TITLE OF THE INVENTION

LOW GWP COMPOSITIONS COMPRISING HFO-1252zc AND USES THEREOF

FIELD

[0001] The present disclosure relates to compositions useful as refrigerants, and in particular, for refrigeration systems. The compositions of the present disclosure are useful in methods for producing cooling, and methods for replacing refrigerants and refrigeration systems, including low and medium temperature refrigeration and transport refrigeration systems.

BACKGROUND

[0002] 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 warmings another environmental concern in many of these applications particularly in light of the Kigali Amendment. HFC refrigerants such as HFC-134a and HFC-125 respectively have global warming potentials (GWP) of 1,430 and 3,500 according to the UN's IPCC Fourth Assessment Report (AR4).

[0003] 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 provide superior performance in a variety of applications and which meet the standards of evolving regulations.

[0004] The instant invention solves certain problems associated with conventional refrigerants and provides refrigerant blends containing 1,1-difluoropropene, which meets the evolving regulatory landscape.

SUMMARY

[0005] In order to meet the rapidly changing regulatory environment, the present inventors have identified a fluoroolefin compound that provides performance relative to existing refrigerants that will allow its use going forward even in view of the standards of the evolving regulatory landscape.

[0006] Disclosed herein is a fluoropropene composition comprising 1,1-difluoropropene (also called HFO-1252zc, or R-1252zc). This compound is shown herein to have advantageous properties for its use in refrigerant applications.

[0007] In one embodiment, disclosed herein are compositions comprising HFO-1252zc, HFO-1234zeE, HFC-32, and at least one of HFC-134, HFC-134a, or CO_2.

[0008] As used herein, % means weight percent.

[0009] According to another embodiment, also disclosed herein are compositions comprising:

HFO-1252zc, HFO-1234zeE, HFC-32, and CO_2; or

HFO-1252zc, HFO-1234zeE, HFC-32, and HFC-134; or

HFO-1252zc, HFO-1234zeE, HFC-32, and HFC-134a; or

HFO-1252zc, HFO-1234zeE, HFC-32, HFC-134, and CO_2; or

HFO-1252zc, HFO-1234zeE, HFC-134, HFC-134a and HFC-32; or

HFO-1252zc, HFO-1234zeE, HFC-134a, HFC-32, and CO_2.

[0010] According to any of the foregoing embodiments, also disclosed herein are compositions comprising, consisting of, or essentially consisting of 1% to 21% HFO-1252zc, 57% to 80% HFO-1234zeE, 13% to 22% HFC-32, and 1% to 2% weight percent CO_2.; or 1.0% to 6.0% of CO_2, 1.0% to 96.0% of HFO-1252zc, 1.0% to 97.0% of HFO-1234zeE, and 1.0% to 49.0% of HFC-32; or 1.0% to 6.0% of CO_2, 1.0% to 96.0% of HFO-1252zc, 1.0% to 97.0% of HFO-1234zeE, and 1.0% to 28.0% of HFC-32; or 1.0% to 6.0% of CO_2, 16.0% to 85.0% of HFO-1252zc, 1.0% to 61.0% of HFO1234zeE 1234ZEE, and 1.0% to 28.0% of HFC-32; or 1.0% to 2.0% of CO_2, 16.0% to 19.0% of HFO-1252zc, 58.0% to 61.0% of HFO-1234zeE, and 20.0% to 22.0% of HFC-32; or about 2.0 wt-% CO_2, about 17.0 wt-% HFO-1252zc, 59.0 wt-% HFO-1234zeE and 22.0 wt-% HFC-32.

[0011] According to any of the foregoing embodiments, also disclosed herein are compositions comprising, consisting of, or essentially consisting of: 1% to 21% HFO-1252zc, 57% to 80% HFO-1234zeE, 13% to 22% HFC-32, and 1% to 6% HFC-134; or 1.0% to 97.0% of HFO-1252zc, 1.0% to 97.0% of HFO-1234zeE, 1.0% to 43.0% of HFC-32, and 1.0% to 28.0% of HFC-134; or 1.0% to 97.0% of HFO-1252zc, 1.0% to 97.0% of HFO-1234zeE, 1.0% to 43.0% of HFC-32, and 1.0% to 28.0% of HFC-134; or 1.0% to 97.0% of HFO-1252zc, 1.0% to 97.0% of HFO-1234zeE, 1.0% to 43.0% of HFC-32, and 1.0% to 28.0% of HFC-134; or 1.0% to 27.0% of HFO-1252zc, 30.0% to 97.0% of HFO-1234zeE, 1.0% to 43.0% of HFC-32, and 1.0% to 28.0% of HFC-134; or about 15.0 wt-% HFO-1252zc, about 41.0 wt-% HFO-1234zeE, about 42.0 wt-% HFC-32 and about 2.0 wt-% HFC-134; or about 10.0 wt-% HFO-1252zc, about 68.0 wt-% HFO-1234zeE, about 1.0 wt-% HFC-32, and about 21.0 wt-% HFC-134.

[0012] According to any of the foregoing embodiments, also disclosed herein are compositions comprising, consisting of, or essentially consisting of: 1% to 21% HFO-1252zc, 57% to 80% HFO-1234zeE, 17% to 22% HFC-32, and 1% to 3% HFC-134a; or 1.0% to 23.0% of HFC-134a, 1.0% to 97.0% of HFO-1252zc, 1.0% to 97.0% of HFO-1234zeE, and 1.0% to 52.0% of HFC-32; or 1.0% to 23.0% of HFC-134a, 1.0% to 97.0% of HFO-1252zc, 1.0% to 97.0% of HFO-1234zeE, and 1.0% to 52.0% of HFC-32; or 1.0% to 22.0% of HFC-134a, 1.0% to 80.0% of HFO-1252zc, 1.0% to 71.0% of HFO-1234zeE, and 1.0% to 49.0% of HFC-32; or 1.0% to 15.0% of HFC-134a, 1.0% to 26.0% of HFO-1252zc, 31.0% to 71.0% of HFO-1234zeE, and 5.0% to 42.0% of HFC-32; or about 1.0 wt-% HFC-134a, about 25.0 wt-% HFO-1252zc, about 35.0 wt-% HFO-1234zeE and about 39.0 wt-% HFC-32; or about 14.0 wt-% HFC-134a, about 15.0 wt-% HFO-1252zc, about 66.0 wt-% HFO-1234zeE, and about 5.0 wt-% HFC-32.

[0013] According to any of the foregoing embodiments, also disclosed herein are compositions comprising, consisting of, or essentially consisting of: 1% to 21% HFO-1252zc, 54% to 80% HFO-1234zeE, 11% to 22% HFC-32, 1% to 6% HFC-134, and 1% to 3% CO_2; or 1.0% to 3.0% of CO_2, 1.0% to 6.0% of HFC-134, 1.0% to 20.0% of HFO-1252zc, 42.0% to 73.0% of HFO-1234zeE, and 11.0% to 38.0% of HFC-32; or 1.0% to 3.0% of CO_2, 1.0% to 6.0% of HFC-134, 1.0% to 20.0% of HFO-1252zc, 42.0% to 73.0% of HFO-1234zeE, and 11.0% to 38.0% of HFC-32; or 2.0% to 2.0%

of CO_2, 1.0% to 1.0% of HFC-134, 18.0% to 18.0% of HFO-1252zc, 57.0% to 57.0% of HFO-1234zeE, and 22.0% to 22.0% of HFC-32; or 2.0% to 2.0% of CO_2, 1.0% to 1.0% of HFC-134, 18.0% to 18.0% of HFO-1252zc, 57.0% to 57.0% of HFO-1234zeE, and 22.0% to 22.0% of HFC-32; or about 2.0 wt-% CO_2, about 1.0 wt-% HFC-134, about 18.0 wt-% HFO-1252zc, about 57.0 wt-% HFO-1234zeE, and about 22.0 wt-% HFC-32; or about 2.0 wt-% CO_2, about 1.0 wt-% HFC-134, about 18.0 wt-% HFO-1252zc, about 57.0 wt-% HFO-1234zeE, and about 22.0 wt-% HFC-32.

[0014] According to any of the foregoing embodiments, also disclosed herein are compositions comprising, consisting of, or essentially consisting of: 1.0% to 96.0% of HFO-1252zc, 1.0% to 96.0% of HFO-1234ze(E), 1.0% to 25.0% of HFC-134, 1.0% to 21.0% of HFC-134a, and 1.0% to 40.0% of HFC-32; or 1.0% to 96.0% of HFO-1252zc, 1.0% to 96.0% of HFO-1234ze(E), 1.0% to 11.0% of HFC-134, 1.0% to 10.0% of HFC-134a, and 1.0% to 18.0% of HFC-32; or 41.0% to 82.0% of HFO-1252zc, 1.0% to 39.0% of HFO-1234ze(E), 1.0% to 3.0% of HFC-134, 1.0% to 2.0% of HFC-134a, and 15.0% to 18.0% of HFC-32; or 41.0% to 63.0% of HFO-1252zc, 17.0% to 39.0% of HFO-1234ze(E), 1.0% to 2.0% of HFC-134, 1.0% to 2.0% of HFC-134a, and 16.0% to 18.0% of HFC-32; or about 63.0 wt-% HFO-1252zc, about 17.0 wt-% HFO-1234ze(E), about 1.0 wt-% HFC-134, about 1.0 wt-% HFC-134a, and about 18.0 wt-% HFC-32; or about 62.0 wt-% HFO-1252zc, about 19.0 wt-% HFO-1234ze(E), about 2.0 wt-% HFC-134, about 1.0 wt-% HFC-134a, and about 16.0 wt-% HFC-32.

[0015] According to any of the foregoing embodiments, also disclosed herein are compositions comprising, consisting of, or essentially consisting of: 0.2% to 89.1% of CO_2, 0.2% to 97.5% of HFO-1252zc, 0.2% to 97.5% of HFO-1234ze(E), 0.2% to 22.0% of HFC-134a, and 0.2% to 43.8% of HFC-32; or 0.2% to 89.1% of CO_2, 0.2% to 97.5% of HFO-1252zc, 0.2% to 97.5% of HFO-1234ze(E), 0.2% to 10.0% of HFC-134a, and 0.2% to 19.9% of HFC-32; or 0.2% to 4.0% of CO_2, 25.7% to 85.6% of HFO-1252zc, 0.2% to 53.5% of HFO-1234ze(E), 0.2% to 8.0% of HFC-134a, and 5.9% to 19.9% of HFC-32; or .2% to 4.0% of CO_2, 25.7% to 63.7% of HFO-1252zc, 15.8% to 53.5% of HFO-1234ze(E), 0.2% to 6.0% of HFC-134a, and 8.0% to 19.9% of HFC-32; or about 2.0 wt-% CO_2, about 61.7 wt-% HFO-1252zc, about 15.9 wt-% HFO-1234ze(E), about 0.5 wt-% HFC-134a, and about 19.9 wt-% HFC-32; or about

0.2 wt-% CO_2, about 55.7 wt-% HFO-1252zc, about 27.9 wt-% HFO-1234ze(E), about 0.2 wt-% HFC-134a, and about 15.9 wt-% HFC-32.

[0016] According to any of the foregoing embodiments, also disclosed herein are compositions further comprising at least one additional compound selected from HCFC-22, HFC-23, HCC-30, HCFC-31, HCC-40, HFC-41, methane, HFC-125, HFC-143, HFC-143a, HFC-152a, HFC-245cb, HCFC-253dc, HFC-254fb, HCC-260fb, HCFC-261fc, HCFC-262fc, HFC-263fb, HFC-272fb, propane, HFO-374, n-butane, allene, 2-butene, cyclobutene, 2-methyl propene, HCFO-1122, HFO-1132, HFO-1132a, HFO-1141, ethylene, HCFO-1233xf, HFO-1234yf, HCFO-1242zf, HFO-1243zf, HCFO-1251, HCO-1260zf, HFO-1261zf, propylene, HFO-1345, HFO-1252ze, HFO-1252yf, HFO-1252zf, HFO-1252ye, and E/Z-t-BuO-CF=CH-CH_3.

[0017] According to any of the foregoing embodiments, also disclosed herein are compositions further comprising at least one additional compound selected from HCFC-22, HCC-40, HFO-1234yf, HFO-1243zf, HFC-263fb, HFO-1252ze, HFO-1252yf, HFO-1252zf, and HFO-1252ye.

[0018] According to any of the foregoing embodiments, also disclosed herein are compositions wherein said composition further comprises from 0.1 to 200 ppm by weight of water; from about 10 ppm by volume to about 0.35 volume percent oxygen; and/or from about 100 ppm by volume to about 1.5 volume percent air or NAG.

[0019] According to any of the foregoing embodiments, also disclosed herein are compositions wherein said composition comprises a stabilizer.

[0020] According to any of the foregoing embodiments, also disclosed herein are compositions wherein the stabilizer is selected from the group consisting of nitromethane, ascorbic acid, terephthalic acid, azoles, phenolic compounds, cyclic monoterpenes, terpenes, phosphites, phosphates, phosphonates, thiols, and lactones.

[0021] According to any of the foregoing embodiments, also disclosed herein are compositions wherein the stabilizer is selected from tolutriazole, benzotriazole, tocopherol, hydroquinone, t-butyl hydroquinone, 2,6-di-terbutyl-4-methylphenol, fluorinated epoxides, n-butyl glycidyl ether, hexanediol diglycidyl ether, allyl glycidyl

ether, butylphenylglycidyl ether, d-limonene, α-terpinene, β-terpinene, α-pinene, β-pinene, or butylated hydroxytoluene.

[0022] According to any of the foregoing embodiments, also disclosed herein are compositions wherein the stabilizer is present in an amount from about 0.001 to 1.0 weight percent based on the weight of the refrigerant.

[0023] According to any of the foregoing embodiments, also disclosed herein are compositions wherein the composition further comprises a lubricant.

[0024] According to any of the foregoing embodiments, also disclosed herein are compositions wherein said lubricant is at least one selected from the group consisting of polyalkylene glycol, polyol ester, poly-α-olefin, and polyvinyl ether.

[0025] According to any of the foregoing embodiments, also disclosed herein are compositions wherein said lubricant is a polyol ester or a polyvinyl ether.

[0026] According to any of the foregoing embodiments, also disclosed herein are compositions wherein said lubricant has at least one property selected from the group consisting of volume resistivity of greater than 10^{10} Ω-m at 20 ºC; surface tension of from about 0.02 N/m to 0.04 N/m at 20 ºC; kinemetic viscosity of from about 20 cSt to about 500 cSt at 40 ºC; a breakdown voltage of at least 25 kV; and a hydroxy value of at most 0.1 mg KOH/g.

[0027] According to any of the foregoing embodiments, also disclosed herein are compositions wherein the composition comprises at least one tracer.

[0028] According to any of the foregoing embodiments, also disclosed herein are compositions wherein said tracer is present in an amount from about 1.0 ppm by weight to about 1000 ppm by weight.

[0029] According to any of the foregoing embodiments, also disclosed herein are compositions wherein said at least one tracer is selected from the group consisting of hydrofluorocarbons, hydrofluoroolefins, hydrochlorocarbons, hydrochloroolefins, hydrochlorofluorocarbons, hydrochlorofluoroolefins, hydrochlorocarbons, hydrochloroolefins, chlorofluorocarbons, chlorofluoroolefins, hydrocarbons, perfluorocarbons, perfluoroolefins, and combinations thereof.

[0030] According to any of the foregoing embodiments, also disclosed herein are compositions wherein said at least one tracer is selected from the group consisting of HFC-23, HCFC-31, HFC-41, HFC-161, HFC-143a, HFC-134a, HFC-125, HFC-236fa, HFC-236ea, HFC-245cb, HFC-245fa, HFC-254eb, HFC-263fb, HFC-272ca, HFC-281ea, HFC-281fa, HFC-329p, HFC-329mmz, HFC338mf, HFC-338pcc, CFC-12, CFC-11, CFC-114, CFC-114a, HCFC-22, HCFC-123, HCFC-124, HCFC-124a, HCFC-141b, HCFC-142b, HCFC-151a, HCFC-244bb, HCC-40, HFO-1141, HCFO-1130, HCFO-1130a, HCFO-1131, HCFO-1122, HFO-1123, HFO-1234yf, HFO-1234ye, HFO-1243zf, HFO-1225ye, HFO-1225zc, PFC-116, PFC-C216, PFC-218, PFC-C318, PFC-1216, PFC-31-10mc, PFC-31-10my, and combinations thereof.

[0031] According to any of the foregoing embodiments, also disclosed herein are compositions wherein the composition is free of or substantially free of Group A Fluorinated Substances, and wherein degradation products of the composition are free of or substantially free of Group A Fluorinated Substances.

[0032] According to any of the foregoing embodiments, also disclosed herein are compositions wherein the composition is classified as class 2 or 2L for flammability.

[0033] According to any of the foregoing embodiments, also disclosed herein are methods for cooling comprising evaporating a composition of any of claims 1 to 21 in the vicinity of a body to be cooled and thereafter condensing said composition, wherein said cooling is provided by a refrigeration system.

[0034] According to any of the foregoing embodiments, also disclosed herein are refrigeration systems comprising a composition of any of the foregoing embodiments.

[0035] According to any of the foregoing embodiments, also disclosed herein are refrigeration systems comprising a composition of any of the foregoing embodiments, for use in high ambient applications, wherein outdoor temperatures are above about 35ºC.

[0036] According to any of the foregoing embodiments, also disclosed herein are refrigeration systems comprising an evaporator, compressor, condenser, and expansion device, each operably connected to perform a vapor compression cycle.

[0037] According to any of the foregoing embodiments, also disclosed herein are refrigeration systems, wherein said refrigeration system is for residential, light commercial, or industrial refrigeration. In another embodiment, are refrigeration systems containing the compositions of any of the foregoing embodiments, wherein said system is for medium temperature refrigeration, low temperature refrigeration, or transport refrigeration.

[0038] According to any of the foregoing embodiments, also disclosed herein are refrigeration systems containing any of the compositions of the foregoing embodiments, wherein said system is for medium temperature refrigeration, low temperature refrigeration, or transport refrigeration.

[0039] According to any of the foregoing embodiments, also disclosed herein are methods of replacing R-454C, R-513A, R-448A, R-449a, R-452A, R-404A, or R-410A in refrigeration systems comprising providing the composition of any of the foregoing embodiments to the system in place of R-454C, R-513A, R-448A, R-449a, R-452A, R-404A, or R-410A.

[0040] According to any of the foregoing embodiments, also disclosed herein is the use of the compositions of any of the foregoing embodiments as refrigerant in low temperature refrigeration systems, medium temperature refrigeration systems, and/or transport refrigeration systems.

DETAILED DESCRIPTION

[0041] This invention relates to compositions containing 1,1-difluoropropene (HFO-1252zc), E-1,3,3,3-tetrafluoropropene (HFO-1234zeE), difluoromethane (HFC-32), and at least one of 1,1,2,2-tetrafluoroethane (HFC-134) or carbon dioxide (CO_2). The compositions may potentially be candidates to replace refrigerants such as R-454C, R-410A, or propane with low Global Warming Potential (GWP), improved environmental fate characteristics, and improved energy efficiency (COP).

[0042] The compositions comprise HFO-1252zc, HFO-1234zeE, HFC-32, and at least one of HFC-134, HFC-134a, or CO_2. These blends provide refrigerant blends with low global warming potential, improved glide as compared to other suggested refrigerant blends, and improved coefficient of performance as compared to existing refrigerants and other proposed replacements.

[0043] A refrigerant is defined as a heat transfer fluid that undergoes a phase change from liquid to gas and back again during a cycle used to transfer of heat.

[0044] A heat transfer system is the system (or apparatus) used to produce a heating or cooling effect in a particular space. A heat transfer system may be a mobile system or a stationary system.

[0045] Examples of heat transfer systems are any type of refrigeration systems and air conditioning systems including, but are not limited to, stationary heat transfer systems, air conditioners, freezers, refrigerators, heat pumps, flooded evaporator heat pumps, direct expansion chillers heat pumps, chillers, flooded evaporator chillers, direct expansion chillers, walk-in coolers, mobile refrigerators, mobile heat transfer systems, mobile heat pumps (including heat pumps for cabin comfort cooling and heating in automobiles), mobile air conditioning units (for cooling of passenger compartments in automobiles), dehumidifiers, and combinations thereof. The focus of the present application is refrigeration systems, including low temperature refrigeration systems and medium temperature refrigeration systems.

[0046] Volumetric capacity is the amount of heat absorbed or rejected divided by the theoretical compressor displacement. Heat removed or absorbed is the enthalpy difference across a heat exchanger multiplied by the refrigerant mass flowrate. Theoretical compressor displacement is the refrigerant mass flowrate divided by the density of the gas entering the compressor (i.e., compressor suction density). More simply, volumetric capacity is the suction density multiplied by the heat exchanger enthalpy difference. Higher volumetric capacity allows the use of a smaller compressor for the same heat load. Herein, cooling capacity refers to the volumetric capacity in cooling mode and heating capacity refers to the volumetric capacity in heating mode.

[0047] Coefficient of performance (COP) is the amount of heat absorbed or rejected divided by the required energy input to operate the cycle (approximated by the compressor power). COP is specific to the mode of operation of a heat pump, thus COP for heating or COP for cooling. COP is directly related to the energy efficiency ratio (EER).

[0048] Subcooling refers to the reduction of the temperature of a liquid below that liquid's saturation point for a given pressure. The liquid saturation point is the

temperature at which the vapor is completely condensed to a liquid. By cooling a liquid below the saturation temperature (or bubble point temperature), the net refrigeration effect can be increased. Subcooling thereby improves refrigeration capacity and energy efficiency of a system. The subcool amount is the amount of cooling below the saturation temperature (in degrees).

[0049] Superheating refers to the increase of the temperature of a vapor above that vapor's saturation point for a given pressure. The vapor saturation point is the temperature at which the liquid is completely evaporated to a vapor. Superheating continues to heat the vapor to a higher temperature vapor at the given pressure. By heating the vapor above the saturation temperature (or dew point temperature), the net refrigeration effect can be increased. Superheating thereby improves refrigeration capacity and energy efficiency of a system when it occurs in the evaporator. Suction line superheat does not add to the net refrigeration effect and can reduce efficiency and capacity. The superheat amount is the amount of heating above the saturation temperature (in degrees).

[0050] Temperature glide (sometimes referred to simply as "glide") is the absolute value of the difference between the starting and ending temperatures of a phase-change process by a refrigerant within a condenser of a refrigerant system, exclusive of any subcooling or superheating. For an evaporator, the glide is the difference in temperature between the dew point and the evaporator inlet. Glide may be used to describe condensation or evaporation of a near azeotrope or non-azeotropic composition. When referring to the temperature glide of an air conditioning or heat pump system, it is common to provide the average temperature glide being the average of the temperature glide in the evaporator and the temperature glide in the condenser. Glide is applicable to blend refrigerants, i.e. refrigerants that are composed of at least 2 components.

[0051] The net refrigeration effect is the quantity of heat that each kilogram of refrigerant absorbs in the evaporator to produce useful cooling.

[0052] The mass flow rate is the quantity of refrigerant in kilograms circulating through the refrigeration, heat pump or air conditioning system over a given period of time.

[0053] As used herein, the term “lubricant” means any material added to a composition or a compressor (and in contact with any heat transfer composition in use within any heat transfer system) that provides hydrodynamic lubrication to the compressor to aid in preventing parts from seizing.

[0054] Global warming potential (GWP) is an index for estimating relative global warming contribution due to atmospheric emission of a kilogram of a particular greenhouse gas compared to emission of a kilogram of carbon dioxide. GWP can be calculated for different time horizons showing the effect of atmospheric lifetime for a given gas. The GWP for the 100-year time horizon is commonly the value referenced. For mixtures, a weighted average can be calculated based on the individual GWPs for each component. Herein, the GWP values are those reported in the United Nations Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report (AR4). The GWP of HFO-1252zc is estimated at 1.

[0055] Ozone depletion potential (ODP) is a number that refers to the amount of ozone depletion caused by a substance. The ODP is the ratio of the impact on ozone of a chemical compared to the impact of a similar mass of CFC-11 (fluorotrichloromethane). Thus, the ODP of CFC-11 is defined to be 1.0. Other CFCs and HCFCs have ODPs that range from 0.01 to 1.0. Hydrofluorocarbons (HFCs) and the hydrofluoro-olefins (HFO’s) described herein have zero ODP because they do not contain chlorine, bromine or iodine, species known to contribute to ozone breakdown and depletion. HFO-1252zc has zero ozone depletion potential.

[0056] 1,1-Difluoropropene (HFO-1252zc or R-1252zc) may be prepared by hydrogenation of 3,3,3-trifluoropropene (HFO-1243zf) over palladium on carbon catalyst to form 1,1,1-trifluoropropane (HFC-263fb), followed by dehydrofluorination of the HFC-263fb over chrome catalyst or by pyrolysis at high temperatures (see attorney docket number FL2084, filed herewith, and herein incorporated by reference).

[0057] E-1,3,3,3-Tetrafluoropropene (HFO-1234zeE or R-1234zeE) is available commercially from Honeywell (Charlotte, North Carolina, USA). And difluoromethane (HFC-32 or R-32), 1,1,2,2-tetrafluoroethane, (HFC-134 or R-134), 1,1,1,2-tetrafluoroethane (HFC-134a or R-134a) and carbon dioxide (CO_2) are available commercially from various sources worldwide.

[0058] 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.

[0059] 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.

[0060] The transitional phrase "consisting essentially of" is used to define a composition, method or apparatus 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. The term 'consisting essentially of' occupies a middle ground between “comprising” and 'consisting of'. Typically, components of the refrigerant mixtures and the refrigerant mixtures themselves can contain minor amounts (e.g., less than about 0.5 weight percent total) of impurities and/or byproducts (e.g., from the manufacture of the refrigerant components or reclamation of the refrigerant components from other systems) which do not materially affect the novel and basic characteristics of the refrigerant mixture.

[0061] 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.

[0062] Unless otherwise defined, all technical and scientific terms used herein have the same meaning as commonly understood by one of ordinary skill in the art to which this invention belongs. Although methods and materials similar or

equivalent to those described herein can be used in the practice or testing of embodiments of the disclosed compositions, suitable methods and materials are described below. All publications, patent applications, patents, and other references mentioned herein are incorporated by reference in their entirety, unless a particular passage is cited. In case of conflict, the present specification, including definitions, will control. In addition, the materials, methods, and examples are illustrative only and not intended to be limiting.

REFRIGERANT COMPOSITIONS

[0063] In one embodiment, compositions comprise, consist of, or consist essentially of HFO-1252zc, HFO-1234zeE, HFC-32, and at least one of HFC-134, HFC-134a, or CO_2. These compositions provide low Global Warming Potential (GWP), improved environmental fate characteristics, and improved energy efficiency (COP) as compared to incumbent refrigerants.

[0064] In another embodiment, the compositions comprise, consist of, or consist essentially of: 1% to 21% HFO-1252zc, 57% to 80% HFO-1234zeE, 13% to 22% HFC-32, and 1% to 2% CO_2; or 1.0% to 6.0% of CO_2, 1.0% to 96.0% of HFO-1252zc, 1.0% to 97.0% of HFO-1234zeE, and 1.0% to 49.0% of HFC-32; or 1.0% to 6.0% of CO_2, 1.0% to 96.0% of HFO-1252zc, 1.0% to 97.0% of HFO-1234zeE, and 1.0% to 28.0% of HFC-32; or 1.0% to 6.0% of CO_2, 16.0% to 85.0% of HFO-1252zc, 1.0% to 61.0% of HFO1234zeE 1234ZEE, and 1.0% to 28.0% of HFC-32; or 1.0% to 2.0% of CO_2, 16.0% to 19.0% of HFO-1252zc, 58.0% to 61.0% of HFO-1234zeE, and 20.0% to 22.0% of HFC-32; or about 2.0 wt-% CO_2, about 17.0 wt-% HFO-1252zc, 59.0 wt-% HFO-1234zeE and 22.0 wt-% HFC-32.

[0065] In another embodiment, the compositions comprise, consist of, or consist essentially of: 1% to 21% HFO-1252zc, 57% to 80% HFO-1234zeE, 13% to 22% HFC-32, and 1% to 6% HFC-134; or 1.0% to 97.0% of HFO-1234zeE, 1.0% to 43.0% of HFC-32, and 1.0% to 28.0% of HFC-134; or 1.0% to 97.0% of HFO-1252zc, 1.0% to 97.0% of HFO-1234zeE, 1.0% to 43.0% of HFC-32, and 1.0% to 28.0% of HFC-134; or 1.0% to 97.0% of HFO-1252zc, 1.0% to 97.0% of HFO-1234zeE, 1.0% to 43.0% of HFC-32, and 1.0% to 28.0% of HFC-134; or 1.0% to 27.0% of HFO-1252zc, 30.0% to 97.0% of HFO-1234zeE, 1.0% to 43.0% of HFC-32, and 1.0% to 28.0% of HFC-134; or about 15.0 wt-% HFO-1252zc, about 41.0 wt-%

HFO-1234zeE, about 42.0 wt-% HFC-32 and about 2.0 wt-% HFC-134; or about 10.0 wt-% HFO-1252zc, about 68.0 wt-% HFO-1234zeE, about 1.0 wt-% HFC-32, and about 21.0 wt-% HFC-134; 1.0-21.0% of HFO-1252zc, 49.0-94.0% of HFO-1234ze(E), 1.0-30.0% of HFC-134, and of 1.0-8.0% of HFC-32; or 14.0-21.0% of HFO-1252zc, 64.0-73.0% of HFO-1234ze(E), 3.0-8.0% of HFC-134, and of 7.0-8.0% of HFC-32; or 15.0-19.0% of HFO-1252zc, 68.0-72.0% of HFO-1234ze(E), 3.0-7.0% of HFC-134, and of 6.0-10.0% of HFC-32; or about 17.0% of HFO-1252zc, about 70.0% of HFO-1234ze(E), about 5.0% of HFC-134, and about 8.0% of HFC-32.

[0066] In another embodiment, the compositions comprise, consist of, or consist essentially of: 1% to 21% HFO-1252zc, 57% to 80% HFO-1234zeE, 17% to 22% HFC-32, and 1% to 3% HFC-134a; or 1.0% to 23.0% of HFC-134a, 1.0% to 97.0% of HFO-1252zc, 1.0% to 97.0% of HFO-1234zeE, and 1.0% to 52.0% of HFC-32; or 1.0% to 23.0% of HFC-134a, 1.0% to 97.0% of HFO-1252zc, 1.0% to 97.0% of HFO-1234zeE, and 1.0% to 52.0% of HFC-32; or 1.0% to 22.0% of HFC-134a, 1.0% to 80.0% of HFO-1252zc, 1.0% to 71.0% of HFO-1234zeE, and 1.0% to 49.0% of HFC-32; or 1.0% to 15.0% of HFC-134a, 1.0% to 26.0% of HFO-1252zc, 31.0% to 71.0% of HFO-1234zeE, and 5.0% to 42.0% of HFC-32; or about 1.0 wt-% HFC-134a, about 25.0 wt-% HFO-1252zc, about 35.0 wt-% HFO-1234zeE and about 39.0 wt-% HFC-32; or about 14.0 wt-% HFC-134a, about 15.0 wt-% HFO-1252zc, about 66.0 wt-% HFO-1234zeE, and about 5.0 wt-% HFC-32.

[0067] In another embodiment, the compositions comprise, consist of, or consist essentially of: 1% to 21% HFO-1252zc, 54% to 80% HFO-1234zeE, 11% to 22% HFC-32, 1% to 6% HFC-134, and 1% to 3% CO_2; or 1.0% to 3.0% of CO_2, 1.0% to 6.0% of HFC-134, 1.0% to 20.0% of HFO-1252zc, 42.0% to 73.0% of HFO-1234zeE, and 11.0% to 38.0% of HFC-32; or 1.0% to 3.0% of CO_2, 1.0% to 6.0% of HFC-134, 1.0% to 20.0% of HFO-1252zc, 42.0% to 73.0% of HFO-1234zeE, and 11.0% to 38.0% of HFC-32; or 2.0% to 2.0% of CO_2, 1.0% to 1.0% of HFC-134, 18.0% to 18.0% of HFO-1252zc, 57.0% to 57.0% of HFO-1234zeE, and 22.0% to 22.0% of HFC-32; or 2.0% to 2.0% of CO_2, 1.0% to 1.0% of HFC-134, 18.0% to 18.0% of HFO-1252zc, 57.0% to 57.0% of HFO-1234zeE, and 22.0% to 22.0% of HFC-32; or about 2.0 wt-% CO_2, about 1.0 wt-% HFC-134, about 18.0 wt-% HFO-1252zc, about 57.0 wt-% HFO-1234zeE, and about 22.0 wt-% HFC-32; or about 2.0 wt-% CO_2,

about 1.0 wt-% HFC-134, about 18.0 wt-% HFO-1252zc, about 57.0 wt-% HFO-1234zeE, and about 22.0 wt-% HFC-32.

[0068] In another embodiment, the compositions comprise, consist of, or consist essentially of: 1.0% to 96.0% of HFO-1252zc, 1.0% to 96.0% of HFO-1234ze(E), 1.0% to 25.0% of HFC-134, 1.0% to 21.0% of HFC-134a, and 1.0% to 40.0% of HFC-32; or 1.0% to 96.0% of HFO-1252zc, 1.0% to 96.0% of HFO-1234ze(E), 1.0% to 11.0% of HFC-134, 1.0% to 10.0% of HFC-134a, and 1.0% to 18.0% of HFC-32; or 41.0% to 82.0% of HFO-1252zc, 1.0% to 39.0% of HFO-1234ze(E), 1.0% to 3.0% of HFC-134, 1.0% to 2.0% of HFC-134a, and 15.0% to 18.0% of HFC-32; or 41.0% to 63.0% of HFO-1252zc, 17.0% to 39.0% of HFO-1234ze(E), 1.0% to 2.0% of HFC-134, 1.0% to 2.0% of HFC-134a, and 16.0% to 18.0% of HFC-32; or about 63.0 wt-% HFO-1252zc, about 17.0 wt-% HFO-1234ze(E), about 1.0 wt-% HFC-134, about 1.0 wt-% HFC-134a, and about 18.0 wt-% HFC-32; or about 62.0 wt-% HFO-1252zc, about 19.0 wt-% HFO-1234ze(E), about 2.0 wt-% HFC-134, about 1.0 wt-% HFC-134a, and about 16.0 wt-% HFC-32.

[0069] In another embodiment, the compositions comprise, consist of, or consist essentially of: 0.2% to 89.1% of CO_2, 0.2% to 97.5% of HFO-1252zc, 0.2% to 97.5% of HFO-1234ze(E), 0.2% to 22.0% of HFC-134a, and 0.2% to 43.8% of HFC-32; or 0.2% to 89.1% of CO_2, 0.2% to 97.5% of HFO-1252zc, 0.2% to 97.5% of HFO-1234ze(E), 0.2% to 10.0% of HFC-134a, and 0.2% to 19.9% of HFC-32; or 0.2% to 4.0% of CO_2, 25.7% to 85.6% of HFO-1252zc, 0.2% to 53.5% of HFO-1234ze(E), 0.2% to 8.0% of HFC-134a, and 5.9% to 19.9% of HFC-32; or .2% to 4.0% of CO_2, 25.7% to 63.7% of HFO-1252zc, 15.8% to 53.5% of HFO-1234ze(E), 0.2% to 6.0% of HFC-134a, and 8.0% to 19.9% of HFC-32; or about 2.0 wt-% CO_2, about 61.7 wt-% HFO-1252zc, about 15.9 wt-% HFO-1234ze(E), about 0.5 wt-% HFC-134a, and about 19.9 wt-% HFC-32; or about 0.2 wt-% CO_2, about 55.7 wt-% HFO-1252zc, about 27.9 wt-% HFO-1234ze(E), about 0.2 wt-% HFC-134a, and about 15.9 wt-% HFC-32.

[0070] The compositions disclosed herein provide GWP less than or equal to 150, COP improved over R-454C, and cooling capacity within 20% of that for R-454C. Additionally, the compositions provide acceptable average temperature glide, preferably less than 10 K, and reasonable compressor discharge temperatures.

Further, the compositions as defined above are estimated to be classified as class 2 or 2L for flammability by ASHRAE.

[0071] Flammability is a term used to mean the ability of a composition to ignite and/or propagate a flame. For refrigerants and other heat transfer compositions or working fluids, the lower flammability limit ("LFL") is the minimum concentration of the heat transfer composition in air that is capable of propagating a flame through a homogeneous mixture of the composition and air under test conditions specified in ASTM (American Society of Testing and Materials) E681. The upper flammability limit ("UFL") is the maximum concentration of the heat transfer composition in air that is capable of propagating a flame through a homogeneous mixture of the composition and air under the same test conditions.

[0072] In order for a refrigerant to be classified by ANSI/ASHRAE as low flammability (class 2L), it must: 1) exhibit flame propagation when tested at 140°F (60°C) and 14.7 psia (101.3 kPa); 2) have an LFL >0.0062 lb/ft^3 (0.10 kg/m^3); 3) have a heat of combustion <8169 Btu/lb (19,000 kJ/kg); and 4) have a maximum burning velocity of ≤3.9 in./s (10 cm/s) when tested at 73.4°F (23.0°C) and 14.7 psia (101.3 kPa) in dry air.

[0073] In order for a refrigerant to be classified by ANSI/ASHRAE as flammable (class 2), it must: 1) exhibit flame propagation when tested at 140°F (60°C) and 14.7 psia (101.3 kPa); 2) have an LFL >0.0062 lb/ft^3 (0.10 kg/m^3); and 3) have a heat of combustion <8169 Btu/lb (19,000 kJ/kg).

[0074] In order for a refrigerant to be classified by ANSI/ASHRAE standard 34 class 3, refrigerant 1) exhibits flame propagation when tested at 140°F (60°C) and 14.7 psia (101.3 kPa), 2) has an LFL < 0.0062 lb/ft^3 (0.10 kg/m^3) or 3) has a heat of combustion >8169 Btu/lb (19,000 kJ/kg).

[0075] ASHRAE Standard 34 provides a methodology to calculate the heat of combustion for refrigerant blends using a balanced stoichiometric equation based on the complete combustion of one mole of refrigerant with enough oxygen for a stoichiometric reaction.

[0076] The compositions comprising, consisting of, or consisting essentially of HFO-1252zc, HFO-1234zeE, HFC-32, and at least one of HFC-134, HFC-134a, or CO_2 may further comprise at least one additional compound from the list in Table A.

TABLE A

Code	Name-ASHRAE Designation	Formula
R-22	chlorodifluoromethane	CHF_2Cl
R-23	trifluoromethane (HFC-23)	CHF_3
R-30	dichloromethane (HCC-30)	CH_2Cl_2
R-31	chlorofluoromethane (HCFC-31)	CH_2FCl
R-40	methyl chloride (HCC-40)	CH_3Cl
R-41	fluoromethane (HFC-41)	CH_3F
R-50	methane	CH_4
R-125	1,1,2,2,2-pentafluoroenthane (HFC-125)	CHF_2CF_3
R-134a	1,1,1,2-tetrafluoroethane	CH_2FCF_3
R-143	1,1,2-trifluoroethane (HFC-143)	CF_2CH_2F
R-143a	1,1,1-trifluoroethane (HFC-143a)	CF_3CH_3
R-152a	1,1,difluoroethane (HFC-152a)	CHF_2CH_3
R-245cb	1,1,1,2,2-pentafluoropropane (HFC-245cb)	$CF_3CF_2CH_3$
R-253dc	2-chloro-1,1,1-trifluoropropane (HCFC-253dc)	$CF_3CHClCH_3$
R-254fb	1,1,1,3-tetrafluoropropane (HFC-254fb)	$CF_3CH_2CH_2F$
R-260fb	1,1,1-trichloropropane (HCC-260fb)	$CCl_3CH_2CH_3$
R-261fc	1,1-dichloro-1-fluoropropane (HCFC-261fc)	$CCl_2FCH_2CH_3$
R-262fc	1-chloro-1,1-difluoropropane (HCFC-262fc)	$CClF_2CH_2CH_3$
R-263fb	1,1,1-trifluoropropane (HFC-263fb)	$CF_3CH_2CH_3$
R-272fb	1,1-difluoropropane (HFC-272fb)	$CHF_2CH_2CH_3$
R-290	propane (HC-290)	$CH_3CH_2CH_3$
R-374	tetrafluorobutene (HFO-374)	$C_4H_6F_4$
R-600	butane (HC-600)	$CH_3CH_2CH_2CH_3$
	allene	$H_2C=C=CH_2$
	2-butene	$CC_3CH=CHCH_3$
	cyclobutene	C_4H_6
	2-methylpropene	$CH_3(CH_3)C=CF_3$
R-1122	1-chloro-2,2-difluoroethylene (HCFO-1122)	$CHCl=CF_2$
R-1132	1,2-difluoroethene (HFO-1132)	CHF=CHF
R-1132a	1,1-difluorothene ((HFO-1132a)	$CH=CF_2$
R-1141	fluoroethene (HFO-1141)	$CH_2=CHF$
R-1150	ethylene (HO-1150)	$CH_2=CH_2$
R-1233xf	2-chloro-3,3,3-trifluoropropene (HCFO-1233xf)	$CF_3CCl=CH_2$
R-1234yf	2,3,3,3-tetrafluoropropene(HFO-1234yf)	CF3CH=CHF
R-1242zf	3-chloro-3,3-difluoropropene (HCFO-1242zf)	$CClF_2CH=CH_2$
R-1243zf	3,3,3-trifluoropropene (HFO-1243zf)	$CF_3CH{=}CH_2$
R-1251	HCFO-1251 isomer	C_3H_4FCl
R-1251	HCFO-1251 isomer	C_3H_4FCl

Code	Name-ASHRAE Designation	Formula
R-1252ze	1,3-difluoropropene (HFO-1252ze)	$CH_2FCH=CHF$
R-1252yf	2,3-difluoropropene (HFO-1252yf)	$CH_2FCF=CH_2$
R-1252zf	3,3-difluoropropene (HFO-1252zf)	$CHF_2CH=CH_2$
R-1252ye	1,2-difluoropropene (HFO1252ye)	$CH_3CF=CHF$
R-1252zc	1,1-difluoropropene (HFO-1252zc)	$CH_3CH=CF_2$
R-1260zf	3-chloropropene (HCO-1260zf)	$CH_2ClCH=CH_2$
R-1261	3-fluoro-1-propene (HFO-1261)	$CH_2FCH=CH_2$
R-1270	propylene (HO-1270)	$CH_3CH=CH_2$
R-1345	pentafluorobutene (HFO-1345)	$C_4H_3F_5$
	E/Z-*t*-BuO-CF=CH-CH_3	E/Z-t-BuO-CF=CH-CH_3

[0077] In another embodiment, the compositions comprising, consisting of, or consisting essentially of HFO-1252zc, HFO-1234zeE, HFC-32, and at least one of HFC-134, HFC-134a, or CO_2 may further comprise at least one additional compound selected from HCFC-22, HCC-40, HFO-1234yf, HFO-1243zf, HFO-263fb, HFO-1252ze, HFO-1252yf, HFO-1252zf, and HFO-1252ye. In another embodiment, the compositions comprising, consisting of, or consisting essentially of HFO-1252zc, HFO-1234zeE, HFC-32, and at least one of HFC-134, HFC-134a, or CO_2 may further comprise at least one additional compound comprising HFO-1234yf. In another embodiment, the compositions comprising, consisting of, or consisting essentially of HFO-1252zc, HFO-1234zeE, HFC-32, and at least one of HFC-134, HFC-134a, or CO_2 may further comprise at least one additional compound comprising HFO-1243zf. In another embodiment, the compositions comprising, consisting of, or consisting essentially of HFO-1252zc, HFO-1234zeE, HFC-32, and at least one of HFC-134, HFC-134a, or CO_2 may further comprise at least one additional compound comprising HFO-263fb.

[0078] 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.

[0079] The amount of additional compounds present in any of the foregoing refrigerant compositions can be greater than 0 ppm and less than 5,000 ppm and, in

particular, can range from greater than zero to about 1,000 ppm, about 5 to about 500 ppm and about 1 to about 100 ppm.

[0080] In one embodiment, the amount of additional compounds present in any of the foregoing refrigerant compositions can be greater than 0 and less than 1 wt% of the refrigerant composition, preferably less than 0.5 weight percent, or more preferably less than 0.1 weight percent.

[0081] The compositions comprising, consisting of, or consisting essentially of HFO-1252zc, HFO-1234zeE, HFC-32, and at least one of HFC-134, HFC-134a, or CO_2 will perform more consistently and be more stable with only minor amounts of water present. Thus, the compositions may further comprise less than 100 ppm (by weight) water, preferably less than 20 ppm (by weight) water, and even more preferably less than 10 ppm (by weight) water.

[0082] Additionally, the compositions comprising, consisting of, or consisting essentially of HFO-1252zc, HFO-1234zeE, HFC-32, and at least one of HFC-134, HFC-134a, or CO_2 will perform more consistently and be more stable with only minor amounts of oxygen or air present. Therefore, the presently claimed compositions may further comprise less than about 5 volume percent non-adsorbable gases (NAG), preferably less than 3 volume percent NAG, and more preferably less than 1.5 volume percent NAG. Further, the presently claimed compositions, due to the presence of air or NAG, will contain less than 1 volume percent oxygen, preferably less than 0.5 volume percent oxygen, and more preferably less than 0.3 volume percent oxygen.

[0083] In another embodiment, the compositions comprising, consisting of, or consisting essentially of HFO-1252zc, HFO-1234zeE, HFC-32, and at least one of HFC-134, HFC-134a, or CO_2 may contain a stabilizer. Such stabilizer compounds are intended to be present in a small amount and prevent decomposition due to the presence of water, air, NAG, or oxygen in a system while in use or while the composition is stored. HFO type refrigerants, due to the presence of a double bond, may be subject to thermal instability and decompose under extreme use, handling or storage situations also. Therefore, there may be advantages to adding stabilizers to HFO type refrigerants. Stabilizers may notably include nitromethane, ascorbic acid, terephthalic acid, azoles such as tolutriazole or benzotriazole, phenolic compounds

such as tocopherol, hydroquinone, t-butyl hydroquinone, 2,6-di-tertbutyl-4-methylphenol, epoxides (possibly fluorinated or perfluorinated alkyl epoxides or alkenyl or aromatic epoxides) such as n-butyl glycidyl ether, hexanediol diglycidyl ether, allyl glycidyl ether, butylphenylglycidyl ether, cyclic monoterpenes, terpenes, such as d-limonene, α-terpinene, β-terpinene, γ-terpinene, α-pinene, or β-pinene, phosphites, phosphates, phosphonates, thiols and lactones. Examples of suitable stabilizers are disclosed in WO2019213004, WO2020222864, and WO2020222865; the disclosures of which are hereby incorporated by reference.

[0084] If the composition does include a stabilizer, it may include any amount from 0.001 wt% up to 1 wt%, preferably from about 0.001 to about 0.5 weight percent, more preferably, from about 0.001 to about 0.3 weight percent of any of the stabilizers listed above.

[0085] In some embodiments, the compositions comprising, consisting of, or consisting essentially of HFO-1252zc, HFO-1234zeE, HFC-32, and at least one of HFC-134, HFC-134a, or CO_2 may contain a tracer compound or tracers. The tracer may comprise two or more tracer compounds. In some embodiments, the tracer is present in the compositions at a total concentration of about 50 parts per million by weight (ppm) to about 1000 ppm, based on the weight of the total composition. 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.

[0086] The tracer may be present in compositions comprising, consisting of, or consisting essentially of HFO-1252zc, HFO-1234zeE, HFC-32, and at least one of HFC-134, HFC-134a, or CO_2 in predetermined quantities to allow detection of any dilution, contamination or other alteration of the composition. The presence of certain compounds in the composition may indicate by what method or process one of the components has been produced. The tracer may also be added to the composition in a specified amount in order to identify the source of the composition. In this manner, detection of infringement on patent rights may be accomplished. The tracers may be refrigerant compounds but are present in the composition at levels that are unlikely to impact performance of the refrigerant component of the composition.

[0087] Tracer compounds may be hydrofluorocarbons, hydrofluoroolefins, hydrochlorocarbons, hydrochloroolefins, hydrochlorofluorocarbons, hydrochlorofluoroolefins, hydrochlorocarbons, hydrochloroolefins, chlorofluorocarbons, chlorofluoroolefins, hydrocarbons, perfluorocarbons, perfluoroolefins, and combinations thereof. Examples of tracer compounds include, but are not limited to HFC-23 (trifluoromethane), HCFC-31 (chlorofluoromethane), HFC-41 (fluoromethane), HFC-161 (fluoroethane), HFC-143a (1,1,1-trifluoroethane), HFC-134a (1,1,1,2-tetrafluoroethane), HFC-125 (pentafluoroethane), HFC-236fa (1,1,1,3,3,3-hexafluoropropane), HFC-236ea (1,1,1,2,3,3-hexafluoropropane), HFC 245cb (1,1,1,2,2-pentafluoropropane), HFC-245fa (1,1,1,3,3-pentafluoropropane) , HFC-254eb (1,1,1,2-tetrafluoropropane), HFC-263fb (1,1,1 trifluoropropane), HFC-272ca (2,2-difluoropropane), HFC-281ea (2-fluoropropane), HFC-281fa (1-fluoropropane), HFC-329p (1,1,1,2,2,3,3,4,4-nonafluorobutane), HFC-329mmz (1,1,1-trifluoro-2-methylpropane), HFC-338mf (1,1,1,2,2,4,4,4-octafluorobutane), HFC-338pcc (1,1,2,2,3,3,4,4-octafluorobutane), CFC-12 (dichlorodifluoromethane), CFC-11 (trichlorofluoromethane), CFC-114 (1,2-dichloro-1,1,2,2-tetrafluoroethane), CFC-114a (1,1,-dichloro-1,2,2,2-tetrafluoroethane), HCFC-22 (chlorodifluoromethane), HCFC-123 (1,1-dichloro-2,2,2-trifluoroethane), HCFC-124 (2-chloro-1,1,1,2-tetrafluoroethane), HCFC-124a (1-chloro-1,1,2,2-tetrafluoroethane), HCFC-141b (1,1-dichloro-1-fluoroethane), HCFC-142b (1-chloro-1,1-difluoroethane), HCFC-151a (1-chloro-1-fluoroethane), HCFC-244bb (2-chloro-1,1,1,2-tetrafluoropropane), HCC-40 (chloromethane), HFO-1141 (fluoroethene), HCFO-1130 (1,2-dichloroethene), HCFO-1130a (1,1-dichloroethene), HCFO-1131 (1-chloro-2-fluoroethene), HCFO-1122 (2-chloro-1,1-difluoroethene), HFO-1123 (1,1,2-trifluoroethene), HFO-1234ye (1,2,3,3-tetrafluoropropene), HFO-1243zf (3,3,3-trifluoropropene), HFO-1225ye (1,2,3,3,3-pentafluoropropene), HFO-1225zc (1,1,3,3,3-pentafluoropropene), PFC-116 (hexafluoroethane), PFC-C216 (hexafluorocyclopropane), PFC-218 (octafluoropropane), PFC-C318 (octafluorocyclobutane), PFC-1216 (hexafluoroethane), PFC-31-10mc (1,1,1,2,2,3,3,4,4,4-decafluorobutane), PFC-31-10my (1,1,1,2,3,3,3-heptafluoro-2-trifluoromethylpropane), and combinations thereof.

[0088] In another embodiment of the present disclosure, the compositions comprising, consisting of, or consisting essentially of HFO-1252zc, HFO-1234zeE,

HFC-32, and at least one of HFC-134, HFC-134a, or CO_2 further comprise at least one lubricant. Lubricants may be selected from polyol ester, polyvinyl ether, and polyalkylene glycol. Lubricants may also 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 polyalphaolefins. Representative conventional lubricants of the present invention are the commercially available BVM 100 N (paraffinic mineral oil sold by BVA Oils), napthenic 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.

[0089] Lubricants of the present invention further comprise those which have been designed for use with hydrofluorocarbon refrigerants and are miscible with refrigerants of the present invention under compression refrigeration and air-conditioning apparatus' operating conditions. 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, Mich.), and polyvinyl ethers (PVEs) such as PVE-FVC68D.

[0090] In one particular embodiment, the compositions comprising, consisting of, or consisting essentially of HFO-1252zc, HFO-1234zeE, HFC-32, and at least one of HFC-134, HFC-134a, or CO_2 are combined with a PAG lubricant or a PVE lubricant or a POE lubricant for usage in a low or medium temperature refrigeration system.

[0091] In the compositions comprising, consisting of, or consisting essentially of HFO-1252zc, HFO-1234zeE, HFC-32, and at least one of HFC-134, HFC-134a, or CO_2 including a lubricant, the lubricant may be present in an amount of less than 80 weight percent of the total composition. The lubricant may further be present in an amount of less than 60 weight percent of the total composition. In other embodiments, the amount of lubricant may be between about 0.1 and 50 weight percent of the total composition. The lubricant may also be between about 0.1 and 20 weight percent of the total composition The lubricant may also be between about 0.1 and 5 weight percent of the total composition.

[0092] If lubricant compatibility is an issue, a system may include an oil separator in order to function more reliably.

[0093] In another aspect of the invention, the inventive composition comprising, consisting of, or consisting essentially of HFO-1252zc, HFO-1234zeE, HFC-32, and at least one of HFC-134, HFC-134a, or CO_2 is used to introduce lubricant into the air-conditioning or heat pump system as well as or alternatively other additives, such as a) acid scavengers, b) performance enhancers, and c) flame suppressants. In one preferred embodiment, the present compositions comprise an acid scavenger.

[0094] Examples of the acid scavengers that may be included in the present compositions include, but are not limited, the stabilizers and/or the epoxide component of the stabilizers disclosed in U.S. Patent No. 8,535,555 and the acid scavengers disclosed in International Application Publication No. WO 2020/222864, the disclosure of each of which is incorporated herein by reference in its entirety.

[0095] In some embodiments, an acid scavenger may comprise one or more epoxides, one or more amines and/or one or more hindered amines, such as, for example but not limited to, epoxybutane.

[0096] 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.

[0097] 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 less than about 5 wt%, less than about 4 wt%, less than about 3 wt%, more preferably less than about 2.5 wt% and most preferably greater than about 2 wt% (e. g. less than about 1.8 wt%) based on the total weight of the refrigerant composition.

[0098] 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-triadiaZole 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).

[0099] 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.

[0100] Mouli et al. (WO 2008/027595 and WO 2009/042847) teach 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.

[0101] Preferred flame suppressants include the flame retardants described in patent application "Refrigerant compositions containing fluorine substituted olefins CA 2557873 A1" and incorporated by reference, as well as fluorinated products such as HFC-125, HFC-227ea, HFC-236fa, CF_3I, and/or Krytox® lubricants, also incorporated by reference and described in patent application "Refrigerant compositions comprising fluoroolefins and uses thereof WO2009018117A1."

[0102] In one embodiment, as used herein, " Group A Fluorinated Substances" includes any substance that (i) contains at least one fully fluorinated methyl ($–CF_3$) or methylene ($–CF_2–$) 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). In one embodiment, Group A Fluorinated Substances include, but are not limited to, trifluoroacetic acid (TFA).

[0103] In another embodiment, as used herein, "Group A Fluorinated Substances" includes any substance that has a Henry's Law constant $\leq$ 250 $Pa*m^3/mol$ and contains at least one fully fluorinated methyl ($–CF_3$) or methylene ($–CF_2–$) carbon atom (without any H/Cl/Br/I attached to it). In one embodiment, Group A Fluorinated Substances include, but are not limited to, TFA.

[0104] Thus, according to some embodiments, compositions of the present invention which comprise, consist of, or consist essentially of HFO-1252zc, HFO-1234zeE, HFC-32, and at least one of HFC-134, HFC-134a, or CO_2 are free of or substantially free of Group A Fluorinated Substances, such as TFA. In one embodiment, the phrase "free of" as used herein with respect to the presence of Group A Fluorinated Substances in the present 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. In one embodiment, the phrase "substantially free of" as used herein with respect to the presence of Group A Fluorinated Substances in the present compositions means that the amount of such substances in the compositions is > 0 wt.% and ≤ 5 wt.%, or > 0 wt.% and ≤ 4 wt.%, or > 0 wt.% and ≤ 3 wt.%, or > 0 wt.% and ≤ 2 wt.%, or > 0 wt.% and ≤ 1 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.

[0105] Further, in some embodiments, degradation products of such compositions of the present invention which comprise, consist of, or consist essentially of HFO-1252zc, HFO-1234zeE, HFC-32, and at least one of HFC-134, HFC-134a, or CO_2 are free of or substantially free of Group A Fluorinated Substances, such as TFA. In one embodiment, the phrase "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 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. In one embodiment, 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 ≤ 5%, or > 0% and ≤ 4%, or > 0% and ≤ 3%, or > 0% and ≤ 2%, or > 0% and ≤ 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.

[0106] The 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. In another embodiment, any of the foregoing refrigerant compositions can be prepared by blending HFO-1252zc, HFO-1234zeE, HFC-32, and at least one of HFC-134, HFC-134a, or CO_2, and, in some cases, at least one of the additional compounds.

[0107] In a further embodiment, the compositions may be prepared from recycled or reclaimed refrigerant. One or more of the components may be recycled or reclaimed by means of removing contaminants, such as air, water, or residue, which may include lubricant or particulate residue from system components. The means of removing the contaminants may vary widely, but can include distillation, decantation, filtration, and/or drying by use of molecular sieves or other absorbents. Then the recycled or reclaimed component(s) may be combined with the other component(s) as describe above.

METHODS AND SYSTEMS

[0108] The compositions comprising, consisting of, or consisting essentially of HFO-1252zc, HFO-1234zeE, HFC-32, and at least one of HFC-134, HFC-134a, or CO_2 are useful in numerous methods and systems that provide refrigeration and freezing.

[0109] In one embodiment, provided is a method of cooling comprising evaporating a composition comprising, consisting of, or consisting essentially of HFO-1252zc, HFO-1234zeE, HFC-32, and at least one of HFC-134, HFC-134a, or CO_2 in the vicinity of a body to be cooled and thereafter condensing said composition. In another embodiment, the cooling is provided by a refrigeration system.

[0110] In one embodiment, the refrigeration system may be a residential, commercial, or industrial refrigeration system. These may include, but are not

limited to, supermarket and convenience store refrigerated cases for beverages, dairy, and produce and prepared foods. Low and medium temperature refrigeration systems include supermarket and convenience store refrigerator and freezer cabinets and displays, ice machines, self-contained coolers and freezers, such as beverage coolers, walk-in and reach-in coolers and freezers, supermarket rack and distributed systems, and refrigerated or frozen food transport.

[0111] In another embodiment, is provided a refrigeration system comprising a composition comprising, consisting of, or consisting essentially of HFO-1252zc, HFO-1234zeE, HFC-32, and at least one of HFC-134, HFC-134a, or CO_2. In another embodiment, the composition comprising, consisting of, or consisting essentially of HFO-1252zc, HFO-1234zeE, HFC-32, and at least one of HFC-134, HFC-134a, or CO_2 comprised within the refrigeration system further includes a lubricant. The refrigeration system comprises an evaporator, compressor, condenser, and expansion device, each operably connected to perform a vapor compression cycle.

[0112] In one embodiment, the refrigeration system may be a residential, commercial, or industrial refrigeration system. These may include, but are not limited to, supermarket and convenience store refrigerated cases for beverages, dairy, and produce and prepared foods. The refrigeration system may be for providing low temperature refrigeration, medium temperature refrigeration, and/or transport refrigeration. Low and medium temperature refrigeration systems include supermarket and convenience store refrigerator and freezer cabinets and displays, ice machines, self-contained coolers and freezers, such as beverage coolers, walk-in and reach-in coolers and freezers, supermarket rack and distributed systems, and refrigerated or frozen food transport.

[0113] In another embodiment, the refrigeration system is a secondary loop system.

[0114] It has been found that the compositions comprising, consisting of, or consisting essentially of HFO-1252zc, HFO-1234zeE, HFC-32, and at least one of HFC-134, HFC-134a, or CO_2 will have some temperature glide in the heat exchangers. Thus, the systems will operate more efficiently if the heat exchangers are operated in counter-current mode or cross-current mode with counter-current

tendency. Counter-current tendency means that the closer the heat exchanger can get to counter-current mode the more efficient the heat transfer. Thus, refrigeration heat exchangers, in particular, evaporators, are designed to provide some aspect of counter-current tendency. Therefore, provided herein is an refrigeration system wherein said system includes one or more heat exchangers (either evaporators, condensers, or both) that operate in counter-current mode or cross-current mode with counter-current tendency. The system may be a medium temperature system, a low temperature system or a transport refrigeration system.

[0115] Additionally, the compositions of the present invention can be used in systems with heat exchangers operating in cross-current mode.

[0116] In another embodiment, provided herein is a refrigeration system containing compositions comprising, consisting of, or consisting essentially of HFO-1252zc, HFO-1234zeE, HFC-32, and at least one of HFC-134, HFC-134a, or CO_2, wherein said system includes one or more heat exchangers (either evaporators, condensers, or both) that operate in counter-current mode, cross-current mode, or cross-current mode with counter-current tendency.

[0117] In one embodiment, a method is provided for replacing R-454C, R-513A, R-448A, R-449a, R-452A, R-404A, or R-410A in refrigeration systems HFO-1252zc, HFO-1234zeE, HFC-32, and at least one of HFC-134, HFC-134a, or CO_2 to the system in place of R-454C, R-513A, R-448A, R-449a, R-452A, R-404A, or R-410A.

[0118] In one embodiment, the compositions comprising, consisting of, or consisting essentially of HFO-1252zc, HFO-1234zeE, HFC-32, and at least one of HFC-134, HFC-134a, or CO_2 are useful as refrigerant in low temperature refrigeration systems, medium temperature refrigeration systems, and/or transport refrigeration systems. In another embodiment, the compositions comprising, consisting of, or consisting essentially of HFO-1252zc, HFO-1234zeE, HFC-32, and at least one of HFC-134, HFC-134a, or CO_2 are useful as refrigerant in any of the refrigeration systems described herein above.

EXAMPLES

Example 1

[0119] [0001] The presently claimed compositions containing HFO-1252zc, HFO-1234zeE, HFC-32, and CO2 are compared to R-454C (ASHRAE designation for a refrigerant containing 78.5 wt% HFO-1234yf and 21.5 wt% HFC-32) and R-404A (ASHRAE designation for a refrigerant containing 44 wt% HFC-125, 4 wt% HFC-134a and 52 wt% HFC-143a) under the conditions for refrigeration shown below. Table 1 provides the calculated results.

[0120] Conditions:

Evaporator avg temp, °C	-6.68
Condenser avg temp, °C	43.34
Suction temp, °C	18.3
Subcool, °C	0
Compressor efficiency	70%

[0121] The data demonstrates that the presently claimed compositions provide GWP less than 150, Capacity within 20% or 15%, or even 10% of that for R-454C, and COP that is at least 2% higher, or even 3% higher than that for R-454C. Additionally, the compositions provide average temperature glide less than 10 K and reasonable compressor discharge temperatures.

[0122] Broadly, for cooling mode, a composition range of 1.0% to 6.0% of CO2, 1.0% to 96.0% of R-1252ZC, 1.0% to 97.0% of R1234ZEE, and 1.0% to 49.0% of R32 will have a GWP less than 298, a maximum average glide of about 10.0 K, a cooling capacity range that has a deviation range of -45.8% to 37.1% from the cooling capacity of R-454C evaluated with the same conditions set, and the cooling COP range has a deviation range from -1.1% to 6.5% than that of the cooling COP of R-454C evaluated with the same conditions set. Table 1 lists example compositions within the GWP<298 range that have ASHRAE flammability classifications of 2L, 2 and 3.

[0123] Similarly, but a little less broadly for cooling mode, a composition range of 1.0% to 6.0% of CO2, 1.0% to 96.0% of R-1252ZC, 1.0% to 97.0% of R1234ZEE, and 1.0% to 28.0% of R32 will have a GWP less than 150, a maximum average glide

of about 10.0 K, an ASHRAE flammability classification of 2L, 2 and 3, a cooling capacity range has a deviation of -45.8% to 8.1% from the cooling capacity of R-454C evaluated with the same conditions set, and the cooling COP range has a deviation of -0.5% to 6.5% than that of the cooling COP of R-454C evaluated with the same conditions set.

[0124] Preferred blend composition ranges for cooling mode within a composition range of 1.0% to 6.0% of CO2, 16.0% to 85.0% of R-1252ZC, 1.0% to 61.0% of R1234ZEE, and 1.0% to 28.0% of R32 will have a GWP < 150, a maximum average heat exchanger glide of 10.0 K, an ASHRAE flammability classification of 2L, 2 and 3, the minimum and maximum cooling capacities are -10.0% and 8.1% than that of R-454C evaluated at the same conditions set, and the minimum and maximum cooling COP efficiencies are -0.4% and 6.1% than that of R-454C evaluated at the same conditions set.

[0125] Even more preferred blend composition ranges for cooling mode within a composition range of 1.0% to 2.0% of CO2, 16.0% to 19.0% of R-1252ZC, 58.0% to 61.0% of R1234ZEE, and 20.0% to 22.0% of R32 will have a GWP < 150, a maximum average heat exchanger glide of 10.0 K, an ASHRAE flammability classification of 2L, the minimum and maximum cooling capacities are -10.0% and -4.8% than that of R-454C evaluated at the same conditions set, and the minimum and maximum cooling COP efficiencies are 2.7% and 4.7% than that of R-454C evaluated at the same conditions set.

[0126] The composition for the even more preferred maximum cooling capacity, which is -4.8% than that of R-454C, is 2.0 wt-% CO2, 17.0 wt-% R-1252ZC, 59.0 wt-% R1234ZEE and 22.0 wt-% R32, where the COP for cooling is 4.7% than that for R-454C under the same cycle conditions, the maximum average heat exchanger glide is 9.9 K and its ASHRAE flammability classification is 2L.

[0127] The composition for the even more preferred maximum cooling COP efficiency, which is 4.7% than that of R-454C, is 2.0 wt-% CO2, 17.0 wt-% R-1252ZC, 59.0 wt-% R1234ZEE, and 22.0 wt-% R32, where the CAP for cooling is -4.8% than that for R-454C under the same cycle conditions, the maximum average heat exchanger glide is 9.9 K and its ASHRAE flammability classification is 2L.

TABLE 1

W_CO2	W_R-1252ZC	W_R1234ZEE	W_R32	GWP	AVG GLIDE (K)	ASHRAE FLAMMABILITY CLASS	COP DEV from 454C	CAP DEV from 454C	COP DEV from 404A	CAP DEV from 404A
0.01	0.26	0.29	0.44	298	6.6	2L	18.5	1.1	24.1	-8.0
0.01	0.25	0.3	0.44	298	6.7	2L	18.5	1.1	24.1	-8.0
0.01	0.24	0.31	0.44	298	6.8	2L	18.4	1.1	24.0	-8.0
0.01	0.23	0.32	0.44	298	6.8	2L	18.2	1.1	23.8	-8.0
0.01	0.22	0.33	0.44	298	6.9	2L	18.2	1.1	23.8	-8.0
0.01	0.21	0.34	0.44	298	6.9	2L	18	1.1	23.6	-8.0
0.01	0.2	0.35	0.44	298	7	2L	18	1.1	23.6	-8.0
0.01	0.19	0.36	0.44	298	7	2L	17.8	1.1	23.4	-8.0
0.01	0.18	0.37	0.44	298	7.1	2L	17.7	1.1	23.3	-8.0
0.01	0.17	0.38	0.44	298	7.2	2L	17.5	1.1	23.1	-8.0
0.01	0.16	0.39	0.44	298	7.3	2L	17.4	1.1	23.0	-8.0
0.01	0.15	0.4	0.44	298	7.3	2L	17.2	1.1	22.8	-8.0
0.01	0.14	0.41	0.44	298	7.4	2L	17.1	1.1	22.7	-8.0
0.01	0.13	0.42	0.44	298	7.5	2L	17	1.1	22.6	-8.0
0.01	0.12	0.43	0.44	298	7.6	2L	16.8	1.1	22.4	-8.0
0.01	0.11	0.44	0.44	298	7.7	2L	16.7	1.1	22.3	-8.0
0.01	0.1	0.45	0.44	298	7.7	2L	16.4	1.1	21.9	-8.0
0.01	0.09	0.46	0.44	298	7.9	2L	16.4	1.1	21.9	-8.0
0.01	0.08	0.47	0.44	298	8	2L	16.2	1.1	21.7	-8.0
0.01	0.07	0.48	0.44	298	8.1	2L	16	1.1	21.5	-8.0
0.01	0.06	0.49	0.44	298	8.1	2L	15.8	1.2	21.3	-7.9
0.01	0.05	0.5	0.44	298	8.2	2L	15.7	1.2	21.2	-7.9
0.01	0.04	0.51	0.44	298	8.3	2L	15.5	1.2	21.0	-7.9
0.01	0.03	0.52	0.44	298	8.5	2L	15.4	1.2	20.9	-7.9
0.01	0.02	0.53	0.44	298	8.6	2L	15.1	1.2	20.6	-7.9
0.01	0.01	0.54	0.44	298	8.7	2L	15	1.3	20.5	-7.8
0.01	0.27	0.28	0.44	298	6.5	2	18.6	1.1	24.2	-8.0
0.01	0.28	0.27	0.44	298	6.5	2	18.6	1.1	24.2	-8.0
0.01	0.29	0.26	0.44	298	6.4	2	18.7	1.1	24.4	-8.0
0.01	0.3	0.25	0.44	298	6.4	2	18.8	1.1	24.5	-8.0
0.01	0.31	0.24	0.44	298	6.3	2	18.9	1.1	24.6	-8.0
0.01	0.33	0.22	0.44	298	6.2	2	19	1.1	24.7	-8.0
0.01	0.34	0.21	0.44	298	6.2	2	19	1.1	24.7	-8.0
0.01	0.35	0.2	0.44	298	6.2	2	19.1	1.1	24.8	-8.0
0.01	0.36	0.19	0.44	298	6.1	2	19	1.1	24.7	-8.0
0.01	0.37	0.18	0.44	298	6	2	19.1	1.1	24.8	-8.0
0.01	0.38	0.17	0.44	298	6	2	19.2	1.1	24.9	-8.0
0.01	0.39	0.16	0.44	298	6	2	19.2	1.1	24.9	-8.0
0.01	0.4	0.14	0.45	298	6	2	19.2	1.1	24.9	-8.0

W_CO2	W_R-1252ZC	W_R1234ZEE	W_R32	GWP	AVG GLIDE (K)	ASHRAE FLAMMABILITY CLASS	COP DEV from 454C	CAP DEV from 454C	COP DEV from 404A	CAP DEV from 404A
0.01	0.41	0.13	0.45	298	6	2	19.3	1.2	25.0	-7.9
0.01	0.42	0.12	0.45	298	5.9	2	19.3	1.1	25.0	-8.0
0.01	0.43	0.11	0.45	298	5.9	2	19.3	1.1	25.0	-8.0
0.01	0.44	0.1	0.45	298	5.9	2	19.3	1.1	25.0	-8.0
0.01	0.46	0.05	0.48	298	5.9	2	19.3	1.1	25.0	-8.0
0.01	0.47	0.04	0.48	298	5.8	2	19.2	1.1	24.9	-8.0
0.01	0.48	0.03	0.48	298	5.8	2	19.2	1.1	24.9	-8.0
0.01	0.49	0.01	0.49	298	5.8	2	19.3	1.1	25.0	-8.0
0.01	0.5	0.48	0.01	298	5.7	2	19.1	1.1	24.8	-8.0
0.01	0.51	0.46	0.02	298	5.8	2	19.2	1.1	24.9	-8.0
0.01	0.52	0.44	0.03	298	5.7	2	19	1	24.7	-8.1
0.01	0.53	0.42	0.04	298	5.8	2	19	1.1	24.7	-8.0
0.01	0.54	0.4	0.05	298	5.8	2	19	1	24.7	-8.1
0.02	0.25	0.29	0.44	298	7.1	2L	21.2	0.7	27.0	-8.4
0.02	0.24	0.3	0.44	298	7.2	2L	21.1	0.7	26.9	-8.4
0.02	0.23	0.31	0.44	298	7.2	2L	21	0.7	26.8	-8.4
0.02	0.22	0.32	0.44	298	7.3	2L	20.9	0.6	26.7	-8.5
0.02	0.21	0.33	0.44	298	7.3	2L	20.7	0.6	26.4	-8.5
0.02	0.2	0.34	0.44	298	7.4	2L	20.7	0.6	26.4	-8.5
0.02	0.19	0.35	0.44	298	7.5	2L	20.6	0.6	26.3	-8.5
0.02	0.18	0.36	0.44	298	7.6	2L	20.5	0.6	26.2	-8.5
0.02	0.17	0.37	0.44	298	7.6	2L	20.3	0.6	26.0	-8.5
0.02	0.16	0.38	0.44	298	7.7	2L	20.3	0.6	26.0	-8.5
0.02	0.15	0.39	0.44	298	7.8	2L	20.2	0.6	25.9	-8.5
0.02	0.14	0.4	0.44	298	7.9	2L	25.3	4	31.3	-5.4
0.02	0.13	0.41	0.44	298	8	2L	25.2	4	31.2	-5.4
0.02	0.12	0.42	0.44	298	8.1	2L	19.8	0.7	25.5	-8.4
0.02	0.11	0.43	0.44	298	8.2	2L	19.6	0.6	25.3	-8.5
0.02	0.1	0.44	0.44	298	8.3	2L	19.4	0.7	25.1	-8.4
0.02	0.09	0.45	0.44	298	8.3	2L	19.2	0.6	24.9	-8.5
0.02	0.08	0.46	0.44	298	8.5	2L	19.1	0.7	24.8	-8.4
0.02	0.07	0.47	0.44	298	8.6	2L	19	0.7	24.7	-8.4
0.02	0.06	0.48	0.44	298	8.6	2L	18.7	0.7	24.4	-8.4
0.02	0.05	0.49	0.44	298	8.8	2L	18.6	0.7	24.2	-8.4
0.02	0.04	0.5	0.44	298	8.9	2L	18.5	0.7	24.1	-8.4
0.02	0.03	0.51	0.44	298	9	2L	18.3	0.7	23.9	-8.4
0.02	0.02	0.52	0.44	298	9.1	2L	18.1	0.7	23.7	-8.4
0.02	0.01	0.53	0.44	298	9.2	2L	17.9	0.8	23.5	-8.3
0.02	0.26	0.28	0.44	298	7	2	21.2	0.6	27.0	-8.5
0.02	0.27	0.27	0.44	298	7	2	21.3	0.6	27.1	-8.5
0.02	0.28	0.26	0.44	298	6.9	2	21.4	0.7	27.2	-8.4

W_CO2	W_R-1252ZC	W_R1234ZEE	W_R32	GWP	AVG GLIDE (K)	ASHRAE FLAMMABILITY CLASS	COP DEV from 454C	CAP DEV from 454C	COP DEV from 404A	CAP DEV from 404A
0.02	0.29	0.25	0.44	298	6.9	2	21.5	0.7	27.3	-8.4
0.02	0.3	0.24	0.44	298	6.8	2	21.6	0.7	27.4	-8.4
0.02	0.31	0.23	0.44	298	6.8	2	21.6	0.7	27.4	-8.4
0.02	0.32	0.22	0.44	298	6.7	2	21.6	0.7	27.4	-8.4
0.02	0.33	0.21	0.44	298	6.7	2	21.7	0.7	27.5	-8.4
0.02	0.34	0.2	0.44	298	6.7	2	21.7	0.7	27.5	-8.4
0.02	0.35	0.19	0.44	298	6.6	2	21.8	0.7	27.6	-8.4
0.02	0.36	0.18	0.44	298	6.6	2	21.8	0.7	27.6	-8.4
0.02	0.37	0.17	0.44	298	6.5	2	21.8	0.7	27.6	-8.4
0.02	0.38	0.15	0.45	298	6.5	2	21.8	0.7	27.6	-8.4
0.02	0.39	0.13	0.46	298	6.5	2	22	0.7	27.8	-8.4
0.02	0.4	0.12	0.46	298	6.4	2	21.9	0.7	27.7	-8.4
0.02	0.41	0.11	0.46	298	6.4	2	21.9	0.7	27.7	-8.4
0.02	0.42	0.1	0.46	298	6.4	2	21.9	0.7	27.7	-8.4
0.02	0.44	0.08	0.46	298	6.3	2	21.9	0.7	27.7	-8.4
0.02	0.45	0.07	0.46	298	6.3	2	21.9	0.7	27.7	-8.4
0.02	0.46	0.06	0.46	298	6.3	2	21.8	0.7	27.6	-8.4
0.02	0.47	0.05	0.46	298	6.3	2	21.8	0.7	27.6	-8.4
0.02	0.48	0.04	0.46	298	6.3	2	26.1	3.4	32.1	-5.9
0.02	0.49	0.03	0.46	298	6.3	2	21.9	0.7	27.7	-8.4
0.02	0.5	0.02	0.46	298	6.2	2	21.7	0.7	27.5	-8.4
0.02	0.51	0.01	0.46	298	6.2	2	21.6	0.6	27.4	-8.5
0.02	0.53	0.44	0.01	298	6.2	2	21.5	0.6	27.3	-8.5
0.03	0.24	0.29	0.44	298	7.6	2L	23.9	0.2	29.8	-8.8
0.03	0.23	0.3	0.44	298	7.7	2L	23.9	0.2	29.8	-8.8
0.03	0.22	0.31	0.44	298	7.7	2L	23.7	0.2	29.6	-8.8
0.03	0.21	0.32	0.44	298	7.8	2L	23.7	0.2	29.6	-8.8
0.03	0.2	0.33	0.44	298	7.9	2L	23.6	0.2	29.5	-8.8
0.03	0.19	0.34	0.44	298	7.9	2L	23.4	0.2	29.3	-8.8
0.03	0.18	0.35	0.44	298	8.1	2L	23.5	0.2	29.4	-8.8
0.03	0.17	0.36	0.44	298	8.1	2L	23.3	0.2	29.2	-8.8
0.03	0.16	0.37	0.44	298	8.2	2L	23.2	0.2	29.1	-8.8
0.03	0.15	0.38	0.44	298	8.3	2L	23.1	0.2	29.0	-8.8
0.03	0.14	0.39	0.44	298	8.4	2L	23	0.2	28.9	-8.8
0.03	0.13	0.4	0.44	298	8.5	2L	22.8	0.2	28.6	-8.8
0.03	0.12	0.41	0.44	298	8.5	2L	22.7	0.2	28.5	-8.8
0.03	0.11	0.42	0.44	298	8.6	2L	22.5	0.2	28.3	-8.8
0.03	0.1	0.43	0.44	298	8.7	2L	22.4	0.2	28.2	-8.8
0.03	0.09	0.44	0.44	298	8.9	2L	22.3	0.2	28.1	-8.8
0.03	0.08	0.45	0.44	298	8.9	2L	22.1	0.2	27.9	-8.8
0.03	0.07	0.46	0.44	298	9	2L	21.9	0.2	27.7	-8.8

W_CO2	W_R-1252ZC	W_R1234ZEE	W_R32	GWP	AVG GLIDE (K)	ASHRAE FLAMMABILITY CLASS	COP DEV from 454C	CAP DEV from 454C	COP DEV from 404A	CAP DEV from 404A
0.03	0.06	0.47	0.44	298	9.2	2L	21.9	0.3	27.7	-8.7
0.03	0.05	0.48	0.44	298	9.2	2L	21.6	0.2	27.4	-8.8
0.03	0.04	0.49	0.44	298	9.4	2L	21.5	0.2	27.3	-8.8
0.03	0.03	0.5	0.44	298	9.4	2L	21.2	0.2	27.0	-8.8
0.03	0.02	0.51	0.44	298	9.6	2L	21.2	0.3	27.0	-8.7
0.03	0.01	0.52	0.44	298	9.7	2L	21	0.3	26.8	-8.7
0.03	0.25	0.28	0.44	298	7.6	2	24	0.2	29.9	-8.8
0.03	0.26	0.27	0.44	298	7.5	2	24.1	0.2	30.0	-8.8
0.03	0.27	0.26	0.44	298	7.4	2	24.2	0.2	30.1	-8.8
0.03	0.28	0.25	0.44	298	7.3	2	24.1	0.2	30.0	-8.8
0.03	0.29	0.23	0.45	298	7.4	2	24.3	0.3	30.2	-8.7
0.03	0.3	0.22	0.45	298	7.3	2	24.3	0.3	30.2	-8.7
0.03	0.31	0.21	0.45	298	7.3	2	24.4	0.3	30.3	-8.7
0.03	0.32	0.2	0.45	298	7.1	2	24.3	0.2	30.2	-8.8
0.03	0.33	0.19	0.45	298	7.1	2	24.4	0.3	30.3	-8.7
0.03	0.34	0.18	0.45	298	7.1	2	29.7	3.5	35.9	-5.8
0.03	0.35	0.17	0.45	298	7	2	24.5	0.3	30.4	-8.7
0.03	0.36	0.16	0.45	298	7	2	24.5	0.3	30.4	-8.7
0.03	0.37	0.15	0.45	298	7	2	24.5	0.3	30.4	-8.7
0.03	0.38	0.14	0.45	298	6.9	2	24.6	0.3	30.5	-8.7
0.03	0.39	0.13	0.45	298	6.9	2	24.6	0.3	30.5	-8.7
0.03	0.4	0.12	0.45	298	6.9	2	24.6	0.3	30.5	-8.7
0.03	0.41	0.11	0.45	298	6.8	2	24.5	0.3	30.4	-8.7
0.03	0.42	0.1	0.45	298	6.8	2	24.5	0.3	30.4	-8.7
0.03	0.43	0.09	0.45	298	6.8	2	24.5	0.3	30.4	-8.7
0.03	0.44	0.08	0.45	298	6.8	2	24.5	0.3	30.4	-8.7
0.03	0.45	0.07	0.45	298	6.8	2	24.6	0.3	30.5	-8.7
0.03	0.46	0.06	0.45	298	6.7	2	24.5	0.3	30.4	-8.7
0.03	0.47	0.05	0.45	298	6.7	2	24.5	0.3	30.4	-8.7
0.03	0.48	0.04	0.45	298	6.7	2	24.4	0.3	30.3	-8.7
0.03	0.49	0.03	0.45	298	6.7	2	24.3	0.2	30.2	-8.8
0.03	0.5	0.02	0.45	298	6.7	2	24.2	0.2	30.1	-8.8
0.03	0.51	0.01	0.45	298	6.7	2	24.3	0.3	30.2	-8.7
0.04	0.23	0.29	0.44	298	8.1	2L	26.7	-0.2	32.7	-9.2
0.04	0.22	0.3	0.44	298	8.2	2L	26.6	-0.2	32.6	-9.2
0.04	0.21	0.31	0.44	298	8.2	2L	26.6	-0.2	32.6	-9.2
0.04	0.2	0.32	0.44	298	8.3	2L	26.5	-0.2	32.5	-9.2
0.04	0.19	0.33	0.44	298	8.4	2L	26.4	-0.2	32.4	-9.2
0.04	0.18	0.34	0.44	298	8.5	2L	30.1	2	36.3	-7.2
0.04	0.17	0.35	0.44	298	8.6	2L	26.2	-0.2	32.2	-9.2
0.04	0.16	0.36	0.44	298	8.7	2L	29.9	2	36.1	-7.2

W_CO2	W_R-1252ZC	W_R1234ZEE	W_R32	GWP	AVG GLIDE (K)	ASHRAE FLAMMABILITY CLASS	COP DEV from 454C	CAP DEV from 454C	COP DEV from 404A	CAP DEV from 404A
0.04	0.15	0.37	0.44	298	8.7	2L	26	-0.2	32.0	-9.2
0.04	0.14	0.38	0.44	298	8.8	2L	25.9	-0.2	31.9	-9.2
0.04	0.13	0.39	0.44	298	8.9	2L	25.7	-0.3	31.7	-9.3
0.04	0.12	0.4	0.44	298	9	2L	25.7	-0.2	31.7	-9.2
0.04	0.11	0.41	0.44	298	9.1	2L	25.5	-0.2	31.5	-9.2
0.04	0.1	0.42	0.44	298	9.2	2L	25.4	-0.2	31.4	-9.2
0.04	0.09	0.43	0.44	298	9.3	2L	25.3	-0.2	31.3	-9.2
0.04	0.08	0.44	0.44	298	9.4	2L	25.1	-0.2	31.1	-9.2
0.04	0.07	0.45	0.44	298	9.5	2L	25	-0.2	31.0	-9.2
0.04	0.06	0.46	0.44	298	9.6	2L	24.7	-0.3	30.6	-9.3
0.04	0.05	0.47	0.44	298	9.7	2L	24.6	-0.3	30.5	-9.3
0.04	0.04	0.48	0.44	298	9.8	2L	24.5	-0.2	30.4	-9.2
0.04	0.03	0.49	0.44	298	10	2L	24.4	-0.2	30.3	-9.2
0.04	0.24	0.28	0.44	298	8	2	26.8	-0.2	32.8	-9.2
0.04	0.25	0.27	0.44	298	7.9	2	26.8	-0.2	32.8	-9.2
0.04	0.26	0.26	0.44	298	7.9	2	26.9	-0.2	32.9	-9.2
0.04	0.27	0.25	0.44	298	7.9	2	27	-0.2	33.0	-9.2
0.04	0.28	0.24	0.44	298	7.8	2	27.1	-0.2	33.2	-9.2
0.04	0.29	0.23	0.44	298	7.8	2	27.2	-0.1	33.3	-9.1
0.04	0.3	0.22	0.44	298	7.7	2	27.1	-0.2	33.2	-9.2
0.04	0.31	0.21	0.44	298	7.6	2	27.2	-0.2	33.3	-9.2
0.04	0.33	0.19	0.44	298	7.6	2	27.2	-0.2	33.3	-9.2
0.04	0.34	0.18	0.44	298	7.5	2	33.1	3.4	39.4	-5.9
0.04	0.35	0.17	0.44	298	7.5	2	27.2	-0.1	33.3	-9.1
0.04	0.36	0.16	0.44	298	7.4	2	27.3	-0.1	33.4	-9.1
0.04	0.37	0.15	0.44	298	7.4	2	27.3	-0.1	33.4	-9.1
0.04	0.38	0.13	0.45	298	7.4	2	27.3	-0.1	33.4	-9.1
0.04	0.39	0.12	0.45	298	7.3	2	27.3	-0.1	33.4	-9.1
0.04	0.4	0.11	0.45	298	7.3	2	27.3	-0.1	33.4	-9.1
0.04	0.41	0.1	0.45	298	7.2	2	27.2	-0.2	33.3	-9.2
0.04	0.42	0.09	0.45	298	7.2	2	27.2	-0.1	33.3	-9.1
0.04	0.43	0.08	0.45	298	7.2	2	27.2	-0.1	33.3	-9.1
0.04	0.44	0.07	0.45	298	7.2	2	27.2	-0.1	33.3	-9.1
0.04	0.45	0.06	0.45	298	7.2	2	27.1	-0.1	33.2	-9.1
0.04	0.46	0.05	0.45	298	7.2	2	27.1	-0.2	33.2	-9.2
0.04	0.47	0.04	0.45	298	7.1	2	27.1	-0.2	33.2	-9.2
0.04	0.48	0.03	0.45	298	7.2	2	27.1	-0.1	33.2	-9.1
0.04	0.49	0.02	0.45	298	7.1	2	26.8	-0.2	32.8	-9.2
0.04	0.5	0.01	0.45	298	7.2	2	27	-0.2	33.0	-9.2
0.05	0.22	0.29	0.44	298	8.6	2L	29.6	-0.6	35.8	-9.6
0.05	0.21	0.3	0.44	298	8.7	2L	29.6	-0.6	35.8	-9.6

W_CO2	W_R-1252ZC	W_R1234ZEE	W_R32	GWP	AVG GLIDE (K)	ASHRAE FLAMMABILITY CLASS	COP DEV from 454C	CAP DEV from 454C	COP DEV from 404A	CAP DEV from 404A
0.05	0.2	0.31	0.44	298	8.8	2L	29.5	-0.6	35.7	-9.6
0.05	0.19	0.32	0.44	298	8.8	2L	29.4	-0.6	35.6	-9.6
0.05	0.18	0.33	0.44	298	8.9	2L	29.2	-0.6	35.4	-9.6
0.05	0.17	0.34	0.44	298	9	2L	29.2	-0.7	35.4	-9.6
0.05	0.16	0.35	0.44	298	9	2L	29.1	-0.7	35.2	-9.6
0.05	0.15	0.36	0.44	298	9.1	2L	28.9	-0.7	35.0	-9.6
0.05	0.14	0.37	0.44	298	9.2	2L	28.8	-0.7	34.9	-9.6
0.05	0.13	0.38	0.44	298	9.3	2L	28.8	-0.7	34.9	-9.6
0.05	0.12	0.39	0.44	298	9.4	2L	28.6	-0.7	34.7	-9.6
0.05	0.11	0.4	0.44	298	9.5	2L	28.5	-0.7	34.6	-9.6
0.05	0.1	0.41	0.44	298	9.6	2L	28.4	-0.7	34.5	-9.6
0.05	0.09	0.42	0.44	298	9.7	2L	28.2	-0.7	34.3	-9.6
0.05	0.08	0.43	0.44	298	9.8	2L	28.2	-0.7	34.3	-9.6
0.05	0.07	0.44	0.44	298	9.9	2L	28	-0.7	34.1	-9.6
0.05	0.23	0.28	0.44	298	8.5	2	29.6	-0.6	35.8	-9.6
0.05	0.24	0.27	0.44	298	8.5	2	29.8	-0.6	36.0	-9.6
0.05	0.25	0.26	0.44	298	8.4	2	29.7	-0.6	35.9	-9.6
0.05	0.26	0.25	0.44	298	8.3	2	29.8	-0.6	36.0	-9.6
0.05	0.27	0.24	0.44	298	8.3	2	29.8	-0.6	36.0	-9.6
0.05	0.28	0.23	0.44	298	8.2	2	29.9	-0.6	36.1	-9.6
0.05	0.29	0.22	0.44	298	8.2	2	29.9	-0.6	36.1	-9.6
0.05	0.3	0.21	0.44	298	8.1	2	30	-0.6	36.2	-9.6
0.05	0.31	0.2	0.44	298	8	2	30	-0.6	36.2	-9.6
0.05	0.32	0.19	0.44	298	8	2	30.1	-0.5	36.3	-9.5
0.05	0.33	0.18	0.44	298	8	2	30	-0.6	36.2	-9.6
0.05	0.34	0.17	0.44	298	7.9	2	30	-0.6	36.2	-9.6
0.05	0.35	0.16	0.44	298	7.8	2	29.9	-0.6	36.1	-9.6
0.05	0.36	0.15	0.44	298	7.8	2	29.9	-0.6	36.1	-9.6
0.05	0.37	0.14	0.44	298	7.8	2	30	-0.6	36.2	-9.6
0.05	0.38	0.13	0.44	298	7.8	2	30	-0.5	36.2	-9.5
0.05	0.39	0.12	0.44	298	7.7	2	30	-0.5	36.2	-9.5
0.05	0.4	0.11	0.44	298	7.7	2	29.9	-0.6	36.1	-9.6
0.05	0.41	0.1	0.44	298	7.7	2	30	-0.5	36.2	-9.5
0.05	0.42	0.08	0.45	298	7.6	2	29.9	-0.6	36.1	-9.6
0.05	0.43	0.07	0.45	298	7.7	2	30	-0.5	36.2	-9.5
0.05	0.44	0.06	0.45	298	7.6	2	29.9	-0.6	36.1	-9.6
0.05	0.45	0.05	0.45	298	7.5	2	29.7	-0.6	35.9	-9.6
0.05	0.46	0.04	0.45	298	7.5	2	29.6	-0.6	35.8	-9.6
0.05	0.47	0.03	0.45	298	7.6	2	29.7	-0.6	35.9	-9.6
0.05	0.48	0.02	0.45	298	7.5	2	29.6	-0.6	35.8	-9.6
0.05	0.49	0.01	0.45	298	7.5	2	29.6	-0.6	35.8	-9.6

W_CO2	W_R-1252ZC	W_R1234ZEE	W_R32	GWP	AVG GLIDE (K)	ASHRAE FLAMMABILITY CLASS	COP DEV from 454C	CAP DEV from 454C	COP DEV from 404A	CAP DEV from 404A
0.06	0.21	0.29	0.44	298	9	2L	32.4	-1	38.7	-9.9
0.06	0.2	0.3	0.44	298	9.1	2L	32.3	-1	38.6	-9.9
0.06	0.19	0.31	0.44	298	9.2	2L	32.3	-1.1	38.6	-10.0
0.06	0.18	0.32	0.44	298	9.3	2L	32.2	-1.1	38.5	-10.0
0.06	0.17	0.33	0.44	298	9.3	2L	32	-1.1	38.3	-10.0
0.06	0.16	0.34	0.44	298	9.4	2L	32.1	-1.1	38.4	-10.0
0.06	0.15	0.35	0.44	298	9.5	2L	31.9	-1.1	38.2	-10.0
0.06	0.14	0.36	0.44	298	9.6	2L	31.9	-1.1	38.2	-10.0
0.06	0.13	0.37	0.44	298	9.7	2L	31.7	-1.1	38.0	-10.0
0.06	0.12	0.38	0.44	298	9.8	2L	31.6	-1.1	37.9	-10.0
0.06	0.11	0.39	0.44	298	9.9	2L	31.6	-1.1	37.9	-10.0
0.06	0.22	0.28	0.44	298	9	2	32.5	-1	38.8	-9.9
0.06	0.23	0.27	0.44	298	8.9	2	32.5	-1	38.8	-9.9
0.06	0.24	0.26	0.44	298	8.8	2	32.5	-1	38.8	-9.9
0.06	0.25	0.25	0.44	298	8.8	2	32.6	-1	38.9	-9.9
0.06	0.26	0.24	0.44	298	8.7	2	32.7	-1	39.0	-9.9
0.06	0.28	0.22	0.44	298	8.6	2	37.1	1.5	43.6	-7.6
0.06	0.29	0.21	0.44	298	8.5	2	32.8	-1	39.1	-9.9
0.06	0.3	0.2	0.44	298	8.5	2	32.8	-1	39.1	-9.9
0.06	0.31	0.19	0.44	298	8.4	2	32.8	-1	39.1	-9.9
0.06	0.32	0.18	0.44	298	8.4	2	32.8	-1	39.1	-9.9
0.06	0.33	0.17	0.44	298	8.3	2	32.8	-1	39.1	-9.9
0.06	0.34	0.16	0.44	298	8.3	2	32.9	-0.9	39.2	-9.8
0.06	0.35	0.15	0.44	298	8.3	2	32.9	-0.9	39.2	-9.8
0.06	0.36	0.14	0.44	298	8.3	2	32.9	-0.9	39.2	-9.8
0.06	0.37	0.13	0.44	298	8.2	2	32.8	-1	39.1	-9.9
0.06	0.38	0.12	0.44	298	8.1	2	32.8	-1	39.1	-9.9
0.06	0.39	0.11	0.44	298	8.1	2	32.7	-1	39.0	-9.9
0.06	0.4	0.09	0.45	298	8.1	2	32.7	-1	39.0	-9.9
0.06	0.41	0.08	0.45	298	8.1	2	32.7	-1	39.0	-9.9
0.06	0.42	0.07	0.45	298	8	2	32.5	-1	38.8	-9.9
0.06	0.43	0.06	0.45	298	8	2	32.6	-1	38.9	-9.9
0.06	0.44	0.05	0.45	298	8	2	32.5	-1	38.8	-9.9
0.06	0.45	0.04	0.45	298	8	2	32.6	-0.9	38.9	-9.8
0.06	0.46	0.03	0.45	298	8	2	32.4	-1	38.7	-9.9
0.06	0.47	0.02	0.45	298	8	2	36.4	1.3	42.9	-7.8
0.06	0.48	0.01	0.45	298	7.9	2	32.3	-1	38.6	-9.9
0.06	0.44	0.45	0.05	28	9.8	3	-16.8	2.3	-12.8	-6.9
0.01	0.33	0.38	0.28	190	7.7	2	0.2	2.7	5.0	-6.6
0.01	0.96	0.01	0.02	8	1.7	3	-27.8	6	-24.4	-3.6
0.02	0.01	0.9	0.07	48	8.7	2L	-33.5	3.4	-30.3	-5.9

W_CO2	W_R-1252ZC	W_R1234ZEE	W_R32	GWP	AVG GLIDE (K)	ASHRAE FLAMMABILITY CLASS	COP DEV from 454C	CAP DEV from 454C	COP DEV from 404A	CAP DEV from 404A
0.01	0.01	0.97	0.01	8	3.3	2L	-45.8	5.1	-43.2	-4.4
0.02	0.62	0.01	0.35	224	6.9	2	10	1.8	15.2	-7.4
0.03	0.82	0.14	0.01	1	4	3	-25.3	4.7	-21.7	-4.7
0.01	0.28	0.55	0.16	109	7.7	2	-13.2	6.5	-9.1	-3.1
0.03	0.24	0.5	0.23	156	10	2	-1.9	2.2	2.8	-7.0
0.02	0.13	0.42	0.43	292	8.2	2L	18.7	0.7	24.4	-8.4
0.06	0.53	0.09	0.32	211	9.4	2	18.4	0.5	24.0	-8.6
0.05	0.52	0.36	0.07	42	8.6	3	-15.6	2.8	-11.6	-6.5
0.01	0.19	0.58	0.22	150	8.8	2L	-9.8	3.2	-5.5	-6.1
0.01	0.18	0.59	0.22	150	8.9	2L	-10	3.2	-5.7	-6.1
0.01	0.17	0.6	0.22	150	9	2L	-10.2	3.2	-5.9	-6.1
0.01	0.16	0.61	0.22	150	9.1	2L	-10.3	3.2	-6.0	-6.1
0.01	0.15	0.62	0.22	150	9.2	2L	-10.6	3.2	-6.3	-6.1
0.01	0.14	0.63	0.22	150	9.3	2L	-10.7	3.2	-6.4	-6.1
0.01	0.13	0.64	0.22	150	9.4	2L	-11	3.2	-6.8	-6.1
0.01	0.12	0.65	0.22	150	9.4	2L	-11.2	3.2	-7.0	-6.1
0.01	0.11	0.66	0.22	150	9.5	2L	-11.4	3.2	-7.2	-6.1
0.01	0.1	0.67	0.22	150	9.6	2L	-11.6	3.2	-7.4	-6.1
0.01	0.09	0.68	0.22	150	9.7	2L	-11.9	3.2	-7.7	-6.1
0.01	0.08	0.69	0.22	150	9.8	2L	-12	3.3	-7.8	-6.0
0.01	0.07	0.7	0.22	150	9.9	2L	-12.3	3.3	-8.1	-6.0
0.01	0.06	0.71	0.22	150	10	2L	-12.6	3.3	-8.4	-6.0
0.01	0.2	0.57	0.22	150	8.7	2	-9.6	3.2	-5.3	-6.1
0.01	0.21	0.56	0.22	150	8.6	2	-9.5	3.2	-5.2	-6.1
0.01	0.23	0.54	0.22	150	8.5	2	-9.1	3.2	-4.8	-6.1
0.01	0.24	0.53	0.22	150	8.4	2	-8.9	3.2	-4.6	-6.1
0.01	0.25	0.52	0.22	150	8.3	2	-8.7	3.2	-4.4	-6.1
0.01	0.26	0.51	0.22	150	8.3	2	-8.6	3.2	-4.2	-6.1
0.01	0.27	0.5	0.22	150	8.2	2	-8.4	3.2	-4.0	-6.1
0.01	0.28	0.49	0.22	150	8.1	2	-8.2	3.2	-3.8	-6.1
0.01	0.3	0.47	0.22	150	8	2	-7.9	3.2	-3.5	-6.1
0.01	0.31	0.46	0.22	150	7.9	2	-7.8	3.3	-3.4	-6.0
0.01	0.32	0.45	0.22	150	7.8	2	-7.6	3.3	-3.2	-6.0
0.01	0.33	0.44	0.22	150	7.7	2	-7.5	3.3	-3.1	-6.0
0.01	0.34	0.43	0.22	150	7.7	2	-4.2	5.9	0.4	-3.6
0.01	0.35	0.42	0.22	150	7.6	2	-7.2	3.3	-2.8	-6.0
0.01	0.37	0.4	0.22	150	7.5	2	-7	3.3	-2.6	-6.0
0.01	0.39	0.37	0.23	150	7.3	2	-6.7	3.3	-2.3	-6.0
0.01	0.4	0.36	0.23	150	7.3	2	-6.6	3.3	-2.2	-6.0
0.01	0.41	0.35	0.23	150	7.3	2	-3.4	5.8	1.2	-3.7
0.01	0.42	0.34	0.23	150	7.2	2	-6.4	3.4	-1.9	-5.9

W_CO2	W_R-1252ZC	W_R1234ZEE	W_R32	GWP	AVG GLIDE (K)	ASHRAE FLAMMABILITY CLASS	COP DEV from 454C	CAP DEV from 454C	COP DEV from 404A	CAP DEV from 404A
0.01	0.43	0.33	0.23	150	7.1	2	-3.2	5.8	1.4	-3.7
0.01	0.44	0.32	0.23	150	7	2	-6.2	3.3	-1.7	-6.0
0.01	0.45	0.28	0.26	150	7	2	-6.1	3.4	-1.6	-5.9
0.01	0.46	0.27	0.26	150	6.9	2	-6	3.4	-1.5	-5.9
0.01	0.47	0.26	0.26	150	6.9	2	-5.9	3.4	-1.4	-5.9
0.01	0.48	0.24	0.27	150	6.8	2	-5.8	3.4	-1.3	-5.9
0.01	0.49	0.23	0.27	150	6.8	2	-5.7	3.4	-1.2	-5.9
0.01	0.51	0.2	0.28	150	6.7	2	-5.5	3.4	-1.0	-5.9
0.01	0.52	0.19	0.28	150	6.6	2	-5.4	3.4	-0.9	-5.9
0.01	0.53	0.18	0.28	150	6.6	2	-5.3	3.5	-0.8	-5.8
0.01	0.54	0.17	0.28	150	6.5	2	-5.3	3.5	-0.8	-5.8
0.01	0.55	0.16	0.28	150	6.5	2	-5.2	3.5	-0.7	-5.8
0.01	0.56	0.15	0.28	150	6.5	2	-5.1	3.5	-0.6	-5.8
0.01	0.57	0.14	0.28	150	6.4	2	-5.1	3.5	-0.6	-5.8
0.01	0.58	0.13	0.28	150	6.4	2	-5	3.5	-0.5	-5.8
0.01	0.59	0.12	0.28	150	6.3	2	-5	3.5	-0.5	-5.8
0.01	0.6	0.11	0.28	150	6.3	3	-4.9	3.5	-0.4	-5.8
0.01	0.61	0.1	0.28	150	6.3	3	-4.9	3.5	-0.4	-5.8
0.01	0.62	0.09	0.28	150	6.3	3	-2.1	5.7	2.6	-3.8
0.01	0.63	0.08	0.28	150	6.2	3	-2.1	5.7	2.6	-3.8
0.01	0.64	0.07	0.28	150	6.2	3	-4.7	3.5	-0.2	-5.8
0.01	0.65	0.06	0.28	150	6.2	3	-4.6	3.5	-0.1	-5.8
0.01	0.66	0.05	0.28	150	6.1	3	-4.7	3.5	-0.2	-5.8
0.01	0.67	0.04	0.28	150	6.1	3	-4.6	3.5	-0.1	-5.8
0.01	0.68	0.03	0.28	150	6.1	3	-4.6	3.5	-0.1	-5.8
0.01	0.69	0.02	0.28	150	6	3	-4.6	3.5	-0.1	-5.8
0.01	0.7	0.01	0.28	150	6.1	3	-4.6	3.5	-0.1	-5.8
0.01	0.72	0.26	0.01	150	6	3	-4.6	3.5	-0.1	-5.8
0.01	0.73	0.24	0.02	150	6	3	-4.6	3.4	-0.1	-5.9
0.01	0.74	0.22	0.03	150	6	3	-4.5	3.5	0.0	-5.8
0.01	0.75	0.2	0.04	150	5.9	3	-4.6	3.4	-0.1	-5.9
0.01	0.76	0.18	0.05	150	6	3	-4.6	3.4	-0.1	-5.9
0.02	0.17	0.59	0.22	150	9.9	2L	-4.8	4.7	-0.3	-4.7
0.02	0.18	0.58	0.22	150	9.8	2L	-7.1	2.7	-2.7	-6.6
0.02	0.16	0.6	0.22	150	10	2L	-7.5	2.7	-3.1	-6.6
0.02	0.19	0.57	0.22	150	9.6	2	-7	2.7	-2.6	-6.6
0.02	0.2	0.56	0.22	150	9.6	2	-6.7	2.8	-2.3	-6.5
0.02	0.21	0.55	0.22	150	9.5	2	-6.6	2.7	-2.2	-6.6
0.02	0.22	0.54	0.22	150	9.4	2	-6.4	2.7	-1.9	-6.6
0.02	0.23	0.53	0.22	150	9.3	2	-6.3	2.7	-1.8	-6.6
0.02	0.24	0.52	0.22	150	9.2	2	-6.1	2.7	-1.6	-6.6

W_CO2	W_R-1252ZC	W_R1234ZEE	W_R32	GWP	AVG GLIDE (K)	ASHRAE FLAMMABILITY CLASS	COP DEV from 454C	CAP DEV from 454C	COP DEV from 404A	CAP DEV from 404A
0.02	0.25	0.51	0.22	150	9.2	2	-3.6	4.6	1.0	-4.8
0.02	0.26	0.5	0.22	150	9.1	2	-5.7	2.8	-1.2	-6.5
0.02	0.27	0.49	0.22	150	9	2	-5.6	2.8	-1.1	-6.5
0.02	0.28	0.48	0.22	150	8.9	2	-5.5	2.8	-1.0	-6.5
0.02	0.29	0.47	0.22	150	8.8	2	-5.3	2.8	-0.8	-6.5
0.02	0.3	0.46	0.22	150	8.8	2	-5.2	2.8	-0.7	-6.5
0.02	0.31	0.45	0.22	150	8.7	2	-5	2.8	-0.5	-6.5
0.02	0.32	0.44	0.22	150	8.6	2	-4.9	2.8	-0.4	-6.5
0.02	0.33	0.43	0.22	150	8.5	2	-4.8	2.8	-0.3	-6.5
0.02	0.34	0.42	0.22	150	8.5	2	-4.6	2.8	-0.1	-6.5
0.02	0.35	0.41	0.22	150	8.4	2	-4.5	2.8	0.0	-6.5
0.02	0.36	0.4	0.22	150	8.3	2	-4.4	2.8	0.2	-6.5
0.02	0.37	0.38	0.23	150	8.3	2	-2.1	4.5	2.6	-4.9
0.02	0.38	0.36	0.24	150	8.2	2	-4.1	2.9	0.5	-6.4
0.02	0.39	0.35	0.24	150	8.1	2	-4	2.9	0.6	-6.4
0.02	0.4	0.34	0.24	150	8.1	2	-3.8	2.9	0.8	-6.4
0.02	0.41	0.33	0.24	150	8	2	-3.8	2.9	0.8	-6.4
0.02	0.42	0.32	0.24	150	7.9	2	-3.7	2.9	0.9	-6.4
0.02	0.43	0.31	0.24	150	7.9	2	-3.6	2.9	1.0	-6.4
0.02	0.44	0.3	0.24	150	7.8	2	-3.5	2.9	1.1	-6.4
0.02	0.45	0.29	0.24	150	7.7	2	-3.4	2.9	1.2	-6.4
0.02	0.46	0.28	0.24	150	7.7	2	-3.3	2.9	1.3	-6.4
0.02	0.47	0.27	0.24	150	7.6	2	-3.2	2.9	1.4	-6.4
0.02	0.48	0.26	0.24	150	7.6	2	-3.1	3	1.5	-6.3
0.02	0.49	0.25	0.24	150	7.5	2	-3	3	1.6	-6.3
0.02	0.5	0.24	0.24	150	7.4	2	-3	2.9	1.6	-6.4
0.02	0.51	0.23	0.24	150	7.4	2	-2.9	3	1.7	-6.3
0.02	0.52	0.22	0.24	150	7.4	2	-2.8	3	1.8	-6.3
0.02	0.53	0.21	0.24	150	7.3	2	-2.7	3	1.9	-6.3
0.02	0.54	0.2	0.24	150	7.3	2	-2.7	3	1.9	-6.3
0.02	0.55	0.19	0.24	150	7.2	2	-2.6	3	2.0	-6.3
0.02	0.56	0.18	0.24	150	7.2	2	-2.6	3	2.0	-6.3
0.02	0.57	0.17	0.24	150	7.2	2	-2.5	3	2.1	-6.3
0.02	0.58	0.16	0.24	150	7.2	2	0.9	5.6	5.7	-3.9
0.02	0.59	0.15	0.24	150	7.1	2	-2.4	3	2.2	-6.3
0.02	0.6	0.14	0.24	150	7	3	-2.4	3	2.2	-6.3
0.02	0.61	0.13	0.24	150	7	3	-2.4	3	2.2	-6.3
0.02	0.62	0.12	0.24	150	7	3	-2.3	3	2.4	-6.3
0.02	0.63	0.11	0.24	150	6.9	3	-2.3	3	2.4	-6.3
0.02	0.64	0.1	0.24	150	6.9	3	-2.2	3	2.5	-6.3
0.02	0.65	0.09	0.24	150	6.9	3	-2.2	3	2.5	-6.3

W_CO2	W_R-1252ZC	W_R1234ZEE	W_R32	GWP	AVG GLIDE (K)	ASHRAE FLAMMABILITY CLASS	COP DEV from 454C	CAP DEV from 454C	COP DEV from 404A	CAP DEV from 404A
0.02	0.66	0.08	0.24	150	6.9	3	-2.2	3	2.5	-6.3
0.02	0.67	0.07	0.24	150	6.8	3	-2.2	3	2.5	-6.3
0.02	0.68	0.06	0.24	150	6.8	3	-2.1	3	2.6	-6.3
0.02	0.69	0.05	0.24	150	6.8	3	-2.2	3	2.5	-6.3
0.02	0.7	0.04	0.24	150	6.8	3	-2.1	3	2.6	-6.3
0.02	0.71	0.03	0.24	150	6.8	3	-2.1	3	2.6	-6.3
0.02	0.72	0.02	0.24	150	6.8	3	-2.1	3	2.6	-6.3
0.02	0.73	0.01	0.24	150	6.8	3	-2.1	3	2.6	-6.3
0.02	0.75	0.22	0.01	150	6.7	3	-2.2	3	2.5	-6.3
0.03	0.25	0.5	0.22	150	9.9	2	-3.1	2.3	1.5	-6.9
0.03	0.26	0.49	0.22	150	9.9	2	-0.2	4.4	4.6	-5.0
0.03	0.27	0.48	0.22	150	9.8	2	-2.8	2.3	1.8	-6.9
0.03	0.28	0.46	0.23	150	9.7	2	-2.6	2.3	2.0	-6.9
0.03	0.29	0.45	0.23	150	9.6	2	-2.5	2.3	2.1	-6.9
0.03	0.3	0.44	0.23	150	9.5	2	-2.4	2.3	2.2	-6.9
0.03	0.32	0.42	0.23	150	9.4	2	-2.1	2.4	2.6	-6.8
0.03	0.33	0.41	0.23	150	9.3	2	-2	2.4	2.7	-6.8
0.03	0.34	0.4	0.23	150	9.2	2	-1.8	2.4	2.9	-6.8
0.03	0.35	0.39	0.23	150	9.1	2	-1.7	2.4	3.0	-6.8
0.03	0.36	0.38	0.23	150	9	2	-1.7	2.4	3.0	-6.8
0.03	0.37	0.37	0.23	150	9	2	-1.5	2.4	3.2	-6.8
0.03	0.38	0.36	0.23	150	8.9	2	-1.5	2.4	3.2	-6.8
0.03	0.39	0.35	0.23	150	8.8	2	-1.3	2.4	3.4	-6.8
0.03	0.4	0.34	0.23	150	8.8	2	-1.2	2.4	3.5	-6.8
0.03	0.41	0.33	0.23	150	8.7	2	-1.1	2.4	3.6	-6.8
0.03	0.42	0.32	0.23	150	8.6	2	-1	2.5	3.7	-6.7
0.03	0.43	0.31	0.23	150	8.6	2	-0.9	2.5	3.8	-6.7
0.03	0.44	0.3	0.23	150	8.5	2	-0.8	2.5	3.9	-6.7
0.03	0.45	0.29	0.23	150	8.5	2	-0.7	2.5	4.0	-6.7
0.03	0.46	0.28	0.23	150	8.4	2	-0.6	2.5	4.1	-6.7
0.03	0.47	0.27	0.23	150	8.3	2	-0.6	2.5	4.1	-6.7
0.03	0.48	0.26	0.23	150	8.3	2	-0.5	2.5	4.2	-6.7
0.03	0.49	0.25	0.23	150	8.2	2	-0.4	2.5	4.3	-6.7
0.03	0.5	0.24	0.23	150	8.2	2	2	4.3	6.9	-5.1
0.03	0.51	0.23	0.23	150	8.1	2	-0.3	2.5	4.4	-6.7
0.03	0.52	0.22	0.23	150	8.1	2	-0.2	2.5	4.6	-6.7
0.03	0.53	0.21	0.23	150	8	2	-0.1	2.6	4.7	-6.6
0.03	0.55	0.19	0.23	150	7.9	2	-0.1	2.5	4.7	-6.7
0.03	0.56	0.18	0.23	150	7.9	2	0	2.6	4.8	-6.6
0.03	0.57	0.17	0.23	150	7.8	2	0	2.6	4.8	-6.6
0.03	0.58	0.16	0.23	150	7.8	2	0.1	2.6	4.9	-6.6

W_CO2	W_R-1252ZC	W_R1234ZEE	W_R32	GWP	AVG GLIDE (K)	ASHRAE FLAMMABILITY CLASS	COP DEV from 454C	CAP DEV from 454C	COP DEV from 404A	CAP DEV from 404A
0.03	0.59	0.15	0.23	150	7.8	3	0.2	2.6	5.0	-6.6
0.03	0.6	0.14	0.23	150	7.8	3	0.2	2.6	5.0	-6.6
0.03	0.61	0.13	0.23	150	7.8	3	0.3	2.6	5.1	-6.6
0.03	0.62	0.12	0.23	150	7.7	3	0.3	2.6	5.1	-6.6
0.03	0.63	0.11	0.23	150	7.7	3	0.3	2.6	5.1	-6.6
0.03	0.64	0.1	0.23	150	7.6	3	0.3	2.6	5.1	-6.6
0.03	0.65	0.09	0.23	150	7.6	3	0.3	2.6	5.1	-6.6
0.03	0.66	0.08	0.23	150	7.6	3	2.6	4.3	7.5	-5.1
0.03	0.67	0.07	0.23	150	7.5	3	0.3	2.6	5.1	-6.6
0.03	0.68	0.06	0.23	150	7.5	3	0.4	2.6	5.2	-6.6
0.03	0.69	0.05	0.23	150	7.5	3	0.3	2.6	5.1	-6.6
0.03	0.7	0.04	0.23	150	7.5	3	0.3	2.6	5.1	-6.6
0.03	0.71	0.03	0.23	150	7.5	3	0.3	2.6	5.1	-6.6
0.03	0.72	0.02	0.23	150	7.5	3	0.3	2.6	5.1	-6.6
0.03	0.73	0.01	0.23	150	7.4	3	0.2	2.5	5.0	-6.7
0.04	0.33	0.41	0.22	150	10	2	0.8	1.9	5.6	-7.3
0.04	0.34	0.4	0.22	150	9.9	2	1	1.9	5.8	-7.3
0.04	0.35	0.39	0.22	150	9.8	2	1.1	2	5.9	-7.2
0.04	0.36	0.38	0.22	150	9.8	2	1.2	2	6.0	-7.2
0.04	0.37	0.36	0.23	150	9.7	2	1.3	2	6.1	-7.2
0.04	0.38	0.35	0.23	150	9.6	2	1.4	2	6.2	-7.2
0.04	0.39	0.34	0.23	150	9.5	2	1.5	2	6.3	-7.2
0.04	0.4	0.33	0.23	150	9.4	2	1.5	2	6.3	-7.2
0.04	0.41	0.32	0.23	150	9.4	2	1.6	2	6.4	-7.2
0.04	0.42	0.31	0.23	150	9.3	2	1.8	2	6.6	-7.2
0.04	0.43	0.3	0.23	150	9.3	2	1.8	2	6.6	-7.2
0.04	0.44	0.29	0.23	150	9.2	2	1.9	2.1	6.8	-7.1
0.04	0.45	0.28	0.23	150	9.1	2	2	2.1	6.9	-7.1
0.04	0.46	0.27	0.23	150	9.1	2	2.1	2.1	7.0	-7.1
0.04	0.47	0.26	0.23	150	9	2	2.1	2.1	7.0	-7.1
0.04	0.48	0.25	0.23	150	9	2	2.2	2.1	7.1	-7.1
0.04	0.49	0.24	0.23	150	8.9	2	2.3	2.1	7.2	-7.1
0.04	0.5	0.23	0.23	150	8.9	2	2.4	2.1	7.3	-7.1
0.04	0.51	0.22	0.23	150	8.8	2	2.3	2.1	7.2	-7.1
0.04	0.52	0.21	0.23	150	8.7	2	2.4	2.1	7.3	-7.1
0.04	0.53	0.2	0.23	150	8.7	2	2.4	2.1	7.3	-7.1
0.04	0.54	0.19	0.23	150	8.7	2	2.6	2.1	7.5	-7.1
0.04	0.55	0.18	0.23	150	8.6	2	2.5	2.1	7.4	-7.1
0.04	0.56	0.17	0.23	150	8.5	2	2.6	2.1	7.5	-7.1
0.04	0.57	0.16	0.23	150	8.5	2	2.7	2.2	7.6	-7.0
0.04	0.58	0.15	0.23	150	8.5	3	2.7	2.2	7.6	-7.0

W_CO2	W_R-1252ZC	W_R1234ZEE	W_R32	GWP	AVG GLIDE (K)	ASHRAE FLAMMABILITY CLASS	COP DEV from 454C	CAP DEV from 454C	COP DEV from 404A	CAP DEV from 404A
0.04	0.59	0.14	0.23	150	8.5	3	2.8	2.2	7.7	-7.0
0.04	0.6	0.13	0.23	150	8.4	3	2.8	2.2	7.7	-7.0
0.04	0.61	0.12	0.23	150	8.4	3	2.8	2.2	7.7	-7.0
0.04	0.62	0.11	0.23	150	8.4	3	2.8	2.2	7.7	-7.0
0.04	0.63	0.1	0.23	150	8.3	3	2.8	2.2	7.7	-7.0
0.04	0.65	0.08	0.23	150	8.3	3	2.9	2.2	7.8	-7.0
0.04	0.66	0.07	0.23	150	8.2	3	2.9	2.2	7.8	-7.0
0.04	0.67	0.06	0.23	150	8.2	3	2.9	2.2	7.8	-7.0
0.04	0.68	0.05	0.23	150	8.2	3	2.9	2.2	7.8	-7.0
0.04	0.69	0.04	0.23	150	8.2	3	2.8	2.1	7.7	-7.1
0.04	0.7	0.03	0.23	150	8.2	3	2.8	2.1	7.7	-7.1
0.04	0.71	0.02	0.23	150	8.1	3	2.7	2.1	7.6	-7.1
0.04	0.72	0.01	0.23	150	8.1	3	2.8	2.1	7.7	-7.1
0.05	0.42	0.3	0.23	150	10	2	4.5	1.6	9.5	-7.6
0.05	0.43	0.29	0.23	150	9.9	2	4.5	1.6	9.5	-7.6
0.05	0.44	0.28	0.23	150	9.9	2	4.7	1.6	9.7	-7.6
0.05	0.45	0.27	0.23	150	9.8	2	4.7	1.7	9.7	-7.5
0.05	0.46	0.26	0.23	150	9.8	2	4.9	1.7	9.9	-7.5
0.05	0.48	0.24	0.23	150	9.6	2	4.9	1.7	9.9	-7.5
0.05	0.49	0.23	0.23	150	9.5	2	4.9	1.7	9.9	-7.5
0.05	0.5	0.22	0.23	150	9.5	2	5	1.7	10.0	-7.5
0.05	0.51	0.21	0.23	150	9.5	2	5.1	1.7	10.1	-7.5
0.05	0.52	0.2	0.23	150	9.4	2	5.1	1.7	10.1	-7.5
0.05	0.53	0.19	0.23	150	9.4	2	5.2	1.7	10.2	-7.5
0.05	0.54	0.18	0.23	150	9.3	2	5.2	1.7	10.2	-7.5
0.05	0.55	0.17	0.23	150	9.3	2	5.3	1.7	10.3	-7.5
0.05	0.56	0.16	0.23	150	9.2	2	5.3	1.7	10.3	-7.5
0.05	0.57	0.15	0.23	150	9.2	3	5.3	1.7	10.3	-7.5
0.05	0.58	0.14	0.23	150	9.1	3	5.3	1.7	10.3	-7.5
0.05	0.59	0.13	0.23	150	9.1	3	5.4	1.8	10.4	-7.4
0.05	0.6	0.12	0.23	150	9.1	3	5.4	1.8	10.4	-7.4
0.05	0.61	0.11	0.23	150	9	3	5.3	1.7	10.3	-7.5
0.05	0.62	0.1	0.23	150	9	3	5.4	1.8	10.4	-7.4
0.05	0.63	0.09	0.23	150	9	3	5.5	1.8	10.5	-7.4
0.05	0.64	0.08	0.23	150	8.9	3	5.4	1.7	10.4	-7.5
0.05	0.65	0.07	0.23	150	8.9	3	5.3	1.7	10.3	-7.5
0.05	0.66	0.06	0.23	150	8.9	3	5.4	1.7	10.4	-7.5
0.05	0.67	0.05	0.23	150	8.9	3	5.4	1.7	10.4	-7.5
0.05	0.68	0.04	0.23	150	8.9	3	5.4	1.7	10.4	-7.5
0.05	0.69	0.03	0.23	150	8.8	3	5.4	1.7	10.4	-7.5
0.05	0.7	0.02	0.23	150	8.8	3	5.3	1.7	10.3	-7.5

W_CO2	W_R-1252ZC	W_R1234ZEE	W_R32	GWP	AVG GLIDE (K)	ASHRAE FLAMMABILITY CLASS	COP DEV from 454C	CAP DEV from 454C	COP DEV from 404A	CAP DEV from 404A
0.05	0.71	0.01	0.23	150	8.8	3	5.3	1.7	10.3	-7.5
0.06	0.53	0.18	0.23	150	9.9	2	7.8	1.3	12.9	-7.8
0.06	0.54	0.17	0.23	150	9.9	2	7.9	1.3	13.0	-7.8
0.06	0.55	0.16	0.23	150	9.9	2	7.9	1.3	13.0	-7.8
0.06	0.56	0.15	0.23	150	9.8	3	8	1.3	13.1	-7.8
0.06	0.57	0.14	0.23	150	9.8	3	8	1.3	13.1	-7.8
0.06	0.58	0.13	0.23	150	9.8	3	8	1.3	13.1	-7.8
0.06	0.59	0.12	0.23	150	9.7	3	8	1.3	13.1	-7.8
0.06	0.6	0.11	0.23	150	9.7	3	8	1.4	13.1	-7.7
0.06	0.61	0.1	0.23	150	9.7	3	8.1	1.4	13.2	-7.7
0.06	0.62	0.09	0.23	150	9.6	3	7.9	1.3	13.0	-7.8
0.06	0.63	0.08	0.23	150	9.6	3	7.9	1.3	13.0	-7.8
0.06	0.64	0.07	0.23	150	9.6	3	8	1.3	13.1	-7.8
0.06	0.65	0.06	0.23	150	9.5	3	8	1.3	13.1	-7.8
0.06	0.66	0.05	0.23	150	9.5	3	8	1.3	13.1	-7.8
0.06	0.67	0.04	0.23	150	9.5	3	8	1.3	13.1	-7.8
0.06	0.68	0.03	0.23	150	9.5	3	7.9	1.3	13.0	-7.8
0.06	0.69	0.02	0.23	150	9.5	3	7.9	1.3	13.0	-7.8
0.06	0.7	0.01	0.23	150	9.4	3	7.9	1.3	13.0	-7.8
0.06	0.54	0.31	0.09	55	9.7	3	-9.9	2.3	-5.6	-6.9
0.01	0.51	0.24	0.24	123	6.4	2	-10.5	3.8	-6.2	-5.6
0.02	0.96	0.01	0.01	8	3	3	-25.6	5.2	-22.1	-4.3
0.03	0.01	0.9	0.06	42	9.9	2L	-32	2.8	-28.8	-6.5
0.03	0.77	0.01	0.19	123	7.2	3	-2.2	4.5	2.5	-4.9
0.05	0.75	0.19	0.01	1	6.4	3	-21	3.5	-17.2	-5.8
0.03	0.31	0.52	0.14	89	9.1	2	-18.5	-0.5	-14.6	-9.5
0.03	0.02	0.93	0.02	15	8.1	2L	-38.1	3	-35.2	-6.3
0.01	0.47	0.45	0.07	21	3.4	2	-31.1	5.2	-27.8	-4.3
0.05	0.65	0.14	0.16	102	8.8	3	-2.8	2.4	1.8	-6.8
0.06	0.67	0.15	0.12	75	9.3	3	-5.1	2.3	-0.6	-6.9
0.01	0.26	0.52	0.21	143	8.2	2	-9.9	3.3	-5.6	-6.0
0.06	0.85	0.01	0.08	48	8.5	3	-9.4	2.5	-5.1	-6.7
0.02	0.16	0.61	0.21	143	9.9	2L	-8.8	2.8	-4.5	-6.5
0.03	0.82	0.01	0.14	89	6.7	3	-9.8	3.4	-5.5	-5.9
0.04	0.72	0.12	0.12	75	7.5	3	-10	3.1	-5.7	-6.2
0.01	0.28	0.52	0.19	129	8	2	-9.2	6.1	-4.9	-3.5
0.05	0.52	0.22	0.21	136	9.5	2	-0.4	-0.4	4.3	-9.4
0.03	0.39	0.4	0.18	116	8.8	2	-7.8	2.8	-3.4	-6.5
0.02	0.7	0.05	0.23	143	6.7	3	-3.3	3.1	1.3	-6.2
0.02	0.17	0.6	0.21	143	9.9	2L	-8.6	2.8	-4.2	-6.5
0.02	0.18	0.6	0.2	136	9.7	2L	-9.8	2.9	-5.5	-6.4

Example 2

[0128] The presently claimed compositions containing HFO-1252zc, HFO-1234zeE, HFC-32, and HFC-134 are compared to R-454C (ASHRAE designation for a refrigerant containing 78.5 wt% HFO-1234yf and 21.5 wt% HFC-32) and R-404A (ASHRAE designation for a refrigerant containing 44 wt% HFC-125, 4 wt% HFC-134a and 52 wt% HFC-143a) under the conditions for refrigeration shown below. Table 2 provides the calculated results.

[0129] Conditions:

Evaporator avg temp, °C	-6.68
Condenser avg temp, °C	43.34
Suction temp, °C	18.3
Subcool, °C	0
Compressor efficiency	70%

[0130] The data demonstrates that the presently claimed compositions provide GWP less than 150, Capacity within 20% or 15% of that for R-454C, and COP that is at least 3% higher, or even 4% higher than that for R-454C. Additionally, the compositions provide average temperature glide less than 10 K and reasonable compressor discharge temperatures.

[0131] Broadly, for cooling mode, a composition range of 1.0% to 97.0% of R-1252ZC, 1.0% to 97.0% of R1234ZEE, 1.0% to 43.0% of R32, and 1.0% to 28.0% of R134 will have a GWP less than 300, a maximum average glide of about 9.6 K, a cooling capacity range that has a deviation range of -47.7% to 16.3% from the cooling capacity of R-454C evaluated with the same conditions set, and the cooling COP range has a deviation range from 1.6% to 57.0% than that of the cooling COP of R-454C evaluated with the same conditions set. Table 2 lists example compositions within the GWP<300 range that have ASHRAE flammability classifications of 2, 2L, 3 and 1.

[0132] Similarly, but a little less broadly for cooling mode, a composition range of 1.0% to 97.0% of R-1252ZC, 1.0% to 97.0% of R1234ZEE, 1.0% to 43.0% of R32, and 1.0% to 28.0% of R134 will have a GWP less than 300, a maximum average glide of about 9.6 K, an ASHRAE flammability classification of 2, 2L, 3 and 1, a cooling capacity range has a deviation of -47.7% to 16.3% from the cooling capacity

of R-454C evaluated with the same conditions set, and the cooling COP range has a deviation of 1.6% to 57.0% than that of the cooling COP of R-454C evaluated with the same conditions set.

[0133] Preferred blend composition ranges for cooling mode within a composition range of 1.0% to 97.0% of R-1252ZC, 1.0% to 97.0% of R1234ZEE, 1.0% to 43.0% of R32, and 1.0% to 28.0% of R134 will have a GWP < 300, a maximum average heat exchanger glide of 9.6 K, an ASHRAE flammability classification of 2, 2L, 3 and 1, the minimum and maximum cooling capacities are -47.7% and 16.3% than that of R-454C evaluated at the same conditions set, and the minimum and maximum cooling COP efficiencies are 1.6% and 57.0% than that of R-454C evaluated at the same conditions set.

[0134] Even more preferred blend composition ranges for cooling mode within a composition range of 1.0% to 27.0% of R-1252ZC, 30.0% to 97.0% of R1234ZEE, 1.0% to 43.0% of R32, and 1.0% to 28.0% of R134 will have a GWP < 300, a maximum average heat exchanger glide of 9.6 K, an ASHRAE flammability classification of 2L, the minimum and maximum cooling capacities are -47.7% and 14.4% than that of R-454C evaluated at the same conditions set, and the minimum and maximum cooling COP efficiencies are 1.6% and 56.4% than that of R-454C evaluated at the same conditions set.

[0135] The composition for the even more preferred maximum cooling capacity, which is 14.4% than that of R-454C, is 15.0 wt-% R-1252ZC, 41.0 wt-% R1234ZEE, 42.0 wt-% R32 and 2.0 wt-% R134, where the COP for cooling is 1.6% than that for R-454C under the same cycle conditions, the maximum average heat exchanger glide is 6.8 K and its ASHRAE flammability classification is 2L.

[0136] The composition for the even more preferred maximum cooling COP efficiency, which is 56.4% than that of R-454C, is 10.0 wt-% R-1252ZC, 68.0 wt-% R1234ZEE, 1.0 wt-% R32, and 21.0 wt-% R134, where the CAP for cooling is -16.2% than that for R-454C under the same cycle conditions, the maximum average heat exchanger glide is 1.4 K and its ASHRAE flammability classification is 2L

TABLE 2

W_R-1252ZC	W_R1234ZEE	W_R32	W_R134	GWP	AVG GLIDE (K)	ASHRAE FLAMMABILITY CLASS	COP DEV from 454C	CAP DEV from 454C	COP DEV from 404A	CAP DEV from 404A
0.62	0.01	0.26	0.11	300	4.8	2	-2.3	4	2.4	-5.4
0.61	0.02	0.26	0.11	300	4.8	2	-2.3	4	2.4	-5.4
0.6	0.03	0.26	0.11	300	4.8	2	-2.4	4	2.2	-5.4
0.59	0.04	0.26	0.11	300	4.9	2	-2.3	4	2.4	-5.4
0.58	0.05	0.26	0.11	300	4.8	2	-2.5	3.9	2.1	-5.5
0.56	0.07	0.25	0.12	300	5	2	-2.5	4	2.1	-5.4
0.54	0.09	0.25	0.12	300	5	2	-2.7	4	1.9	-5.4
0.53	0.1	0.26	0.11	300	5.1	2	-2.7	4	1.9	-5.4
0.52	0.11	0.26	0.11	300	5.1	2	-2.8	4	1.8	-5.4
0.51	0.12	0.26	0.11	300	5.1	2	-2.9	3.9	1.7	-5.5
0.5	0.13	0.26	0.11	300	5.2	2	-3	4	1.6	-5.4
0.49	0.14	0.26	0.11	300	5.2	2	-3	4	1.6	-5.4
0.48	0.15	0.25	0.12	300	5.2	2	-3.2	3.9	1.4	-5.5
0.47	0.16	0.26	0.11	300	5.3	2	-3.2	3.9	1.4	-5.5
0.46	0.17	0.26	0.11	300	5.4	2	-3.3	3.9	1.3	-5.5
0.45	0.18	0.26	0.11	300	5.4	2	-3.5	3.9	1.1	-5.5
0.44	0.19	0.26	0.11	300	5.5	2	-3.5	3.9	1.1	-5.5
0.43	0.2	0.26	0.11	300	5.5	2	-3.6	3.9	1.0	-5.5
0.42	0.21	0.25	0.12	300	5.6	2	-3.7	3.9	0.9	-5.5
0.41	0.22	0.26	0.11	300	5.6	2	-3.8	3.9	0.8	-5.5
0.4	0.23	0.26	0.11	300	5.7	2	-4	3.9	0.6	-5.5
0.39	0.24	0.23	0.14	300	5.7	2	-4.1	3.9	0.5	-5.5
0.38	0.25	0.26	0.11	300	5.8	2	-4.1	3.9	0.5	-5.5
0.37	0.26	0.26	0.11	300	5.8	2	-4.4	3.9	0.2	-5.5
0.36	0.27	0.26	0.11	300	5.9	2	-4.5	3.9	0.0	-5.5
0.35	0.28	0.25	0.12	300	6	2	-4.6	3.9	-0.1	-5.5
0.34	0.29	0.25	0.12	300	6	2	-4.7	3.9	-0.2	-5.5
0.33	0.3	0.25	0.12	300	6.1	2	-4.8	3.9	-0.3	-5.5
0.31	0.32	0.26	0.11	300	6.2	2	-5.2	3.9	-0.7	-5.5
0.3	0.33	0.26	0.11	300	6.3	2	-5.3	3.9	-0.8	-5.5
0.29	0.34	0.26	0.11	300	6.4	2	-5.5	3.9	-1.0	-5.5
0.28	0.35	0.24	0.13	300	6.4	2	-5.7	3.9	-1.2	-5.5
0.27	0.36	0.26	0.11	300	6.5	2L	-5.9	3.9	-1.4	-5.5
0.26	0.37	0.26	0.11	300	6.6	2L	-6	3.9	-1.5	-5.5
0.25	0.38	0.26	0.11	300	6.6	2L	-6.2	3.9	-1.7	-5.5
0.23	0.4	0.26	0.11	300	6.8	2L	-6.5	3.9	-2.0	-5.5
0.22	0.41	0.26	0.11	300	6.9	2L	-6.6	3.9	-2.2	-5.5
0.21	0.42	0.26	0.11	300	7	2L	-6.9	3.9	-2.5	-5.5
0.2	0.43	0.25	0.12	300	7.1	2L	-7	3.9	-2.6	-5.5

W_R-1252ZC	W_R1234ZEE	W_R32	W_R134	GWP	AVG GLIDE (K)	ASHRAE FLAMMABILITY CLASS	COP DEV from 454C	CAP DEV from 454C	COP DEV from 404A	CAP DEV from 404A
0.19	0.44	0.26	0.11	300	7.1	2L	-7.2	3.9	-2.8	-5.5
0.18	0.45	0.26	0.11	300	7.2	2L	-7.4	4	-3.0	-5.4
0.16	0.47	0.26	0.11	300	7.3	2L	-7.8	3.9	-3.4	-5.5
0.15	0.48	0.24	0.13	300	7.4	2L	-8.1	3.9	-3.7	-5.5
0.14	0.49	0.21	0.16	300	7.5	2L	-8.3	4	-3.9	-5.4
0.13	0.5	0.26	0.11	300	7.6	2L	-8.5	4	-4.1	-5.4
0.11	0.52	0.25	0.12	300	7.8	2L	-8.9	4	-4.6	-5.4
0.1	0.53	0.26	0.11	300	7.8	2L	-9.2	4	-4.9	-5.4
0.09	0.54	0.26	0.11	300	7.9	2L	-9.4	4	-5.1	-5.4
0.08	0.55	0.26	0.11	300	8	2L	-9.6	4.1	-5.3	-5.3
0.07	0.56	0.26	0.11	300	8.1	2L	-9.9	4.1	-5.6	-5.3
0.06	0.57	0.26	0.11	300	8.2	2L	-10.1	4.1	-5.8	-5.3
0.05	0.58	0.25	0.12	300	8.2	2L	-10.4	4.1	-6.1	-5.3
0.03	0.6	0.26	0.11	300	8.4	2L	-10.8	4.2	-6.6	-5.2
0.02	0.61	0.25	0.12	300	8.5	2L	-11.1	4.2	-6.9	-5.2
0.01	0.62	0.25	0.12	300	8.5	2L	-11.5	4.2	-7.3	-5.2
0.97	0.01	0.01	0.01	19	0.4	3	-29.9	6.9	-26.6	-2.7
0.01	0.75	0.12	0.12	212	6.7	2L	-29.6	4.9	-26.2	-4.6
0.01	0.97	0.01	0.01	15	1.8	2L	-47	6	-44.5	-3.6
0.81	0.01	0.14	0.04	140	3.8	3	-15.5	4.9	-11.5	-4.6
0.11	0.45	0.43	0.01	298	7.2	2L	13.8	1.6	19.2	-7.6
0.15	0.59	0.01	0.25	279	2.3	2L	-38.5	6.1	-35.6	-3.5
0.14	0.57	0.01	0.28	299	3.5	2L	-34.7	5.7	-31.6	-3.8
0.61	0.11	0.27	0.01	195	5.6	2	-1.5	3.5	3.2	-5.8
0.34	0.22	0.43	0.01	298	5.7	2	16.3	1.6	21.8	-7.6
0.03	0.95	0.01	0.01	19	1.1	2L	-47.7	6.4	-45.2	-3.2
0.01	0.72	0.01	0.26	294	1.8	1	-17.7	57	-13.8	42.9
0.15	0.41	0.42	0.02	298	6.8	2L	14.4	1.6	19.8	-7.6
0.01	0.72	0.26	0.01	184	9.6	2L	-9.8	3.5	-5.5	-5.8
0.58	0.24	0.16	0.02	132	4.9	3	-14.7	4.6	-10.6	-4.8
0.59	0.15	0.09	0.17	252	2.7	2	-21.7	5.6	-18.0	-3.9
0.12	0.71	0.04	0.13	169	3.5	2L	-37.7	5.6	-34.7	-3.9
0.03	0.73	0.01	0.23	265	1	1	-45.3	6.7	-42.7	-2.9
0.01	0.78	0.18	0.03	152	8.8	2L	-21.1	4.2	-17.3	-5.2
0.64	0.01	0.25	0.1	282	4.7	2	-3.4	4	1.2	-5.4
0.02	0.54	0.43	0.01	298	8	2L	12.2	1.7	17.5	-7.5
0.74	0.01	0.01	0.24	276	0.3	3	-28.2	6.8	-24.8	-2.8
0.05	0.79	0.15	0.01	109	8.3	2L	-24.3	4.2	-20.7	-5.2
0.71	0.06	0.03	0.2	245	1	3	-26.9	6.4	-23.4	-3.2
0.57	0.07	0.33	0.03	258	5.6	2	5.1	3	10.1	-6.3
0.13	0.65	0.16	0.06	176	7.1	2L	-22.1	4.4	-18.4	-5.0

W_R-1252ZC	W_R1234ZEE	W_R32	W_R134	GWP	AVG GLIDE (K)	ASHRAE FLAMMABILITY CLASS	COP DEV from 454C	CAP DEV from 454C	COP DEV from 404A	CAP DEV from 404A
0.02	0.71	0.01	0.26	294	1.5	1	-44	6.5	-41.3	-3.1
0.01	0.73	0.11	0.15	239	6.2	2L	-30.9	5.1	-27.6	-4.4
0.75	0.01	0.11	0.13	221	2.9	3	-18.1	5.5	-14.2	-4.0
0.61	0.32	0.01	0.06	75	0.7	3	-32.8	6.6	-29.6	-3.0
0.14	0.65	0.2	0.01	212	2.4	2L	-39.4	6	-36.5	-3.6
0.62	0.15	0.12	0.11	205	3.4	3	-18.4	5.3	-14.5	-4.2
0.31	0.48	0.11	0.1	187	4.7	2	-24.7	5	-21.1	-4.5
0.1	0.7	0.18	0.02	145	8.1	2L	-20.1	4.1	-16.3	-5.3
0.01	0.71	0.07	0.21	279	4.6	1	-36.2	5.5	-33.2	-4.0
0.27	0.41	0.15	0.17	293	5.3	2L	-19.6	4.8	-15.8	-4.6
0.01	0.77	0.04	0.18	225	3.4	2L	-40.7	5.8	-37.9	-3.7
0.27	0.3	0.42	0.01	296	6.3	2L	13.5	1.8	18.9	-7.4
0.04	0.52	0.43	0.01	298	7.8	2L	12.5	1.7	17.9	-7.5
0.09	0.74	0.01	0.16	187	1.2	2L	-44	6.3	-41.3	-3.3
0.08	0.72	0.19	0.01	141	8.4	2L	-19.2	4	-15.4	-5.4
0.1	0.68	0.01	0.21	243	1.4	2L	-16.2	56.4	-12.2	42.3
0.01	0.84	0.09	0.06	125	6.2	2L	-34.4	4.9	-31.3	-4.6

Example 3

[0137] [0015] The presently claimed compositions containing HFO-1252zc, HFO-1234zeE, HFC-32, and HFC-134a are compared to R-454C (ASHRAE designation for a refrigerant containing 78.5 wt% HFO-1234yf and 21.5 wt% HFC-32) and R-404A (ASHRAE designation for a refrigerant containing 44 wt% HFC-125, 4 wt% HFC-134a and 52 wt% HFC-143a) under the conditions for refrigeration shown below. Table 3 provides the calculated results.

[0138] Conditions

Evaporator avg temp, °C	-6.68
Condenser avg temp, °C	43.34
Suction temp, °C	18.3
Subcool, °C	0
Compressor efficiency	70%

[0139] The data demonstrates that the presently claimed compositions provide GWP less than 150, Capacity within 20% or 15% of that for R-454C, and COP that is

at least 3% higher, or even 4% higher than that for R-454C. Additionally, the compositions provide average temperature glide less than 10 K and reasonable compressor discharge temperatures.

[0140] Broadly, for cooling mode, a composition range of 1.0% to 23.0% of R134A, 1.0% to 97.0% of R-1252ZC, 1.0% to 97.0% of R1234ZEE, and 1.0% to 52.0% of R32 will have a GWP less than 300, a maximum average glide of about 9.5 K, a cooling capacity range that has a deviation range of -48.9% to 14.8% from the cooling capacity of R-454C evaluated with the same conditions set, and the cooling COP range has a deviation range from 1.7% to 55.3% than that of the cooling COP of R-454C evaluated with the same conditions set. Table 3 lists example compositions within the GWP<300 range that have ASHRAE flammability classifications of 2L, 2, 3 and 1.

[0141] Similarly, but a little less broadly for cooling mode, a composition range of 1.0% to 23.0% of R134A, 1.0% to 97.0% of R-1252ZC, 1.0% to 97.0% of R1234ZEE, and 1.0% to 52.0% of R32 will have a GWP less than 300, a maximum average glide of about 9.5 K, an ASHRAE flammability classification of 2L, 2, 3 and 1, a cooling capacity range has a deviation of -48.9% to 14.8% from the cooling capacity of R-454C evaluated with the same conditions set, and the cooling COP range has a deviation of 1.7% to 55.3% than that of the cooling COP of R-454C evaluated with the same conditions set.

[0142] Preferred blend composition ranges for cooling mode within a composition range of 1.0% to 22.0% of R134A, 1.0% to 80.0% of R-1252ZC, 1.0% to 71.0% of R1234ZEE, and 1.0% to 49.0% of R32 will have a GWP < 300, a maximum average heat exchanger glide of 9.5 K, an ASHRAE flammability classification of 2L, 2 and 3, the minimum and maximum cooling capacities are -10.0% and 10.0% than that of R-454C evaluated at the same conditions set, and the minimum and maximum cooling COP efficiencies are 1.9% and 55.3% than that of R-454C evaluated at the same conditions set.

[0143] Even more preferred blend composition ranges for cooling mode within a composition range of 1.0% to 15.0% of R134A, 1.0% to 26.0% of R-1252ZC, 31.0% to 71.0% of R1234ZEE, and 5.0% to 42.0% of R32 will have a GWP < 300, a maximum average heat exchanger glide of 9.5 K, an ASHRAE flammability

classification of 2L, the minimum and maximum cooling capacities are -10.0% and 10.0% than that of R-454C evaluated at the same conditions set, and the minimum and maximum cooling COP efficiencies are 1.9% and 54.6% than that of R-454C evaluated at the same conditions set.

[0144] The composition for the even more preferred maximum cooling capacity, which is 10.0% than that of R-454C, is 1.0 wt-% R134A, 25.0 wt-% R-1252ZC, 35.0 wt-% R1234ZEE and 39.0 wt-% R32, where the COP for cooling is 2.0% than that for R-454C under the same cycle conditions, the maximum average heat exchanger glide is 6.7 K and its ASHRAE flammability classification is 2L.

[0145] The composition for the even more preferred maximum cooling COP efficiency, which is 54.6% than that of R-454C, is 14.0 wt-% R134A, 15.0 wt-% R-1252ZC, 66.0 wt-% R1234ZEE, and 5.0 wt-% R32, where the CAP for cooling is -3.8% than that for R-454C under the same cycle conditions, the maximum average heat exchanger glide is 4.1 K and its ASHRAE flammability classification is 2L.

TABLE 3

W_R134A	W_R-1252ZC	W_R1234ZEE	W_R32	GWP	AVG GLIDE (K)	ASHRAE FLAMMABILITY CLASS	COP DEV from 454C	CAP DEV from 454C	COP DEV from 404A	CAP DEV from 404A
0.09	0.01	0.63	0.27	300	8.8	2L	3.4	-8.4	8.3	-16.7
0.09	0.02	0.62	0.27	300	8.7	2L	3.4	-8.2	8.3	-16.5
0.09	0.03	0.61	0.27	300	8.6	2L	3.3	-7.9	8.2	-16.2
0.09	0.04	0.6	0.27	300	8.5	2L	3.3	-7.7	8.2	-16.0
0.09	0.05	0.59	0.27	300	8.4	2L	3.3	-7.4	8.2	-15.7
0.09	0.06	0.58	0.27	300	8.3	2L	3.3	-7.2	8.2	-15.6
0.09	0.07	0.57	0.27	300	8.2	2L	3.2	-6.9	8.1	-15.3
0.09	0.08	0.56	0.27	300	8.2	2L	3.3	-6.6	8.2	-15.0
0.09	0.09	0.55	0.27	300	8	2L	3.2	-6.5	8.1	-14.9
0.09	0.1	0.54	0.27	300	7.9	2L	3.2	-6.2	8.1	-14.7
0.09	0.11	0.53	0.27	300	7.9	2L	3.2	-6	8.1	-14.5
0.09	0.12	0.52	0.27	300	7.8	2L	3.2	-5.8	8.1	-14.3
0.09	0.13	0.51	0.27	300	7.7	2L	3.2	-5.6	8.1	-14.1
0.09	0.14	0.5	0.27	300	7.6	2L	3.1	-5.4	8.0	-13.9
0.09	0.16	0.48	0.27	300	7.4	2L	3.1	-5	8.0	-13.6
0.09	0.17	0.47	0.27	300	7.3	2L	3.1	-4.8	8.0	-13.4
0.09	0.19	0.45	0.27	300	7.2	2L	3.1	-4.4	8.0	-13.0
0.09	0.2	0.44	0.27	300	7.1	2L	3.1	-4.2	8.0	-12.8

W_R134A	W_R-1252ZC	W_R1234ZEE	W_R32	GWP	AVG GLIDE (K)	ASHRAE FLAMMABILITY CLASS	COP DEV from 454C	CAP DEV from 454C	COP DEV from 404A	CAP DEV from 404A
0.09	0.22	0.42	0.27	300	7	2L	3.1	-3.8	8.0	-12.5
0.09	0.23	0.41	0.27	300	6.9	2L	3.1	-3.6	8.0	-12.3
0.09	0.24	0.4	0.27	300	6.8	2L	3.1	-3.5	8.0	-12.2
0.09	0.25	0.39	0.27	300	6.7	2L	3.1	-3.3	8.0	-12.0
0.09	0.26	0.38	0.27	300	6.6	2L	3.1	-3.1	8.0	-11.8
0.09	0.27	0.37	0.27	300	6.5	2	3.1	-3	8.0	-11.7
0.09	0.28	0.36	0.27	300	6.5	2	3.1	-2.8	8.0	-11.6
0.09	0.29	0.35	0.27	300	6.4	2	3.1	-2.7	8.0	-11.5
0.09	0.3	0.34	0.27	300	6.4	2	3.1	-2.5	8.0	-11.3
0.09	0.31	0.33	0.27	300	6.3	2	3.1	-2.3	8.0	-11.1
0.09	0.32	0.31	0.28	300	6.2	2	3.1	-2.2	8.0	-11.0
0.09	0.33	0.3	0.28	300	6.2	2	3.1	-2.1	8.0	-10.9
0.09	0.34	0.29	0.28	300	6.1	2	3.1	-2	8.0	-10.8
0.09	0.36	0.26	0.29	300	6	2	3.1	-1.7	8.0	-10.6
0.09	0.37	0.25	0.29	300	5.9	2	3.1	-1.6	8.0	-10.5
0.09	0.38	0.24	0.29	300	5.8	2	3.1	-1.5	8.0	-10.4
0.09	0.39	0.23	0.29	300	5.8	2	3.1	-1.3	8.0	-10.2
0.09	0.4	0.22	0.29	300	5.7	2	3.2	-1.2	8.1	-10.1
0.09	0.41	0.21	0.29	300	5.7	2	3.2	-1.1	8.1	-10.0
0.09	0.42	0.2	0.29	300	5.6	2	3.2	-1	8.1	-9.9
0.09	0.43	0.19	0.29	300	5.6	2	3.2	-0.9	8.1	-9.8
0.09	0.44	0.18	0.29	300	5.5	2	3.2	-0.8	8.1	-9.7
0.09	0.45	0.19	0.27	300	5.5	2	3.2	-0.7	8.1	-9.6
0.09	0.46	0.18	0.27	300	5.4	2	3.1	-0.7	8.0	-9.6
0.09	0.47	0.17	0.27	300	5.4	2	3.2	-0.5	8.1	-9.5
0.09	0.48	0.16	0.27	300	5.3	2	3.2	-0.5	8.1	-9.5
0.09	0.5	0.14	0.27	300	5.3	2	3.2	-0.3	8.1	-9.3
0.09	0.51	0.13	0.27	300	5.2	2	3.2	-0.3	8.1	-9.3
0.09	0.52	0.12	0.27	300	5.2	2	3.2	-0.2	8.1	-9.2
0.09	0.53	0.11	0.27	300	5.2	2	3.2	-0.1	8.1	-9.1
0.09	0.54	0.1	0.27	300	5.1	2	3.2	-0.1	8.1	-9.1
0.09	0.55	0.09	0.27	300	5.1	2	3.2	-0.1	8.1	-9.1
0.09	0.56	0.08	0.27	300	5.1	2	3.2	0	8.1	-9.0
0.09	0.57	0.07	0.27	300	5	2	3.2	0.1	8.1	-8.9
0.09	0.58	0.06	0.27	300	5	2	3.2	0.2	8.1	-8.8
0.09	0.59	0.05	0.27	300	5	2	3.2	0.1	8.1	-8.9
0.09	0.6	0.04	0.27	300	5	2	3.2	0.2	8.1	-8.8
0.09	0.61	0.03	0.27	300	4.9	2	3.2	0.2	8.1	-8.8
0.09	0.62	0.02	0.27	300	4.9	2	3.2	0.2	8.1	-8.8
0.09	0.63	0.01	0.27	300	4.9	2	3.2	0.2	8.1	-8.8
0.23	0.27	0.49	0.01	299	1.1	2	5.8	-36.6	10.8	-42.3

W_R134A	W_R-1252ZC	W_R1234ZEE	W_R32	GWP	AVG GLIDE (K)	ASHRAE FLAMMABILITY CLASS	COP DEV from 454C	CAP DEV from 454C	COP DEV from 404A	CAP DEV from 404A
0.01	0.58	0.1	0.31	223	5.7	2	2.9	3	7.8	-6.3
0.01	0.97	0.01	0.01	20	0.4	3	6.8	-29.8	11.9	-36.1
0.04	0.01	0.67	0.28	242	9.2	2L	3.4	-7.8	8.3	-16.1
0.01	0.01	0.97	0.01	20	1	2L	6.4	-48.3	11.5	-53.0
0.09	0.83	0.01	0.07	164	2.4	3	5.5	-21.6	10.5	-28.7
0.01	0.46	0.01	0.52	284	5.6	2	2	12.5	6.9	2.4
0.07	0.73	0.19	0.01	91	0.3	3	6.7	-31.4	11.8	-37.6
0.01	0.5	0.07	0.42	297	5.4	2	1.8	14.8	6.6	4.5
0.02	0.03	0.94	0.01	26	0.3	2L	6.7	-48.9	11.8	-53.5
0.1	0.49	0.39	0.02	144	2	2	55.3	0.3	62.7	-8.7
0.01	0.55	0.02	0.42	297	5.3	2	1.7	14.7	6.5	4.4
0.01	0.01	0.71	0.27	196	9.5	2L	3.5	-9.6	8.4	-17.7
0.08	0.13	0.6	0.19	233	7.5	2L	3.8	-16.5	8.7	-24.0
0.2	0.4	0.35	0.05	294	2.5	2	5.1	-27.2	10.1	-33.8
0.04	0.69	0.25	0.02	221	5.2	3	3.5	-2.8	8.4	-11.6
0.21	0.02	0.76	0.01	280	1.3	1	6.1	-43.8	11.2	-48.9
0.23	0.42	0.34	0.01	299	0.8	2	5.8	-32.7	10.8	-38.8
0.01	0.13	0.72	0.14	108	7.2	2L	4.3	-25.1	9.3	-31.8
0.1	0.01	0.87	0.02	144	1.9	2L	5.9	-44.9	10.9	-49.9
0.11	0.77	0.01	0.11	218	3.2	3	4.9	-16.8	9.9	-24.3
0.02	0.16	0.81	0.01	26	0.8	2L	6.4	-44.8	11.5	-49.8
0.06	0.02	0.73	0.19	207	8.5	2L	4	-19.8	9.0	-27.0
0.02	0.48	0.34	0.16	80	3.7	2	5.2	-26.1	10.2	-32.8
0.05	0.54	0.4	0.01	72	1	3	6.3	-33.6	11.4	-39.6
0.22	0.02	0.73	0.03	300	1.9	1	5.8	-42.1	10.8	-47.3
0.22	0.57	0.19	0.02	300	1.2	2	52.9	5.4	60.2	-4.1
0.01	0.32	0.33	0.34	223	6.9	2	2.9	1.2	7.8	-7.9
0.01	0.8	0.18	0.01	20	0.5	3	52.6	-1.4	59.9	-10.3
0.05	0.01	0.64	0.3	268	9.1	2L	3.2	-5	8.1	-13.6
0.06	0.64	0.01	0.29	261	5.2	2	3.3	-0.3	8.2	-9.3
0.01	0.46	0.04	0.49	264	5.8	2	2.3	9.3	7.2	-0.5
0.06	0.63	0.3	0.01	281	5.2	2	2.9	2.9	7.8	-6.4
0.01	0.25	0.35	0.39	277	6.7	2L	2	10	6.9	0.1
0.11	0.57	0.14	0.18	265	4.5	2	4.1	-10	9.1	-18.1
0.01	0.07	0.51	0.41	291	7.8	2L	1.9	9.6	6.8	-0.3
0.03	0.11	0.53	0.33	256	8.2	2L	2.8	-0.5	7.7	-9.5
0.05	0.47	0.22	0.26	214	5.7	2	3.8	-7.4	8.7	-15.7
0.07	0.68	0.02	0.23	240	4.8	3	3.8	-5.6	8.7	-14.1
0.15	0.17	0.62	0.06	229	3.9	2L	54.2	-2.9	61.5	-11.7
0.01	0.21	0.44	0.34	243	7.4	2L	2.6	3.4	7.5	-5.9
0.06	0.26	0.35	0.33	295	6.7	2L	2.7	2.5	7.6	-6.7

W_R134A	W_R-1252ZC	W_R1234ZEE	W_R32	GWP	AVG GLIDE (K)	ASHRAE FLAMMABILITY CLASS	COP DEV from 454C	CAP DEV from 454C	COP DEV from 404A	CAP DEV from 404A
0.06	0.01	0.62	0.31	288	9	2L	3.1	-3.5	8.0	-12.2
0.03	0.26	0.31	0.4	296	6.5	2L	2.1	9.3	7.0	-0.5
0.01	0.01	0.56	0.42	297	8.3	2L	1.9	9.6	6.8	-0.3
0.13	0.2	0.62	0.05	203	3.9	2L	54.1	-2.5	61.4	-11.3
0.08	0.01	0.64	0.27	280	8.8	2L	3.5	-10	8.4	-18.1
0.14	0.15	0.66	0.05	216	4.1	2L	54.6	-3.8	62.0	-12.5
0.04	0.11	0.58	0.27	235	8.3	2L	3.3	-6.8	8.2	-15.2

Example 4

[0146] The presently claimed compositions containing HFO-1252zc, HFO-1234zeE, HFC-32, HFC-134, and CO_2 are compared to R-454C (ASHRAE designation for a refrigerant containing 78.5 wt% HFO-1234yf and 21.5 wt% HFC-32) and R-404A (ASHRAE designation for a refrigerant containing 44 wt% HFC-125, 4 wt% HFC-134a and 52 wt% HFC-143a) under the conditions for refrigeration shown below. Table 4 provides the calculated results.

[0147] Conditions:

Evaporator avg temp, °C	-6.68
Condenser avg temp, °C	43.34
Suction temp, °C	18.3
Subcool, °C	0
Compressor efficiency	70%

[0148] Broadly, for cooling mode, a composition range of 1.0% to 3.0% of CO2, 1.0% to 6.0% of R134, 1.0% to 20.0% of R-1252ZC, 42.0% to 73.0% of R1234ZEE, and 11.0% to 38.0% of R32 will have a GWP less than 149, a maximum average glide of about 10.0 K, a cooling capacity range that has a deviation range of -20.0% to -9.8% from the cooling capacity of R-454C evaluated with the same conditions set, and the cooling COP range has a deviation range from 2.8% to 3.9% than that of the cooling COP of R-454C evaluated with the same conditions set. Table 4 lists example compositions within the GWP<149 range that have ASHRAE flammability classifications of 2L.

[0149] Similarly, but a little less broadly for cooling mode, a composition range of 1.0% to 3.0% of CO2, 1.0% to 6.0% of R134, 1.0% to 20.0% of R-1252ZC, 42.0% to 73.0% of R1234ZEE, and 11.0% to 38.0% of R32 will have a GWP less than 149, a maximum average glide of about 10.0 K, an ASHRAE flammability classification of 2L, a cooling capacity range has a deviation of -20.0% to -9.8% from the cooling capacity of R-454C evaluated with the same conditions set, and the cooling COP range has a deviation of 2.8% to 3.9% than that of the cooling COP of R-454C evaluated with the same conditions set.

[0150] Preferred blend composition ranges for cooling mode within a composition range of 2.0% to 2.0% of CO2, 1.0% to 1.0% of R134, 18.0% to 18.0% of R-1252ZC, 57.0% to 57.0% of R1234ZEE, and 22.0% to 22.0% of R32 will have a GWP < 149, a maximum average heat exchanger glide of 9.7 K, an ASHRAE flammability classification of 2L, the minimum and maximum cooling capacities are -9.8% and -9.8% than that of R-454C evaluated at the same conditions set, and the minimum and maximum cooling COP efficiencies are 3.0% and 3.0% than that of R-454C evaluated at the same conditions set.

[0151] Even more preferred blend composition ranges for cooling mode within a composition range of 2.0% to 2.0% of CO2, 1.0% to 1.0% of R134, 18.0% to 18.0% of R-1252ZC, 57.0% to 57.0% of R1234ZEE, and 22.0% to 22.0% of R32 will have a GWP < 149, a maximum average heat exchanger glide of 9.7 K, an ASHRAE flammability classification of 2L, the minimum and maximum cooling capacities are -9.8% and -9.8% than that of R-454C evaluated at the same conditions set, and the minimum and maximum cooling COP efficiencies are 3.0% and 3.0% than that of R-454C evaluated at the same conditions set.

[0152] The composition for the even more preferred maximum cooling capacity, which is -9.8% than that of R-454C, is 2.0 wt-% CO2, 1.0 wt-% R134, 18.0 wt-% R-1252ZC, 57.0 wt-% R1234ZEE, and 22.0 wt-% R32, where the COP for cooling is 3.0% than that for R-454C under the same cycle conditions, the maximum average heat exchanger glide is 9.7 K and its ASHRAE flammability classification is 2L.

[0153] The composition for the even more preferred maximum cooling COP efficiency, which is 3.0% than that of R-454C, is 2.0 wt-% CO2, 1.0 wt-% R134, 18.0 wt-% R-1252ZC, 57.0 wt-% R1234ZEE, and 22.0 wt-% R32, where the CAP for

cooling is -9.8% than that for R-454C under the same cycle conditions, the maximum average heat exchanger glide is 9.7 K and its ASHRAE flammability classification is 2L

TABLE 4

W_CO2	W_R134	W_R-1252ZC	W_R1234ZEE	W_R32	GWP	AVG GLIDE (K)	ASHRAE FLAMMABILITY CLASS	COP DEV from 454C	CAP DEV from 454C	COP DEV from 404A	CAP DEV from 404A
0.01	0.03	0.05	0.53	0.38	149	9.3	2L	3.7	-19.9	8.6	-27.1
0.01	0.03	0.06	0.52	0.38	149	9.2	2L	3.7	-19.7	8.6	-26.9
0.01	0.03	0.07	0.51	0.38	149	9.2	2L	3.7	-19.4	8.6	-26.7
0.01	0.03	0.08	0.5	0.38	149	9.1	2L	3.7	-19.1	8.6	-26.4
0.01	0.03	0.09	0.49	0.38	149	9	2L	3.7	-18.9	8.6	-26.2
0.01	0.03	0.1	0.48	0.38	149	8.9	2L	3.7	-18.7	8.6	-26.0
0.01	0.03	0.11	0.47	0.38	149	8.9	2L	3.7	-18.3	8.6	-25.7
0.01	0.03	0.12	0.46	0.38	149	8.7	2L	3.7	-18.2	8.6	-25.6
0.01	0.03	0.13	0.45	0.38	149	8.7	2L	3.7	-17.9	8.6	-25.3
0.01	0.03	0.14	0.44	0.38	149	8.6	2L	3.7	-17.7	8.6	-25.1
0.01	0.03	0.15	0.43	0.38	149	8.5	2L	3.7	-17.5	8.6	-24.9
0.01	0.03	0.16	0.42	0.38	149	8.5	2L	3.7	-17.2	8.6	-24.7
0.01	0.03	0.2	0.59	0.17	149	8.1	2L	3.7	-16.5	8.6	-24.0
0.01	0.03	0.19	0.6	0.17	149	8.2	2L	3.7	-16.7	8.6	-24.2
0.01	0.03	0.18	0.61	0.17	149	8.3	2L	3.7	-16.8	8.6	-24.3
0.01	0.03	0.17	0.62	0.17	149	8.4	2L	3.7	-17	8.6	-24.5
0.02	0.03	0.19	0.54	0.22	149	9.2	2L	3.2	-13.7	8.1	-21.5
0.02	0.03	0.18	0.55	0.22	149	9.3	2L	3.2	-14	8.1	-21.8
0.02	0.03	0.17	0.56	0.22	149	9.4	2L	3.2	-14.1	8.1	-21.8
0.02	0.03	0.16	0.57	0.22	149	9.5	2L	3.2	-14.4	8.1	-22.1
0.02	0.03	0.15	0.58	0.22	149	9.6	2L	3.2	-14.6	8.1	-22.3
0.02	0.03	0.14	0.59	0.22	149	9.6	2L	3.1	-14.8	8.0	-22.5
0.02	0.03	0.13	0.6	0.22	149	9.7	2L	3.1	-15.1	8.0	-22.8
0.02	0.03	0.12	0.61	0.22	149	9.8	2L	3.2	-15.2	8.1	-22.8
0.02	0.03	0.11	0.62	0.22	149	9.9	2L	3.2	-15.5	8.1	-23.1
0.03	0.05	0.17	0.62	0.13	145	9.9	2L	2.9	-16.8	7.8	-24.3
0.01	0.01	0.12	0.62	0.24	134	9.1	2L	3.5	-16.8	8.4	-24.3
0.03	0.06	0.14	0.65	0.12	149	9.9	2L	3	-18.9	7.9	-26.2
0.01	0.01	0.06	0.66	0.26	147	9.8	2L	3.5	-15.3	8.4	-22.9
0.01	0.02	0.01	0.63	0.33	145	9.9	2L	3.7	-19.6	8.6	-26.8
0.01	0.01	0.01	0.73	0.24	134	10	2L	3.6	-19.6	8.5	-26.8
0.03	0.05	0.17	0.64	0.11	131	9.5	2L	3	-19.8	7.9	-27.0
0.02	0.01	0.18	0.57	0.22	147	9.7	2L	3	-9.8	7.9	-17.9

W_CO2	W_R134	W_R-1252ZC	W_R1234ZEE	W_R32	GWP	AVG GLIDE (K)	ASHRAE FLAMMABILITY CLASS	COP DEV from 454C	CAP DEV from 454C	COP DEV from 404A	CAP DEV from 404A
0.01	0.02	0.17	0.5	0.3	125	8.1	2L	3.7	-20	8.6	-27.2
0.01	0.04	0.18	0.61	0.16	147	8	2L	3.9	-19.6	8.8	-26.8
0.03	0.03	0.17	0.61	0.16	122	10	2L	2.8	-17	7.7	-24.5
0.03	0.05	0.14	0.66	0.12	138	10	2L	2.9	-18.9	7.8	-26.2
0.01	0.02	0.08	0.57	0.32	138	9.2	2L	3.7	-19.2	8.6	-26.5
0.03	0.06	0.18	0.61	0.12	149	9.6	2L	3	-17.9	7.9	-25.3
0.01	0.01	0.08	0.66	0.24	134	9.4	2L	3.5	-17.8	8.4	-25.2
0.03	0.06	0.13	0.66	0.12	149	10	2L	2.9	-19.2	7.8	-26.5
0.01	0.01	0.16	0.56	0.26	147	8.9	2L	3.4	-13.1	8.3	-20.9
0.01	0.04	0.2	0.59	0.16	147	7.8	2L	3.8	-19.2	8.7	-26.5
0.02	0.02	0.11	0.69	0.16	132	9.9	2L	3.2	-16.9	8.1	-24.4

Example 5

[0154] The presently claimed compositions containing HFO-1252zc, HFO-1234zeE, HFC-134, HFC-134a and HFC-32 are compared to R-454C (ASHRAE designation for a refrigerant containing 78.5 wt% HFO-1234yf and 21.5 wt% HFC-32) and R-404A (ASHRAE designation for a refrigerant containing 44 wt% HFC-125, 4 wt% HFC-134a and 52 wt% HFC-143a) under the conditions for refrigeration shown below. Table 5 provides the calculated results.

Conditions:

Evaporator avg temp, °C	-7
Condenser avg temp, °C	40
Suction temp, °C	18
Subcool, °C	0
Compressor efficiency	70%

[0155] Broadly, for cooling mode, a composition range of 1.0% to 96.0% of R-1252ZC, 1.0% to 96.0% of R1234ZE(E), 1.0% to 25.0% of R134, 1.0% to 21.0% of R134A, and 1.0% to 40.0% of R32 will have a GWP less than 300, a maximum average glide of about 9.8 K, a cooling capacity range that has a deviation range of -48.6% to 21.3% from the cooling capacity of R-454C evaluated with the same conditions set, and the cooling COP range has a deviation range from -0.7% to 6.3%

than that of the cooling COP of R-454C evaluated with the same conditions set. Table 5 lists example compositions within the GWP<300 range that have ASHRAE flammability classifications of 2L, 3, 2 and 1.

[0156] Similarly, but a little less broadly for cooling mode, a composition range of 1.0% to 96.0% of R-1252ZC, 1.0% to 96.0% of R1234ZE(E), 1.0% to 11.0% of R134, 1.0% to 10.0% of R134A, and 1.0% to 18.0% of R32 will have a GWP less than 150, a maximum average glide of about 9.1 K, an ASHRAE flammability classification of 2, 3 and 2L, a cooling capacity range has a deviation of -48.6% to -5.5% from the cooling capacity of R-454C evaluated with the same conditions set, and the cooling COP range has a deviation of 2.3% to 5.9% than that of the cooling COP of R-454C evaluated with the same conditions set.

[0157] Preferred blend composition ranges for cooling mode within a composition range of 41.0% to 82.0% of R-1252ZC, 1.0% to 39.0% of R1234ZE(E), 1.0% to 3.0% of R134, 1.0% to 2.0% of R134A, and 15.0% to 18.0% of R32 will have a GWP < 150, a maximum average heat exchanger glide of 7.6 K, an ASHRAE flammability classification of 3 and 2, the minimum and maximum cooling capacities are -10.0% and -5.5% than that of R-454C evaluated at the same conditions set, and the minimum and maximum cooling COP efficiencies are 2.3% and 2.8% than that of R-454C evaluated at the same conditions set.

[0158] Even more preferred blend composition ranges for cooling mode within a composition range of 41.0% to 63.0% of R-1252ZC, 17.0% to 39.0% of R1234ZE(E), 1.0% to 2.0% of R134, 1.0% to 2.0% of R134A, and 16.0% to 18.0% of R32 will have a GWP < 150, a maximum average heat exchanger glide of 7.6 K, an ASHRAE flammability classification of 2, the minimum and maximum cooling capacities are -10.0% and -6.3% than that of R-454C evaluated at the same conditions set, and the minimum and maximum cooling COP efficiencies are 2.3% and 2.6% than that of R-454C evaluated at the same conditions set.

[0159] The composition for the even more preferred maximum cooling capacity, which is -6.3% than that of R-454C, is 63.0 wt-% R-1252ZC, 17.0 wt-% R1234ZE(E), 1.0 wt-% R134, 1.0 wt-% R134A, and 18.0 wt-% R32, where the COP for cooling is 2.3% than that for R-454C under the same cycle conditions, the maximum average heat exchanger glide is 7.0 K and its ASHRAE flammability classification is 2.

[0160] The composition for the even more preferred maximum cooling COP efficiency, which is 2.6% than that of R-454C, is 62.0 wt-% R-1252ZC, 19.0 wt-% R1234ZE(E), 2.0 wt-% R134, 1.0 wt-% R134A, and 16.0 wt-% R32, where the CAP for cooling is -9.4% than that for R-454C under the same cycle conditions, the maximum average heat exchanger glide is 6.7 K and its ASHRAE flammability classification is 2.

TABLE 5

W_R-1252ZC	W_R1234ZE(E)	W_R134	W_R134A	W_R32	GWP	ASHRAE FLAMMABILITY CLASS	AVG GLIDE (K)	COP DEV from 454C	CAP DEV from 454C	COP DEV from 404A	CAP DEV from 404A
0.22	0.5	0.22	0.02	0.04	300	2L	3.1	4.8	-34.8	9.1	-41.0
0.22	0.44	0.03	0.09	0.22	300	2L	7.9	2.4	-7.8	6.6	-16.6
0.96	0.01	0.01	0.01	0.01	31	3	0.8	5.7	-29.7	10.0	-36.4
0.01	0.62	0.06	0.03	0.28	296	2L	9.1	3.2	-8.6	7.4	-17.3
0.01	0.96	0.01	0.01	0.01	32	2L	1.1	5.8	-48.6	10.1	-53.5
0.79	0.01	0.06	0.1	0.04	224	3	2.4	4.5	-23.6	8.7	-30.9
0.7	0.03	0.25	0.01	0.01	300	3	0.6	5.8	-30.4	10.1	-37.0
0.21	0.66	0.01	0.03	0.09	112	2L	6.3	3.6	-28.7	7.8	-35.5
0.33	0.43	0.01	0.21	0.02	298	2	2.2	4.4	-31.9	8.6	-38.4
0.16	0.53	0.13	0.01	0.17	274	2L	7.6	3.5	-18.3	7.7	-26.1
0.47	0.11	0.01	0.01	0.4	295	2	6.3	-0.5	20.5	3.5	9.1
0.55	0.4	0.01	0.03	0.01	57	3	1.2	5.1	-32.9	9.4	-39.3
0.57	0.01	0.01	0.01	0.4	295	2	6.5	-0.7	21.3	3.3	9.8
0.31	0.46	0.11	0.08	0.04	255	2	3.8	6.3	-30.1	10.6	-36.7
0.56	0.02	0.01	0.01	0.4	295	2	6.4	-0.7	21.2	3.3	9.7
0.01	0.7	0.01	0.01	0.27	208	2L	9.8	3	-9.9	7.2	-18.5
0.68	0.09	0.12	0.08	0.03	259	3	1.8	4.8	-26.3	9.1	-33.3
0.32	0.43	0.01	0.17	0.07	280	2	4.4	3.5	-25.4	7.7	-32.5
0.19	0.51	0.04	0.07	0.19	265	2L	8	2.9	-13.4	7.1	-21.6
0.01	0.76	0.04	0.18	0.01	286	1	1.2	5.6	-44.8	9.9	-50.0
0.33	0.52	0.08	0.02	0.05	150	2	3.8	4.2	-31.3	8.4	-37.8
0.01	0.89	0.03	0.01	0.06	88	2L	4.6	4.5	-40.7	8.7	-46.3
0.89	0.01	0.06	0.01	0.03	101	3	2	5	-26.9	9.3	-33.8
0.24	0.63	0.11	0.01	0.01	144	2	1.7	5.4	-39.9	9.7	-45.6
0.72	0.11	0.01	0.01	0.15	126	3	6.6	2.7	-9.9	6.9	-18.5
0.01	0.87	0.01	0.1	0.01	149	2L	1.2	5.7	-46.7	10.0	-51.8
0.49	0.35	0.07	0.01	0.08	146	2	4.6	3.7	-23.4	7.9	-30.7
0.78	0.02	0.01	0.01	0.18	146	3	7.3	2.3	-5.5	6.4	-14.5
0.17	0.7	0.08	0.04	0.01	149	2L	1.7	5.4	-41.7	9.7	-47.2

W_R-1252ZC	W_R1234ZE(E)	W_R134	W_R134A	W_R32	GWP	ASHRAE FLAMMABILITY CLASS	AVG GLIDE (K)	COP DEV from 454C	CAP DEV from 454C	COP DEV from 404A	CAP DEV from 404A
0.79	0.01	0.01	0.01	0.18	146	3	7.3	2.3	-5.5	6.4	-14.5
0.01	0.87	0.1	0.01	0.01	133	2L	1	5.9	-47.5	10.2	-52.5
0.01	0.86	0.11	0.01	0.01	144	2L	1	5.9	-47.4	10.2	-52.4
0.73	0.07	0.01	0.01	0.18	146	3	7.1	2.3	-5.6	6.4	-14.6
0.72	0.08	0.01	0.01	0.18	146	3	7.1	2.3	-5.7	6.4	-14.7
0.71	0.09	0.01	0.01	0.18	146	3	7.1	2.3	-5.7	6.4	-14.7
0.7	0.1	0.01	0.01	0.18	146	3	7.1	2.3	-5.8	6.4	-14.7
0.69	0.11	0.01	0.01	0.18	146	3	7.1	2.3	-5.9	6.4	-14.8
0.68	0.12	0.01	0.01	0.18	146	3	7	2.3	-5.9	6.4	-14.8
0.67	0.13	0.01	0.01	0.18	146	3	7	2.3	-6	6.4	-14.9
0.66	0.14	0.01	0.01	0.18	146	3	7	2.3	-6.1	6.4	-15.0
0.65	0.15	0.01	0.01	0.18	146	3	7	2.3	-6.2	6.4	-15.1
0.64	0.16	0.01	0.01	0.18	146	3	7	2.3	-6.2	6.4	-15.1
0.63	0.17	0.01	0.01	0.18	146	2	7	2.3	-6.3	6.4	-15.2
0.62	0.18	0.01	0.01	0.18	146	2	7	2.3	-6.5	6.4	-15.4
0.61	0.19	0.01	0.01	0.18	146	2	7	2.3	-6.6	6.4	-15.5
0.6	0.2	0.01	0.01	0.18	146	2	7	2.3	-6.7	6.4	-15.6
0.59	0.21	0.01	0.01	0.18	146	2	7	2.3	-6.8	6.4	-15.7
0.58	0.22	0.01	0.01	0.18	146	2	7.1	2.3	-6.9	6.4	-15.7
0.57	0.23	0.01	0.01	0.18	146	2	7.1	2.3	-7	6.4	-15.8
0.56	0.24	0.01	0.01	0.18	146	2	7.1	2.3	-7.2	6.4	-16.0
0.55	0.25	0.01	0.01	0.18	146	2	7.1	2.3	-7.3	6.4	-16.1
0.54	0.26	0.01	0.01	0.18	146	2	7.1	2.3	-7.5	6.4	-16.3
0.53	0.27	0.01	0.01	0.18	146	2	7.2	2.3	-7.6	6.4	-16.4
0.52	0.28	0.01	0.01	0.18	146	2	7.2	2.3	-7.8	6.4	-16.6
0.04	0.76	0.01	0.01	0.18	147	2L	9.1	3.5	-21.3	7.7	-28.8
0.75	0.13	0.07	0.02	0.03	125	3	1.9	4.8	-27.3	9.1	-34.2
0.48	0.44	0.02	0.04	0.02	88	2	2	4.7	-32.4	8.9	-38.8
0.1	0.8	0.02	0.07	0.01	121	2L	1.7	5.4	-44	9.7	-49.3
0.73	0.08	0.03	0.01	0.15	148	3	6.5	2.8	-10	7.0	-18.6
0.82	0.01	0.01	0.01	0.15	126	3	6.8	2.7	-9.6	6.9	-18.2
0.41	0.39	0.01	0.01	0.18	146	2	7.6	2.4	-9.9	6.6	-18.5
0.74	0.07	0.03	0.01	0.15	148	3	6.5	2.8	-9.9	7.0	-18.5
0.63	0.19	0.01	0.01	0.16	133	3	6.7	2.5	-9.2	6.7	-17.8
0.65	0.16	0.01	0.02	0.16	146	3	6.6	2.5	-8.8	6.7	-17.5
0.63	0.18	0.02	0.01	0.16	144	3	6.7	2.6	-9.3	6.8	-17.9
0.8	0.01	0.03	0.01	0.15	148	3	6.6	2.8	-9.7	7.0	-18.3
0.72	0.1	0.02	0.01	0.15	137	3	6.5	2.7	-10	6.9	-18.6
0.79	0.02	0.03	0.01	0.15	148	3	6.6	2.8	-9.8	7.0	-18.4
0.78	0.03	0.03	0.01	0.15	148	3	6.6	2.8	-9.8	7.0	-18.4

W_R-1252 ZC	W_R1234Z E(E)	W_R134	W_R134A	W_R32	GWP	ASHRAE FLAMMABILITY CLASS	AVG GLIDE (K)	COP DEV from 454C	CAP DEV from 454C	COP DEV from 404A	CAP DEV from 404A
0.71	0.1	0.02	0.01	0.16	144	3	6.7	2.6	-8.6	6.8	-17.3
0.6	0.21	0.01	0.01	0.17	140	2	6.9	2.4	-8.1	6.6	-16.8
0.61	0.2	0.02	0.01	0.16	144	2	6.7	2.6	-9.5	6.8	-18.1
0.58	0.23	0.01	0.02	0.16	146	2	6.7	2.5	-9.6	6.7	-18.2
0.59	0.22	0.01	0.02	0.16	146	2	6.7	2.5	-9.5	6.7	-18.1
0.49	0.31	0.01	0.01	0.18	146	2	7.3	2.3	-8.3	6.4	-17.0
0.62	0.2	0.01	0.01	0.16	133	2	6.7	2.5	-9.3	6.7	-17.9
0.57	0.25	0.01	0.01	0.16	133	2	6.8	2.5	-10	6.7	-18.6
0.62	0.19	0.02	0.01	0.16	144	2	6.7	2.6	-9.4	6.8	-18.0
0.6	0.21	0.02	0.01	0.16	144	2	6.7	2.6	-9.6	6.8	-18.2
0.59	0.22	0.02	0.01	0.16	144	2	6.7	2.6	-9.7	6.8	-18.3
0.58	0.23	0.02	0.01	0.16	144	2	6.7	2.6	-9.9	6.8	-18.5
0.51	0.29	0.01	0.01	0.18	146	2	7.2	2.3	-8	6.4	-16.7

Example 6

[0161] The presently claimed compositions containing HFO-1252zc, HFO-1234zeE, HFC-134, HFC-32, and CO_2 are compared to R-454C (ASHRAE designation for a refrigerant containing 78.5 wt% HFO-1234yf and 21.5 wt% HFC-32) and R-404A (ASHRAE designation for a refrigerant containing 44 wt% HFC-125, 4 wt% HFC-134a and 52 wt% HFC-143a) under the conditions for refrigeration shown below. Table 6 provides the calculated results.

[0162] Conditions:

Evaporator avg temp, °C	-7
Condenser avg temp, °C	40
Suction temp, °C	18
Subcool, °C	0
Compressor efficiency	70%

[0163] Broadly, for cooling mode, a composition range of 0.2% to 89.5% of CARBON DIOXIDE, 0.2% to 97.5% of R-1252ZC, 0.2% to 97.5% of R1234ZE(E), 0.2% to 25.9% of R134, and 0.2% to 43.8% of R32 will have a GWP less than 300, a maximum average glide of about 10.0 K, a cooling capacity range that has a deviation range of -49.8% to 227.6% from the cooling capacity of R-454C evaluated

with the same conditions set, and the cooling COP range has a deviation range from -56.1% to 6.2% than that of the cooling COP of R-454C evaluated with the same conditions set. Table 6 lists example compositions within the GWP<300 range that have ASHRAE flammability classifications of 2L, 1, 3 and 2.

[0164] Similarly, but a little less broadly for cooling mode, a composition range of 0.2% to 89.5% of CARBON DIOXIDE, 0.2% to 97.5% of R-1252ZC, 0.2% to 97.5% of R1234ZE(E), 0.2% to 12.0% of R134, and 0.2% to 19.9% of R32 will have a GWP less than 149, a maximum average glide of about 10.0 K, an ASHRAE flammability classification of 1, 3, 2L and 2, a cooling capacity range has a deviation of -49.8% to 224.5% from the cooling capacity of R-454C evaluated with the same conditions set, and the cooling COP range has a deviation of -56.1% to 6.0% than that of the cooling COP of R-454C evaluated with the same conditions set.

[0165] Preferred blend composition ranges for cooling mode within a composition range of 0.2% to 4.0% of CARBON DIOXIDE, 25.7% to 85.6% of R-1252ZC, 0.2% to 53.5% of R1234ZE(E), 0.2% to 8.0% of R134, and 7.9% to 19.9% of R32 will have a GWP < 149, a maximum average heat exchanger glide of 10.0 K, an ASHRAE flammability classification of 2 and 3, the minimum and maximum cooling capacities are -10.0% and 2.7% than that of R-454C evaluated at the same conditions set, and the minimum and maximum cooling COP efficiencies are 0.8% and 2.6% than that of R-454C evaluated at the same conditions set.

[0166] Even more preferred blend composition ranges for cooling mode within a composition range of 0.2% to 4.0% of CARBON DIOXIDE, 25.7% to 63.7% of R-1252ZC, 15.8% to 53.5% of R1234ZE(E), 0.2% to 8.0% of R134, and 8.0% to 19.9% of R32 will have a GWP < 149, a maximum average heat exchanger glide of 10.0 K, an ASHRAE flammability classification of 2, the minimum and maximum cooling capacities are -10.0% and 1.9% than that of R-454C evaluated at the same conditions set, and the minimum and maximum cooling COP efficiencies are 1.0% and 2.4% than that of R-454C evaluated at the same conditions set.

[0167] The composition for the even more preferred maximum cooling capacity, which is 1.9% than that of R-454C, is 2.0 wt-% CARBON DIOXIDE, 61.7 wt-% R-1252ZC, 15.9 wt-% R1234ZE(E), 0.5 wt-% R134, and 19.9 wt-% R32, where the COP for cooling is 1.0% than that for R-454C under the same cycle conditions, the

maximum average heat exchanger glide is 9.2 K and its ASHRAE flammability classification is 2.

[0168] The composition for the even more preferred maximum cooling COP efficiency, which is 2.4% than that of R-454C, is 0.2 wt-% CARBON DIOXIDE, 55.7 wt-% R-1252ZC, 27.9 wt-% R1234ZE(E), 0.2 wt-% R134, and 15.9 wt-% R32, where the CAP for cooling is -9.8% than that for R-454C under the same cycle conditions, the maximum average heat exchanger glide is 7.2 K and its ASHRAE flammability classification is 2.

TABLE 6

W_CARBON DIOXIDE	W_R-1252ZC	W_R1234ZE(E)	W_R134	W_R32	GWP	ASHRAE FLAMMABILITY CLASS	AVG GLIDE (K)	COP DEV from 454C	CAP DEV from 454C	COP DEV from 404A	CAP DEV from 404A
0.02	0.002	0.537	0.002	0.438	300	2L	9.6	0.3	16.7	4.4	5.6
0.537	0.002	0.02	0.002	0.438	300	1	9.6	-19.9	193	-16.7	165.2
0.896	0.002	0.08	0.02	0.002	25	1	5.5	-53.6	159.7	-51.7	135.0
0.002	0.935	0.06	0.002	0.002	3	3	0.5	5.7	-30.8	10.0	-37.4
0.02	0.975	0.002	0.002	0.002	3	3	4.3	3.2	-25.5	7.4	-32.6
0.002	0.002	0.955	0.04	0.002	47	2L	0.6	6	-49.5	10.3	-54.3
0.002	0.002	0.975	0.02	0.002	24	2L	0.6	5.9	-49.8	10.2	-54.6
0.696	0.002	0.002	0.002	0.298	205	1	6.6	-28.4	223.7	-25.5	192.9
0.002	0.002	0.736	0.259	0.002	292	1	0.6	6.2	-47.2	10.5	-52.2
0.002	0.637	0.358	0.002	0.002	3	3	0.7	5.3	-33.2	9.6	-39.5
0.002	0.199	0.358	0.002	0.438	300	2L	7.1	-0.2	19.2	3.8	7.9
0.002	0.338	0.657	0.002	0.002	4	2	1.5	5.2	-39.4	9.5	-45.2
0.756	0.002	0.002	0.002	0.239	164	1	5.2	-32.9	227.6	-30.2	196.5
0.836	0.139	0.02	0.002	0.002	5	1	4.5	-56.1	132.1	-54.3	110.0
0.04	0.5	0.28	0.1	0.08	167	2	10	1	-10.9	5.1	-19.4
0.005	0.04	0.577	0.04	0.338	274	2L	9.6	2.1	1.4	6.2	-8.2
0.836	0.1	0.02	0.005	0.04	33	1	4	-52.1	155.3	-50.2	131.0
0.01	0.257	0.594	0.02	0.119	103	2	8.5	2.6	-20.4	6.8	-28.0
0.005	0.696	0.139	0.02	0.139	117	3	6.9	2.5	-10.5	6.7	-19.0
0.78	0.02	0.02	0.06	0.12	149	1	8.8	-34.8	215.7	-32.2	185.7
0.896	0.002	0.06	0.04	0.002	47	1	5.9	-51.4	171.6	-49.4	145.8
0.002	0.915	0.002	0.002	0.08	56	3	4.9	3.6	-19.3	7.8	-27.0
0.002	0.975	0.02	0.002	0.002	3	3	0.5	5.8	-30.7	10.1	-37.3
0.002	0.002	0.975	0.002	0.02	16	2L	2.3	5.2	-47.2	9.5	-52.2
0.02	0.002	0.975	0.002	0.002	4	2L	5.2	3.3	-44.8	7.5	-50.0
0.002	0.896	0.002	0.1	0.002	113	3	0.5	5.8	-30.7	10.1	-37.3

W_CARBON DIOXIDE	W_R-1252ZC	W_R1234ZE(E)	W_R134	W_R32	GWP	ASHRAE FLAMMABILITY CLASS	AVG GLIDE (K)	COP DEV from 454C	CAP DEV from 454C	COP DEV from 404A	CAP DEV from 404A
0.02	0.06	0.78	0.12	0.02	149	2L	6.3	3.1	-38.4	7.3	-44.3
0.002	0.06	0.935	0.002	0.002	4	2L	1	5.7	-48	10.0	-52.9
0.002	0.458	0.338	0.002	0.199	138	2	8	2	-5.6	6.1	-14.6
0.002	0.438	0.557	0.002	0.002	4	2	1.3	5.1	-37	9.4	-43.0
0.776	0.002	0.02	0.002	0.199	138	1	5.5	-34.7	224.5	-32.1	193.7
0.002	0.002	0.876	0.119	0.002	136	2L	0.7	6	-48.6	10.3	-53.5
0.002	0.002	0.896	0.1	0.002	113	2L	0.7	6	-48.8	10.3	-53.7
0.02	0.14	0.66	0.06	0.12	149	2L	10	2.4	-20.6	6.6	-28.1
0.04	0.48	0.38	0.04	0.06	86	2	10	0.9	-14.6	5.0	-22.7
0.002	0.002	0.896	0.02	0.08	77	2L	6.2	4	-37.5	8.2	-43.4
0.02	0.455	0.396	0.119	0.01	140	2	5	3	-28.9	7.2	-35.7
0.02	0.911	0.01	0.04	0.02	58	3	5.2	2.9	-22.9	7.1	-30.2
0.82	0.04	0.06	0.06	0.02	82	1	10	-38.8	205.4	-36.3	176.4
0.02	0.6	0.2	0.06	0.12	149	2	8.1	1.9	-9.8	6.0	-18.4
0.04	0.6	0.2	0.08	0.08	144	3	9.9	1	-9.5	5.1	-18.1
0.002	0.796	0.002	0.002	0.199	137	3	7.9	2	-2.5	6.1	-11.8
0.02	0.856	0.002	0.002	0.119	84	3	8.6	1.8	-8.3	5.9	-17.0
0.005	0.257	0.535	0.005	0.198	140	2	9.2	2.3	-9.9	6.4	-18.5
0.002	0.816	0.002	0.002	0.179	123	3	7.6	2.2	-5.2	6.3	-14.2
0.04	0.7	0.1	0.08	0.08	144	3	9.9	1	-8.5	5.1	-17.2
0.04	0.792	0.01	0.079	0.079	142	3	10	1	-8.4	5.1	-17.1
0.02	0.776	0.002	0.002	0.199	138	3	9.5	1	2.7	5.1	-7.1
0.005	0.832	0.005	0.02	0.139	116	3	7.1	2.6	-10	6.8	-18.6
0.04	0.56	0.24	0.08	0.08	144	2	9.9	1	-10	5.1	-18.6
0.04	0.673	0.198	0.01	0.079	65	3	10	0.8	-9	4.9	-17.6
0.04	0.693	0.178	0.01	0.079	65	3	10	0.8	-8.9	4.9	-17.6
0.002	0.816	0.02	0.002	0.159	111	3	7.3	2.4	-7.7	6.6	-16.5
0.005	0.436	0.356	0.005	0.198	140	2	8.3	1.9	-5.5	6.0	-14.5
0.002	0.279	0.517	0.002	0.199	138	2	8.9	2.3	-9.9	6.4	-18.5
0.002	0.637	0.159	0.002	0.199	138	2	7.6	1.9	-3	6.0	-12.2
0.02	0.614	0.158	0.01	0.198	145	2	9.1	1.1	1.7	5.2	-8.0
0.002	0.597	0.199	0.002	0.199	138	2	7.6	1.9	-3.4	6.0	-12.6
0.02	0.498	0.279	0.005	0.199	141	2	9.4	1.1	0.4	5.2	-9.1
0.02	0.617	0.159	0.005	0.199	141	2	9.2	1	1.9	5.1	-7.8
0.002	0.557	0.279	0.002	0.159	111	2	7.2	2.4	-9.8	6.6	-18.4
0.002	0.577	0.259	0.002	0.159	111	2	7.2	2.4	-9.5	6.6	-18.1
0.002	0.597	0.239	0.002	0.159	111	2	7.1	2.4	-9.2	6.6	-17.8
0.02	0.356	0.416	0.01	0.198	146	2	10	1.3	-2.7	5.4	-11.9
0.005	0.337	0.455	0.005	0.198	140	2	8.8	2.1	-7.7	6.2	-16.5

Example 7

[0169] The presently claimed compositions containing HFO-1252zc, HFO-1234zeE, HFC-134a, HFC-32, and CO_2 are compared to R-454C (ASHRAE designation for a refrigerant containing 78.5 wt% HFO-1234yf and 21.5 wt% HFC-32) and R-404A (ASHRAE designation for a refrigerant containing 44 wt% HFC-125, 4 wt% HFC-134a and 52 wt% HFC-143a) under the conditions for refrigeration shown below. Table 7 provides the calculated results.

[0170] Conditions:

Evaporator avg temp, °C	-7
Condenser avg temp, °C	40
Suction temp, °C	18
Subcool, °C	0
Compressor efficiency	70%

[0171] Broadly, for cooling mode, a composition range of 0.2% to 89.1% of CARBON DIOXIDE, 0.2% to 97.5% of R-1252ZC, 0.2% to 97.5% of R1234ZE(E), 0.2% to 22.0% of R134A, and 0.2% to 43.8% of R32 will have a GWP less than 300, a maximum average glide of about 10.0 K, a cooling capacity range that has a deviation range of -49.6% to 227.6% from the cooling capacity of R-454C evaluated with the same conditions set, and the cooling COP range has a deviation range from -54.1% to 7.5% than that of the cooling COP of R-454C evaluated with the same conditions set. Table 7 lists example compositions within the GWP<300 range that have ASHRAE flammability classifications of 2, 1, 3 and 2L.

[0172] Similarly, but a little less broadly for cooling mode, a composition range of 0.2% to 89.1% of CARBON DIOXIDE, 0.2% to 97.5% of R-1252ZC, 0.2% to 97.5% of R1234ZE(E), 0.2% to 10.0% of R134A, and 0.2% to 19.9% of R32 will have a GWP less than 149, a maximum average glide of about 10.0 K, an ASHRAE flammability classification of 1, 2, 3 and 2L, a cooling capacity range has a deviation of -49.6% to 224.5% from the cooling capacity of R-454C evaluated with the same conditions set, and the cooling COP range has a deviation of -54.1% to 7.5% than that of the cooling COP of R-454C evaluated with the same conditions set.

[0173] Preferred blend composition ranges for cooling mode within a composition range of 0.2% to 4.0% of CARBON DIOXIDE, 25.7% to 85.6% of R-1252ZC, 0.2% to

53.5% of R1234ZE(E), 0.2% to 8.0% of R134A, and 5.9% to 19.9% of R32 will have a GWP < 149, a maximum average heat exchanger glide of 10.0 K, an ASHRAE flammability classification of 2 and 3, the minimum and maximum cooling capacities are -10.0% and 2.8% than that of R-454C evaluated at the same conditions set, and the minimum and maximum cooling COP efficiencies are 0.5% and 2.6% than that of R-454C evaluated at the same conditions set.

[0174] Even more preferred blend composition ranges for cooling mode within a composition range of 0.2% to 4.0% of CARBON DIOXIDE, 25.7% to 63.7% of R-1252ZC, 15.8% to 53.5% of R1234ZE(E), 0.2% to 6.0% of R134A, and 8.0% to 19.9% of R32 will have a GWP < 149, a maximum average heat exchanger glide of 10.0 K, an ASHRAE flammability classification of 2, the minimum and maximum cooling capacities are -10.0% and 2.1% than that of R-454C evaluated at the same conditions set, and the minimum and maximum cooling COP efficiencies are 0.6% and 2.4% than that of R-454C evaluated at the same conditions set.

[0175] The composition for the even more preferred maximum cooling capacity, which is 2.1% than that of R-454C, is 2.0 wt-% CARBON DIOXIDE, 61.7 wt-% R-1252ZC, 15.9 wt-% R1234ZE(E), 0.5 wt-% R134A, and 19.9 wt-% R32, where the COP for cooling is 1.0% than that for R-454C under the same cycle conditions, the maximum average heat exchanger glide is 9.1 K and its ASHRAE flammability classification is 2.

[0176] The composition for the even more preferred maximum cooling COP efficiency, which is 2.4% than that of R-454C, is 0.2 wt-% CARBON DIOXIDE, 55.7 wt-% R-1252ZC, 27.9 wt-% R1234ZE(E), 0.2 wt-% R134A, and 15.9 wt-% R32, where the CAP for cooling is -9.7% than that for R-454C under the same cycle conditions, the maximum average heat exchanger glide is 7.2 K and its ASHRAE flammability classification is 2.

TABLE 7

W_CARBON DIOXIDE	W_R-1252ZC	W_R1234ZE(E)	W_R134A	W_R32	GWP	ASHRAE FLAMMABILITY CLASS	AVG GLIDE (K)	COP DEV from 454C	CAP DEV from 454C	COP DEV from 404A	CAP DEV from 404A
0.02	0.34	0.4	0.22	0.02	300	2	5.6	2.3	-25.3	6.4	-32.4
0.04	0.34	0.38	0.22	0.02	300	2	8.7	0.7	-18.8	4.8	-26.5
0.891	0.003	0.099	0.003	0.003	8	1	5.6	-53.3	160.1	-51.4	135.4
0.002	0.318	0.677	0.002	0.002	4	2	1.5	5.2	-39.9	9.5	-45.6
0.002	0.975	0.02	0.002	0.002	3	3	0.5	5.8	-30.7	10.1	-37.3
0.002	0.002	0.935	0.002	0.06	44	2L	5.1	4.3	-41	8.5	-46.6
0.002	0.002	0.975	0.002	0.02	17	2L	2.3	5.2	-47.2	9.5	-52.2
0.637	0.002	0.002	0.002	0.358	245	1	7.7	-24.9	215	-21.9	185.1
0.02	0.42	0.32	0.22	0.02	300	2	5.2	2.2	-23.2	6.3	-30.5
0.002	0.696	0.002	0.002	0.298	204	2	8	0.6	10.2	4.7	-0.3
0.002	0.557	0.002	0.002	0.438	299	2	6.1	-1.5	26	2.5	14.0
0.002	0.856	0.002	0.139	0.002	182	3	0.8	5.1	-27.6	9.4	-34.5
0.756	0.002	0.002	0.002	0.239	165	1	5.2	-32.9	227.6	-30.2	196.5
0.002	0.002	0.975	0.02	0.002	28	2L	0.7	5.9	-49.6	10.2	-54.4
0.02	0.378	0.577	0.02	0.005	30	2	7	7.5	-27.6	11.9	-34.5
0.832	0.119	0.01	0.02	0.02	40	1	4.1	-54.1	142.7	-52.2	119.6
0.04	0.52	0.26	0.08	0.1	172	2	10	0.5	-5.7	4.6	-14.7
0.02	0.02	0.535	0.01	0.416	295	2L	9.7	0.4	15	4.5	4.1
0.772	0.079	0.059	0.01	0.079	67	1	8.2	-37.3	203.3	-34.8	174.5
0.005	0.637	0.1	0.119	0.139	250	2	6.1	2.2	-8.3	6.3	-17.0
0.002	0.637	0.159	0.199	0.002	261	3	1	4.6	-27.6	8.8	-34.5
0.72	0.02	0.06	0.02	0.18	149	1	9	-30.9	213.5	-28.1	183.7
0.74	0.02	0.04	0.02	0.18	149	1	7.6	-32.4	217.3	-29.7	187.2
0.76	0.02	0.02	0.02	0.18	149	1	6.3	-34.1	219.9	-31.4	189.5
0.002	0.239	0.756	0.002	0.002	4	2	1.6	5.3	-42.2	9.6	-47.7
0.02	0.975	0.002	0.002	0.002	3	3	4.3	3.2	-25.4	7.4	-32.5
0.876	0.002	0.119	0.002	0.002	4	1	7.7	-46.2	191.1	-44.0	163.4
0.002	0.856	0.002	0.002	0.139	97	3	6.9	2.7	-10.7	6.9	-19.2
0.02	0.6	0.26	0.1	0.02	144	3	5.1	2.5	-22.7	6.7	-30.0
0.002	0.478	0.517	0.002	0.002	4	2	1.2	5.1	-36.1	9.4	-42.2
0.002	0.318	0.478	0.002	0.199	138	2	8.6	2.2	-8.8	6.3	-17.5
0.002	0.199	0.796	0.002	0.002	4	2	1.5	5.3	-43.4	9.6	-48.8
0.776	0.002	0.02	0.002	0.199	139	1	5.4	-34.8	224.5	-32.2	193.7
0.04	0.62	0.24	0.02	0.08	80	3	10	0.7	-8.8	4.8	-17.5
0.01	0.079	0.851	0.04	0.02	66	2L	4.6	3.8	-41.2	8.0	-46.8
0.01	0.436	0.515	0.02	0.02	40	2	4	3.5	-31.2	7.7	-37.7
0.02	0.876	0.08	0.005	0.02	20	3	5.2	2.8	-22.8	7.0	-30.1
0.816	0.04	0.005	0.02	0.119	108	1	4	-42.5	201.9	-40.2	173.2

W_CARBON DIOXIDE	W_R-1252ZC	W_R1234ZE(E)	W_R134A	W_R32	GWP	ASHRAE FLAMMABILITY CLASS	AVG GLIDE (K)	COP DEV from 454C	CAP DEV from 454C	COP DEV from 404A	CAP DEV from 404A
0.02	0.34	0.44	0.02	0.18	148	2	9.9	1.3	-5.2	5.4	-14.2
0.04	0.7	0.14	0.04	0.08	106	3	9.8	0.7	-7.5	4.8	-16.3
0.002	0.796	0.002	0.002	0.199	137	3	7.9	2	-2.5	6.1	-11.8
0.02	0.856	0.002	0.002	0.119	84	3	8.6	1.8	-8.2	5.9	-16.9
0.005	0.257	0.535	0.005	0.198	141	2	9.2	2.2	-9.8	6.3	-18.4
0.002	0.836	0.002	0.002	0.159	110	3	7.3	2.5	-7.9	6.7	-16.7
0.04	0.72	0.1	0.08	0.06	145	3	9.2	0.7	-9.4	4.8	-18.0
0.002	0.498	0.298	0.002	0.199	138	2	7.8	2	-4.8	6.1	-13.8
0.04	0.832	0.01	0.059	0.059	118	3	9.5	0.8	-9.6	4.9	-18.2
0.02	0.756	0.02	0.005	0.199	141	3	9.4	1	2.8	5.1	-7.0
0.02	0.416	0.416	0.01	0.139	107	2	9.2	1.6	-10	5.7	-18.6
0.002	0.816	0.002	0.04	0.139	146	3	6.7	2.6	-9.7	6.8	-18.3
0.04	0.6	0.2	0.06	0.1	146	3	10	0.5	-5	4.6	-14.0
0.04	0.62	0.18	0.06	0.1	146	3	10	0.5	-4.8	4.6	-13.8
0.04	0.64	0.16	0.06	0.1	146	3	10	0.5	-4.5	4.6	-13.6
0.04	0.66	0.14	0.06	0.1	146	3	10	0.5	-4.4	4.6	-13.5
0.04	0.68	0.12	0.06	0.1	146	3	10	0.5	-4.2	4.6	-13.3
0.01	0.653	0.139	0.02	0.178	147	3	8	1.7	-3.2	5.8	-12.4
0.02	0.455	0.376	0.01	0.139	107	2	9	1.6	-9.2	5.7	-17.8
0.04	0.52	0.3	0.06	0.08	133	2	9.9	0.6	-9.3	4.7	-17.9
0.002	0.557	0.279	0.002	0.159	111	2	7.2	2.4	-9.7	6.6	-18.3
0.002	0.637	0.159	0.002	0.199	138	2	7.6	1.9	-3	6.0	-12.2
0.005	0.634	0.158	0.005	0.198	141	2	7.8	1.8	-2.3	5.9	-11.6
0.04	0.56	0.26	0.06	0.08	133	2	9.8	0.6	-8.6	4.7	-17.3
0.002	0.617	0.179	0.002	0.199	138	2	7.6	1.9	-3.1	6.0	-12.3
0.02	0.617	0.159	0.005	0.199	141	2	9.1	1	2.1	5.1	-7.6
0.002	0.577	0.259	0.002	0.159	111	2	7.1	2.4	-9.4	6.6	-18.0
0.002	0.597	0.239	0.002	0.159	111	2	7.1	2.4	-9.1	6.6	-17.7
0.04	0.54	0.28	0.06	0.08	133	2	9.9	0.6	-8.9	4.7	-17.6
0.02	0.358	0.418	0.005	0.199	142	2	10	1.2	-2.4	5.3	-11.7
0.02	0.56	0.24	0.02	0.16	135	2	8.8	1.3	-3.8	5.4	-12.9

Example 8

[0177] The presently claimed compositions containing HFO-1252zc, HFO-1234zeE, HFC-134, and HFC-32 are compared to R-404A (ASHRAE designation for a refrigerant containing 44 wt% HFC-125, 4 wt% HFC-134a and 52 wt% HFC-143a) under the conditions for refrigeration shown below. Tables 8A and 8B provide the calculated results.

Conditions:

Evaporator avg temp, °C	-7
Condenser avg temp, °C	43
Superheat, °C	0.0
Subcool, °C	8.3
Compressor efficiency	70%

[0178] Broadly, for cooling mode, a composition range of 1.0-21.0% of HFO-1252zc, 49.0-94.0% of HFO-1234ze(E), 1.0-30.0% of HFC-134, and of 1.0-8.0% of HFC-32 will have a GWP less than 150, a maximum average glide of 6.0 K, an ASHRAE flammability rating of 2L, a cooling capacity in a range of 50.0-61.3% of the cooling capacity of R-404A evaluated with the same conditions set, and a cooling COP range in a range of 106.6-108.7% of the cooling COP of R-404A evaluated with the same conditions set.

[0179] Similarly, but a little less broadly for cooling mode, a composition range of 14.0-21.0% of HFO-1252zc, 64.0-73.0% of HFO-1234ze(E), 3.0-8.0% of HFC-134, and of 7.0-8.0% of HFC-32 will have a GWP less than 148, a maximum average glide of 6.0K, an ASHRAE flammability rating of 2L, a cooling capacity in a range of 60.0-62.0% of the cooling capacity of R-404A evaluated with the same conditions set, and a cooling COP range in a range of 106.5-106.8% of the cooling COP of R-404A evaluated with the same conditions set.

[0180] Even more preferred compositions of 15.0-19.0% of HFO-1252zc, 68.0-72.0% of HFO-1234ze(E), 3.0-7.0% of HFC-134, and of 6.0-10.0% of HFC-32 will have a GWP of less than 137, a maximum average glide of 5.9 K, an ASHRAE flammability rating of 2L, a cooling capacity in a range of 58.1-61.3% of the cooling capacity of R-404A evaluated with the same conditions set, and a cooling COP range in a range of 106.6-106.9 % of the cooling COP of R-404A evaluated with the same conditions set.

TABLE 8A

wt% R32	wt% R1252zc	%wt R134	%wt R1234zeE	GWP	AVG GLIDE (K)	$P_{Suction}$ (bar)	$T_{Discharge}$ (°C)	$P_{Discharge}$ (bar)	ASHRAE Flammability Class	CAP dev from R404A (%)	COP dev from R404A (%)
0.08	0.19	0.05	0.68	125	5.8	2.4	88.9	11.7	2L	-38.7	6.6
0.08	0.18	0.08	0.66	147	5.7	2.4	88.9	11.7	2L	-38.8	6.6
0.08	0.17	0.08	0.67	147	5.7	2.4	88.7	11.6	2L	-39.1	6.7
0.08	0.17	0.07	0.68	136	5.8	2.4	88.7	11.6	2L	-39.2	6.6
0.08	0.17	0.06	0.69	125	5.8	2.4	88.6	11.6	2L	-39.2	6.6
0.07	0.21	0.08	0.64	140	5.2	2.4	88.6	11.6	2L	-39.4	6.7
0.07	0.2	0.08	0.65	140	5.2	2.4	88.5	11.5	2L	-39.7	6.7
0.07	0.2	0.07	0.66	129	5.3	2.4	88.4	11.5	2L	-39.7	6.7
0.08	0.15	0.05	0.72	114	5.9	2.4	88.3	11.5	2L	-39.9	6.7
0.08	0.15	0.04	0.73	103	6.0	2.4	88.2	11.5	2L	-39.9	6.6
0.07	0.19	0.08	0.66	140	5.2	2.4	88.3	11.5	2L	-39.9	6.7
0.07	0.19	0.07	0.67	129	5.3	2.4	88.3	11.5	2L	-40.0	6.7
0.08	0.14	0.07	0.71	136	5.8	2.4	88.3	11.5	2L	-40.0	6.7
0.07	0.19	0.06	0.68	118	5.4	2.4	88.2	11.4	2L	-40.1	6.7
0.07	0.19	0.04	0.7	96	5.5	2.4	88.1	11.4	2L	-40.2	6.6
0.08	0.13	0.07	0.72	136	5.8	2.4	88.1	11.4	2L	-40.3	6.8
0.07	0.18	0.06	0.69	118	5.4	2.4	88.1	11.4	2L	-40.4	6.7
0.07	0.18	0.05	0.7	107	5.4	2.4	88.0	11.4	2L	-40.4	6.7
0.08	0.13	0.04	0.75	103	6.0	2.3	87.9	11.4	2L	-40.5	6.7
0.08	0.12	0.05	0.75	114	5.9	2.3	87.9	11.4	2L	-40.7	6.8
0.07	0.17	0.03	0.73	85	5.6	2.3	87.8	11.3	2L	-40.8	6.7
0.08	0.11	0.06	0.75	125	5.9	2.3	87.8	11.3	2L	-41.0	6.8
0.06	0.19	0.09	0.66	144	4.7	2.3	87.7	11.2	2L	-41.3	6.9
0.07	0.14	0.08	0.71	140	5.3	2.3	87.7	11.2	2L	-41.4	6.9
0.08	0.1	0.04	0.78	103	6.0	2.3	87.5	11.3	2L	-41.4	6.8
0.07	0.14	0.06	0.73	118	5.4	2.3	87.5	11.2	2L	-41.5	6.8
0.07	0.15	0.01	0.77	63	5.7	2.3	87.4	11.2	2L	-41.5	6.7
0.06	0.19	0.04	0.71	89	5.0	2.3	87.4	11.2	2L	-41.6	6.8
0.08	0.09	0.03	0.8	114	5.9	2.3	87.4	11.2	2L	-41.7	6.9
0.06	0.18	0.07	0.69	122	4.8	2.3	87.5	11.1	2L	-41.7	6.9
0.06	0.18	0.04	0.72	89	5.0	2.3	87.3	11.1	2L	-41.9	6.8
0.08	0.07	0.06	0.79	147	5.7	2.3	87.3	11.1	2L	-42.1	7.0
0.05	0.21	0.09	0.65	137	4.2	2.3	87.3	11.0	2L	-42.1	6.9
0.08	0.07	0.05	0.8	136	5.8	2.3	87.3	11.1	2L	-42.2	7.0
0.06	0.17	0.02	0.75	78	5.0	2.3	87.1	11.1	2L	-42.3	6.8
0.07	0.12	0.03	0.78	85	5.6	2.3	87.1	11.1	2L	-42.3	6.8

wt% R32	wt% R1252zc	%wt R134	%wt R1234zeE	GWP	AVG GLIDE (K)	$P_{Suction}$ (bar)	$T_{Discharge}$ (°C)	$P_{Discharge}$ (bar)	ASHRAE Flammability Class	CAP dev from R404A (%)	COP dev from R404A (%)
0.07	0.11	0.07	0.75	129	5.3	2.3	87.2	11.1	2L	-42.3	6.9
0.07	0.12	0.02	0.79	74	5.6	2.3	87.0	11.1	2L	-42.3	6.8
0.06	0.17	0	0.77	56	5.2	2.3	87.0	11.1	2L	-42.4	6.7
0.06	0.15	0.08	0.71	144	4.7	2.3	87.2	11.0	2L	-42.4	7.0
0.07	0.12	0.01	0.8	63	5.7	2.3	87.0	11.1	2L	-42.4	6.8
0.06	0.15	0.06	0.73	122	4.8	2.3	87.1	11.0	2L	-42.5	6.9
0.07	0.1	0.07	0.76	140	5.3	2.2	87.1	11.0	2L	-42.5	7.0
0.07	0.11	0.03	0.79	85	5.6	2.3	87.0	11.0	2L	-42.6	6.8
0.07	0.11	0	0.82	52	5.8	2.2	86.8	11.0	2L	-42.7	6.8
0.07	0.1	0.04	0.79	107	5.4	2.2	86.9	11.0	2L	-42.7	6.9
0.06	0.14	0.07	0.73	133	4.8	2.3	87.0	11.0	2L	-42.8	7.0
0.06	0.15	0.3	0.49	47	5.2	2.3	86.9	11.0	2L	-42.8	6.8
0.08	0.05	0.06	0.81	125	5.8	2.2	86.9	11.0	2L	-42.9	7.0
0.05	0.18	0.09	0.68	148	4.2	2.3	87.0	10.9	2L	-42.9	7.0
0.07	0.1	0.3	0.53	54	5.7	2.2	86.9	11.0	2L	-42.9	6.8
0.06	0.14	0.05	0.75	111	4.9	2.2	86.9	10.9	2L	-42.9	6.9
0.06	0.13	0.08	0.73	133	4.8	2.2	86.9	10.9	2L	-43.0	7.0
0.07	0.09	0.03	0.81	96	5.5	2.2	86.7	10.9	2L	-43.1	6.9
0.05	0.17	0.1	0.68	149	4.2	2.2	86.8	10.9	2L	-43.1	7.1
0.07	0.08	0.07	0.78	140	5.2	2.2	86.8	10.9	2L	-43.2	7.0
0.05	0.18	0.05	0.72	104	4.3	2.2	86.7	10.9	2L	-43.2	7.0
0.08	0.04	0.06	0.82	125	5.7	2.2	86.8	10.9	2L	-43.2	7.0
0.06	0.12	0.09	0.73	144	4.7	2.2	86.8	10.9	2L	-43.3	7.1
0.06	0.12	0.08	0.74	133	4.8	2.2	86.7	10.9	2L	-43.3	7.0
0.05	0.18	0.02	0.75	72	4.5	2.2	86.5	10.8	2L	-43.4	6.9
0.06	0.12	0.07	0.75	122	4.8	2.2	86.7	10.9	2L	-43.4	7.0
0.06	0.13	0	0.81	45	5.2	2.2	86.4	10.9	2L	-43.6	6.8
0.06	0.12	0.04	0.78	90	5.0	2.2	86.5	10.8	2L	-43.6	7.0
0.08	0.02	0.08	0.82	147	5.6	2.2	86.6	10.8	2L	-43.7	7.2
0.06	0.11	0.06	0.77	112	4.9	2.2	86.5	10.8	2L	-43.8	7.0
0.04	0.2	0.09	0.67	131	3.6	2.2	86.5	10.7	2L	-43.8	7.1
0.05	0.16	0.04	0.75	83	4.4	2.2	86.3	10.7	2L	-43.9	7.0
0.05	0.17	0	0.78	39	4.7	2.2	86.2	10.8	2L	-43.9	6.9
0.06	0.11	0.04	0.79	90	5.0	2.2	86.3	10.8	2L	-43.9	7.0
0.07	0.06	0.04	0.83	107	5.4	2.2	86.4	10.8	2L	-44.0	7.1
0.06	0.1	0.07	0.77	123	4.8	2.2	86.4	10.7	2L	-44.0	7.1
0.05	0.16	0.02	0.77	61	4.5	2.2	86.2	10.7	2L	-44.0	6.9
0.08	0.01	0.08	0.83	147	5.5	2.2	86.5	10.8	2L	-44.1	7.2

wt% R32	wt% R1252zc	%wt R134	%wt R1234zeE	GWP	AVG GLIDE (K)	$P_{Suction}$ (bar)	$T_{Discharge}$ (°C)	$P_{Discharge}$ (bar)	ASHRAE Flammability Class	CAP dev from R404A (%)	COP dev from R404A (%)
0.08	0.02	0.02	0.88	81	6.0	2.2	86.3	10.8	2L	-44.1	7.0
0.07	0.06	0.02	0.85	86	5.5	2.2	86.3	10.8	2L	-44.1	7.0
0.07	0.05	0.06	0.82	130	5.2	2.2	86.3	10.7	2L	-44.2	7.1
0.05	0.15	0.04	0.76	83	4.4	2.2	86.2	10.7	2L	-44.2	7.0
0.07	0.06	0.01	0.86	75	5.6	2.2	86.2	10.8	2L	-44.2	7.0
0.06	0.11	0	0.83	46	5.2	2.2	86.1	10.8	2L	-44.2	6.9
0.05	0.15	0.03	0.77	72	4.5	2.2	86.1	10.7	2L	-44.3	7.0
0.04	0.18	0.1	0.68	142	3.6	2.2	86.3	10.6	2L	-44.3	7.2
0.05	0.15	0.02	0.78	61	4.5	2.2	86.1	10.7	2L	-44.3	7.0
0.06	0.1	0.02	0.82	68	5.1	2.2	86.1	10.7	2L	-44.4	7.0
0.07	0.05	0.03	0.85	97	5.4	2.2	86.2	10.7	2L	-44.4	7.1
0.07	0.05	0.02	0.86	86	5.5	2.2	86.1	10.7	2L	-44.4	7.0
0.05	0.14	0.04	0.77	83	4.4	2.2	86.0	10.7	2L	-44.5	7.0
0.08	0.01	0.01	0.9	70	6.0	2.1	86.1	10.7	2L	-44.5	7.0
0.06	0.08	0.08	0.78	145	4.7	2.2	86.2	10.7	2L	-44.5	7.2
0.08	0	0.07	0.85	136	5.5	2.1	86.3	10.7	2L	-44.5	7.2
0.07	0.05	0.01	0.87	75	5.5	2.2	86.1	10.7	2L	-44.5	7.0
0.08	0	0.06	0.86	125	5.6	2.1	86.2	10.7	2L	-44.5	7.2
0.05	0.12	0.1	0.73	149	4.2	2.2	86.1	10.6	2L	-44.6	7.2
0.08	0	0.03	0.89	92	5.8	2.1	86.1	10.7	2L	-44.7	7.1
0.04	0.18	0.04	0.74	76	3.8	2.2	85.9	10.6	2L	-44.8	7.1
0.07	0.03	0.08	0.82	141	5.1	2.1	86.1	10.6	2L	-44.8	7.2
0.07	0.04	0.02	0.87	86	5.4	2.1	86.0	10.7	2L	-44.8	7.1
0.05	0.13	0.03	0.79	72	4.5	2.2	85.9	10.6	2L	-44.8	7.0
0.07	0.04	0	0.89	64	5.6	2.1	85.9	10.7	2L	-44.9	7.0
0.05	0.12	0.06	0.77	105	4.3	2.2	85.9	10.6	2L	-44.9	7.1
0.04	0.16	0.09	0.71	131	3.7	2.2	85.9	10.5	2L	-44.9	7.2
0.05	0.13	0.02	0.8	61	4.5	2.2	85.8	10.6	2L	-44.9	7.0
0.04	0.17	0.05	0.74	87	3.8	2.2	85.8	10.5	2L	-45.0	7.1
0.07	0.03	0.05	0.85	108	5.3	2.1	85.9	10.6	2L	-45.0	7.2
0.05	0.11	0.08	0.76	127	4.2	2.1	85.9	10.5	2L	-45.0	7.2
0.03	0.2	0.11	0.66	146	3.0	2.2	85.9	10.5	2L	-45.0	7.3
0.06	0.08	0	0.86	57	5.1	2.1	85.8	10.6	2L	-45.1	7.0
0.04	0.16	0.07	0.73	109	3.7	2.2	85.8	10.5	2L	-45.1	7.2
0.07	0.03	0.03	0.87	86	5.4	2.1	85.8	10.6	2L	-45.1	7.1
0.06	0.06	0.08	0.8	145	4.6	2.1	85.9	10.6	2L	-45.1	7.2
0.06	0.07	0.03	0.84	90	4.9	2.1	85.8	10.6	2L	-45.2	7.1
0.06	0.06	0.07	0.81	134	4.7	2.1	85.9	10.5	2L	-45.2	7.2

wt% R32	wt% R1252zc	%wt R134	%wt R1234zeE	GWP	AVG GLIDE (K)	$P_{Suction}$ (bar)	$T_{Discharge}$ (°C)	$P_{Discharge}$ (bar)	ASHRAE Flammability Class	CAP dev from R404A (%)	COP dev from R404A (%)
0.05	0.12	0.02	0.81	61	4.5	2.1	85.7	10.5	2L	-45.2	7.0
0.06	0.07	0.02	0.85	79	5.0	2.1	85.7	10.6	2L	-45.2	7.1
0.06	0.06	0.06	0.82	123	4.7	2.1	85.8	10.5	2L	-45.2	7.2
0.05	0.1	0.09	0.76	138	4.2	2.1	85.8	10.5	2L	-45.2	7.2
0.06	0.07	0.3	0.57	47	5.1	2.1	85.8	10.6	2L	-45.3	7.0
0.04	0.15	0.08	0.73	120	3.7	2.1	85.7	10.5	2L	-45.3	7.2
0.07	0.03	0	0.9	53	5.6	2.1	85.7	10.6	2L	-45.3	7.0
0.04	0.15	0.07	0.74	109	3.7	2.1	85.6	10.5	2L	-45.3	7.2
0.06	0.06	0.04	0.84	101	4.8	2.1	85.7	10.5	2L	-45.4	7.2
0.06	0.05	0.09	0.8	145	4.6	2.1	85.8	10.5	2L	-45.4	7.3
0.04	0.15	0.06	0.75	98	3.8	2.1	85.6	10.4	2L	-45.4	7.2
0.05	0.09	0.1	0.76	149	4.1	2.1	85.7	10.5	2L	-45.5	7.3
0.03	0.19	0.09	0.69	124	3.1	2.2	85.6	10.4	2L	-45.5	7.3
0.04	0.16	0.01	0.79	43	4.0	2.1	85.4	10.4	2L	-45.6	7.1
0.05	0.1	0.05	0.8	94	4.3	2.1	85.6	10.5	2L	-45.6	7.2
0.04	0.14	0.07	0.75	109	3.7	2.1	85.5	10.4	2L	-45.6	7.2
0.05	0.1	0.04	0.81	83	4.4	2.1	85.5	10.4	2L	-45.6	7.2
0.07	0.01	0.03	0.89	97	5.2	2.1	85.6	10.5	2L	-45.7	7.2
0.05	0.09	0.07	0.79	116	4.2	2.1	85.5	10.4	2L	-45.7	7.2
0.07	0.01	0.02	0.9	86	5.3	2.1	85.5	10.5	2L	-45.8	7.2
0.07	0.01	0.3	0.62	54	5.5	2.1	85.6	10.5	2L	-45.8	7.1
0.05	0.09	0.06	0.8	105	4.3	2.1	85.5	10.4	2L	-45.8	7.2
0.04	0.14	0.05	0.77	87	3.8	2.1	85.4	10.4	2L	-45.8	7.2
0.03	0.17	0.11	0.69	146	3.0	2.1	85.4	10.3	2L	-45.8	7.4
0.06	0.05	0.02	0.87	68	5.0	2.1	85.4	10.4	2L	-45.9	7.1
0.05	0.08	0.07	0.8	127	4.2	2.1	85.5	10.4	2L	-45.9	7.3
0.06	0.05	0.01	0.88	57	5.0	2.1	85.3	10.4	2L	-46.0	7.1
0.04	0.13	0.06	0.77	98	3.7	2.1	85.3	10.3	2L	-46.0	7.3
0.07	0	0.03	0.9	97	5.2	2.1	85.5	10.4	2L	-46.0	7.2
0.04	0.13	0.05	0.78	87	3.8	2.1	85.2	10.3	2L	-46.1	7.2
0.07	0	0.02	0.91	86	5.3	2.1	85.4	10.4	2L	-46.1	7.2
0.05	0.09	0.02	0.84	61	4.5	2.1	85.2	10.4	2L	-46.1	7.1
0.07	0	0.3	0.63	54	5.4	2.1	85.5	10.4	2L	-46.1	7.1
0.04	0.12	0.08	0.76	120	3.7	2.1	85.3	10.3	2L	-46.1	7.3
0.04	0.14	0.01	0.81	43	3.9	2.1	85.1	10.3	2L	-46.1	7.1
0.07	0	0.01	0.92	75	5.3	2.1	85.3	10.4	2L	-46.2	7.2
0.05	0.07	0.08	0.8	138	4.1	2.1	85.4	10.3	2L	-46.2	7.3
0.05	0.08	0.04	0.83	94	4.3	2.1	85.3	10.4	2L	-46.2	7.2

wt% R32	wt% R1252zc	%wt R134	%wt R1234zeE	GWP	AVG GLIDE (K)	$P_{Suction}$ (bar)	$T_{Discharge}$ (°C)	$P_{Discharge}$ (bar)	ASHRAE Flammability Class	CAP dev from R404A (%)	COP dev from R404A (%)
0.03	0.17	0.07	0.73	102	3.1	2.1	85.2	10.3	2L	-46.2	7.4
0.04	0.12	0.07	0.77	109	3.7	2.1	85.2	10.3	2L	-46.2	7.3
0.03	0.17	0.06	0.74	91	3.1	2.1	85.1	10.3	2L	-46.3	7.3
0.05	0.07	0.06	0.82	116	4.2	2.1	85.3	10.3	2L	-46.3	7.3
0.06	0.03	0.05	0.86	101	4.7	2.1	85.3	10.4	2L	-46.4	7.3
0.03	0.17	0.05	0.75	80	3.2	2.1	85.0	10.2	2L	-46.4	7.3
0.03	0.16	0.08	0.73	113	3.1	2.1	85.1	10.2	2L	-46.4	7.4
0.05	0.06	0.09	0.8	149	4.0	2.1	85.3	10.3	2L	-46.4	7.4
0.06	0.03	0.04	0.87	90	4.8	2.1	85.2	10.3	2L	-46.4	7.2
0.03	0.17	0.04	0.76	69	3.2	2.1	85.0	10.2	2L	-46.5	7.3
0.05	0.07	0.04	0.84	94	4.3	2.1	85.1	10.3	2L	-46.5	7.3
0.03	0.16	0.06	0.75	91	3.1	2.1	85.0	10.2	2L	-46.6	7.4
0.05	0.07	0.03	0.85	83	4.3	2.1	85.1	10.3	2L	-46.6	7.2
0.04	0.1	0.09	0.77	131	3.6	2.1	85.1	10.2	2L	-46.6	7.4
0.03	0.15	0.08	0.74	113	3.1	2.1	85.0	10.2	2L	-46.7	7.4
0.06	0.02	0.05	0.87	101	4.7	2.1	85.1	10.3	2L	-46.7	7.3
0.02	0.2	0.07	0.71	106	2.4	2.1	84.9	10.1	2L	-46.7	7.5
0.05	0.06	0.05	0.84	105	4.2	2.1	85.0	10.3	2L	-46.7	7.3
0.04	0.12	0.01	0.83	43	3.9	2.1	84.9	10.2	2L	-46.7	7.2
0.05	0.05	0.08	0.82	138	4.0	2.1	85.1	10.2	2L	-46.8	7.4
0.04	0.11	0.03	0.82	65	3.8	2.1	84.8	10.2	2L	-46.9	7.3
0.03	0.15	0.05	0.77	80	3.1	2.1	84.8	10.1	2L	-46.9	7.4
0.04	0.11	0.02	0.83	54	3.9	2.1	84.8	10.2	2L	-46.9	7.2
0.04	0.09	0.09	0.78	131	3.6	2.1	84.9	10.2	2L	-46.9	7.4
0.04	0.1	0.05	0.81	87	3.7	2.1	84.8	10.2	2L	-47.0	7.3
0.03	0.15	0.04	0.78	69	3.2	2.1	84.7	10.1	2L	-47.0	7.4
0.06	0	0.08	0.86	145	4.4	2.0	85.1	10.2	2L	-47.1	7.5
0.03	0.13	0.1	0.74	135	3.0	2.1	84.8	10.1	2L	-47.1	7.5
0.06	0.01	0.03	0.9	90	4.7	2.0	84.9	10.2	2L	-47.1	7.3
0.04	0.11	0	0.85	32	4.0	2.1	84.7	10.2	2L	-47.1	7.2
0.02	0.19	0.05	0.74	84	2.5	2.1	84.6	10.1	2L	-47.1	7.5
0.05	0.04	0.08	0.83	127	4.0	2.0	84.9	10.2	2L	-47.2	7.4
0.06	0.01	0.3	0.63	47	4.9	2.0	84.9	10.2	2L	-47.2	7.2
0.03	0.14	0.05	0.78	80	3.1	2.1	84.6	10.1	2L	-47.2	7.4
0.04	0.08	0.08	0.8	131	3.5	2.1	84.8	10.1	2L	-47.2	7.4
0.05	0.04	0.07	0.84	116	4.1	2.0	84.8	10.2	2L	-47.3	7.4
0.05	0.05	0.3	0.6	40	4.4	2.0	84.8	10.2	2L	-47.3	7.2
0.02	0.17	0.1	0.71	128	2.4	2.1	84.6	10.0	2L	-47.3	7.6

wt% R32	wt% R1252zc	%wt R134	%wt R1234zeE	GWP	AVG GLIDE (K)	$P_{Suction}$ (bar)	$T_{Discharge}$ (°C)	$P_{Discharge}$ (bar)	ASHRAE Flammability Class	CAP dev from R404A (%)	COP dev from R404A (%)
0.03	0.13	0.07	0.77	102	3.1	2.1	84.6	10.1	2L	-47.3	7.5
0.05	0.03	0.1	0.82	149	3.9	2.0	84.9	10.1	2L	-47.3	7.5
0.03	0.15	0	0.82	25	3.3	2.1	84.4	10.1	2L	-47.4	7.3
0.01	0.21	0.12	0.66	144	1.7	2.1	84.5	10.0	2L	-47.5	7.7
0.02	0.16	0.11	0.71	139	2.3	2.1	84.5	10.0	2L	-47.5	7.6
0.04	0.07	0.08	0.81	131	3.5	2.0	84.6	10.1	2L	-47.5	7.5
0.03	0.14	0.01	0.82	36	3.3	2.1	84.4	10.1	2L	-47.6	7.3
0.02	0.17	0.07	0.74	95	2.4	2.1	84.4	10.0	2L	-47.6	7.6
0.06	0	0	0.94	57	4.8	2.0	84.6	10.1	2L	-47.6	7.3
0.05	0.02	0.1	0.83	149	3.9	2.0	84.7	10.1	2L	-47.7	7.5
0.05	0.03	0.05	0.87	94	4.1	2.0	84.6	10.1	2L	-47.7	7.4
0.04	0.06	0.09	0.81	142	3.4	2.0	84.6	10.0	2L	-47.8	7.5
0.03	0.12	0.05	0.8	80	3.1	2.0	84.3	10.0	2L	-47.8	7.5
0.04	0.08	0.01	0.87	54	3.8	2.0	84.4	10.0	2L	-47.8	7.3
0.04	0.06	0.08	0.82	131	3.5	2.0	84.5	10.0	2L	-47.9	7.5
0.03	0.1	0.11	0.76	146	2.9	2.0	84.5	10.0	2L	-47.9	7.6
0.03	0.13	0.01	0.83	36	3.2	2.0	84.2	10.0	2L	-47.9	7.4
0.05	0.02	0.07	0.86	116	4.0	2.0	84.5	10.0	2L	-47.9	7.5
0.03	0.11	0.06	0.8	91	3.0	2.0	84.3	10.0	2L	-48.0	7.5
0.01	0.19	0.11	0.69	133	1.7	2.0	84.1	9.8	2L	-48.1	7.8
0.02	0.14	0.1	0.74	129	2.3	2.0	84.2	9.9	2L	-48.2	7.7
0.02	0.16	0.03	0.79	52	2.5	2.0	84.0	9.9	2L	-48.3	7.6
0.02	0.14	0.09	0.75	118	2.3	2.0	84.1	9.9	2L	-48.3	7.7
0.03	0.09	0.09	0.79	125	2.9	2.0	84.2	9.9	2L	-48.3	7.6
0.02	0.13	0.1	0.75	140	2.3	2.0	84.1	9.9	2L	-48.4	7.7
0.04	0.05	0.06	0.85	98	3.5	2.0	84.2	9.9	2L	-48.4	7.5
0.01	0.18	0.1	0.71	122	1.7	2.0	83.9	9.8	2L	-48.4	7.8
0.03	0.08	0.11	0.78	147	2.8	2.0	84.2	9.9	2L	-48.5	7.6
0.01	0.19	0.07	0.73	89	1.7	2.0	83.8	9.8	2L	-48.5	7.8
0.05	0.01	0.04	0.9	83	4.1	2.0	84.2	10.0	2L	-48.5	7.4
0.02	0.16	0	0.82	19	2.6	2.0	83.8	9.8	2L	-48.5	7.5
0.01	0.18	0.09	0.72	111	1.7	2.0	83.8	9.8	2L	-48.5	7.8
0.02	0.15	0.03	0.8	52	2.5	2.0	83.8	9.8	2L	-48.5	7.6
0.03	0.08	0.1	0.79	136	2.9	2.0	84.1	9.9	2L	-48.5	7.6
0.04	0.06	0	0.9	43	3.8	2.0	84.0	9.9	2L	-48.5	7.4
0.02	0.13	0.07	0.78	107	2.3	2.0	83.9	9.8	2L	-48.6	7.7
0.02	0.12	0.1	0.76	140	2.3	2.0	83.9	9.8	2L	-48.7	7.7
0.04	0.05	0.03	0.88	65	3.6	2.0	84.0	9.9	2L	-48.7	7.4

wt% R32	wt% R1252zc	%wt R134	%wt R1234zeE	GWP	AVG GLIDE (K)	$P_{Suction}$ (bar)	$T_{Discharge}$ (°C)	$P_{Discharge}$ (bar)	ASHRAE Flammability Class	CAP dev from R404A (%)	COP dev from R404A (%)
0	0.21	0.13	0.66	148	0.9	2.0	83.7	9.7	2L	-48.7	8.0
0.01	0.18	0.07	0.74	89	1.7	2.0	83.7	9.7	2L	-48.7	7.8
0.02	0.13	0.06	0.79	96	2.4	2.0	83.8	9.8	2L	-48.7	7.7
0.03	0.08	0.07	0.82	103	2.9	2.0	83.9	9.8	2L	-48.8	7.6
0.02	0.14	0.03	0.81	52	2.5	2.0	83.7	9.8	2L	-48.8	7.6
0.03	0.07	0.1	0.8	136	2.8	2.0	84.0	9.8	2L	-48.8	7.7
0.01	0.17	0.08	0.74	100	1.7	2.0	83.6	9.7	2L	-48.9	7.8
0.02	0.12	0.07	0.79	107	2.3	2.0	83.7	9.8	2L	-48.9	7.7
0.04	0.05	0	0.91	33	3.8	2.0	83.8	9.9	2L	-48.9	7.4
0.03	0.09	0.02	0.86	48	3.1	2.0	83.7	9.8	2L	-49.0	7.5
0.03	0.08	0.05	0.84	81	3.0	2.0	83.8	9.8	2L	-49.0	7.6
0.04	0.04	0.03	0.89	66	3.6	2.0	83.8	9.8	2L	-49.0	7.5
0.02	0.12	0.06	0.8	96	2.3	2.0	83.7	9.7	2L	-49.0	7.7
0.01	0.16	0.09	0.74	111	1.7	2.0	83.5	9.7	2L	-49.1	7.9
0.04	0.03	0.04	0.89	77	3.5	2.0	83.7	9.8	2L	-49.2	7.5
0.04	0.02	0.07	0.87	110	3.4	2.0	83.8	9.8	2L	-49.3	7.6
0.03	0.07	0.05	0.85	81	2.9	2.0	83.6	9.7	2L	-49.3	7.6
0.02	0.1	0.09	0.79	129	2.2	2.0	83.6	9.7	2L	-49.3	7.8
0	0.19	0.12	0.69	137	0.9	2.0	83.3	9.6	2L	-49.4	8.1
0.01	0.14	0.07	0.78	89	1.9	2.0	82.7	9.6	2L	-49.4	8.6
0.02	0.11	0.05	0.82	85	2.3	2.0	83.4	9.7	2L	-49.4	7.7
0.01	0.15	0.03	0.81	45	2.0	2.0	82.5	9.5	2L	-49.4	8.7
0.04	0.01	0.09	0.86	132	3.2	1.9	83.8	9.7	2L	-49.4	7.7
0.01	0.15	0.08	0.76	100	1.7	2.0	83.3	9.6	2L	-49.5	7.9
0.02	0.11	0.03	0.84	63	2.4	2.0	83.3	9.6	2L	-49.6	7.7
0.04	0.02	0.03	0.91	66	3.5	1.9	83.5	9.7	2L	-49.6	7.5
0	0.19	0.09	0.72	104	0.9	2.0	83.1	9.5	2L	-49.7	8.1
0.03	0.06	0.03	0.88	70	2.9	1.9	83.4	9.7	2L	-49.7	7.6
0.02	0.1	0.05	0.83	85	2.3	2.0	83.3	9.6	2L	-49.7	7.7
0.01	0.13	0.11	0.75	133	1.6	2.0	83.3	9.6	2L	-49.7	7.9
0.01	0.14	0.08	0.77	100	1.6	2.0	83.2	9.6	2L	-49.8	7.9
0.03	0.04	0.09	0.84	136	2.7	1.9	83.5	9.7	2L	-49.8	7.8
0.04	0	0.09	0.87	132	3.2	1.9	83.6	9.7	2L	-49.8	7.7
0.04	0.02	0.01	0.93	44	3.6	1.9	83.4	9.7	2L	-49.8	7.5
0.01	0.13	0.1	0.76	122	1.6	2.0	83.2	9.5	2L	-49.8	7.9
0.01	0.15	0.04	0.8	56	1.7	2.0	83.0	9.6	2L	-49.9	7.8
0.02	0.08	0.1	0.8	129	2.2	1.9	83.3	9.6	2L	-49.9	7.8

wt% R32	wt% R1252zc	%wt R134	%wt R1234zeE	GWP	AVG GLIDE (K)	$P_{Suction}$ (bar)	$T_{Discharge}$ (°C)	$P_{Discharge}$ (bar)	ASHRAE Flammability Class	CAP dev from R404A (%)	COP dev from R404A (%)
0.01	0.14	0.06	0.79	78	1.7	2.0	83.0	9.5	2L	-50.0	7.9

TABLE 8B

wt% R32	wt% R1252zc	%wt R134	%wt R1234zeE	GWP	AVG GLIDE (K)	PSuction (bar)	TDischarge (°C)	PDischarge (bar)	ASHRAE Flammability Class	CAP dev from R404A (%)	COP dev from R404A (%)
0.08	0.21	0.07	0.64	146	5.6	2.5	89.3	11.8	2L	-38.0	6.6
0.08	0.2	0.07	0.65	146	5.7	2.5	89.1	11.8	2L	-38.3	6.6
0.08	0.2	0.06	0.66	135	5.7	2.5	89.1	11.8	2L	-38.3	6.6
0.08	0.2	0.05	0.67	124	5.8	2.5	89.0	11.8	2L	-38.4	6.5
0.08	0.2	0.04	0.68	113	5.8	2.4	88.9	11.8	2L	-38.5	6.5
0.08	0.19	0.07	0.66	146	5.7	2.4	89.0	11.7	2L	-38.6	6.6
0.08	0.19	0.06	0.67	136	5.7	2.4	88.9	11.7	2L	-38.6	6.6
0.08	0.19	0.05	0.68	125	5.8	2.4	88.9	11.7	2L	-38.7	6.6
0.08	0.19	0.04	0.69	114	5.9	2.4	88.8	11.7	2L	-38.7	6.5
0.08	0.19	0.03	0.7	103	5.9	2.4	88.8	11.7	2L	-38.8	6.5
0.08	0.18	0.08	0.66	147	5.7	2.4	88.9	11.7	2L	-38.8	6.6
0.08	0.18	0.07	0.67	136	5.8	2.4	88.8	11.7	2L	-38.9	6.6
0.08	0.18	0.06	0.68	125	5.8	2.4	88.7	11.7	2L	-38.9	6.6
0.08	0.18	0.05	0.69	114	5.9	2.4	88.7	11.7	2L	-39.0	6.6
0.08	0.18	0.04	0.7	103	6.0	2.4	88.6	11.7	2L	-39.1	6.6
0.08	0.17	0.08	0.67	147	5.7	2.4	88.7	11.6	2L	-39.1	6.7
0.08	0.17	0.07	0.68	136	5.8	2.4	88.7	11.6	2L	-39.2	6.6
0.08	0.17	0.06	0.69	125	5.8	2.4	88.6	11.6	2L	-39.2	6.6
0.08	0.17	0.05	0.7	114	5.9	2.4	88.5	11.6	2L	-39.3	6.6
0.08	0.17	0.04	0.71	103	6.0	2.4	88.5	11.6	2L	-39.3	6.6
0.08	0.16	0.08	0.68	147	5.7	2.4	88.6	11.6	2L	-39.4	6.7
0.07	0.21	0.08	0.64	140	5.2	2.4	88.6	11.6	2L	-39.4	6.7
0.08	0.16	0.07	0.69	136	5.8	2.4	88.5	11.6	2L	-39.5	6.7
0.08	0.16	0.06	0.7	125	5.8	2.4	88.5	11.6	2L	-39.5	6.7
0.08	0.16	0.05	0.71	114	5.9	2.4	88.4	11.6	2L	-39.6	6.6
0.08	0.16	0.04	0.72	103	6.0	2.4	88.3	11.6	2L	-39.6	6.6
0.07	0.2	0.08	0.65	140	5.2	2.4	88.5	11.5	2L	-39.7	6.7

wt% R32	wt% R1252 zc	%wt R134	%wt R123 4zeE	GWP	AVG GLIDE (K)	PSuc tion (bar)	TDisc harge (°C)	PDis charg e (bar)	ASH RAE Fla mm abili ty Clas s	CAP dev from R404A (%)	COP dev from R404 A (%)
0.08	0.15	0.08	0.69	147	5.7	2.4	88.5	11.5	2L	-39.7	6.7
0.07	0.2	0.07	0.66	129	5.3	2.4	88.4	11.5	2L	-39.7	6.7
0.08	0.15	0.07	0.7	136	5.8	2.4	88.4	11.5	2L	-39.7	6.7
0.08	0.15	0.06	0.71	125	5.9	2.4	88.3	11.5	2L	-39.8	6.7
0.07	0.2	0.06	0.67	118	5.3	2.4	88.4	11.5	2L	-39.8	6.7
0.08	0.15	0.05	0.72	114	5.9	2.4	88.3	11.5	2L	-39.9	6.7
0.08	0.15	0.04	0.73	103	6.0	2.4	88.2	11.5	2L	-39.9	6.6
0.07	0.19	0.08	0.66	140	5.2	2.4	88.3	11.5	2L	-39.9	6.7
0.08	0.14	0.08	0.7	147	5.7	2.4	88.3	11.5	2L	-40.0	6.8

CLAIMS

What is claimed is:

1. A composition comprising HFO-1252zc, HFO-1234zeE, HFC-32, and at least one of HFC-134, HFC-134a, or CO_2.

2. The composition of claim 1 comprising:

   HFO-1252zc, HFO-1234zeE, HFC-32, and CO2; or

   HFO-1252zc, HFO-1234zeE, HFC-32, and HFC-134; or

   HFO-1252zc, HFO-1234zeE, HFC-32, and HFC-134a; or

   HFO-1252zc, HFO-1234zeE, HFC-32, HFC-134, and CO2; or

   HFO-1252zc, HFO-1234zeE, HFC-134, HFC-134a and HFC-32; or

   HFO-1252zc, HFO-1234zeE, HFC-134a, HFC-32, and CO2.

3. The composition of claim 1 or claim 2, comprising:

   1.0% to 6.0% of CO_2, 1.0% to 96.0% of HFO-1252zc, 1.0% to 97.0% of HFO-1234zeE, and 1.0% to 49.0% of HFC-32; or

   1.0% to 6.0% of CO_2, 1.0% to 96.0% of HFO-1252zc, 1.0% to 97.0% of HFO-1234zeE, and 1.0% to 28.0% of HFC-32; or

   1.0% to 6.0% of CO_2, 16.0% to 85.0% of HFO-1252zc, 1.0% to 61.0% of HFO1234zeE 1234ZEE, and 1.0% to 28.0% of HFC-32; or

   1.0% to 2.0% of CO_2, 16.0% to 19.0% of HFO-1252zc, 58.0% to 61.0% of HFO-1234zeE, and 20.0% to 22.0% of HFC-32; or

   about 2.0 wt-% CO_2, about 17.0 wt-% HFO-1252zc, 59.0 wt-% HFO-1234zeE and 22.0 wt-% HFC-32.

4. The composition of claim 3, wherein the composition exhibits a GWP less than 298 or less than 150.

5. The composition of claim 3 or claim 4, wherein the composition exhibits an average temperature glide of no more than 10.0 K or no more than 9.9 K.

6. The composition of any one of claims 3-5, wherein the composition has an ASHRAE flammability rating of 2 or 2L.

7. The composition of any one of claims 3-6, wherein the composition exhibits a volumetric cooling capacity, relative to R-454C, in a range of:

54.2-137.1% of the volumetric cooling capacity of R-454C; or

54.2-108.1% of the volumetric cooling capacity of R-454C; or

90.0-108.1% of the volumetric cooling capacity of R-454C; or

90.0-104.8% of the volumetric cooling capacity of R-454C; or

about 95.2% of the volumetric cooling capacity of R-454C.

8. The composition any one of claims 3-7, wherein the composition exhibits a cooling COP, relative to R-454C, in a range of:

98.9-106.5% of the cooling COP of R-454C; or

99.5-106.5% of the cooling COP of R-454C; or

99.6-106.1% of the cooling COP of R-454C; or

102.7-104.7% of the cooling COP of R-454C; or

about 104.7% of the cooling COP of R-454C; or

about 95.2% of the cooling COP of R-454C.

9. The composition of claim 1 or claim 2, comprising:

1.0% to 97.0% of HFO-1252zc, 1.0% to 97.0% of HFO-1234zeE, 1.0% to 43.0% of HFC-32, and 1.0% to 28.0% of HFC-134; or

1.0% to 97.0% of HFO-1252zc, 1.0% to 97.0% of HFO-1234zeE, 1.0% to 43.0% of HFC-32, and 1.0% to 28.0% of HFC-134; or

1.0% to 97.0% of HFO-1252zc, 1.0% to 97.0% of HFO-1234zeE, 1.0% to 43.0% of HFC-32, and 1.0% to 28.0% of HFC-134; or

1.0% to 27.0% of HFO-1252zc, 30.0% to 97.0% of HFO-1234zeE, 1.0% to 43.0% of HFC-32, and 1.0% to 28.0% of HFC-134; or

1.0-21.0% of HFO-1252zc, 49.0-94.0% of HFO-1234ze(E), 1.0-8.0% of HFC-32, and 1.0-30.0% of HFC-134; or

14.0-21.0% of HFO-1252zc, 64.0-73.0% of HFO-1234ze(E), 7.0-8.0% of HFC-32, and 3.0-8.0% of HFC-134; or

15.0-19.0% of HFO-1252zc, 68.0-72.0% of HFO-1234ze(E), 6.0-10.0% of HFC-32, and 3.0-7.0% of HFC-134; or

about 17.0% of HFO-1252zc, about 70.0% of HFO-1234ze(E), about 8.0% of HFC-32, and about 5.0% of HFC-134; or

about 15.0 wt-% HFO-1252zc, about 41.0 wt-% HFO-1234zeE, about 42.0 wt-% HFC-32 and about 2.0 wt-% HFC-134; or

about 10.0 wt-% HFO-1252zc, about 68.0 wt-% HFO-1234zeE, about 1.0 wt-% HFC-32, and about 21.0 wt-% HFC-134.

10. The composition of claim 9, wherein the composition exhibits a GWP less than 300 or less than 147.

11 The composition of claim 9 or claim 10, wherein the composition exhibits an average temperature glide of no more than 9.6 K, or no more than 6.0 K or no more than 6.8 K, or no more than 1.4 K.

12. The composition any one of claims 9-11, wherein the composition has an ASHRAE flammability rating of 1, or 2, or 2L.

13. The composition any one of claims 9-12, wherein the composition exhibits a volumetric cooling capacity, relative to R-454C, in a range of:

52.3-116.3% of the volumetric cooling capacity of R-454C; or

52.3% to 116.3% of the volumetric cooling capacity of R-454C; or

52.3% and 116.3% of the volumetric cooling capacity of R-454C; or

52.3% and 114.4% of the volumetric cooling capacity of R-454C; or

about 114.4% of the volumetric cooling capacity of R-454C; or

about 83.3% of the volumetric cooling capacity of R-454C.

14. The composition any one of claims 9-13, wherein the composition exhibits a cooling COP, relative to R-454C, in a range of:

101.6-157.0% of the cooling COP of R-454C; or

101.6-156.4% of the cooling COP of R-454C; or

about 101.6% of the cooling COP of R-454C; or

about 156.4% of the cooling COP of R-454C.

15. The composition of claim 1 or claim 2, comprising:

1.0-21.0% of HFO-1252zc, 49.0-94.0% of HFO-1234ze(E), 1.0-8.0% of HFC-32, and 1.0-30.0% of HFC-134; or

14.0-21.0% of HFO-1252zc, 64.0-73.0% of HFO-1234ze(E), 7.0-8.0% of HFC-32, and 3.0-8.0% of HFC-134; or

15.0-19.0% of HFO-1252zc, 68.0-72.0% of HFO-1234ze(E), 6.0-10.0% of HFC-32, and 3.0-7.0% of HFC-134; or

about 17.0% of HFO-1252zc, about 70.0% of HFO-1234ze(E), about 8.0% of HFC-32, and about 5.0% of HFC-134.

16. The composition of claim 15, wherein the composition exhibits a volumetric cooling capacity, relative to R-404A, in a range of:

50.0-61.3% of the volumetric cooling capacity of R-454C; or

60.0-62.0% of the volumetric cooling capacity of R-454C; or

58.1-61.3% of the volumetric cooling capacity of R-454C.

17. The composition of claim 15 or claim 16, wherein the composition exhibits a cooling COP, relative to R-454C, in a range of:

106.6-108.7% of the cooling COP of R-454C; or

106.5-106.8% of the cooling COP of R-454C; or

106.6-106.9% of the cooling COP of R-454C; or

18. The composition of claim 1 or claim 2, comprising:

1.0% to 23.0% of HFC-134a, 1.0% to 97.0% of HFO-1252zc, 1.0% to 97.0% of HFO-1234zeE, and 1.0% to 52.0% of HFC-32; or

1.0% to 23.0% of HFC-134a, 1.0% to 97.0% of HFO-1252zc, 1.0% to 97.0% of HFO-1234zeE, and 1.0% to 52.0% of HFC-32; or

1.0% to 22.0% of HFC-134a, 1.0% to 80.0% of HFO-1252zc, 1.0% to 71.0% of HFO-1234zeE, and 1.0% to 49.0% of HFC-32; or

1.0% to 15.0% of HFC-134a, 1.0% to 26.0% of HFO-1252zc, 31.0% to 71.0% of HFO-1234zeE, and 5.0% to 42.0% of HFC-32; or

about 1.0 wt-% HFC-134a, about 25.0 wt-% HFO-1252zc, about 35.0 wt-% HFO-1234zeE and about 39.0 wt-% HFC-32; or

about 14.0 wt-% HFC-134a, about 15.0 wt-% HFO-1252zc, about 66.0 wt-% HFO-1234zeE, and about 5.0 wt-% HFC-32.

19. The composition of claim 18, wherein the composition exhibits a GWP less than 300.

20. The composition of claim 18 or claim 19, wherein the composition exhibits an average temperature glide of no more than 9.5 K, or no more than 6.7 K, or no more than 4.1 K.

21. The composition any one of claims 18-20, wherein the composition has an ASHRAE flammability rating of 1, or 2, or 2L.

22. The composition any one of claims 18-21, wherein the composition exhibits a volumetric cooling capacity, relative to R-454C, in a range of:

51.1% to 14.8% of the volumetric cooling capacity of R-454C; or

51.1% to 14.8% of the volumetric cooling capacity of R-454C; or

90.0% and 10.0% of the volumetric cooling capacity of R-454C; or

90.0% and 10.0% of the volumetric cooling capacity of R-454C; or

about 110.0% of the volumetric cooling capacity of R-454C; or

about 96.2% of the volumetric cooling capacity of R-454C.

23. The composition any one of claims 18-22, wherein the composition exhibits a cooling COP, relative to R-454C, in a range of:

1.7% to 55.3% of the cooling COP of R-454C; or

1.7% to 55.3% of the cooling COP of R-454C; or

1.9% and 55.3% of the cooling COP of R-454C; or

1.9% and 54.6% of the cooling COP of R-454C; or

2.0% of the cooling COP of R-454C; or

54.6% of the cooling COP of R-454C.

24. The composition of claim 1 or claim 2, comprising:

1.0% to 3.0% of CO_2, 1.0% to 6.0% of HFC-134, 1.0% to 20.0% of HFO-1252zc, 42.0% to 73.0% of HFO-1234zeE, and 11.0% to 38.0% of HFC-32; or

1.0% to 3.0% of CO_2, 1.0% to 6.0% of HFC-134, 1.0% to 20.0% of HFO-1252zc, 42.0% to 73.0% of HFO-1234zeE, and 11.0% to 38.0% of HFC-32; or

2.0% to 2.0% of CO_2, 1.0% to 1.0% of HFC-134, 18.0% to 18.0% of HFO-1252zc, 57.0% to 57.0% of HFO-1234zeE, and 22.0% to 22.0% of HFC-32; or

2.0% to 2.0% of CO_2, 1.0% to 1.0% of HFC-134, 18.0% to 18.0% of HFO-1252zc, 57.0% to 57.0% of HFO-1234zeE, and 22.0% to 22.0% of HFC-32; or

about 2.0 wt-% CO_2, about 1.0 wt-% HFC-134, about 18.0 wt-% HFO-1252zc, about 57.0 wt-% HFO-1234zeE, and about 22.0 wt-% HFC-32; or

about 2.0 wt-% CO_2, about 1.0 wt-% HFC-134, about 18.0 wt-% HFO-1252zc, about 57.0 wt-% HFO-1234zeE, and about 22.0 wt-% HFC-32.

25. The composition of claim 24, wherein the composition exhibits a GWP less than 149.

26. The composition of claim 24 or claim 25, wherein the composition exhibits an average temperature glide of no more than 10.0 K or no more than 9.7 K.

27. The composition any one of claims 24-26, wherein the composition has an ASHRAE flammability rating of 2L.

28. The composition any one of claims 24-27, wherein the composition exhibits a volumetric cooling capacity, relative to R-454C, in a range of:

80-90.2% of the volumetric cooling capacity of R-454C; or

about 90.2% of the volumetric cooling capacity of R-454C.

29. The composition any one of claims 24-28, wherein the composition exhibits a cooling COP, relative to R-454C, in a range of:

102.8-103.9% of the cooling COP of R-454C; or

about 103.0% of the cooling COP of R-454C,

30. The composition of claim 1 or claim 2, comprising:

1.0% to 96.0% of HFO-1252zc, 1.0% to 96.0% of HFO-1234ze(E), 1.0% to 25.0% of HFC-134, 1.0% to 21.0% of HFC-134a, and 1.0% to 40.0% of HFC-32; or

1.0% to 96.0% of HFO-1252zc, 1.0% to 96.0% of HFO-1234ze(E), 1.0% to 11.0% of HFC-134, 1.0% to 10.0% of HFC-134a, and 1.0% to 18.0% of HFC-32; or

41.0% to 82.0% of HFO-1252zc, 1.0% to 39.0% of HFO-1234ze(E), 1.0% to 3.0% of HFC-134, 1.0% to 2.0% of HFC-134a, and 15.0% to 18.0% of HFC-32; or

41.0% to 63.0% of HFO-1252zc, 17.0% to 39.0% of HFO-1234ze(E), 1.0% to 2.0% of HFC-134, 1.0% to 2.0% of HFC-134a, and 16.0% to 18.0% of HFC-32; or

about 63.0 wt-% HFO-1252zc, about 17.0 wt-% HFO-1234ze(E), about 1.0 wt-% HFC-134, about 1.0 wt-% HFC-134a, and about 18.0 wt-% HFC-32; or

about 62.0 wt-% HFO-1252zc, about 19.0 wt-% HFO-1234ze(E), about 2.0 wt-% HFC-134, about 1.0 wt-% HFC-134a, and about 16.0 wt-% HFC-32.

31. The composition of claim 30, wherein the composition exhibits a GWP less than 300 or less than 150.

32. The composition of claim 30 or claim 31, wherein the composition exhibits an average temperature glide of no more than 9.8 K, or no more than 9.1 K, or no more than 7.6 K, or no more than 7.0 K, or no more than 6.6 K.

33. The composition any one of claims 30-32, wherein the composition has an ASHRAE flammability rating of 1, or 2, or 2L.

34. The composition of any one of claims 30-33, wherein the composition exhibits a volumetric cooling capacity, relative to R-454C, in a range of:

51.4-121.3% of the volumetric cooling capacity of R-454C; or

51.4-94.5% of the volumetric cooling capacity of R-454C; or

90.0-94.5% of the volumetric cooling capacity of R-454C; or

90.0-93.7% of the volumetric cooling capacity of R-454C; or

about 90.6% of the volumetric cooling capacity of R-454C.

35. The composition of any one of claims 30-34, wherein the composition exhibits a cooling COP, relative to R-454C, in a range of:

99.3-106.3% of the cooling COP of R-454C; or

102.3-105.9% of the cooling COP of R-454C; or

102.3-102.8% of the cooling COP of R-454C; or

102.3-102.6% of the cooling COP of R-454C; or

about 102.3% of the cooling COP of R-454C.

36. The composition of claim 1 or claim 2, comprising:

0.2% to 89.5% of CO_2, 0.2% to 97.5% of HFO-1252zc, 0.2% to 97.5% of HFO-1234ze(E), 0.2% to 25.9% of HFC-134, and 0.2% to 43.8% of HFC-32; or

0.2% to 89.5% of CO_2, 0.2% to 97.5% of HFO-1252zc, 0.2% to 97.5% of HFO-1234ze(E), 0.2% to 12.0% of HFC-134, and 0.2% to 19.9% of HFC-32; or

0.2% to 4.0% of CO_2, 25.7% to 85.6% of HFO-1252zc, 0.2% to 53.5% of HFO-1234ze(E), 0.2% to 8.0% of HFC-134, and 7.9% to 19.9% of HFC-32; or

0.2% to 4.0% of CO_2, 25.7% to 63.7% of HFO-1252zc, 15.8% to 53.5% of HFO-1234ze(E), 0.2% to 8.0% of HFC-134, and 8.0% to 19.9% of HFC-32; or

about 2.0 wt-% CO_2, about 61.7 wt-% HFO-1252zc, about 15.9 wt-% HFO-1234ze(E), about 0.5 wt-% HFC-134, and about 19.9 wt-% HFC-32; or

about 0.2 wt-% CO_2, about 55.7 wt-% HFO-1252zc, about 27.9 wt-% HFO-1234ze(E), about 0.2 wt-% HFC-134, and about 15.9 wt-% HFC-32.

37. The composition of claim 36, wherein the composition exhibits a GWP less than 300 or less than 149.

38. The composition of claim 36 or claim 37, wherein the composition exhibits an average temperature glide of no more than 10.0 K, or no more than 9.2 K, or no more than 7.2 K.

39. The composition of any one of claims 36-38, wherein the composition has an ASHRAE flammability rating of 1, or 2, or 2L.

40. The composition of any one of claims 36-39, wherein the composition exhibits a volumetric cooling capacity, relative to R-454C, in a range of:

50.2-227.6% of the volumetric cooling capacity of R-454C; or

90.0-102.7% of the volumetric cooling capacity of R-454C; or

90.0-101.9% of the volumetric cooling capacity of R-454C; or

101.9% of the volumetric cooling capacity of R-454C; or

90.2 % of the volumetric cooling capacity of R-454C.

41. The composition of any one of claims 36-40, wherein the composition exhibits a cooling COP, relative to R-454C, in a range of:

43.9-106.2% of the cooling COP of R-454C; or

43.9-106.0% of the cooling COP of R-454C; or

100.8-102.6% of the cooling COP of R-454C; or

101.00-102.4% of the cooling COP of R-454C; or

about 101.0% of the cooling COP of R-454C.

42. The composition of claim 1 or claim 2, comprising:

0.2% to 89.1% of CO_2, 0.2% to 97.5% of HFO-1252zc, 0.2% to 97.5% of HFO-1234ze(E), 0.2% to 22.0% of HFC-134a, and 0.2% to 43.8% of HFC-32; or

0.2% to 89.1% of CO_2, 0.2% to 97.5% of HFO-1252zc, 0.2% to 97.5% of HFO-1234ze(E), 0.2% to 10.0% of HFC-134a, and 0.2% to 19.9% of HFC-32; or

0.2% to 4.0% of CO_2, 25.7% to 85.6% of HFO-1252zc, 0.2% to 53.5% of HFO-1234ze(E), 0.2% to 8.0% of HFC-134a, and 5.9% to 19.9% of HFC-32; or

.2% to 4.0% of CO_2, 25.7% to 63.7% of HFO-1252zc, 15.8% to 53.5% of HFO-1234ze(E), 0.2% to 6.0% of HFC-134a, and 8.0% to 19.9% of HFC-32; or

about 2.0 wt-% CO_2, about 61.7 wt-% HFO-1252zc, about 15.9 wt-% HFO-1234ze(E), about 0.5 wt-% HFC-134a, and about 19.9 wt-% HFC-32; or

about 0.2 wt-% CO_2, about 55.7 wt-% HFO-1252zc, about 27.9 wt-% HFO-1234ze(E), about 0.2 wt-% HFC-134a, and about 15.9 wt-% HFC-32.

43. The composition of claim 42, wherein the composition exhibits a GWP less than 300 or less than 149.

44. The composition of claim 42 or claim 43, wherein the composition exhibits an average temperature glide of no more than 10.0 K, or no more than 9.1 K, or no more than 7.2 K.

45. The composition of any one of claims 42-44, wherein the composition has an ASHRAE flammability rating of 1, or 2, or 2L.

46. The composition of any one of claims 42-45, wherein the composition exhibits a volumetric cooling capacity, relative to R-454C, in a range of:

50.4-227.6% of the volumetric cooling capacity of R-454C; or

50.4-224.5% of the volumetric cooling capacity of R-454C; or

90.0-102.8% of the volumetric cooling capacity of R-454C; or

90.0-102.1% of the volumetric cooling capacity of R-454C; or

about 2.1% of the volumetric cooling capacity of R-454C.

47. The composition of any one of claims 42-46, wherein the composition exhibits a cooling COP, relative to R-454C, in a range of:

-54.1% to 7.5% of the cooling COP of R-454C; or

-54.1% to 7.5% of the cooling COP of R-454C; or

0.5% and 2.6% of the cooling COP of R-454C; or

0.6% and 2.4% of the cooling COP of R-454C; or

about 1.0% of the cooling COP of R-454C; or

about -9.7% of the cooling COP of R-454C.

48. The composition of any of claims 1 to 47, further comprising at least one additional compound selected from HCFC-22, HFC-23, HCC-30, HCFC-31, HCC-40, HFC-41, methane, HFC-125, HFC-134a, HFC-143, HFC-143a, HFC-152a, HFC-245cb, HCFC-253dc, HFC-254fb, HCC-260fb, HCFC-261fc, HCFC-262fc, HFC-263fb, HFC-272fb, propane, HFO-374, n-butane, allene, 2-butene,

cyclobutene, 2-methyl propene, HCFO-1122, HFO-1132, HFO-1132a, HFO-1141, ethylene, HCFO-1233xf, HFO-1234yf, HCFO-1242zf, HFO-1243zf, HCFO-1251, HCO-1260zf, HFO-1261zf, propylene, HFO-1345, HFO-1252ze, HFO-1252yf, HFO-1252zf, HFO-1252ye, and E/Z-t-BuO-CF=CH-CH_3.

49. The composition of any of claims 1 to 48, further comprising at least one additional compound selected from HCFC-22, HCC-40, HFO-1234yf, HFO-1243zf, HFC-263fb, HFO-1252ze, HFO-1252yf, HFO-1252zf, and HFO-1252ye.

50. The composition of any of claims 1 to 49, wherein said composition further comprises from 0.1 to 200 ppm by weight of water; from about 10 ppm by volume to about 0.35 volume percent oxygen; and/or from about 100 ppm by volume to about 1.5 volume percent air or NAG.

51. The composition of any of claims 1 to 50, wherein said composition comprises a stabilizer.

52. The composition of claim 51, wherein the stabilizer is selected from the group consisting of nitromethane, ascorbic acid, terephthalic acid, azoles, phenolic compounds, cyclic monoterpenes, terpenes, phosphites, phosphates, phosphonates, thiols, and lactones.

53. The composition of any of claims 51 or 52, wherein the stabilizer is selected from tolutriazole, benzotriazole, tocopherol, hydroquinone, t-butyl hydroquinone, 2,6-di-terbutyl-4-methylphenol, fluorinated epoxides, n-butyl glycidyl ether, hexanediol diglycidyl ether, allyl glycidyl ether, butylphenylglycidyl ether, d-limonene, α-terpinene, β-terpinene, α-pinene, β-pinene, or butylated hydroxytoluene.

54. The composition of any of claims 51 to 53, wherein the stabilizer is present in an amount from about 0.001 to 1.0 weight percent based on the weight of the refrigerant.

55. The composition of any of claims 1 to 54, wherein the composition further comprises a lubricant.

56. The composition of claim 55, wherein said lubricant is at least one selected from the group consisting of polyalkylene glycol, polyol ester, poly-α-olefin, and polyvinyl ether.

57. The composition of claim 55 or 57, wherein said lubricant is a polyol ester or a polyvinyl ether.

58. The composition of any of claims 55 to 57, wherein said lubricant has at least one property selected from the group consisting of volume resistivity of greater than 10^{10} Ω-m at 20 ºC; surface tension of from about 0.02 N/m to 0.04 N/m at 20 ºC; kinemetic viscosity of from about 20 cSt to about 500 cSt at 40 ºC; a breakdown voltage of at least 25 kV; and a hydroxy value of at most 0.1 mg KOH/g.

59. The composition of any of claims 1 to 58, wherein the composition comprises at least one tracer.

60. The composition of claim 59, wherein said tracer is present in an amount from about 1.0 ppm by weight to about 1000 ppm by weight.

61. The composition of any of claims 59 or 60, wherein said at least one tracer is selected from the group consisting of hydrofluorocarbons, hydrofluoroolefins, hydrochlorocarbons, hydrochloroolefins, hydrochlorofluorocarbons, hydrochlorofluoroolefins, hydrochlorocarbons, hydrochloroolefins, chlorofluorocarbons, chlorofluoroolefins, hydrocarbons, perfluorocarbons, perfluoroolefins, and combinations thereof.

62. The composition of any of claims 59 to 61, wherein said at least one tracer is selected from the group consisting of HFC-23, HCFC-31, HFC-41, HFC-161, HFC-143a, HFC-134a, HFC-125, HFC-236fa, HFC-236ea, HFC-245cb, HFC-245fa, HFC-254eb, HFC-263fb, HFC-272ca, HFC-281ea, HFC-281fa, HFC-329p, HFC-329mmz, HFC338mf, HFC-338pcc, CFC-12, CFC-11, CFC-114, CFC-114a, HCFC-22, HCFC-123, HCFC-124, HCFC-124a, HCFC-141b, HCFC-142b, HCFC-151a, HCFC-244bb, HCC-40, HFO-1141, HCFO-1130, HCFO-1130a, HCFO-1131, HCFO-1122, HFO-1123, HFO-1234yf, HFO-1234ye, HFO-1243zf, HFO-1225ye, HFO-1225zc, PFC-116, PFC-C216, PFC-

218, PFC-C318, PFC-1216, PFC-31-10mc, PFC-31-10my, and combinations thereof.

63. The composition of any of claims 1 to 62, wherein the composition is free of or substantially free of Group A Fluorinated Substances, and wherein degradation products of the composition are free of or substantially free of Group A Fluorinated Substances.

64. A method for cooling comprising evaporating a composition of any of claims 1 to 63 in the vicinity of a body to be cooled and thereafter condensing said composition, wherein said cooling is provided by a refrigeration system.

65. A refrigeration system comprising a composition of any of claims 1 to 63.

66. A refrigeration system comprising a composition of any of claims 1 to 63, for use in high ambient applications, wherein outdoor temperatures are above about 35ºC.

67. The system of claim 65 or 66, comprising an evaporator, compressor, condenser, and expansion device, each operably connected to perform a vapor compression cycle.

68. The system of any of claims 65 to 67, wherein said refrigeration system is for residential, light commercial, or industrial refrigeration.

69. The system of any of claims 65 to 67, wherein said system is for medium temperature refrigeration, low temperature refrigeration, or transport refrigeration.

70. A method of replacing R-454C, R-513A, R-448A, R-449a, R-452A, R-410A, or R-404A in refrigeration systems comprising providing the composition of any of claims 1 to 63 to the system in place of R-454C, R-513A, R-448A, R-449a, R-452A, R-410A, or R-404A.

71. Use of the composition of any of claims 1 to 63 as refrigerant in low temperature refrigeration systems, medium temperature refrigeration systems, and/or transport refrigeration systems.