the following more detailed description, taken in conjunction with the accompanying drawings which illustrate, by way of example, the principles of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0059] The following detailed description of preferred embodiments of the present invention will be better understood when read in conjunction with the appended drawings. For the purposes of illustrating the invention, there is shown in the drawings embodiments which are presently preferred. It is understood, however, that the invention is not limited to the precise arrangements and instrumentalities shown. In the drawings:

[0060] FIG. 1 is a perspective view of a refrigerant distribution system according to an embodiment of the present disclosure.

[0061] FIG. 2 is a front view of a vertical ton tank, according to an embodiment.

[0062] FIG. 3 is a side view of a vertical ton tank, according to an embodiment.

[0063] FIG. 4A is an expanded front view of the internal piping of the vertical ton tank, according to an embodiment.

[0064] FIG. 4B is an expanded side view of the internal piping of the vertical ton tank, according to an embodiment.

[0065] FIG. 5 shows the piping couplers of the vertical ton tank, according to an embodiment.

[0066] FIG. 6 is a view of the bottom portion of a vertical ton tank, according to an embodiment.

[0067] FIG. 7 is an expanded top view of the valve configuration of a vertical ton tank, according to an embodiment.

[0068] FIG. 8 is an expanded side view of the valve configuration of a vertical ton tank, according to an embodiment.

[0069] FIG. 9 is a view of a vertical ton tank having a bottom protective collar, according to an embodiment.

[0070] FIG. 10 shows a door as part of bottom protective collar of a vertical ton tank, according to an embodiment.

[0071] Wherever possible, the same reference numbers will be used throughout the drawings to represent the same parts.

DETAILED DESCRIPTION OF THE INVENTION

[0072] The present invention provides a stabilized refrigerant composition comprising at least one fluoropropene, more particularly at least one difluoropropene.

[0073] As used herein, the terms "comprises," "comprising," "includes," "including," "has," "having" or any other variation thereof, are intended to cover a non-exclusive inclusion. For example, a composition, process, method, article, or apparatus that comprises a list of elements is not necessarily limited to only those elements but may include other elements not expressly listed or inherent to such composition, process, method, article, or apparatus. Further, unless expressly stated to the contrary, "or" refers to an inclusive or and not to an exclusive or. For example, a condition A or B is satisfied by any one of the following: A is true (or present) and B is false (or not present), A is false (or not present) and B is true (or present), and both A and B are true (or present).

[0074] The transitional phrase "consisting of" excludes any element, step, or ingredient not specified. If in the claim such would close the claim to the inclusion of materials other than those recited except for impurities ordinarily associated therewith. When the phrase "consists of" appears in a clause of the body of a claim, rather than immediately following the preamble, it limits only the element set forth in that clause; other elements are not excluded from the claim as a whole.

[0075] The transitional phrase "consisting essentially of" is used to define a composition, method that includes materials, steps, features, components, or

elements, in addition to those literally disclosed provided that these additional included materials, steps, features, components, or elements do not materially affect the basic and novel characteristic(s) of the claimed invention, especially the mode of action to achieve the desired result of any of the processes of the present invention. The term “consisting essentially of” occupies a middle ground between “comprising” and “consisting of.”

[0076] Where applicants have defined an invention or a portion thereof with an open-ended term such as “comprising,” it should be readily understood that (unless otherwise stated) the description should be interpreted to also include such an invention using the terms “consisting essentially of” or “consisting of.”

[0077] Also, use of “a” or “an” are employed to describe elements and components described herein. This is done merely for convenience and to give a general sense of the scope of the invention. This description should be read to include one or at least one and the singular also includes the plural unless it is obvious that it is meant otherwise.

[0078] The instant invention can solve problems caused by decomposition, contamination and undesired reaction of refrigerants (and refrigerant blends), particularly difluoropropenes and difluoropropene blends, which may occur during handling, storage and transferring refrigerants.

[0079] Compounds referred to in this disclosure may be referred to by code, based on fluorochemical naming convention, chemical structure and/or chemical name. For convenience and reference, selected compounds with codes, structures and chemical names are provided in Table 1.

TABLE 1

Code	Name-ASHRAE Designation	Formula
R-23	trifluoromethane (HFC-23)	CHF ₃
R-30	dichloromethane (HCC-30)	CH ₂ Cl ₂
R-31	chlorofluoromethane (HCFC-31)	CH ₂ FCl
R-40	methyl chloride (HCC-40)	CH ₃ Cl
R-50	methane	CH ₄
R-125	1,1,2,2,2-pentafluoroethane (HFC-125)	CF ₂ CF ₃
R-143	1,1,2-trifluoroethane (HFC-143)	CF ₂ CH ₂ F
R-143a	1,1,1-trifluoroethane (HFC-143a)	CF ₃ CH ₃

Code	Name-ASHRAE Designation	Formula
R-152a	1,1-difluoroethane (HFC-152a)	CHF_2CH_3
R-245cb	1,1,1,2,2-pentafluoropropane (HFC-245cb)	$\text{CF}_3\text{CF}_2\text{CH}_3$
R-253dc	2-chloro-1,1,1-trifluoropropane (HCFC-253dc)	$\text{CF}_3\text{CHClCH}_3$
R-254fb	1,1,1,3-tetrafluoropropane (HFC-254fb)	$\text{CF}_3\text{CH}_2\text{CH}_2\text{F}$
R-260fb	1,1,1-trichloropropane (HCC-260fb)	$\text{CCl}_3\text{CH}_2\text{CH}_3$
R-261fc	1,1-dichloro-1-fluoropropane (HCFC-261fc)	$\text{CCl}_2\text{FCH}_2\text{CH}_3$
R-262fc	1-chloro-1,1-difluoropropane (HCFC-262fc)	$\text{CClF}_2\text{CH}_2\text{CH}_3$
R-263fb	1,1,1-trifluoropropane (HFC-263fb)	$\text{CF}_3\text{CH}_2\text{CH}_3$
R-272fb	1,1-difluoropropane (HFC-272fb)	$\text{CHF}_2\text{CH}_2\text{CH}_3$
R-290	propane (HC-290)	$\text{CH}_3\text{CH}_2\text{CH}_3$
R-374	Tetrafluorobutene (HFO-374)	$\text{C}_4\text{H}_6\text{F}_4$
R-600	butane (HC-600)	$\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_3$
	allene	$\text{H}_2\text{C}=\text{C}=\text{CH}_2$
	2-butene	$\text{CC}_3\text{CH}=\text{CHCH}_3$
	cyclobutene	C_4H_6
	2-methylpropene	$\text{CH}_3(\text{CH}_3)\text{C}=\text{CF}_3$
R-1122	1-chloro-2,2-difluoroethylene (HCFO-1122)	$\text{CHCl}=\text{CF}_2$
R-1132	1,2-difluoroethene (HFO-1132)	$\text{CHF}=\text{CHF}$
R-1132a	1,1-difluoroethene ((HFO-1132a)	$\text{CH}=\text{CF}_2$
R-1141	fluoroethene (HFO-1141)	$\text{CH}_2=\text{CHF}$
R-1150	ethylene (HO-1150)	$\text{CH}_2=\text{CH}_2$
R-1225zc	1,1,3,3,3-pentafluoropropene	$\text{CF}_3\text{CH}=\text{CF}_2$
R-1233xf	2-chloro-3,3,3-trifluoropropene (HCFO-1233xf)	$\text{CF}_3\text{CCl}=\text{CH}_2$
R-1234yf	2,3,3,3-tetrafluoropropene (HFO-1234yf)	$\text{CF}_3\text{CH}=\text{CHF}$
R-1242zf	3-chloro-3,3-difluoropropene (HCFO-1242zf)	$\text{CClF}_2\text{CH}=\text{CH}_2$
R-1243zf	3,3,3-trifluoropropene (HFO-1243zf)	$\text{CF}_3\text{CH}=\text{CH}_2$
R-1251	HCFO-1251 isomer I	$\text{C}_3\text{H}_4\text{FCl}$
R-1251	HCFO-1251 isomer II	$\text{C}_3\text{H}_4\text{FCl}$
R-1252ze,	1,3-difluoropropene (HFO-1252ze)	$\text{CH}_2\text{FCH}=\text{CHF}$
R-1252yf,	2,3-difluoropropene (HFO-1252yf)	$\text{CH}_2\text{FCF}=\text{CH}_2$
R-1252zf	3,3-difluoropropene (HFO-1252zf)	$\text{CHF}_2\text{CH}=\text{CH}_2$
R-1252ye	1,2-difluoropropene (HFO-1252ye)	$\text{CH}_3\text{CF}=\text{CHF}$
R-1252zc	1,1-difluoropropene (HFO-1252zc)	$\text{CH}_3\text{CH}=\text{CF}_2$
R-1260zf	3-chloropropene (HCO-1260zf)	$\text{CH}_2\text{ClCH}=\text{CH}_2$
R-1261zf	3-fluoro-1-propene (HFO-1261zf)	$\text{CH}_2\text{FCH}=\text{CH}_2$
R-1261ze	1-fluoropropene (HFO-1261ze)	$\text{CHF}=\text{CHCH}_3$
R-1270	propylene (HO-1270)	$\text{CH}_3\text{CH}=\text{CH}_2$
R-1345	pentafluorobutene (HFO-1345)	$\text{C}_4\text{H}_3\text{F}_5$
	E/Z-t-BuO-CF=CH-CH ₃	E/Z-t-BuO-CF=CH-CH ₃

[0080] Some of the compounds present in the compositions of the present invention identified in Table 1 may exist as different configurational isomers or stereoisomers. The present invention is intended to include all single configurational isomers, single stereoisomers or any combination or mixture thereof. For instance,

1,2-difluoroethene (HFO-1132) is meant to represent the cis-isomer (Z), trans-isomer (E), or any combination or mixture of both isomers in any ratio. Single isomers or multiple isomers of the same compound may be used in any proportion.

[0081] In one embodiment, the stabilized composition according to the present invention comprises, consists of or consists essentially of a difluoropropene. In one embodiment, the stabilized composition according to the present invention comprises, consists of or consists essentially of a difluoropropene selected from HFO-1252zf, HFO-1252yf, HFO-1252ye, HFO-1252ze and HFO-1252zc, and mixtures thereof. In one embodiment, the stabilized composition according to the present invention comprises, consists of or consists essentially of HFO-1252zc.

[0082] In one embodiment, the stabilized composition according to the present invention comprises, consists of or consists essentially of a difluoropropene selected from HFO-1252zf, HFO-1252yf, HFO-1252ye, HFO-1252ze and HFO-1252zc, each having a purity of greater than 99 wt%, greater than 99.5 wt% pure, and in some cases greater than 99.5 to 99 wt% pure, and in some cases 98 wt% pure.

[0083] In certain embodiments disclosed herein, the stabilized compositions comprise at least one of HFO-1252zf, HFO-1252yf, HFO-1252ye, HFO-1252ze and HFO-1252zc, preferably HFO-1252zc, and one or more additional compounds or members, such as one or more of the compounds identified in Table 1, in any combination, wherein each additional compound is present in an amount of between:

- a. greater than 0 and less than about 4 wt. percent,
- b. greater than 0 and less than about 3 wt. percent,
- c. greater than 0 and less than about 2 wt. percent,
- d. greater than 0 and less than about 1 wt. percent,
- e. greater than 0 and less than about 0.5 wt. percent,
- f. greater than 0 and less than about 0.1 wt. percent,
- g. greater than 0 and less than about 0.01 wt. percent,
- h. greater than 0 and less than about 0.005 wt. percent,
- i. greater than 0.001 and less than about 4 wt. percent,
- j. greater than 0.001 and less than about 3 wt. percent,

- k. greater than 0.001 and less than about 2 wt. percent,
- l. greater than 0.001 and less than about 1 wt. percent,
- m. greater than 0.001 and less than about 0.5 wt. percent,
- n. greater than 0.001 and less than about 0.1 wt. percent,
- o. greater than 0.001 and less than about 0.01 wt. percent, or
- p. greater than 0.001 and less than about 0.005 wt. percent,

based on the total amount of the composition *with the proviso* that the total amount of additional compounds other than HFO-1252zf, HFO-1252yf, HFO-1252ye, HFO-1252ze or HFO-1252zc is greater than 0.0001 and less than 10 wt.%, greater than 0.0001 and less than 9 wt.%, greater than 0.0001 and less than 8 wt.%, greater than 0.0001 and less than 7 wt.%, greater than 0.0001 and less than 6 wt.%, greater than 0.0001 and less than 5 wt.%, greater than 0.0001 and less than 4 wt.%, greater than 0.0001 and less than 3 wt.%, greater than 0.0001 and less than 2 wt.%, greater than 0.0001 and less than 1 wt.%, greater than 0.0001 and less than 0.5 wt.%, or greater than 0.0001 and less than 0.1 wt.%.

[0084] In certain embodiments disclosed herein, the stabilized compositions comprise at least one of HFO-1252zf, HFO-1252yf, HFO-1252ye, HFO-1252ze and HFO-1252zc, preferably HFO-1252zc, and one or more additional compounds such as C₂-C₄ alkenes selected from ethylene, propylene, butylene, allene, and cyclobutene.

[0085] In certain embodiments disclosed herein, the stabilized composition comprises, consists essentially of, or consists of at least one of HFO-1252zf, HFO-1252yf, HFO-1252ye, HFO-1252ze and HFO-1252zc, preferably HFO-1252zc, and one or more additional members or compounds selected from methane, ethylene, trifluoromethane (HFC-23), fluoroethylene (HFO-1141), propane (HC-290), propylene (HFO-1270), 2,3,3,3-tetrafluoropropene (HFO-1234yf), allene, C₃H₄F₂, 3-fluoro-1-propene (HFO-1261zf), 1-fluoropropene (E/Z-HFO-1261ze), 1,1,1-trifluoropropane (HFC-263fb), 2-butene, cyclobutene, 2-methyl-1-propene, 1,1-difluoropropane, 2-chloro-3,3,3-trifluoropropene (HCFO-1233xf), 3-chloropropene (HCO-1260zf), and C₃H₄FCI (HCFO-1251 isomers).

[0086] In certain embodiments disclosed herein, the stabilized composition comprises, consists essentially of, or consists of 1,1-difluoropropene (HFO-1252zc), optionally 1,1,1-trifluoropropane (HFC-263fb), and (i) one or more additional members or compounds selected from methane, ethylene, trifluoromethane (HFC-23), fluoroethylene (HFO-1141), propane (HC-290), propylene (HO-1270), 2,3,3,3-tetrafluoropropene (HFO-1234yf), allene, $C_3H_4F_2$, 3-fluoro-1-propene (HFO-1261zf), 1,1,1-trifluoropropane (HFC-263fb), 1-fluoropropene (E/Z-HFO-1261ze), 2-butene, cyclobutene, 2-methyl-1-propene, 1,1-difluoropropane, 2-chloro-3,3,3-trifluoropropene (HCFO-1233xf), 3-chloropropene (HCO-1260zf), and C_3H_4FCl (HCFO-1251 isomers), or (2) one or more additional members selected from HFO-1132a, HFC-125, HFC-143a, HFO-1225zc, HFC-152a, HFO-1252ze, HFO-1252yf, HFO-1252zf, and HFO-1252ye.

[0087] In certain embodiments disclosed herein, the stabilized composition comprises, consists essentially of, or consists of at least one of HFO-1252zf, HFO-1252yf, HFO-1252ye, HFO-1252ze and HFO-1252zc, preferably HFO-1252zc, optionally 1-chloro-1,1-difluoropropane (HCFC-262fc) or 1,1,1-trifluoropropane (HFC-263fb), and one or more additional members or compounds selected from methane, ethylene, trifluoromethane (HFC-23), fluoroethylene (HFO-1141), propane (HC-290), propylene (HO-1270), 2,3,3,3-tetrafluoropropene (HFO-1234yf), allene, $C_3H_4F_2$, 3-fluoro-1-propene (HFO-1261zf), 1-fluoropropene (E/Z-HFO-1261ze), 2-butene, cyclobutene, 2-methyl-1-propene, 1,1-difluoropropane, 2-chloro-3,3,3-trifluoropropene (HCFO-1233xf), 3-chloropropene (HCO-1260zf), and C_3H_4FCl (HCFO-1251 isomers).

[0088] In certain embodiments disclosed herein, the stabilized composition comprises, consists essentially of, or consists of at least one of HFO-1252zf, HFO-1252yf, HFO-1252ye, HFO-1252ze and HFO-1252zc, preferably HFO-1252zc, optionally 1,1,1-trifluoropropane (HFC-263fb), and one or more additional members selected from methane, ethylene, trifluoromethane (HFC-23), fluoroethylene (HFO-1141), propane (HC-290), propylene (HO-1270), 2,3,3,3-tetrafluoropropene (HFO-1234yf), allene, $C_3H_4F_2$, 3-fluoro-1-propene (HFO-1261zf), 1-fluoropropene (E/Z-HFO-1261ze), 2-butene, cyclobutene, 2-methyl-1-propene, 1,1-difluoropropane, 2-

chloro-3,3,3-trifluoropropene (HCFO-1233xf), 3-chloropropene (HCO-1260zf), and C₃H₄FCI (HCFO-1251 isomers).

[0089] In certain embodiments disclosed herein, the stabilized composition comprises, consists essentially of, or consists of at least one of HFO-1252zf, HFO-1252yf, HFO-1252ye, HFO-1252ze and HFO-1252zc, preferably HFO-1252zc, optionally 1-chloro-1,1-difluoropropane (HCFC-262fc), optionally 1,1,1-trifluoropropane (HFC-263fb), and one or more additional members selected from ethylene, trifluoromethane (HFC-23), 1,1-difluoroethene (HFO-1132a), fluoroethylene (HFO-1141), 1,1,2,2,2-pentafluoroethane (HFC-125), propane (HC-290), 1,1,2-trifluoroethane (HFC-143), 2,3,3,3-tetrafluoropropene (HFO-1234yf), 1,1,1-difluoroethane (HFC-152a), 3-fluoro-1-propene (HFO-1261zf), 1-fluoropropene (E/Z-HFO-1261ze), 1,1,1-trifluoropropane (HFC-263fb), 1,1,1-trifluoroethane (HFC-143a), difluoropropane, chlorotrifluoropropene, pentafluorobutene (HFO-1345) and C₄H₆F₄ (HFC-374).

[0090] In certain embodiments disclosed herein, the stabilized composition comprises, consists essentially of, or consists of at least one of HFO-1252zf, HFO-1252yf, HFO-1252ye, HFO-1252ze and HFO-1252zc, preferably HFO-1252zc, optionally 1,1,1-trifluoropropane (HFC-263fb), and one or more additional members selected from ethylene, trifluoromethane (HFC-23), 1,1-difluoroethene (HFO-1132a), fluoroethylene (HFO-1141), 1,1,2,2,2-pentafluoroethane (HFC-125), propane (HC-290), 1,1,2-trifluoroethane (HFC-143), 2,3,3,3-tetrafluoropropene (HFO-1234yf), 1,1,1-difluoroethane (HFC-152a), 3-fluoro-1-propene (HFO-1261zf), 1-fluoropropene (E/Z-HFO-1261ze), 1,1,1-trifluoropropane (HFC-263fb), 1,1,1-trifluoroethane (HFC-143a), difluoropropane, chlorotrifluoropropene, pentafluorobutene (HFO-1345) and C₄H₆F₄ (HFC-374).

[0091] In certain embodiments disclosed herein, the stabilized composition comprises, consists essentially of, or consists of at least one of HFO-1252zf, HFO-1252yf, HFO-1252ye, HFO-1252ze and HFO-1252zc, preferably HFO-1252zc, optionally 1-chloro-1,1-difluoropropane (HCFC-262fc) and/or 1,1,1-trifluoropropane (HFC-263fb), and one or more additional members selected from trifluoromethane (HFC-23), dichloromethane (HCC-30), chlorofluoromethane (HCFC-31), methyl chloride (HCC-40), methane, 1,1,2,2,2-pentafluoroethane (HFC-125), 1,1,2-

trifluoroethane (HFC-143), 1,1,1-trifluoroethane (HFC-143a), 1,1-difluoroethane (HFC-152a), 1,1,1,2,2-pentafluoropropane (HFC-245cb), 2-chloro-1,1,1-trifluoropropane (HCFC-253dc), 1,1,1,3-tetrafluoropropane (HFC-254fb), 1,1,1-trichloropropane (HCC-260fb), 1,1-dichloro-1-fluoropropane (HCFC-261fc), 1,1-difluoropropane (HFC-272fb), propane (HC-290), tetrafluorobutene (HFO-374, butane (HC-600), allene, 2-butene, cyclobutene, 2-methylpropene, 1-chloro-2,2-difluoroethylene (HCFO-1122), 1,2-difluoroethene (HFO-1132), 1,1-difluoroethene ((HFO-1132a), fluoroethylene (HFO-1141), ethylene (HO-1150), 2-chloro-3,3,3-trifluoropropene (HCFO-1233xf), 2,3,3,3-tetrafluoropropene (HFO-1234yf), 3-chloro-3,3-difluoropropene (HCFO-1242zf), 3,3,3-trifluoropropene (HFO-1243zf), HCFO-1251 isomer (I), HCFO-1251 isomer (II), 3-chloropropene (HCO-1260zf), 3-fluoro-1-propene (HFO-1261), propylene (HO-1270), pentafluorobutene (HFO-1345), and E/Z-t-BuO-CF=CH-CH₃.

[0092] In certain embodiments disclosed herein the stabilized composition comprises, consists essentially of, or consists of 1,1-difluoropropene (HFO-1252zc), optionally 1,1,1-trifluoropropane (HFC-263fb), and one or more additional members HFO-1243zf, HFO-1234yf, allene, HFO-1252ye, HFO-1252yf, and HFO-1252zf.

[0093] In certain embodiments disclosed herein the stabilized composition comprises, consists essentially of, or consists of at least one of HFO-1252zf, HFO-1252yf, HFO-1252ye, HFO-1252ze and HFO-1252zc, preferably HFO-1252zc, optionally at least one of HFC-263fb, HCFC-262fc, and one or more additional members selected from ethylene, HFC-23, HFO-1132a, propane, HFO-1234yf, HFO-1234ze, HFO-1261zf, E/Z-HFO-1261ze, HFC-143a, HCFO-1233xf, and HFC-374.

[0094] In certain embodiments disclosed herein, the stabilized composition comprises, consists essentially of, or consists of at least one of HFO-1252zf, HFO-1252yf, HFO-1252ye, HFO-1252ze and HFO-1252zc, preferably HFO-1252zc, and one or more additional members selected from HCFO-1233xf, HFC-152a, HFC-263fb, HFC-254fb, HFC-253dc, HFC-252dc and HCFO-1230xa.

[0095] In certain embodiments disclosed herein, the stabilized composition comprises, consists essentially of, or consists of at least one of HFO-1252zf, HFO-1252yf, HFO-1252ye, HFO-1252ze and HFO-1252zc, preferably HFO-1252zc, and

one or more additional members selected from HCFC-262fc, HCC-250fb, HFC-263fb, HFO-1243zf, other HCFO-1252 isomers, ethane, ethylene, HFC-23, HCFC-22, HFO-1132a, propane, HFC-143a, HCFC-142b, HFO-1234yf, HFO-1234ze, HFO-1225zc, HCFO-1242zf and HCFC-252fc.

[0096] In certain embodiments disclosed herein, the stabilized composition comprises, consists essentially of, or consists of at least one of HFO-1252zf, HFO-1252yf, HFO-1252ye, HFO-1252ze and HFO-1252zc, preferably HFO-1252zc, and one or more additional members selected from at least one of HCC-250fb, HCFC-252fc and HCFC-262fc, and one or more additional compounds selected from HFC-263fb, HFO-1243zf, other 1252 isomers, ethane, ethylene, HFC-23, HCFC-22, HFO-1132a, propane, HFC-143a, HCFC-142b, HFO-1234yf, HFO-1234ze, HFO-1225zc, and HCFO-1242zf.

[0097] In certain embodiments disclosed herein, the stabilized composition comprises, consists essentially of, or consists of at least one of HFO-1252zf, HFO-1252yf, HFO-1252ye, HFO-1252ze and HFO-1252zc, preferably HFO-1252zc, and one or more additional members selected from HCC-250fb, HFC-263fb, HFO-1243zf, other 1252 isomers, ethane, ethylene, HFC-23, HCFC-22, HFO-1132a, propane, HFC-143a, HCFC-142b, HFO-1234yf, HFO-1234ze, HFO-1225zc, HCFO-1242zf and HCFC-252fc.

[0098] In certain embodiments disclosed herein, the stabilized composition comprises, consists essentially of, or consists of at least one of HFO-1252zf, HFO-1252yf, HFO-1252ye, HFO-1252ze and HFO-1252zc, preferably HFO-1252zc, and one or more additional members selected from HCC-250fb, HFC-263fb, HFO-1243zf, other 1252 isomers, ethane, ethylene, HFC-23, HCFC-22, HFO-1132a, propane, HFC-143a, HCFC-142b, HFO-1234yf, HFO-1234ze, HFO-1225zc and HCFO-1242zf.

[0099] In certain embodiments disclosed herein, the stabilized composition comprises, consists essentially of, or consists of at least one of HFO-1252zf, HFO-1252yf, HFO-1252ye, HFO-1252ze and HFO-1252zc, preferably HFO-1252zc, and one or more additional members selected from HCFC-262fc, HCC-250fb, HFC-263fb, HCFO-1242zf, HFO-1252zf, HFO-1243zf and HCFC-252fc.

[0100] In certain embodiments disclosed herein, the stabilized composition comprises, consists essentially of, or consists of (i) at least one of HFO-1252zf, HFO-1252yf, HFO-1252ye, HFO-1252ze and HFO-1252zc, preferably HFO-1252zc, (ii) optionally at least one of HCC-250fb and HCFO-1242zf; and (iii) one or more additional compounds selected from HCFC-262fc, HFC-263fb, HFO-1252zf, HFO-1243zf and HCFC-252fc.

[0101] In certain embodiments disclosed herein, the stabilized composition comprises, consists essentially of, or consists of at least one of HFO-1252zf, HFO-1252yf, HFO-1252ye, HFO-1252ze and HFO-1252zc, preferably HFO-1252zc, and one or more additional compounds selected from HCFO-1242zf, HCFC-262fc, HCC-250fb, HFC-263fb, HFO-1252zf, HFO-1243zf and HCFC-252fc.

[0102] In certain embodiments disclosed herein, the stabilized composition comprises, consists essentially of, or consists of at least one of HFO-1252zf, HFO-1252yf, HFO-1252ye, HFO-1252ze and HFO-1252zc, preferably HFO-1252zc, and one or more additional compounds selected from HCC-250fb, HCFC-252fc, HCFC-262fc, HCFO-1242zf, HFC-263fb, other 1252 isomers, ethane, ethylene, HFC-23, HCFC-22, HFO-1132a, propane, HFC-143a, HCFC-142b, HFO-1234yf, HFO-1234ze, and HFO-1225zc and HFO-1243zf.

[0103] In certain embodiment disclosed herein, the total amount of additional compounds/members in any of the foregoing stabilized HFO-1252 refrigerant compositions is selected from between: greater than 0 and less than about 0.5 wt. percent, greater than 0 and less than about 0.4 wt. percent, greater than 0 and less than about 0.2 wt. percent, greater than 0 and less than about 0.2 wt. percent, greater than 0 and less than about 0.1 wt. percent, or greater than 0 and less than about 0.01 wt. percent based on the total amount of the composition, with the *proviso* that the total amount of the composition is 100 wt.%; and/or the respective amount of an additional compound/member is selected from one of greater than 0 and less than about 0.2 wt. percent, greater than 0 and less than about 0.1 wt. percent, greater than 0 and less than about 0.01 wt. percent, greater than 0 and less than about 0.001 wt. percent, or greater than 0 and less than about 0.02001 percent based on the total amount of the composition, with the *proviso* that the total amount of the composition is 100 wt.%; and/or the respective amount of an additional

compound/member is independently selected from one of greater than 0 and less than about 0.2 wt. percent, greater than 0 and less than about 0.1 wt. percent, greater than 0 and less than about 0.01 wt. percent, greater than 0 and less than about 0.001 wt. percent, or greater than 0 and less than about 0.0001 wt. percent based on the total amount of the composition, with the *proviso* that the total amount of the composition is 100 wt.%; and/or the total amount of the additional compounds/members in any of the foregoing stabilized HFO-1252 refrigerant compositions is selected from between greater than 0.0001 and less than about 10 wt.%, greater than 0.0001 and less than about 9 wt.%, greater than 0.0001 and less than about 8 wt.%, greater than 0.0001 and less than about 7 wt.%, greater than 0.0001 and less than about 6 wt.%, greater than 0.0001 and less than about 5 wt.%, greater than 0.0001 and less than about 4 wt.%, greater than 0.0001 and less than about 3 wt.%, greater than 0.0001 and less than about 2 wt.%, greater than 0.0001 and less than about 1 wt.%, greater than 0.0001 and less than about 0.5 wt.%, or greater than 0.0001 and less than about 0.1 wt.%, based on the total amount of the composition, with the *proviso* that the total amount of the composition is 100 wt.%.

[0104] In some embodiments, the stabilized composition comprises a refrigerant blend including at least one difluoropropene and at least one other compound. Such a composition may further comprise one or more of any of the additional compounds listed above and/or in Table 1. The at least one difluoropropene is selected from HFO-1252zf, HFO-1252yf, HFO-1252ye, HFO-1252ze and HFO-1252zc, and is preferably HFO-1252zc.

[0105] In one embodiment, the at least one other compound of the refrigerant blends may be selected from fluoroolefins, hydrofluorocarbons, hydrocarbons, dimethyl ether, CF₃I, ammonia, carbon dioxide (CO₂), and mixtures thereof, meaning mixtures of any of the additional compounds listed in this paragraph. The amount of the other refrigerant compound can range from about 1 to about 90 wt%, about 5 to about 75 wt%, and in some cases about 10 to about 50 wt%, inclusive of all intervening values and ranges.

[0106] In one embodiment, the stabilized composition comprises a refrigerant blend comprising at least one difluoropropene selected from HFO-1252zf, HFO-1252yf, HFO-1252ye, HFO-1252ze and HFO-1252zc, preferably HFO-1252zc, and

at least one other compound selected from, CO₂, HFO-1234ze(E), HFO-1234ze(Z), HFO-1336mzz(E), HFO-1336mzz(Z), HFC-32, HFC-152a, HFC-125, HFC-134a, HFO-1132(E), HFO-1132(Z), HCFO-1233zd(E), HCFO-1233zd(Z), HFO-1234yf, HFC-143, HFC-143a, HFC-134, CFC-12, HFO-1243zf, HFO-1224yd(Z), HFO-1233xf, HFO-1131a, HFO-1122a(Z), HFO-1234yc, HFO-1234ye(E), HFO-1234ye(Z), HFO-1234zc, HFO-1243yc, HFO-1243zc, HFO-1243ye(E), HFO-1243ye(Z), HFO-1243ze(E), HFO-1243ze(Z), HFC-227ea, HFO-1252zc, HFO-1252zf, HFO-1252ye(E), HFO-1252ye(Z), HFO-1252ze(E), HFO-1252ze(Z), HFO-1252yf, ethane, propane, butane and combinations thereof.

[0107] In one embodiment, the stabilized composition comprises a refrigerant blend comprising at least one difluoropropene selected from HFO-1252zf, HFO-1252yf, HFO-1252ye, HFO-1252ze and HFO-1252zc, preferably HFO-1252zc, and selected from CO₂, HFO-1132(E), HFO-1132(Z), HFO-1234ze(E), HFO-1234ze(Z), HFO-1336mzz(E), HFO-1336mzz(Z), HFC-32, HFC-152a, HFC-125, HCFO-1233zd(E), HCFO-1233zd(Z), HFC-143a, HFC-134, CFC-12, HFO-1243zf, HFO-1131a, HFO-1122a(Z), HFO-1234yc, HFO-1234ye(E), HFO-1234ye(Z), HFO-1234zc, HFO-1243yc, HFO-1243zc, HFO-1243ye(E), HFO-1243ye(Z), HFO-1243ze(E), HFO-1243ze(Z), HFO-1252zc, HFO-1252zf, HFO-1252ye(E), HFO-1252ye(Z), HFO-1252ze(E), HFO-1252ze(Z), HFO-1252yf, ethane, propane, butane and combinations thereof.

[0108] In some embodiments, the at least one other compound includes a fluoroolefin, such as any of the fluoroolefins listed above. The amount of the other fluoroolefins can range from about 1 to about 90 wt%, about 5 to about 75 wt%, and in some cases about 10 to about 50 wt%, inclusive of all intervening values and ranges.

[0109] In one embodiment, the at least one other compound comprises hydrofluorocarbons. The hydrofluorocarbon (HFC) compounds of the present invention comprise saturated compounds containing carbon, hydrogen, and fluorine. Of particular utility are hydrofluorocarbons having 1-7 carbon atoms and having a normal boiling point of from about -90°C to about 80°C. Hydrofluorocarbons are commercial products available from a number of sources, or may be prepared by methods known in the art. Representative hydrofluorocarbon compounds include

but are not limited to fluoromethane (CH_3F , HFC-41), difluoromethane (CH_2F_2 , HFC-32), trifluoromethane (CHF_3 , HFC-23), pentafluoroethane (CF_3CHF_2 , HFC-125), 1,1,2,2-tetrafluoroethane (CHF_2CHF_2 , HFC-134), 1,1,1,2-tetrafluoroethane ($\text{CF}_3\text{CH}_2\text{F}$, HFC-134a), 1,1,1-trifluoroethane (CF_3CH_3 , HFC-143a), 1,1-difluoroethane (CHF_2CH_3 , HFC-152a), fluoroethane ($\text{CH}_3\text{CH}_2\text{F}$, HFC-161), 1,1,1,2,2,3,3-heptafluoropropane ($\text{CF}_3\text{CF}_2\text{CHF}_2$, HFC-227ca), 1,1,1,2,3,3,3-heptafluoropropane ($\text{CF}_3\text{CHFCF}_3$, HFC-227ea), 1,1,2,2,3,3,3-hexafluoropropane ($\text{CHF}_2\text{CF}_2\text{CHF}_2$, HFC-236ca), 1,1,1,2,2,3-hexafluoropropane ($\text{CF}_3\text{CF}_3\text{CH}_2\text{F}$, HFC-236cb), 1,1,1,2,3,3-hexafluoropropane ($\text{CF}_3\text{CHFCHF}_2$, HFC-236ea), 1,1,1,3,3,3-hexafluoropropane ($\text{CF}_3\text{CH}_2\text{CF}_3$, HFC-236fa), 1,1,2,2,3-pentafluoropropane ($\text{CHF}_2\text{CF}_2\text{CH}_2\text{F}$, HFC-245ca), 1,1,1,2,2-pentafluoropropane ($\text{CF}_3\text{CF}_2\text{CH}_3$, HFC-245cb), 1,1,2,3,3-pentafluoropropane ($\text{CHF}_2\text{CHFCHF}_2$, HFC-245ea), 1,1,1,2,3-pentafluoropropane ($\text{CF}_3\text{CHFCH}_2\text{F}$, HFC-245eb), 1,1,1,3,3-pentafluoropropane ($\text{CF}_3\text{CH}_2\text{CHF}_2$, HFC-245fa), 1,2,2,3-tetrafluoropropane ($\text{CH}_2\text{FCF}_2\text{CH}_2\text{F}$, HFC-254ca), 1,1,2,2-tetrafluoropropane ($\text{CHF}_2\text{CF}_2\text{CH}_3$, HFC-254cb), 1,1,2,3-tetrafluoropropane ($\text{CHF}_2\text{CHFCH}_2\text{F}$, HFC-254ea), 1,1,1,2-tetrafluoropropane ($\text{CF}_3\text{CHFCH}_3$, HFC-254eb), 1,1,3,3-tetrafluoropropane ($\text{CHF}_2\text{CH}_2\text{CHF}_2$, HFC-254fa), 1,1,1,3-tetrafluoropropane ($\text{CF}_3\text{CH}_2\text{CH}_2\text{F}$, HFC-254fb), 1,1,1-trifluoropropane ($\text{CF}_3\text{CH}_2\text{CH}_3$, HFC-263fb), 2,2-difluoropropane ($\text{CH}_3\text{CF}_2\text{CH}_3$, HFC-272ca), 1,2-difluoropropane ($\text{CH}_2\text{FCHFCH}_3$, HFC-272ea), 1,3-difluoropropane ($\text{CH}_2\text{FCH}_2\text{CH}_2\text{F}$, HFC-272fa), 1,1-difluoropropane ($\text{CHF}_2\text{CH}_2\text{CH}_3$, HFC-272fb), 2-fluoropropane ($\text{CH}_3\text{CHFCH}_3$, HFC-281ea), 1-fluoropropane ($\text{CH}_2\text{FCH}_2\text{CH}_3$, HFC-281fa), 1,1,2,2,3,3,4,4-octafluorobutane ($\text{CHF}_2\text{CF}_2\text{CF}_2\text{CHF}_2$, HFC-338pcc), 1,1,1,2,2,4,4,4-octafluorobutane ($\text{CF}_3\text{CH}_2\text{CF}_2\text{CF}_3$, HFC-338mf), 1,1,1,3,3-pentafluorobutane ($\text{CF}_3\text{CH}_2\text{CHF}_2$, HFC-365mfc), 1,1,1,2,3,4,4,5,5,5-decafluoropentane ($\text{CF}_3\text{CHFCHFCF}_2\text{CF}_3$, HFC-43-10mee), and 1,1,1,2,2,3,4,5,5,6,6,7,7,7-tetradecafluoroheptane ($\text{CF}_3\text{CF}_2\text{CHFCHFCF}_2\text{CF}_2\text{CF}_3$, HFC-63-14mee).

[0110] In one embodiment, examples of suitable hydrofluorocarbons comprise at least one member selected from HFC-32, HFC-125, HFC-134a, HFC-152a, HFC-236fa, and HFC-227ea. The amount of hydrofluorocarbon can range from about 1 to about 90 wt%, about 5 to about 75 wt%, and in some cases about 10 to about 50 wt%, inclusive of all intervening values and ranges.

[0111] In another embodiment, the at least one other compound comprises hydrocarbons. The hydrocarbons of the present invention comprise compounds having only carbon and hydrogen. Of particular utility are compounds having 3-7 carbon atoms. Hydrocarbons are commercially available through numerous chemical suppliers. Representative hydrocarbons include but are not limited to propane, n-butane, isobutane, cyclobutane, n-pentane, 2-methylbutane, 2,2-dimethylpropane, cyclopentane, n-hexane, 2-methylpentane, 2,2-dimethylbutane, 2,3-dimethylbutane, 3-methylpentane, cyclohexane, n-heptane, and cycloheptane.

[0112] In another embodiment, the at least one other compound comprises hydrocarbons containing heteroatoms, such as dimethylether (DME, CH_3OCH_3). DME is commercially available. The amount of the hydrocarbon can range from about 1 to about 90 wt%, about 5 to about 75 wt%, and in some cases about 10 to about 50 wt%, inclusive of all intervening values and ranges.

[0113] In another embodiment, the at least one other compound comprises iodotrifluoromethane (CF_3I), which is commercially available from various sources or may be prepared by methods known in the art. The amount of CF_3I can range from about 1 to about 90 wt%, about 5 to about 75 wt%, and in some cases about 10 to about 50 wt%, inclusive of all intervening values and ranges.

[0114] In another embodiment, the at least one other compound comprises carbon dioxide (CO_2), which is commercially available from various sources or may be prepared by methods known in the art. The amount of CO_2 can range from about 1 to about 90 wt%, about 5 to about 75 wt%, and in some cases about 10 to about 50 wt%, inclusive of all intervening values and ranges.

[0115] In another embodiment, the at least one other compound comprises at least one member selected from HFC-23, HFC-41, HFC-134a, HCFC-22, CFC-12, HCC-40, and HFC-143a, in an amount ranging from about 1 to about 90 wt%, about 5 to about 75 wt%, and in some cases about 10 to about 50 wt%, inclusive of all intervening values and ranges.

[0116] In another embodiment, the at least one other compound comprises at least one member selected from water, air (N_2/O_2 78/21 ratio), air ($\text{N}_2/\text{O}_2 > 78/21$ ratio), O_2 , N_2 , Ar, CO_2 , CH_4 , and He.

[0117] In one embodiment, the stabilized composition comprises a refrigerant blend comprising at least one difluoropropene selected from HFO-1252zf, HFO-1252yf, HFO-1252ye, HFO-1252ze and HFO-1252zc, preferably HFO-1252zc, and at least one other refrigerant compound selected from 2,3,3,3-tetrafluoropropene (HFO-1234yf), difluoromethane (HFC-32), 1,3,3,3-tetrafluoropropene (HFO-1234ze(E)), and 1,1-difluoroethane (HFC-152a). The at least one difluoropropene is selected from HFO-1252zf, HFO-1252yf, HFO-1252ye, HFO-1252ze and HFO-1252zc, and is preferably HFO-1252zc. In some embodiments, the refrigerant blend further includes at least one refrigerant compound selected from trifluoroethylene (HFO-1123), trifluoroiodomethane (CF₃I), carbon dioxide (R-744, CO₂), 1,1,1,2-tetrafluoroethane (HFC-134a), and 1,1,2,2-tetrafluoroethane (HFC-134).

[0118] In one embodiment, the stabilized composition comprises a refrigerant blend comprising at least one difluoropropene selected from HFO-1252zf, HFO-1252yf, HFO-1252ye, HFO-1252ze and HFO-1252zc, preferably HFO-1252zc, and at least one other refrigerant compound selected from HFC-227ca, HFC-134, HFC-152a, HFC-32, HFC-41, R131I (CF₃I), CO₂, HFO-1123, HFO-1132a, HFO-1132(E), HFO-1132(Z), HCFO-1131a, HCFO-1122a(Z), and HCFO-1122a(E).

[0119] In one embodiment, the stabilized composition comprises a refrigerant blend comprising at least one difluoropropene selected from HFO-1252zf, HFO-1252yf, HFO-1252ye, HFO-1252ze and HFO-1252zc, preferably HFO-1252zc, and at least one other refrigerant compound selected from HFC-227ca, HFC-134, HFC-152a, HFC-32, HFC-41, R131I (CF₃I), CO₂, HFO-1123, HFO-1132a, HFO-1132(E), HFO-1132(Z), HCFO-1131a, HCFO-1122a(Z), HCFO-1122a(E), HFO-1234yc, HFO-1234ye(E), HFO-1234ye(Z), HFO-1234zc, HFO-1243yc, HFO-1243zf, HFO-1243zc, HFO-1243ye(E), HFO-1243ye(Z), HFO-1243ze(E), HFO-1243z(-)Z, HFO-1336mzz(Z), HFO-1336mzz(E), HCFO-1233zd(E), and HCFO-1233zd(Z).

[0120] In one embodiment, the stabilized composition comprises a refrigerant blend comprising at least one difluoropropene selected from HFO-1252zf, HFO-1252yf, HFO-1252ye, HFO-1252ze and HFO-1252zc, preferably HFO-1252zc, and HFC-32 (i.e., as the other refrigerant compound).

[0121] In one embodiment, the stabilized composition comprises a refrigerant blend comprising at least one difluoropropene selected from HFO-1252zf, HFO-

1252yf, HFO-1252ye, HFO-1252ze and HFO-1252zc, preferably HFO-1252zc, and HFC-1132(E) (i.e., as the other refrigerant compound).

[0122] In one embodiment, the stabilized composition comprises a refrigerant blend comprising at least one difluoropropene selected from HFO-1252zf, HFO-1252yf, HFO-1252ye, HFO-1252ze and HFO-1252zc, preferably HFO-1252zc, and HFC-32 and HFC-152a (i.e., as the other refrigerant compounds).

[0123] In one embodiment, the stabilized composition comprises a refrigerant blend comprising at least one difluoropropene selected from HFO-1252zf, HFO-1252yf, HFO-1252ye, HFO-1252ze and HFO-1252zc, preferably HFO-1252zc, and HFC-32 and HFC-134 (i.e., as the other refrigerant compounds).

[0124] In one embodiment, the stabilized composition comprises a refrigerant blend comprising at least one difluoropropene selected from HFO-1252zf, HFO-1252yf, HFO-1252ye, HFO-1252ze and HFO-1252zc, preferably HFO-1252zc, and HFC-32 and HFC-227ca (i.e., as the other refrigerant compounds).

[0125] In one embodiment, the stabilized composition comprises a refrigerant blend comprising at least one difluoropropene selected from HFO-1252zf, HFO-1252yf, HFO-1252ye, HFO-1252ze and HFO-1252zc, preferably HFO-1252zc, and HFC-32 and CF₃I (i.e., as the other refrigerant compounds).

[0126] In one embodiment, the stabilized composition comprises a refrigerant blend comprising at least one difluoropropene selected from HFO-1252zf, HFO-1252yf, HFO-1252ye, HFO-1252ze and HFO-1252zc, preferably HFO-1252zc, and HFC-1132(E) and HFC-152a (i.e., as the other refrigerant compounds).

[0127] In one embodiment, the stabilized composition comprises a refrigerant blend comprising at least one difluoropropene selected from HFO-1252zf, HFO-1252yf, HFO-1252ye, HFO-1252ze and HFO-1252zc, preferably HFO-1252zc, and HFC-1132(E) and HFC-134 (i.e., as the other refrigerant compounds).

[0128] In one embodiment, the stabilized composition comprises a refrigerant blend comprising at least one difluoropropene selected from HFO-1252zf, HFO-1252yf, HFO-1252ye, HFO-1252ze and HFO-1252zc, preferably HFO-1252zc, and HFC-1132(E) and HFC-227ca (i.e., as the other refrigerant compounds).

[0129] In one embodiment, the stabilized composition comprises a refrigerant blend comprising at least one difluoropropene selected from HFO-1252zf, HFO-1252yf, HFO-1252ye, HFO-1252ze and HFO-1252zc, preferably HFO-1252zc, and HFC-1132(E) and CF₃I (i.e., as the other refrigerant compounds).

[0130] In some embodiments, the refrigerant blend which makes up the refrigerant portion of the composition comprises from about 1 to about 96 wt% difluoropropene and from about 4 wt% to about 99 wt% of at least one other refrigerant compound, alternatively about 1 to about 20 wt% difluoropropene and from about 80 wt% to about 99 wt% of at least one other refrigerant compound, alternatively about 2 to about 14 wt% difluoropropene and from about 86 wt% to about 98 wt% of at least one other refrigerant compound, alternatively about 20 wt% or greater difluoropropene and up to about 80 wt% of at least one other refrigerant compound, alternatively about 72 to about 96 wt% difluoropropene and from about 4 wt% to about 28 wt% of at least one other refrigerant compound, or any value, range, or sub-range therebetween.

[0131] In some particular embodiments, the refrigerant blend which makes up the refrigerant portion of the stabilized composition comprises from 2 to 35 wt% difluoropropene, from 2 to 96 wt% of a second refrigerant compound, and from 2 to 96 wt% of a third refrigerant compound, such as, for example, from 4 to 10 wt% difluoropropene, from 2 to 30 wt% of the second refrigerant compound, and from 60 to 94 wt% of the third refrigerant compound.

[0132] In some particular embodiments, the refrigerant blend which makes up the refrigerant portion of the stabilized composition comprises from about 1 wt% to about 35 wt% difluoropropene, from about 1 wt% to about 40 wt% of a second refrigerant compound, and from about 40 wt% to about 98 wt% of a third refrigerant compound.

[0133] According to one embodiment, some of the stabilized compositions of the present invention are free of or substantially free of Group A Fluorinated Substances, such as trifluoroacetic acid (TFA). In one embodiment, as used herein, "Group A Fluorinated Substances" includes any substance that (i) contains at least one fully fluorinated methyl (–CF₃) or methylene (–CF₂–) carbon atom (without any H/Cl/Br/I attached to it); and (ii) meets the criterion for persistence in soil/sediment and water established in Annex XIII (Section 1.1.1) of the European Union's REACH

Regulation (<https://reachonline.eu/reach/en/annex-xiii-1-1.1-1.1.1.html> as accessed on May 2, 2023) and referenced in the Annex XV Restriction Report dated March 22, 2023, the disclosure of which is hereby incorporated by reference (<https://echa.europa.eu/documents/10162/f605d4b5-7c17-7414-8823-b49b9fd43aea> as accessed on May 2, 2023).

[0134] In another embodiment, as used herein, "Group A Fluorinated Substances" includes any substance that has a Henry's Law constant $\leq 250 \text{ Pa}\cdot\text{m}^3/\text{mol}$ and contains at least one fully fluorinated methyl ($-\text{CF}_3$) or methylene ($-\text{CF}_2-$) carbon atom (without any H/Cl/Br/I attached to it).

[0135] In embodiments, Group A Fluorinated Substances include, but are not limited to, TFA.

[0136] The phrase "free of" as used herein with respect to the presence of Group A Fluorinated Substances in the present stabilized compositions means that the amount of such substances in the compositions is sufficiently low so as to not be detectable, including but not limited to 0%, when measured by gas chromatography with a flame ionization detector, gas chromatography with a mass detector by analysis of a gas sample or liquid sample, and/or ion chromatography by analysis of a water sample after bubbling the thermal fluid through water. Such methodologies are well known to those skilled in the art. The phrase "substantially free of" as used herein with respect to the presence of Group A Fluorinated Substances in the present stabilized compositions means that the amount of such substances in the compositions is $> 0 \text{ wt.}\%$ and $\leq 5 \text{ wt.}\%$, or $> 0 \text{ wt.}\%$ and $\leq 4 \text{ wt.}\%$, or $> 0 \text{ wt.}\%$ and $\leq 3 \text{ wt.}\%$, or $> 0 \text{ wt.}\%$ and $\leq 2 \text{ wt.}\%$, or $> 0 \text{ wt.}\%$ and $\leq 1 \text{ wt.}\%$, and all values and ranges therebetween, when measured by gas chromatographic (GC) techniques, for example gas chromatography (GC) with a flame ionization or electron-capture detector, or GC coupled with a mass detector (gas chromatography/mass spectral (GC/MS) method), by ion chromatograph(IC) or ion chromatography mass spectrometry (IC-MS) techniques, or by high-performance liquid chromatography (HPLC) or high-performance liquid chromatography mass spectrometry (HPLC-MS) techniques. The TFA analytical standard may be used in either gas chromatography or ion chromatography and is available from, for example, Sigma Aldrich.

[0137] In one embodiment, the stabilized composition according to the present invention comprises at least one difluoropropene, such as HFO-1252zf, HFO-1252yf, HFO-1252ye, HFO-1252ze or HFO-1252zc, preferably HFO-1252zc; and optionally one or more of the additional members or additional compounds disclosed herein; and the stabilized composition is free of or substantially free of Group A Fluorinated Substances, such as TFA.

[0138] In one embodiment, the stabilized composition according to the present invention comprises at least one difluoropropene, such as HFO-1252zf, HFO-1252yf, HFO-1252ye, HFO-1252ze or HFO-1252zc, preferably HFO-1252zc; at least one other refrigerant selected from CO₂, HFO-1132(E), HFO-1132(Z), HFO-1234ze(E), HFO-1234ze(Z), HFO-1336mzz(E), HFO-1336mzz(Z), HFC-32, HFC-152a, HFC-125, HCFO-1233zd(E), HCFO-1233zd(Z), HFC-143a, HFC-134, CFC-12, HFO-1243zf, HFO-1131a, HFO-1122a(Z), HFO-1234yc, HFO-1234ye(E), HFO-1234ye(Z), HFO-1234zc, HFO-1243yc, HFO-1243zc, HFO-1243ye(E), HFO-1243ye(Z), HFO-1243ze(E), HFO-1243ze(Z), HFO-1252zc, HFO-1252zf, HFO-1252ye(E), HFO-1252ye(Z), HFO-1252ze(E), HFO-1252ze(Z), HFO-1252yf, ethane, propane, butane and combinations thereof; and optionally one or more of the additional members or additional compounds disclosed herein, and the stabilized composition is free of or substantially free of Group A Fluorinated Substances, such as TFA.

[0139] In one embodiment, degradation products of some of the stabilized compositions according to the present invention are free of or substantially free of Group A Fluorinated Substances, such as TFA. The phrase "free of" as used herein with respect to the formation of Group A Fluorinated Substances as degradation products of the present compositions means that the theoretical molar yield of such substances in environmental compartments of air, soil/sediment and water produced during tropospheric degradation of the compositions is sufficiently low so as to not be detectable, including but not limited to 0%, when measured by GC techniques, for example GC with a flame ionization or electron-capture detector or GC/MS method, by IC or IC-MS techniques, or by HPLC or HPLC-MS techniques. The phrase "substantially free of" as used herein with respect to the formation of Group A Fluorinated Substances by the present compositions means that the theoretical molar yield of such substances in environmental compartments of air, soil/sediment and water produced during tropospheric degradation of the compositions is > 0%

and $\leq 5\%$, or $> 0\%$ and $\leq 4\%$, or $> 0\%$ and $\leq 3\%$, or $> 0\%$ and $\leq 2\%$, or $> 0\%$ and $\leq 1\%$, and all values and ranges therebetween, when measured by GC techniques, for example GC with a flame ionization or electron-capture detector or GC/MS method, by IC or IC-MS techniques, or by HPLC or HPLC-MS techniques.

[0140] In one embodiment, the stabilized composition according to the present invention comprises at least one difluoropropene, such as HFO-1252zf, HFO-1252yf, HFO-1252ye, HFO-1252ze or HFO-1252zc, preferably HFO-1252zc; and optionally one or more of the additional members or additional compounds disclosed herein; wherein degradation products of the stabilized composition are free of or substantially free of Group A Fluorinated Substances, such as TFA.

[0141] In one embodiment, the stabilized composition according to the present invention comprises at least one difluoropropene, such as HFO-1252zf, HFO-1252yf, HFO-1252ye, HFO-1252ze or HFO-1252zc, preferably HFO-1252zc; at least one other refrigerant selected from CO₂, HFO-1132(E), HFO-1132(Z), HFO-1234ze(E), HFO-1234ze(Z), HFO-1336mzz(E), HFO-1336mzz(Z), HFC-32, HFC-152a, HFC-125, HCFO-1233zd(E), HCFO-1233zd(Z), HFC-143a, HFC-134, CFC-12, HFO-1243zf, HFO-1131a, HFO-1122a(Z), HFO-1234yc, HFO-1234ye(E), HFO-1234ye(Z), HFO-1234zc, HFO-1243yc, HFO-1243zc, HFO-1243ye(E), HFO-1243ye(Z), HFO-1243ze(E), HFO-1243ze(Z), HFO-1252zc, HFO-1252zf, HFO-1252ye(E), HFO-1252ye(Z), HFO-1252ze(E), HFO-1252ze(Z), HFO-1252yf, ethane, propane, butane and combinations thereof; and optionally one or more of the additional members or additional compounds disclosed herein, wherein degradation products of the stabilized composition are free of or substantially free of Group A Fluorinated Substances, such as TFA.

[0142] By “stabilized” it is meant to refer to a composition in which the difluoropropene component has a reduced or no propensity to react under conditions of extreme temperatures and more particularly high heat (e.g., above 100°C, or above 150°C, or above 200°C) or in the presence of base compounds which results decomposition by the loss of an HF molecule and/or a reduced or no propensity to interact with other compounds which results in the formation of dimers, oligomers, homopolymers or polymeric products.

[0143] In one embodiment, stabilization of the difluoropropene composition is achieved by inclusion in the composition of an effective amount of at least one inhibitor compound. In one embodiment, any of the stabilized compositions according to any of the embodiments the present invention, neat or blends, further comprises an effective amount of at least one inhibitor. Preferably, the inhibitor is present in a liquid difluoropropene.

[0144] In one embodiment, the inhibitor inhibits, if not eliminates a fluoropropene, more particularly a difluoropropene, from interacting with another compound and forming dimers, oligomers, homopolymers or polymeric products. Examples of such compounds that can cause such interactions include oxidizers such as air, oxygen, cumene hydroperoxide, and fluoroolefin polyperoxides, peroxides, hydroperoxides, persulfates, percarbonates, perborates, hydropersulfates among other initiators. Initiator compounds can be present in an amount from about 10 to about 15,000 ppm by weight, about 1,000 to about 10,000 ppm and in some cases about 1,000 to about 3,000 ppm and in some embodiments 30 to 2,000 ppm. Such initiator compounds can be present as contaminants in at least one of conduits, lines and other systems used for handling the fluoropropene containing refrigerant compositions; packaging (containers), and a refrigeration, air-conditioning or heat pump system. Without wishing to be bound by any theory or explanation it is believed that certain contaminants can function as radical initiators thereby causing the fluoropropene to oligomerize, homopolymerize or form other polymeric products.

[0145] In one embodiment of the invention, the stabilized difluoropropene compositions are substantially free of oligomeric, homopolymers or other polymeric products derived from a hydrofluoroolefin. By "substantially free" it is meant that the composition contains about 1 wt% or less, or about 0.07 wt% or less, or about 0.03 wt% or less, and in some cases about 0 ppm, of such products when measured by IR or NMR.

[0146] In another embodiment of the invention, the stabilized difluoropropene compositions are substantially free of certain conventional inhibitor compounds including sesquiterpene compounds such as at least one member selected from famesol, famesene; ionic liquids such as an ionic liquid comprising an anion selected from the group consisting of $[\text{CH}_3\text{CO}_2]^-$, $[\text{HSO}_4]^-$, $[\text{CH}_3\text{OSO}_3]^-$, $[\text{C}_2\text{H}_5\text{OSO}_3]^-$, $[\text{AlCl}_4]^-$,

$[\text{CO}_3]^{2-}$, $[\text{HCO}_3]^-$, $[\text{NO}_2]^-$, $[\text{NO}_3]^-$, $[\text{SO}_4]^{2-}$, $[\text{PO}_4]^{3-}$, $[\text{HPO}_4]^{2-}$, $[\text{H}_2\text{PO}_4]^-$, $[\text{HSO}_3]$, and certain fluorinated anion wherein the fluorinated anion is selected from $[\text{BF}_4]^-$, $[\text{PF}_6]^-$, $[\text{SbF}_6]^-$, $[\text{CF}_3\text{SO}_3]^-$, $[\text{HCF}_2\text{CF}_2\text{SO}_3]^-$, $[\text{CF}_3\text{HFCCF}_2\text{SO}_3]^-$, $[\text{HCClFCF}_2\text{SO}_3]^-$, $[(\text{CF}_3\text{SO}_2)_2\text{N}]^-$, $[(\text{CF}_3\text{CF}_2\text{SO}_2)_2\text{N}]^-$, $[(\text{CF}_3\text{SO}_2)_3\text{C}]^-$, $[\text{CF}_3\text{CO}_2]^-$, $[\text{CF}_3\text{OCFHCF}_2\text{SO}_3]^-$, $[\text{CF}_3\text{CF}_2\text{OCFHCF}_2\text{SO}_3]^-$, $[\text{CF}_3\text{CFHOCF}_2\text{CF}_2\text{SO}_3]^-$, $[\text{CF}_2\text{HCF}_2\text{OCF}_2\text{CF}_2\text{SO}_3]^-$, $[\text{CF}_2\text{ICF}_2\text{OCF}_2\text{CF}_2\text{SO}_3]^-$, $[\text{CF}_3\text{CF}_2\text{OCF}_2\text{CF}_2\text{SO}_3]^-$, $[(\text{CF}_2\text{HCF}_2\text{SO}_2)_2\text{N}]^-$, $[(\text{CF}_3\text{CFHCF}_2\text{SO}_2)_2\text{N}]^-$ and mixtures thereof. By “substantially free” it is meant that the stabilized difluoropropene compositions contains about 500 ppm or less, typically about 250 ppm or less, in some cases about 100 ppm or less, and in some cases about 0 ppm of such conventional inhibitors.

[0147] In one embodiment, stabilized compositions according to the present invention, and more particularly according to any of the foregoing embodiments, further comprises at least one inhibitor comprising at least one member selected from limonene, α -terpinene, α -tocopherol, butylated hydroxytoluene, 4-methoxyphenol, benzene-1,4-diol.

[0148] In one embodiment, the stabilized difluoropropene refrigerant compositions comprise an inhibitor that can interact or react with O_2 and fluoroolefin polyperoxides and, in turn, inhibit or preclude reaction of such compounds with a hydrofluoroolefin, such as HFO-1252zc. Examples of such an inhibitor comprise at least one of limonene and α -terpinene. Limonene and α -terpinene have the following structures:



Limonene

 α -Terpinene

[0149] In one embodiment of the invention, the inhibitor comprises α -terpinene. Without wishing to be bound by any theory or explanation, it is believed that due to the presence of the conjugated double bond in its structure, α -terpinene can form an aromatic ring upon oxidation.

[0150] In one embodiment of the invention, limonene or α -terpinene optionally with an antioxidant has unique fragrance even at a few ppm level. This pleasant odor can

be utilized for refrigerant leakage detection with refrigerant and blends based on hydrofluoroolefins (e.g., comprising at least one of HFO-1252zf, HFO-1252yf, HFO-1252ye, HFO-1252ze and HFO-1252zc, and mixtures thereof). This is especially beneficial for early refrigerant leakage detection in household air conditioner or mobile air conditioner as paraprofessional electronic leak detectors often are not available in either location.

[0151] One embodiment of the invention relates to a refrigerant composition comprising:

- a. at least one difluoropropene selected from HFO-1252zf, HFO-1252yf, HFO-1252ye, HFO-1252ze and HFO-1252zc, and mixtures thereof;
- b. optionally at least one lubricant; and
- c. an effective amount of at least one inhibitor comprising at least one of: hydrocarbons comprising cyclic monoterpene; lipophilic organic compounds including tocopherol including α -Tocopherol; phenols, aromatic organic compounds having the chemical formula $C_6H_4(OH)$ including benzene-1,4-diol; wherein the inhibitor is present in a liquid fluoroolefin as well as the lubricant (when present).

[0152] In one embodiment of the invention, stabilization of the difluoropropene composition is achieved by inclusion of an effective amount of at least one inhibitor compound that inhibits, if not eliminates a fluoropropene, more particularly a difluoropropene, from decomposition (e.g., loss of HF) under high heat conditions or in the presence of base compounds. In one embodiment, such inhibitors comprise an acid scavenger, as described herein.

[0153] One embodiment of the invention relates to any of the foregoing stabilized difluoropropene refrigerant compositions further comprising at least one antioxidant. While any suitable antioxidant can be employed, examples of suitable antioxidants comprise at least one member selected from butylated hydroxytoluene, butylated hydroxyanisole, tertiary-butylhydroquinone, gallate, 2-phenyl-2-propanol, 1-(2,4,5-trihydroxyphenyl)-1-butanone, bisphenol methane derivatives, 2,2'-methylene bis (4-methyl-6-*t*-butyl phenol), among other phenolics, and combinations thereof. The amount of antioxidant can range from about 0.01 to about 5,000 ppm by weight, about 0.03 to about 2000 ppm and in some cases about 0.05 to about 1000 ppm.

[0154] One particular embodiment relates to using the foregoing antioxidants with an inhibitor comprising at least one of limonene and α -terpinene.

[0155] In some embodiments, at least a portion of any of the compositions disclosed herein comprises reclaimed materials.

[0156] Another embodiment of the invention relates to a method for stabilizing a refrigerant composition comprising at least one difluoropropene selected from HFO-1252zf, HFO-1252yf, HFO-1252ye, HFO-1252ze and HFO-1252zc, and mixtures thereof, said method comprising adding an effective amount of at least one inhibitor wherein the inhibitor is selected from hydrocarbon comprising at least one member selected from cyclic monoterpene; lipophilic organic compounds including tocopherol including α -Tocopherol; phenols, and aromatic organic compounds having the chemical formula $C_6H_4(OH)$ including benzene-1,4-diol, and mixtures thereof, to the composition.

[0157] Another embodiment of the invention relates to a method for reducing or prevent undesired reactions, such as decomposition (e.g., by loss of HF), oligomerization or homopolymerization, of a refrigerant composition comprising at least one difluoropropene, which is caused by the presence of high heat or an inadvertent or undesired contaminant present in at least one of conduits, lines and other systems used for handling the difluoropropene containing refrigerant compositions; packaging (containers), and a refrigeration, air-conditioning or heat pump system, said method comprising adding an inhibitor comprising at least one member selected from hydrocarbon comprising cyclic monoterpene; lipophilic organic compounds including tocopherol including α -Tocopherol; phenols, aromatic organic compounds having the chemical formula $C_6H_4(OH)$ including benzene-1,4-diol, and mixtures thereof, to at least one of said system, container and composition comprising at least one difluoropropene, such as HFO-1252zc.

[0158] A further embodiment of the invention relates to a stabilized difluoropropene refrigerant composition stored within a container wherein the difluoropropene has a reduced potential to undergo undesirable reactions, such as decomposition, oligomerization or homopolymerization, in comparison to refrigerant compositions without the inventive inhibitor composition.

[0159] One embodiment of the invention relates to a refrigerant composition comprising at least one difluoropropene, such as HFO-1252zc, and an effective amount of at least one inhibitor and wherein the composition is substantially free of oligomeric, homopolymers or other polymeric products derived from the difluoropropene.

[0160] Another embodiment of the invention relates to any of the foregoing stabilized difluoropropene refrigerant compositions wherein the composition comprises about 0.03 wt.% or less of oligomeric, homopolymers or other polymeric products.

[0161] Another embodiment of the invention relates to any of the foregoing stabilized difluoropropene refrigerant compositions and further comprising at least one member selected from air, oxygen, cumene hydroperoxide, and fluoroolefin polyperoxides, peroxides, hydroperoxides, persulfates, percarbonates, perborates and hydropersulfates.

[0162] Another embodiment of the invention relates to any of the foregoing stabilized difluoropropene refrigerant compositions wherein the inhibitor comprises a liquid at a temperature of about -50 to 150°C.

[0163] One embodiment of the invention relates to a method for reducing formation of oligomers and homopolymers comprising contacting a refrigerant composition comprising at least one difluoropropene with an amount of at least one member selected from limonene, α -terpinene, α -tocopherol, butylated hydroxytoluene, 4-methoxyphenol, and benzene-1,4-diol, that is effective to reduce oligomer or homopolymer formation.

[0164] Another embodiment of the invention relates to any of the foregoing methods wherein the stabilized difluoropropene refrigerant composition has been exposed to at least one member selected from the group consisting of air, oxygen, cumene hydroperoxide, and fluoroolefin polyperoxides, peroxides, hydroperoxides, persulfates, percarbonates, perborates and hydropersulfates before said contacting.

[0165] Another embodiment of the invention relates to any of the foregoing methods that employs any of the foregoing stabilized difluoropropene refrigerant compositions for heating or cooling.

[0166] Another embodiment of the invention relates to a container with a refrigerant comprising any of the foregoing stabilized difluoropropene refrigerant compositions.

[0167] Any suitable effective amount of inhibitor may be used in the foregoing stabilized refrigerant compositions comprising at least one difluoropropene, such as HFO-1252zc. As described herein, the phrase “effective amount” refers to an amount of inhibitor of the present invention which, when added to a composition comprising at least one difluoropropene, such as HFO-1252zc, results in a composition wherein the difluoropropene will not interact with an initiator, and/or degrade to produce as great a reduction in performance, for example, when in use in a cooling or heating apparatus as compared to the composition without an inhibitor and be present in a liquid phase difluoropropene, as well, in some embodiments, in a lubricant. For a cooling or heating apparatus, such effective amounts of inhibitor may be determined by way of testing under the conditions of standard test ASHRAE 97-2007 (RA 2017). In a certain embodiments of the present invention, an effective amount may be said to be that amount of inhibitor that when included as a component of a refrigerant composition comprising at least one difluoropropene and a lubricant allows a cooling apparatus utilizing said composition to perform at the same level of refrigeration performance and cooling/heating capacity as if a composition comprising 1,1,1,2-tetrafluoroethane (hfc-134a), 2,3,3,3-tetrafluoroethylene (HFO-1234yf) or other standard refrigerant (CFC-12, HCFC-22, R-502, R-507A, R-508, R-401A, R-401B, R-402A, R-402B, R-408, R-410A, R-404A, R-407C, R-413A, R-417A, R-422A, R-422B, R-422C, R-422D, R-423, CFC-114, CFC-11, CFC-113, HCFC-123, HCFC-124, HFC-236fa, or HFC-245fa) depending upon what refrigerant may have been used in a similar system in the past, were being utilized as the working fluid.

[0168] The instant invention employs effective amounts of at least one inhibitor, such as any of the foregoing inhibitors. While any suitable effective amount can be employed, effective amounts comprise from about 0.001 wt% to about 10 wt%, about

0.01 wt% to about 5 wt%, about 0.3 wt% to about 4 wt%, about 0.3 wt% to about 1 wt% based on the total weight of HFO-1252 refrigerant compositions as described herein. In one embodiment, an effective amount comprises about 10 to about 2,000 ppm by weight, about 10 to about 1,000 ppm and in some cases about 10 to about 500 ppm of at least one inhibitor.

[0169] In one embodiment of the invention, in use, where the refrigerant composition is used in a system comprising a lubricant or where the refrigerant composition itself includes a lubricant, the inhibitor partitions between the two liquid phases, namely, the liquid phase difluoropropene and the lubricant. The amount of inhibitor present in the liquid phase of the difluoropropene can range about 10 to about 80 wt%, about 25 to about 75 wt% and, in some cases, about 45 to about 60 wt% of the inhibitor with the remainder of the inhibitor predominantly present in the lubricant phase.

[0170] In one embodiment, the present invention relates to a method for increasing a purity of a composition, comprising contacting a refrigerant composition comprising at least one difluoropropene with a desiccant for a predetermined duration. In some embodiments, the desiccant may be an aluminum containing adsorbent. The aluminum containing adsorbent may be selected from zeolite Y, zeolite X, zeolite beta, zeolite A, zeolite ZK-20, zeolite ZSM-3, faujasite, LZ-10, AW-500, ZSM-5-type zeolites, crystalline silicates such as silicalite, erionite, mordenite, offretite, chabazite, FU-1-type zeolite, NU-type zeolites and LZ-210-type zeolite. In some embodiments, the aluminum containing adsorbent is a molecular sieve. In some embodiments, the molecular sieve has openings which have a nominal pore size of about 3 Å to about 10 Å, or a nominal pore size of about 3 Å to about 5 Å, preferably about 3 Å, or a nominal pore size of about 9 Å to 10 Å, preferably about 10 Å. In some embodiments, the aluminum containing adsorbent is zeolite 3A or molecular sieve 13X.

[0171] The stabilized refrigerant compositions have a variety of utilities such as heat transfer mediums (e.g., heat transfer fluids and refrigerants for use in refrigeration systems, refrigerators, air conditioning systems, heat pumps, chillers, and the like), among others. The inventive compounds are particularly suited for use in mobile or stationary air conditioning systems and heat pump systems and as a

component for making a refrigerant blend for use in mobile or stationary heat transfer systems and heat pump systems.

[0172] A heat transfer medium (also referred to herein as a heat transfer fluid, a heat transfer composition or a heat transfer fluid composition) is a working fluid used to carry heat from a heat source to a heat sink.

[0173] A refrigerant is a compound or mixture of compounds that function as a heat transfer fluid in a cycle wherein the fluid undergoes a phase change from a liquid to a gas (or vapor) and back. The inhibitor is present in at least the liquid fluoropropene containing phase of the refrigerant, and in some embodiments in a lubricant component of the refrigerant composition as well. In one embodiment, about 10 to about 80 wt%, about 25 to about 75 wt% and, in some cases, about 45 to about 60 wt% of the inhibitor is present in the liquid fluoropropene phase with the remainder predominantly present in the lubricant phase. In one embodiment, the vapor phase is substantially free of inhibitor. By "substantially free" it is meant that the amount of inhibitor in the vapor fluoropropene phase is about 10 ppm or less, in some cases about 5 ppm or less and typically about 2 ppm or less. In one embodiment, the refrigerant comprises a vapor phase comprising at least one fluoropropene (and more particularly difluoropropene) and a liquid phase comprising at least one fluoropropene (and more particularly difluoropropene) and at least one inhibitor, and optionally at least one lubricant, and in some cases wherein the vapor phase is substantially free of the inhibitor.

[0174] In some embodiments, any of the foregoing stabilized refrigerant compositions may further comprise at least one lubricant. The optional lubricant component of the refrigerant compositions can comprise those suitable for use with refrigeration or air-conditioning apparatus. Among these lubricants are those conventionally used in compression refrigeration apparatus utilizing chlorofluorocarbon refrigerants. Such lubricants and their properties are discussed in the 1990 ASHRAE Handbook, Refrigeration Systems and Applications, chapter 8, titled "Lubricants in Refrigeration Systems", pages 8.1 through 8.21, herein incorporated by reference. Lubricants of the present invention may comprise those commonly known as "mineral oils" in the field of compression refrigeration lubrication. Mineral oils comprise paraffins (i.e. straight-chain and branched-carbon-

chain, saturated hydrocarbons), naphthenes (i.e. cyclic or ring structure saturated hydrocarbons, which may be paraffins) and aromatics (i.e. unsaturated, cyclic hydrocarbons containing one or more rings characterized by alternating double bonds). Lubricants of the present invention further comprise those commonly known as “synthetic oils” in the field of compression refrigeration lubrication. Synthetic oils comprise alkylaryls (i.e., linear and branched alkyl alkylbenzenes), synthetic paraffins and naphthenes, silicones, and poly-alpha-olefins. Representative conventional lubricants of the present invention are the commercially available BVM 100 N (paraffinic mineral oil sold by BVA Oils), naphthenic mineral oil commercially available under the trademark from Suniso® 3GS and Suniso® 5GS by Crompton Co., naphthenic mineral oil commercially available from Pennzoil under the trademark Sontex® 372LT, naphthenic mineral oil commercially available from Calumet Lubricants under the trademark Calumet® RO-30, linear alkylbenzenes commercially available from Shrieve Chemicals under the trademarks Zerol® 75, Zerol® 150 and Zerol® 500 and branched alkylbenzene, sold by Nippon Oil as HAB 22.

[0175] In another embodiment, the optional lubricant component of the present inventive stabilized difluoropropene refrigerant compositions can comprise those which have been designed for use with hydrofluorocarbon refrigerants and are miscible with refrigerants and inhibitors of the present invention under compression refrigeration and air-conditioning apparatus' operating conditions. Such lubricants and their properties are discussed in “Synthetic Lubricants and High-Performance Fluids”, R. L. Shubkin, editor, Marcel Dekker, 1993. Such lubricants include, but are not limited to, polyol esters (POEs) such as Castrol® 100 (Castrol, United Kingdom), polyalkylene glycols (PAGs) such as RL-488A from Dow (Dow Chemical, Midland, Michigan), and polyvinyl ethers (PVEs).

[0176] Lubricants of the present invention are selected by considering a given compressor's requirements and the environment to which the lubricant will be exposed. The amount of lubricant can range from about 1 to about 50, about 1 to about 20 and in some cases about 1 to about 3. In one particular embodiment, the foregoing refrigerant compositions are combined with a PAG lubricant for usage in an automotive A/C system having an internal combustion engine. In another particular embodiment, the foregoing stabilized difluoropropene refrigerant

compositions are combined with a POE lubricant for usage in an automotive A/C system having an electric or hybrid electric drive train.

[0177] In one embodiment, the inhibitor has sufficient miscibility in the lubricant such that a portion of the inhibitor is present within the lubricant. The amount of inhibitor present in the lubricant may vary when the stabilized difluoropropene refrigerant composition is employed as a working fluid or heat transfer medium.

[0178] In one embodiment of the invention, in addition to the inventive inhibitor, the stabilized difluoropropene refrigerant composition can comprise at least one additive which can improve the refrigerant and air-conditioning system lifetime and compressor durability are desirable. In one aspect of the invention, any of the foregoing stabilized difluoropropene refrigerant compositions further comprise at least one member selected from acid scavengers, performance enhancers, and flame suppressants.

[0179] In one embodiment, a stabilized composition according to the present invention comprises consists of or consists essentially of a difluoropropene selected from HFO-1252zf, HFO-1252yf, HFO-1252ye, HFO-1252ze and HFO-1252zc; at least one inhibitor comprising at least one of: hydrocarbons comprising cyclic monoterpene, lipophilic organic compounds including tocopherol including α -Tocopherol, phenols, and aromatic organic compounds having the chemical formula $C_6H_4(OH)$ including benzene-1,4-diol; and at least one acid scavenger.

[0180] In some embodiments, an acid scavenger may comprise a butyl oxide, a siloxane, an activated aromatic compound, or a combination thereof. Serrano et al. (paragraph 38 of US 2011/0272624 A1), which is hereby incorporated by reference, discloses that the siloxane may be any molecule having a siloxyfunctionality. The siloxane may include an alkyl siloxane, an aryl siloxane, or a siloxane containing mixtures of aryl and alkyl substituents. For example, the siloxane may be an alkyl siloxane, including a dialkylsiloxane or a polydialkylsiloxane. Preferred siloxanes include an oxygen atom bonded to two silicon atoms, i.e., a group having the structure: $SiOSi$. For example, the siloxane may be a siloxane of Formula IV: $R_1[Si(R_2R_3)_4O]_nSi(R_2R_3)_4R_4$, Where n is 1 or more. Siloxanes of Formula IV have n that is preferably 2 or more, more preferably 3 or more, (e.g., about 4 or more). Siloxanes of formula IV have n that is preferably about 30 or less, more preferably

about 12 or less, and most preferably about 7 or less. Preferably the R4 group is an aryl group or an alkyl group. Preferably the R2 groups are aryl groups or alkyl groups or mixtures thereof. Preferably the R3 groups are aryl groups or alkyl groups or mixtures thereof. Preferably the R4 group is an aryl group or an alkyl group. Preferably R1, R2, R3, R4, or any combination thereof are not hydrogen. The R2 groups in a molecule may be the same or different. Preferably the R2 groups in a molecule are the same. The R2 groups in a molecule may be the same or different from the R3 groups. Preferably, the R2 groups and R3 groups in a molecule are the same. Preferred siloxanes include siloxanes of Formula IV, wherein R1, R2, R3, R4, R5, or any combination thereof is a methyl, ethyl, propyl, or butyl group, or any combination thereof. Exemplary siloxanes that may be used include hexamethyldisiloxane, polydimethylsiloxane, polymethylphenylsiloxane, dodecamethylpentasiloxane, decamethylcyclo-pentasiloxane, decamethyltetrasiloxane, octamethyltrisiloxane, or any combination thereof.

[0181] Incorporated by previous reference from paragraph 38 of Serrano et al., in one aspect of the invention, the siloxane is an alkylsiloxane containing from about 1 to about 12 carbon atoms, such as hexamethyldisiloxane. The siloxane may also be a polymer such as polydialkylsiloxane, Where the alkyl group is a methyl, ethyl, propyl, butyl, or any combination thereof. Suitable polydialkylsiloxanes have a molecular weight from about 100 to about 10,000. Highly preferred siloxanes include hexamethyldisiloxane, polydimethylsiloxane, and combinations thereof. The siloxane may consist essentially of polydimethylsiloxane, hexamethyldisiloxane, or a combination thereof.

[0182] The activated aromatic compound may be any aromatic molecule activated towards a Friedel-Crafts addition reaction, or mixtures thereof. An aromatic molecule activated towards a Friedel-Crafts addition reaction is defined to be any aromatic molecule capable of an addition reaction with mineral acids. Especially aromatic molecules capable of addition reactions with mineral acids either in the application environment (AC system) or during the ASHRAE 97: 2007 "Sealed Glass Tube Method to Test the Chemical Stability of Materials for Use within Refrigerant Systems" thermal stability test. Such molecules or compounds are typically activated by substitution of a hydrogen atoms of the aromatic ring with one of the following groups: NH₂, NHR, NR₂, ADH, AD, NHCOCH₃, NHCOR, 4OCH₃, OR, CH₃, 4C₂H₅,

R, or C₆H₅, where R is a hydrocarbon (preferably a hydrocarbon containing from about 1 to about 100 carbon atoms). The activated aromatic molecule may be an alcohol, or an ether, where the oxygen atom (i.e., the oxygen atom of the alcohol or ether group) is bonded directly to an aromatic group. The activated aromatic molecule may be an amine Where the nitrogen atom (i.e., the nitrogen atom of the amine group) is bonded directly to an aromatic group. By way of example, the activated aromatic molecule may have the formula ArXR_n, Where X is O (i.e., oxygen) or N (i.e., nitrogen); n:1 When X:O; n:2 When x:N; Ar is an aromatic group (i.e., group, C₆H₅); R may be H or a carbon containing group; and When n:2, the R groups may be the same or different. For example, R may be H (i.e., hydrogen), Ar, an alkyl group, or any combination thereof, Exemplary activated aromatic molecules that may be employed in a refrigerant composition according to the teachings herein include diphenyl oxide (i.e., diphenyl ether), methyl phenyl ether (e.g., anisole), ethyl phenyl ether, butyl phenyl ether or any combination thereof. One highly preferred aromatic molecule activated to Wards a Friedel-Crafts addition reaction is diphenyl oxide.

[0183] In one embodiment, the acid scavenger is preferably a butyl oxide.

[0184] Incorporated by previous reference from Serrano et al., the acid scavenger (e.g., the activated aromatic compound, the siloxane, or both) may be present in any concentration that results in a relatively low total acid number, a relatively low total halides concentration, a relatively low total organic acid concentration, or any combination thereof. Preferably the acid scavenger is present at a concentration greater than about 0.0050 wt%, more preferably greater than about 0.05 wt% and even more preferably greater than about 0.1 wt% (e.g. greater than about 0.5 wt%) based on the total weight of the refrigerant composition. The acid scavenger preferably is present in a concentration about 3 wt% or less, more preferably about 2.5 wt% or less, and most preferably about 2 wt% or less (e. g. less than about 1.8 wt%), based on the total weight of the refrigerant composition.

[0185] Additional examples of acid scavengers which may be included in the refrigerant composition and preferably are excluded from the refrigerant composition include those described by Kaneko (U.S. patent application Ser. No. 11/575,256, published as U.S. Patent Publication 2007/0290164, paragraph 42, expressly

incorporated herein by reference), such as one or more of: phenyl glycidyl ethers, alkyl glycidyl ethers, alkylene glycol glycidylethers, cyclohexene oxides, otolenoxides, or epoxy compounds such as epoxidized soybean oil, and those described by Singh et al. (U.S. patent application Ser. No. 11/250,219, published as 20060116310, paragraphs 34-42, expressly incorporated herein by reference).

[0186] Preferred additives include those described in U.S. Pat. Nos. 5,152,926; 4,755,316, which are hereby incorporated by reference. In particular, the preferred extreme pressure additives include mixtures of (A) tolyltriazole or substituted derivatives thereof, (B) an amine (e.g. Jeffamine M-600) and (C) a third component which is (i) an ethoxylated phosphate ester (e.g. Antara LP-700 type), or (ii) a phosphate alcohol (e.g. ZELEC 3337 type), or (iii) a Zinc dialkyldithiophosphate (e.g. Lubrizol 5139, 5604, 5178, or 5186 type), or (iv) a mercaptobenzothiazole, or (v) a 2,5-dimercapto-1,3,4-triazole derivative (e.g. Curvan 826) or a mixture thereof. Additional examples of additives which may be used are given in U.S. Pat. No. 5,976,399 (Schnur, 5:12-6:51, hereby incorporated by reference).

[0187] Acid number is measured according to ASTM D664-01 in units of mg KOH/g. The total halides concentration, the fluorine ion concentration, and the total organic acid concentration is measured by ion chromatography. Chemical stability of the refrigerant system is measured according to ASHRAE 97: 2007 (RA 2017) "Sealed Glass Tube Method to Test the Chemical Stability of Materials for Use within Refrigerant Systems". The viscosity of the lubricant is tested at 40°C according to ASTM D-7042.

[0188] Mouli et al. (WO 2008/027595 and WO 2009/042847) teaches the use of alkyl silanes as a stabilizer in refrigerant compositions containing fluoroolefins. Phosphates, phosphites, epoxides, and phenolic additives also have been employed in certain refrigerant compositions. These are described for example by Kaneko (U.S. patent application Ser. No. 11/575,256, published as U.S. Publication 2007/0290164) and Singh et al. (U.S. patent application Ser. No. 11/250,219, published as U.S. Publication 2006/0116310). All of these aforementioned applications are expressly incorporated herein by reference.

[0189] Preferred flame suppressants include those described in patent application "Refrigerant compositions containing fluorine substituted olefins CA 2557873 A1"

and incorporated by reference along with fluorinated products such as HFC-125 and/or Krytox® lubricants, also incorporated by reference and described in patent application "Refrigerant compositions comprising fluoroolefins and uses thereof WO2009018117A1."

[0190] In one embodiment, any of the foregoing stabilized difluoropropene compositions of the present invention further comprises a tracer. The tracer may be a single compound or two or more tracer compounds from the same class of compounds or from different classes of compounds. In some embodiments, the tracer is present in the compositions at a total concentration of about 1 part per million by weight (ppm) to about 5000 ppm, based on the weight of the total composition. In other embodiments, the tracer is present at a total concentration of about 10 ppm to about 1000 ppm. In other embodiments, the tracer is present at a total concentration of about 20 ppm to about 500 ppm. In other embodiments, the tracer is present at a total concentration of about 25 ppm to about 500 ppm. In other embodiments, the tracer is present at a total concentration of about 50 ppm to about 500 ppm. Alternatively, the tracer is present at a total concentration of about 100 ppm to about 300 ppm.

[0191] The tracer may be selected from hydrofluorocarbons (HFCs), deuterated hydrofluorocarbons, chlorofluorocarbons (CFCs), hydrofluorochlorocarbons (HCFCs), chlorocarbons, perfluorocarbons, fluoroethers, brominated compounds, iodated compounds, alcohols, aldehydes and ketones, nitrous oxide and combinations thereof. Alternatively, the tracer may be selected from trifluoromethane (HFC-23), dichlorodifluoromethane (CFC-12), chlorodifluoromethane HCFC-22), methyl chloride (HCC-40), chlorofluoromethane (HCFC-31), fluoroethane (HFC-161), 1,1,-difluoroethane (HFC-152a), 1,1,1-trifluoroethane (HFC-143a), chloropentafluoroethane (CFC-115), 1,2-dichloro-1,1,2,2-tetrafluoroethane (CFC-114), 1,1-dichloro-1,2,2,2-tetrafluoroethane (CFC-114a), 2-chloro-1,1,1,2-tetrafluoroethane (HCFC-124), pentafluoroethane (HFC-125), 1,1,2,2-tetrafluoroethane (HFC-134), 1,1,1,2-tetrafluoroethane (HFC-134a), 1,1,1,3,3,3-hexafluoropropane (HFC-236fa), 1,1,1,2,3,3,3-heptafluoropropane (HFC-227ea), 1,1,1,2,2,3,3-heptafluoropropane (HFC-227ea), 1,1,1,3,3-pentafluoropropane (HFC-245fa), 1,1,1,2,2-pentafluoropropane (HFC-245cb), 1,1,1,2,3-pentafluoropropane (HFC-245eb), 1,1,2,2-tetrafluoropropane (HFC-254cb), 1,1,1,2-tetrafluoropropane

(HFC-254eb), 1,1,1-trifluoropropane (HFC-263fb), 1,1-difluoro-2-chloroethylene (HCFC-1122), 2-chloro-1,1,2-trifluoroethylene (CFC-1113), 1,1,1,3,3-pentafluorobutane (HFC-365mfc), 1,1,1,2,3,4,4,5,5,5-decafluoropentane (HFC-43-10mee), 1,1,1,2,2,3,4,5,5,6,6,7,7,7-tetradecafluoroheptane, hexafluorobutadiene, 3,3,3-trifluoropropyne, iodotrifluoromethane, deuterated hydrocarbons, deuterated hydrofluorocarbons, perfluorocarbons, fluoroethers, brominated compounds, iodated compounds, alcohols, aldehydes, ketones, nitrous oxide (N₂O) and mixtures thereof. In some embodiments, the tracer is a blend containing two or more hydrofluorocarbons, or one hydrofluorocarbon in combination with one or more perfluorocarbons. In other embodiments, the tracer is a blend of at least one CFC and at least one HCFC, HFC, or PFC.

[0192] The tracer may be added to the stabilized difluoropropene compositions of the present invention in predetermined quantities to allow detection of any dilution, contamination or other alteration of the composition. Additionally, the tracers may allow detection of product that infringes existing patent rights, by identification of the patent owner's product versus competitive infringing product. Further, in one embodiment, the tracer compounds may allow detection of a manufacturing process by which a product is produced, thus, allowing detection of infringement of a patent to specific manufacturing process chemistry.

[0193] The stabilized difluoropropene refrigerant compositions of the present invention may be prepared by any convenient method to combine the desired amount of the individual components. A preferred method is to weigh the desired component amounts and thereafter combine the components in an appropriate vessel. Agitation may be used, if desired.

[0194] The present invention further relates to a process for producing cooling comprising condensing any of the foregoing stabilized difluoropropene refrigerant compositions, and thereafter evaporating said composition in the vicinity of a body to be cooled.

[0195] A body to be cooled may be any space, location or object requiring refrigeration or air-conditioning. In stationary applications the body may be the interior of a structure, i.e., residential or commercial, or a storage location for perishables, such as food or pharmaceuticals. For mobile refrigeration applications

the body may be incorporated into a transportation unit for the road, rail, sea or air. Certain refrigeration systems operate independently with regards to any moving carrier, these are known as “intermodal” systems. Such intermodal systems include “containers” (combined sea/land transport) as well as “swap bodies” (combined road and rail transport).

[0196] The present invention further relates to a process for producing heat comprising condensing any of the foregoing stabilized difluoropropene refrigerant compositions in the vicinity of a body to be heated, and thereafter evaporating said composition.

[0197] A body to be heated may be any space, location or object requiring heat. These may be the interior of structures either residential or commercial in a similar manner to the body to be cooled. Additionally, mobile units as described for cooling may be similar to those requiring heating. Certain transport units require heating to prevent the material being transported from solidifying inside the transport container.

[0198] Another embodiment of the invention relates to an air-conditioning or refrigeration apparatus comprising the foregoing stabilized refrigerant (neat or blend) compositions containing a difluoropropene.

[0199] Another embodiment of the invention relates to storing any of the foregoing refrigerant compositions in gaseous and/or liquid phases within a sealed container wherein the oxygen concentration in the gas and/or liquid phases ranges from about 0.4 vol% or less, about 0.315 vol% or less, and in some cases about 0.3 vol% or less, about 0.0003 vol% to less than about 0.3 vol%, 0.0003 vol% to less than about 0.3 vol%, about 0.0005 vol% to less than about 0.1 vol% and in some cases about 0.0005 vol% to less than about 0.05 vol%, at a temperature of about 25°C, inclusive of all values and ranges therebetween and inclusive of non-detectable or zero amounts.

[0200] Another embodiment of the invention relates to storing any of the foregoing refrigerant compositions in gaseous and/or liquid phases within a sealed container wherein the non-absorbable gas (NAG) concentration in the gas and/or liquid phases ranges from about 3 vol% or less, about 2 vol% or less, about 1.5 vol% or less, and in some cases about 1 vol% or less, about 0.005 vol% to less than about 0.2 vol%, or 0.01 vol% to less than about 1.5 vol%, at a temperature of about 25°C, inclusive of

all values and ranges therebetween and inclusive of non-detectable or zero amounts.

[0201] Another embodiment of the invention relates to storing any of the foregoing refrigerant compositions in gaseous and/or liquid phases within a sealed container wherein the acidity (e.g., total acid number in mg KOH/g) of the composition in the gas and/or liquid phases ranges from less than about 1; greater than 0 and less than 1; greater than 0 and less than about 0.75; and, in some cases, greater than 0 and less than about 0.4, at a temperature of about 25°C, inclusive of all values and ranges therebetween and inclusive of non-detectable or zero amounts.

[0202] Another embodiment of the invention relates to storing any of the foregoing refrigerant compositions in gaseous and/or liquid phases within a sealed container wherein the moisture content in the gas and/or liquid phases is less than about 20 ppm by weight per AHRI 700, or less than about 10 ppm by weight based per AHRI 700, or less than about 5 ppm by weight based on AHRI 700, at a temperature of about 25°C, inclusive of all values and ranges therebetween and inclusive of non-detectable or zero amounts.

[0203] The container for storing any of the foregoing stabilized difluoropropene refrigerant compositions can be constructed of any suitable material and design that is capable of sealing the stabilized difluoropropene refrigerant compositions therein while maintaining gaseous and liquids phases. Examples of suitable containers comprise pressure resistant containers such as a tank, a filling cylinder, and a secondary filling cylinder. The container can be constructed from any suitable material such as carbon steel, manganese steel, chromium-molybdenum steel, among other low-alloy steels, stainless steel and in some case an aluminum alloy. The container can include a pierce top or valves suitable for dispensing flammable substances.

[0204] In one embodiment, the container is a pressurized container filled with any of the compositions disclosed herein. In one embodiment, the invention relates to a storage stable refrigerant comprising a pressurized container filled with any of the compositions disclosed herein.

[0205] Another embodiment relates to a method for packaging a container of refrigerant. The method comprises: providing a container suitable for holding a

composition comprising a difluoropropene, such as HFO-1252zc; optionally conditioning the container for receiving the composition; and sealably connecting a container to a source of the composition comprising HFO-1252zc and filling the container with the composition such that the contents of the container include at least one of: (i) an oxygen concentration of the composition is less than about 0.4 vol%, preferably about 0.315 vol% or less, at a temperature of about 25°C, (ii) an amount of non-absorbable gases is about 2 vol% or less, preferably less than about 1.5 vol% or less, at a temperature of about 25°C, and (iii) a moisture content of the composition is less than about 20 ppm by weight per AHRI 700, or less than about 10 ppm by weight based per AHRI 700, or less than about 5 ppm by weight based on AHRI 700, at a temperature of about 25°C. In some embodiments, the total acid number (mg KOH/g) of the composition is less than about 1; greater than 0 and less than 1; greater than 0 and less than about 0.75; and, in some cases, greater than 0 and less than about 0.4, at a temperature of about 25°C.

[0206] In some embodiments, the invention relates to a pressurized container filled according to this method. In some embodiments, the invention relates to a storage stable refrigerant comprising a pressurized container filled according to this method.

[0207] While any suitable method can be employed for preparing the inventive stabilized difluoropropene refrigerant compositions, examples of such methods including blending the foregoing inhibitors with any of the foregoing difluoropropene (e.g., HFO-1252zc) compositions, purging lines and containers with a material comprising the inhibitor (e.g., an inhibitor with a nitrogen carrier, or the inventive stabilized composition) and optionally combining with a lubricant; among other suitable methods.

[0208] In one embodiment, the inventive composition is prepared by adding the inhibitor to the difluoropropene (e.g., HFO-1252zc) component and/or the optional lubricant, and then combining the difluoropropene component with the lubricant. In the event, the inhibitor is added to only one of the difluoropropene or lubricant and then the difluoropropene and lubricant are combined, the inhibitor will partition such that the inhibitor becomes present in the difluoropropene and lubricant. In another embodiment, the inhibitor can be added to a composition comprising at least one difluoropropene component and at least one lubricant.

[0209] In one embodiment of the present invention, provided herein is a method and system of transporting and transferring difluoropropene refrigerants, and more particularly any of the foregoing difluoroethylene compositions with or without the added inhibitor, in a manner which prevents the formation of undesirable reaction products.

[0210] Referring to Fig. 1, there is shown a refrigerant distribution system 100 comprising a storage vessel or delivery vessel 110 containing a difluoropropene-containing refrigerant composition 115 and a monitoring system 120 including a sensor 125. The difluoropropene-containing refrigerant composition 115 may be any of the foregoing stabilized refrigerant (neat or blend) compositions. The monitoring system 120 receives data associated with at least one parameter of the refrigerant composition 115 from the sensor 125. The at least one parameter may include, for example, temperature, moisture concentration, oxygen concentration, NAG concentration, metals concentration, acidity, and combinations thereof. NAGs include atmospheric gases (which is typically comprised of 78% nitrogen, 21% oxygen, and about 1% argon), accumulated in the vapor phase of refrigerants where the solubility of air in the refrigerant liquid phase is relatively low. While reducing the total amount of NAG contained within said refrigerant (dissolved within the liquid refrigerant) may be desirable, it is typically more desirable to reduce the oxygen containing portion of the NAG preferentially over the nitrogen portion, because the oxygen containing portion, under certain scenarios, may increase the propensity of the refrigerant to decompose or form unwanted polymeric materials.

[0211] In some embodiments, a predetermined duration of time elapses after the storage vessel or delivery vessel 110 is filled with the difluoropropene composition and before the first NAG measurement is taken, so as to ensure that the vessel contents have time to settle and an accurate NAG measurement can be taken. In some embodiments, the initial elapsed duration is about 12 to about 24 hours, but may be longer. If the initial NAG measurement is greater than 5 vol%, preferably greater than 3 vol%, and more preferably greater than 1.5 vol%, the volume of the difluoropropene composition contained in the storage/delivery vessel 110 is divided equally amongst at least two storage/delivery vessels 110, such that each storage/delivery vessel 110 is about 50% liquid filled with the refrigerant composition to increase the headspace volume and facilitate easier removal of NAGs, e.g., by

venting. In some embodiments, each storage/delivery vessel 110 is vented until the total amount of NAGs is less than 5 vol%, preferably less than 3 vol%, more preferably less than 1.5 vol%.

[0212] In some embodiments, during the entire storage period, NAG measurements are taken at predetermined intervals, and if the NAG measurement is greater than 5 vol%, preferably greater than 3 vol%, and more preferably greater than 1.5 vol%, the storage vessel 110 contents are divided as described above and each 50% liquid filled vessel 110 is vented until the total amount of NAGs is less than 5 vol%, preferably less than 3 vol%, more preferably less than 1.5 vol%. In some embodiments, the interval duration is about 12 hours, but may be shorter or longer in certain circumstances.

[0213] In one embodiment, any of the stabilizer or inhibitor materials described herein may be introduced into the distribution system 100 and/or conditions (e.g., temperature, moisture content, acidity, etc.) of the stored composition 115 may be adjusted, based on the data of the parameter(s) received by the monitoring system 120, to reduce or eliminate risk of decomposition (e.g., by loss of HF) and/or to reduce (or eliminate formation of) unwanted polymeric materials. Such introductions and adjustments may be performed automatically and initiated by a system controller (not shown) based upon the data of the parameter(s) received by the monitoring system 120. For example, the stabilizer or inhibitor material can be introduced and/or conditions (e.g., temperature, moisture content, acidity, etc.) of the stored composition 115 may be adjusted in response to detection of a temperature that exceeds a threshold, such as 200°C, 150°C or 100°C, preferably 54.5°C; an oxidant concentration that exceeds a threshold such as the foregoing disclosed oxygen concentrations; an acidity content that exceeds a threshold such as the foregoing disclosed acidity contents; a moisture concentration that exceeds a threshold such as the foregoing disclosed moisture concentrations; and/or a NAG concentration that exceeds a threshold such as the foregoing disclosed NAG concentrations.

[0214] In some embodiments, at least one parameter predetermined threshold includes a temperature of no more than 100°C, moisture level of 20 ppm by weight per AHRI 700, a NAG concentration of less than 1.5 volume percent at 25°C per

AHRI 700, an oxygen concentration of less than 0.315 volume percent at 25°C per AHRI 700, an acidity level of 1 ppm HCl by weight, and combinations thereof.

[0215] In some embodiments, at least one parameter predetermined threshold includes a temperature of no more than 200°C, moisture level of 20 ppm by weight per AHRI 700, a NAG concentration of less than 1.5 volume percent at 25°C per AHRI 700, an oxygen concentration of less than 0.315 volume percent at 25°C per AHRI 700, an acidity level of 1 ppm HCl by weight, and combinations thereof.

[0216] Although Fig. 1 shows a sensor 125 on the storage/delivery vessel 110, in other embodiments, sensor 125 may be omitted. In one embodiment, the monitoring system 120 employs an in-line apparatus for detecting the presence of any of the foregoing parameters. The in-line apparatus can be located at any suitable location or locations within the distribution system. For example, an in-line GC/MS apparatus for detecting temperature, concentration of oxidants and NAGs, moisture and acidity levels, etc.

[0217] In one embodiment, the storage/delivery vessel 110 may be transported from a first location to a second location. The delivery vessel 110 may be transported by any suitable mode of transportation, such as via rail, road or water.

[0218] In one embodiment, at least a portion of the stabilized refrigerant composition 115 is transferred from the storage/delivery vessel 110, via a distribution line 111, optionally including a transfer pump 112, to a distribution vessel 130, at the second location. The refrigerant composition 115 may be sampled during and/or after transfer to the distribution vessel 130, by the monitoring system 120. The monitoring system 120 may include a sensor 125, configured to sample the stabilized refrigerant composition 115 within the distribution vessel 130, in the same manner as discussed above with respect to the storage/delivery vessel 110, and the system may be configured to adjust conditions or introduce components (e.g., stabilizer or inhibitor) based on the data received by the monitoring system 120 in the same manner as discussed above with respect to the storage/delivery vessel 110.

[0219] The distribution system 100 may transfer at least a portion of the stabilized difluoropropene (neat or blend) refrigerant composition 115 to an end user. A distribution line 111 is connected to the distribution vessel 130 via a distribution valve

151. The operation of the distribution valve 151 may be regulated by the monitoring system 120, based on user inputs, data from one or more sensors, other data, and combinations thereof. The distribution valve 151 may be used to regulate the flow of the refrigerant composition 115. The pressure within the distribution line may be regulated by one or more distribution pumps 152. One or more distribution sensors 125 are configured to sample the refrigerant composition 115 within the distribution line 111. The monitoring system 120 receives at least one distribution parameter (e.g., any of the foregoing parameters) of the refrigerant composition 115 from the one or more distribution sensors 125. The monitoring system 120 determines whether the at least one distribution parameter is below at least one predetermined threshold. If the at least one distribution parameter is below the at least one predetermined threshold, the refrigerant composition 115 is suitable for transmission to the end user. Although Fig. 1 shows a sensor 125 on the distribution line 111, in other embodiments, sensor 125 on the distribution line 111 may be omitted.

[0220] In one embodiment, the distribution system may include a rack system, a plurality of distribution line branches, to deliver the refrigerant composition 115 to one or more end user refrigerant systems, such as the rack system 160 described U.S. Patent Application Publication No. 2022/0136748, the entire contents of which are incorporated herein by reference.

[0221] In one embodiment, the system further includes a treatment unit. In one embodiment, the treatment unit stores inhibitor to be added to the vessel 110/130 when detection of oxidant concentrations above the predetermined threshold are detected. In one embodiment, the treatment unit includes a dehydration module configured to remove water from the composition stored in the vessel 110/130, for example by contacting the difluoropropene refrigerant composition with a desiccant (e.g., molecular sieves), in response to detection of a moisture level above the predetermined threshold as described above. In one embodiment, the treatment unit includes a module configured to remove acid from the composition stored in the vessel 110/130, for example by a wash tank or absorbents, in response to detection of an acidity level above the predetermined threshold as described above.

[0222] In one embodiment, the treatment unit includes a deoxygenation module configured to reduce oxygen levels in the vessel 110/130, in response to detection of

an oxygen concentration above the predetermined threshold as described above. For example, the treatment unit may include an inert gas purge module which contacts the difluoropropene refrigerant composition with an inert gas, such as nitrogen, argon, or xenon, to displace dissolved reactive gases in the refrigerant composition. In one embodiment, the inert gas may include dry nitrogen. The inert gas purge may result in the concentration of the one or more components being altered to less than one or more predetermined thresholds in the refrigerant composition.

[0223] In one embodiment, the treatment unit includes a NAG reduction unit configured to contact the difluoropropene refrigerant composition with a reducing agent, such as a metal powder, which may react with oxygen or other oxidizable components of the refrigerant composition. In one embodiment, the reducing agent may include iron powder. Treatment by the NAG reduction unit may result in the concentration of one or components of the refrigerant composition being reduced to less than one or more predetermined thresholds discussed above.

[0224] Operation of the treatment unit may be initiated by a system controller in response to data received by the monitoring system 120 when any of the foregoing parameters exceeds or falls below a predetermined threshold.

[0225] In one embodiment, the inventive process uses a container which enables distribution, blending, transport, transfer, storage, recovery and usage of difluoropropene refrigerant compositions in accordance with the instant invention. In the exemplary embodiments described herein, the container is a 500L to 1000 L, or more specifically, 750L to 950L or more specifically 850L to 950L vertical cylinder designed for holding, transferring or conveying a flammable compositions in accordance with the inventive process. In one embodiment, the vertically-oriented tank is the tank described in U.S. Patent Application Publication Nos. 2021/0301189 and 2022/0136748, the entire disclosures of which are incorporated herein by reference.

[0226] Due to the vertical orientation, it lends itself to ease of processing of said refrigerant. It should be noted that any vertical cylinder designed for flammable refrigerants, can also be conveniently used for non-flammable refrigerants. The vertical cylinder, hereinafter referred to as a vertical ton tank (VTT), has specific

design parameters, which in the combinations noted below, make it uniquely useful in conjunction with other processes mention above. One or more vertical ton tanks may be used in the refrigeration distribution system 100 in various roles, including as the storage/delivery vessel 110 and/or distribution vessel 130. Different views and components of the vertical ton tank are provided in Figs. 2-10.

[0227] The pressure, flammability and volume will follow the appropriate design codes for refrigerant compositions containing a difluoropropene compound. In the US for example, the vertical ton tank will follow the ASME design construction and pressure rating, while in the EU the vertical ton tank will follow ADR and in Japan the vertical ton tank will follow HPGL.

EXAMPLES

Example 1: Purification of 1252zc by adsorption of mol sieve 3A

[0228] 100 grams of HFO-1252zc was mixed with 10 grams of preactivated 3A mol sieve. The mixture was stored in a closed vessel at room temperature for 10 weeks. The GC analysis showed the purity of the HFO-1252zc increased from 99.77% to 99.81% during this storage time.

[0229] While the invention has been described with reference to one or more embodiments, it will be understood by those skilled in the art that various changes may be made and equivalents may be substituted for elements thereof without departing from the scope of the invention. In addition, many modifications may be made to adapt a particular situation or material to the teachings of the invention without departing from the essential scope thereof. Therefore, it is intended that the invention not be limited to the particular embodiment disclosed as the best mode contemplated for carrying out this invention, but that the invention will include all embodiments falling within the scope of the appended claims. In addition, all numerical values identified in the detailed description shall be interpreted as though the precise and approximate values are both expressly identified.

CLAIMS

What is claimed is:

1. A composition comprising a difluoropropene and an effective amount of at least one inhibitor, wherein preferably the difluoropropene is selected from the group consisting of 3,3-difluoropropene (HFO-1252zf, $\text{CHF}_2\text{CH}=\text{CH}_2$), 2,3-difluoropropene (HFO-1252yf, $\text{CH}_2\text{FCF}=\text{CH}_2$), 1,2-difluoropropene (HFO-1252ye, $\text{CH}_3\text{CF}=\text{CHF}$), 1,3-difluoropropene (HFO-1252ze, $\text{CH}_2\text{FCH}=\text{CHF}$) and 1,1-difluoropropene (HFO-1252zc, $\text{CH}_3\text{CH}=\text{CF}_2$), and wherein the composition is substantially free of oligomeric, homopolymers or other polymeric products.
2. A composition comprising a difluoropropene; one or more additional compounds selected from one of hydrofluorocarbons (HFCs), hydrochlorocarbons (HCCs), hydrofluoroolefins (HFOs), and hydrochlorofluoroolefins (HCFOs); and an effective amount of at least one inhibitor, wherein preferably the difluoropropene is selected from the group consisting of 3,3-difluoropropene (HFO-1252zf, $\text{CHF}_2\text{CH}=\text{CH}_2$), 2,3-difluoropropene (HFO-1252yf, $\text{CH}_2\text{FCF}=\text{CH}_2$), 1,2-difluoropropene (HFO-1252ye, $\text{CH}_3\text{CF}=\text{CHF}$), 1,3-difluoropropene (HFO-1252ze, $\text{CH}_2\text{FCH}=\text{CHF}$) and 1,1-difluoropropene (HFO-1252zc, $\text{CH}_3\text{CH}=\text{CF}_2$), and wherein the composition is substantially free of oligomeric, homopolymers or other polymeric products.
3. The composition according to any of claims 1-2, wherein the difluoropropene is HFO-1252zc.
4. The composition according to any of claims 1-3, wherein an oxygen concentration of the composition is about 0.4 vol% or less, preferably about 0.315 vol% or less, at a temperature of about 25°C.
5. The composition according to any of claims 1-4, wherein the composition comprises non-absorbable gases in an amount of about 3 vol% or less, preferably about 1.5 vol% or less, at a temperature of about 25°C.
6. The composition according to any of claims 1-5, wherein a moisture content of the composition is less than about 20 ppm by weight per AHRI 700, or less than about 10 ppm by weight based per AHRI 700, or less than about 5 ppm by weight based on AHRI 700, at a temperature of about 25°C.

7. The composition according to any of claims 1-6, wherein the total acid number of the composition is between 0 and about 1 mg KOH/g, at a temperature of about 25°C.
8. The composition according to any of claims 1-7, the composition further comprising an acid scavenger.
9. The composition according to claim 8, wherein the acid scavenger is selected from the group consisting of a butyl oxide, siloxane, an activated aromatic compound, and a combination thereof.
10. The composition according to any of claims 1-9, the composition further comprising a tracer.
11. The composition according to claim 10, wherein the tracer is selected from the group consisting of hydrofluorocarbons (HFCs), deuterated hydrofluorocarbons, chlorofluorocarbons (CFCs), hydrofluorochlorocarbons (HCFCs), chlorocarbons, perfluorocarbons, fluoroethers, brominated compounds, iodated compounds, alcohols, aldehydes and ketones, nitrous oxide and combinations thereof, and preferably selected from the group consisting of trifluoromethane (HFC-23), dichlorodifluoromethane (CFC-12), chlorodifluoromethane HCFC-22), methyl chloride, chlorofluoromethane (HCFC-31), fluoroethane (HFC-161), 1,1,-difluoroethane (HFC-152a), 1,1,1-trifluoroethane (HFC-143a), chloropentafluoroethane (CFC-115), 1,2-dichloro-1,1,2,2-tetrafluoroethane (CFC-114), 1,1-dichloro-1,2,2,2-tetrafluoroethane (CFC-114a), 2-chloro-1,1,1,2-tetrafluoroethane (HCFC-124), pentafluoroethane (HFC-125), 1,1,2,2-tetrafluoroethane (HFC-134), 1,1,1,2-tetrafluoroethane (HFC-134a), 1,1,1,3,3,3-hexafluoropropane (HFC-236fa), 1,1,1,2,3,3,3-heptafluoropropane (HFC-227ea), 1,1,1,2,2,3,3-heptafluoropropane (HFC-227ea), 1,1,1,3,3-pentafluoropropane (HFC-245fa), 1,1,1,2,2-pentafluoropropane (HFC-245cb), 1,1,1,2,3-pentafluoropropane (HFC-245eb), 1,1,2,2-tetrafluoropropane (HFC-254cb), 1,1,1,2-tetrafluoropropane (HFC-254eb), 1,1,1-trifluoropropane (HFC-263fb), 1,1-difluoro-2-chloroethylene (HCFC-1122), 2-chloro-1,1,2-trifluoroethylene (CFC-1113), 1,1,1,3,3-pentafluorobutane (HFC-365mfc), 1,1,1,2,3,4,4,5,5,5-decafluoropentane (HFC-43-10mee), 1,1,1,2,2,3,4,5,5,6,6,7,7,7-tetradecafluoroheptane, hexafluorobutadiene, 3,3,3-

trifluoropropyne, iodotrifluoromethane, deuterated hydrocarbons, deuterated hydrofluorocarbons, perfluorocarbons, fluoroethers, brominated compounds, iodated compounds, alcohols, aldehydes, ketones, nitrous oxide (N₂O) and mixtures thereof.

12. The composition according to any of claims 1-11, wherein the additional compounds are selected from the group consisting of C₂-C₄ alkenes selected from ethylene, propylene, butylene, allene, and cyclobutene.
13. The composition according to any of claims 1-11, wherein the additional compounds are selected from the group consisting of methane, ethylene, trifluoromethane (HFC-23), fluoroethylene (HFO-1141), propane (HC-290), propylene (HO-1270), 2,3,3,3-tetrafluoropropene (HFO-1234yf), allene, C₃H₄F₂, 3-fluoro-1-propene (HFO-1261zf), 1,1,1-trifluoropropane (HFC-263fb), 1-fluoropropene (E/Z-HFO-1261ze), 2-butene, cyclobutene, 2-methyl-1-propene, 1,1-difluoropropane, 2-chloro-3,3,3-trifluoropropene (HCFO-1233xf), 3-chloropropene (HCO-1260zf), and C₃H₄FCI (HCFO-1251 isomers).
14. The composition according to any of claims 1-11, wherein the additional compounds are selected from the group consisting of ethylene, trifluoromethane (HFC-23), 1,1-difluoroethane (HFO-1132a), fluoroethene (HFO-1141), 1,1,2,2,2-pentafluoroethane (HFC-125), propane (HC-290), 1,1,2-trifluoroethane (HFC-143), 2,3,3,3-tetrafluoropropene (HFO-1234yf), 1,1,1-difluoroethane (HFC-152a), 3-fluoro-1-propene (HFO-1261zf), 1-fluoropropene (E/Z-HFO-1261ze), 1,1,1-trifluoropropane (HFC-263fb), 1,1,1-trifluoroethane (HFC-143a), difluoropropane, chlorotrifluoropropene, pentafluorobutene (HFO-1345) and C₄H₆F₄ (HFC-374).
15. The composition according to any of claims 1-11,
wherein the additional compounds are selected from the group consisting of methane, ethylene, trifluoromethane (HFC-23), fluoroethylene (HFO-1141), propane (HC-290), propylene (HO-1270), 2,3,3,3-tetrafluoropropene (HFO-1234yf), allene, C₃H₄F₂, 3-fluoro-1-propene (HFO-1261zf), 1,1,1-trifluoropropane (HFC-263fb), 1-fluoropropene (E/Z-HFO-1261ze), 2-butene, cyclobutene, 2-methyl-1-propene, 1,1-difluoropropane, 2-chloro-3,3,3-

trifluoropropene (HCFO-1233xf), 3-chloropropene (HCO-1260zf), and C_3H_4FCl (HCFO-1251 isomers); or

wherein the additional compounds are selected from the group consisting of HFO-1132a, HFC-125, HFC-143a, HFO-1225zc, HFC-152a, HFO-1252ze, HFO-1252yf, HFO-1252zf, and HFO-1252ye; or

wherein the additional compounds are selected from the group consisting of methane, ethylene, trifluoromethane (HFC-23), fluoroethylene (HFO-1141), propane (HC-290), propylene (HO-1270), 2,3,3,3-tetrafluoropropene (HFO-1234yf), allene, $C_3H_4F_2$, 3-fluoro-1-propene (HFO-1261zf), 1-fluoropropene (E/Z-HFO-1261ze), 2-butene, cyclobutene, 2-methyl-1-propene, 1,1-difluoropropane, 2-chloro-3,3,3-trifluoropropene (HCFO-1233xf), 3-chloropropene (HCO-1260zf), and C_3H_4FCl (HCFO-1251 isomers); or

wherein the additional compounds are selected from the group consisting of methane, ethylene, trifluoromethane (HFC-23), fluoroethylene (HFO-1141), propane (HC-290), propylene (HO-1270), 2,3,3,3-tetrafluoropropene (HFO-1234yf), allene, $C_3H_4F_2$, 3-fluoro-1-propene (HFO-1261zf), 1-fluoropropene (E/Z-HFO-1261ze), 2-butene, cyclobutene, 2-methyl-1-propene, 1,1-difluoropropane, 2-chloro-3,3,3-trifluoropropene (HCFO-1233xf), 3-chloropropene (HCO-1260zf), and C_3H_4FCl (HCFO-1251 isomers); or

wherein the additional compounds are selected from the group consisting of ethylene, trifluoromethane (HFC-23), 1,1-difluoroethene (HFO-1132a), fluoroethylene (HFO-1141), 1,1,2,2,2-pentafluoroethane (HFC-125), propane (HC-290), 1,1,2-trifluoroethane (HFC-143), 2,3,3,3-tetrafluoropropene (HFO-1234yf), 1,1,1-difluoroethane (HFC-152a), 3-fluoro-1-propene (HFO-1261zf), 1-fluoropropene (E/Z-HFO-1261ze), 1,1,1-trifluoropropane (HFC-263fb), 1,1,1-trifluoroethane (HFC-143a), difluoropropane, chlorotrifluoropropene, pentafluorobutene (HFO-1345) and $C_4H_6F_4$ (HFC-374); or

wherein the additional compounds are selected from the group consisting of ethylene, trifluoromethane (HFC-23), 1,1-difluoroethene (HFO-1132a), fluoroethylene (HFO-1141), 1,1,2,2,2-pentafluoroethane (HFC-125), propane (HC-290), 1,1,2-trifluoroethane (HFC-143), 2,3,3,3-tetrafluoropropene (HFO-1234yf), 1,1,1-difluoroethane (HFC-152a), 3-fluoro-1-propene (HFO-1261zf), 1-fluoropropene (E/Z-HFO-1261ze), 1,1,1-trifluoropropane (HFC-263fb), 1,1,1-

trifluoroethane (HFC-143a), difluoropropane, chlorotrifluoropropene, pentafluorobutene (HFO-1345) and $C_4H_6F_4$ (HFC-374); or

wherein the additional compounds are selected from the group consisting of trifluoromethane (HFC-23), dichloromethane (HCC-30), chlorofluoromethane (HCFC-31), methyl chloride (HCC-40), methane, 1,1,2,2,2-pentafluoroethane (HFC-125), 1,1,2-trifluoroethane (HFC-143), 1,1,1-trifluoroethane (HFC-143a), 1,1,1-difluoroethane (HFC-152a), 1,1,1,2,2-pentafluoropropane (HFC-245cb), 2-chloro-1,1,1-trifluoropropane (HCFC-253dc), 1,1,1,3-tetrafluoropropane (HFC-254fb), 1,1,1-trichloropropane (HCC-260fb), 1,1-dichloro-1-fluoropropane (HCFC-261fc), 1,1-difluoropropane (HFC-272fb), propane (HC-290), tetrafluorobutene (HFO-374), butane (HC-600), allene, 2-butene, cyclobutene, 2-methylpropene, 1-chloro-2,2-difluoroethylene (HCFO-1122), 1,2-difluoroethene (HFO-1132), 1,1-difluoroethene ((HFO-1132a), fluoroethylene (HFO-1141), ethylene (HO-1150), 2-chloro-3,3,3-trifluoropropene (HCFO-1233xf), 2,3,3,3-tetrafluoropropene (HFO-1234yf), 3-chloro-3,3-difluoropropene (HCFO-1242zf), 3,3,3-trifluoropropene (HFO-1243zf), HCFO-1251 isomer (I), HCFO-1251 isomer (II), 3-chloropropene (HCO-1260zf), 3-fluoro-1-propene (HFO-1261), propylene (HO-1270), pentafluorobutene (HFO-1345), and E/Z-t-BuO-CF=CH-CH₃, or

wherein the additional compounds are selected from the group consisting of ethylene, HFC-23, HFO-1132a, propane, HFO-1234yf, HFO-1234ze, HFO-1261zf, E/Z-HFO-1261ze, HFC-143a, HCFO-1233xf, and HFC-374; or

wherein the additional compounds are selected from the group consisting of HCFO-1233xf, HFC-152a, HFC-263fb, HFC-254fb, HFC-253dc, HFC-252dc and HCFO-1230xa.

16. The composition according to any of claims 1-11, wherein the additional compounds are selected from the group consisting of ethylene, HFC-23, HFO-1132a, propane, HFO-1234yf, HFO-1234ze, HFO-1261zf, E/Z-HFO-1261ze, HFC-143a, HCFO-1233xf, and HFC-374.

17. The composition according to any of claims 1-11, wherein the composition optionally further comprises at least one of HCC-250fb and HCFO-1242zf, and
- (i) wherein the additional compounds are selected from the group consisting of HCFC-262fc, HCC-250fb, HFC-263fb, HFO-1243zf, other HCFO-1252 isomers, ethane, ethylene, HFC-23, HCFC-22, HFO-1132a, propane, HFC-143a, HCFC-142b, HFO-1234yf, HFO-1234ze, HFO-1225zc, HCFO-1242zf and HCFC-252fc; or
 - (ii) wherein the additional compounds are selected from the group consisting of HCC-250fb, HCFC-252fc and HCFC-262fc, and one or more additional compounds selected from HFC-263fb, HFO-1243zf, other 1252 isomers, ethane, ethylene, HFC-23, HCFC-22, HFO-1132a, propane, HFC-143a, HCFC-142b, HFO-1234yf, HFO-1234ze, HFO-1225zc, and HCFO-1242zf; or
 - (iii) wherein the additional compounds are selected from the group consisting of HCC-250fb, HFC-263fb, HFO-1243zf, other 1252 isomers, ethane, ethylene, HFC-23, HCFC-22, HFO-1132a, propane, HFC-143a, HCFC-142b, HFO-1234yf, HFO-1234ze, HFO-1225zc, HCFO-1242zf and HCFC-252fc; or
 - (iv) wherein the additional compounds are selected from the group consisting of HCC-250fb, HFC-263fb, HFO-1243zf, other 1252 isomers, ethane, ethylene, HFC-23, HCFC-22, HFO-1132a, propane, HFC-143a, HCFC-142b, HFO-1234yf, HFO-1234ze, HFO-1225zc and HCFO-1242zf; or
 - (v) wherein the additional compounds are selected from the group consisting of HCFC-262fc, HCC-250fb, HFC-263fb, HCFO-1242zf, HFO-1252zf, HFO-1243zf and HCFC-252fc; or
 - (vi) wherein the additional compounds are selected from the group consisting of HCFC-262fc, HFC-263fb, HFO-1252zf, HFO-1243zf and HCFC-252fc; or
 - (vii) wherein the additional compounds are selected from the group consisting of HCFO-1242zf, HCFC-262fc, HCC-250fb, HFC-263fb, HFO-1252zf, HFO-1243zf and HCFC-252fc; or

- (viii) wherein the additional compounds are selected from the group consisting of HCC-250fb, HCFC-252fc, HCFC-262fc, HCFO-1242zf, HFC-263fb, other 1252 isomers, ethane, ethylene, HFC-23, HCFC-22, HFO-1132a, propane, HFC-143a, HCFC-142b, HFO-1234yf, HFO-1234ze, and HFO-1225zc and HFO-1243zf.
18. The composition of any of claims 1-17, wherein a total amount of the additional compounds is selected from one of about 0.5 wt.% or less, about 0.4 wt.% or less, about 0.3 wt.% or less, about 0.2 wt.% or less, and about 0.1 wt.% or less.
19. The composition according to any of claims 1-18, wherein the composition further comprises at least one of HFC-263fb and HCFC-262fc.
20. A composition comprising a difluoropropene selected from the group consisting of HFO-1252zf, HFO-1252yf, HFO-1252ye, HFO-1252ze and HFO-1252zc, wherein at least one of:
- an oxygen concentration of the composition is about 0.4 vol% or less, preferably about 0.315 vol% or less, at a temperature of about 25°C;
 - an amount of non-absorbable gases is about 2 vol% or less, preferably less than about 1.5 vol% or less, at a temperature of about 25°C; and
 - a moisture content of the composition is less than about 20 ppm by weight per AHRI 700, or less than about 10 ppm by weight based per AHRI 700, or less than about 5 ppm by weight based on AHRI 700, at a temperature of about 25°C.
21. The composition according to claim 20, wherein the total acid number of the composition is between 0 and about 1 mg KOH/g, at a temperature of about 25°C.
22. The composition according to any of claims 1-21, wherein the composition is free of or substantially free of Group A Fluorinated Substances.
23. The composition according to any of claims 1-21, wherein degradation products of the stabilized composition are free of or substantially free of Group A Fluorinated Substances.
24. A pressurized container filled with the composition of any of claims 1-23.

25. A storage stable refrigerant comprising a pressurized container filled with the composition of any of claims 1-23.
26. A method for packaging a container of refrigerant, the method comprising:
 - providing a container suitable for holding a composition comprising HFO-1252zc;
 - optionally conditioning the container for receiving the composition,
 - sealably connecting a container to a source of the composition comprising HFO-1252zc and filling the container with the composition such that the contents of the container include at least one of:
 - an oxygen concentration of the composition is about 0.4 vol%, or less preferably about 0.315 vol% or less, at a temperature of about 25°C;
 - an amount of non-absorbable gases is about 2 vol% or less, preferably about 1.5 vol% or less, at a temperature of about 25°C; and
 - a moisture content of the composition is less than about 20 ppm by weight per AHRI 700, or less than about 10 ppm by weight based per AHRI 700, or less than about 5 ppm by weight based on AHRI 700, at a temperature of about 25°C.
27. The method according to claim 26, wherein the total acid number of the composition is between 0 and about 1 mg KOH/g, at a temperature of about 25°C.
28. The method according to any of claims 26-27, wherein the composition further comprises one or more additional compounds selected from the groups of any of claims 12-17.
29. The method according to any of claims 26-28, wherein the composition further comprises at least one of HFC-263fb and HCFC-262fc.
30. A pressurized container filled according to the method of any of claims 26-29.
31. A storage stable refrigerant comprising a pressurized container filled according to the method of any of claims 26-29.
32. A method comprising storing a composition comprising HFO-1252zc and one or more additional compounds in a container, the method comprising:

maintaining an oxygen concentration of about 0.4 vol% or less, preferably about 0.315 vol% or less, at a temperature of about 25°C;

maintaining an amount of non-absorbable gases to be about 2 vol% or less, preferably about 1.5 vol% or less, at a temperature of about 25°C;

maintaining a moisture content of the composition to be less than about 20 ppm by weight per AHRI 700, or less than about 10 ppm by weight based per AHRI 700, or less than about 5 ppm by weight based on AHRI 700, at a temperature of about 25°C; or

maintaining a total acid number of the composition to be between 0 and about 1 mg KOH/g, at a temperature of about 25°C.

33. The method according to claim 32, wherein the additional compounds are selected from the groups of any of claims 12-17.
34. The method of any of claims 26-29 and 32-33, the method further comprising monitoring at least parameter of the composition with one or more sensors, wherein the at least one parameter is selected from the group consisting of temperature, moisture concentration, non-absorbable gas concentration, acidity and combinations thereof.
35. The method of claim 34, wherein the method further comprises adjusting a property of the composition when monitoring of the at least one parameter determines a value that exceeds or falls below a respective threshold parameter.
36. The method of claim 35, wherein the threshold parameter is a composition temperature of about 200°C.
37. The method of claim 35, wherein the threshold parameter is a composition moisture concentration measured with the one or more sensors exceeds a threshold parameter of a refrigerant moisture concentration of 20 ppm by weight, per AHRI 700.
38. The method of claim 35, wherein the threshold parameter is a non-absorbable gas concentration of about 1.5 volume percent at 25°C, per AHRI 700.
39. The method of claim 38, wherein the non-absorbable gas is oxygen.

40. The composition according to any of claims 1 to 23, further comprising at least one antioxidant.
41. A composition comprising a difluoropropene, an effective amount of at least one inhibitor, and at least one antioxidant, wherein preferably the difluoropropene is selected from the group consisting of 3,3-difluoropropene (HFO-1252zf, $\text{CHF}_2\text{CH}=\text{CH}_2$), 2,3-difluoropropene (HFO-1252yf, $\text{CH}_2\text{FCF}=\text{CH}_2$), 1,2-difluoropropene (HFO-1252ye, $\text{CH}_3\text{CF}=\text{CHF}$), 1,3-difluoropropene (HFO-1252ze, $\text{CH}_2\text{FCH}=\text{CHF}$) and 1,1-difluoropropene (HFO-1252zc, $\text{CH}_3\text{CH}=\text{CF}_2$), preferably HFO-1252zc, and wherein the composition is substantially free of oligomeric, homopolymers or other polymeric products.
42. The composition according to any of claims 40 or 41, wherein the at least one antioxidant comprises at least one member selected from the group consisting of butylated hydroxytoluene, butylated hydroxyanisole, tertiary-butylhydroquinone, gallate, 2-phenyl-2-propanol, 1-(2,4,5-trihydroxyphenyl)-1-butanone, bisphenol methane derivatives, 2,2'-methylene bis (4-methyl-6-t-butyl phenol), among other phenolics, and combinations thereof.
43. The composition according to any of claims 40 to 42, wherein an amount of the at least one antioxidant ranges from about 0.01 to about 5,000 ppm by weight, preferably about 0.03 to about 2000 ppm, more preferably about 0.05 to about 1000 ppm.
44. A method of storing the composition according to any of the preceding claims, the method comprising:
- (i) introducing the composition into a storage vessel;
 - (ii) allowing a predetermined duration to elapse after introducing the composition into the storage vessel;
 - (iii) measuring a content of non-absorbable gases contained in the composition after the predetermined duration has elapsed; and
 - (iv) if the content of non-absorbable gases is greater than 5 vol%, preferably greater than 3 vol%, and more preferably greater than 1.5 vol%, dividing the composition contained in the storage vessel equally amongst at least two storage vessels, such that each storage vessel contains a

portion of the composition up to about 50% of the volume of the storage vessel, and subsequently removing the non-absorbable gases until the total amount of non-absorbable gases in each storage vessel is less than 5 vol%, preferably less than 3 vol%, more preferably less than 1.5 vol%.

45. The method of claim 44, wherein the non-absorbable gases are removed by venting.
46. The method of any of claims 44 or 45, wherein the predetermined duration is from about 12 hours to about 24 hours.
47. The method of any of claims 44 to 46, wherein steps (iii) and (iv) are repeated at predetermined time intervals during storage of the composition.