

**TITLE OF THE INVENTION**

RECOVERED AND RECLAIMED THERMAL MANAGEMENT FLUID  
COMPOSITIONS

**CROSS REFERENCE TO RELATED APPLICATIONS**

**[0001]** This application claims priority to U.S. Provisional Application No. 63/627,419, filed on January 31, 2024, the disclosure of which is herein incorporated by reference in its entirety.

**FIELD OF THE INVENTION**

**[0002]** The present disclosure relates to recovered and reclaimed thermal management fluid compositions, as well as to systems containing the same and processes of thermal management fluid recovery and reclamation. More specifically, the present disclosure relates to thermal management fluid compositions which have been recovered from a heat transfer system, as well as to uses thereof in heat transfer systems, methods of recovery of the same, methods of reclamation of the same, methods of using the same, and storage of the same.

**BACKGROUND OF THE INVENTION**

**[0003]** Recovery and reclamation of thermal management fluids has long attracted significant attention, due to regulatory requirements and increasing emphasis on circularity, emissions reduction, and resource efficiency. As the regulatory landscape evolved, thermal management fluids have undergone multiple transitions. For example, ozone depleting chlorofluorocarbons (CFCs) and hydrochlorofluorocarbons (HCFCs) were phased out as a result of the Montreal Protocol, and were initially replaced by hydrofluorocarbons (HFCs) and ultimately by hydrofluoroolefins (HFOs) for use as refrigerants, solvents, fire extinguishing agents, blowing agents and propellants.

**[0004]** With each transition, thermal management fluid reclamation becomes more complicated as more molecules are introduced into the process. For example, R-515B has replaced HFC-134a in chillers, but some residual HFC-134a often remains present in the chiller. Therefore, R-515B removed from retrofitted chiller systems or other types of chiller systems which have previously been filled with an HFC-134a

containing composition may contain residual amounts of HFC-134a. Typically, the residual HFC-134a is removed during the reclamation process. However, it is energy-intensive, labor-intensive, and time-consuming to completely remove HFC-134a in the reclamation process, because the difference in boiling points between HFC-134a and HFO-1234ze(E) is less than 10°C. Thus, it is difficult to separate the compounds from each other in the reclaiming process. Further, separating such close-boiling or azeotropic thermal management fluids also results in a large environmental footprint, since large separation columns, extractive distillation and the like are needed. Such challenges and complexities in separation may arise with many recovered thermal management fluids.

[0005] There is a need for refrigerant compositions that not only meet low ODP standards and have low global warming potentials and meet the standards of evolving regulations, but that also can be reclaimed in a manner which is efficient in terms of costs, energy and time, minimizes environmental footprint, and provides compositions exhibiting equivalent or superior performance in a variety of applications.

#### **SUMMARY OF THE INVENTION**

[0006] In certain aspects, the invention relates to thermal management fluid compositions, particularly recovered, recycled or reclaimed thermal management fluid compositions, which comprise at least one residual refrigerant. The invention also relates to systems containing the same and processes of thermal management fluid recovery and reclamation. In certain aspects, the invention relates to such thermal management fluid compositions which have been recovered from a heat transfer system, as well as to uses thereof in heat transfer systems, methods of recovery of the same, methods of reclamation of the same, methods of using the same, and storage of the same, for example in a recovery container or cylinder.

[0007] Other features and advantages of the present invention will be apparent from the following more detailed description, taken in conjunction with the accompanying drawings which illustrate, by way of example, the principles of this disclosure.



### **BRIEF DESCRIPTION OF THE DRAWINGS**

[0008] FIG. 1 depicts a schematic operation of a medium or low temperature cycle of an auto or stationary air conditioning or heat pump system;

[0009] FIG. 2 depicts a schematic operation of a cycle of a stationary chiller system; and

[0010] FIG. 3 depicts a schematic operation of an Organic Rankine Cycle.

### **DETAILED DESCRIPTION OF THE INVENTION**

[0011] Before addressing details of embodiments described below, some terms are defined or clarified.

[0012] As used herein, the term heat transfer composition means a composition used to carry heat from a heat source to a heat sink.

[0013] A heat source is defined as any space, location, object or body from which it is desirable to add, transfer, move or remove heat, more particularly any space, location, object or body from which it is desirable to remove heat. Examples of heat sources is spaces (open or enclosed) requiring refrigeration or cooling, such as refrigerator or freezer cases in a supermarket, building spaces requiring air-conditioning, industrial water chillers or the passenger compartment of an automobile requiring air-conditioning. In some embodiments, the heat transfer composition may remain in a constant state throughout the transfer process (i.e., not evaporate or condense). In other embodiments, evaporative cooling processes may utilize heat transfer compositions as well.

[0014] A heat sink is defined as any space, location, object or body capable of absorbing heat. For example, a vapor compression refrigeration system is one example of a system that utilizes both a heat source and a heat sink to operate, with the heat sink being the component into which heat is rejected from the condenser of the vapor compression system.

[0015] 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. In some embodiments related to automotive applications, a heat transfer system implies the heating or cooling system which

provides heating or cooling of the passenger compartment of an automobile, as well as power electronics, batteries and motors. Sometimes this system is called a heat pump system and may be a reversible heating system or a reversible cooling system, or simply a heating and cooling system.

**[0016]** In some embodiments, the disclosed compositions may function as primary refrigerants in secondary loop systems that provide cooling to remote locations by use of a secondary heat transfer fluid, which may comprise water, an aqueous salt solution (e.g., calcium chloride), a glycol, carbon dioxide, or a fluorinated hydrocarbon fluid. In this case the secondary heat transfer fluid is the body to be cooled as it is adjacent to the evaporator and is cooled before moving to a second remote body to be cooled.

**[0017]** Examples of heat transfer systems included but are not limited to air conditioners, freezers, refrigerators, heat pumps, water chillers, flooded evaporator chillers, direct expansion chillers, walk-in coolers, supermarket systems, heat pumps, mobile refrigerators, mobile air conditioning units and combinations thereof.

**[0018]** More particularly, examples of air conditioning or heat pump systems include but are not limited to air conditioners, residential heat pumps, chillers, including flooded evaporator chillers and direct expansion chillers, mobile air conditioning units, dehumidifiers, and combinations thereof.

**[0019]** As used herein, mobile refrigeration, air conditioning or heat pump systems refers to any refrigeration, air conditioner or heat pump apparatus incorporated into a transportation unit for the road, rail, sea or air. Mobile air conditioning or heat pumps systems may be used in automobiles, trucks, railcars or other transportation systems. Mobile refrigeration may include transport refrigeration in trucks, airplanes, or rail cars. In addition, apparatus which are meant to provide refrigeration for a system independent of any moving carrier, known as "intermodal" systems, are included in the present inventions. Such intermodal systems include "containers" (combined sea/land transport) as well as "swap bodies" (combined road and rail transport).

**[0020]** As used herein, stationary air conditioning or heat pump systems are systems that are fixed in place during operation. A stationary air conditioning or heat pump system may be associated within or attached to buildings of any variety. These

stationary applications may be stationary air conditioning and heat pumps, including but not limited to chillers, heat pumps, including residential and high temperature heat pumps, residential, commercial or industrial air conditioning systems, and including window, ductless, ducted, packaged terminal, and those exterior but connected to the building such as rooftop systems.

**[0021]** Examples of refrigeration systems the disclosed compositions may be useful in are equipment including commercial, industrial or residential refrigerators and freezers, ice machines, self-contained coolers and freezers, flooded evaporator chillers, direct expansion chillers, walk-in and reach-in coolers and freezers, and combination systems. In some embodiments, the disclosed compositions may be used in supermarket refrigeration systems.

**[0022]** Additionally, stationary applications may utilize a secondary loop system that uses a primary refrigerant to produce cooling or heating in one location that is transferred to a remote location via a secondary heat transfer fluid.

**[0023]** The operation cycle of some of these types of heat transfer systems are shown in FIGS. 1-3.

**[0024]** Organic Rankine Cycle (ORC) systems are often used to recover waste heat from industrial processes. In combined heat and power (cogeneration) applications, waste heat from combustion of fuel used to drive the prime mover of a generator set is recovered and used to make hot water for building heat, for example, or for supplying heat to operate an absorption chiller to provide cooling. In some cases, the demand for hot water is small or does not exist. The most difficult case is when the thermal requirement is variable and load matching becomes difficult, confounding efficient operation of the combined heat and power system. In such an instance, it is more useful to convert the waste heat to shaft power by using an organic Rankine cycle system. The shaft power can be used to operate pumps, for example, or it may be used to generate electricity. By using this approach, the overall system efficiency is higher and fuel utilization is greater. Air emissions from fuel combustion can be decreased since more electric power can be generated for the same amount of fuel input.

**[0025]** The process that produces waste heat is at least one selected from the group consisting of fuel cells, internal combustion engines, internal compression

engines, external combustion engines, and turbines. Other sources of waste heat can be found in association with operations at oil refineries, petrochemical plants, oil and gas pipelines, chemical industry, commercial buildings, hotels, shopping malls, supermarkets, bakeries, food processing industries, restaurants, paint curing ovens, furniture making, plastics molders, cement kilns, lumber kilns (drying), calcining operations, steel industry, glass industry, foundries, smelting, air-conditioning, refrigeration, and central heating. See U.S. Pat. No. 7,428,816, the disclosure of which is hereby incorporated herein by reference.

**[0026]** As used herein, “refrigerant compound” refers to any fluorocarbon (FC), hydrofluorocarbon (HFC), hydrochlorofluorocarbon (HCFC), chlorofluorocarbon (CFC), hydrochloroolefin (HCO), hydrofluoroolefin (HFO), chlorofluoroolefin (CFO), hydrochlorofluoroolefin (HCFO), hydrocarbon (HC), or carbon dioxide (R-744) that may be used alone or in a blend with other refrigerant compounds as a thermal management fluid.

**[0027]** As used herein, “thermal management fluid” refers to any fluid used for heat transfer in a closed-loop system.

**[0028]** As used herein, “virgin thermal management fluid” refers to a thermal management fluid composition having at least about 95 wt% organic purity, preferably at least about 99 wt% organic purity, most preferably at least about 99.5 wt% organic purity, and that has not yet been used in a thermal management fluid application.

**[0029]** As used herein, “used thermal management fluid” refers to a thermal management fluid composition having at least about 95 wt% organic purity, preferably at least about 99 wt% organic purity, most preferably at least about 99.5 wt% organic purity, and that has been used as a thermal management fluid.

**[0030]** As used herein, “spent thermal management fluid” refers to a thermal management fluid composition having less than about 95 wt% organic purity, preferably less than about 99 wt% organic purity, most preferably less than about 99.5 wt% organic purity, and that has been used as a thermal management fluid.

**[0031]** As used herein, “recovered thermal management fluid” refers to a spent thermal management fluid or a used thermal management fluid drained or otherwise

removed from a thermal management device, such as, for example, a refrigeration system, an air-conditioning system or a heat pump.

**[0032]** As used herein, “recycled thermal management fluid” refers to a recovered thermal management fluid, either as recovered or after purification or other processing, having at least about 95 wt% organic purity, preferably at least about 99 wt% organic purity, most preferably at least about 99.5 wt% organic purity and meeting conventional specifications for commercial use or sale as a thermal management fluid.

**[0033]** As used herein, “reclaimed thermal management fluid” refers to a thermal management fluid having at least one reprocessed refrigerant, including but not limited to a recovered thermal management fluid or a reprocessed product, such as a distillation product, of a recovered thermal management fluid, and having at least about 95 wt% organic purity, preferably at least about 99 wt% organic purity, most preferably at least about 99.5 wt% organic purity and meeting conventional specifications for commercial use or sale as a thermal management fluid.

**[0034]** As used herein, “reprocessing” refers to one or more processes including, but not limited to, blending, distillation, nitrogen purging, filtration, dehydration, caustic scrubbing, moisture removal, acid removal, oil removal, decanting, composition ratio adjustment (i.e., adjusting the composition of the thermal management fluid as needed) and combinations thereof. As used herein, “reprocessed product” refers to a product which has been subjected to reprocessing.

**[0035]** As used herein, “organic purity” refers to the degree to which a fluid or fluid composition is free of contaminants such as oil and inorganic materials, such as water, acid, non-absorbable gases (NAGs), particulates/solids, and the like.

**[0036]** As used herein, “residual refrigerant” refers to a refrigerant compound which has been carried over from a retrofit or from replacement of a previously filled system. More particularly, as used herein, “residual refrigerant” refers to a refrigerant compound which was present in an original refrigerant composition contained in a heat transfer system, wherein the heat transfer system has been or is being retrofitted or filled with a replacement refrigerant composition, and a residual amount of the refrigerant compound of the original refrigerant composition is present

in the replacement refrigerant composition contained in the heat transfer system and/or when removed from the heat transfer system.

**[0037]** As used herein, in another embodiment, “residual refrigerant” refers to a refrigerant compound which has been carried over from reprocessing, such as a distillation process. More particularly, as used herein, in one embodiment, “residual refrigerant” refers to a refrigerant compound which was present in a thermal management fluid blend, for example a refrigerant blend composition contained in a heat transfer system, wherein the thermal management fluid blend is subjected to processing. In one embodiment, such processing may be distillation for separation of the components thereof and isolation of a target refrigerant compound and a residual amount of the carryover refrigerant compound of the thermal management fluid blend is present in the distillation product.

**[0038]** As used herein, “residual amount” means that the total amount of residual refrigerants present in a composition is greater than zero and no more than about 20 wt%, preferably no more than about 10 wt%, more preferably no more than about 5 wt%, most preferably no more than about 2 wt%, or about 1 wt%, or about 0.9 wt%, or about 0.8 wt%, or about 0.7 wt%, or about 0.6 wt%, or about 0.5 wt%, based on the total weight of the composition, based on the total weight of the composition.

**[0039]** It will be understood by those skilled in the art that all percentages (%) disclosed herein with respect to various “R-” blends refer to weight percentages.

**[0040]** As used herein, the terms “comprises,” “comprising,” “includes,” “including,” “has,” “having” or any other variation thereof, are intended to cover a non-exclusive inclusion. For example, a composition, process, method, article, or apparatus that comprises a list of elements is not necessarily limited to only those elements but may include other elements not expressly listed or inherent to such composition, process, method, article, or apparatus. Further, unless expressly stated to the contrary, “or” refers to an inclusive or and not to an exclusive or. For example, a condition A or B is satisfied by any one of the following: A is true (or present) and B is false (or not present), A is false (or not present) and B is true (or present), and both A and B are true (or present).

**[0041]** 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.

**[0042]** The transitional phrase "consisting essentially of" is used to define a composition, method that includes materials, steps, features, components, or elements, in addition to those literally disclosed provided that these additional included materials, steps, features, components, or elements do not materially affect the basic and novel characteristic(s) of the claimed invention, especially the mode of action to achieve the desired result of any of the processes of the present invention. The term 'consisting essentially of' occupies a middle ground between "comprising" and 'consisting of'.

**[0043]** Where applicants have defined an invention or a portion thereof with an open-ended term such as "comprising," it should be readily understood that (unless otherwise stated) the description should be interpreted to also include such an invention using the terms "consisting essentially of" or "consisting of" including, for example, a composition consisting essentially of or consisting of.

**[0044]** 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.

**[0045]** Some of the compounds making up the compositions according to the present invention are defined in Table 1.

**Table 1**

| Name     | Structure                          | Chemical Name                      |
|----------|------------------------------------|------------------------------------|
| CFC-11   | CCl <sub>3</sub> F                 | trichlorofluoromethane             |
| HCFC-22  | CHClF <sub>2</sub>                 | chlorodifluoromethane              |
| CFC-12   | CCl <sub>2</sub> F <sub>2</sub>    | dichlorodifluoromethane            |
| HFC-32   | CH <sub>2</sub> F <sub>2</sub>     | difluoromethane                    |
| CFC-115  | CClF <sub>2</sub> -CF <sub>3</sub> | chloropentafluoroethane            |
| HCFC-123 | CHCl <sub>2</sub> -CF <sub>3</sub> | 1,1-dichloro-2,2,2-trifluoroethane |
| HFC-125  | CHF <sub>2</sub> -CF <sub>3</sub>  | pentafluoroethane                  |

| Name          | Structure                                          | Chemical Name                         |
|---------------|----------------------------------------------------|---------------------------------------|
| HFC-134a      | CH <sub>2</sub> F-CF <sub>3</sub>                  | 1,1,1,2-tetrafluoroethane             |
| HFC-143a      | CH <sub>3</sub> -CF <sub>3</sub>                   | 1,1,1-trifluoroethane                 |
| HFC-152a      | CH <sub>3</sub> -CHF <sub>2</sub>                  | 1,1-difluoroethane                    |
| HFC-227ea     | CF <sub>3</sub> -CHF-CF <sub>3</sub>               | 1,1,1,2,3,3,3-heptafluoropropane      |
| HFC-245fa     | CF <sub>3</sub> -CH <sub>2</sub> -CHF <sub>2</sub> | 1,1,1,3,3-pentafluoropropane          |
| E-HFO-1132    | E CHF=CHF                                          | E-1,2-difluoroethylene                |
| Z-HFO-1132    | Z CHF=CHF                                          | Z-1,2-difluoroethylene                |
| Z-HFO-1224yd  | Z CHCl=CF-CF <sub>3</sub>                          | Z-1-chloro-2,3,3,3-tetrafluoropropene |
| E-HFO-1233zd  | E CHCl=CH-CF <sub>3</sub>                          | E-1-chloro-3,3,3-tetrafluoropropene   |
| HFO-1234yf    | CF <sub>3</sub> -CF=CH <sub>2</sub>                | 2,3,3,3-tetrafluoro-1-propene         |
| E-HFO-1234ze  | E CF <sub>3</sub> -CH=CHF                          | E-1,3,3,3-tetrafluoro-1-propene       |
| Z-HFO-1234ze  | Z CF <sub>3</sub> -CH=CHF                          | Z-1,3,3,3-tetrafluoro-1-propene       |
| HFO-1252zc    | CF <sub>2</sub> =CH-CH <sub>3</sub>                | 1,1-difluoropropene                   |
| E-HFO-1336mzz | E CF <sub>3</sub> -CH=CH-CF <sub>3</sub>           | E-1,1,1,4,4,4-hexafluoro-2-butene     |
| Z-HFO-1336mzz | Z CF <sub>3</sub> -CH=CH-CF <sub>3</sub>           | Z-1,1,1,4,4,4-hexafluoro-2-butene     |
| t-DCE         | trans CHCl=CHCl                                    | trans - 1,2-dichloroethylene          |

[0046] Some of the compounds used in the compositions of the present invention 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, 1,3,3,3-tetrafluoropropene (HFO-1234ze) is meant to represent the Z-isomer, E-isomer, or any combination or mixture of both isomers in any ratio.

## COMPOSITIONS

### Embodiment 1

[0047] In one embodiment, a composition comprises, consists essentially of, or consists of HFC-32 and HFC-125, and at least one of HCFC-22 and HFC-134a.

[0048] In some embodiments, the HFC-32 and HFC-125 constitute a major refrigerant portion of the composition, while the HCFC-22 and/or HFC-134a constitute a minor refrigerant portion thereof.

[0049] In one embodiment, the HCFC-22 and/or HFC-134a are residual refrigerants. In one embodiment, a residual amount of the HCFC-22 and/or HFC-134a is contained in the composition.



**[0050]** In some embodiments, the composition comprises from about 99.5 to about 99.9 weight percent of HFC-32 and HFC-125, and from about 0.00001 to about 0.5 weight percent, preferably from about 0.0001 to about 0.5 weight percent, of at least one of HCFC-22, HFC-134a and combinations thereof.

**[0051]** It will be understood by those skilled in the art that when an amount, concentration, or other value or parameter is given as either a range, preferred range, or a list of upper preferable values and lower preferable values, this is to be understood as specifically disclosing all ranges formed from any pair of any upper range limit or preferred value and any lower range limit or preferred value, regardless of whether ranges are separately disclosed. Where a range of numerical values is recited herein, unless otherwise stated, the range is intended to include the endpoints thereof, and all integers and fractions within the range. It is not intended that the scope of the invention be limited to the specific values recited when defining a range. In particular, for example, the range of about 0.00001 to about 0.5 weight percent (e.g., in the context of the amount of residual refrigerants present) is intended to encompass all ranges within the broader range, such as, but not limited to, from about 0.0001 to about 0.5 weight percent, or from about 0.0001 to about 0.5 weight percent, or from about 0.001 to about 0.5 weight percent.

**[0052]** In one embodiment, a composition comprises, consists essentially of, or consists of HFC-32; HFC-125; at least one of HCFC-22 and HFC-134a; one or more additional compounds selected from HFC-23, HFC-32, HFC-143a, HFC-134a, CFC-115, CFO-1113 and HCC-40; and one or more additional compounds selected from HFC-143a, HFC-41, HFC-134a, HCFC-22, CFC-12 and HCC-40.

**[0053]** In one embodiment, a composition comprises, consists essentially of, or consists of HFC-32; HFC-125; at least one of HCFC-22 and HFC-134a; and one or more additional compounds selected from CFC-115, HFC-143a and HCFC-22.

**[0054]** In some embodiments, the HFC-32 and HFC-125 constitute a major refrigerant portion of the composition, while the remaining compounds (e.g., the HCFC-22 and/or HFC-134a and the additional compounds) constitute a minor refrigerant portion of the composition.

**[0055]** In one embodiment, a composition comprises, consists essentially of, or consists of:

a first refrigerant portion comprising, consisting essentially of, or consisting of HFC-125 and HFC-32, one or more additional compounds selected from HFC-23, HFC-32, HFC-143a, HFC-134a, CFC-115, CFO-1113 and HCC-40, and one or more additional compounds selected from HFC-143a, HFC-41, HFC-134a, HCFC-22, CFC-12 and HCC-40, and

a second refrigerant portion comprising, consisting essentially of, or consisting of at least one of HCFC-22 and HFC-134a.

**[0056]** In some embodiments, the first refrigerant portion comprises, consists essentially of, or consists of HFC-125 and HFC-32, and one or more additional compounds selected from CFC-115, HFC-143a and HCFC-22.

**[0057]** In some embodiments, the HFC-32 and HFC-125 of the first refrigerant portion constitute a major refrigerant portion of the composition, while the HCFC-22 and/or HFC-134a of the second refrigerant portion and the additional compounds of the first refrigerant portion constitute a minor refrigerant portion thereof.

**[0058]** In one embodiment, a composition comprises, consists essentially of, or consists of R-410A (50% HFC-125 / 50% HFC-32) and at least one of HCFC-22 and HFC-134a.

**[0059]** In some embodiments, the R-410A constitutes a major refrigerant portion of the composition, while the HCFC-22 and/or HFC-134a constitute a minor refrigerant portion thereof.

**[0060]** In some embodiments, the composition comprises from about 99.5 to about 99.9 weight percent of R-410A, and from about 0.00001 to about 0.5 weight percent, preferably from about 0.0001 to about 0.5 weight percent, of at least one of HCFC-22, HFC-134a and combinations thereof.

**[0061]** In one embodiment, a composition comprises, consists essentially of, or consists of R-410A (50% HFC-125 / 50% HFC-32); at least one of HCFC-22 and HFC-134a; one or more additional compounds selected from HFC-23, HFC-32, HFC-143a, HFC-134a, CFC-115, CFO-1113 and HCC-40; and one or more additional compounds selected from HFC-143a, HFC-41, HFC-134a, HCFC-22, CFC-12 and HCC-40.

**[0062]** In one embodiment, a composition comprises, consists essentially of, or consists of R-410A; and one or more additional compounds selected from CFC-115, HFC-143a and HCFC-22.

**[0063]** In some embodiments, the R-410A constitutes a major refrigerant portion of the composition, while the remaining compounds (e.g., the HCFC-22 and/or HFC-134a and the additional compounds) constitute a minor refrigerant portion of the composition.

**[0064]** In one embodiment, a composition comprises, consists essentially of, or consists of:

a first refrigerant portion comprising, consisting essentially of, or consisting of R-410A, one or more additional compounds selected from HFC-23, HFC-32, HFC-143a, HFC-134a, CFC-115, CFO-1113 and HCC-40, and one or more additional compounds selected from HFC-143a, HFC-41, HFC-134a, HCFC-22, CFC-12 and HCC-40, and

a second refrigerant portion comprising, consisting essentially of, or consisting of at least one of HCFC-22 and HFC-134a.

**[0065]** In some embodiments, the first refrigerant portion comprises, consists essentially of, or consists of R-410A, and one or more additional compounds selected from CFC-115, HFC-143a and HCFC-22.

**[0066]** In some embodiments, the R-410A of the first refrigerant portion constitutes a major refrigerant portion of the composition, while the HCFC-22 and/or HFC-134a of the second refrigerant portion and the additional compounds of the first refrigerant portion constitute a minor refrigerant portion thereof.

**[0067]** In some embodiments, the second refrigerant portion of any of the foregoing compositions of Embodiment 1 comprises residual refrigerants.

**[0068]** In some embodiments, any of the foregoing compositions of Embodiment 1 comprises from about 99.5 to about 99.9 weight percent of the first refrigerant portion, and from about 0.00001 to about 0.5 weight percent, preferably from about 0.0001 to about 0.5 weight percent, of the second refrigerant portion.

[0069] In one embodiment, the total amount of additional compound(s) in the first refrigerant portion of any of the foregoing compositions of Embodiment 1 ranges from greater than 0 wt.% to less than or equal to about 2 wt.%, about 1 wt.%, about 0.9 wt.%, about 0.8 wt.%, about 0.7 wt.%, about 0.6 wt.%, about 0.5 wt.%, about 0.4 wt.%, about 0.3 wt.%, about 0.2 wt.%, about 0.1 wt.%, based on the total weight of the first refrigerant portion of the composition. In another embodiment, the total amount of additional compound(s) ranges from 0.01 ppm (weight) to about 1 wt.%, and all values therebetween up to 1 wt.%. In another embodiment, the total amount of additional compound(s) ranges from 0.1 ppm (weight) to about 1 wt.%. In another embodiment, the total amount of additional compound(s) ranges from 0.001 wt.% to about 1 wt.%. In another embodiment, the total amount of additional compound(s) ranges from 0.001 wt.% to about 0.5 wt.%. In another embodiment, the total amount of additional compound(s) ranges from 0.001 wt.% to 0.4 wt.% or less, based on the total weight of the first refrigerant portion of the composition. In another embodiment, the total amount of additional compound(s) ranges from 0.001 wt.% to 0.1 wt.% or less, based on the total weight of the first refrigerant portion of the composition. In one embodiment, the total amount of additional compound(s) is about 0.1 wt.% based on the total weight of the first refrigerant portion of the composition.

## **Embodiment 2**

[0070] In one embodiment, a composition comprises, consists essentially of, or consists of HFC-32, HFC-134a, HFC-125 and HCFC-22.

[0071] In some embodiments, the HFC-32, HFC-134a and HFC-125 constitute a major refrigerant portion of the composition, while the HCFC-22 constitutes a minor refrigerant portion thereof.

[0072] In some embodiments, the HCFC-22 is a residual refrigerant. In one embodiment, a residual amount of the HCFC-22 is contained in the composition.

[0073] In some embodiments, the composition comprises from about 99.5 to about 99.9 weight percent of HFC-32, HFC-134a and HFC-125, and from about 0.00001 to about 0.5 weight percent, preferably from about 0.0001 to about 0.5 weight percent, of HCFC-22.

**[0074]** In one embodiment, a composition comprises, consists essentially of, or consists of HCFC-22; HFC-32; HFC-134a; HFC-125; one or more additional compounds selected from HFC-23, HFC-32, HFC-143a, HFC-134a, CFC-115, CFO-1113 and HCC-40; one or more additional compounds selected from HFC-143a, HFO-1225zc, HFC-245cb, HFC-134, HFC-152a, HFO-1225ye, HFC-161, E-HFO-1234ze, HCFC-22, HFO-1243zf, CHFC-124, HCC-40, CHFO-1122, HCFC-31, CFC-114, CFC-114a and HCO-1140; and one or more additional compounds selected from HFC-143a, HFC-41, HFC-134a, HCFC-22, CFC-12 and HCC-40.

**[0075]** In one embodiment, a composition comprises, consists essentially of, or consists of HCFC-22; HFC-32; HFC-134a; HFC-125; and one or more additional compounds selected from HFC-134, HFC-143a and CFC-115.

**[0076]** In some embodiments, the HFC-32, HFC-134a and HFC-125 constitute a major refrigerant portion of the composition, while the remaining compounds (e.g., the HCFC-22 and the additional compounds) constitute a minor refrigerant portion of the composition.

**[0077]** In one embodiment, a composition comprises, consists essentially of, or consists of:

a first refrigerant portion comprising, consisting essentially of, or consisting of HFC-125; HFC-134a; HFC-32; one or more additional compounds selected from HFC-23, HFC-32, HFC-143a, HFC-134a, CFC-115, CFO-1113 and HCC-40; one or more additional compounds selected from HFC-143a, HFO-1225zc, HFC-245cb, HFC-134, HFC-152a, HFO-1225ye, HFC-161, E-HFO-1234ze, HCFC-22, HFO-1243zf, CHFC-124, HCC-40, CHFO-1122, HCFC-31, CFC-114, CFC-114a and HCO-1140; and one or more additional compounds selected from HFC-143a, HFC-41, HFC-134a, HCFC-22, CFC-12 and HCC-40, and

a second refrigerant portion comprising, consisting essentially of, or consisting of HCFC-22.

**[0078]** In some embodiments, the first refrigerant portion comprises, consists essentially of, or consists of HFC-125; HFC-134a; HFC-32; and one or more additional compounds selected from HFC-134a, HFC-143a and CFC-115.

**[0079]** In some embodiments, the HFC-32, HFC-134a and HFC-125 of the first refrigerant portion constitute a major refrigerant portion of the composition, while the HCFC-22 of the second refrigerant portion and the additional compounds of the first refrigerant portion constitute a minor refrigerant portion thereof.

**[0080]** In one embodiment, a composition comprises, consists essentially of, or consists of R-407C (25% HFC-125 / 23% HFC-32 / 52% HFC-134a) and HCFC-22.

**[0081]** In some embodiments, the R-407C constitutes a major refrigerant portion of the composition, while the HCFC-22 constitutes a minor refrigerant portion thereof.

**[0082]** In some embodiments, the composition comprises from about 99.5 to about 99.9 weight percent of R-407C, and from about 0.00001 to about 0.5 weight percent, preferably from about 0.0001 to about 0.5 weight percent, of HCFC-22.

**[0083]** In one embodiment, a composition comprises, consists essentially of, or consists of R-407C (25% HFC-125 / 23% HFC-32 / 52% HFC-134a); HCFC-22; one or more additional compounds selected from HFC-23, HFC-32, HFC-143a, HFC-134a, CFC-115, CFO-1113 and HCC-40; one or more additional compounds selected from HFC-143a, HFO-1225zc, HFC-245cb, HFC-134, HFC-152a, HFO-1225ye, HFC-161, E-HFO-1234ze, HCFC-22, HFO-1243zf, CHFC-124, HCC-40, CHFO-1122, HCFC-31, CFC-114, CFC-114a and HCO-1140; and one or more additional compounds selected from HFC-143a, HFC-41, HFC-134a, HCFC-22, CFC-12 and HCC-40.

**[0084]** In one embodiment, a composition comprises, consists essentially of, or consists of R-407C (25% HFC-125 / 23% HFC-32 / 52% HFC-134a); HCFC-22; and one or more additional compounds selected from HFC-134a, HFC-143a and CFC-115.

**[0085]** In some embodiments, the R-407C constitutes a major refrigerant portion of the composition, while the remaining compounds (e.g., the HCFC-22 and the additional compounds) constitute a minor refrigerant portion of the composition.

**[0086]** In one embodiment, a composition comprises, consists essentially of, or consists of:

a first refrigerant portion comprising, consisting essentially of, or consisting of R-407C, one or more additional compounds selected from HFC-23, HFC-32, HFC-

143a, HFC-134a, CFC-115, CFO-1113 and HCC-40, one or more additional compounds selected from HFC-143a, HFO-1225zc, HFC-245cb, HFC-134, HFC-152a, HFO-1225ye, HFC-161, E-HFO-1234ze, HCFC-22, HFO-1243zf, CHFC-124, HCC-40, CHFO-1122, HCFC-31, CFC-114, CFC-114a and HCO-1140; and one or more additional compounds selected from HFC-143a, HFC-41, HFC-134a, HCFC-22, CFC-12 and HCC-40, and

a second refrigerant portion comprising, consisting essentially of, or consisting of HCFC-22.

**[0087]** In some embodiments, the first refrigerant portion comprises, consists essentially of, or consists of R-407C, and one or more additional compounds selected from HFC-134a, HFC-143a and CFC-115.

**[0088]** In some embodiments, the R-407C of the first refrigerant portion constitutes a major refrigerant portion of the composition, while the HCFC-22 of the second refrigerant portion and the additional compounds of the first refrigerant portion constitute a minor refrigerant portion thereof.

**[0089]** In some embodiments, the second refrigerant portion of any of the foregoing compositions of Embodiment 2 comprises residual refrigerants.

**[0090]** In some embodiments, any of the foregoing compositions of Embodiment 2 comprises from about 99.5 to about 99.9 weight percent of the first refrigerant portion, and from about 0.00001 to about 0.5 weight percent, preferably from about 0.0001 to about 0.5 weight percent, of the second refrigerant portion.

**[0091]** In one embodiment, the total amount of additional compound(s) in the first refrigerant portion of any of the foregoing compositions of Embodiment 2 ranges from greater than 0 wt.% to less than or equal to about 2 wt.%, about 1 wt.%, about 0.9 wt.%, about 0.8 wt.%, about 0.7 wt.%, about 0.6 wt.%, about 0.5 wt.%, about 0.4 wt.%, about 0.3 wt.%, about 0.2 wt.%, about 0.1 wt.%, based on the total weight of the first refrigerant portion of the composition. In another embodiment, the total amount of additional compound(s) ranges from 0.01 ppm (weight) to about 1 wt.%, and all values therebetween up to 1 wt.%. In another embodiment, the total amount of additional compound(s) ranges from 0.1 ppm (weight) to about 1 wt.%. In another embodiment, the total amount of additional compound(s) ranges from 0.001 wt.% to

about 1 wt.%. In another embodiment, the total amount of additional compound(s) ranges from 0.001 wt.% to about 0.5 wt.%. In another embodiment, the total amount of additional compound(s) ranges from 0.001 wt.% to 0.4 wt.% or less, based on the total weight of the first refrigerant portion of the composition. In another embodiment, the total amount of additional compound(s) ranges from 0.001 wt.% to 0.1 wt.% or less, based on the total weight of the first refrigerant portion of the composition. In one embodiment, the total amount of additional compound(s) is about 0.1 wt.% based on the total weight of the first refrigerant portion of the composition.

### **Embodiment 3**

**[0092]** In one embodiment, a composition comprises, consists essentially of, or consists of HFC-32, HFC-125 and HFO-1234yf, and at least one compound selected from HCFC-22, HFC-134, HFC-134a and CO<sub>2</sub>.

**[0093]** In some embodiments, the HFC-32, HFC-125 and HFO-1234yf constitute a major refrigerant portion of the composition, while the HCFC-22, HFC-134, HFC-134a and/or CO<sub>2</sub> constitute a minor refrigerant portion thereof.

**[0094]** In some embodiments, the HCFC-22, HFC-134a and/or CO<sub>2</sub> are residual refrigerants as defined herein. In one embodiment, a residual amount of the HCFC-22, HFC-134, HFC-134a and/or CO<sub>2</sub> is contained in the composition.

**[0095]** In some embodiments, the composition comprises from about 99.5 to about 99.9 weight percent of HFC-32, HFC-125 and HFO-1234yf, and from about 0.00001 to about 0.5 weight percent, preferably from about 0.0001 to about 0.5 weight percent, of at least one of HCFC-22, HFC-134, HFC-134a, CO<sub>2</sub> and combinations thereof.

**[0096]** In one embodiment, a composition comprises, consists essentially of, or consists of HFC-32; HFC-125; HFO-1234yf; at least one of HCFC-22, HFC-134, HFC-134a and CO<sub>2</sub>; one or more additional compounds selected from HFC-143a, HFC-41, HFC-134a, HCFC-22, CFC-12 and HCC-40; one or more additional compounds selected from HFC-23, HFC-32, HFC-143a, HFC-134a, CFC-115, CFO-1113 and HCC-40; and one or more additional compounds selected from HFO-1225ye, HFO-1243zf, E-HFO-1234ze, HFC-236ea, HCFC-244bb, HFC-245fa, HFC-



245eb, HFC-245cb, 3,3,3-trifluoropropyne, HFC-152a, FO-1114, HFO-1123, HCFO-1131a, trans-HCFO-1131, HCO- 1140, HCFO-1214ya, HFO-1216, HCFO-1224yd, HFO-1252 isomers, HFC-143a, HCFC-225 isomers, HFC-254eb, HFC-263fb, HFC-236fa, HCFC-142b, HCFC-244cc, HCFO-1223, HFO-1132a and HCC-40.

**[0097]** In one embodiment, a composition comprises, consists essentially of, or consists of HFC-32; HFC-125; HFO-1234yf; at least one of HCFC-22, HFC-134a, HFC-134, and CO<sub>2</sub>; and one or more additional compounds selected from HFC-143a and HFO-1234zf.

**[0098]** In some embodiments, the HFO-1234yf, HFC-125 and HFC-32 constitute a major refrigerant portion of the composition, while the remaining compounds (e.g., the HCFC-22, HFC-134, HFC-134a and/or CO<sub>2</sub> and the additional compounds) constitute a minor refrigerant portion of the composition.

**[0099]** In one embodiment, a composition comprises, consists essentially of, or consists of:

a first refrigerant portion comprising, consisting essentially of, or consisting of HFC-32; HFC-125; HFO-1234yf; one or more additional compounds selected from HFC-143a, HFC-41, HFC-134a, HCFC-22, CFC-12 and HCC-40; one or more additional compounds selected from HFC-23, HFC-32, HFC-143a, HFC-134a, CFC-115, CFO-1113 and HCC-40; and one or more additional compounds selected from HFO-1225ye, HFO-1243zf, E-HFO-1234ze, HFC-236ea, HCFC-244bb, HFC-245fa, HFC-245eb, HFC-245cb, 3,3,3-trifluoropropyne, HFC-152a, FO-1114, HFO-1123, HCFO-1131a, trans-HCFO-1131, HCO- 1140, HCFO-1214ya, HFO-1216, HCFO-1224yd, HFO-1252 isomers, HFC-143a, HCFC-225 isomers, HFC-254eb, HFC-263fb, HFC- 236fa, HCFC-142b, HCFC-244cc, HCFO-1223, HFO-1132a and HCC-40, and

a second refrigerant portion comprising, consisting essentially of, or consisting of at least one of HCFC-22, HFC-134, HFC-134a and CO<sub>2</sub>.

**[0100]** In some embodiments, the first refrigerant portion comprises, consists essentially of, or consists of HFC-32; HFC-125; HFO-1234yf; and one or more additional compounds selected from HFC-143a and HFO-1234zf.

**[0101]** In some embodiments, the HFC-32, HFC-125 and HFO-1234yf of the first refrigerant portion constitute a major refrigerant portion of the composition, while the HCFC-22, HFC-134, HFC-134a and/or CO<sub>2</sub> of the second refrigerant portion and the additional compounds of the first refrigerant portion constitute a minor refrigerant portion thereof.

**[0102]** In one embodiment, a composition comprises, consists essentially of, or consists of R-452B (67% HFC-32 / 7% HFC-125 / 26% HFO-1234yf), and at least one of HCFC-22, HFC-134, HFC-134a and CO<sub>2</sub>.

**[0103]** In some embodiments, the R-452B constitutes a major refrigerant portion of the composition, while the HCFC-22, HFC-134, HFC-134a and/or CO<sub>2</sub> constitute a minor refrigerant portion thereof.

**[0104]** In some embodiments, the composition comprises from about 99.5 to about 99.9 weight percent of R-452B, and from about 0.00001 to about 0.5 weight percent, preferably from about 0.0001 to about 0.5 weight percent, of at least one of HCFC-22, HFC-134, HFC-134a, CO<sub>2</sub> and combinations thereof.

**[0105]** In one embodiment, a composition comprises, consists essentially of, or consists of R-452B (67% HFC-32 / 7% HFC-125 / 26% HFO-1234yf); one or more additional compounds selected from HFC-143a, HFC-41, HFC-134a, HCFC-22, CFC-12 and HCC-40; one or more additional compounds selected from HFC-23, HFC-32, HFC-143a, HFC-134a, CFC-115, CFO-1113 and HCC-40; one or more additional compounds selected from HFO-1225ye, HFO-1243zf, E-HFO-1234ze, HFC-236ea, HCFC-244bb, HFC-245fa, HFC-245eb, HFC-245cb, 3,3,3-trifluoropropyne, HFC-152a, FO-1114, HFO-1123, HCFO-1131a, trans-HCFO-1131, HCO-1140, HCFO-1214ya, HFO-1216, HCFO-1224yd, HFO-1252 isomers, HFC-143a, HCFC-225 isomers, HFC-254eb, HFC-263fb, HFC-236fa, HCFC-142b, HCFC-244cc, HCFO-1223, HFO-1132a and HCC-40; and at least one of HCFC-22, HFC-134, HFC-134a and CO<sub>2</sub>.

**[0106]** In some embodiments, a composition comprises, consists essentially of, or consists of R-452B; and one or more additional compounds selected from HFC-143a and HFO-1234zf.

**[0107]** In some embodiments, the R-452B constitutes a major refrigerant portion of the composition, while the remaining compounds (e.g., the HCFC-22, HFC-134, HFC-134a and/or CO<sub>2</sub> and the additional compounds) constitute a minor refrigerant portion of the composition.

**[0108]** In one embodiment, a composition comprises, consists essentially of, or consists of:

a first refrigerant portion comprising, consisting essentially of, or consisting of R-452B; one or more additional compounds selected from HFC-143a, HFC-41, HFC-134a, HCFC-22, CFC-12 and HCC-40; one or more additional compounds selected from HFC-23, HFC-32, HFC-143a, HFC-134a, CFC-115, CFO-1113 and HCC-40; one or more additional compounds selected from HFO-1225ye, HFO-1243zf, E-HFO-1234ze, HFC-236ea, HCFC-244bb, HFC-245fa, HFC-245eb, HFC-245cb, 3,3,3-trifluoropropyne, HFC-152a, FO-1114, HFO-1123, HCFO-1131a, trans-HCFO-1131, HCO- 1140, HCFO-1214ya, HFO-1216, HCFO-1224yd, HFO-1252 isomers, HFC-143a, HCFC-225 isomers, HFC-254eb, HFC-263fb, HFC- 236fa, HCFC-142b, HCFC-244cc, HCFO-1223, HFO-1132a and HCC-40; and

a second refrigerant portion comprising, consisting essentially of, or consisting of at least one of HCFC-22, HFC-134, HFC-134a and CO<sub>2</sub>.

**[0109]** In some embodiments, the first refrigerant portion comprises, consists essentially of, or consists of R-452B and one or more additional compounds selected from HFC-143a and HFO-1234zf.

**[0110]** In some embodiments, the R-452B of the first refrigerant portion constitutes a major refrigerant portion of the composition, while the HCFC-22, HFC-134, HFC-134a and/or CO<sub>2</sub> of the second refrigerant portion and the additional compounds of the first refrigerant portion constitute a minor refrigerant portion thereof.

**[0111]** In some embodiments, the second refrigerant portion of any of the foregoing compositions of Embodiment 3 comprises residual refrigerants.

**[0112]** In some embodiments, any of the foregoing compositions of Embodiment 3 comprises from about 99.5 to about 99.9 weight percent of the first refrigerant

portion, and from about 0.00001 to about 0.5 weight percent, preferably from about 0.0001 to about 0.5 weight percent, of the second refrigerant portion.

**[0113]** In one embodiment, the total amount of additional compound(s) in the first refrigerant portion of any of the foregoing compositions of Embodiment 3 ranges from greater than 0 wt.% to less than or equal to about 2 wt.%, about 1 wt.%, about 0.9 wt.%, about 0.8 wt.%, about 0.7 wt.%, about 0.6 wt.%, about 0.5 wt.%, about 0.4 wt.%, about 0.3 wt.%, about 0.2 wt.%, about 0.1 wt.%, based on the total weight of the first refrigerant portion of the composition. In another embodiment, the total amount of additional compound(s) ranges from 0.01 ppm (weight) to about 1 wt.%, and all values therebetween up to 1 wt.%. In another embodiment, the total amount of additional compound(s) ranges from 0.1 ppm (weight) to about 1 wt.%. In another embodiment, the total amount of additional compound(s) ranges from 0.001 wt.% to about 1 wt.%. In another embodiment, the total amount of additional compound(s) ranges from 0.001 wt.% to about 0.5 wt.%. In another embodiment, the total amount of additional compound(s) ranges from 0.001 wt.% to 0.4 wt.% or less, based on the total weight of the first refrigerant portion of the composition. In another embodiment, the total amount of additional compound(s) ranges from 0.001 wt.% to 0.1 wt.% or less, based on the total weight of the first refrigerant portion of the composition. In one embodiment, the total amount of additional compound(s) is about 0.1 wt.% based on the total weight of the first refrigerant portion of the composition.

#### **Embodiment 4**

**[0114]** In one embodiment, a composition comprises, consists essentially of, or consists of HFC-32 and HFO-1234yf, and at least one compound selected from HCFC-22, HFC-125, HFC-134a and CO<sub>2</sub>.

**[0115]** In some embodiments, the HFC-32 and HFO-1234yf constitute a major refrigerant portion of the composition, while the HCFC-22, HFC-125, HFC-134a and/or CO<sub>2</sub> constitute a minor refrigerant portion thereof.

**[0116]** In one embodiment, the HCFC-22, HFC-125, HFC-134a and/or CO<sub>2</sub> are residual refrigerants as defined herein. In one embodiment, a residual amount of the HCFC-22, HFC-125, HFC-134a and/or CO<sub>2</sub> is contained in the composition.

**[0117]** In some embodiments, the composition comprises from about 99.5 to about 99.9 weight percent of HFC-32 and HFO-1234yf, and from about 0.00001 to about 0.5 weight percent, preferably from about 0.0001 to about 0.5 weight percent, of at least one of HCFC-22, HFC-125, HFC-134a, CO<sub>2</sub> and combinations thereof.

**[0118]** In one embodiment, a composition comprises, consists essentially of, or consists of HFC-32; HFO-1234yf; one or more additional compounds selected from HFC-143a, HFC-41, HFC-134a, HCFC-22, CFC-12 and HCC-40; one or more additional compounds selected from HFO-1225ye, HFO-1243zf, E-HFO-1234ze, HFC-236ea, HCFC-244bb, HFC-245fa, HFC-245eb, HFC-245cb, 3,3,3-trifluoropropyne, HFC-152a, FO-1114, HFO-1123, HCFO-1131a, trans-HCFO-1131, HCO- 1140, HCFO-1214ya, HFO-1216, HCFO-1224yd, HFO-1252 isomers, HFC-143a, HCFC-225 isomers, HFC-254eb, HFC-263fb, HFC- 236fa, HCFC-142b, HCFC-244cc, HCFO-1223, HFO-1132a and HCC-40; and at least one of HCFC-22, HFC-125, HFC-134a and CO<sub>2</sub>.

**[0119]** In one embodiment, a composition comprises, consists essentially of, or consists of HFC-32; HFO-1234yf; at least one of HCFC-22, HFC-125, HFC-134a and CO<sub>2</sub>; and one or more additional compounds selected from HFC-143a, HFC-245cb and HFO-1243zf.

**[0120]** In some embodiments, the HFC-32 and HFO-1234yf constitute a major refrigerant portion of the composition, while the remaining compounds (e.g., the HCFC-22, HFC-125, HFC-134a and/or CO<sub>2</sub> and the additional compounds) constitute a minor refrigerant portion of the composition.

**[0121]** In one embodiment, a composition comprises, consists essentially of, or consists of:

a first refrigerant portion comprising, consisting essentially of, or consisting of HFC-32; HFO-1234yf; one or more additional compounds selected from HFC-143a, HFC-41, HFC-134a, HCFC-22, CFC-12 and HCC-40; and one or more additional compounds selected from HFO-1225ye, HFO-1243zf, E-HFO-1234ze, HFC-236ea, HCFC-244bb, HFC-245fa, HFC-245eb, HFC-245cb, 3,3,3-trifluoropropyne, HFC-152a, FO-1114, HFO-1123, HCFO-1131a, trans-HCFO-1131, HCO- 1140, HCFO-1214ya, HFO-1216, HCFO-1224yd, HFO-1252

isomers, HFC-143a, HCFC-225 isomers, HFC-254eb, HFC-263fb, HFC- 236fa, HCFC-142b, HCFC-244cc, HCFO-1223, HFO-1132a and HCC-40, and

a second refrigerant portion comprising, consisting essentially of, or consisting of at least one of HCFC-22, HFC-125, HFC-134a and CO<sub>2</sub>.

**[0122]** In some embodiments, the first refrigerant portion comprises, consists essentially of, or consists of HFC-32; HFO-1234yf; and one or more additional compounds selected from HFC-143a, HFC-245cb and HFO-1243zf.

**[0123]** In some embodiments, the HFC-32 and HFO-1234yf of the first refrigerant portion constitute a major refrigerant portion of the composition, while the HCFC-22, HFC-125, HFC-134a and/or CO<sub>2</sub> of the second refrigerant portion and the additional compounds of the first refrigerant portion constitute a minor refrigerant portion thereof.

**[0124]** In one embodiment, a composition comprises, consists essentially of, or consists of R-454B (68.9% HFC-32 / 31.1% HFO-1234yf), and at least one of HCFC-22, HFC-125, HFC-134a and CO<sub>2</sub>.

**[0125]** In some embodiments, the R-454B constitutes a major refrigerant portion of the composition, while the HCFC-22, HFC-125, HFC-134a and/or CO<sub>2</sub> constitute a minor refrigerant portion thereof.

**[0126]** In some embodiments, the composition comprises from about 99.5 to about 99.9 weight percent R-454B, and from about 0.00001 to about 0.5 weight percent, preferably from about 0.0001 to about 0.5 weight percent, of at least one of HCFC-22, HFC-125, HFC-134a, CO<sub>2</sub> and combinations thereof.

**[0127]** In one embodiment, a composition comprises, consists essentially of, or consists of R-454B (68.9% HFC-32 / 31.1% HFO-1234yf); one or more additional compounds selected from HFC-143a, HFC-41, HFC-134a, HCFC-22, CFC-12 and HCC-40; one or more additional compounds selected from HFO-1225ye, HFO-1243zf, E-HFO-1234ze, HFC-236ea, HCFC-244bb, HFC-245fa, HFC-245eb, HFC-245cb, 3,3,3-trifluoropropyne, HFC-152a, FO-1114, HFO-1123, HCFO-1131a, trans-HCFO-1131, HCO- 1140, HCFO-1214ya, HFO-1216, HCFO-1224yd, HFO-1252 isomers, HFC-143a, HCFC-225 isomers, HFC-254eb, HFC-263fb, HFC- 236fa,

HCFC-142b, HCFC-244cc, HCFO-1223, HFO-1132a and HCC-40; and at least one of HCFC-22, HFC-125, HFC-134a and CO<sub>2</sub>.

**[0128]** In some embodiments, a composition comprises, consists essentially of, or consists of R-454B, and one or more additional compounds selected from HFC-143a, HFC-245cb and HFO-1243zf.

**[0129]** In some embodiments, the R-454B constitutes a major refrigerant portion of the composition, while the remaining compounds (e.g., the HCFC-22, HFC-125, HFC-134a and/or CO<sub>2</sub> and the additional compounds) constitute a minor refrigerant portion of the composition.

**[0130]** In one embodiment, a composition comprises, consists essentially of, or consists of:

a first refrigerant portion comprising, consisting essentially of, or consisting of R-454B, one or more additional compounds selected from HFC-143a, HFC-41, HFC-134a, HCFC-22, CFC-12 and HCC-40, and one or more additional compounds selected from HFO-1225ye, HFO-1243zf, E-HFO-1234ze, HFC-236ea, HCFC-244bb, HFC-245fa, HFC-245eb, HFC-245cb, 3,3,3-trifluoropropyne, HFC-152a, FO-1114, HFO-1123, HCFO-1131a, trans-HCFO-1131, HCO-1140, HCFO-1214ya, HFO-1216, HCFO-1224yd, HFO-1252 isomers, HFC-143a, HCFC-225 isomers, HFC-254eb, HFC-263fb, HFC-236fa, HCFC-142b, HCFC-244cc, HCFO-1223, HFO-1132a and HCC-40, and

a second refrigerant portion comprising, consisting essentially of, or consisting of at least one of HCFC-22, HFC-125, HFC-134a and CO<sub>2</sub>.

**[0131]** In some embodiments, the first refrigerant portion comprises, consists essentially of, or consists of R-454B, and one or more additional compounds selected from HFC-143a, HFC-245cb and HFO-1243zf.

**[0132]** In some embodiments, the R-454B of the first refrigerant portion constitutes a major refrigerant portion of the composition, while the HCFC-22, HFC-125, HFC-134a and/or CO<sub>2</sub> of the second refrigerant portion and the additional compounds of the first refrigerant portion constitute a minor refrigerant portion thereof.

**[0133]** In some embodiments, the second refrigerant portion of any of the foregoing compositions of Embodiment 4 comprises residual refrigerants.

[0134] In some embodiments, any of the foregoing compositions of Embodiment 4 comprises from about 99.5 to about 99.9 weight percent of the first refrigerant portion, and from about 0.00001 to about 0.5 weight percent, preferably from about 0.0001 to about 0.5 weight percent, of the second refrigerant portion.

[0135] In one embodiment, the total amount of additional compound(s) in the first refrigerant portion of any of the foregoing compositions of Embodiment 4 ranges from greater than 0 wt.% to less than or equal to about 2 wt.%, about 1 wt.%, about 0.9 wt.%, about 0.8 wt.%, about 0.7 wt.%, about 0.6 wt.%, about 0.5 wt.%, about 0.4 wt.%, about 0.3 wt.%, about 0.2 wt.%, about 0.1 wt.%, based on the total weight of the first refrigerant portion of the composition. In another embodiment, the total amount of additional compound(s) ranges from 0.01 ppm (weight) to about 1 wt.%, and all values therebetween up to 1 wt.%. In another embodiment, the total amount of additional compound(s) ranges from 0.1 ppm (weight) to about 1 wt.%. In another embodiment, the total amount of additional compound(s) ranges from 0.001 wt.% to about 1 wt.%. In another embodiment, the total amount of additional compound(s) ranges from 0.001 wt.% to about 0.5 wt.%. In another embodiment, the total amount of additional compound(s) ranges from 0.001 wt.% to 0.4 wt.% or less, based on the total weight of the first refrigerant portion of the composition. In another embodiment, the total amount of additional compound(s) ranges from 0.001 wt.% to 0.1 wt.% or less, based on the total weight of the first refrigerant portion of the composition. In one embodiment, the total amount of additional compound(s) is about 0.1 wt.% based on the total weight of the first refrigerant portion of the composition.

#### **Embodiment 5**

[0136] In one embodiment, a composition comprises, consists essentially of, or consists of HFC-32, HFC-134a, HFC-125 and at least one of HCFC-22 and HFC-143a.

[0137] In some embodiments, the HFC-32, HFC-134a and HFC-125 constitute a major refrigerant portion of the composition, while the HCFC-22 and/or HFC-143a constitutes a minor refrigerant portion thereof.



**[0138]** In one embodiment, the HFC-32, HFC-134a and/or HFC-125 are residual refrigerants. In one embodiment, a residual amount of the HFC-32, HFC-134a and/or HFC-125 is contained in the composition.

**[0139]** In some embodiments, the composition comprises from about 99.5 to about 99.9 weight percent of HFC-32, HFC-134a and HFC-125, and from about 0.00001 to about 0.5 weight percent, preferably from about 0.0001 to about 0.5 weight percent, of at least one of HCFC-22, HFC-143a and combinations thereof.

**[0140]** In one embodiment, a composition comprises, consists essentially of, or consists of HFC-32; HFC-134a; HFC-125; one or more additional compounds selected from HFC-23, HFC-32, HFC-143a, HFC-134a, CFC-115, CFO-1113 and HCC-40; one or more additional compounds selected from HFC-143a, HFO-1225zc, HFC-245cb, HFC-134, HFC-152a, HFO-1225ye, HFC-161, E-HFO-1234ze, HCFC-22, HFO-1243zf, CHFC-124, HCC-40, CHFO-1122, HCFC-31, CFC-114, CFC-114a and HCO-1140; and one or more additional compounds selected from HFC-143a, HFC-41, HFC-134a, HCFC-22, CFC-12 and HCC-40; and at least one of HCFC-22 and HFC-143a.

**[0141]** In one embodiment, a composition comprises, consists essentially of, or consists of HFC-32; HFC-134a; HFC-125; at least one of HCFC-22 and HFC-143a; and one or more additional compounds selected from HFC-134a and CFC-115.

**[0142]** In some embodiments, the HFC-32, HFC-134a and HFC-125 constitute a major refrigerant portion of the composition, while the remaining compounds (e.g., the HCFC-22 and/or HFC-143a and the additional compounds) constitute a minor refrigerant portion of the composition.

**[0143]** In one embodiment, a composition comprises, consists essentially of, or consists of:

a first refrigerant portion comprising, consisting essentially of, or consisting of HFC-125; HFC-134a; HFC-32; one or more additional compounds selected from HFC-23, HFC-32, HFC-143a, HFC-134a, CFC-115, CFO-1113 and HCC-40; one or more additional compounds selected from HFC-143a, HFO-1225zc, HFC-245cb, HFC-134, HFC-152a, HFO-1225ye, HFC-161, E-HFO-1234ze, HCFC-22, HFO-1243zf, CHFC-124, HCC-40, CHFO-1122, HCFC-31, CFC-114, CFC-114a

and HCO-1140; and one or more additional compounds selected from HFC-143a, HFC-41, HFC-134a, HCFC-22, CFC-12 and HCC-40, and

a second refrigerant portion comprising, consisting essentially of, or consisting of at least one of HCFC-22 and HFC-143a.

**[0144]** In one embodiment, the first refrigerant portion comprises, consists essentially of, or consists of HFC-32; HFC-134a; HFC-125; and one or more additional compounds selected from HFC-134a and CFC-115.

**[0145]** In some embodiments, the HFC-32, HFC-134a and HFC-125 of the first refrigerant portion constitute a major refrigerant portion of the composition, while the HCFC-22 and/or HFC-143a of the second refrigerant portion and the additional compounds of the first refrigerant portion constitute a minor refrigerant portion thereof.

**[0146]** In one embodiment, a composition comprises, consists essentially of, or consists of R-407A (20% HFC-32 / 40% HFC-125 / 40% HFC-134a) and at least one of HCFC-22 and HFC-143a.

**[0147]** In some embodiments, the R-407A constitutes a major refrigerant portion of the composition, while the HCFC-22 and/or HFC-143a constitute a minor refrigerant portion thereof.

**[0148]** In some embodiments, the composition comprises from about 99.5 to about 99.9 weight percent of R-407A, and from about 0.00001 to about 0.5 weight percent, preferably from about 0.0001 to about 0.5 weight percent, of at least one of HCFC-22, HFC-143a and combinations thereof.

**[0149]** In one embodiment, a composition comprises, consists essentially of, or consists of R-407A (20% HFC-32 / 40% HFC-125 / 40% HFC-134a); one or more additional compounds selected from HFC-23, HFC-32, HFC-143a, HFC-134a, CFC-115, CFO-1113 and HCC-40; one or more additional compounds selected from HFC-143a, HFO-1225zc, HFC-245cb, HFC-134, HFC-152a, HFO-1225ye, HFC-161, E-HFO-1234ze, HCFC-22, HFO-1243zf, CHFC-124, HCC-40, CHFO-1122, HCFC-31, CFC-114, CFC-114a and HCO-1140; one or more additional compounds selected from HFC-143a, HFC-41, HFC-134a, HCFC-22, CFC-12 and HCC-40; and at least one of HCFC-22 and HFC-143a.

**[0150]** In one embodiment, a composition comprises, consists essentially of, or consists of R-407A, at least one of HCFC-22 and HFC-143a, and one or more additional compounds selected from HFC-134a and CFC-115.

**[0151]** In some embodiments, the R-407A constitutes a major refrigerant portion of the composition, while the remaining compounds (e.g., the HCFC-22 and/or HFC-143a and the additional compounds) constitute a minor refrigerant portion of the composition.

**[0152]** In one embodiment, a composition comprises, consists essentially of, or consists of:

a first refrigerant portion comprising, consisting essentially of, or consisting of R-407A, one or more additional compounds selected from HFC-23, HFC-32, HFC-143a, HFC-134a, CFC-115, CFO-1113 and HCC-40, one or more additional compounds selected from HFC-143a, HFO-1225zc, HFC-245cb, HFC-134, HFC-152a, HFO-1225ye, HFC-161, E-HFO-1234ze, HCFC-22, HFO-1243zf, CHFC-124, HCC-40, CHFO-1122, HCFC-31, CFC-114, CFC-114a and HCO-1140; and one or more additional compounds selected from HFC-143a, HFC-41, HFC-134a, HCFC-22, CFC-12 and HCC-40, and

a second refrigerant portion comprising, consisting essentially of, or consisting of at least one of HCFC-22 and HFC-143a.

**[0153]** In one embodiment, the first refrigerant portion comprises, consists essentially of, or consists of R-407A, and one or more additional compounds selected from HFC-134a and CFC-115.

**[0154]** In some embodiments, the R-407A of the first refrigerant portion constitutes a major refrigerant portion of the composition, while the HCFC-22 and/or HFC-143a of the second refrigerant portion and the additional compounds of the first refrigerant portion constitute a minor refrigerant portion thereof.

**[0155]** In some embodiments, the second refrigerant portion of any of the foregoing compositions of Embodiment 5 comprises residual refrigerants.

**[0156]** In some embodiments, any of the foregoing compositions of Embodiment 5 comprises from about 99.5 to about 99.9 weight percent of the first refrigerant

portion, and from about 0.00001 to about 0.5 weight percent, preferably from about 0.0001 to about 0.5 weight percent, of the second refrigerant portion.

**[0157]** In one embodiment, the total amount of additional compound(s) in the first refrigerant portion of any of the foregoing compositions of Embodiment 5 ranges from greater than 0 wt.% to less than or equal to about 2 wt.%, about 1 wt.%, about 0.9 wt.%, about 0.8 wt.%, about 0.7 wt.%, about 0.6 wt.%, about 0.5 wt.%, about 0.4 wt.%, about 0.3 wt.%, about 0.2 wt.%, about 0.1 wt.%, based on the total weight of the first refrigerant portion of the composition. In another embodiment, the total amount of additional compound(s) ranges from 0.01 ppm (weight) to about 1 wt.%, and all values therebetween up to 1 wt.%. In another embodiment, the total amount of additional compound(s) ranges from 0.1 ppm (weight) to about 1 wt.%. In another embodiment, the total amount of additional compound(s) ranges from 0.001 wt.% to about 1 wt.%. In another embodiment, the total amount of additional compound(s) ranges from 0.001 wt.% to about 0.5 wt.%. In another embodiment, the total amount of additional compound(s) ranges from 0.001 wt.% to 0.4 wt.% or less, based on the total weight of the first refrigerant portion of the composition. In another embodiment, the total amount of additional compound(s) ranges from 0.001 wt.% to 0.1 wt.% or less, based on the total weight of the first refrigerant portion of the composition. In one embodiment, the total amount of additional compound(s) is about 0.1 wt.% based on the total weight of the first refrigerant portion of the composition.

#### **Embodiment 6**

**[0158]** In one embodiment, a composition comprises, consists essentially of, or consists of R-407A (20% HFC-32 / 40% HFC-125 / 40% HFC-134a); R-407C (25% HFC-125 / 23% HFC-32 / 52% HFC-134a); and at least one of HCFC-22 and HFC-143a.

**[0159]** In some embodiments, the R-407A and R-407C constitute a major refrigerant portion of the composition, while the HCFC-22 and/or HFC-143a constitute a minor refrigerant portion thereof.

**[0160]** In one embodiment, the HCFC-22 and/or HFC-134a are residual refrigerants. In one embodiment, a residual amount of the HCFC-22 and/or HFC-134a is contained in the composition.

**[0161]** In some embodiments, the composition comprises from about 99.5 to about 99.9 weight percent of R-407A and R-407C, and from about 0.00001 to about 0.5 weight percent, preferably from about 0.0001 to about 0.5 weight percent, of at least one of HCFC-22, HFC-143a and combinations thereof.

**[0162]** In one embodiment, a composition comprises, consists essentially of, or consists of R-407A (20% HFC-32 / 40% HFC-125 / 40% HFC-134a); R-407C (25% HFC-125 / 23% HFC-32 / 52% HFC-134a); one or more additional compounds selected from HFC-23, HFC-32, HFC-143a, HFC-134a, CFC-115, CFO-1113 and HCC-40; one or more additional compounds selected from HFC-143a, HFO-1225zc, HFC-245cb, HFC-134, HFC-152a, HFO-1225ye, HFC-161, E-HFO-1234ze, HCFC-22, HFO-1243zf, CHFC-124, HCC-40, CHFO-1122, HCFC-31, CFC-114, CFC-114a and HCO-1140; one or more additional compounds selected from HFC-143a, HFC-41, HFC-134a, HCFC-22, CFC-12 and HCC-40; and at least one of HCFC-22 and HFC-143a.

**[0163]** In one embodiment, a composition comprises, consists essentially of, or consists of R-407A; R-407C; at least one of HCFC-22 and HFC-143a; and one or more additional compounds selected from HFC-134a, HFC-143a and CFC-115.

**[0164]** In some embodiments, the R-407A and R-407C constitute a major refrigerant portion of the composition, while the remaining compounds (e.g., the HCFC-22 and/or HFC-143a and the additional compounds) constitute a minor refrigerant portion of the composition.

**[0165]** In one embodiment, a composition comprises, consists essentially of, or consists of:

a first refrigerant portion comprising, consisting essentially of, or consisting of R-407A; R-407C; one or more additional compounds selected from HFC-23, HFC-32, HFC-143a, HFC-134a, CFC-115, CFO-1113 and HCC-40; one or more additional compounds selected from HFC-143a, HFO-1225zc, HFC-245cb, HFC-134, HFC-152a, HFO-1225ye, HFC-161, E-HFO-1234ze, HCFC-22, HFO-1243zf,

CHFC-124, HCC-40, CHFO-1122, HCFC-31, CFC-114, CFC-114a and HCO-1140; and one or more additional compounds selected from HFC-143a, HFC-41, HFC-134a, HCFC-22, CFC-12 and HCC-40, and

a second refrigerant portion comprising, consisting essentially of, or consisting of at least one of HCFC-22 and HFC-143a.

**[0166]** In one embodiment, the first refrigerant portion comprises, consists essentially of, or consists of R-407A; R-407C; and one or more additional compounds selected from HFC-134a, HFC-143a and CFC-115.

**[0167]** In some embodiments, the R-407A and R-407C of the first refrigerant portion constitutes a major refrigerant portion of the composition, while the HCFC-22 and/or HFC-143a of the second refrigerant portion and the additional compounds of the first refrigerant portion constitute a minor refrigerant portion thereof.

**[0168]** In some embodiments, the second refrigerant portion of any of the foregoing compositions of Embodiment 6 comprises residual refrigerants.

**[0169]** In some embodiments, any of the foregoing compositions of Embodiment 6 comprises from about 99.5 to about 99.9 weight percent of the first refrigerant portion, and from about 0.00001 to about 0.5 weight percent, preferably from about 0.0001 to about 0.5 weight percent, of the second refrigerant portion.

**[0170]** In one embodiment, the total amount of additional compound(s) in the first refrigerant portion of any of the foregoing compositions of Embodiment 6 ranges from greater than 0 wt.% to less than or equal to about 2 wt.%, about 1 wt.%, about 0.9 wt.%, about 0.8 wt.%, about 0.7 wt.%, about 0.6 wt.%, about 0.5 wt.%, about 0.4 wt.%, about 0.3 wt.%, about 0.2 wt.%, about 0.1 wt.%, based on the total weight of the first refrigerant portion of the composition. In another embodiment, the total amount of additional compound(s) ranges from 0.01 ppm (weight) to about 1 wt.%, and all values therebetween up to 1 wt.%. In another embodiment, the total amount of additional compound(s) ranges from 0.1 ppm (weight) to about 1 wt.%. In another embodiment, the total amount of additional compound(s) ranges from 0.001 wt.% to about 1 wt.%. In another embodiment, the total amount of additional compound(s) ranges from 0.001 wt.% to about 0.5 wt.%. In another embodiment, the total amount of additional compound(s) ranges from 0.001 wt.% to 0.4 wt.% or less, based on the

total weight of the first refrigerant portion of the composition. In another embodiment, the total amount of additional compound(s) ranges from 0.001 wt. % to 0.1 wt. % or less, based on the total weight of the first refrigerant portion of the composition. In one embodiment, the total amount of additional compound(s) is about 0.1 wt. % based on the total weight of the first refrigerant portion of the composition.

### **Embodiment 7**

**[0171]** In one embodiment, a composition comprises, consists essentially of, or consists of HFC-32, CO<sub>2</sub> and HFO-1234yf, and at least one compound selected from HFC-125, HFC-134a, E-HFO-1234ze, HCFC-22, CFC-115 and HFC-143a.

**[0172]** In some embodiments, the HFC-32, CO<sub>2</sub> and HFO-1234yf constitute a major refrigerant portion of the composition, while the HFC-125, HFC-134a, E-HFO-1234ze, HCFC-22, CFC-115 and/or HFC-143a constitute a minor refrigerant portion thereof.

**[0173]** In one embodiment, the HFC-125, HFC-134a, E-HFO-1234ze, HCFC-22, CFC-115 and/or HFC-143a are residual refrigerants. In one embodiment, a residual amount of the HFC-125, HFC-134a, E-HFO-1234ze, HCFC-22, CFC-115 and/or HFC-143a is contained in the composition.

**[0174]** In some embodiments, the composition comprises from about 99.5 to about 99.9 weight percent of HFC-32, CO<sub>2</sub> and HFO-1234yf, and from about 0.00001 to about 0.5 weight percent, preferably from about 0.0001 to about 0.5 weight percent, of at least one of HFC-125, HFC-134a, E-HFO-1234ze, HCFC-22, CFC-115, HFC-143a and combinations thereof.

**[0175]** In one embodiment, a composition comprises, consists essentially of, or consists of HFC-32; CO<sub>2</sub>; HFO-1234yf; one or more additional compounds selected from HFC-143a, HFC-41, HFC-134a, HCFC-22, CFC-12 and HCC-40; one or more additional compounds selected from N<sub>2</sub>, Ar, CO and O<sub>2</sub>; one or more additional compounds selected from HFO-1225ye, HFO-1243zf, E-HFO-1234ze, HFC-236ea, HCFC-244bb, HFC-245fa, HFC-245eb, HFC-245cb, 3,3,3-trifluoropropyne, HFC-152a, FO-1114, HFO-1123, HCFO-1131a, trans-HCFO-1131, HCO-1140, HCFO-1214ya, HFO-1216, HCFO-1224yd, HFO-1252 isomers, HFC-143a, HCFC-225

isomers, HFC-254eb, HFC-263fb, HFC- 236fa, HCFC-142b, HCFC-244cc, HCFO-1223, HFO-1132a and HCC-40; and at least one of HFC-125, HFC-134a, E-HFO-1234ze, HCFC-22, CFC-115 and HFC-143a.

**[0176]** In one embodiment, a composition comprises, consists essentially of, or consists of HFC-32; CO<sub>2</sub>; HFO-1234yf; at least one of HFC-125, HFC-134a, E-HFO-1234ze, HCFC-22, CFC-115 and HFC-143a; and one or more additional compounds selected from HFC-143a, HFC-245cb and HFO-1243zf.

**[0177]** In some embodiments, the HFC-32, CO<sub>2</sub> and HFO-1234yf constitute a major refrigerant portion of the composition, while the remaining compounds (e.g., the HFC-125, HFC-134a, E-HFO-1234ze, HCFC-22, CFC-115 and/or HFC-143a and the additional compounds) constitute a minor refrigerant portion of the composition.

**[0178]** In one embodiment, a composition comprises, consists essentially of, or consists of:

a first refrigerant portion comprising, consisting essentially of, or consisting of HFC-32; CO<sub>2</sub>; HFO-1234yf; one or more additional compounds selected from HFC-143a, HFC-41, HFC-134a, HCFC-22, CFC-12 and HCC-40; one or more additional compounds selected from N<sub>2</sub>, Ar, CO and O<sub>2</sub>; one or more additional compounds selected from HFO-1225ye, HFO-1243zf, E-HFO-1234ze, HFC-236ea, HCFC-244bb, HFC-245fa, HFC-245eb, HFC-245cb, 3,3,3-trifluoropropyne, HFC-152a, FO-1114, HFO-1123, HCFO-1131a, trans-HCFO-1131, HCO- 1140, HCFO-1214ya, HFO-1216, HCFO-1224yd, HFO-1252 isomers, HFC-143a, HCFC-225 isomers, HFC-254eb, HFC-263fb, HFC- 236fa, HCFC-142b, HCFC-244cc, HCFO-1223, HFO-1132a and HCC-40; and

a second refrigerant portion comprising, consisting essentially of, or consisting of at least one of HFC-125, HFC-134a, E-HFO-1234ze, HCFC-22, CFC-115 and HFC-143a.

**[0179]** In one embodiment, the first refrigerant portion comprises, consists essentially of, or consists of HFC-32; CO<sub>2</sub>; HFO-1234yf; and one or more additional compounds selected from HFC-143a, HFC-245cb and HFO-1243zf.

**[0180]** In some embodiments, the HFC-32, CO<sub>2</sub> and HFO-1234yf of the first refrigerant portion constitute a major refrigerant portion of the composition, while the



HFC-125, HFC-134a, E-HFO-1234ze, HCFC-22, CFC-115 and/or HFC-143a of the second refrigerant portion and the additional compounds of the first refrigerant portion constitute a minor refrigerant portion thereof.

**[0181]** In one embodiment, a composition comprises, consists essentially of, or consists of R-455A (21.5% HFC-32 / 3% CO<sub>2</sub> / 75.5% HFO-1234yf), and at least one of HFC-125, HFC-134a, E-HFO-1234ze, HCFC-22, CFC-115 and HFC-143a.

**[0182]** In some embodiments, the R-455A constitutes a major refrigerant portion of the composition, while the HFC-125, HFC-134a, E-HFO-1234ze, HCFC-22, CFC-115 and/or HFC-143a constitute a minor refrigerant portion thereof.

**[0183]** In some embodiments, the composition comprises from about 99.5 to about 99.9 weight percent of R-455A, and from about 0.00001 to about 0.5 weight percent, preferably from about 0.0001 to about 0.5 weight percent, of at least one of HFC-125, HFC-134a, E-HFO-1234ze, HCFC-22, CFC-115, HFC-143a and combinations thereof.

**[0184]** In one embodiment, a composition comprises, consists essentially of, or consists of R-455A (21.5% HFC-32 / 3% CO<sub>2</sub> / 75.5% HFO-1234yf); one or more additional compounds selected from HFC-143a, HFC-41, HFC-134a, HCFC-22, CFC-12 and HCC-40; one or more additional compounds selected from N<sub>2</sub>, Ar, CO and O<sub>2</sub>; one or more additional compounds selected from HFO-1225ye, HFO-1243zf, E-HFO-1234ze, HFC-236ea, HCFC-244bb, HFC-245fa, HFC-245eb, HFC-245cb, 3,3,3-trifluoropropyne, HFC-152a, FO-1114, HFO-1123, HCFO-1131a, trans-HCFO-1131, HCO-1140, HCFO-1214ya, HFO-1216, HCFO-1224yd, HFO-1252 isomers, HFC-143a, HCFC-225 isomers, HFC-254eb, HFC-263fb, HFC-236fa, HCFC-142b, HCFC-244cc, HCFO-1223, HFO-1132a and HCC-40; and at least one of HFC-125, HFC-134a, E-HFO-1234ze, HCFC-22, CFC-115 and HFC-143a.

**[0185]** In one embodiment, a composition comprises, consists essentially of, or consists of R-455A; at least one of HFC-125, HFC-134a, E-HFO-1234ze, HCFC-22, CFC-115 and HFC-143a; and one or more additional compounds selected from HFC-143a, HFC-245cb and HFO-1243zf.

**[0186]** In some embodiments, the R-455A constitutes a major refrigerant portion of the composition, while the remaining compounds (e.g., the HFC-125, HFC-134a, E-

HFO-1234ze, HCFC-22, CFC-115 and/or HFC-143a and the additional compounds) constitute a minor refrigerant portion of the composition.

**[0187]** In one embodiment, a composition comprises, consists essentially of, or consists of:

a first refrigerant portion comprising, consisting essentially of, or consisting of R-455A; one or more additional compounds selected from HFC-143a, HFC-41, HFC-134a, HCFC-22, CFC-12 and HCC-40; one or more additional compounds selected from N<sub>2</sub>, Ar, CO and O<sub>2</sub>; one or more additional compounds selected from HFO-1225ye, HFO-1243zf, E-HFO-1234ze, HFC-236ea, HCFC-244bb, HFC-245fa, HFC-245eb, HFC-245cb, 3,3,3-trifluoropropyne, HFC-152a, FO-1114, HFO-1123, HCFO-1131a, trans-HCFO-1131, HCO- 1140, HCFO-1214ya, HFO-1216, HCFO-1224yd, HFO-1252 isomers, HFC-143a, HCFC-225 isomers, HFC-254eb, HFC-263fb, HFC- 236fa, HCFC-142b, HCFC-244cc, HCFO-1223, HFO-1132a and HCC-40; and

a second refrigerant portion comprising, consisting essentially of, or consisting of at least one of HFC-125, HFC-134a, E-HFO-1234ze, HCFC-22, CFC-115 and HFC-143a.

**[0188]** In one embodiment, the first refrigerant portion comprises, consists essentially of, or consists of R-455A; one or more additional compounds selected from HFC-143a, HFC-41, HFC-134a, HCFC-22, CFC-12 and HCC-40; one or more additional compounds selected from N<sub>2</sub>, Ar, CO and O<sub>2</sub>; and one or more additional compounds selected from HFO-1225ye, HFO-1243zf, E-HFO-1234ze, HFC-236ea, HCFC-244bb, HFC-245fa, HFC-245eb, HFC-245cb, 3,3,3-trifluoropropyne, HFC-152a, FO-1114, HFO-1123, HCFO-1131a, trans-HCFO-1131, HCO- 1140, HCFO-1214ya, HFO-1216, HCFO-1224yd, HFO-1252 isomers, HFC-143a, HCFC-225 isomers, HFC-254eb, HFC-263fb, HFC- 236fa, HCFC-142b, HCFC-244cc, HCFO-1223, HFO-1132a and HCC-40.

**[0189]** In some embodiments, the R-455A of the first refrigerant portion constitutes a major refrigerant portion of the composition, while the HFC-125, HFC-134a, E-HFO-1234ze, HCFC-22, CFC-115 and/or HFC-143a of the second refrigerant portion and the additional compounds of the first refrigerant portion constitute a minor refrigerant portion thereof.

[0190] In some embodiments, the second refrigerant portion of any of the foregoing compositions of Embodiment 7 comprises residual refrigerants.

[0191] In some embodiments, any of the foregoing compositions of Embodiment 7 comprises from about 99.5 to about 99.9 weight percent of the first refrigerant portion, and from about 0.00001 to about 0.5 weight percent, preferably from about 0.0001 to about 0.5 weight percent, of the second refrigerant portion.

[0192] In one embodiment, the total amount of additional compound(s) in the first refrigerant portion of any of the foregoing compositions of Embodiment 7 ranges from greater than 0 wt.% to less than or equal to about 2 wt.%, about 1 wt.%, about 0.9 wt.%, about 0.8 wt.%, about 0.7 wt.%, about 0.6 wt.%, about 0.5 wt.%, about 0.4 wt.%, about 0.3 wt.%, about 0.2 wt.%, about 0.1 wt.%, based on the total weight of the first refrigerant portion of the composition. In another embodiment, the total amount of additional compound(s) ranges from 0.01 ppm (weight) to about 1 wt.%, and all values therebetween up to 1 wt.%. In another embodiment, the total amount of additional compound(s) ranges from 0.1 ppm (weight) to about 1 wt.%. In another embodiment, the total amount of additional compound(s) ranges from 0.001 wt.% to about 1 wt.%. In another embodiment, the total amount of additional compound(s) ranges from 0.001 wt.% to about 0.5 wt.%. In another embodiment, the total amount of additional compound(s) ranges from 0.001 wt.% to 0.4 wt.% or less, based on the total weight of the first refrigerant portion of the composition. In another embodiment, the total amount of additional compound(s) ranges from 0.001 wt.% to 0.1 wt.% or less, based on the total weight of the first refrigerant portion of the composition. In one embodiment, the total amount of additional compound(s) is about 0.1 wt.% based on the total weight of the first refrigerant portion of the composition.

#### **Embodiment 8**

[0193] In one embodiment, a composition comprises, consists essentially of, or consists of HFC-32, HFC-125, HFC-134a, HFO-1234yf, E-HFO-1234ze, and at least one compound selected from HCFC-22, CFC-115 and HFC-143a.

**[0194]** In some embodiments, the HFC-32, HFC-125, HFC-134a, HFO-1234yf and E-HFO-1234ze constitute a major refrigerant portion of the composition, while the HCFC-22, CFC-115 and/or HFC-143a constitute a minor refrigerant portion thereof.

**[0195]** In one embodiment, the HCFC-22, CFC-115 and/or HFC-143a are residual refrigerants. In one embodiment, a residual amount of the HCFC-22, CFC-115 and/or HFC-143a is contained in the composition.

**[0196]** In some embodiments, the composition comprises from about 99.5 to about 99.9 weight percent of HFC-32, HFC-125, HFC-134a, HFO-1234yf and E-HFO-1234ze, and from about 0.00001 to about 0.5 weight percent, preferably from about 0.0001 to about 0.5 weight percent, of at least one of HCFC-22, CFC-115, HFC-143a and combinations thereof.

**[0197]** In one embodiment, a composition comprises, consists essentially of, or consists of HFC-32; HFC-125; HFC-134a; HFO-1234yf; E-HFO-1234ze; at least one of HCFC-22, CFC-115 and HFC-143a; one or more additional compounds selected from HFC-143a, HFC-41, HFC-134a, HCFC-22, CFC-12 and HCC-40; one or more additional compounds selected from HFC-23, HFC-32, HFC-143a, HFC-134a, CFC-115, CFO-1113 and HCC-40; one or more additional compounds selected from HFC-143a, HFO-1225zc, HFC-245cb, HFC-134, HFC-152a, HFO-1225ye, HFC-161, E-HFO-1234ze, HCFC-22, HFO-1243zf, CHFC-124, HCC-40, CHFO-1122, HCFC-31, CFC-114, CFC-114a and HCO-1140; one or more additional compounds selected from HFO-1225ye, HFO-1243zf, E-HFO-1234ze, HFC-236ea, HCFC-244bb, HFC-245fa, HFC-245eb, HFC-245cb, 3,3,3-trifluoropropyne, HFC-152a, FO-1114, HFO-1123, HCFO-1131a, trans-HCFO-1131, HCO-1140, HCFO-1214ya, HFO-1216, HCFO-1224yd, HFO-1252 isomers, HFC-143a, HCFC-225 isomers, HFC-254eb, HFC-263fb, HFC-236fa, HCFC-142b, HCFC-244cc, HCFO-1223, HFO-1132a and HCC-40; and one or more additional compounds selected from HFO-1234yf, HFC-245cb, HFO-1225ye(E), HFO-1225ye(Z), HFO-1225zc, HFC-236fa, HFC-152a, HFC-143a, HFC-125, HFC-134a, HFO-1234zc, HFO-1233xf, HFO-1233zd, CFC-114, HCFC-124, 3,3,3-trifluoropropyne (R-2223), HFO-1234ze(Z), HFC-245fa, HFC-227ea, HFO-1243zf, HFC-263fb and HFC-134.

**[0198]** In one embodiment, a composition comprises, consists essentially of, or consists of HFC-32; HFC-125; HFC-134a; HFO-1234yf; E-HFO-1234ze; at least one

of HCFC-22, CFC-115 and HFC-143a; and one or more additional compounds selected from HFC-134, HFC-245cb and HFO-1243zf.

**[0199]** In some embodiments, the HFC-32, HFC-125, HFC-134a, HFO-1234yf and E-HFO-1234ze constitute a major refrigerant portion of the composition, while the remaining compounds (e.g., the HCFC-22, CFC-115 and/or HFC-143a and the additional compounds) constitute a minor refrigerant portion of the composition.

**[0200]** In one embodiment, a composition comprises, consists essentially of, or consists of:

a first refrigerant portion comprising, consisting essentially of, or consisting of HFC-32; HFC-125; HFC-134a; HFO-1234yf; E-HFO-1234ze; at least one of HCFC-22, CFC-115 and HFC-143a; one or more additional compounds selected from HFC-143a, HFC-41, HFC-134a, HCFC-22, CFC-12 and HCC-40; one or more additional compounds selected from HFC-23, HFC-32, HFC-143a, HFC-134a, CFC-115, CFO-1113 and HCC-40; one or more additional compounds selected from HFC-143a, HFO-1225zc, HFC-245cb, HFC-134, HFC-152a, HFO-1225ye, HFC-161, E-HFO-1234ze, HCFC-22, HFO-1243zf, HCFC-124, HCC-40, HCFO-1122, HCFC-31, CFC-114, CFC-114a and HCO-1140; one or more additional compounds selected from HFO-1225ye, HFO-1243zf, E-HFO-1234ze, HFC-236ea, HCFC-244bb, HFC-245fa, HFC-245eb, HFC-245cb, 3,3,3-trifluoropropyne, HFC-152a, FO-1114, HFO-1123, HCFO-1131a, trans-HCFO-1131, HCO-1140, HCFO-1214ya, HFO-1216, HCFO-1224yd, HFO-1252 isomers, HFC-143a, HCFC-225 isomers, HFC-254eb, HFC-263fb, HFC-236fa, HCFC-142b, HCFC-244cc, HCFO-1223, HFO-1132a and HCC-40; and one or more additional compounds selected from HFO-1234yf, HFC-245cb, HFO-1225ye(E), HFO-1225ye(Z), HFO-1225zc, HFC-236fa, HFC-152a, HFC-143a, HFC-125, HFC-134a, HFO-1234zc, HFO-1233xf, HFO-1233zd, CFC-114, HCFC-124, 3,3,3-trifluoropropyne, HFO-1234ze(Z), HFC-245fa, HFC-227ea, HFO-1243zf, HFC-263fb and HFC-134; and

a second refrigerant portion comprising, consisting essentially of, or consisting of at least one of HCFC-22, CFC-115 and HFC-143a.

**[0201]** In one embodiment, the first refrigerant portion comprises, consists essentially of, or consists of HFC-32; HFC-125; HFC-134a; HFO-1234yf; E-HFO-

1234ze; and one or more additional compounds selected from HFC-134, HFC-245cb and HFO-1243zf.

**[0202]** In some embodiments, the HFC-32, HFC-125, HFC-134a, HFO-1234yf and E-HFO-1234ze of the first refrigerant portion constitute a major refrigerant portion of the composition, while the HCFC-22, CFC-115 and/or HFC-143a of the second refrigerant portion and the additional compounds of the first refrigerant portion constitute a minor refrigerant portion thereof.

**[0203]** In one embodiment, a composition comprises, consists essentially of, or consists of R-448A (26% HFC-32 / 26% HFC-125 / 21% HFC-134a / 20% HFO-1234yf / 7% E-HFO-1234ze), and at least one of HCFC-22, CFC-115 and HFC-143a.

**[0204]** In some embodiments, the R-448A constitutes a major refrigerant portion of the composition, while the HCFC-22, CFC-115 and/or HFC-143a constitute a minor refrigerant portion thereof.

**[0205]** In some embodiments, the composition comprises from about 99.5 to about 99.9 weight percent of R-448A, and from about 0.00001 to about 0.5 weight percent, preferably from about 0.0001 to about 0.5 weight percent, of at least one of HCFC-22, CFC-115, HFC-143a and combinations thereof.

**[0206]** In one embodiment, a composition comprises, consists essentially of, or consists of R-448A; one or more additional compounds selected from HFC-143a, HFC-41, HFC-134a, HCFC-22, CFC-12 and HCC-40; one or more additional compounds selected from HFC-23, HFC-32, HFC-143a, HFC-134a, CFC-115, CFO-1113 and HCC-40; one or more additional compounds selected from HFC-143a, HFO-1225zc, HFC-245cb, HFC-134, HFC-152a, HFO-1225ye, HFC-161, E-HFO-1234ze, HCFC-22, HFO-1243zf, CHFC-124, HCC-40, CHFO-1122, HCFC-31, CFC-114, CFC-114a and HCO-1140; one or more additional compounds selected from HFO-1225ye, HFO-1243zf, E-HFO-1234ze, HFC-236ea, HCFC-244bb, HFC-245fa, HFC-245eb, HFC-245cb, 3,3,3-trifluoropropyne, HFC-152a, FO-1114, HFO-1123, HCFO-1131a, trans-HCFO-1131, HCO-1140, HCFO-1214ya, HFO-1216, HCFO-1224yd, HFO-1252 isomers, HFC-143a, HCFC-225 isomers, HFC-254eb, HFC-263fb, HFC-236fa, HCFC-142b, HCFC-244cc, HCFO-1223, HFO-1132a and HCC-40; and one or more additional compounds selected from HFO-1234yf, HFC-245cb,

HFO-1225ye(E), HFO-1225ye(Z), HFO-1225zc, HFC-236fa, HFC-152a, HFC-143a, HFC-125, HFC-134a, HFO-1234zc, HFO-1233xf, HFO-1233zd, CFC-114, HCFC-124, 3,3,3-trifluoropropyne, HFO-1234ze(Z), HFC-245fa, HFC-227ea, HFO-1243zf, HFC-263fb and HFC-134; and at least one of HCFC-22, CFC-115 and HFC-143a.

**[0207]** In one embodiment, a composition comprises, consists essentially of, or consists of R-448A; at least one of HCFC-22, CFC-115 and HFC-143a; and one or more additional compounds selected from HFC-134, HFC-245cb and HFO-1243zf.

**[0208]** In some embodiments, the R-448A constitutes a major refrigerant portion of the composition, while the remaining compounds (e.g., the HCFC-22, CFC-115 and/or HFC-143a and the additional compounds) constitute a minor refrigerant portion of the composition.

**[0209]** In one embodiment, a composition comprises, consists essentially of, or consists of:

a first refrigerant portion comprising, consisting essentially of, or consisting of R-448A; one or more additional compounds selected from HFC-143a, HFC-41, HFC-134a, HCFC-22, CFC-12 and HCC-40; one or more additional compounds selected from HFC-23, HFC-32, HFC-143a, HFC-134a, CFC-115, CFO-1113 and HCC-40; one or more additional compounds selected from HFC-143a, HFO-1225zc, HFC-245cb, HFC-134, HFC-152a, HFO-1225ye, HFC-161, E-HFO-1234ze, HCFC-22, HFO-1243zf, CHFC-124, HCC-40, CHFO-1122, HCFC-31, CFC-114, CFC-114a and HCO-1140; one or more additional compounds selected from HFO-1225ye, HFO-1243zf, E-HFO-1234ze, HFC-236ea, HCFC-244bb, HFC-245fa, HFC-245eb, HFC-245cb, 3,3,3-trifluoropropyne, HFC-152a, FO-1114, HFO-1123, HCFO-1131a, trans-HCFO-1131, HCO-1140, HCFO-1214ya, HFO-1216, HCFO-1224yd, HFO-1252 isomers, HFC-143a, HCFC-225 isomers, HFC-254eb, HFC-263fb, HFC-236fa, HCFC-142b, HCFC-244cc, HCFO-1223, HFO-1132a and HCC-40; and one or more additional compounds selected from HFO-1234yf, HFC-245cb, HFO-1225ye(E), HFO-1225ye(Z), HFO-1225zc, HFC-236fa, HFC-152a, HFC-143a, HFC-125, HFC-134a, HFO-1234zc, HFO-1233xf, HFO-1233zd, CFC-114, HCFC-124, 3,3,3-trifluoropropyne, HFO-1234ze(Z), HFC-245fa, HFC-227ea, HFO-1243zf, HFC-263fb and HFC-134; and

a second refrigerant portion comprising, consisting essentially of, or consisting of at least one of HCFC-22, CFC-115 and HFC-143a.

**[0210]** In one embodiment, the first refrigerant portion comprises, consists essentially of, or consists of R-448A, and one or more additional compounds selected from HFC-134, HFC-245cb and HFO-1243zf.

**[0211]** In some embodiments, the R-448A of the first refrigerant portion constitutes a major refrigerant portion of the composition, while the HCFC-22, CFC-115 and/or HFC-143a of the second refrigerant portion and the additional compounds of the first refrigerant portion constitute a minor refrigerant portion thereof.

**[0212]** In some embodiments, the second refrigerant portion of any of the foregoing compositions of Embodiment 8 comprises residual refrigerants.

**[0213]** In some embodiments, any of the foregoing compositions of Embodiment 8 comprises from about 99.5 to about 99.9 weight percent of the first refrigerant portion, and from about 0.00001 to about 0.5 weight percent, preferably from about 0.0001 to about 0.5 weight percent, of the second refrigerant portion.

**[0214]** In one embodiment, the total amount of additional compound(s) in the first refrigerant portion of any of the foregoing compositions of Embodiment 8 ranges from greater than 0 wt.% to less than or equal to about 2 wt.%, about 1 wt.%, about 0.9 wt.%, about 0.8 wt.%, about 0.7 wt.%, about 0.6 wt.%, about 0.5 wt.%, about 0.4 wt.%, about 0.3 wt.%, about 0.2 wt.%, about 0.1 wt.%, based on the total weight of the first refrigerant portion of the composition. In another embodiment, the total amount of additional compound(s) ranges from 0.01 ppm (weight) to about 1 wt.%, and all values therebetween up to 1 wt.%. In another embodiment, the total amount of additional compound(s) ranges from 0.1 ppm (weight) to about 1 wt.%. In another embodiment, the total amount of additional compound(s) ranges from 0.001 wt.% to about 1 wt.%. In another embodiment, the total amount of additional compound(s) ranges from 0.001 wt.% to about 0.5 wt.%. In another embodiment, the total amount of additional compound(s) ranges from 0.001 wt.% to 0.4 wt.% or less, based on the total weight of the first refrigerant portion of the composition. In another embodiment, the total amount of additional compound(s) ranges from 0.001 wt.% to 0.1 wt.% or less, based on the total weight of the first refrigerant portion of the composition. In one embodiment, the total amount of additional compound(s) is



about 0.1 wt.% based on the total weight of the first refrigerant portion of the composition.

#### **Embodiment 9**

**[0215]** In one embodiment, a composition comprises, consists essentially of, or consists of HFC-32, HFC-125, HFC-134a, HFO-1234yf, and at least one compound selected from HCFC-22, CFC-115, HFC-143a and E-HFO-1234ze.

**[0216]** In some embodiments, the HFC-32, HFC-125, HFC-134a and HFO-1234yf constitute a major refrigerant portion of the composition, while the HCFC-22, CFC-115, HFC-143a and/or E-HFO-1234ze constitute a minor refrigerant portion thereof.

**[0217]** In one embodiment, the HCFC-22, CFC-115, HFC-143a and/or E-HFO-1234ze are residual refrigerants. In one embodiment, a residual amount of the E-HFO-1234ze, HCFC-22, CFC-115 and/or HFC-143a is contained in the composition.

**[0218]** In some embodiments, the composition comprises from about 99.5 to about 99.9 weight percent of HFC-32, HFC-125, HFC-134a and HFO-1234yf, and from about 0.00001 to about 0.5 weight percent, preferably from about 0.0001 to about 0.5 weight percent, of at least one of HCFC-22, CFC-115, HFC-143a, E-HFO-1234ze and combinations thereof.

**[0219]** In one embodiment, a composition comprises, consists essentially of, or consists of HFC-32; HFC-125; HFC-134a; HFO-1234yf; at least one of HCFC-22, CFC-115, HFC-143a and E-HFO-1234ze; one or more additional compounds selected from HFC-143a, HFC-41, HFC-134a, HCFC-22, CFC-12 and HCC-40; one or more additional compounds selected from HFC-23, HFC-32, HFC-143a, HFC-134a, CFC-115, CFO-1113 and HCC-40; one or more additional compounds selected from HFC-143a, HFO-1225zc, HFC-245cb, HFC-134, HFC-152a, HFO-1225ye, HFC-161, E-HFO-1234ze, HCFC-22, HFO-1243zf, CHFC-124, HCC-40, CHFO-1122, HCFC-31, CFC-114, CFC-114a and HCO-1140; and one or more additional compounds selected from HFO-1225ye, HFO-1243zf, E-HFO-1234ze, HFC-236ea, HCFC-244bb, HFC-245fa, HFC-245eb, HFC-245cb, 3,3,3-trifluoropropyne, HFC-152a, FO-1114, HFO-1123, HCFO-1131a, trans-HCFO-1131, HCO-1140, HCFO-1214ya, HFO-1216, HCFO-1224yd, HFO-1252 isomers, HFC-

143a, HCFC-225 isomers, HFC-254eb, HFC-263fb, HFC- 236fa, HCFC-142b, HCFC-244cc, HCFO-1223, HFO-1132a and HCC-40.

**[0220]** In one embodiment, a composition comprises, consists essentially of, or consists of HFC-32; HFC-125; HFC-134a; HFO-1234yf; at least one of HCFC-22, CFC-115, HFC-143a and E-HFO-1234ze; and one or more additional compounds selected from HFC-134, HFC-245cb and HFO-1243zf.

**[0221]** In some embodiments, the HFC-32, HFC-125, HFC-134a and HFO-1234yf constitute a major refrigerant portion of the composition, while the remaining compounds (e.g., the HCFC-22, CFC-115, HFC-143a and/or E-HFO-1234ze and the additional compounds) constitute a minor refrigerant portion of the composition.

**[0222]** In one embodiment, a composition comprises, consists essentially of, or consists of:

a first refrigerant portion comprising, consisting essentially of, or consisting of HFC-32; HFC-125; HFC-134a; HFO-1234yf; at least one of HCFC-22, CFC-115 and HFC-143a; one or more additional compounds selected from HFC-143a, HFC-41, HFC-134a, HCFC-22, CFC-12 and HCC-40; one or more additional compounds selected from HFC-23, HFC-32, HFC-143a, HFC-134a, CFC-115, CFO-1113 and HCC-40; one or more additional compounds selected from HFC-143a, HFO-1225zc, HFC-245cb, HFC-134, HFC-152a, HFO-1225ye, HFC-161, E-HFO-1234ze, HCFC-22, HFO-1243zf, CHFC-124, HCC-40, CHFO-1122, HCFC-31, CFC-114, CFC-114a and HCO-1140; and one or more additional compounds selected from HFO-1225ye, HFO-1243zf, E-HFO-1234ze, HFC-236ea, HCFC-244bb, HFC-245fa, HFC-245eb, HFC-245cb, 3,3,3-trifluoropropyne, HFC-152a, FO-1114, HFO-1123, HCFO-1131a, trans-HCFO-1131, HCO- 1140, HCFO-1214ya, HFO-1216, HCFO-1224yd, HFO-1252 isomers, HFC-143a, HCFC-225 isomers, HFC-254eb, HFC-263fb, HFC- 236fa, HCFC-142b, HCFC-244cc, HCFO-1223, HFO-1132a and HCC-40; and

a second refrigerant portion comprising, consisting essentially of, or consisting of at least one of HCFC-22, CFC-115, HFC-143a and E-HFO-1234ze.

**[0223]** In one embodiment, the first refrigerant portion comprises, consists essentially of, or consists of HFC-32; HFC-125; HFC-134a; HFO-1234yf; and one or more additional compounds selected from HFC-134, HFC-245cb and HFO-1243zf.

**[0224]** In some embodiments, the HFC-32, HFC-125, HFC-134a and HFO-1234yf of the first refrigerant portion constitute a major refrigerant portion of the composition, while the HCFC-22, CFC-115, HFC-143a and/or E-HFO-1234ze of the second refrigerant portion and the additional compounds of the first refrigerant portion constitute a minor refrigerant portion thereof.

**[0225]** In one embodiment, a composition comprises, consists essentially of, or consists of R-449A (24.3% HFC-32 / 24.7% HFC-125 / 25.7% HFC-134a / 25.3% HFO-1234yf), and at least one of HCFC-22, CFC-115, HFC-143a and E-HFO-1234ze.

**[0226]** In some embodiments, the R-449A constitutes a major refrigerant portion of the composition, while the HCFC-22, CFC-115, HFC-143a and/or E-HFO-1234ze constitute a minor refrigerant portion thereof.

**[0227]** In some embodiments, the composition comprises from about 99.5 to about 99.9 weight percent of R-449A, and from about 0.00001 to about 0.5 weight percent, preferably from about 0.0001 to about 0.5 weight percent, of at least one of HCFC-22, CFC-115, HFC-143a, E-HFO-1234ze and combinations thereof.

**[0228]** In one embodiment, a composition comprises, consists essentially of, or consists of R-449A; one or more additional compounds selected from HFC-143a, HFC-41, HFC-134a, HCFC-22, CFC-12 and HCC-40; one or more additional compounds selected from HFC-23, HFC-32, HFC-143a, HFC-134a, CFC-115, CFO-1113 and HCC-40; one or more additional compounds selected from HFC-143a, HFO-1225zc, HFC-245cb, HFC-134, HFC-152a, HFO-1225ye, HFC-161, E-HFO-1234ze, HCFC-22, HFO-1243zf, CHFC-124, HCC-40, CHFO-1122, HCFC-31, CFC-114, CFC-114a and HCO-1140; and one or more additional compounds selected from HFO-1225ye, HFO-1243zf, E-HFO-1234ze, HFC-236ea, HCFC-244bb, HFC-245fa, HFC-245eb, HFC-245cb, 3,3,3-trifluoropropyne, HFC-152a, FO-1114, HFO-1123, HCFO-1131a, trans-HCFO-1131, HCO-1140, HCFO-1214ya, HFO-1216, HCFO-1224yd, HFO-1252 isomers, HFC-143a, HCFC-225 isomers, HFC-254eb, HFC-263fb, HFC-236fa, HCFC-142b, HCFC-244cc, HCFO-1223, HFO-1132a and HCC-40; and at least one of HCFC-22, CFC-115, HFC-143a and E-HFO-1234ze.

**[0229]** In one embodiment, a composition comprises, consists essentially of, or consists of R-449A; at least one of HCFC-22, CFC-115, HFC-143a and E-HFO-

1234ze; and one or more additional compounds selected from HFC-134, HFC-245cb and HFO-1243zf.

**[0230]** In some embodiments, the R-449A constitutes a major refrigerant portion of the composition, while the remaining compounds (e.g., the HCFC-22, CFC-115, HFC-143a and/or E-HFO-1234ze and the additional compounds) constitute a minor refrigerant portion of the composition.

**[0231]** In one embodiment, a composition comprises, consists essentially of, or consists of:

a first refrigerant portion comprising, consisting essentially of, or consisting of R-449A; one or more additional compounds selected from HFC-143a, HFC-41, HFC-134a, HCFC-22, CFC-12 and HCC-40; one or more additional compounds selected from HFC-23, HFC-32, HFC-143a, HFC-134a, CFC-115, CFO-1113 and HCC-40; one or more additional compounds selected from HFC-143a, HFO-1225zc, HFC-245cb, HFC-134, HFC-152a, HFO-1225ye, HFC-161, E-HFO-1234ze, HCFC-22, HFO-1243zf, CHFC-124, HCC-40, CHFO-1122, HCFC-31, CFC-114, CFC-114a and HCO-1140; and one or more additional compounds selected from HFO-1225ye, HFO-1243zf, E-HFO-1234ze, HFC-236ea, HCFC-244bb, HFC-245fa, HFC-245eb, HFC-245cb, 3,3,3-trifluoropropyne, HFC-152a, FO-1114, HFO-1123, HCFO-1131a, trans-HCFO-1131, HCO-1140, HCFO-1214ya, HFO-1216, HCFO-1224yd, HFO-1252 isomers, HFC-143a, HCFC-225 isomers, HFC-254eb, HFC-263fb, HFC-236fa, HCFC-142b, HCFC-244cc, HCFO-1223, HFO-1132a and HCC-40; and

a second refrigerant portion comprising, consisting essentially of, or consisting of at least one of HCFC-22, CFC-115, HFC-143a and E-HFO-1234ze.

**[0232]** In one embodiment, the first refrigerant portion comprises, consists essentially of, or consists of R-449A, and one or more additional compounds selected from HFC-134, HFC-245cb and HFO-1243zf.

**[0233]** In some embodiments, the R-449A of the first refrigerant portion constitutes a major refrigerant portion of the composition, while the HCFC-22, CFC-115, HFC-143a and/or E-HFO-1234ze of the second refrigerant portion and the additional compounds of the first refrigerant portion constitute a minor refrigerant portion thereof.

[0234] In some embodiments, the second refrigerant portion of any of the foregoing compositions of Embodiment 9 comprises residual refrigerants.

[0235] In some embodiments, any of the foregoing compositions of Embodiment 9 comprises from about 99.5 to about 99.9 weight percent of the first refrigerant portion, and from about 0.00001 to about 0.5 weight percent, preferably from about 0.0001 to about 0.5 weight percent, of the second refrigerant portion.

[0236] In one embodiment, the total amount of additional compound(s) in the first refrigerant portion of any of the foregoing compositions of Embodiment 9 ranges from greater than 0 wt.% to less than or equal to about 2 wt.%, about 1 wt.%, about 0.9 wt.%, about 0.8 wt.%, about 0.7 wt.%, about 0.6 wt.%, about 0.5 wt.%, about 0.4 wt.%, about 0.3 wt.%, about 0.2 wt.%, about 0.1 wt.%, based on the total weight of the first refrigerant portion of the composition. In another embodiment, the total amount of additional compound(s) ranges from 0.01 ppm (weight) to about 1 wt.%, and all values therebetween up to 1 wt.%. In another embodiment, the total amount of additional compound(s) ranges from 0.1 ppm (weight) to about 1 wt.%. In another embodiment, the total amount of additional compound(s) ranges from 0.001 wt.% to about 1 wt.%. In another embodiment, the total amount of additional compound(s) ranges from 0.001 wt.% to about 0.5 wt.%. In another embodiment, the total amount of additional compound(s) ranges from 0.001 wt.% to 0.4 wt.% or less, based on the total weight of the first refrigerant portion of the composition. In another embodiment, the total amount of additional compound(s) ranges from 0.001 wt.% to 0.1 wt.% or less, based on the total weight of the first refrigerant portion of the composition. In one embodiment, the total amount of additional compound(s) is about 0.1 wt.% based on the total weight of the first refrigerant portion of the composition.

#### **Embodiment 10**

[0237] In one embodiment, a composition comprises, consists essentially of, or consists of HFC-125, HFC-134a, HFC-143a, and at least one of HCFC-22 and CFC-115.

**[0238]** In some embodiments, the HFC-125, HFC-134a and HFC-143a constitute a major refrigerant portion of the composition, while the HCFC-22 and/or CFC-115 constitute a minor refrigerant portion thereof.

**[0239]** In one embodiment, the HCFC-22 and/or CFC-115 are residual refrigerants. In one embodiment, a residual amount of the HCFC-22 and/or CFC-115 is contained in the composition.

**[0240]** In some embodiments, the composition comprises from about 99.5 to about 99.9 weight percent of HFC-125, HFC-134a and HFC-143a, and from about 0.00001 to about 0.5 weight percent, preferably from about 0.0001 to about 0.5 weight percent, of at least one of HCFC-22, CFC-115 and combinations thereof.

**[0241]** In one embodiment, a composition comprises, consists essentially of, or consists of HFC-125; HFC-134a; HFC-143a; at least one of HCFC-22 and CFC-115; one or more additional compounds selected from HFC-23, HFC-32, HFC-143a, HFC-134a, CFC-115, CFO-1113 and HCC-40; one or more additional compounds selected from HFC-143a, HFO-1225zc, HFC-245cb, HFC-134, HFC-152a, HFO-1225ye, HFC-161, E-HFO-1234ze, HCFC-22, HFO-1243zf, CHFC-124, HCC-40, CHFO-1122, HCFC-31, CFC-114, CFC-114a and HCO-1140; and one or more additional compounds selected from CFC-115, HFC-134a, HFC-152a, HCFC-22, CFC-12, HCFC-124, CFC-114a and HCFC-133a.

**[0242]** In one embodiment, a composition comprises, consists essentially of, or consists of HFC-125; HFC-134a; HFC-143a; at least one of HCFC-22 and CFC-115; and one or more additional compounds selected from HFC-134, HCC-40 and CFC-114a.

**[0243]** In some embodiments, the HFC-125, HFC-134a and HFC-143a constitute a major refrigerant portion of the composition, while the remaining compounds (e.g., the HCFC-22 and/or CFC-115 and the additional compounds) constitute a minor refrigerant portion of the composition.

**[0244]** In one embodiment, a composition comprises, consists essentially of, or consists of:

a first refrigerant portion comprising, consisting essentially of, or consisting of HFC-125; HFC-134a; HFC-143a; at least one of HCFC-22 and CFC-115; one or

more additional compounds selected from HFC-23, HFC-32, HFC-143a, HFC-134a, CFC-115, CFO-1113 and HCC-40; one or more additional compounds selected from HFC-143a, HFO-1225zc, HFC-245cb, HFC-134, HFC-152a, HFO-1225ye, HFC-161, E-HFO-1234ze, HCFC-22, HFO-1243zf, CHFC-124, HCC-40, CHFO-1122, HCFC-31, CFC-114, CFC-114a and HCO-1140; and one or more additional compounds selected from CFC-115, HFC-134a, HFC-152a, HCFC-22, CFC-12, HCFC-124, CFC-114a and HCFC-133a; and

a second refrigerant portion comprising, consisting essentially of, or consisting of at least one of HCFC-22 and CFC-115.

**[0245]** In one embodiment, the first refrigerant portion, comprises, consists essentially of, or consists of HFC-125; HFC-134a; HFC-143a; and one or more additional compounds selected from HFC-134, HCC-40 and CFC-114a.

**[0246]** In some embodiments, the HFC-125, HFC-134a and HFC-143a of the first refrigerant portion constitute a major refrigerant portion of the composition, while the HCFC-22 and/or CFC-115 of the second refrigerant portion and the additional compounds of the first refrigerant portion constitute a minor refrigerant portion thereof.

**[0247]** In one embodiment, a composition comprises, consists essentially of, or consists of R-404A (44% HFC-125 / 4% HFC-134a / 52% HFC-143a), and at least one of HCFC-22 and CFC-115.

**[0248]** In some embodiments, the R-404A constitutes a major refrigerant portion of the composition, while the HCFC-22 and/or CFC-115 constitute a minor refrigerant portion thereof.

**[0249]** In some embodiments, the composition comprises from about 99.5 to about 99.9 weight percent of R-404A, and from about 0.00001 to about 0.5 weight percent, preferably from about 0.0001 to about 0.5 weight percent, of at least one of HCFC-22, CFC-115 and combinations thereof.

**[0250]** In one embodiment, a composition comprises, consists essentially of, or consists of R-404A; one or more additional compounds selected from HFC-23, HFC-32, HFC-143a, HFC-134a, CFC-115, CFO-1113 and HCC-40; one or more additional compounds selected from HFC-143a, HFO-1225zc, HFC-245cb,

HFC-134, HFC-152a, HFO-1225ye, HFC-161, E-HFO-1234ze, HCFC-22, HFO-1243zf, CHFC-124, HCC-40, CHFO-1122, HCFC-31, CFC-114, CFC-114a and HCO-1140; and one or more additional compounds selected from CFC-115, HFC-134a, HFC-152a, HCFC-22, CFC-12, HCFC-124, CFC-114a and HCFC-133a; and at least one of HCFC-22 and CFC-115.

**[0251]** In one embodiment, a composition comprises, consists essentially of, or consists of R-404A; at least one of HCFC-22 and CFC-115; and one or more additional compounds selected from HFC-134, HCC-40 and CFC-114a.

**[0252]** In some embodiments, the R-404A constitutes a major refrigerant portion of the composition, while the remaining compounds (e.g., the HCFC-22 and/or CFC-115 and the additional compounds) constitute a minor refrigerant portion of the composition.

**[0253]** In one embodiment, a composition comprises, consists essentially of, or consists of:

a first refrigerant portion comprising, consisting essentially of, or consisting of R-404A; one or more additional compounds selected from HFC-23, HFC-32, HFC-143a, HFC-134a, CFC-115, CFO-1113 and HCC-40; one or more additional compounds selected from HFC-143a, HFO-1225zc, HFC-245cb, HFC-134, HFC-152a, HFO-1225ye, HFC-161, E-HFO-1234ze, HCFC-22, HFO-1243zf, CHFC-124, HCC-40, CHFO-1122, HCFC-31, CFC-114, CFC-114a and HCO-1140; and one or more additional compounds selected from CFC-115, HFC-134a, HFC-152a, HCFC-22, CFC-12, HCFC-124, CFC-114a and HCFC-133a; and

a second refrigerant portion comprising, consisting essentially of, or consisting of at least one of HCFC-22 and CFC-115.

**[0254]** In one embodiment, the first refrigerant portion comprises, consists essentially of, or consists of R-404A; and one or more additional compounds selected from HFC-134, HCC-40 and CFC-114a.

**[0255]** In some embodiments, the R-404A of the first refrigerant portion constitutes a major refrigerant portion of the composition, while the HCFC-22 and/or CFC-115 of the second refrigerant portion and the additional compounds of the first refrigerant portion constitute a minor refrigerant portion thereof.



[0256] In some embodiments, the second refrigerant portion of any of the foregoing compositions of Embodiment 10 comprises residual refrigerants.

[0257] In some embodiments, any of the foregoing compositions of Embodiment 10 comprises from about 99.5 to about 99.9 weight percent of the first refrigerant portion, and from about 0.00001 to about 0.5 weight percent, preferably from about 0.0001 to about 0.5 weight percent, of the second refrigerant portion.

[0258] In one embodiment, the total amount of additional compound(s) in the first refrigerant portion of any of the foregoing compositions of Embodiment 10 ranges from greater than 0 wt.% to less than or equal to about 2 wt.%, about 1 wt.%, about 0.9 wt.%, about 0.8 wt.%, about 0.7 wt.%, about 0.6 wt.%, about 0.5 wt.%, about 0.4 wt.%, about 0.3 wt.%, about 0.2 wt.%, about 0.1 wt.%, based on the total weight of the first refrigerant portion of the composition. In another embodiment, the total amount of additional compound(s) ranges from 0.01 ppm (weight) to about 1 wt.%, and all values therebetween up to 1 wt.%. In another embodiment, the total amount of additional compound(s) ranges from 0.1 ppm (weight) to about 1 wt.%. In another embodiment, the total amount of additional compound(s) ranges from 0.001 wt.% to about 1 wt.%. In another embodiment, the total amount of additional compound(s) ranges from 0.001 wt.% to about 0.5 wt.%. In another embodiment, the total amount of additional compound(s) ranges from 0.001 wt.% to 0.4 wt.% or less, based on the total weight of the first refrigerant portion of the composition. In another embodiment, the total amount of additional compound(s) ranges from 0.001 wt.% to 0.1 wt.% or less, based on the total weight of the first refrigerant portion of the composition. In one embodiment, the total amount of additional compound(s) is about 0.1 wt.% based on the total weight of the first refrigerant portion of the composition.

#### **Embodiment 11**

[0259] In one embodiment, a composition comprises, consists essentially of, or consists of HFC-125, HFC-143a, and at least one of HCFC-22 and CFC-115.

[0260] In some embodiments, the HFC-125 and HFC-143a constitute a major refrigerant portion of the composition, while the HCFC-22 and/or CFC-115 constitute a minor refrigerant portion thereof.

**[0261]** In one embodiment, the HCFC-22 and/or CFC-115 are residual refrigerants. In one embodiment, a residual amount of the HCFC-22 and/or CFC-115 is contained in the composition.

**[0262]** In some embodiments, the composition comprises from about 99.5 to about 99.9 weight percent of HFC-125 and HFC-143a, and from about 0.00001 to about 0.5 weight percent, preferably from about 0.0001 to about 0.5 weight percent, of at least one of HCFC-22, CFC-115 and combinations thereof.

**[0263]** In one embodiment, a composition comprises, consists essentially of, or consists of HFC-125; HFC-143a; at least one of HCFC-22 and CFC-115; one or more additional compounds selected from HFC-23, HFC-32, HFC-143a, HFC-134a, CFC-115, CFO-1113 and HCC-40; and one or more additional compounds selected from CFC-115, HFC-134a, HFC-152a, HCFC-22, CFC-12, HCFC-124, CFC-114a and HCFC-133a.

**[0264]** In one embodiment, a composition comprises, consists essentially of, or consists of HFC-125; HFC-143a; at least one of HCFC-22 and CFC-115; and one or more additional compounds selected from HFC-134a and HCC-40.

**[0265]** In some embodiments, the HFC-125 and HFC-143a constitute a major refrigerant portion of the composition, while the remaining compounds (e.g., the HCFC-22 and/or CFC-115 and the additional compounds) constitute a minor refrigerant portion of the composition.

**[0266]** In one embodiment, a composition comprises, consists essentially of, or consists of:

a first refrigerant portion comprising, consisting essentially of, or consisting of HFC-125; HFC-143a; at least one of HCFC-22 and CFC-115; one or more additional compounds selected from HFC-23, HFC-32, HFC-143a, HFC-134a, CFC-115, CFO-1113 and HCC-40; and one or more additional compounds selected from CFC-115, HFC-134a, HFC-152a, HCFC-22, CFC-12, HCFC-124, CFC-114a and HCFC-133a; and

a second refrigerant portion comprising, consisting essentially of, or consisting of at least one of HCFC-22 and CFC-115.

**[0267]** In one embodiment, the first refrigerant portion comprises, consists essentially of, or consists of HFC-125; HFC-143a; and one or more additional compounds selected from HFC-134a and HCC-40.

**[0268]** In some embodiments, the HFC-125 and HFC-143a of the first refrigerant portion constitute a major refrigerant portion of the composition, while the HCFC-22 and/or CFC-115 of the second refrigerant portion and the additional compounds of the first refrigerant portion constitute a minor refrigerant portion thereof.

**[0269]** In one embodiment, a composition comprises, consists essentially of, or consists of R-507 (50% HFC-125 / 50% HFC-143a), and at least one of HCFC-22 and CFC-115.

**[0270]** In some embodiments, the R-507 constitutes a major refrigerant portion of the composition, while the HCFC-22 and/or CFC-115 constitute a minor refrigerant portion thereof.

**[0271]** In some embodiments, the composition comprises from about 99.5 to about 99.9 weight percent of R-507, and from about 0.00001 to about 0.5 weight percent, preferably from about 0.0001 to about 0.5 weight percent, of at least one of HCFC-22, CFC-115 and combinations thereof.

**[0272]** In one embodiment, a composition comprises, consists essentially of, or consists of R-507; one or more additional compounds selected from HFC-23, HFC-32, HFC-143a, HFC-134a, CFC-115, CFO-1113 and HCC-40; and one or more additional compounds selected from CFC-115, HFC-134a, HFC-152a, HCFC-22, CFC-12, HCFC-124, CFC-114a and HCFC-133a; and at least one of HCFC-22 and CFC-115.

**[0273]** In one embodiment, a composition comprises, consists essentially of, or consists of R-507; at least one of HCFC-22 and CFC-115; and one or more additional compounds selected from HFC-134a and HCC-40.

**[0274]** In some embodiments, the R-507 constitutes a major refrigerant portion of the composition, while the remaining compounds (e.g., the HCFC-22 and/or CFC-115 and the additional compounds) constitute a minor refrigerant portion of the composition.

**[0275]** In one embodiment, a composition comprises, consists essentially of, or consists of:

a first refrigerant portion comprising, consisting essentially of, or consisting of R-507; one or more additional compounds selected from HFC-23, HFC-32, HFC-143a, HFC-134a, CFC-115, CFO-1113 and HCC-40; and one or more additional compounds selected from CFC-115, HFC-134a, HFC-152a, HCFC-22, CFC-12, HCFC-124, CFC-114a and HCFC-133a; and

a second refrigerant portion comprising, consisting essentially of, or consisting of at least one of HCFC-22 and CFC-115.

**[0276]** In one embodiment, the first refrigerant portion comprises, consists essentially of, or consists of R-507; and one or more additional compounds selected from HFC-134a and HCC-40.

**[0277]** In some embodiments, the R507 of the first refrigerant portion constitutes a major refrigerant portion of the composition, while the HCFC-22 and/or CFC-115 of the second refrigerant portion and the additional compounds of the first refrigerant portion constitute a minor refrigerant portion thereof.

**[0278]** In some embodiments, the second refrigerant portion of any of the foregoing compositions of Embodiment 11 comprises residual refrigerants.

**[0279]** In some embodiments, any of the foregoing compositions of Embodiment 11 comprises from about 99.5 to about 99.9 weight percent of the first refrigerant portion, and from about 0.00001 to about 0.5 weight percent, preferably from about 0.0001 to about 0.5 weight percent, of the second refrigerant portion.

**[0280]** In one embodiment, the total amount of additional compound(s) in the first refrigerant portion of any of the foregoing compositions of Embodiment 11 ranges from greater than 0 wt.% to less than or equal to about 2 wt.%, about 1 wt.%, about 0.9 wt.%, about 0.8 wt.%, about 0.7 wt.%, about 0.6 wt.%, about 0.5 wt.%, about 0.4 wt.%, about 0.3 wt.%, about 0.2 wt.%, about 0.1 wt.%, based on the total weight of the first refrigerant portion of the composition. In another embodiment, the total amount of additional compound(s) ranges from 0.01 ppm (weight) to about 1 wt.%, and all values therebetween up to 1 wt.%. In another embodiment, the total amount of additional compound(s) ranges from 0.1 ppm (weight) to about 1 wt.%. In another

embodiment, the total amount of additional compound(s) ranges from 0.001 wt.% to about 1 wt.%. In another embodiment, the total amount of additional compound(s) ranges from 0.001 wt.% to about 0.5 wt.%. In another embodiment, the total amount of additional compound(s) ranges from 0.001 wt.% to 0.4 wt.% or less, based on the total weight of the first refrigerant portion of the composition. In another embodiment, the total amount of additional compound(s) ranges from 0.001 wt.% to 0.1 wt.% or less, based on the total weight of the first refrigerant portion of the composition. In one embodiment, the total amount of additional compound(s) is about 0.1 wt.% based on the total weight of the first refrigerant portion of the composition.

### **Embodiment 12**

**[0281]** In one embodiment, a composition comprises, consists essentially of, or consists of HFC-32 and HFO-1234yf, and at least one of HCFC-22, CFC-12, CFC-115, HFC-125, HFC-134a and HFC-143a.

**[0282]** In some embodiments, the HFO-1234yf and HFC-32 constitute a major refrigerant portion of the composition, while the HCFC-22, CFC-12, CFC-115, HFC-125, HFC-134a and/or HFC-143a constitute a minor refrigerant portion thereof.

**[0283]** In one embodiment, the HCFC-22, CFC-12, CFC-115, HFC-125, HFC-134a and/or HFC-143a are residual refrigerants. In one embodiment, a residual amount of the HCFC-22, CFC-12, CFC-115, HFC-125, HFC-134a and/or HFC-143a is contained in the composition.

**[0284]** In some embodiments, the composition comprises from about 99.5 to about 99.9 weight percent of HFO-1234yf and HFC-32, and from about 0.00001 to about 0.5 weight percent, preferably from about 0.0001 to about 0.5 weight percent, of at least one of HCFC-22, CFC-12, CFC-115, HFC-125, HFC-134a, HFC-143a and combinations thereof.

**[0285]** In one embodiment, a composition comprises, consists essentially of, or consists of HFC-32; HFO-1234yf; one or more additional compounds selected from HFC-143a, HFC-41, HFC-134a, HCFC-22, CFC-12 and HCC-40; one or more additional compounds selected from HFO-1225ye, HFO-1243zf, E-HFO-1234ze, HFC-236ea, HCFC-244bb, HFC-245fa, HFC-245eb, HFC-245cb, 3,3,3-

trifluoropropyne, HFC-152a, FO-1114, HFO-1123, HCFO-1131a, trans-HCFO-1131, HCO- 1140, HCFO-1214ya, HFO-1216, HCFO-1224yd, HFO-1252 isomers, HFC-143a, HCFC-225 isomers, HFC-254eb, HFC-263fb, HFC- 236fa, HCFC-142b, HCFC-244cc, HCFO-1223, HFO-1132a and HCC-40; and at least one of HCFC-22, CFC-12, CFC-115, HFC-125, HFC-134a and HFC-143a.

**[0286]** In one embodiment, a composition comprises, consists essentially of, or consists of HFC-32; HFO-1234yf; at least one of HCFC-22, CFC-12, CFC-115, HFC-125, HFC-134a and HFC-143a; and one or more additional compounds selected from HFC-143a, HFC-245cb, HFO-1243zf and E-HFO-1234ze.

**[0287]** In some embodiments, the HFO-1234yf and HFC-32 constitute a major refrigerant portion of the composition, while the remaining compounds (e.g., the HCFC-22, CFC-12, CFC-115, HFC-125, HFC-134a and/or HFC-143a and the additional compounds) constitute a minor refrigerant portion of the composition.

**[0288]** In one embodiment, the invention relates to a composition comprising, consisting essentially of, or consisting of:

a first refrigerant portion comprising, consisting essentially of, or consisting of HFC-32; HFO-1234yf; one or more additional compounds selected from HFC-143a, HFC-41, HFC-134a, HCFC-22, CFC-12 and HCC-40; and one or more additional compounds selected from HFO-1225ye, HFO-1243zf, E-HFO-1234ze, HFC-236ea, HCFC-244bb, HFC-245fa, HFC-245eb, HFC-245cb, 3,3,3-trifluoropropyne, HFC-152a, FO-1114, HFO-1123, HCFO-1131a, trans-HCFO-1131, HCO- 1140, HCFO-1214ya, HFO-1216, HCFO-1224yd, HFO-1252 isomers, HFC-143a, HCFC-225 isomers, HFC-254eb, HFC-263fb, HFC- 236fa, HCFC-142b, HCFC-244cc, HCFO-1223, HFO-1132a and HCC-40, and

a second refrigerant portion comprising, consisting essentially of, or consisting of at least one of HCFC-22, CFC-12, CFC-115, HFC-125, HFC-134a and HFC-143a.

**[0289]** In one embodiment, the first refrigerant portion comprises, consists essentially of, or consists of HFC-32; HFO-1234yf; and one or more additional compounds selected from HFC-143a, HFC-245cb, HFO-1243zf and E-HFO-1234ze.

**[0290]** In some embodiments, the HFC-32 and HFO-1234yf of the first refrigerant portion constitute a major refrigerant portion of the composition, while the HCFC-22, CFC-12, CFC-115, HFC-125, HFC-134a and/or HFC-143a of the second refrigerant portion and the additional compounds of the first refrigerant portion constitute a minor refrigerant portion thereof.

**[0291]** In one embodiment, a composition comprises, consists essentially of, or consists of at least one of R-454A (35% HFC-32 / 65% HFO-1234yf) and R-454C (21.5% HFC-32 / 78.5% HFO-1234yf), and at least one of HCFC-22, CFC-12, CFC-115, HFC-125, HFC-134a and HFC-143a.

**[0292]** In some embodiments, the R-454A or R-454C constitutes a major refrigerant portion of the composition, while the HCFC-22, CFC-12, CFC-115, HFC-125, HFC-134a and HFC-143a constitute a minor refrigerant portion thereof.

**[0293]** In some embodiments, the composition comprises from about 99.5 to about 99.9 weight percent of R-454A or R-454C, and from about 0.00001 to about 0.5 weight percent, preferably from about 0.0001 to about 0.5 weight percent, of at least one of HCFC-22, CFC-12, CFC-115, HFC-125, HFC-134a, HFC-143a and combinations thereof.

**[0294]** In one embodiment, a composition comprises, consists essentially of, or consists of at least one of R-454A and R-454C; one or more additional compounds selected from HFC-143a, HFC-41, HFC-134a, HCFC-22, CFC-12 and HCC-40; one or more additional compounds selected from HFO-1225ye, HFO-1243zf, E-HFO-1234ze, HFC-236ea, HCFC-244bb, HFC-245fa, HFC-245eb, HFC-245cb, 3,3,3-trifluoropropyne, HFC-152a, FO-1114, HFO-1123, HCFO-1131a, trans-HCFO-1131, HCO-1140, HCFO-1214ya, HFO-1216, HCFO-1224yd, HFO-1252 isomers, HFC-143a, HCFC-225 isomers, HFC-254eb, HFC-263fb, HFC-236fa, HCFC-142b, HCFC-244cc, HCFO-1223, HFO-1132a and HCC-40; and at least one of HCFC-22, CFC-12, CFC-115, HFC-125, HFC-134a and HFC-143a.

**[0295]** In one embodiment, a composition comprises, consists essentially of, or consists of at least one of R-454A and R-454C; at least one of HCFC-22, CFC-12, CFC-115, HFC-125, HFC-134a and HFC-143a; and one or more additional compounds selected from HFC-143a, HFC-245cb, HFO-1243zf and E-HFO-1234ze.

**[0296]** In some embodiments, the R-454A or R-454C constitutes a major refrigerant portion of the composition, while the remaining compounds (e.g., the HCFC-22, CFC-12, CFC-115, HFC-125, HFC-134a and/or HFC-143a and the additional compounds) constitute a minor refrigerant portion thereof.

**[0297]** In one embodiment, a composition comprises, consists essentially of, or consists of:

a first refrigerant portion comprising, consisting essentially of, or consisting of at least one of R-454A and R-454C; one or more additional compounds selected from HFC-143a, HFC-41, HFC-134a, HCFC-22, CFC-12 and HCC-40; one or more additional compounds selected from HFO-1225ye, HFO-1243zf, E-HFO-1234ze, HFC-236ea, HCFC-244bb, HFC-245fa, HFC-245eb, HFC-245cb, 3,3,3-trifluoropropyne, HFC-152a, FO-1114, HFO-1123, HCFO-1131a, trans-HCFO-1131, HCO-1140, HCFO-1214ya, HFO-1216, HCFO-1224yd, HFO-1252 isomers, HFC-143a, HCFC-225 isomers, HFC-254eb, HFC-263fb, HFC-236fa, HCFC-142b, HCFC-244cc, HCFO-1223, HFO-1132a and HCC-40; and

a second refrigerant portion comprising, consisting essentially of, or consisting of at least one of HCFC-22, CFC-12, CFC-115, HFC-125, HFC-134a and HFC-143a.

**[0298]** In one embodiment, the first refrigerant portion comprises, consists essentially of, or consists of at least one of R-454A and R-454C; and one or more additional compounds selected from HFC-143a, HFC-245cb, HFO-1243zf and E-HFO-1234ze.

**[0299]** In some embodiments, the R-454A or R-454C of the first refrigerant portion constitutes a major refrigerant portion of the composition, while the HCFC-22, CFC-12, CFC-115, HFC-125, HFC-134a and/or HFC-143a of the second refrigerant portion and the additional compounds of the first refrigerant portion constitute a minor refrigerant portion thereof.

**[0300]** In some embodiments, the second refrigerant portion of any of the foregoing compositions of Embodiment 12 comprises residual refrigerants.

**[0301]** In some embodiments, any of the foregoing compositions of Embodiment 12 comprises from about 99.5 to about 99.9 weight percent of the first refrigerant



portion, and from about 0.00001 to about 0.5 weight percent, preferably from about 0.0001 to about 0.5 weight percent, of the second refrigerant portion.

**[0302]** In one embodiment, the total amount of additional compound(s) in the first refrigerant portion of any of the foregoing compositions of Embodiment 12 ranges from greater than 0 wt.% to less than or equal to about 2 wt.%, about 1 wt.%, about 0.9 wt.%, about 0.8 wt.%, about 0.7 wt.%, about 0.6 wt.%, about 0.5 wt.%, about 0.4 wt.%, about 0.3 wt.%, about 0.2 wt.%, about 0.1 wt.%, based on the total weight of the first refrigerant portion of the composition. In another embodiment, the total amount of additional compound(s) ranges from 0.01 ppm (weight) to about 1 wt.%, and all values therebetween up to 1 wt.%. In another embodiment, the total amount of additional compound(s) ranges from 0.1 ppm (weight) to about 1 wt.%. In another embodiment, the total amount of additional compound(s) ranges from 0.001 wt.% to about 1 wt.%. In another embodiment, the total amount of additional compound(s) ranges from 0.001 wt.% to about 0.5 wt.%. In another embodiment, the total amount of additional compound(s) ranges from 0.001 wt.% to 0.4 wt.% or less, based on the total weight of the first refrigerant portion of the composition. In another embodiment, the total amount of additional compound(s) ranges from 0.001 wt.% to 0.1 wt.% or less, based on the total weight of the first refrigerant portion of the composition. In one embodiment, the total amount of additional compound(s) is about 0.1 wt.% based on the total weight of the first refrigerant portion of the composition.

### **Embodiment 13**

**[0303]** In one embodiment, a composition comprises, consists essentially of, or consists of HFC-227ea, HFO-1234ze(E) and HFO-1336mzz(E), and at least one of HCFC-22, CFC-12, CFC-115, HFC-125, HFC-134a and HFC-143a.

**[0304]** In some embodiments, the HFC-227ea, HFO-1234ze(E) and HFO-1336mzz(E) constitute a major refrigerant portion of the composition, while the HCFC-22, CFC-12, CFC-115, HFC-125, HFC-134a and/or HFC-143a constitute a minor refrigerant portion thereof.

**[0305]** In one embodiment, the HCFC-22, CFC-12, CFC-115, HFC-125, HFC-134a and/or HFC-143a are residual refrigerants. In one embodiment, a residual amount of

the HCFC-22, CFC-12, CFC-115, HFC-125, HFC-134a and/or HFC-143a is contained in the composition.

**[0306]** In some embodiments, the composition comprises from about 99.5 to about 99.9 weight percent of HFC-227ea, HFO-1234ze(E) and HFO-1336mzz(E), and from about 0.00001 to about 0.5 weight percent, preferably from about 0.0001 to about 0.5 weight percent, of at least one of HCFC-22, CFC-12, CFC-115, HFC-125, HFC-134a, HFC-143a and combinations thereof.

**[0307]** In one embodiment, a composition comprises, consists essentially of, or consists of HFC-227ea; HFO-1234ze(E); HFO-1336mzz(E); one or more additional compounds selected from HFC-23, FC-1216, HFC-143a, HFC-134a, HCFC-22, HCFC-124, FC-218, HFC-236fa and HFO-1225zc; one or more additional compounds selected from HFO-1234yf, HFC-245cb, HFO-1225ye(E), HFO-1225ye(Z), HFO-1225zc, HFC-236fa, HFC-152a, HFC-143a, HFC-125, HFC-134a, HFO-1234zc, HFO-1233xf, HFO-1233zd, CFC-114, HCFC-124, 3,3,3-trifluoropropyne, HFO-1234ze(Z), HFC-245fa, HFC-227ea, HFO-1243zf, HFC-263fb and HFC-134; one or more additional compounds selected from C-30, HCFC-114, HCFC-114a, HCFC-133, HCFC-133a, HFC-245fa, HFC-338mee, HFC-338mf, HFC-347mef, HCO-1140, HCFO-1224 isomers, HCFO-1224yd, HCFO-1224yb, HCFO-1233xf, HCFO-1233zd, HFO-1243zf, HFO-1327mz, HFO-1336ft and HCFO-1326mxz; and at least one of HCFC-22, CFC-12, CFC-115, HFC-125, HFC-134a and HFC-143a.

**[0308]** In one embodiment, a composition comprises, consists essentially of, or consists of HFC-227ea; HFO-1234ze(E); HFO-1336mzz(E); at least one of HCFC-22, CFC-12, CFC-115, HFC-125, HFC-134a and HFC-143a; and one or more additional compounds selected from HCFC-133, HFO-1234yf, HFO-1225zc and HFO-1336ft.

**[0309]** In some embodiments, the HFC-227ea, HFO-1234ze(E) and HFO-1336mzz(E) constitute a major refrigerant portion of the composition, while the remaining compounds (e.g., the HCFC-22, CFC-12, CFC-115, HFC-125, HFC-134a and/or HFC-143a and the additional compounds) constitute a minor refrigerant portion of the composition.

**[0310]** In one embodiment, the invention relates to a composition comprising, consisting essentially of, or consisting of:

a first refrigerant portion comprising, consisting essentially of, or consisting of HFC-227ea; HFO-1234ze(E); HFO-1336mzz(E); one or more additional compounds selected from HFC-23, FC-1216, HFC-143a, HFC-134a, HCFC-22, HCFC-124, FC-218, HFC-236fa and HFO-1225zc; one or more additional compounds selected from HFO-1234yf, HFC-245cb, HFO-1225ye(E), HFO-1225ye(Z), HFO-1225zc, HFC-236fa, HFC-152a, HFC-143a, HFC-125, HFC-134a, HFO-1234zc, HFO-1233xf, HFO-1233zd, CFC-114, HCFC-124, 3,3,3-trifluoropropyne, HFO-1234ze(Z), HFC-245fa, HFC-227ea, HFO-1243zf, HFC-263fb and HFC-134; one or more additional compounds selected from C-30, HCFC-114, HCFC-114a, HCFC-133, HCFC-133a, HFC-245fa, HFC-338mee, HFC-338mf, HFC-347mef, HCO-1140, HCFO-1224 isomers, HCFO-1224yd, HCFO-1224yb, HCFO-1233xf, HCFO-1233zd, HFO-1243zf, HFO-1327mz, HFO-1336ft and HCFO-1326mxz; and

a second refrigerant portion comprising, consisting essentially of, or consisting of at least one of HCFC-22, CFC-12, CFC-115, HFC-125, HFC-134a and HFC-143a.

**[0311]** In one embodiment, the first refrigerant portion comprises, consists essentially of, or consists of HFC-227ea; HFO-1234ze(E); HFO-1336mzz(E); and one or more additional compounds selected from HCFC-133, HFO-1234yf, HFO-1225zc and HFO-1336ft.

**[0312]** In some embodiments, the HFC-227ea, HFO-1234ze(E) and HFO-1336mzz(E) of the first refrigerant portion constitute a major refrigerant portion of the composition, while the HCFC-22, CFC-12, CFC-115, HFC-125, HFC-134a and/or HFC-143a of the second refrigerant portion and the additional compounds of the first refrigerant portion constitute a minor refrigerant portion thereof.

**[0313]** In one embodiment, a composition comprises, consists essentially of, or consists of R-471A (4.3% HFC-227ea / 78.7% HFO-1234ze(E) / 17% HFO-1336mzz(E)), and at least one compound selected from HCFC-22, CFC-12, CFC-115, HFC-125, HFC-134a and HFC-143a.

**[0314]** In some embodiments, the R-471A constitutes a major refrigerant portion of the composition, while the HCFC-22, CFC-12, CFC-115, HFC-125, HFC-134a and HFC-143a constitute a minor refrigerant portion thereof.

**[0315]** In some embodiments, the composition comprises from about 99.5 to about 99.9 weight percent of R-471A, and from about 0.00001 to about 0.5 weight percent, preferably from about 0.0001 to about 0.5 weight percent, of at least one of HCFC-22, CFC-12, CFC-115, HFC-125, HFC-134a, HFC-143a and combinations thereof.

**[0316]** In one embodiment, a composition comprises, consists essentially of, or consists of R-471A (4.3% HFC-227ea / 78.7% HFO-1234ze(E) / 17% HFO-1336mzz(E); one or more additional compounds selected from HFC-23, FC-1216, HFC-143a, HFC-134a, HCFC-22, HCFC-124, FC-218, HFC-236fa and HFO-1225zc, one or more additional compounds selected from HFO-1234yf, HFC-245cb, HFO-1225ye(E), HFO-1225ye(Z), HFO-1225zc, HFC-236fa, HFC-152a, HFC-143a, HFC-125, HFC-134a, HFO-1234zc, HFO-1233xf, HFO-1233zd, CFC-114, HCFC-124, 3,3,3-trifluoropropyne, HFO-1234ze(Z), HFC-245fa, HFC-227ea, HFO-1243zf, HFC-263fb and HFC-134; one or more additional compounds selected from C-30, HCFC-114, HCFC-114a, HCFC-133, HCFC-133a, HFC-245fa, HFC-338mee, HFC-338mf, HFC-347mef, HCO-1140, HCFO-1224 isomers, HCFO-1224yd, HCFO-1224yb, HCFO-1233xf, HCFO-1233zd, HFO-1243zf, HFO-1327mz, HFO-1336ft and HCFO-1326mxz; and at least one of HCFC-22, CFC-12, CFC-115, HFC-125, HFC-134a and HFC-143a.

**[0317]** In one embodiment, a composition comprises, consists essentially of, or consists of R-471A; at least one of HCFC-22, CFC-12, CFC-115, HFC-125, HFC-134a and HFC-143a; and one or more additional compounds selected from HCFC-133, HFO-1234yf, HFO-1225zc and HFO-1336ft.

**[0318]** In some embodiments, the R-471A constitutes a major refrigerant portion of the composition, while the remaining compounds (e.g., the HCFC-22, CFC-12, CFC-115, HFC-125, HFC-134a and/or HFC-143a and the additional compounds) constitute a minor refrigerant portion of the composition.

**[0319]** In one embodiment, the invention relates to a composition comprising, consisting essentially of, or consisting of:

a first refrigerant portion comprises, consists essentially of, or consists of R-471A (4.3% HFC-227ea / 78.7% HFO-1234ze(E) / 17% HFO-1336mzz(E); one or more additional compounds selected from HFC-23, FC-1216, HFC-143a, HFC-134a, HCFC-22, HCFC-124, FC-218, HFC-236fa and HFO-1225zc, one or more additional compounds selected from HFO-1234yf, HFC-245cb, HFO-1225ye(E), HFO-1225ye(Z), HFO-1225zc, HFC-236fa, HFC-152a, HFC-143a, HFC-125, HFC-134a, HFO-1234zc, HFO-1233xf, HFO-1233zd, CFC-114, HCFC-124, 3,3,3-trifluoropropyne, HFO-1234ze(Z), HFC-245fa, HFC-227ea, HFO-1243zf, HFC-263fb and HFC-134; one or more additional compounds selected from C-30, HCFC-114, HCFC-114a, HCFC-133, HCFC-133a, HFC-245fa, HFC-338mee, HFC-338mf, HFC-347mef, HCO-1140, HCFO-1224 isomers, HCFO-1224yd, HCFO-1224yb, HCFO-1233xf, HCFO-1233zd, HFO-1243zf, HFO-1327mz, HFO-1336ft and HCFO-1326mxz; and

a second refrigerant portion comprises, consists essentially of, or consists of at least one of HCFC-22, CFC-12, CFC-115, HFC-125, HFC-134a and HFC-143a.

**[0320]** In one embodiment, the first refrigerant portion comprises, consists essentially of, or consists of R-471A, and one or more additional compounds selected from HCFC-133, HFO-1234yf, HFO-1225zc and HFO-1336ft.

**[0321]** In some embodiments, the R-471A of the first refrigerant portion constitutes a major refrigerant portion of the composition, while the HCFC-22, CFC-12, CFC-115, HFC-125, HFC-134a and/or HFC-143a of the second refrigerant portion and the additional compounds of the first refrigerant portion constitute a minor refrigerant portion thereof.

**[0322]** In some embodiments, the second refrigerant portion of any of the foregoing compositions of Embodiment 13 comprises residual refrigerants.

**[0323]** In some embodiments, any of the foregoing compositions of Embodiment 13 comprises from about 99.5 to about 99.9 weight percent of the first refrigerant portion, and from about 0.00001 to about 0.5 weight percent, preferably from about 0.0001 to about 0.5 weight percent, of the second refrigerant portion.

**[0324]** In one embodiment, the total amount of additional compound(s) in the first refrigerant portion of any of the foregoing compositions of Embodiment 13 ranges from greater than 0 wt.% to less than or equal to about 2 wt.%, about 1 wt.%, about 0.9 wt.%, about 0.8 wt.%, about 0.7 wt.%, about 0.6 wt.%, about 0.5 wt.%, about 0.4 wt.%, about 0.3 wt.%, about 0.2 wt.%, about 0.1 wt.%, based on the total weight of the first refrigerant portion of the composition. In another embodiment, the total amount of additional compound(s) ranges from 0.01 ppm (weight) to about 1 wt.%, and all values therebetween up to 1 wt.%. In another embodiment, the total amount of additional compound(s) ranges from 0.1 ppm (weight) to about 1 wt.%. In another embodiment, the total amount of additional compound(s) ranges from 0.001 wt.% to about 1 wt.%. In another embodiment, the total amount of additional compound(s) ranges from 0.001 wt.% to about 0.5 wt.%. In another embodiment, the total amount of additional compound(s) ranges from 0.001 wt.% to 0.4 wt.% or less, based on the total weight of the first refrigerant portion of the composition. In another embodiment, the total amount of additional compound(s) ranges from 0.001 wt.% to 0.1 wt.% or less, based on the total weight of the first refrigerant portion of the composition. In one embodiment, the total amount of additional compound(s) is about 0.1 wt.% based on the total weight of the first refrigerant portion of the composition.

#### **Embodiment 14**

**[0325]** In one embodiment, a composition comprises, consists essentially of, or consists of HFC-134a, HFO-1234ze(E) and HFO-1336mzz(E), and at least one of HCFC-22, CFC-12, CFC-115, HFC-125 and HFC-143a.

**[0326]** In some embodiments, the HFC-134a, HFO-1234ze(E) and HFO-1336mzz(E) constitute a major refrigerant portion of the composition, while the HCFC-22, CFC-12, CFC-115, HFC-125 and/or HFC-143a constitute a minor refrigerant portion thereof.

**[0327]** In one embodiment, the HCFC-22, CFC-12, CFC-115, HFC-125 and/or HFC-143a are residual refrigerants. In one embodiment, a residual amount of the HCFC-22, CFC-12, CFC-115, HFC-125 and/or HFC-143a is contained in the composition.

**[0328]** In some embodiments, the composition comprises from about 99.5 to about 99.9 weight percent of HFC-134a, HFO-1234ze(E) and HFO-1336mzz(E), and from about 0.00001 to about 0.5 weight percent, preferably from about 0.0001 to about 0.5 weight percent, of at least one of HCFC-22, CFC-12, CFC-115, HFC-125, HFC-143a and combinations thereof.

**[0329]** In one embodiment, a composition comprises, consists essentially of, or consists of HFC-134a; HFO-1234ze(E); HFO-1336mzz(E); one or more additional compounds selected from HFC-143a, HFO-1225zc, HFC-245cb, HFC-134, HFC-152a, HFO-1225ye, HFC-161, E-HFO-1234ze, HCFC-22, HFO-1243zf, HCFC-124, HCC-40, HCFO-1122, HCFC-31, CFC-114, CFC-114a and HCO-1140; one or more additional compounds selected from HFO-1234yf, HFC-245cb, HFO-1225ye(E), HFO-1225ye(Z), HFO-1225zc, HFC-236fa, HFC-152a, HFC-143a, HFC-125, HFC-134a, HFO-1234zc, HFO-1233xf, HFO-1233zd, CFC-114, HCFC-124, 3,3,3-trifluoropropyne, HFO-1234ze(Z), HFC-245fa, HFC-227ea, HFO-1243zf, HFC-263fb and HFC-134; one or more additional compounds selected from C-30, HCFC-114, HCFC-114a, HCFC-133, HCFC-133a, HFC-245fa, HFC-338mee, HFC-338mf, HFC-347mef, HCO-1140, HCFO-1224 isomers, HCFO-1224yd, HCFO-1224yb, HCFO-1233xf, HCFO-1233zd, HFO-1243zf, HFO-1327mz, HFO-1336ft and HCFO-1326mxz; and at least one of HCFC-22, CFC-12, CFC-115, HFC-125 and HFC-143a.

**[0330]** In one embodiment, a composition comprises, consists essentially of, or consists of HFC-134a; HFO-1234ze(E); HFO-1336mzz(E); at least one of HCFC-22, CFC-12, CFC-115, HFC-125 and HFC-143a; and one or more additional compounds selected from HFC-134a, HFC-245cb, HFO-1234yf, HFO-1225zc and HFO-1336ft.

**[0331]** In some embodiments, the HFC-134a, HFO-1234ze(E) and HFO-1336mzz(E) constitute a major refrigerant portion of the composition, while the remaining compounds (e.g., the HCFC-22, CFC-12, CFC-115, HFC-125 and/or HFC-143a and the additional compounds) constitute a minor refrigerant portion of the composition.

**[0332]** In one embodiment, the invention relates to a composition comprising, consisting essentially of, or consisting of:

a first refrigerant portion comprising, consisting essentially of, or consisting of HFC-134a; HFO-1234ze(E); HFO-1336mzz(E); one or more additional compounds selected from HFC-143a, HFO-1225zc, HFC-245cb, HFC-134, HFC-152a, HFO-1225ye, HFC-161, E-HFO-1234ze, HCFC-22, HFO-1243zf, CHFC-124, HCC-40, HCFO-1122, HCFC-31, CFC-114, CFC-114a and HCO-1140; one or more additional compounds selected from HFO-1234yf, HFC-245cb, HFO-1225ye(E), HFO-1225ye(Z), HFO-1225zc, HFC-236fa, HFC-152a, HFC-143a, HFC-125, HFC-134a, HFO-1234zc, HFO-1233xf, HFO-1233zd, CFC-114, HCFC-124, 3,3,3-trifluoropropyne, HFO-1234ze(Z), HFC-245fa, HFC-227ea, HFO-1243zf, HFC-263fb and HFC-134; one or more additional compounds selected from C-30, HCFC-114, HCFC-114a, HCFC-133, HCFC-133a, HFC-245fa, HFC-338mee, HFC-338mf, HFC-347mef, HCO-1140, HCFO-1224 isomers, HCFO-1224yd, HCFO-1224yb, HCFO-1233xf, HCFO-1233zd, HFO-1243zf, HFO-1327mz, HFO-1336ft and HCFO-1326mxz; and

a second refrigerant portion comprising, consisting essentially of, or consisting of at least one of HCFC-22, CFC-12, CFC-115, HFC-125 and HFC-143a.

**[0333]** In one embodiment, the first refrigerant portion comprises, consists essentially of, or consists of HFC-134a; HFO-1234ze(E); HFO-1336mzz(E); and one or more additional compounds selected from HFC-134a, HFC-245cb, HFO-1234yf, HFO-1225zc and HFO-1336ft.

**[0334]** In some embodiments, the HFC-134a, HFO-1234ze(E) and HFO-1336mzz(E) of the first refrigerant portion constitute a major refrigerant portion of the composition, while the HCFC-22, CFC-12, CFC-115, HFC-125 and/or HFC-143a of the second refrigerant portion and the additional compounds of the first refrigerant portion constitute a minor refrigerant portion thereof.

**[0335]** In one embodiment, a composition comprises, consists essentially of, or consists of R-476A (10% HFC-134a / 78% HFO-1234ze(E) / 12% HFO-1336mzz(E)), and at least one compound selected from HCFC-22, CFC-12, CFC-115, HFC-125 and HFC-143a.



**[0336]** In some embodiments, the R-476A constitutes a major refrigerant portion of the composition, while the HCFC-22, CFC-12, CFC-115, HFC-125 and HFC-143a constitute a minor refrigerant portion thereof.

**[0337]** In some embodiments, the composition comprises from about 99.5 to about 99.9 weight percent of R-476A, and from about 0.00001 to about 0.5 weight percent, preferably from about 0.0001 to about 0.5 weight percent, of at least one of HCFC-22, CFC-12, CFC-115, HFC-125, HFC-143a and combinations thereof.

**[0338]** In one embodiment, a composition comprises, consists essentially of, or consists of R-476A; one or more additional compounds selected from HFC-143a, HFO-1225zc, HFC-245cb, HFC-134, HFC-152a, HFO-1225ye, HFC-161, E-HFO-1234ze, HCFC-22, HFO-1243zf, HCFC-124, HCC-40, HCFO-1122, HCFC-31, CFC-114, CFC-114a and HCO-1140; one or more additional compounds selected from HFO-1234yf, HFC-245cb, HFO-1225ye(E), HFO-1225ye(Z), HFO-1225zc, HFC-236fa, HFC-152a, HFC-143a, HFC-125, HFC-134a, HFO-1234zc, HFO-1233xf, HFO-1233zd, CFC-114, HCFC-124, 3,3,3-trifluoropropyne, HFO-1234ze(Z), HFC-245fa, HFC-227ea, HFO-1243zf, HFC-263fb and HFC-134; one or more additional compounds selected from C-30, HCFC-114, HCFC-114a, HCFC-133, HCFC-133a, HFC-245fa, HFC-338mee, HFC-338mf, HFC-347mef, HCO-1140, HCFO-1224 isomers, HCFO-1224yd, HCFO-1224yb, HCFO-1233xf, HCFO-1233zd, HFO-1243zf, HFO-1327mz, HFO-1336ft and HCFO-1326mxz; and at least one of HCFC-22, CFC-12, CFC-115, HFC-125 and HFC-143a.

**[0339]** In one embodiment, a composition comprises, consists essentially of, or consists of R-476A; at least one of HCFC-22, CFC-12, CFC-115, HFC-125 and HFC-143a; one or more additional compounds selected from HFC-134a, HFC-245cb, HFO-1234yf, HFO-1225zc and HFO-1336ft.

**[0340]** In some embodiments, the R-476A constitutes a major refrigerant portion of the composition, while the remaining compounds (e.g., the HCFC-22, CFC-12, CFC-115, HFC-125 and/or HFC-143a and the additional compounds) constitute a minor refrigerant portion of the composition.

**[0341]** In one embodiment, the invention relates to a composition comprising, consisting essentially of, or consisting of:

a first refrigerant portion comprises, consists essentially of, or consists of R-476A; one or more additional compounds selected from HFC-143a, HFO-1225zc, HFC-245cb, HFC-134, HFC-152a, HFO-1225ye, HFC-161, E-HFO-1234ze, HCFC-22, HFO-1243zf, CHFC-124, HCC-40, CHFO-1122, HCFC-31, CFC-114, CFC-114a and HCO-1140; one or more additional compounds selected from HFO-1234yf, HFC-245cb, HFO-1225ye(E), HFO-1225ye(Z), HFO-1225zc, HFC-236fa, HFC-152a, HFC-143a, HFC-125, HFC-134a, HFO-1234zc, HFO-1233xf, HFO-1233zd, CFC-114, HCFC-124, 3,3,3-trifluoropropyne, HFO-1234ze(Z), HFC-245fa, HFC-227ea, HFO-1243zf, HFC-263fb and HFC-134; one or more additional compounds selected from C-30, HCFC-114, HCFC-114a, HCFC-133, HCFC-133a, HFC-245fa, HFC-338mee, HFC-338mf, HFC-347mef, HCO-1140, HCFO-1224 isomers, HCFO-1224yd, HCFO-1224yb, HCFO-1233xf, HCFO-1233zd, HFO-1243zf, HFO-1327mz, HFO-1336ft and HCFO-1326mxz; and

a second refrigerant portion comprises, consists essentially of, or consists of at least one of HCFC-22, CFC-12, CFC-115, HFC-125 and HFC-143a.

**[0342]** In one embodiment, a composition comprises, consists essentially of, or consists of R-476A, and one or more additional compounds selected from HFC-134a, HFC-245cb, HFO-1234yf, HFO-1225zc and HFO-1336ft.

**[0343]** In some embodiments, the R-476A of the first refrigerant portion constitutes a major refrigerant portion of the composition, while the HCFC-22, CFC-12, CFC-115, HFC-125 and/or HFC-143a of the second refrigerant portion and the additional compounds of the first refrigerant portion constitute a minor refrigerant portion thereof.

**[0344]** In some embodiments, the second refrigerant portion of any of the foregoing compositions of Embodiment 14 comprises residual refrigerants.

**[0345]** In some embodiments, any of the foregoing compositions of Embodiment 14 comprises from about 99.5 to about 99.9 weight percent of the first refrigerant portion, and from about 0.00001 to about 0.5 weight percent, preferably from about 0.0001 to about 0.5 weight percent, of the second refrigerant portion.

**[0346]** In one embodiment, the total amount of additional compound(s) in the first refrigerant portion of any of the foregoing compositions of Embodiment 14 ranges from greater than 0 wt.% to less than or equal to about 2 wt.%, about 1 wt.%, about 0.9 wt.%, about 0.8 wt.%, about 0.7 wt.%, about 0.6 wt.%, about 0.5 wt.%, about 0.4 wt.%, about 0.3 wt.%, about 0.2 wt.%, about 0.1 wt.%, based on the total weight of the first refrigerant portion of the composition. In another embodiment, the total amount of additional compound(s) ranges from 0.01 ppm (weight) to about 1 wt.%, and all values therebetween up to 1 wt.%. In another embodiment, the total amount of additional compound(s) ranges from 0.1 ppm (weight) to about 1 wt.%. In another embodiment, the total amount of additional compound(s) ranges from 0.001 wt.% to about 1 wt.%. In another embodiment, the total amount of additional compound(s) ranges from 0.001 wt.% to about 0.5 wt.%. In another embodiment, the total amount of additional compound(s) ranges from 0.001 wt.% to 0.4 wt.% or less, based on the total weight of the first refrigerant portion of the composition. In another embodiment, the total amount of additional compound(s) ranges from 0.001 wt.% to 0.1 wt.% or less, based on the total weight of the first refrigerant portion of the composition. In one embodiment, the total amount of additional compound(s) is about 0.1 wt.% based on the total weight of the first refrigerant portion of the composition.

#### **Embodiment 15**

**[0347]** In one embodiment, a composition comprises, consists essentially of, or consists of HFC-134a, HFO-1234ze(E) and HFO-1224yd(Z), and at least one of HCFC-22, CFC-12, CFC-115, HFC-125 and HFC-143a.

**[0348]** In some embodiments, the HFC-134a, HFO-1234ze(E) and HFO-1224yd(Z) constitute a major refrigerant portion of the composition, while the HCFC-22, CFC-12, CFC-115, HFC-125 and/or HFC-143a constitute a minor refrigerant portion thereof.

**[0349]** In one embodiment, the HCFC-22, CFC-12, CFC-115, HFC-125 and/or HFC-143a are residual refrigerants. In one embodiment, a residual amount of the HCFC-22, CFC-12, CFC-115, HFC-125 and/or HFC-143a is contained in the composition.

**[0350]** In some embodiments, the composition comprises from about 99.5 to about 99.9 weight percent of HFC-134a, HFO-1234ze(E) and HFO-1224yd(Z), and from about 0.00001 to about 0.5 weight percent, preferably from about 0.0001 to about 0.5 weight percent, of at least one of HCFC-22, CFC-12, CFC-115, HFC-125, HFC-143a and combinations thereof.

**[0351]** In one embodiment, a composition comprises, consists essentially of, or consists of HFC-134a; HFO-1234ze(E); HFO-1224yd(Z); one or more additional compounds selected from HFC-143a, HFO-1225zc, HFC-245cb, HFC-134, HFC-152a, HFO-1225ye, HFC-161, E-HFO-1234ze, HCFC-22, HFO-1243zf, HCFC-124, HCC-40, HCFO-1122, HCFC-31, CFC-114, CFC-114a and HCO-1140; one or more additional compounds selected from HFO-1234yf, HFC-245cb, HFO-1225ye(E), HFO-1225ye(Z), HFO-1225zc, HFC-236fa, HFC-152a, HFC-143a, HFC-125, HFC-134a, HFO-1234zc, HFO-1233xf, HFO-1233zd, CFC-114, HCFC-124, 3,3,3-trifluoropropyne, HFO-1234ze(Z), HFC-245fa, HFC-227ea, HFO-1243zf, HFC-263fb and HFC-134; one or more additional compounds selected from HFO-1234yf, HFO-1234ze(E), HFO-1243zf, HFC-263fb, HFC-254eb, HFO-1215yb, HCFC-244bb, HCFO-1224yd(E), HCFO-1224 isomer(s), CFO-1112a, HFC-225ca, HFC-225cb and HFC-234bb; and at least one of HCFC-22, CFC-12, CFC-115, HFC-125 and HFC-143a.

**[0352]** In one embodiment, a composition comprises, consists essentially of, or consists of HFC-134a; HFO-1234ze(E); HFO-1224yd(Z); at least one of HCFC-22, CFC-12, CFC-115, HFC-125 and HFC-143a; and one or more additional compounds selected from HFC-134, HFC-245cb, HFO-1234yf and HFO-1243zf.

**[0353]** In some embodiments, the HFC-134a, HFO-1234ze(E) and HFO-1224yd(Z) constitute a major refrigerant portion of the composition, while the remaining compounds (e.g., the HCFC-22, CFC-12, CFC-115, HFC-125 and/or HFC-143a and the additional compounds) constitute a minor refrigerant portion of the composition.

**[0354]** In one embodiment, the invention relates to a composition comprising, consisting essentially of, or consisting of:

a first refrigerant portion comprising, consisting essentially of, or consisting of HFC-134a; HFO-1234ze(E); HFO-1224yd(Z); one or more additional compounds

selected from HFC-143a, HFO-1225zc, HFC-245cb, HFC-134, HFC-152a, HFO-1225ye, HFC-161, E-HFO-1234ze, HCFC-22, HFO-1243zf, CHFC-124, HCC-40, CHFO-1122, HCFC-31, CFC-114, CFC-114a and HCO-1140; one or more additional compounds selected from HFO-1234yf, HFC-245cb, HFO-1225ye(E), HFO-1225ye(Z), HFO-1225zc, HFC-236fa, HFC-152a, HFC-143a, HFC-125, HFC-134a, HFO-1234zc, HFO-1233xf, HFO-1233zd, CFC-114, HCFC-124, 3,3,3-trifluoropropyne, HFO-1234ze(Z), HFC-245fa, HFC-227ea, HFO-1243zf, HFC-263fb and HFC-134; one or more additional compounds selected from HFO-1234yf, HFO-1234ze(E), HFO-1243zf, HFC-263fb, HFC-254eb, HFO-1215yb, HCFC-244bb, HCFO-1224yd(E), HCFO-1224 isomer(s), CFO-1112a, HFC-225ca, HFC-225cb and HFC-234bb; and

a second refrigerant portion comprising, consisting essentially of, or consisting of at least one of HCFC-22, CFC-12, CFC-115, HFC-125 and HFC-143a.

**[0355]** In one embodiment, the first refrigerant portion comprises, consists essentially of, or consists of HFC-134a; HFO-1234ze(E); HFO-1224yd(Z); and one or more additional compounds selected from HFC-134, HFC-245cb, HFO-1234yf and HFO-1243zf.

**[0356]** In some embodiments, the HFC-134a, HFO-1234ze(E) and HFO-1224yd(Z) of the first refrigerant portion constitute a major refrigerant portion of the composition, while the HCFC-22, CFC-12, CFC-115, HFC-125 and/or HFC-143a of the second refrigerant portion and the additional compounds of the first refrigerant portion constitute a minor refrigerant portion thereof.

**[0357]** In one embodiment, a composition comprises, consists essentially of, or consists of R-482A (10% HFC-134a / 83.5% HFO-1234ze(E) / 6.5% HFO-1224yd(Z)), and at least one compound selected from HCFC-22, CFC-12, CFC-115, HFC-125 and HFC-143a.

**[0358]** In some embodiments, the R-482A constitutes a major refrigerant portion of the composition, while the HCFC-22, CFC-12, CFC-115, HFC-125 and/or HFC-143a constitute a minor refrigerant portion thereof.

**[0359]** In some embodiments, the composition comprises from about 99.5 to about 99.9 weight percent of R-482A, and from about 0.00001 to about 0.5 weight percent,

preferably from about 0.0001 to about 0.5 weight percent, of at least one of HCFC-22, CFC-12, CFC-115, HFC-125, HFC-143a and combinations thereof.

**[0360]** In one embodiment, a composition comprises, consists essentially of, or consists of R-482A; one or more additional compounds selected from HFC-143a, HFO-1225zc, HFC-245cb, HFC-134, HFC-152a, HFO-1225ye, HFC-161, E-HFO-1234ze, HCFC-22, HFO-1243zf, CHFC-124, HCC-40, CHFO-1122, HCFC-31, CFC-114, CFC-114a and HCO-1140; one or more additional compounds selected from HFO-1234yf, HFC-245cb, HFO-1225ye(E), HFO-1225ye(Z), HFO-1225zc, HFC-236fa, HFC-152a, HFC-143a, HFC-125, HFC-134a, HFO-1234zc, HFO-1233xf, HFO-1233zd, CFC-114, HCFC-124, 3,3,3-trifluoropropyne, HFO-1234ze(Z), HFC-245fa, HFC-227ea, HFO-1243zf, HFC-263fb and HFC-134; one or more additional compounds selected from HFO-1234yf, HFO-1234ze(E), HFO-1243zf, HFC-263fb, HFC-254eb, HFO-1215yb, HCFC-244bb, HCFO-1224yd(E), HCFO-1224 isomer(s), CFO-1112a, HFC-225ca, HFC-225cb and HFC-234bb; and at least one of HCFC-22, CFC-12, CFC-115, HFC-125 and HFC-143a.

**[0361]** In one embodiment, a composition comprises, consists essentially of, or consists of R-482A; at least one of HCFC-22, CFC-12, CFC-115, HFC-125 and HFC-143a; and one or more additional compounds selected from HFC-134, HFC-245cb, HFO-1234yf and HFO-1243zf.

**[0362]** In some embodiments, the R-482A constitutes a major refrigerant portion of the composition, while the remaining compounds (e.g., the HCFC-22, CFC-12, CFC-115, HFC-125 and/or HFC-143a and the additional compounds) constitute a minor refrigerant portion of the composition.

**[0363]** In one embodiment, the invention relates to a composition comprising, consisting essentially of, or consisting of:

a first refrigerant portion comprises, consists essentially of, or consists of R-482A; one or more additional compounds selected from HFC-143a, HFO-1225zc, HFC-245cb, HFC-134, HFC-152a, HFO-1225ye, HFC-161, E-HFO-1234ze, HCFC-22, HFO-1243zf, CHFC-124, HCC-40, CHFO-1122, HCFC-31, CFC-114, CFC-114a and HCO-1140; one or more additional compounds selected from HFO-1234yf, HFC-245cb, HFO-1225ye(E), HFO-1225ye(Z), HFO-1225zc, HFC-236fa, HFC-152a, HFC-143a, HFC-125, HFC-134a, HFO-1234zc, HFO-1233xf,

HFO-1233zd, CFC-114, HCFC-124, 3,3,3-trifluoropropyne, HFO-1234ze(Z), HFC-245fa, HFC-227ea, HFO-1243zf, HFC-263fb and HFC-134; one or more additional compounds selected from HFO-1234yf, HFO-1234ze(E), HFO-1243zf, HFC-263fb, HFC-254eb, HFO-1215yb, HCFC-244bb, HCFO-1224yd(E), HCFO-1224 isomer(s), CFO-1112a, HFC-225ca, HFC-225cb and HFC-234bb; and

a second refrigerant portion comprises, consists essentially of, or consists of at least one of HCFC-22, CFC-12, CFC-115, HFC-125 and HFC-143a.

**[0364]** In one embodiment, the first refrigerant portion comprises, consists essentially of, or consists of R-482A, and one or more additional compounds selected from HFC-134, HFC-245cb, HFO-1234yf and HFO-1243zf.

**[0365]** In some embodiments, the R-482A of the first refrigerant portion constitutes a major refrigerant portion of the composition, while the HCFC-22, CFC-12, CFC-115, HFC-125 and/or HFC-143a of the second refrigerant portion and the additional compounds of the first refrigerant portion constitute a minor refrigerant portion thereof.

**[0366]** In some embodiments, the second refrigerant portion of any of the foregoing compositions of Embodiment 15 comprises residual refrigerants.

**[0367]** In some embodiments, any of the foregoing compositions of Embodiment 15 comprises from about 99.5 to about 99.9 weight percent of the first refrigerant portion, and from about 0.00001 to about 0.5 weight percent, preferably from about 0.0001 to about 0.5 weight percent, of the second refrigerant portion.

**[0368]** In one embodiment, the total amount of additional compound(s) in the first refrigerant portion of any of the foregoing compositions of Embodiment 15 ranges from greater than 0 wt.% to less than or equal to about 2 wt.%, about 1 wt.%, about 0.9 wt.%, about 0.8 wt.%, about 0.7 wt.%, about 0.6 wt.%, about 0.5 wt.%, about 0.4 wt.%, about 0.3 wt.%, about 0.2 wt.%, about 0.1 wt.%, based on the total weight of the first refrigerant portion of the composition. In another embodiment, the total amount of additional compound(s) ranges from 0.01 ppm (weight) to about 1 wt.%, and all values therebetween up to 1 wt.%. In another embodiment, the total amount of additional compound(s) ranges from 0.1 ppm (weight) to about 1 wt.%. In another embodiment, the total amount of additional compound(s) ranges from 0.001 wt.% to

about 1 wt.%. In another embodiment, the total amount of additional compound(s) ranges from 0.001 wt.% to about 0.5 wt.%. In another embodiment, the total amount of additional compound(s) ranges from 0.001 wt.% to 0.4 wt.% or less, based on the total weight of the first refrigerant portion of the composition. In another embodiment, the total amount of additional compound(s) ranges from 0.001 wt.% to 0.1 wt.% or less, based on the total weight of the first refrigerant portion of the composition. In one embodiment, the total amount of additional compound(s) is about 0.1 wt.% based on the total weight of the first refrigerant portion of the composition.

#### **Embodiment 16**

**[0369]** In one embodiment, a composition comprises, consists essentially of, or consists of HFC-227ea, E-HFO-1234ze and at least one of CFC-11 and HFC-134a.

**[0370]** In some embodiments, the HFC-227ea and E-HFO-1234ze, constitute a major refrigerant portion of the composition, while the CFC-11 and/or HFC-134a constitute a minor refrigerant portion thereof.

**[0371]** In one embodiment, the CFC-11 and/or HFC-134a are residual refrigerants. In one embodiment, a residual amount of the CFC-11 and/or HFC-134a is contained in the composition.

**[0372]** In some embodiments, the composition comprises from about 99.5 to about 99.9 weight percent of HFC-227ea and E-HFO-1234ze, and from about 0.00001 to about 0.5 weight percent, preferably from about 0.0001 to about 0.5 weight percent, of at least one of CFC-11, HFC-134a and combinations thereof.

**[0373]** In one embodiment, a composition comprises, consists essentially of, or consists of HFC-227ea; E-HFO-1234ze; one or more additional compounds selected from HFC-23, FC-1216, HFC-143a, HFC-134a, HCFC-22, HCFC-124, FC-218, HFC-236fa and HFO-1225zc; one or more additional compounds selected from HFO-1234yf, HFC-245cb, HFO-1225ye(E), HFO-1225ye(Z), HFO-1225zc, HFC-236fa, HFC-152a, HFC-143a, HFC-125, HFC-134a, HFO-1234zc, HFO-1233xf, HFO-1233zd, CFC-114, HCFC-124, 3,3,3-trifluoropropyne, HFO-1234ze(Z), HFC-245fa, HFC-227ea, HFO-1243zf, HFC-263fb and HFC-134; and at least one of CFC-11 and HFC-134a.



**[0374]** In one embodiment, a composition comprises, consists essentially of, or consists of HFC-227ea; E-HFO-1234ze; at least one of CFC-11 and HFC-134a; and one or more additional compounds selected from HFC-245cb, HFO-1234yf, HFO-1225zc and FC-1216.

**[0375]** In some embodiments, the HFC-227ea and E-HFO-1234ze constitute a major refrigerant portion of the composition, while the remaining compounds (e.g., the CFC-11 and/or HFC-134a and the additional compounds) constitute a minor refrigerant portion of the composition.

**[0376]** In one embodiment, the invention relates to a composition comprising, consisting essentially of, or consisting of:

a first refrigerant portion comprising, consisting essentially of, or consisting of HFC-227ea; E-HFO-1234ze; one or more additional compounds selected from HFC-23, FC-1216, HFC-143a, HFC-134a, HCFC-22, HCFC-124, FC-218, HFC-236fa and HFO-1225zc; one or more additional compounds selected from HFO-1234yf, HFC-245cb, HFO-1225ye(E), HFO-1225ye(Z), HFO-1225zc, HFC-236fa, HFC-152a, HFC-143a, HFC-125, HFC-134a, HFO-1234zc, HFO-1233xf, HFO-1233zd, CFC-114, HCFC-124, 3,3,3-trifluoropropyne, HFO-1234ze(Z), HFC-245fa, HFC-227ea, HFO-1243zf, HFC-263fb and HFC-134; and

a second refrigerant portion comprising, consisting essentially of, or consisting of at least one of CFC-11 and HFC-134a.

**[0377]** In one embodiment, the first refrigerant portion comprises, consists essentially of, or consists of HFC-227ea; E-HFO-1234ze; and one or more additional compounds selected from HFC-245cb, HFO-1234yf, HFO-1225zc and FC-1216.

**[0378]** In some embodiments, the HFC-227ea and E-HFO-1234ze of the first refrigerant portion constitute a major refrigerant portion of the composition, while the CFC-11 and/or HFC-134a of the second refrigerant portion and the additional compounds of the first refrigerant portion constitute a minor refrigerant portion thereof.

**[0379]** In one embodiment, a composition comprises, consists essentially of, or consists of R-515B (8.9% HFC-227ea / 91.1% E-HFO-1234ze), and at least one of CFC-11 and HFC-134a.

**[0380]** In some embodiments, the R-515B constitutes a major refrigerant portion of the composition, while the CFC-11 and/or HFC-134a constitute a minor refrigerant portion thereof.

**[0381]** In some embodiments, the composition comprises from about 99.5 to about 99.9 weight percent of R-515B, and from about 0.00001 to about 0.5 weight percent, preferably from about 0.0001 to about 0.5 weight percent, of at least one of CFC-11, HFC-134a and combinations thereof.

**[0382]** In one embodiment, a composition comprises, consists essentially of, or consists of R-515B; one or more additional compounds selected from HFC-23, FC-1216, HFC-143a, HFC-134a, HCFC-22, HCFC-124, FC-218, HFC-236fa and HFO-1225zc; one or more additional compounds selected from HFO-1234yf, HFC-245cb, HFO-1225ye(E), HFO-1225ye(Z), HFO-1225zc, HFC-236fa, HFC-152a, HFC-143a, HFC-125, HFC-134a, HFO-1234zc, HFO-1233xf, HFO-1233zd, CFC-114, HCFC-124, 3,3,3-trifluoropropyne, HFO-1234ze(Z), HFC-245fa, HFC-227ea, HFO-1243zf, HFC-263fb and HFC-134; and at least one of CFC-11 and HFC-134a.

**[0383]** In one embodiment, a composition comprises, consists essentially of, or consists of R-515B; one or more additional compounds selected from HFC-245cb, HFO-1234yf, HFO-1225zc and FC-1216; and at least one of CFC-11 and HFC-134a.

**[0384]** In some embodiments, the R-515B constitutes a major refrigerant portion of the composition, while the remaining compounds (e.g., the CFC-11 and/or HFC-134a and the additional compounds) constitute a minor refrigerant portion of the composition.

**[0385]** In one embodiment, the invention relates to a composition comprising, consisting essentially of, or consisting of:

a first refrigerant portion comprises, consists essentially of, or consists of R-515B; one or more additional compounds selected from HFC-23, FC-1216, HFC-143a, HFC-134a, HCFC-22, HCFC-124, FC-218, HFC-236fa and HFO-1225zc; one or more additional compounds selected from HFO-1234yf, HFC-245cb, HFO-1225ye(E), HFO-1225ye(Z), HFO-1225zc, HFC-236fa, HFC-152a, HFC-143a, HFC-125, HFC-134a, HFO-1234zc, HFO-1233xf, HFO-1233zd, CFC-114,

HCFC-124, 3,3,3-trifluoropropyne, HFO-1234ze(Z), HFC-245fa, HFC-227ea, HFO-1243zf, HFC-263fb and HFC-134; and

a second refrigerant portion comprises, consists essentially of, or consists of at least one of CFC-11 and HFC-134a.

[0386] In one embodiment, the first refrigerant portion comprises, consists essentially of, or consists of R-515B, and one or more additional compounds selected from HFC-245cb, HFO-1234yf, HFO-1225zc and FC-1216.

[0387] In some embodiments, the R-515B of the first refrigerant portion constitutes a major refrigerant portion of the composition, while the CFC-11 and/or HFC-134a of the second refrigerant portion and the additional compounds of the first refrigerant portion constitute a minor refrigerant portion thereof.

[0388] In some embodiments, the second refrigerant portion of any of the foregoing compositions of Embodiment 16 comprises residual refrigerants.

[0389] In some embodiments, any of the foregoing compositions of Embodiment 16 comprises from about 99.5 to about 99.9 weight percent of the first refrigerant portion, and from about 0.00001 to about 0.5 weight percent, preferably from about 0.0001 to about 0.5 weight percent, of the second refrigerant portion.

[0390] In one embodiment, the total amount of additional compound(s) in the first refrigerant portion of any of the foregoing compositions of Embodiment 16 ranges from greater than 0 wt.% to less than or equal to about 2 wt.%, about 1 wt.%, about 0.9 wt.%, about 0.8 wt.%, about 0.7 wt.%, about 0.6 wt.%, about 0.5 wt.%, about 0.4 wt.%, about 0.3 wt.%, about 0.2 wt.%, about 0.1 wt.%, based on the total weight of the first refrigerant portion of the composition. In another embodiment, the total amount of additional compound(s) ranges from 0.01 ppm (weight) to about 1 wt.%, and all values therebetween up to 1 wt.%. In another embodiment, the total amount of additional compound(s) ranges from 0.1 ppm (weight) to about 1 wt.%. In another embodiment, the total amount of additional compound(s) ranges from 0.001 wt.% to about 1 wt.%. In another embodiment, the total amount of additional compound(s) ranges from 0.001 wt.% to about 0.5 wt.%. In another embodiment, the total amount of additional compound(s) ranges from 0.001 wt.% to 0.4 wt.% or less, based on the total weight of the first refrigerant portion of the composition. In another

embodiment, the total amount of additional compound(s) ranges from 0.001 wt.% to 0.1 wt.% or less, based on the total weight of the first refrigerant portion of the composition. In one embodiment, the total amount of additional compound(s) is about 0.1 wt.% based on the total weight of the first refrigerant portion of the composition.

#### **Embodiment 17**

**[0391]** In one embodiment, a composition comprises, consists essentially of, or consists of Z-HFO-1336mzz, trans-1,2-dichloroethylene (t-DCE), and at least one of CFC-11 and HFC-123.

**[0392]** In some embodiments, the Z-HFO-1336mzz and t-DCE, constitute a major refrigerant portion of the composition, while the CFC-11 and/or HCFC-123 constitute a minor refrigerant portion thereof.

**[0393]** In one embodiment, the CFC-11 and/or HCFC-123 are residual refrigerants. In one embodiment, a residual amount of the CFC-11 and/or HCFC-123 is contained in the composition.

**[0394]** In some embodiments, the composition comprises from about 99.5 to about 99.9 weight percent of Z-HFO-1336mzz and t-DCE, and from about 0.00001 to about 0.5 weight percent, preferably from about 0.0001 to about 0.5 weight percent, of at least one of CFC-11, HCFC-123 and combinations thereof.

**[0395]** In one embodiment, a composition comprises, consists essentially of, or consists of Z-HFO-1336mzz; t-DCE; one or more additional compounds selected from HFO-1326mxz(E), HFO-1326mxz(Z), HFC-346mdf, HFC-356mff and HFO-1336mzz(E); one or more additional compounds selected from chloroethyne (HCC-2120), vinyl chloride (HCC-1140), 1,1-dichloroethene (HCO-1130a), methylene chloride (HCC-30), 1,1-dichloroethane (HCC-150a), cis-DCE, chloroform (HCC-20), 1,1,1-trichloroethane (HCC-140a) and trichloroethylene (HCO-1120); and at least one of CFC-11 and HFC-123.

**[0396]** In one embodiment, a composition comprises, consists essentially of, or consists of Z-HFO-1336mzz; t-DCE; at least one of CFC-11 and HFC-123; and one or more additional compounds selected from HFO-1326mxz(E), HFO-1326mxz(Z), HCC-2120, HCC-1140, HCO-1130a, cis-DCE and HCC-30.

**[0397]** In some embodiments, the Z-HFO-1336mzz and t-DCE constitute a major refrigerant portion of the composition, while the remaining compounds (e.g., the CFC-11 and/or HCFC-123 and the additional compounds) constitute a minor refrigerant portion of the composition.

**[0398]** In one embodiment, the invention relates to a composition comprising, consisting essentially of, or consisting of:

a first refrigerant portion comprising, consisting essentially of, or consisting of Z-HFO-1336mzz; t-DCE; one or more additional compounds selected from HFO-1326mxzE, HFO-1326nxzZ, HFC-346mdf, HFC-356mff and HFO-1336mzz(E); one or more additional compounds selected from HCC-2120, HCC-1140, HCO-1130a, HCC-30, HCC-150a, cis 1,2-DCE, HCC-20, HCC-140a and HCO-1120; and

a second refrigerant portion comprising, consisting essentially of, or consisting of at least one of CFC-11 and HFC-123.

**[0399]** In one embodiment, the first refrigerant portion comprises, consists essentially of, or consists of Z-HFO-1336mzz; t-DCE; and one or more additional compounds selected from HFO-1326mxz(E), HFO-1326mxz(Z), HCC-2120, HCC-1140, HCO-1130a, cis-DCE and HCC-30.

**[0400]** In some embodiments, the Z-HFO-1336mzz and t-DCE of the first refrigerant portion constitute a major refrigerant portion of the composition, while the CFC-11 and/or HCFC-123 of the second refrigerant portion and the additional compounds of the first refrigerant portion constitute a minor refrigerant portion thereof.

**[0401]** In one embodiment, a composition comprises, consists essentially of, or consists of R-514A (74.7% Z-HFO-1336mzz / 25.3% t-DCE), and at least one of CFC-11 and HFC-123.

**[0402]** In some embodiments, the R-514A constitutes a major refrigerant portion of the composition, while the CFC-11 and/or HCFC-123 constitute a minor refrigerant portion thereof.

**[0403]** In some embodiments, the composition comprises from about 99.5 to about 99.9 weight percent of R-514A, and from about 0.00001 to about 0.5 weight percent,

preferably from about 0.0001 to about 0.5 weight percent, of at least one of CFC-11, HCFC-123 and combinations thereof.

**[0404]** In one embodiment, a composition comprises, consists essentially of, or consists of R-514A; one or more additional compounds selected from HFO-1326mxzE, HFO-1326nxzZ, HFC-346mdf, HFC-356mff and HFO-1336mzz(E); one or more additional compounds selected from HCC-2120, HCC-1140, HCO-1130a, HCC-30, HCC-150a, cis 1,2-DCE, HCC-20, HCC-140a and HCO-1120; and at least one of CFC-11 and HFC-123.

**[0405]** In one embodiment, a composition comprises, consists essentially of, or consists of R-514A; at least one of CFC-11 and HFC-123; and one or more additional compounds selected from HFO-1326mxz(E), HFO-1326mxz(Z), HCC-2120, HCC-1140, HCO-1130a, cis-DCE and HCC-30.

**[0406]** In some embodiments, the R-514A constitutes a major refrigerant portion of the composition, while the remaining compounds (e.g., the CFC-11 and/or HCFC-123 and the additional compounds) constitute a minor refrigerant portion of the composition.

**[0407]** In one embodiment, the invention relates to a composition comprising, consisting essentially of, or consisting of:

a first refrigerant portion comprises, consists essentially of, or consists of R-514A; one or more additional compounds selected from HFO-1326mxzE, HFO-1326nxzZ, HFC-346mdf, HFC-356mff and HFO-1336mzz(E); one or more additional compounds selected from HCC-2120, HCC-1140, HCO-1130a, HCC-30, HCC-150a, cis 1,2-DCE, HCC-20, HCC-140a and HCO-1120; and

a second refrigerant portion comprises, consists essentially of, or consists of at least one of CFC-11 and HFC-123.

**[0408]** In one embodiment, the first refrigerant portion comprises, consists essentially of, or consists of R-514A, and one or more additional compounds selected from HFO-1326mxz(E), HFO-1326mxz(Z), HCC-2120, HCC-1140, HCO-1130a, cis-DCE and HCC-30.

**[0409]** In some embodiments, the R-514A of the first refrigerant portion constitutes a major refrigerant portion of the composition, while the CFC-11 and/or HCFC-123 of

the second refrigerant portion and the additional compounds of the first refrigerant portion constitute a minor refrigerant portion thereof.

**[0410]** In some embodiments, the second refrigerant portion of any of the foregoing compositions of Embodiment 17 comprises residual refrigerants.

**[0411]** In some embodiments, any of the foregoing compositions of Embodiment 17 comprises from about 99.5 to about 99.9 weight percent of the first refrigerant portion, and from about 0.00001 to about 0.5 weight percent, preferably from about 0.0001 to about 0.5 weight percent, of the second refrigerant portion.

**[0412]** In one embodiment, the total amount of additional compound(s) in the first refrigerant portion of any of the foregoing compositions of Embodiment 17 ranges from greater than 0 wt.% to less than or equal to about 2 wt.%, about 1 wt.%, about 0.9 wt.%, about 0.8 wt.%, about 0.7 wt.%, about 0.6 wt.%, about 0.5 wt.%, about 0.4 wt.%, about 0.3 wt.%, about 0.2 wt.%, about 0.1 wt.%, based on the total weight of the first refrigerant portion of the composition. In another embodiment, the total amount of additional compound(s) ranges from 0.01 ppm (weight) to about 1 wt.%, and all values therebetween up to 1 wt.%. In another embodiment, the total amount of additional compound(s) ranges from 0.1 ppm (weight) to about 1 wt.%. In another embodiment, the total amount of additional compound(s) ranges from 0.001 wt.% to about 1 wt.%. In another embodiment, the total amount of additional compound(s) ranges from 0.001 wt.% to about 0.5 wt.%. In another embodiment, the total amount of additional compound(s) ranges from 0.001 wt.% to 0.4 wt.% or less, based on the total weight of the first refrigerant portion of the composition. In another embodiment, the total amount of additional compound(s) ranges from 0.001 wt.% to 0.1 wt.% or less, based on the total weight of the first refrigerant portion of the composition. In one embodiment, the total amount of additional compound(s) is about 0.1 wt.% based on the total weight of the first refrigerant portion of the composition.

#### **Embodiment 18**

**[0413]** In one embodiment, a composition comprises, consists essentially of, or consists of HFC-32, HFC-152a, E-HFO-1234ze and at least one of CFC-12, HFC-134a and HFO-1234yf.

**[0414]** In some embodiments, the HFC-32, HFC-152a and E-HFO-1234ze, constitute a major refrigerant portion of the composition, while the CFC-12, HFC-134a and/or HFO-1234yf constitute a minor refrigerant portion thereof.

**[0415]** In one embodiment, the CFC-12, HFC-134a and/or HFO-1234yf are residual refrigerants. In one embodiment, a residual amount of the CFC-12, HFC-134a and/or HFO-1234yf is contained in the composition.

**[0416]** In some embodiments, the composition comprises from about 99.5 to about 99.9 weight percent of HFC-32, HFC-152a and E-HFO-1234ze, and from about 0.00001 to about 0.5 weight percent, preferably from about 0.0001 to about 0.5 weight percent, of at least one of CFC-12, HFC-134a, HFO-1234yf and combinations thereof.

**[0417]** In one embodiment, a composition comprises, consists essentially of, or consists of HFC-32; HFC-152a; E-HFO-1234ze; one or more additional compounds selected from HFC-143a, HFC-41, HFC-134a, HCFC-22, CFC-12 and HCC-40; one or more additional compounds selected from HFC-161, HCC-40, isobutane, HCO-1140, HCC-160 and CFC-114a; one or more additional compounds selected from HFO-1234yf, HFC-245cb, HFO-1225ye(E), HFO-1225ye(Z), HFO-1225zc, HFC-236fa, HFC-152a, HFC-143a, HFC-125, HFC-134a, HFO-1234zc, HFO-1233xf, HFO-1233zd, CFC-114, HCFC-124, 3,3,3-trifluoropropyne, HFO-1234ze(Z), HFC-245fa, HFC-227ea, HFO-1243zf, HFC-263fb and HFC-134; and at least one of CFC-12, HFC-134a and HFO-1234yf.

**[0418]** In one embodiment, a composition comprises, consists essentially of, or consists of HFC-32; HFC-152a; E-HFO-1234ze; at least one of CFC-12, HFC-134a and HFO-1234yf; and one or more additional compounds selected from HFC-143a, HFC-245cb and HFO-1225zc.

**[0419]** In some embodiments, the HFC-32, HFC-152a and E-HFO-1234ze constitute a major refrigerant portion of the composition, while the remaining compounds (e.g., the CFC-12, HFC-134a and/or HFO-1234yf and the additional compounds) constitute a minor refrigerant portion of the composition.



**[0420]** In one embodiment, the invention relates to a composition comprising, consisting essentially of, or consisting of:

a first refrigerant portion comprising, consisting essentially of, or consisting of HFC-32; HFC-152a; E-HFO-1234ze; one or more additional compounds selected from HFC-143a, HFC-41, HFC-134a, HCFC-22, CFC-12 and HCC-40; one or more additional compounds selected from HFC-161, HCC-40, isobutane, HCO-1140, HCC-160 and CFC-114a; and one or more additional compounds selected from HFO-1234yf, HFC-245cb, HFO-1225ye(E), HFO-1225ye(Z), HFO-1225zc, HFC-236fa, HFC-152a, HFC-143a, HFC-125, HFC-134a, HFO-1234zc, HFO-1233xf, HFO-1233zd, CFC-114, HCFC-124, 3,3,3-trifluoropropyne, HFO-1234ze(Z), HFC-245fa, HFC-227ea, HFO-1243zf, HFC-263fb and HFC-134; and

a second refrigerant portion comprising, consisting essentially of, or consisting of at least one of CFC-12, HFC-134a and HFO-1234yf.

**[0421]** In one embodiment, the first refrigerant portion comprises, consists essentially of, or consists of HFC-32; HFC-152a; E-HFO-1234ze; and one or more additional compounds selected from HFC-143a, HFC-245cb and HFO-1225zc.

**[0422]** In some embodiments, the HFC-32, HFC-152a and E-HFO-1234ze of the first refrigerant portion constitute a major refrigerant portion of the composition, while the CFC-12, HFC-134a and/or HFO-1234yf of the second refrigerant portion and the additional compounds of the first refrigerant portion constitute a minor refrigerant portion thereof.

**[0423]** In one embodiment, a composition comprises, consists essentially of, or consists of R-444A (12% HFC-32 / 5% HFC-152a / 83% E-HFO-1234ze), and at least one of CFC-12, HFC-134a and HFO-1234yf.

**[0424]** In some embodiments, the R-444A constitutes a major refrigerant portion of the composition, while the CFC-12, HFC-134a and/or HFO-1234yf constitute a minor refrigerant portion thereof.

**[0425]** In some embodiments, the composition comprises from about 99.5 to about 99.9 weight percent of R-444A, and from about 0.00001 to about 0.5 weight percent, preferably from about 0.0001 to about 0.5 weight percent, of at least one of CFC-12, HFC-134a, HFO-1234yf and combinations thereof.

**[0426]** In one embodiment, a composition comprises, consists essentially of, or consists of R-444A; one or more additional compounds selected from HFC-143a, HFC-41, HFC-134a, HCFC-22, CFC-12 and HCC-40; one or more additional compounds selected from HFC-161, HCC-40, isobutane, HCO-1140, HCC-160 and CFC-114a; one or more additional compounds selected from HFO-1234yf, HFC-245cb, HFO-1225ye(E), HFO-1225ye(Z), HFO-1225zc, HFC-236fa, HFC-152a, HFC-143a, HFC-125, HFC-134a, HFO-1234zc, HFO-1233xf, HFO-1233zd, CFC-114, HCFC-124, 3,3,3-trifluoropropyne, HFO-1234ze(Z), HFC-245fa, HFC-227ea, HFO-1243zf, HFC-263fb and HFC-134; and at least one of CFC-12, HFC-134a and HFO-1234yf.

**[0427]** In one embodiment, a composition comprises, consists essentially of, or consists of R-444A; at least one of CFC-12, HFC-134a and HFO-1234yf; and one or more additional compounds selected from HFC-143a, HFC-245cb and HFO-1225zc.

**[0428]** In some embodiments, the R-444A constitutes a major refrigerant portion of the composition, while the remaining compounds (e.g., the CFC-12, HFC-134a and/or HFO-1234yf and the additional compounds) constitute a minor refrigerant portion of the composition.

**[0429]** In one embodiment, the invention relates to a composition comprising, consisting essentially of, or consisting of:

a first refrigerant portion comprises, consists essentially of, or consists of R-444A; one or more additional compounds selected from HFC-143a, HFC-41, HFC-134a, HCFC-22, CFC-12 and HCC-40; one or more additional compounds selected from HFC-161, HCC-40, isobutane, HCO-1140, HCC-160 and CFC-114a; and one or more additional compounds selected from HFO-1234yf, HFC-245cb, HFO-1225ye(E), HFO-1225ye(Z), HFO-1225zc, HFC-236fa, HFC-152a, HFC-143a, HFC-125, HFC-134a, HFO-1234zc, HFO-1233xf, HFO-1233zd, CFC-114, HCFC-124, 3,3,3-trifluoropropyne, HFO-1234ze(Z), HFC-245fa, HFC-227ea, HFO-1243zf, HFC-263fb and HFC-134; and

a second refrigerant portion comprises, consists essentially of, or consists of at least one of CFC-12, HFC-134a and HFO-1234yf.

**[0430]** In one embodiment, the first refrigerant portion comprises, consists essentially of, or consists of R-444A, and one or more additional compounds selected from HFC-143a, HFC-245cb and HFO-1225zc.

**[0431]** In some embodiments, the R-444A of the first refrigerant portion constitutes a major refrigerant portion of the composition, while the CFC-12, HFC-134a and/or HFO-1234yf of the second refrigerant portion and the additional compounds of the first refrigerant portion constitute a minor refrigerant portion thereof.

**[0432]** In some embodiments, the second refrigerant portion of any of the foregoing compositions of Embodiment 18 comprises residual refrigerants.

**[0433]** In some embodiments, any of the foregoing compositions of Embodiment 18 comprises from about 99.5 to about 99.9 weight percent of the first refrigerant portion, and from about 0.00001 to about 0.5 weight percent, preferably from about 0.0001 to about 0.5 weight percent, of the second refrigerant portion.

**[0434]** In one embodiment, the total amount of additional compound(s) in the first refrigerant portion of any of the foregoing compositions of Embodiment 18 ranges from greater than 0 wt.% to less than or equal to about 2 wt.%, about 1 wt.%, about 0.9 wt.%, about 0.8 wt.%, about 0.7 wt.%, about 0.6 wt.%, about 0.5 wt.%, about 0.4 wt.%, about 0.3 wt.%, about 0.2 wt.%, about 0.1 wt.%, based on the total weight of the first refrigerant portion of the composition. In another embodiment, the total amount of additional compound(s) ranges from 0.01 ppm (weight) to about 1 wt.%, and all values therebetween up to 1 wt.%. In another embodiment, the total amount of additional compound(s) ranges from 0.1 ppm (weight) to about 1 wt.%. In another embodiment, the total amount of additional compound(s) ranges from 0.001 wt.% to about 1 wt.%. In another embodiment, the total amount of additional compound(s) ranges from 0.001 wt.% to about 0.5 wt.%. In another embodiment, the total amount of additional compound(s) ranges from 0.001 wt.% to 0.4 wt.% or less, based on the total weight of the first refrigerant portion of the composition. In another embodiment, the total amount of additional compound(s) ranges from 0.001 wt.% to 0.1 wt.% or less, based on the total weight of the first refrigerant portion of the composition. In one embodiment, the total amount of additional compound(s) is about 0.1 wt.% based on the total weight of the first refrigerant portion of the composition.

[0435] In one embodiment, any of the compositions of any of the foregoing Embodiments comprise one additional compound, or two additional compounds, or three or more additional compounds.

#### **REFRIGERANT ADDITIVES**

[0436] In one embodiment, compositions of the present invention may further comprise at least one non-refrigerant component. That is, in one embodiment, the present invention relates to compositions comprising a refrigerant composition, such as any of the compositions of any of the foregoing Embodiments disclosed herein, and one or more non-refrigerant components.

[0437] The optional non-refrigerant components (also referred to herein as “additives”) in the compositions disclosed herein may include one or more of the following components: lubricants, dyes (including UV dyes), solubilizing agents, compatibilizers, stabilizers, tracers, perfluoropolyethers, anti-wear agents, extreme pressure agents, corrosion and oxidation inhibitors, polymerization inhibitors, metal surface energy reducers, metal surface deactivators, acid scavengers, foam control agents, viscosity index improvers, pour point depressants, detergents, viscosity adjusters, performance enhancers, flame suppressants and mixtures thereof. Indeed, many of these optional non-refrigerant components fit into one or more of these categories and may have qualities that lend themselves to achieve one or more performance characteristics.

[0438] The additive component(s) and amounts thereof selected for the disclosed compositions are elected on the basis of utility, individual equipment components, and/or the system requirements.

[0439] Lubricants which may be included in compositions of the present invention comprise those suitable for use with refrigeration or air-conditioning apparatus. Among these lubricants are those conventionally used in compression refrigeration apparatus utilizing chlorofluorocarbon refrigerants. Such lubricants and their properties are discussed in the 2022 ASHRAE Refrigeration Handbook, Chapter 12, Lubricants in Refrigeration Systems, herein incorporated by reference. Lubricants of the present invention may comprise those commonly known as “mineral oils” in the field of compression refrigeration lubrication. Mineral oils comprise paraffins

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

**[0440]** 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. Such lubricants and their properties are discussed in “Synthetic Lubricants and High-Performance Fluids”, R. L. Shubkin, editor, Marcel Dekker, 1993. Such lubricants include, but are not limited to, polyol esters (POEs) such as Castrol® 100 (Castrol, United Kingdom), polyalkylene glycols (PAGs) such as RL-488A from Dow (Dow Chemical, Midland, Mich.), and polyvinyl ethers (PVEs) such as PVE-FVC68D.

**[0441]** In one particular embodiment, the foregoing refrigerant compositions are combined with a PAG lubricant or a POE lubricant for usage in an automotive A/C system having an internal combustion engine or an electric or hybrid electric drive train.

**[0442]** In the compositions of the present invention 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.

**[0443]** In one aspect of the invention, the inventive refrigerant composition is used to introduce lubricant into the A/C 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.

**[0444]** 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.

**[0445]** 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.

**[0446]** In some embodiments, an acid scavenger may comprise a siloxane, an activated aromatic compound, or a combination of both. Serrano et al (paragraph 38 of US 2011/0272624 A1), which is hereby incorporated by reference, discloses that the siloxane may be any molecule having a siloxyfunctionality. The siloxane may include an alkyl siloxane, an aryl siloxane, or a siloxane containing mixtures of aryl and alkyl substituents. For example, the siloxane may be an alkyl siloxane, including a dialkylsiloxane or a polydialkylsiloxane. Preferred siloxanes include an oxygen atom bonded to two silicon atoms, i.e., a group having the structure: SiOSi. For example, the siloxane may be a siloxane of Formula IV:

$R_1[Si(R_2R_3)_4O]_nSi(R_2R_3)R_4$ , where  $n$  is 1 or more. Siloxanes of Formula IV have  $n$  that is preferably 2 or more, more preferably 3 or more, (e.g., about 4 or more). Siloxanes of formula IV have  $n$  that is preferably about 30 or less, more preferably about 12 or less, and most preferably about 7 or less. Preferably the  $R_4$  group is an aryl group or an alkyl group. Preferably the  $R_2$  groups are aryl groups or alkyl groups or mixtures thereof. Preferably the  $R_3$  groups are aryl groups or alkyl groups or

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

**[0447]** Incorporated by previous reference from Serrano et al paragraph notes that in one aspect of the invention, the siloxane is an alkylsiloxane containing from about 1 to about 12 carbon atoms, such as hexamethyldisiloxane. The siloxane may also be a polymer such as polydialkylsiloxane, where the alkyl group is a methyl, ethyl, propyl, butyl, or any combination thereof. Suitable polydialkylsiloxanes have a molecular weight from about 100 to about 10,000. Highly preferred siloxanes include hexamethyldisiloxane, polydimethylsiloxane, and combinations thereof. The siloxane may consist essentially of polydimethylsiloxane, hexamethyldisiloxane, or a combination thereof.

**[0448]** The activated aromatic compound may be any aromatic molecule activated towards a Friedel-Crafts addition reaction, or mixtures thereof. An aromatic molecule activated towards a Friedel-Crafts addition reaction is defined to be any aromatic molecule capable of an addition reaction with mineral acids. Especially aromatic molecules capable of addition reactions with mineral acids either in the application environment (AC system) or during the ASHRAE 97: 2007 "Sealed Glass Tube Method to Test the Chemical Stability of Materials for Use within Refrigerant Systems" thermal stability test. Such molecules or compounds are typically activated by substitution of a hydrogen atoms of the aromatic ring with one of the following groups: NH<sub>2</sub>, NHR, NR<sub>2</sub>, ADH, AD, NHCOCH<sub>3</sub>, NHCOR, 4OCH<sub>3</sub>, OR, CH<sub>3</sub>, 4C<sub>2</sub>H<sub>5</sub>, R, or C<sub>6</sub>H<sub>5</sub>, where R is a hydrocarbon (preferably a hydrocarbon containing from about 1 to about 100 carbon atoms). The activated aromatic molecule may be an alcohol, or an ether, where the oxygen atom (i.e., the oxygen atom of the alcohol or

ether group) is bonded directly to an aromatic group. The activated aromatic molecule may be an amine Where the nitrogen atom (i.e., the nitrogen atom of the amine group) is bonded directly to an aromatic group. By way of example, the activated aromatic molecule may have the formula  $ArXR_n$ , Where X is O (i.e., oxygen) or N (i.e., nitrogen); n:1 When X:O; n:2 When x:N; Ar is an aromatic group (i.e., group,  $C_6H_5$ ); R may be H or a carbon containing group; and When n:2, the R groups may be the same or different. For example, R may be H (i.e., hydrogen), Ar, an alkyl group, or any combination thereof, Exemplary activated aromatic molecules that may be employed in a refrigerant composition according to the teachings herein include diphenyl oxide (i.e., diphenyl ether), methyl phenyl ether (e.g., anisole), ethyl phenyl ether, butyl phenyl ether or any combination thereof. One highly preferred aromatic molecule activated to Wards a Friedel-Crafts addition reaction is diphenyl oxide.

**[0449]** Incorporated by previous reference from Serrano et al. The acid scavenger (e.g., the activated aromatic compound, the siloxane, or both) may be present in any concentration that results in a relatively low total acid number, a relatively low total halides concentration, a relatively low total organic acid concentration, or any combination thereof.

**[0450]** 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.

**[0451]** Additional examples of acid scavengers which may be included in the refrigerant composition and preferably are excluded from the refrigerant composition include those described by Kaneko (U.S. patent application Ser. No. 11/575,256, published as U.S. Patent Publication 2007/0290164, paragraph 42, expressly incorporated herein by reference), such as one or more of: phenyl glycidyl ethers, alkyl glycidyl ethers, alkyleneglycolglycidylethers, cyclohexeneoxides, otolenoxides,



or epoxy compounds such as epoxidized soybean oil, and those described by Singh et al. (U.S. patent application Ser. No. 11/250,219, published as 20060116310, paragraphs 34-42, expressly incorporated herein by reference).

**[0452]** 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).

**[0453]** 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.

**[0454]** 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.

**[0455]** 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 and/or Krytox® lubricants, also incorporated by reference and described

in patent application “Refrigerant compositions comprising fluoroolefins and uses thereof WO2009018117A1.”

**[0456]** In one embodiment, compositions of the present invention include a composition comprising HFO-1234ze(Z) and at least one acid scavenger. In particular, in some embodiments, any of the HFO-1234ze(Z) compositions disclosed herein may include at least one acid scavenger.

**[0457]** Additionally, the present compositions may further comprise at least one tracer compound or mixture of tracer compounds. Tracers may be used to identify the process by which a refrigerant, or refrigerant mixture is produced. The tracer compounds may be specific to the manner of production or may be added as a single tracer or mixture of tracers in particular amounts in order to detect dilution, adulteration, contamination, or other unauthorized practices.

**[0458]** The tracer may be a single compound or two or more tracer compounds from the same class of compounds or from different classes of compounds. In some embodiments, the tracer is present in the compositions at a total concentration of about 1 part per million by weight (ppm) to about 5000 ppm, based on the weight of the total composition. In other embodiments, the tracer is present at a total concentration of about 1 ppm to about 1000 ppm. In other embodiments, the tracer is present at a total concentration of about 2 ppm to about 500 ppm. Alternatively, the tracer is present at a total concentration of about 10 ppm to about 300 ppm.

**[0459]** The tracer compound or compounds in amounts up to 100 ppm, 200 ppm, 300, ppm, 400 ppm, 500 ppm, 600 ppm, 700 ppm, 800 ppm and 900 ppm may be selected from hydrofluorocarbons, hydrofluoroolefins, hydrochlorocarbons, hydrochloroolefins, hydrochlorofluorocarbons, hydrochlorofluoroolefins, hydrochlorocarbons, hydrochloroolefins, chlorofluorocarbons, chlorofluoroolefins, hydrocarbons, perfluorocarbons, perfluoroolefins, and combinations thereof. In particular, the tracers may include, but are not limited to compounds selected from HFC-23 (trifluoromethane), HCFC-31 (chlorofluoromethane), HFC-41 (fluoromethane), HFC-161 (fluoroethane), HFC-152a (1,1-difluoromethane), HFC-143a (1,1,1-trifluoroethane), HFC-227ca (1,1,1,2,2,3,3-heptafluoropropane), HFC-227ea (1,1,1,2,3,3,3-heptafluoropropane), HFC-236fa (1,1,1,3,3,3-hexafluoropropane), HFC-236cb (1,1,1,2,2,3-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-245eb (1,1,1,2,3-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 (2-trifluoromethyl-1,1,1,3,3,3-hexafluoropropane), 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 (2,2-dichloro-1,1,1,2-tetrafluoroethane), CFC-115 (chloropentafluoroethane), HCFC-22 (chlorodifluoromethane), HCFC-123 (2,2-dichloro-1,1,1-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 (fluoroethylene), HCO-1130 (1,2-dichloroethylene, E- and/or Z-isomer), HCO-1130a (1,1-dichloroethylene), HCFO-1131 (1-chloro-2-fluoroethylene, E- and/or Z-isomer), HCFO-1131a (1-chloro-1-fluoroethylene), HCFO-1122 (2-chloro-1,1-difluoroethylene), HFO-1123 (trifluoroethylene), HFO-1234ye (1,2,3,3-tetrafluoropropene), HFO-1243zf (3,3,3-trifluoropropene), HFO-1225yeZ (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 (hexafluoropropene), PFC-31-10mc (decafluorobutane), PFC-31-10my (2-trifluoromethyl-1,1,1,2,3,3,3-heptafluoropropane), 2-chloro-1,1,2-trifluoroethylene (CFO-1113), 1,1,1,3,3-pentafluorobutane (HFC-365mfc), 1,1,1,2,3,4,4,5,5,5-decafluoropentane (HFC-43-10mee), 1,1,1,2,2,3,4,5,5,6,6,7,7,7-tetradecafluoroheptane, hexafluorobutadiene, 3,3,3-trifluoropropyne, deuterated hydrocarbons, deuterated hydrofluorocarbons, perfluorocarbons, fluoroethers, and mixtures thereof.

**[0460]** In some embodiments, the tracer is a blend containing two or more hydrofluorocarbons, or one hydrofluorocarbon in combination with one or more perfluorocarbons. In other embodiments, the tracer is a blend of at least one CFC and at least one HCFC, HFC, or PFC. In one embodiment, compositions of the

present invention may comprise HFO-1234ze(Z), HFO-1336mzz(Z), HFO-1336mzz(E), HCFO-1224yd(E), HCFO-1224yd(Z), HFO-1327mz(Z), HFO-1327mz(E), one or more hydrofluoroethers, and one or more hydrofluorocarbons.

**[0461]** In exemplary embodiments, for any of the compositions of any of the foregoing Embodiments which includes at least one HFO refrigerant compound, particularly HFO-1234yf or HFO-1234ze(E), the composition may further comprise a stabilizer package. In exemplary embodiments, the stabilizer package includes an effective amount of at least one inhibitor such that the thermal management fluid remains substantially free of oligomeric, homopolymeric, or other polymeric products derived from the thermal management fluid. In some embodiments, at least one inhibitor is selected from hydrocarbons including at least one of cyclic monoterpene; lipophilic organic compounds including tocopherols such as  $\alpha$ -tocopherol; or phenols, aromatic organic compounds having at least one chemical moiety  $-C_6H_4(OH)$ , including benzene-1,4-diol. Specific examples of inhibitor compounds include at least one member selected from the group consisting of limonene,  $\alpha$ -pinene,  $\beta$ -pinene,  $\alpha$ -terpinene,  $\alpha$ -tocopherol, butylated hydroxytoluene (BHT), 4-methoxyphenol, and benzene-1,4-diol. In one embodiment, the inhibitor composition includes a liquid at a temperature from about  $-80^{\circ}\text{C}$  to about  $180^{\circ}\text{C}$ , about  $-70^{\circ}\text{C}$  to about  $170^{\circ}\text{C}$ , and in some cases about  $-60^{\circ}\text{C}$  to about  $160^{\circ}\text{C}$ . By “stabilized” it is meant to refer to a composition including an effective amount of at least one inhibitor compound that inhibits, if not eliminates, a fluoroethylene from interacting with another compound and forming dimers, oligomers, homopolymers, or polymeric products.

#### **STORAGE, SYSTEMS, METHODS OF USE AND REPLACEMENT, RECOVERY, RECYCLE AND RECLAIM**

**[0462]** In some embodiments, any of the compositions of any of the foregoing Embodiments, particularly Embodiments 1 to 4, may be useful in air conditioning systems and heat pump systems. In some embodiments, the air conditioning or heat pump systems comprise an evaporator, compressor, condenser and an expansion device. In one embodiment, the refrigeration, air conditioning or heat pump system is a stationary refrigeration, air conditioning or heat pump system. In another embodiment the refrigeration, air conditioning or heat pump system is a mobile refrigeration, air conditioning or heat pump system. Examples of air conditioning or

heat pump systems include but are not limited to air conditioners, residential heat pumps, chillers, including flooded evaporator chillers and direct expansion chillers, mobile air conditioning units, dehumidifiers, and combinations thereof.

**[0463]** In some embodiments, any of the compositions of any of the foregoing Embodiments, particularly Embodiments 5 to 12, may be useful in refrigeration applications, particularly low temperature refrigeration and/or medium temperature refrigeration. Low temperature refrigeration systems include, but are not limited to, supermarket and convenience store freezer cabinets and displays, ice machines and frozen food transport. Other specific uses include, but are not limited to, commercial, industrial or residential refrigerators and freezers, ice machines, self-contained coolers and freezers, supermarket rack and distributed systems, flooded evaporator chillers, direct expansion chillers, walk-in and reach-in coolers and freezers, and combination systems. Medium temperature refrigeration systems include, but are not limited to, supermarket and convenience store refrigerated cases, such as cases for beverages, dairy, fresh food, and other refrigerated items. Medium temperature refrigeration systems may also include fresh food transport systems.

**[0464]** In some embodiments, any of the compositions of any of the foregoing Embodiments, particularly Embodiments 13 to 15, may be useful in a heat transfer system, particularly stationary and mobile air conditioning systems, medium temperature refrigeration systems and automobile air conditioning systems. Medium temperature refrigeration systems include, but are not limited to, supermarket and convenience store refrigerated cases, such as cases for beverages, dairy, fresh food, and other refrigerated items. Medium temperature refrigeration systems may also include fresh food transport systems.

**[0465]** In some embodiments, any of the compositions of the foregoing Embodiments, particularly Embodiment 16, may be useful in a heat transfer system, particularly medium temperature refrigeration systems and air conditioning systems. Medium temperature refrigeration systems include, but are not limited to, supermarket and convenience store refrigerated cases, such as cases for beverages, dairy, fresh food, and other refrigerated items. Medium temperature refrigeration systems may also include fresh food transport systems. In some embodiments, the air conditioning systems comprise an evaporator, compressor,

condenser and an expansion device. In one embodiment, the refrigeration, air conditioning or heat pump system is a stationary refrigeration, air conditioning or heat pump system. In another embodiment the refrigeration, air conditioning or heat pump system is a mobile refrigeration, air conditioning or heat pump system. Examples of air conditioning systems include but are not limited to air conditioners, residential heat pumps, chillers, including flooded evaporator chillers and direct expansion chillers, mobile air conditioning units, dehumidifiers, and combinations thereof.

**[0466]** In some embodiments, any of the compositions of any of the foregoing Embodiments, particularly Embodiment 17, may be useful in refrigeration systems, particularly low temperature refrigeration systems, and air conditioning applications. Low temperature refrigeration systems include, but are not limited to, supermarket and convenience store freezer cabinets and displays, ice machines and frozen food transport. Other specific uses include, but are not limited to, commercial, industrial or residential refrigerators and freezers, ice machines, self-contained coolers and freezers, supermarket rack and distributed systems, flooded evaporator chillers, direct expansion chillers, walk-in and reach-in coolers and freezers, and combination systems. In some embodiments, the air conditioning systems comprise an evaporator, compressor, condenser and an expansion device. In one embodiment, the refrigeration, air conditioning or heat pump system is a stationary refrigeration, air conditioning or heat pump system. In another embodiment the refrigeration, air conditioning or heat pump system is a mobile refrigeration, air conditioning or heat pump system. Examples of air conditioning systems include but are not limited to air conditioners, residential heat pumps, chillers, including flooded evaporator chillers and direct expansion chillers, mobile air conditioning units, dehumidifiers, and combinations thereof.

**[0467]** In some embodiments, any of the compositions of any of the foregoing Embodiments, particularly Embodiment 18, may be useful in a heat transfer system, particularly automotive applications for heating or cooling of the passenger compartment of an automobile. Sometimes this system is called a heat pump system and may be a reversible heating system or a reversible cooling system, or simply a heating and cooling system.

**[0468]** In some embodiments, the invention relates to a method for producing heating or cooling in a refrigeration, air-conditioning, or heat pump apparatus, wherein the method comprises introducing a working fluid comprising any of the compositions of any of the foregoing Embodiments into the apparatus.

**[0469]** In some embodiments, the invention relates to a refrigeration, air-conditioning or heat pump apparatus containing any of the compositions of any of the foregoing Embodiments.

**[0470]** In some embodiments, the invention relates to a mobile refrigeration or air-conditioning apparatus containing any of the compositions of any of the foregoing Embodiments.

**[0471]** In some embodiments, the invention relates to a stationary refrigeration, air-conditioning or heat pump apparatus containing any of the compositions of any of the foregoing Embodiments.

**[0472]** Further aspects of the compositions of the foregoing Embodiments (e.g., uses thereof, applications thereof, storage thereof, etc.) are discussed in greater detail below.

**[0473]** In some embodiments, the invention relates to a method for replacing an original refrigerant with a replacement refrigerant in a heat transfer system that uses, used or was designed to use the original refrigerant. The method comprises charging the heat transfer system that was designed for use with the original refrigerant with the replacement refrigerant, wherein at least some of the original refrigerant remains in the heat transfer system as a residual refrigerant, and wherein

- (i) the original refrigerant comprises, consists essentially of or consists of at least one of HCFC-22, HFC-32, HFC-125 and combinations thereof; and the replacement refrigerant comprises, consists essentially of or consists of at least R-410A;
- (ii) the original refrigerant comprises, consists essentially of or consists of at least HCFC-22, HFC-32, HFC-125, HFC-134a, HFC-143a and combinations thereof, and the replacement refrigerant comprises, consists essentially of or consists of at least one of R-407C, R-404A, R-507 and combinations thereof;

- (iii) the original refrigerant comprises, consists essentially of or consists of at least one of HCFC-22, HFC-32, HFC-125, HFC-134a, HFC-143a, HFO-1234yf and combinations thereof, and the replacement refrigerant comprises, consists essentially of or consists of at least one of R-452B, R-454B and combinations thereof;
- (iv) the original refrigerant comprises, consists essentially of or consists of at least one of CFC-12, HFC-134a, HFO-1234yf and combinations thereof, and the replacement refrigerant comprises, consists essentially of or consists of at least R-513A;
- (v) the original refrigerant comprises, consists essentially of or consists of at least one of CFC-12, HFC-32, HFC-134a, HFC-227ea, E-HFO-1234ze, HFO-1234yf, E-HFO-1336mzz, Z-HFO-1224yd and combinations thereof, and the replacement refrigerant comprises, consists essentially of or consists of at least one of R-454A, R-454C, R-471A, R-476A, R-482A and combinations thereof;
- (vi) the original refrigerant comprises, consists essentially of or consists of HCFC-22, CFC-115, CFC-125, HFC-134a, HFC-143a and combinations thereof, and the replacement refrigerant comprises, consists essentially of or consists of at least one of R-404A, R-507 and combinations thereof;
- (vii) the original refrigerant comprises, consists essentially of or consists of at least one of CFC-11, HFC-134a, HFO-1234yf and combinations thereof, and the replacement refrigerant comprises, consists essentially of or consists of at least one of R-513A, R-515B and combinations thereof;
- (viii) the original refrigerant comprises, consists essentially of or consists of at least one of HFC-32, HFC-125, HFC-134a, E-HFO-1234ze, HCFC-22, CFC-115, HFC-143a, HFO-1234yf and combinations thereof, and the replacement refrigerant comprises, consists essentially of or consists of at least R-455A;
- (ix) the original refrigerant comprises, consists essentially of or consists of at least one of HCFC-22, CFC-115, HFC-32, HFC-143a, HFC-125, HFC-134a, HFO-1234yf, E-HFO-1234ze, CO<sub>2</sub> and combinations thereof, and the replacement refrigerant comprises, consists essentially of or consists of at least one of R-448A, R-449A, R-407 and combinations thereof;



- (x) the original refrigerant comprises, consists essentially of or consists of at least one of HCFC-22, CFC-115, HFC-143a, HFC-125, HFC-134a, E-HFO-1234ze, HFC-32, HFO-1234yf, CO<sub>2</sub> and combinations thereof, and the replacement refrigerant comprises, consists essentially of or consists of at least one of R-454C, R-455A, R-454A, and combinations thereof;
- (xi) the original refrigerant comprises, consists essentially of or consists of at least one of CFC-11, HCFC-123, t-DCE, Z-HFO-1336mzz and combinations thereof, and the replacement refrigerant comprises, consists essentially of or consists of at least R-514A; or
- (xii) the original refrigerant comprises, consists essentially of or consists of at least one of CFC-12, HFC-32, HFC-134a, HFC-152a, HFO-1234yf, HFO-1132(E), E-HFO-1234ze and combinations thereof, and the replacement refrigerant comprises, consists essentially of or consists of at least R-444A.

**[0474]** In some embodiments, a method for replacing an original refrigerant with a replacement refrigerant in a heat transfer system that uses, used or was designed to use the original refrigerant comprises removing a substantial portion of the original refrigerant from the heat transfer system, at least a portion of the original refrigerant remaining in the heat transfer system as a residual refrigerant; optionally retaining a substantial portion of any lubricant present in the system; and charging the system with the replacement refrigerant, wherein

- (i) the original refrigerant comprises, consists essentially of or consists of at least one of HCFC-22, HFC-32, HFC-125 and combinations thereof; and the replacement refrigerant comprises, consists essentially of or consists of at least R-410A;
- (ii) the original refrigerant comprises, consists essentially of or consists of at least HCFC-22, HFC-32, HFC-125, HFC-134a, HFC-143a and combinations thereof, and the replacement refrigerant comprises, consists essentially of or consists of at least one of R-407C, R-404A, R-507 and combinations thereof;
- (iii) the original refrigerant comprises, consists essentially of or consists of at least one of HCFC-22, HFC-32, HFC-125, HFC-134a, HFC-143a, HFO-1234yf and combinations thereof, and the replacement refrigerant comprises,

consists essentially of or consists of at least one of R-452B, R-454B and combinations thereof;

- (iv) the original refrigerant comprises, consists essentially of or consists of at least one of CFC-12, HFC-134a, HFO-1234yf and combinations thereof, and the replacement refrigerant comprises, consists essentially of or consists of at least R-513A;
- (v) the original refrigerant comprises, consists essentially of or consists of at least one of CFC-12, HFC-32, HFC-134a, HFC-227ea, E-HFO-1234ze, HFO-1234yf, E-HFO-1336mzz, Z-HFO-1224yd and combinations thereof, and the replacement refrigerant comprises, consists essentially of or consists of at least one of R-454A, R-454C, R-471A, R-476A, R-482A and combinations thereof;
- (vi) the original refrigerant comprises, consists essentially of or consists of HCFC-22, CFC-115, CFC-125, HFC-134a, HFC-143a and combinations thereof, and the replacement refrigerant comprises, consists essentially of or consists of at least one of R-404A, R-507 and combinations thereof;
- (vii) the original refrigerant comprises, consists essentially of or consists of at least one of CFC-11, HFC-134a, HFO-1234yf and combinations thereof, and the replacement refrigerant comprises, consists essentially of or consists of at least one of R-513A, R-515B and combinations thereof;
- (viii) the original refrigerant comprises, consists essentially of or consists of at least one of HFC-32, HFC-125, HFC-134a, E-HFO-1234ze, HCFC-22, CFC-115, HFC-143a, HFO-1234yf and combinations thereof, and the replacement refrigerant comprises, consists essentially of or consists of at least R-455A;
- (ix) the original refrigerant comprises, consists essentially of or consists of at least one of HCFC-22, CFC-115, HFC-32, HFC-143a, HFC-125, HFC-134a, HFO-1234yf, E-HFO-1234ze, CO<sub>2</sub> and combinations thereof, and the replacement refrigerant comprises, consists essentially of or consists of at least one of R-448A, R-449A, R-407 and combinations thereof;
- (x) the original refrigerant comprises, consists essentially of or consists of at least one of HCFC-22, CFC-115, HFC-143a, HFC-125, HFC-134a, E-HFO-1234ze, HFC-32, HFO-1234yf, CO<sub>2</sub> and combinations thereof, and the

replacement refrigerant comprises, consists essentially of or consists of at least one of R-454C, R-455A, R-454A, and combinations thereof;

- (xi) the original refrigerant comprises, consists essentially of or consists of at least one of CFC-11, HCFC-123, t-DCE, Z-HFO-1336mzz and combinations thereof, and the replacement refrigerant comprises, consists essentially of or consists of at least R-514A; or
- (xii) the original refrigerant comprises, consists essentially of or consists of at least one of CFC-12, HFC-32, HFC-134a, HFC-152a, HFO-1234yf, HFO-1132(E), E-HFO-1234ze and combinations thereof, and the replacement refrigerant comprises, consists essentially of or consists of at least R-444A.

**[0475]** In some embodiments of any of the foregoing replacement methods, the replacement refrigerant is a recovered thermal management fluid. In some embodiments of any of the foregoing replacement methods, the replacement refrigerant is a recycled thermal management fluid. In some embodiments of any of the foregoing replacement methods, the replacement refrigerant is a reclaimed thermal management fluid.

**[0476]** In some embodiments, any of the compositions of any of the foregoing Embodiments may be a recovered thermal management fluid, and more particularly a spent thermal management fluid or a used thermal management fluid drained or otherwise removed from a thermal management device, such as, for example, a refrigeration, an air-conditioning system or a heat pump, as defined herein.

**[0477]** In some embodiments, any of the compositions of any of the foregoing Embodiments may be a reclaimed thermal management fluid, and more particularly a recovered thermal management fluid or a reprocessed product (e.g., distillation product) of a recovered thermal management fluid, and having at least about 95 wt% organic purity, preferably at least about 99 wt% organic purity, most preferably at least about 99.5 wt% organic purity and meeting conventional specifications for commercial use or sale as a thermal management fluid, as defined herein.

**[0478]** In a further embodiment, all or a portion of any of the compositions of any of the foregoing Embodiments 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 one or more of distillation, decantation, filtration, and/or drying by use of molecular sieves or other absorbents.

**[0479]** In some embodiments, any of the compositions of any of the foregoing Embodiments may be free of or substantially free of HFO-E-1132 and/or HFO-Z-1132, with “substantially free of” meaning 2,000 ppm or less.

**[0480]** In some embodiments, the invention relates to a recovery container, a recovery cylinder, or a recycle, recover, recharge (“RRR”) machine containing any of the compositions of any of the foregoing Embodiments. RRR machines are portable containers used in connection with servicing heat transfer systems, particularly refrigeration circuits such as the air conditioning unit of a vehicle. The portable machines include hoses coupled to the system to be serviced. RRR machines operate to recover refrigerant from the system, optionally store the recovered refrigerant in a refrigerant tank, recycle the refrigerant to some intermittent quality level removing gross contaminants, and then recharge the refrigerant back into the same system after repairs or servicing have been completed. The recovered refrigerant may also be stored in a refrigerant tank in the RRR machine until needed for use in another system.

**[0481]** In some embodiments, at least a portion of any of the compositions of any of the foregoing Embodiments may comprise one or more reclaimed thermal management fluids.

**[0482]** In some embodiments, any of the compositions of any of the foregoing Embodiments may be collected and stored as a recovered thermal management fluid or a reclaimed thermal management fluid in a storage tank until needed for a further application.

**[0483]** In some embodiments, the invention relates to a method of reclaiming refrigerant comprising:

- removing an unreclaimed refrigerant composition from a heat transfer system, the unreclaimed refrigerant composition having at least a first refrigerant compound and a second refrigerant compound; and

- performing at least one treatment selected from transferring, blending, distillation, nitrogen purging, filtration, dehydration, caustic scrubbing, moisture removal, acid removal, oil removal, decanting, composition ratio adjustment and combinations thereof to form a partially reclaimed refrigerant composition or a reclaimed refrigerant composition; and
- either storing the partially reclaimed refrigerant composition or a reclaimed refrigerant composition in a container for use in another system or introducing the partially reclaimed refrigerant composition or a reclaimed refrigerant composition back into the heat transfer system,

wherein the treatment does not involve separation of the first and second refrigerant compounds.

**[0484]** In embodiments of this reclamation method, the unreclaimed refrigerant composition is any of the compositions of any of the foregoing Embodiments, and the amounts of the first and second refrigerant compounds are the same in the unreclaimed refrigerant composition and in the partially reclaimed or reclaimed refrigerant compositions. In some embodiments, the unreclaimed refrigerant composition comprises a plurality of refrigerant compounds which are not separated during the treatment, and the amounts of each of the plurality of refrigerant compounds are the same in the unreclaimed refrigerant composition and in the partially reclaimed or reclaimed refrigerant compositions.

**[0485]** In some embodiments, the reclaiming method further comprise performing an analysis selected from the group consisting of gas chromatography, mass spectrometry, atomic absorption spectroscopy, flame emission spectroscopy, infrared spectroscopy, and combinations thereof on the unreclaimed refrigerant composition to determine the composition of the unreclaimed refrigerant composition sample.

**[0486]** In some embodiments, the invention relates to a method of recycling refrigerant comprising:

- removing a spent or used refrigerant composition from a heat transfer system, the spent or used refrigerant composition having at least a first refrigerant compound and a second refrigerant compound; and

- forming a recycled refrigerant composition; and
- introducing the recycled refrigerant composition back into the heat transfer system,

wherein the treatment does not involve separation of the first and second refrigerant compounds.

**[0487]** In some embodiments, the recovering to remove the thermal management fluid from a thermal management device is by a recovery system, which may include at least one of a recovery cylinder, a recovery compressor, an air-cooled condenser, a fan, or a combination thereof, from which compressed and condensed refrigerant may be sent for testing for composition and/or impurities or to a recovery tank. The thermal management fluid recovery may be configured to recover a wide variety or only a limited number of thermal management fluids or refrigerant compounds. A recovery system may utilize a single circuit for a single thermal management fluid type or multiple circuits for multiple fluid types.

**[0488]** In some embodiments, the recycling includes testing the recovered thermal management fluid, purifying the recovered thermal management fluid as needed, adjusting the composition of the recovered thermal management fluid as needed, and/or stabilizing the recovered thermal management fluid as needed. In some embodiments, the recycling includes validating the recycled recovered thermal management fluid as a recycled thermal management fluid.

**[0489]** In some embodiments, the testing includes determining the composition and/or the amount of organic purity of the recovered thermal management fluid. In some embodiments, a refrigerant analyzer performs the testing. The analyzer determines the composition and purity of the recovered thermal management fluid. In some embodiments, the analyzer determines the type of recovered thermal management fluid and purity as it is being recovered from a thermal management device. The analyzer may alternatively determine the type and purity of a consolidated composition of recovered thermal management fluids. If the analyzed thermal management fluid is determined to be organically pure e.g., at least about 95 wt%, or about 96 wt%, or about 97 wt%, or about 98 wt%, or about 99 wt%, or about 99.5 wt%) and of a thermal management fluid type by the analyzer, the thermal management fluid may be transferred to an appropriate recycled thermal

management fluid tank. If, however, there are impurities (or the organic purity is less than about 95 wt%, or about 96 wt%, or about 97 wt%, or about 98 wt%, or about 99 wt%, or about 99.5 wt%.), such as, air, unknown fluids, or incorrect thermal management fluid, found in the analyzed thermal management fluid by the analyzer, the recovered thermal management fluid may be sent for reclamation. Fluids which contain higher amounts of oil or moisture may be reduced by the RRR equipment to acceptable levels. Again, if refrigerants with high oil, moisture or other contaminants cannot be reduced, the refrigerant may be sent off-site for reclamation.

**[0490]** In some embodiments, the purifying includes removing one or more impurities from the recovered thermal management fluid. In some embodiments, the purifying includes removing acids, moisture and high boiling residues by, for example, a filter, filter drier, absorbent bed(s) or absorbent column(s). The absorbent may be one or the combination of alumina, molecular sieves, silica gel, zeolites, and the like. In some embodiments, the purifying includes a process to remove NAG.

**[0491]** If the purity does not meet the appropriate standards for a recycled thermal management fluid after purification, the recovered thermal management fluid may be returned for further purifying or sent to a reclamation site for reclamation.

**[0492]** Optionally, in some embodiments, the purifying is performed by a regenerator. The regenerator can include at least one of a compressor, a separator, a filter dryer, and may further include at least one of a distiller, a diluter, or a reformulator. In some embodiments, the compressor is driven to circulate the thermal management fluid in a refrigerant circuit such that a voltage is applied to reduce or remove oil, such as the refrigerating machine oil, in the thermal management fluid. In some embodiments, the separator is a type of oil separator. In some embodiments, the filter dryer reduces or removes water and acid included in the thermal management fluid. The regenerator can also determine information on the appropriateness of the oil, water, and acid included in the thermal management fluid after the regeneration processing and compile the thermal management fluid composition, the weight, and the like. After appropriate purification, the thermal management fluid meets AHRI Standard 700 purity specifications.

[0493] In some embodiments, the validating includes confirming that the recovered thermal management fluid has an organic purity greater than about 95 wt%, or about 96 wt%, or about 97 wt%, or about 98 wt%, or about 99 wt%, or about 99.5 wt%, and meets predetermined standards for a recycled thermal management fluid. In the case of thermal management fluids of or including R-134a and/or R-1234yf, the recycled thermal management fluid meets Society of Automotive Engineers (SAE) J2099 standards, which includes less than 1.5 % NAG, by volume, less than 500 ppm (parts per million) by weight high boiling residue, and less than 50 ppm by weight moisture.

[0494] In some embodiments, the recycled and reused thermal management fluid meets the *Standard for Specifications for Refrigerants*, Air-Conditioning, Heating & Refrigeration Institute (AHRI)(AHRI 700), which is incorporated by reference in its entirety herein. AHRI 700 specifies acceptable levels of contaminants (purity requirements) for fluorocarbon, hydrocarbon, and carbon dioxide refrigerants regardless of source and lists acceptable test methods.

[0495] In some embodiments of this recycling method, the used or spent refrigerant composition is any of the compositions of any of the foregoing Embodiments, and the amounts of the first and second refrigerant compounds are the same in the used or spent refrigerant composition and in the recycled refrigerant composition. In some embodiments, the used or spent refrigerant composition comprises a plurality of refrigerant compounds which are not separated during the treatment, and the amounts of each of the plurality of refrigerant compounds are the same in the used or spent refrigerant composition and in recycled refrigerant composition.

[0496] In some embodiments, the present invention relates to a container or storage tank comprising any of the compositions of any of the foregoing Embodiments.

[0497] Another embodiment of the invention relates to storing any of the foregoing compositions of any of the foregoing Embodiments in gaseous and/or liquid phases within a sealed container. The water concentration within the gas and/or liquid phase in the sealed container ranges from about 0.1 to 200 ppm by weight. The oxygen concentration within the gas and/or liquid phase in the sealed container ranges from



about 10 ppm by volume to about 1 volume percent, preferably from about 10 ppm by volume to about 0.35 volume percent, at about 25°C. The air concentration within the gas and/or liquid phase in the sealed container ranges from about 100 ppm by volume to about 5 volume percent, preferably from about 100 ppm by volume to about 1.5 volume percent.

**[0498]** The container for storing the foregoing compositions can be constructed of any suitable material and design that is capable of sealing the compositions therein while maintaining gaseous and liquids phases. Examples of suitable containers comprise pressure resistant containers such as a tank, a filling cylinder, and a secondary filling cylinder. The container can be constructed from any suitable material such as carbon steel, manganese steel, chromium-molybdenum steel, among other low-alloy steels, stainless steel and in some cases an aluminum alloy.

**[0499]** In some embodiments, all or a portion of any of the compositions of any of the foregoing Embodiments may be packaged and sold as a blending building block, such as for forming commercial thermal management fluid blends.

**[0500]** In some embodiments, all or a portion of any of the compositions of any of the foregoing Embodiments may be combined with all or a portion of a virgin, a used, a reclaimed, or other thermal management fluid(s) sharing at least some of the same refrigerant compounds to adjust their composition ratios, such as to make an azeotropic or zeotropic composition or azeotropic or zeotropic commercial thermal management fluid blend.

**[0501]** In some embodiments, all or a portion of any of the compositions of any of the foregoing Embodiments may be combined with all or a portion of a virgin, a used, a reclaimed, or other thermal management fluid(s) having at least one additional refrigerant compound to make an azeotropic or zeotropic composition or azeotropic or zeotropic commercial thermal management fluid blend.

**[0502]** The compositions disclosed herein are useful as heat transfer compositions, aerosol propellants, foaming agents, blowing agents, solvents, cleaning agents, carrier fluids, displacement drying agents, buffing abrasion agents, polymerization media, expansion agents for polyolefins and polyurethane, gaseous dielectrics, fire extinguishing agents, and fire suppression agents. Additionally, in liquid or gaseous form, the disclosed compositions may act as working fluids used to

carry heat from a heat source to a heat sink. Such heat transfer compositions may also be useful as refrigerants in a cycle wherein the fluid undergoes phase changes; that is, from a liquid to a gas and back or vice versa.

**[0503]** In one embodiment, there is provided a heat transfer system containing a composition as disclosed herein. In another embodiment is disclosed a refrigeration, air-conditioning, or heat pump apparatus containing a composition as disclosed herein. In another embodiment, is disclosed a stationary refrigeration, air-conditioning, or heat pump apparatus containing a composition as disclosed herein. In yet another embodiment is disclosed a mobile refrigeration or air conditioning apparatus containing a composition as disclosed herein.

**[0504]** In another embodiment, disclosed is a method of using the composition of the present invention as a heat transfer fluid composition. The method comprises transporting said composition from a heat source to a heat sink.

**[0505]** Examples of heat transfer systems which may contain any of the compositions of any of the foregoing Embodiments include but are not limited to air conditioners, freezers, refrigerators, heat pumps, water chillers, flooded evaporator chillers, direct expansion chillers, walk-in coolers, heat pumps, mobile refrigerators, mobile air conditioning units and combinations thereof.

**[0506]** These compositions of the present invention are useful in connection with numerous methods and systems, including as heat transfer fluids in methods and systems for transferring heat, such as refrigerants used in refrigeration, air conditioning, including vehicle air conditioning systems, and heat pump systems including high temperature heat pump systems (with condenser temperatures greater than 55°C, 70°C, or 100°C).

**[0507]** In many applications, some embodiments of the disclosed compositions are useful as refrigerants and provide at least comparable cooling performance (meaning cooling capacity and energy efficiency) as the refrigerant for which a replacement is being sought.

**[0508]** In some embodiments, the compositions disclosed herein are useful for any positive displacement compressor system designed for any number of heat transfer compositions. Additionally, many of the compositions disclosed are useful in new

equipment utilizing positive displacement compressors to provide similar performance to the aforementioned refrigerants.

**[0509]** In one embodiment, disclosed herein is a process to produce cooling comprising condensing a composition as disclosed herein and thereafter evaporating said composition in the vicinity of a body to be cooled.

**[0510]** In another embodiment, disclosed herein is a process to produce heat comprising condensing a composition as disclosed herein in the vicinity of a body to be heated and thereafter evaporating said composition.

**[0511]** In some embodiments, the use of the above disclosed compositions includes using the composition as a heat transfer composition in a process for producing cooling, wherein the composition is first cooled and stored under pressure and when exposed to a warmer environment, the composition absorbs some of the ambient heat, expands, and the warmer environment is thusly cooled.

**[0512]** In some embodiments, the compositions as disclosed herein may be useful in particular in air conditioning applications including but not limited to chillers, high temperature heat pumps, residential, commercial or industrial air conditioning systems (including residential heat pumps), and including window, ductless, ducted, packaged terminal, chillers, and those exterior but connected to the building such as rooftop systems.

**[0513]** In some embodiments, the compositions as disclosed herein may be useful in particular in refrigeration applications including high, medium or low temperature refrigeration. High temperature refrigeration systems include those for supermarket produce sections among others. Medium temperature refrigeration systems include supermarket and convenience store refrigerated cases for beverages, dairy and other items requiring refrigeration. Low temperature refrigeration systems include supermarket and convenience store freezer cabinets and displays, ice machines and frozen food transport. Other specific uses such as in commercial, industrial or residential refrigerators and freezers, ice machines, self-contained coolers and freezers, supermarket rack and distributed systems, flooded evaporator chillers, direct expansion chillers, walk-in and reach-in coolers and freezers, and combination systems.

[0514] Additionally, in some embodiments, the disclosed compositions may function as primary refrigerants in secondary loop systems that provide cooling to remote locations by use of a secondary heat transfer fluid.

[0515] The modeled cycles presented in the Examples were performed using physical properties from NIST Refprop and thermodynamic calculations.

**EXAMPLES**

[0516] It has been found that the presence of residual refrigerants, as defined and described herein, in any of the compositions of any of the foregoing Embodiments, not only avoids the need for complex and costly separation processes and equipment, such as large separation columns, extractive distillation and the like, and thus minimizes environmental footprint, for example for a reclamation process, but also does not negatively impact performance of the compositions and, in some cases, actually enhances performance, for example in terms of capacity and/or coefficient of performance, as demonstrated in the Examples.

**EXAMPLE 1**

**Performance**

[0517] Tables 2-5 show the performance of some exemplary R-410A compositions containing residual refrigerant(s) (HCFC-22 or HFC-134a) as compared with the same compositions without the residual refrigerant(s) in a stationary chiller system and in an Organic Rankine Cycle, as shown in Figs. 1-3. The data are based on the following conditions.

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|                                  |        |
|----------------------------------|--------|
| <b>Chiller</b>                   |        |
| Condenser Mid-Point Temperature  | 40.6°C |
| Condenser Subcooling             | 0 K    |
| Evaporator Mid-Point Temperature | 5.0°C  |
| Useful Superheat                 | 11.1 K |
| Compressor Isentropic Efficiency | 0.7    |

**Organic Rankine Cycle (ORC)**

|                        |        |
|------------------------|--------|
| Condenser Temperature  | 4.4°C  |
| Evaporator Temperature | 37.8°C |
| Expander Efficiency    | 0.85   |
| Pump Efficiency        | 0.85   |
| Subcooling             | 3.1 K  |
| Superheat              | 6.2 K  |

**Table 2**  
**Performance of R410A Compositions in Chiller System**

| Blend Composition<br>(wt. fraction) |               |               |              | NBP<br>(°F) | Average<br>Glide<br>(K) |
|-------------------------------------|---------------|---------------|--------------|-------------|-------------------------|
| <i>R-22</i>                         | <i>R-410A</i> | <i>R-143a</i> | <i>R-115</i> |             |                         |
| 0                                   | 0.995         | 0             | 0.005        | -60.459     | 0.031                   |
| 0                                   | 0.995         | 0.001         | 0.004        | -60.461     | 0.026                   |
| 0                                   | 0.995         | 0.002         | 0.003        | -60.462     | 0.021                   |
| 0                                   | 0.995         | 0.003         | 0.002        | -60.464     | 0.017                   |
| 0                                   | 0.995         | 0.004         | 0.001        | -60.465     | 0.012                   |
| 0                                   | 0.995         | 0.005         | 0            | -60.466     | 0.008                   |
| 0.001                               | 0.995         | 0             | 0.004        | -60.455     | 0.028                   |
| 0.001                               | 0.995         | 0.001         | 0.003        | -60.457     | 0.024                   |
| 0.001                               | 0.995         | 0.002         | 0.002        | -60.458     | 0.019                   |
| 0.001                               | 0.995         | 0.003         | 0.001        | -60.46      | 0.015                   |
| 0.001                               | 0.995         | 0.004         | 0            | -60.461     | 0.01                    |
| 0.002                               | 0.995         | 0             | 0.003        | -60.451     | 0.026                   |
| 0.002                               | 0.995         | 0.001         | 0.002        | -60.453     | 0.021                   |
| 0.002                               | 0.995         | 0.002         | 0.001        | -60.454     | 0.017                   |
| 0.002                               | 0.995         | 0.003         | 0            | -60.456     | 0.012                   |
| 0.003                               | 0.995         | 0             | 0.002        | -60.447     | 0.024                   |
| 0.003                               | 0.995         | 0.001         | 0.001        | -60.449     | 0.019                   |
| 0.003                               | 0.995         | 0.002         | 0            | -60.45      | 0.015                   |
| 0.004                               | 0.995         | 0             | 0.001        | -60.443     | 0.021                   |
| 0.004                               | 0.995         | 0.001         | 0            | -60.445     | 0.017                   |
| 0.005                               | 0.995         | 0             | 0            | -60.439     | 0.019                   |
| 0                                   | 0.996         | 0             | 0.004        | -60.466     | 0.024                   |
| 0                                   | 0.996         | 0.001         | 0.003        | -60.467     | 0.02                    |
| 0                                   | 0.996         | 0.002         | 0.002        | -60.469     | 0.015                   |
| 0                                   | 0.996         | 0.003         | 0.001        | -60.47      | 0.011                   |
| 0                                   | 0.996         | 0.004         | 0            | -60.471     | 0.006                   |
| 0.001                               | 0.996         | 0             | 0.003        | -60.462     | 0.022                   |
| 0.001                               | 0.996         | 0.001         | 0.002        | -60.463     | 0.018                   |
| 0.001                               | 0.996         | 0.002         | 0.001        | -60.465     | 0.013                   |
| 0.001                               | 0.996         | 0.003         | 0            | -60.466     | 0.008                   |
| 0.002                               | 0.996         | 0             | 0.002        | -60.458     | 0.02                    |
| 0.002                               | 0.996         | 0.001         | 0.001        | -60.459     | 0.015                   |
| 0.002                               | 0.996         | 0.002         | 0            | -60.461     | 0.011                   |
| 0.003                               | 0.996         | 0             | 0.001        | -60.454     | 0.018                   |
| 0.003                               | 0.996         | 0.001         | 0            | -60.455     | 0.013                   |
| 0.004                               | 0.996         | 0             | 0            | -60.45      | 0.015                   |
| 0                                   | 0.997         | 0             | 0.003        | -60.472     | 0.018                   |
| 0                                   | 0.997         | 0.001         | 0.002        | -60.474     | 0.014                   |

| Blend Composition<br>(wt. fraction) |               |               |              | NBP<br>(°F) | Average<br>Glide<br>(K) |
|-------------------------------------|---------------|---------------|--------------|-------------|-------------------------|
| <i>R-22</i>                         | <i>R-410A</i> | <i>R-143a</i> | <i>R-115</i> |             |                         |
| 0                                   | 0.997         | 0.002         | 0.001        | -60.475     | 0.009                   |
| 0                                   | 0.997         | 0.003         | 0            | -60.476     | 0.005                   |
| 0.001                               | 0.997         | 0             | 0.002        | -60.468     | 0.016                   |
| 0.001                               | 0.997         | 0.001         | 0.001        | -60.47      | 0.011                   |
| 0.001                               | 0.997         | 0.002         | 0            | -60.471     | 0.007                   |
| 0.002                               | 0.997         | 0             | 0.001        | -60.464     | 0.014                   |
| 0.002                               | 0.997         | 0.001         | 0            | -60.466     | 0.009                   |
| 0.003                               | 0.997         | 0             | 0            | -60.46      | 0.011                   |
| 0                                   | 0.998         | 0             | 0.002        | -60.478     | 0.012                   |
| 0                                   | 0.998         | 0.001         | 0.001        | -60.48      | 0.008                   |
| 0                                   | 0.998         | 0.002         | 0            | -60.481     | 0.003                   |
| 0.001                               | 0.998         | 0             | 0.001        | -60.474     | 0.01                    |
| 0.001                               | 0.998         | 0.001         | 0            | -60.476     | 0.005                   |
| 0.002                               | 0.998         | 0             | 0            | -60.47      | 0.008                   |
| 0                                   | 0.999         | 0             | 0.001        | -60.485     | 0.006                   |
| 0                                   | 0.999         | 0.001         | 0            | -60.486     | 0.002                   |
| 0.001                               | 0.999         | 0             | 0            | -60.481     | 0.004                   |
| 0                                   | 1             | 0             | 0            | -60.586     | 0.098                   |

Table 2 (continued)

## Performance of R410A Compositions in Chiller System

| Discharge<br>Temp. (°C) | Capacity<br>(kJ/m <sup>3</sup> ) | COP   | Cap %<br>Increase | COP %<br>Increase |
|-------------------------|----------------------------------|-------|-------------------|-------------------|
| 76.661                  | 5563.521                         | 4.158 | -0.30747          | -0.04808          |
| 76.664                  | 5564.108                         | 4.158 | -0.29695          | -0.04808          |
| 76.668                  | 5564.694                         | 4.158 | -0.28645          | -0.04808          |
| 76.671                  | 5565.277                         | 4.158 | -0.27601          | -0.04808          |
| 76.674                  | 5565.858                         | 4.158 | -0.26559          | -0.04808          |
| 76.677                  | 5566.437                         | 4.158 | -0.25522          | -0.04808          |
| 76.682                  | 5564.121                         | 4.159 | -0.29672          | -0.02404          |
| 76.685                  | 5564.706                         | 4.159 | -0.28624          | -0.02404          |
| 76.689                  | 5565.289                         | 4.158 | -0.27579          | -0.04808          |
| 76.692                  | 5565.869                         | 4.158 | -0.2654           | -0.04808          |
| 76.695                  | 5566.448                         | 4.158 | -0.25502          | -0.04808          |
| 76.703                  | 5564.718                         | 4.159 | -0.28602          | -0.02404          |
| 76.706                  | 5565.3                           | 4.159 | -0.27559          | -0.02404          |
| 76.71                   | 5565.88                          | 4.159 | -0.2652           | -0.02404          |
| 76.713                  | 5566.458                         | 4.159 | -0.25484          | -0.02404          |
| 76.724                  | 5565.311                         | 4.159 | -0.2754           | -0.02404          |
| 76.727                  | 5565.891                         | 4.159 | -0.265            | -0.02404          |
| 76.731                  | 5566.468                         | 4.159 | -0.25466          | -0.02404          |
| 76.745                  | 5565.901                         | 4.159 | -0.26482          | -0.02404          |
| 76.749                  | 5566.478                         | 4.159 | -0.25449          | -0.02404          |
| 76.766                  | 5566.488                         | 4.16  | -0.25431          | 0                 |
| 76.678                  | 5565.747                         | 4.158 | -0.26758          | -0.04808          |
| 76.682                  | 5566.332                         | 4.158 | -0.2571           | -0.04808          |
| 76.685                  | 5566.916                         | 4.158 | -0.24664          | -0.04808          |
| 76.688                  | 5567.497                         | 4.158 | -0.23623          | -0.04808          |
| 76.691                  | 5568.077                         | 4.158 | -0.22583          | -0.04808          |

| Discharge Temp. (°C) | Capacity (kJ/m3) | COP   | Cap % Increase | COP % Increase |
|----------------------|------------------|-------|----------------|----------------|
| 76.699               | 5566.345         | 4.159 | -0.25687       | -0.02404       |
| 76.703               | 5566.928         | 4.158 | -0.24642       | -0.04808       |
| 76.706               | 5567.509         | 4.158 | -0.23601       | -0.04808       |
| 76.709               | 5568.088         | 4.158 | -0.22564       | -0.04808       |
| 76.72                | 5566.939         | 4.159 | -0.24622       | -0.02404       |
| 76.724               | 5567.52          | 4.159 | -0.23581       | -0.02404       |
| 76.727               | 5568.098         | 4.159 | -0.22546       | -0.02404       |
| 76.741               | 5567.53          | 4.159 | -0.23563       | -0.02404       |
| 76.745               | 5568.108         | 4.159 | -0.22528       | -0.02404       |
| 76.763               | 5568.118         | 4.159 | -0.2251        | -0.02404       |
| 76.696               | 5567.971         | 4.158 | -0.22773       | -0.04808       |
| 76.699               | 5568.555         | 4.158 | -0.21727       | -0.04808       |
| 76.702               | 5569.137         | 4.158 | -0.20684       | -0.04808       |
| 76.705               | 5569.717         | 4.158 | -0.19645       | -0.04808       |
| 76.717               | 5568.567         | 4.158 | -0.21705       | -0.04808       |
| 76.72                | 5569.148         | 4.158 | -0.20664       | -0.04808       |
| 76.723               | 5569.727         | 4.158 | -0.19627       | -0.04808       |
| 76.738               | 5569.159         | 4.159 | -0.20644       | -0.02404       |
| 76.741               | 5569.738         | 4.158 | -0.19607       | -0.04808       |
| 76.759               | 5569.748         | 4.159 | -0.19589       | -0.02404       |
| 76.713               | 5570.194         | 4.158 | -0.1879        | -0.04808       |
| 76.716               | 5570.777         | 4.158 | -0.17745       | -0.04808       |
| 76.719               | 5571.357         | 4.158 | -0.16706       | -0.04808       |
| 76.734               | 5570.788         | 4.158 | -0.17725       | -0.04808       |
| 76.737               | 5571.368         | 4.158 | -0.16686       | -0.04808       |
| 76.755               | 5571.378         | 4.158 | -0.16668       | -0.04808       |
| 76.73                | 5572.416         | 4.158 | -0.14808       | -0.04808       |
| 76.733               | 5572.997         | 4.158 | -0.13767       | -0.04808       |
| 76.751               | 5573.008         | 4.158 | -0.13747       | -0.04808       |
| 76.808               | 5580.68          | 4.16  | 0              | 0              |

**Table 3**  
**Performance of R410A Compositions in Chiller System**

| Blend Composition |               |               |              | NBP (°F) | Average Glide (K) |
|-------------------|---------------|---------------|--------------|----------|-------------------|
| <i>R-134a</i>     | <i>R-410A</i> | <i>R-143a</i> | <i>R-115</i> |          |                   |
| 0                 | 0.995         | 0             | 0.005        | -60.459  | 0.031             |
| 0                 | 0.995         | 0.001         | 0.004        | -60.461  | 0.026             |
| 0                 | 0.995         | 0.002         | 0.003        | -60.462  | 0.021             |
| 0                 | 0.995         | 0.003         | 0.002        | -60.464  | 0.017             |
| 0                 | 0.995         | 0.004         | 0.001        | -60.465  | 0.012             |
| 0                 | 0.995         | 0.005         | 0            | -60.466  | 0.008             |
| 0.001             | 0.995         | 0             | 0.004        | -60.449  | 0.036             |
| 0.001             | 0.995         | 0.001         | 0.003        | -60.45   | 0.031             |
| 0.001             | 0.995         | 0.002         | 0.002        | -60.451  | 0.026             |
| 0.001             | 0.995         | 0.003         | 0.001        | -60.453  | 0.022             |
| 0.001             | 0.995         | 0.004         | 0            | -60.454  | 0.017             |
| 0.002             | 0.995         | 0             | 0.003        | -60.438  | 0.041             |
| 0.002             | 0.995         | 0.001         | 0.002        | -60.439  | 0.036             |
| 0.002             | 0.995         | 0.002         | 0.001        | -60.441  | 0.032             |

| Blend Composition |               |               |              | NBP<br>(°F) | Average<br>Glide<br>(K) |
|-------------------|---------------|---------------|--------------|-------------|-------------------------|
| <i>R-134a</i>     | <i>R-410A</i> | <i>R-143a</i> | <i>R-115</i> |             |                         |
| 0.002             | 0.995         | 0.003         | 0            | -60.442     | 0.027                   |
| 0.003             | 0.995         | 0             | 0.002        | -60.427     | 0.046                   |
| 0.003             | 0.995         | 0.001         | 0.001        | -60.429     | 0.041                   |
| 0.003             | 0.995         | 0.002         | 0            | -60.43      | 0.037                   |
| 0.004             | 0.995         | 0             | 0.001        | -60.416     | 0.051                   |
| 0.004             | 0.995         | 0.001         | 0            | -60.418     | 0.046                   |
| 0.005             | 0.995         | 0             | 0            | -60.406     | 0.056                   |
| 0                 | 0.996         | 0             | 0.004        | -60.466     | 0.024                   |
| 0                 | 0.996         | 0.001         | 0.003        | -60.467     | 0.02                    |
| 0                 | 0.996         | 0.002         | 0.002        | -60.469     | 0.015                   |
| 0                 | 0.996         | 0.003         | 0.001        | -60.47      | 0.011                   |
| 0                 | 0.996         | 0.004         | 0            | -60.471     | 0.006                   |
| 0.001             | 0.996         | 0             | 0.003        | -60.455     | 0.029                   |
| 0.001             | 0.996         | 0.001         | 0.002        | -60.456     | 0.025                   |
| 0.001             | 0.996         | 0.002         | 0.001        | -60.458     | 0.02                    |
| 0.001             | 0.996         | 0.003         | 0            | -60.459     | 0.016                   |
| 0.002             | 0.996         | 0             | 0.002        | -60.444     | 0.035                   |
| 0.002             | 0.996         | 0.001         | 0.001        | -60.446     | 0.03                    |
| 0.002             | 0.996         | 0.002         | 0            | -60.447     | 0.026                   |
| 0.003             | 0.996         | 0             | 0.001        | -60.434     | 0.04                    |
| 0.003             | 0.996         | 0.001         | 0            | -60.435     | 0.035                   |
| 0.004             | 0.996         | 0             | 0            | -60.423     | 0.045                   |
| 0                 | 0.997         | 0             | 0.003        | -60.472     | 0.018                   |
| 0                 | 0.997         | 0.001         | 0.002        | -60.474     | 0.014                   |
| 0                 | 0.997         | 0.002         | 0.001        | -60.475     | 0.009                   |
| 0                 | 0.997         | 0.003         | 0            | -60.476     | 0.005                   |
| 0.001             | 0.997         | 0             | 0.002        | -60.461     | 0.023                   |
| 0.001             | 0.997         | 0.001         | 0.001        | -60.463     | 0.019                   |
| 0.001             | 0.997         | 0.002         | 0            | -60.464     | 0.014                   |
| 0.002             | 0.997         | 0             | 0.001        | -60.451     | 0.028                   |
| 0.002             | 0.997         | 0.001         | 0            | -60.452     | 0.024                   |
| 0.003             | 0.997         | 0             | 0            | -60.44      | 0.034                   |
| 0                 | 0.998         | 0             | 0.002        | -60.478     | 0.012                   |
| 0                 | 0.998         | 0.001         | 0.001        | -60.48      | 0.008                   |
| 0                 | 0.998         | 0.002         | 0            | -60.481     | 0.003                   |
| 0.001             | 0.998         | 0             | 0.001        | -60.468     | 0.017                   |
| 0.001             | 0.998         | 0.001         | 0            | -60.469     | 0.013                   |
| 0.002             | 0.998         | 0             | 0            | -60.457     | 0.022                   |
| 0                 | 0.999         | 0             | 0.001        | -60.485     | 0.006                   |
| 0                 | 0.999         | 0.001         | 0            | -60.486     | 0.002                   |
| 0.001             | 0.999         | 0             | 0            | -60.474     | 0.011                   |
| 0                 | 1             | 0             | 0            | -60.586     | 0.098                   |

**Table 3 (Continued)**  
**Performance of R410A Compositions in Chiller System**

| Discharge<br>Temp.<br>(°C) | Capacity<br>(kJ/m3) | COP   | Cap %<br>Increase | COP %<br>Increase |
|----------------------------|---------------------|-------|-------------------|-------------------|
| 76.661                     | 5563.521            | 4.158 | -0.30747          | -0.04808          |
| 76.664                     | 5564.108            | 4.158 | -0.29695          | -0.04808          |



| Discharge Temp. (°C) | Capacity (kJ/m3) | COP   | Cap % Increase | COP % Increase |
|----------------------|------------------|-------|----------------|----------------|
| 76.668               | 5564.694         | 4.158 | -0.28645       | -0.04808       |
| 76.671               | 5565.277         | 4.158 | -0.27601       | -0.04808       |
| 76.674               | 5565.858         | 4.158 | -0.26559       | -0.04808       |
| 76.677               | 5566.437         | 4.158 | -0.25522       | -0.04808       |
| 76.677               | 5562.804         | 4.159 | -0.32032       | -0.02404       |
| 76.68                | 5563.388         | 4.158 | -0.30985       | -0.04808       |
| 76.683               | 5563.971         | 4.158 | -0.29941       | -0.04808       |
| 76.687               | 5564.551         | 4.158 | -0.28901       | -0.04808       |
| 76.69                | 5565.129         | 4.158 | -0.27866       | -0.04808       |
| 76.692               | 5562.083         | 4.159 | -0.33324       | -0.02404       |
| 76.696               | 5562.664         | 4.159 | -0.32283       | -0.02404       |
| 76.699               | 5563.243         | 4.158 | -0.31245       | -0.04808       |
| 76.702               | 5563.821         | 4.158 | -0.3021        | -0.04808       |
| 76.708               | 5561.357         | 4.159 | -0.34625       | -0.02404       |
| 76.711               | 5561.936         | 4.159 | -0.33587       | -0.02404       |
| 76.715               | 5562.512         | 4.159 | -0.32555       | -0.02404       |
| 76.724               | 5560.628         | 4.159 | -0.35931       | -0.02404       |
| 76.727               | 5561.204         | 4.159 | -0.34899       | -0.02404       |
| 76.739               | 5559.895         | 4.159 | -0.37245       | -0.02404       |
| 76.678               | 5565.747         | 4.158 | -0.26758       | -0.04808       |
| 76.682               | 5566.332         | 4.158 | -0.2571        | -0.04808       |
| 76.685               | 5566.916         | 4.158 | -0.24664       | -0.04808       |
| 76.688               | 5567.497         | 4.158 | -0.23623       | -0.04808       |
| 76.691               | 5568.077         | 4.158 | -0.22583       | -0.04808       |
| 76.694               | 5565.027         | 4.158 | -0.28049       | -0.04808       |
| 76.697               | 5565.61          | 4.158 | -0.27004       | -0.04808       |
| 76.7                 | 5566.19          | 4.158 | -0.25965       | -0.04808       |
| 76.704               | 5566.769         | 4.158 | -0.24927       | -0.04808       |
| 76.709               | 5564.303         | 4.159 | -0.29346       | -0.02404       |
| 76.713               | 5564.883         | 4.158 | -0.28307       | -0.04808       |
| 76.716               | 5565.461         | 4.158 | -0.27271       | -0.04808       |
| 76.725               | 5563.576         | 4.159 | -0.30649       | -0.02404       |
| 76.729               | 5564.152         | 4.159 | -0.29616       | -0.02404       |
| 76.741               | 5562.844         | 4.159 | -0.3196        | -0.02404       |
| 76.696               | 5567.971         | 4.158 | -0.22773       | -0.04808       |
| 76.699               | 5568.555         | 4.158 | -0.21727       | -0.04808       |
| 76.702               | 5569.137         | 4.158 | -0.20684       | -0.04808       |
| 76.705               | 5569.717         | 4.158 | -0.19645       | -0.04808       |
| 76.711               | 5567.249         | 4.158 | -0.24067       | -0.04808       |
| 76.714               | 5567.83          | 4.158 | -0.23026       | -0.04808       |
| 76.718               | 5568.409         | 4.158 | -0.21988       | -0.04808       |
| 76.727               | 5566.523         | 4.158 | -0.25368       | -0.04808       |
| 76.73                | 5567.101         | 4.158 | -0.24332       | -0.04808       |
| 76.742               | 5565.793         | 4.159 | -0.26676       | -0.02404       |
| 76.713               | 5570.194         | 4.158 | -0.1879        | -0.04808       |
| 76.716               | 5570.777         | 4.158 | -0.17745       | -0.04808       |
| 76.719               | 5571.357         | 4.158 | -0.16706       | -0.04808       |
| 76.728               | 5569.47          | 4.158 | -0.20087       | -0.04808       |
| 76.732               | 5570.049         | 4.158 | -0.1905        | -0.04808       |
| 76.744               | 5568.741         | 4.158 | -0.21393       | -0.04808       |
| 76.73                | 5572.416         | 4.158 | -0.14808       | -0.04808       |
| 76.733               | 5572.997         | 4.158 | -0.13767       | -0.04808       |
| 76.746               | 5571.69          | 4.158 | -0.16109       | -0.04808       |
| 76.808               | 5580.68          | 4.16  | 0              | 0              |

**Table 4**  
**Performance of R410A Compositions in ORC**

| Blend Composition |             |              |               |              | NBP (°F) | Evaporator Heat Duty (kJ/kg) | Expander Work (kJ/kg) |
|-------------------|-------------|--------------|---------------|--------------|----------|------------------------------|-----------------------|
| <i>R-22</i>       | <i>R-32</i> | <i>R-125</i> | <i>R-143a</i> | <i>R-115</i> |          |                              |                       |
| 0                 | 0.5         | 0.5          | 0             | 0            | -60.586  | 232.30828                    | 19.58263              |
| 0.001             | 0.4975      | 0.4975       | 0             | 0.004        | -60.455  | 231.67140                    | 19.52644              |
| 0.001             | 0.4975      | 0.4975       | 0.004         | 0            | -60.461  | 232.14688                    | 19.56785              |
| 0.002             | 0.4975      | 0.4975       | 0.001         | 0.002        | -60.453  | 231.93144                    | 19.54932              |
| 0.002             | 0.4975      | 0.4975       | 0.002         | 0.001        | -60.454  | 232.05030                    | 19.55967              |
| 0.003             | 0.4975      | 0.4975       | 0.001         | 0.001        | -60.449  | 232.07255                    | 19.56185              |
| 0.003             | 0.4985      | 0.4985       | 0             | 0            | -60.46   | 232.26480                    | 19.57897              |
| 0.005             | 0.4975      | 0.4975       | 0             | 0            | -60.439  | 232.23586                    | 19.57656              |

**Table 4**  
**Performance of R410A Compositions in ORC**

| Pump Work (kJ/kg) | Volumetric Capacity at outlet (kJ/m <sup>3</sup> ) | Efficiency | Cap % Increase | Efficiency % Increase |
|-------------------|----------------------------------------------------|------------|----------------|-----------------------|
| 1.38599           | 662.64862                                          | 7.83297    | 0.00000        | 0.00000               |
| 1.38555           | 662.66374                                          | 7.83044    | 0.00228        | -0.03228              |
| 1.38525           | 661.93768                                          | 7.83237    | -0.10729       | -0.00772              |
| 1.38486           | 662.24038                                          | 7.83182    | -0.06161       | -0.01464              |
| 1.38478           | 662.05868                                          | 7.83231    | -0.08903       | -0.00850              |
| 1.38424           | 661.99811                                          | 7.83273    | -0.09817       | -0.00313              |
| 1.38425           | 662.07650                                          | 7.83361    | -0.08634       | 0.00820               |
| 1.38309           | 661.69533                                          | 7.83405    | -0.14386       | 0.01375               |

**Table 5**  
**Performance of R410A Compositions in ORC**

| Blend Composition |             |              |               |              | NBP (°F) | Evaporator Heat Duty (kJ/kg) |
|-------------------|-------------|--------------|---------------|--------------|----------|------------------------------|
| <i>R-134a</i>     | <i>R-32</i> | <i>R-125</i> | <i>R-143a</i> | <i>R-115</i> |          |                              |
| 0                 | 0.5         | 0.5          | 0             | 0            | -60.587  | 232.30828                    |
| 0.001             | 0.4975      | 0.4975       | 0             | 0.004        | -60.715  | 231.70618                    |
| 0.001             | 0.4975      | 0.4975       | 0.004         | 0            | -60.569  | 232.18158                    |
| 0.002             | 0.4975      | 0.4975       | 0.001         | 0.002        | -60.623  | 232.00088                    |
| 0.002             | 0.4975      | 0.4975       | 0.002         | 0.001        | -60.587  | 232.11970                    |
| 0.003             | 0.4975      | 0.4975       | 0.001         | 0.001        | -60.568  | 232.17659                    |
| 0.003             | 0.4985      | 0.4985       | 0             | 0            | -60.531  | 232.36886                    |
| 0.005             | 0.4975      | 0.4975       | 0             | 0            | -60.493  | 232.40897                    |

**Table 5 (continued)**  
**Performance of R410A Compositions in ORC**

| Expander Work<br>(kJ/kg) | Pump Work<br>(kJ/kg) | Volumetric Capacity<br>at outlet<br>(kJ/m <sup>3</sup> ) | Efficiency | Cap %<br>Increase | Efficiency %<br>Increase |
|--------------------------|----------------------|----------------------------------------------------------|------------|-------------------|--------------------------|
| 19.58263                 | 1.38599              | 662.64864                                                | 7.83297    | 0.00000           | 0.00000                  |
| 19.52908                 | 1.38513              | 662.46282                                                | 7.83059    | -0.02804          | -0.03045                 |
| 19.57080                 | 1.38483              | 661.74878                                                | 7.83265    | -0.13579          | -0.00413                 |
| 19.55502                 | 1.38402              | 661.85451                                                | 7.83230    | -0.11984          | -0.00859                 |
| 19.56539                 | 1.38394              | 661.67383                                                | 7.83279    | -0.14710          | -0.00232                 |
| 19.57036                 | 1.38298              | 661.41971                                                | 7.83342    | -0.18545          | 0.00578                  |
| 19.58752                 | 1.38299              | 661.49886                                                | 7.83432    | -0.17351          | 0.01725                  |
| 19.59067                 | 1.38099              | 660.72968                                                | 7.83519    | -0.28959          | 0.02826                  |

**[0518]** Performance of the R-410A compositions containing residual amounts of HCFC-22 or HFC-134a is similar to the R-410A composition which does not contain these residual refrigerants. More particularly, differences in energy efficiency (shown as COP) and capacity among the compositions are *de minimis*. Thus, the data indicate that the presence of HCFC-22 or HFC-134a as residual refrigerants in R-410A compositions does not negatively impact performance of the compositions.

#### **Impact on Distillation**

**[0519]** Table 6 shows distillation requirements for obtaining an HFC-32/HFC-125 (e.g., R410A) composition containing up to 0.5 wt.% residual HCFC-22 as compared with obtaining an HFC-32/HFC-125 (e.g., R410A) composition containing little to no (e.g., 10 ppm) residual HCFC-22. The mass reflux ratio for distilling the latter is more than double that required for a composition that contains up to 0.5 wt.% of the residual refrigerant. Thus, the data show that removing essentially all of the residual refrigerant from the composition would require a significantly larger distillation column and higher energy input, and thus exhibit a much larger environmental footprint, as compared with allowing up to 0.5 wt.% of the residual refrigerant to remain in the composition.

Table 6

|                   | 10% HCFC-22 to 0.5% HCFC-22 |          |         | 10% HCFC-22 to 10 ppm HCFC-22 |          |         |
|-------------------|-----------------------------|----------|---------|-------------------------------|----------|---------|
| Column Stages     | 80                          |          |         | 80                            |          |         |
| Feed Stage        | 40                          |          |         | 40                            |          |         |
| Mass Reflux Ratio | 3.1                         |          |         | 7.4                           |          |         |
| Stream            | Feed                        | Overhead | Bottom  | Feed                          | Overhead | Bottom  |
| Temp (deg C)      | 25                          | 4.5      | 8.4     | 25                            | 4.2      | 11.8    |
| Pressure (psia)   | 139.7                       | 134.7    | 134.7   | 139.7                         | 134.7    | 134.7   |
| 32 wt fraction    | 0.45                        | 0.59415  | 0.23378 | 0.45                          | 0.7452   | 0.00721 |
| 125 wt fraction   | 0.45                        | 0.40085  | 0.52372 | 0.45                          | 0.25479  | 0.74281 |
| 22 wt fraction    | 0.1                         | 0.005    | 0.2425  | 0.1                           | 0.00001  | 0.24999 |

**EXAMPLE 2****Performance**

[0520] Tables 7-10 show the performance of some exemplary R-448A compositions containing residual refrigerant(s) (HCFC-22 or HFC-143a) as compared with the same compositions without the residual refrigerant(s) in a stationary chiller system and in an Organic Rankine Cycle. The data are based on the same conditions as set forth above in Example 1.

Table 7

**Performance of R448A Compositions in Chiller System**

| Blend Composition |         |         |         |          |          |       |
|-------------------|---------|---------|---------|----------|----------|-------|
| R-22              | R-32    | R-125   | R-134a  | R-1234ze | R-1234yf | R-134 |
| 0                 | 0.2587  | 0.2587  | 0.20895 | 0.06965  | 0.199    | 0.005 |
| 0                 | 0.25896 | 0.25896 | 0.20916 | 0.06972  | 0.1992   | 0.004 |
| 0                 | 0.25922 | 0.25922 | 0.20937 | 0.06979  | 0.1994   | 0.003 |
| 0                 | 0.25948 | 0.25948 | 0.20958 | 0.06986  | 0.1996   | 0.002 |
| 0                 | 0.25974 | 0.25974 | 0.20979 | 0.06993  | 0.1998   | 0.001 |
| 0                 | 0.26    | 0.26    | 0.21    | 0.07     | 0.2      | 0     |
| 0.001             | 0.2587  | 0.2587  | 0.20895 | 0.06965  | 0.199    | 0.004 |
| 0.001             | 0.25896 | 0.25896 | 0.20916 | 0.06972  | 0.1992   | 0.003 |
| 0.001             | 0.25922 | 0.25922 | 0.20937 | 0.06979  | 0.1994   | 0.002 |
| 0.001             | 0.25948 | 0.25948 | 0.20958 | 0.06986  | 0.1996   | 0.001 |
| 0.001             | 0.25974 | 0.25974 | 0.20979 | 0.06993  | 0.1998   | 0     |
| 0.002             | 0.2587  | 0.2587  | 0.20895 | 0.06965  | 0.199    | 0.003 |
| 0.002             | 0.25896 | 0.25896 | 0.20916 | 0.06972  | 0.1992   | 0.002 |
| 0.002             | 0.25922 | 0.25922 | 0.20937 | 0.06979  | 0.1994   | 0.001 |
| 0.002             | 0.25948 | 0.25948 | 0.20958 | 0.06986  | 0.1996   | 0     |
| 0.003             | 0.2587  | 0.2587  | 0.20895 | 0.06965  | 0.199    | 0.002 |
| 0.003             | 0.25896 | 0.25896 | 0.20916 | 0.06972  | 0.1992   | 0.001 |
| 0.003             | 0.25922 | 0.25922 | 0.20937 | 0.06979  | 0.1994   | 0     |
| 0.004             | 0.2587  | 0.2587  | 0.20895 | 0.06965  | 0.199    | 0.001 |

| Blend Composition |             |              |               |                 |                 |              |
|-------------------|-------------|--------------|---------------|-----------------|-----------------|--------------|
| <i>R-22</i>       | <i>R-32</i> | <i>R-125</i> | <i>R-134a</i> | <i>R-1234ze</i> | <i>R-1234yf</i> | <i>R-134</i> |
| 0.004             | 0.25896     | 0.25896      | 0.20916       | 0.06972         | 0.1992          | 0            |
| 0.005             | 0.2587      | 0.2587       | 0.20895       | 0.06965         | 0.199           | 0            |

**Table 7 (Continued)**  
**Performance of R448A Compositions in Chiller System**

| NBP (°F) | Average Glide (K) | Dis-charge Temp. (°C) | Capacity (kJ/m3) | COP   | Cap % Increase | COP % Increase |
|----------|-------------------|-----------------------|------------------|-------|----------------|----------------|
| -50.851  | 4.581             | 72.156                | 4143.8           | 4.293 | -0.299         | 0.093262       |
| -50.881  | 4.569             | 72.15                 | 4146.271         | 4.292 | -0.23954       | 0.069946       |
| -50.91   | 4.557             | 72.144                | 4148.748         | 4.291 | -0.17995       | 0.046631       |
| -50.94   | 4.545             | 72.138                | 4151.233         | 4.291 | -0.12016       | 0.046631       |
| -50.969  | 4.532             | 72.132                | 4153.726         | 4.29  | -0.06017       | 0.023315       |
| -50.998  | 4.519             | 72.126                | 4156.227         | 4.289 | 0              | 0              |
| -50.874  | 4.566             | 72.156                | 4146.013         | 4.292 | -0.24575       | 0.069946       |
| -50.904  | 4.554             | 72.15                 | 4148.49          | 4.292 | -0.18615       | 0.069946       |
| -50.933  | 4.542             | 72.144                | 4150.975         | 4.291 | -0.12636       | 0.046631       |
| -50.963  | 4.529             | 72.138                | 4153.468         | 4.29  | -0.06638       | 0.023315       |
| -50.992  | 4.516             | 72.131                | 4155.969         | 4.289 | -0.00621       | 0              |
| -50.897  | 4.551             | 72.156                | 4148.231         | 4.292 | -0.19239       | 0.069946       |
| -50.927  | 4.538             | 72.15                 | 4150.716         | 4.291 | -0.1326        | 0.046631       |
| -50.956  | 4.526             | 72.144                | 4153.208         | 4.29  | -0.07264       | 0.023315       |
| -50.985  | 4.513             | 72.137                | 4155.709         | 4.29  | -0.01246       | 0.023315       |
| -50.92   | 4.535             | 72.156                | 4150.456         | 4.291 | -0.13885       | 0.046631       |
| -50.95   | 4.523             | 72.15                 | 4152.948         | 4.291 | -0.07889       | 0.046631       |
| -50.979  | 4.51              | 72.143                | 4155.449         | 4.29  | -0.01872       | 0.023315       |
| -50.943  | 4.52              | 72.155                | 4152.687         | 4.291 | -0.08517       | 0.046631       |
| -50.973  | 4.507             | 72.149                | 4155.187         | 4.29  | -0.02502       | 0.023315       |
| -50.966  | 4.504             | 72.155                | 4154.929         | 4.29  | -0.03123       | 0.023315       |

**Table 8**  
**Performance of R448A Compositions in Chiller System**

| Blend Composition |             |              |               |                 |                 |              |
|-------------------|-------------|--------------|---------------|-----------------|-----------------|--------------|
| <i>R-143a</i>     | <i>R-32</i> | <i>R-125</i> | <i>R-134a</i> | <i>R-1234ze</i> | <i>R-1234yf</i> | <i>R-134</i> |
| 0                 | 0.2587      | 0.2587       | 0.20895       | 0.06965         | 0.199           | 0.005        |
| 0                 | 0.25896     | 0.25896      | 0.20916       | 0.06972         | 0.1992          | 0.004        |
| 0                 | 0.25922     | 0.25922      | 0.20937       | 0.06979         | 0.1994          | 0.003        |
| 0                 | 0.25948     | 0.25948      | 0.20958       | 0.06986         | 0.1996          | 0.002        |
| 0                 | 0.25974     | 0.25974      | 0.20979       | 0.06993         | 0.1998          | 0.001        |
| 0                 | 0.26        | 0.26         | 0.21          | 0.07            | 0.2             | 0            |
| 0.001             | 0.2587      | 0.2587       | 0.20895       | 0.06965         | 0.199           | 0.004        |
| 0.001             | 0.25896     | 0.25896      | 0.20916       | 0.06972         | 0.1992          | 0.003        |
| 0.001             | 0.25922     | 0.25922      | 0.20937       | 0.06979         | 0.1994          | 0.002        |
| 0.001             | 0.25948     | 0.25948      | 0.20958       | 0.06986         | 0.1996          | 0.001        |
| 0.001             | 0.25974     | 0.25974      | 0.20979       | 0.06993         | 0.1998          | 0            |
| 0.002             | 0.2587      | 0.2587       | 0.20895       | 0.06965         | 0.199           | 0.003        |
| 0.002             | 0.25896     | 0.25896      | 0.20916       | 0.06972         | 0.1992          | 0.002        |
| 0.002             | 0.25922     | 0.25922      | 0.20937       | 0.06979         | 0.1994          | 0.001        |

| Blend Composition |             |              |               |                 |                 |              |
|-------------------|-------------|--------------|---------------|-----------------|-----------------|--------------|
| <i>R-143a</i>     | <i>R-32</i> | <i>R-125</i> | <i>R-134a</i> | <i>R-1234ze</i> | <i>R-1234yf</i> | <i>R-134</i> |
| 0.002             | 0.25948     | 0.25948      | 0.20958       | 0.06986         | 0.1996          | 0            |
| 0.003             | 0.2587      | 0.2587       | 0.20895       | 0.06965         | 0.199           | 0.002        |
| 0.003             | 0.25896     | 0.25896      | 0.20916       | 0.06972         | 0.1992          | 0.001        |
| 0.003             | 0.25922     | 0.25922      | 0.20937       | 0.06979         | 0.1994          | 0            |
| 0.004             | 0.2587      | 0.2587       | 0.20895       | 0.06965         | 0.199           | 0.001        |
| 0.004             | 0.25896     | 0.25896      | 0.20916       | 0.06972         | 0.1992          | 0            |
| 0.005             | 0.2587      | 0.2587       | 0.20895       | 0.06965         | 0.199           | 0            |

**Table 8 (Continued)**  
**Performance of R448A Compositions in Chiller System**

| NBP (°F) | Average Glide (K) | Discharge Temp. (°C) | Capacity (kJ/m <sup>3</sup> ) | COP   | Cap % Increase | COP % Increase |
|----------|-------------------|----------------------|-------------------------------|-------|----------------|----------------|
| -50.851  | 4.581             | 72.156               | 4143.8                        | 4.293 | -0.299         | 0.09326        |
| -50.881  | 4.569             | 72.15                | 4146.27                       | 4.292 | -0.23954       | 0.06995        |
| -50.91   | 4.557             | 72.144               | 4148.75                       | 4.291 | -0.17995       | 0.04663        |
| -50.94   | 4.545             | 72.138               | 4151.23                       | 4.291 | -0.12016       | 0.04663        |
| -50.969  | 4.532             | 72.132               | 4153.73                       | 4.29  | -0.06017       | 0.02332        |
| -50.998  | 4.519             | 72.126               | 4156.23                       | 4.289 | 0              | 0              |
| -50.888  | 4.566             | 72.143               | 4146.28                       | 4.292 | -0.23935       | 0.06995        |
| -50.918  | 4.554             | 72.137               | 4148.76                       | 4.291 | -0.17975       | 0.04663        |
| -50.947  | 4.542             | 72.131               | 4151.24                       | 4.29  | -0.11999       | 0.02332        |
| -50.977  | 4.529             | 72.124               | 4153.73                       | 4.29  | -0.06001       | 0.02332        |
| -51.006  | 4.517             | 72.118               | 4156.23                       | 4.289 | 0.00014        | 0              |
| -50.925  | 4.552             | 72.129               | 4148.76                       | 4.291 | -0.17959       | 0.04663        |
| -50.955  | 4.539             | 72.123               | 4151.25                       | 4.29  | -0.11982       | 0.02332        |
| -50.984  | 4.527             | 72.117               | 4153.74                       | 4.29  | -0.05989       | 0.02332        |
| -51.013  | 4.514             | 72.11                | 4156.24                       | 4.289 | 0.00029        | 0              |
| -50.962  | 4.536             | 72.115               | 4151.25                       | 4.29  | -0.1197        | 0.02332        |
| -50.992  | 4.524             | 72.109               | 4153.74                       | 4.289 | -0.05974       | 0              |
| -51.021  | 4.511             | 72.103               | 4156.24                       | 4.289 | 0.00038        | 0              |
| -50.999  | 4.521             | 72.101               | 4153.75                       | 4.289 | -0.05965       | 0              |
| -51.028  | 4.508             | 72.095               | 4156.25                       | 4.289 | 0.00048        | 0              |
| -51.036  | 4.506             | 72.087               | 4156.25                       | 4.288 | 0.00055        | -0.0233        |

**Table 9**  
**Performance of R448A Compositions in ORC**

| Blend Composition |             |              |               |                  |                 |              | NBP (°F) |
|-------------------|-------------|--------------|---------------|------------------|-----------------|--------------|----------|
| <i>R-22</i>       | <i>R-32</i> | <i>R-125</i> | <i>R-134a</i> | <i>R-1234zeE</i> | <i>R-1234yf</i> | <i>R-134</i> |          |
| 0                 | 0.2587      | 0.2587       | 0.20895       | 0.06965          | 0.199           | 0.005        | -50.851  |
| 0                 | 0.25896     | 0.25896      | 0.20916       | 0.06972          | 0.1992          | 0.004        | -50.851  |
| 0                 | 0.25922     | 0.25922      | 0.20937       | 0.06979          | 0.1994          | 0.003        | -50.91   |
| 0                 | 0.25948     | 0.25948      | 0.20958       | 0.06986          | 0.1996          | 0.002        | -50.94   |
| 0                 | 0.25974     | 0.25974      | 0.20979       | 0.06993          | 0.1998          | 0.001        | -50.969  |
| 0                 | 0.26        | 0.26         | 0.21          | 0.07             | 0.2             | 0            | -50.998  |
| 0.001             | 0.2587      | 0.2587       | 0.20895       | 0.06965          | 0.199           | 0.004        | -50.874  |
| 0.001             | 0.25896     | 0.25896      | 0.20916       | 0.06972          | 0.1992          | 0.003        | -50.904  |

| Blend Composition |             |              |               |                  |                 |              | NBP (°F) |
|-------------------|-------------|--------------|---------------|------------------|-----------------|--------------|----------|
| <i>R-22</i>       | <i>R-32</i> | <i>R-125</i> | <i>R-134a</i> | <i>R-1234zeE</i> | <i>R-1234yf</i> | <i>R-134</i> |          |
| 0.001             | 0.25922     | 0.25922      | 0.20937       | 0.06979          | 0.1994          | 0.002        | -50.933  |
| 0.001             | 0.25948     | 0.25948      | 0.20958       | 0.06986          | 0.1996          | 0.001        | -50.963  |
| 0.001             | 0.25974     | 0.25974      | 0.20979       | 0.06993          | 0.1998          | 0            | -50.992  |
| 0.002             | 0.2587      | 0.2587       | 0.20895       | 0.06965          | 0.199           | 0.003        | -50.897  |
| 0.002             | 0.25896     | 0.25896      | 0.20916       | 0.06972          | 0.1992          | 0.002        | -50.927  |
| 0.002             | 0.25922     | 0.25922      | 0.20937       | 0.06979          | 0.1994          | 0.001        | -50.956  |
| 0.002             | 0.25948     | 0.25948      | 0.20958       | 0.06986          | 0.1996          | 0            | -50.985  |
| 0.003             | 0.2587      | 0.2587       | 0.20895       | 0.06965          | 0.199           | 0.002        | -50.92   |
| 0.003             | 0.25896     | 0.25896      | 0.20916       | 0.06972          | 0.1992          | 0.001        | -50.95   |
| 0.003             | 0.25922     | 0.25922      | 0.20937       | 0.06979          | 0.1994          | 0            | -50.979  |
| 0.004             | 0.2587      | 0.2587       | 0.20895       | 0.06965          | 0.199           | 0.001        | -50.943  |
| 0.004             | 0.25896     | 0.25896      | 0.20916       | 0.06972          | 0.1992          | 0            | -50.973  |
| 0.005             | 0.2587      | 0.2587       | 0.20895       | 0.06965          | 0.199           | 0            | -50.966  |

**Table 9 (Continued)**  
**Performance of R448A Compositions in ORC**

| Evaporator Heat Duty (kJ/kg) | Expander Work (kJ/kg) | Pump Work (kJ/kg) | Volumetric Capacity at outlet (kJ/m <sup>3</sup> ) | Efficiency | Cap % Increase | Efficiency % Increase |
|------------------------------|-----------------------|-------------------|----------------------------------------------------|------------|----------------|-----------------------|
| 224.8039                     | 18.5438               | 0.9951            | 492.6474                                           | 7.8062     | -0.3365188     | 0.0110105             |
| 224.7371                     | 18.5393               | 0.9961            | 492.9786                                           | 7.8061     | -0.2695076     | 0.0090211             |
| 224.6697                     | 18.5347               | 0.9972            | 493.3106                                           | 7.8059     | -0.2023564     | 0.0069131             |
| 224.6018                     | 18.5301               | 0.9982            | 493.6432                                           | 7.8058     | -0.1350638     | 0.0047108             |
| 224.5333                     | 18.5254               | 0.9993            | 493.9766                                           | 7.8056     | -0.0676192     | 0.0024028             |
| 224.4643                     | 18.5207               | 1.0004            | 494.3109                                           | 7.8054     | 0              | 0                     |
| 224.7297                     | 18.5391               | 0.9959            | 492.9296                                           | 7.8064     | -0.2794242     | 0.0123091             |
| 224.6624                     | 18.5345               | 0.9970            | 493.2615                                           | 7.8062     | -0.2122915     | 0.0102                |
| 224.5945                     | 18.5299               | 0.9980            | 493.5940                                           | 7.8060     | -0.1450164     | 0.0079958             |
| 224.5261                     | 18.5253               | 0.9991            | 493.9273                                           | 7.8058     | -0.0775907     | 0.0056848             |
| 224.4572                     | 18.5205               | 1.0002            | 494.2614                                           | 7.8056     | -0.0100085     | 0.0032619             |
| 224.6551                     | 18.5344               | 0.9968            | 493.2122                                           | 7.8064     | -0.2222575     | 0.0134884             |
| 224.5873                     | 18.5297               | 0.9978            | 493.5447                                           | 7.8063     | -0.1549981     | 0.01128               |
| 224.5190                     | 18.5251               | 0.9989            | 493.8779                                           | 7.8061     | -0.0875832     | 0.0089655             |
| 224.4501                     | 18.5203               | 1.0000            | 494.2119                                           | 7.8059     | -0.0200215     | 0.006541              |
| 224.5801                     | 18.5296               | 0.9976            | 493.4953                                           | 7.8065     | -0.164997      | 0.0145623             |
| 224.5119                     | 18.5249               | 0.9987            | 493.8284                                           | 7.8063     | -0.0976031     | 0.0122462             |
| 224.4430                     | 18.5202               | 0.9998            | 494.1623                                           | 7.8062     | -0.0300559     | 0.0098182             |
| 224.5048                     | 18.5247               | 0.9985            | 493.7788                                           | 7.8066     | -0.1076438     | 0.0155251             |
| 224.4360                     | 18.5200               | 0.9996            | 494.1126                                           | 7.8064     | -0.0401159     | 0.0130955             |
| 224.4290                     | 18.5198               | 0.9994            | 494.0627                                           | 7.8067     | -0.0501965     | 0.016371              |

**Table 10**  
**Performance of R448A Compositions in ORC**

| Blend Composition |             |              |               |                  |                 |              | NBP (°F) |
|-------------------|-------------|--------------|---------------|------------------|-----------------|--------------|----------|
| <i>R-143a</i>     | <i>R-32</i> | <i>R-125</i> | <i>R-134a</i> | <i>R-1234zeE</i> | <i>R-1234yf</i> | <i>R-134</i> |          |
| 0                 | 0.2587      | 0.2587       | 0.20895       | 0.06965          | 0.199           | 0.005        | -50.851  |
| 0                 | 0.26        | 0.26         | 0.21          | 0.07             | 0.2             | 0            | -50.998  |
| 0.002             | 0.25896     | 0.25896      | 0.20916       | 0.06972          | 0.1992          | 0.002        | -50.955  |
| 0.003             | 0.25922     | 0.25922      | 0.20937       | 0.06979          | 0.1994          | 0            | -51.021  |
| 0.005             | 0.2587      | 0.2587       | 0.20895       | 0.06965          | 0.199           | 0            | -51.036  |

**Table 10 (Continued)**  
**Performance of R448A Compositions in ORC**

| Evaporator Heat Duty (kJ/kg) | Expander Work (kJ/kg) | Pump Work (kJ/kg) | Volumetric Capacity at outlet (kJ/m <sup>3</sup> ) | Efficiency | Cap % Increase | Efficiency % Increase |
|------------------------------|-----------------------|-------------------|----------------------------------------------------|------------|----------------|-----------------------|
| 224.80394                    | 18.54383              | 0.99507           | 492.64743                                          | 7.80625    | -0.336513911   | 0.011014964           |
| 224.46435                    | 18.52070              | 1.00038           | 494.31085                                          | 7.80539    | 0              | 0                     |
| 224.56542                    | 18.52708              | 0.99868           | 493.67085                                          | 7.80548    | -0.129473249   | 0.001114073           |
| 224.40998                    | 18.51615              | 1.00103           | 494.35166                                          | 7.80497    | 0.008255101    | -0.005428852          |
| 224.37381                    | 18.51313              | 1.00146           | 494.37846                                          | 7.80469    | 0.013676223    | -0.009027554          |

**[0521]** Performance of the R-448A compositions containing residual amounts of HCFC-22 or HFC-143a is similar to the R-448A composition which does not contain these residual refrigerants. More particularly, differences in capacity among the compositions are *de minimis* and the energy efficiency (shown as COP) increases slightly for compositions containing the residual refrigerants. Thus, the data indicate that the presence of HCFC-22 or HFC-143a as residual refrigerants in R-448A compositions does not negatively impact performance of the compositions.

### **EXAMPLE 3**

#### **Performance**

**[0522]** Tables 11-12 show the performance of some exemplary R-515B compositions containing residual refrigerant(s) (CFC-11 or HFC-134a) as compared with the same compositions without the residual refrigerant(s) in a stationary chiller system. The data are based on the same conditions as set forth above in Example 1.



**Table 11**  
**Performance of R515B Compositions in Chiller System**

| Blend Composition |                |                  |                 |               | NBP<br>(°F) |
|-------------------|----------------|------------------|-----------------|---------------|-------------|
| <i>R-11</i>       | <i>R-227ea</i> | <i>R-1234zeE</i> | <i>R-1234yf</i> | <i>R-134a</i> |             |
| 0                 | 0.08856        | 0.90645          | 0               | 0.005         | -2.251      |
| 0                 | 0.08856        | 0.90645          | 0.001           | 0.004         | -2.265      |
| 0                 | 0.08856        | 0.90645          | 0.002           | 0.003         | -2.279      |
| 0                 | 0.08856        | 0.90645          | 0.003           | 0.002         | -2.294      |
| 0                 | 0.08856        | 0.90645          | 0.004           | 0.001         | -2.308      |
| 0                 | 0.08856        | 0.90645          | 0.005           | 0             | -2.322      |
| 0                 | 0.08864        | 0.90736          | 0               | 0.004         | -2.223      |
| 0                 | 0.08864        | 0.90736          | 0.001           | 0.003         | -2.237      |
| 0                 | 0.08864        | 0.90736          | 0.002           | 0.002         | -2.252      |
| 0                 | 0.08864        | 0.90736          | 0.003           | 0.001         | -2.266      |
| 0                 | 0.08864        | 0.90736          | 0.004           | 0             | -2.28       |
| 0                 | 0.08873        | 0.90827          | 0               | 0.003         | -2.195      |
| 0                 | 0.08873        | 0.90827          | 0.001           | 0.002         | -2.21       |
| 0                 | 0.08873        | 0.90827          | 0.002           | 0.001         | -2.224      |
| 0                 | 0.08873        | 0.90827          | 0.003           | 0             | -2.238      |
| 0                 | 0.08882        | 0.90918          | 0               | 0.002         | -2.168      |
| 0                 | 0.08882        | 0.90918          | 0.001           | 0.001         | -2.182      |
| 0                 | 0.08882        | 0.90918          | 0.002           | 0             | -2.196      |
| 0                 | 0.08891        | 0.91009          | 0               | 0.001         | -2.14       |
| 0                 | 0.08891        | 0.91009          | 0.001           | 0             | -2.154      |
| 0                 | 0.08900        | 0.91100          | 0               | 0             | -2.112      |
| 0.001             | 0.08856        | 0.90645          | 0               | 0.004         | -2.192      |
| 0.001             | 0.08856        | 0.90645          | 0.001           | 0.003         | -2.207      |
| 0.001             | 0.08856        | 0.90645          | 0.002           | 0.002         | -2.221      |
| 0.001             | 0.08856        | 0.90645          | 0.003           | 0.001         | -2.235      |
| 0.001             | 0.08856        | 0.90645          | 0.004           | 0             | -2.249      |
| 0.001             | 0.08864        | 0.90736          | 0               | 0.003         | -2.165      |
| 0.001             | 0.08864        | 0.90736          | 0.001           | 0.002         | -2.179      |
| 0.001             | 0.08864        | 0.90736          | 0.002           | 0.001         | -2.193      |
| 0.001             | 0.08864        | 0.90736          | 0.003           | 0             | -2.208      |
| 0.001             | 0.08873        | 0.90827          | 0               | 0.002         | -2.137      |
| 0.001             | 0.08873        | 0.90827          | 0.001           | 0.001         | -2.151      |
| 0.001             | 0.08873        | 0.90827          | 0.002           | 0             | -2.166      |
| 0.001             | 0.08882        | 0.90918          | 0               | 0.001         | -2.109      |
| 0.001             | 0.08882        | 0.90918          | 0.001           | 0             | -2.123      |
| 0.001             | 0.08891        | 0.91009          | 0               | 0             | -2.081      |
| 0.002             | 0.08856        | 0.90645          | 0               | 0.003         | -2.134      |
| 0.002             | 0.08856        | 0.90645          | 0.001           | 0.002         | -2.148      |
| 0.002             | 0.08856        | 0.90645          | 0.002           | 0.001         | -2.162      |
| 0.002             | 0.08856        | 0.90645          | 0.003           | 0             | -2.177      |
| 0.002             | 0.08864        | 0.90736          | 0               | 0.002         | -2.106      |
| 0.002             | 0.08864        | 0.90736          | 0.001           | 0.001         | -2.12       |
| 0.002             | 0.08864        | 0.90736          | 0.002           | 0             | -2.135      |
| 0.002             | 0.08873        | 0.90827          | 0               | 0.001         | -2.078      |
| 0.002             | 0.08873        | 0.90827          | 0.001           | 0             | -2.092      |
| 0.002             | 0.08882        | 0.90918          | 0               | 0             | -2.05       |
| 0.003             | 0.08856        | 0.90645          | 0               | 0.002         | -2.075      |
| 0.003             | 0.08856        | 0.90645          | 0.001           | 0.001         | -2.089      |
| 0.003             | 0.08856        | 0.90645          | 0.002           | 0             | -2.103      |
| 0.003             | 0.08864        | 0.90736          | 0               | 0.001         | -2.047      |
| 0.003             | 0.08864        | 0.90736          | 0.001           | 0             | -2.061      |

| Blend Composition |                |                  |                 |               | NBP<br>(°F) |
|-------------------|----------------|------------------|-----------------|---------------|-------------|
| <i>R-11</i>       | <i>R-227ea</i> | <i>R-1234zeE</i> | <i>R-1234yf</i> | <i>R-134a</i> |             |
| 0.003             | 0.08873        | 0.90827          | 0               | 0             | -2.019      |
| 0.004             | 0.08856        | 0.90645          | 0               | 0.001         | -2.016      |
| 0.004             | 0.08856        | 0.90645          | 0.001           | 0             | -2.03       |
| 0.004             | 0.08864        | 0.90736          | 0               | 0             | -1.988      |
| 0.005             | 0.08856        | 0.90645          | 0               | 0             | -1.957      |

Table 11 (Continued)

## Performance of R515B Compositions in Chiller System

| Average<br>Glide<br>(K) | Discharge<br>Temp (°C) | Capacity<br>(kJ/m3) | COP   | Cap %<br>Increase | COP %<br>Increase |
|-------------------------|------------------------|---------------------|-------|-------------------|-------------------|
| 0.022                   | 57.713                 | 1868.958            | 4.529 | 0.22668149        | 0                 |
| 0.024                   | 57.706                 | 1868.927            | 4.529 | 0.22501905        | 0                 |
| 0.026                   | 57.698                 | 1868.895            | 4.529 | 0.22330299        | 0                 |
| 0.027                   | 57.691                 | 1868.862            | 4.529 | 0.22153329        | 0                 |
| 0.029                   | 57.683                 | 1868.828            | 4.528 | 0.21970997        | -0.02208          |
| 0.031                   | 57.675                 | 1868.794            | 4.528 | 0.21788665        | -0.02208          |
| 0.018                   | 57.704                 | 1868.113            | 4.529 | 0.18136664        | 0                 |
| 0.019                   | 57.696                 | 1868.082            | 4.529 | 0.1797042         | 0                 |
| 0.021                   | 57.689                 | 1868.049            | 4.529 | 0.17793451        | 0                 |
| 0.023                   | 57.681                 | 1868.016            | 4.529 | 0.17616482        | 0                 |
| 0.025                   | 57.674                 | 1867.982            | 4.528 | 0.1743415         | -0.02208          |
| 0.013                   | 57.695                 | 1867.268            | 4.529 | 0.1360518         | 0                 |
| 0.015                   | 57.687                 | 1867.236            | 4.529 | 0.13433573        | 0                 |
| 0.017                   | 57.68                  | 1867.204            | 4.529 | 0.13261966        | 0                 |
| 0.019                   | 57.672                 | 1867.171            | 4.529 | 0.13084997        | 0                 |
| 0.009                   | 57.685                 | 1866.423            | 4.529 | 0.09073695        | 0                 |
| 0.011                   | 57.678                 | 1866.391            | 4.529 | 0.08902088        | 0                 |
| 0.013                   | 57.67                  | 1866.358            | 4.529 | 0.08725119        | 0                 |
| 0.005                   | 57.676                 | 1865.577            | 4.529 | 0.04536847        | 0                 |
| 0.007                   | 57.669                 | 1865.545            | 4.529 | 0.04365241        | 0                 |
| 0                       | 57.667                 | 1864.731            | 4.529 | 0                 | 0                 |
| 0.087                   | 57.764                 | 1865.28             | 4.53  | 0.02944124        | 0.02208           |
| 0.089                   | 57.757                 | 1865.246            | 4.529 | 0.02761792        | 0                 |
| 0.091                   | 57.749                 | 1865.211            | 4.529 | 0.02574098        | 0                 |
| 0.093                   | 57.742                 | 1865.176            | 4.529 | 0.02386403        | 0                 |
| 0.095                   | 57.734                 | 1865.14             | 4.529 | 0.02193346        | 0                 |
| 0.083                   | 57.755                 | 1864.434            | 4.53  | -0.0159272        | 0.02208           |
| 0.085                   | 57.747                 | 1864.4              | 4.529 | -0.0177505        | 0                 |
| 0.087                   | 57.74                  | 1864.365            | 4.529 | -0.0196275        | 0                 |
| 0.089                   | 57.732                 | 1864.329            | 4.529 | -0.0215581        | 0                 |
| 0.079                   | 57.746                 | 1863.588            | 4.53  | -0.0612957        | 0.02208           |
| 0.081                   | 57.738                 | 1863.553            | 4.529 | -0.0631727        | 0                 |
| 0.083                   | 57.731                 | 1863.518            | 4.529 | -0.0650496        | 0                 |
| 0.075                   | 57.736                 | 1862.741            | 4.53  | -0.1067178        | 0.02208           |
| 0.077                   | 57.729                 | 1862.707            | 4.53  | -0.1085411        | 0.02208           |
| 0.07                    | 57.727                 | 1861.895            | 4.53  | -0.1520863        | 0.02208           |
| 0.153                   | 57.815                 | 1861.607            | 4.53  | -0.1675309        | 0.02208           |
| 0.155                   | 57.807                 | 1861.57             | 4.53  | -0.1695151        | 0.02208           |
| 0.157                   | 57.8                   | 1861.533            | 4.53  | -0.1714993        | 0.02208           |
| 0.159                   | 57.792                 | 1861.495            | 4.529 | -0.1735371        | 0                 |
| 0.149                   | 57.806                 | 1860.76             | 4.53  | -0.212953         | 0.02208           |

| Average Glide (K) | Discharge Temp (°C) | Capacity (kJ/m3) | COP   | Cap % Increase | COP % Increase |
|-------------------|---------------------|------------------|-------|----------------|----------------|
| 0.151             | 57.798              | 1860.723         | 4.53  | -0.2149372     | 0.02208        |
| 0.153             | 57.791              | 1860.686         | 4.53  | -0.2169214     | 0.02208        |
| 0.144             | 57.796              | 1859.913         | 4.53  | -0.2583751     | 0.02208        |
| 0.146             | 57.789              | 1859.876         | 4.53  | -0.2603593     | 0.02208        |
| 0.14              | 57.787              | 1859.065         | 4.53  | -0.3038508     | 0.02208        |
| 0.218             | 57.866              | 1857.939         | 4.531 | -0.3642348     | 0.04416        |
| 0.22              | 57.858              | 1857.9           | 4.53  | -0.3663263     | 0.02208        |
| 0.222             | 57.851              | 1857.861         | 4.53  | -0.3684178     | 0.02208        |
| 0.214             | 57.856              | 1857.091         | 4.531 | -0.4097106     | 0.04416        |
| 0.216             | 57.849              | 1857.052         | 4.53  | -0.411802      | 0.02208        |
| 0.21              | 57.847              | 1856.243         | 4.531 | -0.4551863     | 0.04416        |
| 0.283             | 57.916              | 1854.277         | 4.531 | -0.5606171     | 0.04416        |
| 0.286             | 57.909              | 1854.236         | 4.531 | -0.5628158     | 0.04416        |
| 0.279             | 57.907              | 1853.428         | 4.531 | -0.6061464     | 0.04416        |
| 0.348             | 57.966              | 1850.621         | 4.531 | -0.7566775     | 0.04416        |

**Table 12**  
**Performance of R515B Compositions in Chiller System**

| Blend Composition |                |                  |                 |              | NBP (°F) |
|-------------------|----------------|------------------|-----------------|--------------|----------|
| <i>R-134a</i>     | <i>R-227ea</i> | <i>R-1234zeE</i> | <i>R-1234yf</i> | <i>R-134</i> |          |
| 0                 | 0.088555       | 0.906445         | 0               | 0.005        | -2.179   |
| 0                 | 0.088555       | 0.906445         | 0.001           | 0.004        | -2.208   |
| 0                 | 0.088555       | 0.906445         | 0.002           | 0.003        | -2.237   |
| 0                 | 0.088555       | 0.906445         | 0.003           | 0.002        | -2.265   |
| 0                 | 0.088555       | 0.906445         | 0.004           | 0.001        | -2.294   |
| 0                 | 0.088555       | 0.906445         | 0.005           | 0            | -2.322   |
| 0                 | 0.088644       | 0.907356         | 0               | 0.004        | -2.166   |
| 0                 | 0.088644       | 0.907356         | 0.001           | 0.003        | -2.195   |
| 0                 | 0.088644       | 0.907356         | 0.002           | 0.002        | -2.223   |
| 0                 | 0.088644       | 0.907356         | 0.003           | 0.001        | -2.252   |
| 0                 | 0.088644       | 0.907356         | 0.004           | 0            | -2.28    |
| 0                 | 0.088733       | 0.908267         | 0               | 0.003        | -2.153   |
| 0                 | 0.088733       | 0.908267         | 0.001           | 0.002        | -2.181   |
| 0                 | 0.088733       | 0.908267         | 0.002           | 0.001        | -2.21    |
| 0                 | 0.088733       | 0.908267         | 0.003           | 0            | -2.238   |
| 0                 | 0.088822       | 0.909178         | 0               | 0.002        | -2.139   |
| 0                 | 0.088822       | 0.909178         | 0.001           | 0.001        | -2.168   |
| 0                 | 0.088822       | 0.909178         | 0.002           | 0            | -2.196   |
| 0                 | 0.088911       | 0.910089         | 0               | 0.001        | -2.126   |
| 0                 | 0.088911       | 0.910089         | 0.001           | 0            | -2.154   |
| 0                 | 0.089          | 0.911            | 0               | 0            | -2.112   |
| 0.001             | 0.088555       | 0.906445         | 0               | 0.004        | -2.194   |
| 0.001             | 0.088555       | 0.906445         | 0.001           | 0.003        | -2.222   |
| 0.001             | 0.088555       | 0.906445         | 0.002           | 0.002        | -2.251   |
| 0.001             | 0.088555       | 0.906445         | 0.003           | 0.001        | -2.279   |
| 0.001             | 0.088555       | 0.906445         | 0.004           | 0            | -2.308   |
| 0.001             | 0.088644       | 0.907356         | 0               | 0.003        | -2.18    |
| 0.001             | 0.088644       | 0.907356         | 0.001           | 0.002        | -2.209   |
| 0.001             | 0.088644       | 0.907356         | 0.002           | 0.001        | -2.238   |
| 0.001             | 0.088644       | 0.907356         | 0.003           | 0            | -2.266   |
| 0.001             | 0.088733       | 0.908267         | 0               | 0.002        | -2.167   |

| Blend Composition |                |                  |                 |              | NBP<br>(°F) |
|-------------------|----------------|------------------|-----------------|--------------|-------------|
| <i>R-134a</i>     | <i>R-227ea</i> | <i>R-1234zeE</i> | <i>R-1234yf</i> | <i>R-134</i> |             |
| 0.001             | 0.088733       | 0.908267         | 0.001           | 0.001        | -2.196      |
| 0.001             | 0.088733       | 0.908267         | 0.002           | 0            | -2.224      |
| 0.001             | 0.088822       | 0.909178         | 0               | 0.001        | -2.153      |
| 0.001             | 0.088822       | 0.909178         | 0.001           | 0            | -2.182      |
| 0.001             | 0.088911       | 0.910089         | 0               | 0            | -2.14       |
| 0.002             | 0.088555       | 0.906445         | 0               | 0.003        | -2.208      |
| 0.002             | 0.088555       | 0.906445         | 0.001           | 0.002        | -2.237      |
| 0.002             | 0.088555       | 0.906445         | 0.002           | 0.001        | -2.265      |
| 0.002             | 0.088555       | 0.906445         | 0.003           | 0            | -2.294      |
| 0.002             | 0.088644       | 0.907356         | 0               | 0.002        | -2.195      |
| 0.002             | 0.088644       | 0.907356         | 0.001           | 0.001        | -2.223      |
| 0.002             | 0.088644       | 0.907356         | 0.002           | 0            | -2.252      |
| 0.002             | 0.088733       | 0.908267         | 0               | 0.001        | -2.181      |
| 0.002             | 0.088733       | 0.908267         | 0.001           | 0            | -2.21       |
| 0.002             | 0.088822       | 0.909178         | 0               | 0            | -2.168      |
| 0.003             | 0.088555       | 0.906445         | 0               | 0.002        | -2.222      |
| 0.003             | 0.088555       | 0.906445         | 0.001           | 0.001        | -2.251      |
| 0.003             | 0.088555       | 0.906445         | 0.002           | 0            | -2.279      |
| 0.003             | 0.088644       | 0.907356         | 0               | 0.001        | -2.209      |
| 0.003             | 0.088644       | 0.907356         | 0.001           | 0            | -2.237      |
| 0.003             | 0.088733       | 0.908267         | 0               | 0            | -2.195      |
| 0.004             | 0.088555       | 0.906445         | 0               | 0.001        | -2.236      |
| 0.004             | 0.088555       | 0.906445         | 0.001           | 0            | -2.265      |
| 0.004             | 0.088644       | 0.907356         | 0               | 0            | -2.223      |
| 0.005             | 0.088555       | 0.906445         | 0               | 0            | -2.251      |

Table 12 (Continued)

## Performance of R515B Compositions in Chiller System

| Average<br>Glide<br>(K) | Discharge<br>Temp (°C) | Capacity<br>(kJ/m3) | COP   | Cap %<br>Increase | COP %<br>Increase |
|-------------------------|------------------------|---------------------|-------|-------------------|-------------------|
| 0.007                   | 57.7                   | 1867.403            | 4.53  | 0.143291          | 0.0220799         |
| 0.012                   | 57.695                 | 1867.682            | 4.529 | 0.158253          | 0                 |
| 0.017                   | 57.69                  | 1867.961            | 4.529 | 0.173215          | 0                 |
| 0.022                   | 57.685                 | 1868.239            | 4.529 | 0.188124          | 0                 |
| 0.026                   | 57.68                  | 1868.516            | 4.528 | 0.202978          | -0.0220799        |
| 0.031                   | 57.675                 | 1868.794            | 4.528 | 0.217887          | -0.0220799        |
| 0.006                   | 57.694                 | 1866.869            | 4.53  | 0.114655          | 0.0220799         |
| 0.011                   | 57.689                 | 1867.149            | 4.529 | 0.12967           | 0                 |
| 0.016                   | 57.684                 | 1867.427            | 4.529 | 0.144578          | 0                 |
| 0.02                    | 57.679                 | 1867.705            | 4.529 | 0.159487          | 0                 |
| 0.025                   | 57.674                 | 1867.982            | 4.528 | 0.174342          | -0.0220799        |
| 0.005                   | 57.687                 | 1866.336            | 4.53  | 0.086071          | 0.0220799         |
| 0.009                   | 57.682                 | 1866.615            | 4.529 | 0.101033          | 0                 |
| 0.014                   | 57.677                 | 1866.893            | 4.529 | 0.115942          | 0                 |
| 0.019                   | 57.672                 | 1867.171            | 4.529 | 0.13085           | 0                 |
| 0.003                   | 57.68                  | 1865.801            | 4.529 | 0.057381          | 0                 |
| 0.008                   | 57.675                 | 1866.08             | 4.529 | 0.072343          | 0                 |
| 0.013                   | 57.67                  | 1866.358            | 4.529 | 0.087251          | 0                 |
| 0.002                   | 57.674                 | 1865.267            | 4.529 | 0.028744          | 0                 |
| 0.007                   | 57.669                 | 1865.545            | 4.529 | 0.043652          | 0                 |
| 0                       | 57.667                 | 1864.731            | 4.529 | 0                 | 0                 |

| Average<br>Glide<br>(K) | Discharge<br>Temp (°C) | Capacity<br>(kJ/m3) | COP   | Cap %<br>Increase | COP %<br>Increase |
|-------------------------|------------------------|---------------------|-------|-------------------|-------------------|
| 0.01                    | 57.703                 | 1867.713            | 4.53  | 0.159916          | 0.0220799         |
| 0.015                   | 57.698                 | 1867.993            | 4.529 | 0.174931          | 0                 |
| 0.02                    | 57.693                 | 1868.272            | 4.529 | 0.189893          | 0                 |
| 0.025                   | 57.688                 | 1868.55             | 4.529 | 0.204802          | 0                 |
| 0.029                   | 57.683                 | 1868.828            | 4.528 | 0.21971           | -0.0220799        |
| 0.009                   | 57.696                 | 1867.18             | 4.529 | 0.131333          | 0                 |
| 0.014                   | 57.691                 | 1867.459            | 4.529 | 0.146295          | 0                 |
| 0.018                   | 57.686                 | 1867.738            | 4.529 | 0.161257          | 0                 |
| 0.023                   | 57.681                 | 1868.016            | 4.529 | 0.176165          | 0                 |
| 0.008                   | 57.69                  | 1866.646            | 4.529 | 0.102696          | 0                 |
| 0.012                   | 57.685                 | 1866.925            | 4.529 | 0.117658          | 0                 |
| 0.017                   | 57.68                  | 1867.204            | 4.529 | 0.13262           | 0                 |
| 0.006                   | 57.683                 | 1866.112            | 4.529 | 0.074059          | 0                 |
| 0.011                   | 57.678                 | 1866.391            | 4.529 | 0.089021          | 0                 |
| 0.005                   | 57.676                 | 1865.577            | 4.529 | 0.045368          | 0                 |
| 0.013                   | 57.706                 | 1868.024            | 4.529 | 0.176594          | 0                 |
| 0.018                   | 57.701                 | 1868.304            | 4.529 | 0.191609          | 0                 |
| 0.023                   | 57.696                 | 1868.583            | 4.529 | 0.206571          | 0                 |
| 0.027                   | 57.691                 | 1868.862            | 4.529 | 0.221533          | 0                 |
| 0.012                   | 57.699                 | 1867.491            | 4.529 | 0.148011          | 0                 |
| 0.017                   | 57.694                 | 1867.77             | 4.529 | 0.162973          | 0                 |
| 0.021                   | 57.689                 | 1868.049            | 4.529 | 0.177935          | 0                 |
| 0.01                    | 57.692                 | 1866.957            | 4.529 | 0.119374          | 0                 |
| 0.015                   | 57.687                 | 1867.236            | 4.529 | 0.134336          | 0                 |
| 0.009                   | 57.685                 | 1866.423            | 4.529 | 0.090737          | 0                 |
| 0.016                   | 57.708                 | 1868.335            | 4.529 | 0.193272          | 0                 |
| 0.021                   | 57.703                 | 1868.615            | 4.529 | 0.208287          | 0                 |
| 0.026                   | 57.698                 | 1868.895            | 4.529 | 0.223303          | 0                 |
| 0.015                   | 57.702                 | 1867.802            | 4.529 | 0.164689          | 0                 |
| 0.019                   | 57.696                 | 1868.082            | 4.529 | 0.179704          | 0                 |
| 0.013                   | 57.695                 | 1867.268            | 4.529 | 0.136052          | 0                 |
| 0.019                   | 57.711                 | 1868.646            | 4.529 | 0.20995           | 0                 |
| 0.024                   | 57.706                 | 1868.927            | 4.529 | 0.225019          | 0                 |
| 0.018                   | 57.704                 | 1868.113            | 4.529 | 0.181367          | 0                 |
| 0.022                   | 57.713                 | 1868.958            | 4.529 | 0.226681          | 0                 |

[0523] Performance of the R-515B compositions containing residual amounts of CFC-11 or HFC-134a is similar to the R-515B composition which does not contain these residual refrigerants. More particularly, differences in energy efficiency (shown as COP) and capacity among the compositions are *de minimis* or COP and/or capacity are actually increased in some cases. Thus, the data indicate that the presence of CFC-11 or HFC-134a as residual refrigerants in R-515B compositions does not negatively impact performance of the compositions.

#### Impact on Distillation

[0524] Table 13 shows distillation requirements for obtaining an HFC-227ea/ E-HFO-1234ze (e.g., R515B) composition containing up to 0.5 wt.% residual HFC-

134a as compared with obtaining an HFC-227ea/ E-HFO-1234ze (e.g., R515B) composition containing little to no (e.g., 10 ppm) residual HFC-134a. The mass reflux ratio for distilling the latter is significantly higher than that required for a composition that contains up to 0.5 wt. % of the residual refrigerant. Thus, the data show that removing essentially all of the residual refrigerant from the composition would require a significantly larger distillation column and higher energy input, and thus exhibit a much larger environmental footprint, as compared with allowing up to 0.5 wt. % of the residual refrigerant to remain in the composition.

Table 13

|                      | 10% HFC-134a to 0.5% HFC-134a |          |         | 10% HFC-134a to 10 ppm HFC-134a |          |         |
|----------------------|-------------------------------|----------|---------|---------------------------------|----------|---------|
| Column Stages        | 80                            |          |         | 80                              |          |         |
| Feed Stage           | 40                            |          |         | 40                              |          |         |
| Mass Reflux Ratio    | 16.5                          |          |         | 44.8                            |          |         |
| Stream               | Feed                          | Overhead | Bottom  | Feed                            | Overhead | Bottom  |
| Temp (deg C)         | 25                            | 39       | 47.2    | 25                              | 38.8     | 47.3    |
| Pressure (psia)      | 139.7                         | 134.7    | 134.7   | 139.7                           | 134.7    | 134.7   |
| E-1234ze wt fraction | 0.8199                        | 0.33941  | 0.90469 | 0.8199                          | 0.315    | 0.909   |
| 227ea wt fraction    | 0.0801                        | 0.02226  | 0.09031 | 0.0801                          | 0.01839  | 0.09099 |
| 134a wt fraction     | 0.1                           | 0.63833  | 0.005   | 0.1                             | 0.66661  | 0.00001 |

### Other Embodiments

**[0525]** Embodiment 1. A composition comprising (i) one of (a) difluoromethane (HFC-32) and pentafluoroethane (HFC-125), or (b) R-410A (50% HFC-125 / 50% HFC-32), and (ii) at least one residual refrigerant selected from the group consisting of chlorodifluoromethane (HCFC-22) and 1,1,1,2-tetrafluoroethane (HFC-134a).

**[0526]** Embodiment 2. A composition comprising (i) one of (a) difluoromethane (HFC-32) and pentafluoroethane (HFC-125), or (b) R-410A (50% HFC-125 / 50% HFC-32); (ii) at least one residual refrigerant selected from the group consisting of chlorodifluoromethane (HCFC-22) and 1,1,1,2-tetrafluoroethane (HFC-134a); (iii) at least one additional compound selected from the group consisting of HFC-23, HFC-32, HFC-143a, HFC-134a, CFC-115, CFO-1113 and HCC-40; and (iv) at least one additional compound selected from the group consisting of HFC-143a, HFC-41, HFC-134a, HCFC-22, CFC-12 and HCC-40.

**[0527]** Embodiment 3. A composition comprising (i) one of (a) difluoromethane (HFC-32) and pentafluoroethane (HFC-125), or (b) R-410A (50% HFC-125 / 50% HFC-32); (ii) at least one residual refrigerant selected from the group consisting of chlorodifluoromethane (HCFC-22) and 1,1,1,2-tetrafluoroethane (HFC-134a); and (iii) at least one additional compound selected from the group consisting of CFC-115, HFC-143a and HCFC-22.

**[0528]** Embodiment 4. A composition comprising: a first refrigerant portion comprising one of (a) difluoromethane (HFC-32) and pentafluoroethane (HFC-125), or (b) R-410A (50% HFC-125 / 50% HFC-32); and a second refrigerant portion comprising at least one compound selected from the group consisting of chlorodifluoromethane (HCFC-22) and 1,1,1,2-tetrafluoroethane (HFC-134a).

**[0529]** Embodiment 5. A composition comprising: a first refrigerant portion comprising (i) one of (a) difluoromethane (HFC-32) and pentafluoroethane (HFC-125), or (b) R-410A (50% HFC-125 / 50% HFC-32); (ii) at least one additional compound selected from the group consisting of HFC-23, HFC-32, HFC-143a, HFC-134a, CFC-115, CFO-1113 and HCC-40; and (iii) at least one additional compound selected from the group consisting of HFC-143a, HFC-41, HFC-134a, HCFC-22, CFC-12 and HCC-40; and a second refrigerant portion comprising at least one compound selected from the group consisting of chlorodifluoromethane (HCFC-22) and 1,1,1,2-tetrafluoroethane (HFC-134a).

**[0530]** Embodiment 6. A composition comprising: a first refrigerant portion comprising (i) one of (a) difluoromethane (HFC-32) and pentafluoroethane (HFC-125), or (b) R-410A (50% HFC-125 / 50% HFC-32); and (ii) at least one additional compound selected from the group consisting of CFC-115, HFC-143a and HCFC-22; and a second refrigerant portion comprising at least one compound selected from the group consisting of chlorodifluoromethane (HCFC-22) and 1,1,1,2-tetrafluoroethane (HFC-134a).

**[0531]** Embodiment 7. A composition comprising (i) one of (a) difluoromethane (HFC-32), pentafluoroethane (HFC-125) and 1,1,1,2-tetrafluoroethane (HFC-134a), or (b) R-407C (25% HFC-125 / 23% HFC-32 / 52% HFC-134a), and (ii) at least one residual refrigerant of chlorodifluoromethane (HCFC-22).

**[0532]** Embodiment 8. A composition comprising (i) one of (a) difluoromethane (HFC-32), pentafluoroethane (HFC-125) and 1,1,1,2-tetrafluoroethane (HFC-134a), or (b) R-407C (25% HFC-125 / 23% HFC-32 / 52% HFC-134a); (ii) at least one residual refrigerant of chlorodifluoromethane (HCFC-22); (iii) at least one additional compound selected from the group consisting of HFC-23, HFC-32, HFC-143a, HFC-134a, CFC-115, CFO-1113 and HCC-40; (iv) at least one additional compound selected from the group consisting of HFC-143a, HFO-1225zc, HFC-245cb, HFC-134, HFC-152a, HFO-1225ye, HFC-161, E-HFO-1234ze, HCFC-22, HFO-1243zf, CHFC-124, HCC-40, CHFO-1122, HCFC-31, CFC-114, CFC-114a and HCO-1140; and (v) at least one additional compound selected from the group consisting of HFC-143a, HFC-41, HFC-134a, HCFC-22, CFC-12 and HCC-40.

**[0533]** Embodiment 9. A composition comprising (i) one of (a) difluoromethane (HFC-32), pentafluoroethane (HFC-125) and 1,1,1,2-tetrafluoroethane (HFC-134a), or (b) R-407C (25% HFC-125 / 23% HFC-32 / 52% HFC-134a); (ii) at least one residual refrigerant of chlorodifluoromethane (HCFC-22); and (iii) at least one additional compound selected from the group consisting of HFC-134a, HFC-143a and CFC-115.

**[0534]** Embodiment 10. A composition comprising: a first refrigerant portion comprising one of (a) difluoromethane (HFC-32), pentafluoroethane (HFC-125) and 1,1,1,2-tetrafluoroethane (HFC-134a), or (b) R-407C (25% HFC-125 / 23% HFC-32 / 52% HFC-134a); and a second refrigerant portion comprising at least chlorodifluoromethane (HCFC-22).

**[0535]** Embodiment 11. A composition comprising: a first refrigerant portion comprising (i) one of (a) difluoromethane (HFC-32), pentafluoroethane (HFC-125) and 1,1,1,2-tetrafluoroethane (HFC-134a), or (b) R-407C (25% HFC-125 / 23% HFC-32 / 52% HFC-134a); (ii) at least one additional compound selected from the group consisting of HFC-23, HFC-32, HFC-143a, HFC-134a, CFC-115, CFO-1113 and HCC-40; (iii) at least one additional compound selected from the group consisting of HFC-143a, HFO-1225zc, HFC-245cb, HFC-134, HFC-152a, HFO-1225ye, HFC-161, E-HFO-1234ze, HCFC-22, HFO-1243zf, CHFC-124, HCC-40, CHFO-1122, HCFC-31, CFC-114, CFC-114a and HCO-1140; and (iv) at least one additional compound selected from the group consisting of HFC-143a, HFC-41,



HFC-134a, HCFC-22, CFC-12 and HCC-40; and a second refrigerant portion comprising at least chlorodifluoromethane (HCFC-22).

**[0536]** Embodiment 12. A composition comprising: a first refrigerant portion comprising (i) one of (a) difluoromethane (HFC-32), pentafluoroethane (HFC-125) and 1,1,1,2-tetrafluoroethane (HFC-134a), or (b) R-407C (25% HFC-125 / 23% HFC-32 / 52% HFC-134a); and (ii) at least one additional compound selected from the group consisting of HFC-134a, HFC-143a and CFC-115; and a second refrigerant portion comprising at least chlorodifluoromethane (HCFC-22).

**[0537]** Embodiment 13. A composition comprising (i) one of (a) difluoromethane (HFC-32), pentafluoroethane (HFC-125) and 2,3,3,3-tetrafluoro-1-propene (HFO-1234yf), or (b) R-452B (67% HFC-32 / 7% HFC-125 / 26% HFO-1234yf), and (ii) at least one residual refrigerant selected from the group consisting of chlorodifluoromethane (HCFC-22), 1,1,1,2-tetrafluoroethane (HFC-134a) and CO<sub>2</sub>.

**[0538]** Embodiment 14. A composition comprising (i) one of (a) difluoromethane (HFC-32), pentafluoroethane (HFC-125) and 2,3,3,3-tetrafluoro-1-propene (HFO-1234yf), or (b) R-452B (67% HFC-32 / 7% HFC-125 / 26% HFO-1234yf); (ii) at least one residual refrigerant selected from the group consisting of chlorodifluoromethane (HCFC-22), 1,1,1,2-tetrafluoroethane (HFC-134a) and CO<sub>2</sub>; (iii) at least one additional compound selected from the group consisting of HFC-143a, HFC-41, HFC-134a, HCFC-22, CFC-12 and HCC-40; (iv) at least one additional compound selected from the group consisting of HFC-23, HFC-32, HFC-143a, HFC-134a, CFC-115, CFO-1113 and HCC-40; and (v) at least one additional compound selected from the group consisting of HFO-1225ye, HFO-1243zf, E-HFO-1234ze, HFC-236ea, HCFC-244bb, HFC-245fa, HFC-245eb, HFC-245cb, 3,3,3-trifluoropropyne, HFC-152a, FO-1114, HFO-1123, HCFO-1131a, trans-HCFO-1131, HCO-1140, HCFO-1214ya, HFO-1216, HCFO-1224yd, HFO-1252 isomers, HFC-143a, HCFC-225 isomers, HFC-254eb, HFC-263fb, HFC-236fa, HCFC-142b, HCFC-244cc, HCFO-1223, HFO-1132a and HCC-40.

**[0539]** Embodiment 15. A composition comprising (i) one of (a) difluoromethane (HFC-32), pentafluoroethane (HFC-125) and 2,3,3,3-tetrafluoro-1-propene (HFO-1234yf), or (b) R-452B (67% HFC-32 / 7% HFC-125 / 26% HFO-1234yf); (ii) at least one residual refrigerant selected from the group consisting of chlorodifluoromethane

(HCFC-22), 1,1,1,2-tetrafluoroethane (HFC-134a) and CO<sub>2</sub>; and (iii) at least one additional compound selected from the group consisting of HFC-143a and HFO-1234zf.

**[0540]** Embodiment 16. A composition comprising: a first refrigerant portion comprising one of (a) difluoromethane (HFC-32), pentafluoroethane (HFC-125) and 2,3,3,3-tetrafluoro-1-propene (HFO-1234yf), or (b) R-452B (67% HFC-32 / 7% HFC-125 / 26% HFO-1234yf); and a second refrigerant portion comprising at least one compound selected from the group consisting of chlorodifluoromethane (HCFC-22), 1,1,1,2-tetrafluoroethane (HFC-134a) and CO<sub>2</sub>.

**[0541]** Embodiment 17. A composition comprising: a first refrigerant portion comprising (i) one of (a) difluoromethane (HFC-32), pentafluoroethane (HFC-125) and 2,3,3,3-tetrafluoro-1-propene (HFO-1234yf), or (b) R-452B (67% HFC-32 / 7% HFC-125 / 26% HFO-1234yf); (ii) at least one additional compound selected from the group consisting of HFC-143a, HFC-41, HFC-134a, HCFC-22, CFC-12 and HCC-40; (iii) at least one additional compound selected from the group consisting of HFC-23, HFC-32, HFC-143a, HFC-134a, CFC-115, CFO-1113 and HCC-40; and (iv) at least one additional compound selected from the group consisting of HFO-1225ye, HFO-1243zf, E-HFO-1234ze, HFC-236ea, HCFC-244bb, HFC-245fa, HFC-245eb, HFC-245cb, 3,3,3-trifluoropropyne, HFC-152a, FO-1114, HFO-1123, HCFO-1131a, trans-HCFO-1131, HCO-1140, HCFO-1214ya, HFO-1216, HCFO-1224yd, HFO-1252 isomers, HFC-143a, HCFC-225 isomers, HFC-254eb, HFC-263fb, HFC-236fa, HCFC-142b, HCFC-244cc, HCFO-1223, HFO-1132a and HCC-40; and a second refrigerant portion comprising at least one compound selected from the group consisting of chlorodifluoromethane (HCFC-22), 1,1,1,2-tetrafluoroethane (HFC-134a) and CO<sub>2</sub>.

**[0542]** Embodiment 18. A composition comprising: a first refrigerant portion comprising (i) one of (a) difluoromethane (HFC-32), pentafluoroethane (HFC-125) and 2,3,3,3-tetrafluoro-1-propene (HFO-1234yf), or (b) R-452B (67% HFC-32 / 7% HFC-125 / 26% HFO-1234yf); and (ii) at least one additional compound selected from the group consisting of HFC-143a and HFO-1234zf; and a second refrigerant portion comprising at least one compound selected from the group consisting of chlorodifluoromethane (HCFC-22), 1,1,1,2-tetrafluoroethane (HFC-134a) and CO<sub>2</sub>.

**[0543]** Embodiment 19. A composition comprising (i) one of (a) difluoromethane (HFC-32) and 2,3,3,3-tetrafluoro-1-propene (HFO-1234yf), or (b) R-454B (68.9% HFC-32 / 31.1% HFO-1234yf); and (ii) at least one residual refrigerant selected from the group consisting of chlorodifluoromethane (HCFC-22), pentafluoroethane (HFC-125), 1,1,1,2-tetrafluoroethane (HFC-134a) and CO<sub>2</sub>.

**[0544]** Embodiment 20. A composition comprising (i) one of (a) difluoromethane (HFC-32) and 2,3,3,3-tetrafluoro-1-propene (HFO-1234yf), or (b) R-454B (68.9% HFC-32 / 31.1% HFO-1234yf); (ii) at least one residual refrigerant selected from the group consisting of chlorodifluoromethane (HCFC-22), pentafluoroethane (HFC-125), 1,1,1,2-tetrafluoroethane (HFC-134a) and CO<sub>2</sub>; (iii) at least one additional compound selected from the group consisting of HFC-143a, HFC-41, HFC-134a, HCFC-22, CFC-12 and HCC-40; and (iv) at least one additional compound selected from the group consisting of HFO-1225ye, HFO-1243zf, E-HFO-1234ze, HFC-236ea, HCFC-244bb, HFC-245fa, HFC-245eb, HFC-245cb, 3,3,3-trifluoropropylene, HFC-152a, FO-1114, HFO-1123, HCFO-1131a, trans-HCFO-1131, HCO-1140, HCFO-1214ya, HFO-1216, HCFO-1224yd, HFO-1252 isomers, HFC-143a, HCFC-225 isomers, HFC-254eb, HFC-263fb, HFC-236fa, HCFC-142b, HCFC-244cc, HCFO-1223, HFO-1132a and HCC-40.

**[0545]** Embodiment 21. A composition comprising (i) one of (a) difluoromethane (HFC-32) and 2,3,3,3-tetrafluoro-1-propene (HFO-1234yf), or (b) R-454B (68.9% HFC-32 / 31.1% HFO-1234yf); (ii) at least one residual refrigerant selected from the group consisting of chlorodifluoromethane (HCFC-22), pentafluoroethane (HFC-125), 1,1,1,2-tetrafluoroethane (HFC-134a) and CO<sub>2</sub>; and (iii) at least one additional compound selected from the group consisting of HFC-143a, HFC-245cb and HFO-1243zf.

**[0546]** Embodiment 22. A composition comprising: a first refrigerant portion comprising one of (a) difluoromethane (HFC-32) and 2,3,3,3-tetrafluoro-1-propene (HFO-1234yf), or (b) R-454B (68.9% HFC-32 / 31.1% HFO-1234yf); and a second refrigerant portion comprising at least one compound selected from the group consisting of chlorodifluoromethane (HCFC-22), pentafluoroethane (HFC-125), 1,1,1,2-tetrafluoroethane (HFC-134a) and CO<sub>2</sub>.

**[0547]** Embodiment 23. A composition comprising: a first refrigerant portion comprising (i) one of (a) difluoromethane (HFC-32) and 2,3,3,3-tetrafluoro-1-propene (HFO-1234yf), or (b) R-454B (68.9% HFC-32 / 31.1% HFO-1234yf); (ii) at least one additional compound selected from the group consisting of HFC-143a, HFC-41, HFC-134a, HCFC-22, CFC-12 and HCC-40; and (iii) at least one additional compound selected from the group consisting of HFO-1225ye, HFO-1243zf, E-HFO-1234ze, HFC-236ea, HCFC-244bb, HFC-245fa, HFC-245eb, HFC-245cb, 3,3,3-trifluoropropyne, HFC-152a, FO-1114, HFO-1123, HCFO-1131a, trans-HCFO-1131, HCO-1140, HCFO-1214ya, HFO-1216, HCFO-1224yd, HFO-1252 isomers, HFC-143a, HCFC-225 isomers, HFC-254eb, HFC-263fb, HFC-236fa, HCFC-142b, HCFC-244cc, HCFO-1223, HFO-1132a and HCC-40; and a second refrigerant portion comprising at least one compound selected from the group consisting of chlorodifluoromethane (HCFC-22), pentafluoroethane (HFC-125), 1,1,1,2-tetrafluoroethane (HFC-134a) and CO<sub>2</sub>.

**[0548]** Embodiment 24. A composition comprising: a first refrigerant portion comprising (i) one of (a) difluoromethane (HFC-32) and 2,3,3,3-tetrafluoro-1-propene (HFO-1234yf), or (b) R-454B (68.9% HFC-32 / 31.1% HFO-1234yf); and (ii) at least one additional compound selected from the group consisting of HFC-143a, HFC-245cb and HFO-1243zf; and a second refrigerant portion comprising at least one compound selected from the group consisting of chlorodifluoromethane (HCFC-22), pentafluoroethane (HFC-125), 1,1,1,2-tetrafluoroethane (HFC-134a) and CO<sub>2</sub>.

**[0549]** Embodiment 25. A composition comprising (i) one of (a) difluoromethane (HFC-32), pentafluoroethane (HFC-125) and 1,1,1,2-tetrafluoroethane (HFC-134a), or (b) R-407A (20% HFC-32 / 40% HFC-125 / 40% HFC-134a); and (ii) at least one residual refrigerant selected from the group consisting of chlorodifluoromethane (HCFC-22) and 1,1,1-trifluoroethane (HFC-143a).

**[0550]** Embodiment 26. A composition comprising (i) one of (a) difluoromethane (HFC-32), pentafluoroethane (HFC-125) and 1,1,1,2-tetrafluoroethane (HFC-134a), or (b) R-407A (20% HFC-32 / 40% HFC-125 / 40% HFC-134a); (ii) at least one residual refrigerant selected from the group consisting of chlorodifluoromethane (HCFC-22) and 1,1,1-trifluoroethane (HFC-143a); (iii) at least one additional compound selected from the group consisting of HFC-23, HFC-32, HFC-143a, HFC-

134a, CFC-115, CFO-1113 and HCC-40; (iv) at least one additional compound selected from the group consisting of HFC-143a, HFO-1225zc, HFC-245cb, HFC-134, HFC-152a, HFO-1225ye, HFC-161, E-HFO-1234ze, HCFC-22, HFO-1243zf, CHFC-124, HCC-40, CHFO-1122, HCFC-31, CFC-114, CFC-114a and HCO-1140; and (v) at least one additional compound selected from the group consisting of HFC-143a, HFC-41, HFC-134a, HCFC-22, CFC-12 and HCC-40.

**[0551]** Embodiment 27. A composition comprising (i) one of (a) difluoromethane (HFC-32), pentafluoroethane (HFC-125) and 1,1,1,2-tetrafluoroethane (HFC-134a), or (b) R-407A (20% HFC-32 / 40% HFC-125 / 40% HFC-134a); (ii) at least one residual refrigerant selected from the group consisting of chlorodifluoromethane (HCFC-22) and 1,1,1-trifluoroethane (HFC-143a); and (iii) at least one additional compound selected from the group consisting of HFC-134a and CFC-115.

**[0552]** Embodiment 28. A composition comprising: a first refrigerant portion comprising one of (a) difluoromethane (HFC-32), pentafluoroethane (HFC-125) and 1,1,1,2-tetrafluoroethane (HFC-134a), or (b) R-407A (20% HFC-32 / 40% HFC-125 / 40% HFC-134a); and a second refrigerant portion comprising at least one compound selected from the group consisting of chlorodifluoromethane (HCFC-22) and 1,1,1-trifluoroethane (HFC-143a).

**[0553]** Embodiment 29. A composition comprising: a first refrigerant portion comprising (i) one of (a) difluoromethane (HFC-32), pentafluoroethane (HFC-125) and 1,1,1,2-tetrafluoroethane (HFC-134a), or (b) R-407A (20% HFC-32 / 40% HFC-125 / 40% HFC-134a); (ii) at least one additional compound selected from the group consisting of HFC-23, HFC-32, HFC-143a, HFC-134a, CFC-115, CFO-1113 and HCC-40; (iii) at least one additional compound selected from the group consisting of HFC-143a, HFO-1225zc, HFC-245cb, HFC-134, HFC-152a, HFO-1225ye, HFC-161, E-HFO-1234ze, HCFC-22, HFO-1243zf, CHFC-124, HCC-40, CHFO-1122, HCFC-31, CFC-114, CFC-114a and HCO-1140; and (iv) at least one additional compound selected from the group consisting of HFC-143a, HFC-41, HFC-134a, HCFC-22, CFC-12 and HCC-40; and a second refrigerant portion comprising at least one compound selected from the group consisting of chlorodifluoromethane (HCFC-22) and 1,1,1-trifluoroethane (HFC-143a).

**[0554]** Embodiment 30. A composition comprising: a first refrigerant portion comprising (i) one of (a) difluoromethane (HFC-32), pentafluoroethane (HFC-125) and 1,1,1,2-tetrafluoroethane (HFC-134a), or (b) R-407A (20% HFC-32 / 40% HFC-125 / 40% HFC-134a); and (ii) at least one additional compound selected from the group consisting of HFC-134a and CFC-115; and a second refrigerant portion comprising at least one compound selected from the group consisting of chlorodifluoromethane (HCFC-22) and 1,1,1-trifluoroethane (HFC-143a).

**[0555]** Embodiment 31. A composition comprising a mixture of R-407A (20% HFC-32 / 40% HFC-125 / 40% HFC-134a) and R-407C (25% HFC-125 / 23% HFC-32 / 52% HFC-134a); and at least one residual refrigerant selected from the group consisting of chlorodifluoromethane (HCFC-22) and 1,1,1-trifluoroethane (HFC-143a); and optionally one or more members selected from the group consisting of R-407B, R-407D, R-407E, R-407F, R-407G, R-407H and R-407I.

**[0556]** Embodiment 32. A composition comprising (i) a mixture of R-407A (20% HFC-32 / 40% HFC-125 / 40% HFC-134a) and R-407C (25% HFC-125 / 23% HFC-32 / 52% HFC-134a); (ii) at least one residual refrigerant selected from the group consisting of chlorodifluoromethane (HCFC-22) and 1,1,1-trifluoroethane (HFC-143a); (iii) at least one additional compound selected from the group consisting of HFC-23, HFC-32, HFC-143a, HFC-134a, CFC-115, CFO-1113 and HCC-40; (iv) at least one additional compound selected from the group consisting of HFC-143a, HFO-1225zc, HFC-245cb, HFC-134, HFC-152a, HFO-1225ye, HFC-161, E-HFO-1234ze, HCFC-22, HFO-1243zf, CHFC-124, HCC-40, CHFO-1122, HCFC-31, CFC-114, CFC-114a and HCO-1140; and (v) at least one additional compound selected from the group consisting of HFC-143a, HFC-41, HFC-134a, HCFC-22, CFC-12 and HCC-40.

**[0557]** Embodiment 33. A composition comprising (i) a mixture of R-407A (20% HFC-32 / 40% HFC-125 / 40% HFC-134a) and R-407C (25% HFC-125 / 23% HFC-32 / 52% HFC-134a); (ii) at least one residual refrigerant selected from the group consisting of chlorodifluoromethane (HCFC-22) and 1,1,1-trifluoroethane (HFC-143a); and (iii) at least one additional compound selected from the group consisting of HFC-134a, HFC-143a and CFC-115.

**[0558]** Embodiment 34. A composition comprising: a first refrigerant portion comprising a mixture of R-407A (20% HFC-32 / 40% HFC-125 / 40% HFC-134a) and R-407C (25% HFC-125 / 23% HFC-32 / 52% HFC-134a); and a second refrigerant portion comprising at least one compound selected from the group consisting of chlorodifluoromethane (HCFC-22) and 1,1,1-trifluoroethane (HFC-143a).

**[0559]** Embodiment 35. A composition comprising: a first refrigerant portion comprising (i) a mixture of R-407A (20% HFC-32 / 40% HFC-125 / 40% HFC-134a) and R-407C (25% HFC-125 / 23% HFC-32 / 52% HFC-134a); (ii) at least one additional compound selected from the group consisting of HFC-23, HFC-32, HFC-143a, HFC-134a, CFC-115, CFO-1113 and HCC-40; (iii) at least one additional compound selected from the group consisting of HFC-143a, HFO-1225zc, HFC-245cb, HFC-134, HFC-152a, HFO-1225ye, HFC-161, E-HFO-1234ze, HCFC-22, HFO-1243zf, CHFC-124, HCC-40, CHFO-1122, HCFC-31, CFC-114, CFC-114a and HCO-1140; and (iv) at least one additional compound selected from the group consisting of HFC-143a, HFC-41, HFC-134a, HCFC-22, CFC-12 and HCC-40; and a second refrigerant portion comprising at least one compound selected from the group consisting of chlorodifluoromethane (HCFC-22) and 1,1,1-trifluoroethane (HFC-143a).

**[0560]** Embodiment 36. A composition comprising: a first refrigerant portion comprising (i) a mixture of R-407A (20% HFC-32 / 40% HFC-125 / 40% HFC-134a) and R-407C (25% HFC-125 / 23% HFC-32 / 52% HFC-134a); and (ii) at least one additional compound selected from the group consisting of HFC-134a, HFC-143a and CFC-115; and a second refrigerant portion comprising at least one compound selected from the group consisting of chlorodifluoromethane (HCFC-22) and 1,1,1-trifluoroethane (HFC-143a).

**[0561]** Embodiment 37. A composition comprising (i) one of (a) difluoromethane (HFC-32), CO<sub>2</sub> and 2,3,3,3-tetrafluoro-1-propene (HFO-1234yf), or (b) R-455A (21.5% HFC-32 / 3% CO<sub>2</sub> / 75.5% HFO-1234yf); and (ii) at least one residual refrigerant selected from the group consisting of pentafluoroethane (HFC-125), 1,1,1,2-tetrafluoroethane (HFC-134a), chlorodifluoromethane (HCFC-22), chloropentafluoroethane (CFC-115), E-1,3,3,3-tetrafluoro-1-propene (E-HFO-1234ze) and 1,1,1-trifluoroethane (HFC-143a).

**[0562]** Embodiment 38. A composition comprising (i) one of (a) difluoromethane (HFC-32), CO<sub>2</sub> and 2,3,3,3-tetrafluoro-1-propene (HFO-1234yf), or (b) R-455A (21.5% HFC-32 / 3% CO<sub>2</sub> / 75.5% HFO-1234yf); (ii) at least one residual refrigerant selected from the group consisting of pentafluoroethane (HFC-125), 1,1,1,2-tetrafluoroethane (HFC-134a), chlorodifluoromethane (HCFC-22), chloropentafluoroethane (CFC-115), E-1,3,3,3-tetrafluoro-1-propene (E-HFO-1234ze) and 1,1,1-trifluoroethane (HFC-143a); (iii) at least one additional compound selected from the group consisting of HFC-143a, HFC-41, HFC-134a, HCFC-22, CFC-12 and HCC-40; (iv) at least one additional compound selected from the group consisting of N<sub>2</sub>, Ar, CO and O<sub>2</sub>; and (v) at least one additional compound selected from the group consisting of HFO-1225ye, HFO-1243zf, E-HFO-1234ze, HFC-236ea, HCFC-244bb, HFC-245fa, HFC-245eb, HFC-245cb, 3,3,3-trifluoropropyne, HFC-152a, FO-1114, HFO-1123, HCFO-1131a, trans-HCFO-1131, HCO-1140, HCFO-1214ya, HFO-1216, HCFO-1224yd, HFO-1252 isomers, HFC-143a, HCFC-225 isomers, HFC-254eb, HFC-263fb, HFC-236fa, HCFC-142b, HCFC-244cc, HCFO-1223, HFO-1132a and HCC-40.

**[0563]** Embodiment 39. A composition comprising (i) one of (a) difluoromethane (HFC-32), CO<sub>2</sub> and 2,3,3,3-tetrafluoro-1-propene (HFO-1234yf), or (b) R-455A (21.5% HFC-32 / 3% CO<sub>2</sub> / 75.5% HFO-1234yf); (ii) at least one residual refrigerant selected from the group consisting of pentafluoroethane (HFC-125), 1,1,1,2-tetrafluoroethane (HFC-134a), chlorodifluoromethane (HCFC-22), chloropentafluoroethane (CFC-115), E-1,3,3,3-tetrafluoro-1-propene (E-HFO-1234ze) and 1,1,1-trifluoroethane (HFC-143a); and (iii) at least one additional compound selected from the group consisting of HFC-143a, HFC-245cb and HFO-1243zf.

**[0564]** Embodiment 40. A composition comprising: a first refrigerant portion comprising one of (a) difluoromethane (HFC-32), CO<sub>2</sub> and 2,3,3,3-tetrafluoro-1-propene (HFO-1234yf), or (b) R-455A (21.5% HFC-32 / 3% CO<sub>2</sub> / 75.5% HFO-1234yf); and a second refrigerant portion comprising at least one compound selected from the group consisting of pentafluoroethane (HFC-125), 1,1,1,2-tetrafluoroethane (HFC-134a), chlorodifluoromethane (HCFC-22), chloropentafluoroethane (CFC-115), E-1,3,3,3-tetrafluoro-1-propene (E-HFO-1234ze) and 1,1,1-trifluoroethane (HFC-143a).



**[0565]** Embodiment 41. A composition comprising: a first refrigerant portion comprising (i) one of (a) difluoromethane (HFC-32), CO<sub>2</sub> and 2,3,3,3-tetrafluoro-1-propene (HFO-1234yf), or (b) R-455A (21.5% HFC-32 / 3% CO<sub>2</sub> / 75.5% HFO-1234yf); (ii) at least one additional compound selected from the group consisting of HFC-143a, HFC-41, HFC-134a, HCFC-22, CFC-12 and HCC-40; (iii) at least one additional compound selected from the group consisting of N<sub>2</sub>, Ar, CO and O<sub>2</sub>; and (iv) at least one additional compound selected from the group consisting of HFO-1225ye, HFO-1243zf, E-HFO-1234ze, HFC-236ea, HCFC-244bb, HFC-245fa, HFC-245eb, HFC-245cb, 3,3,3-trifluoropropyne, HFC-152a, FO-1114, HFO-1123, HCFO-1131a, trans-HCFO-1131, HCO-1140, HCFO-1214ya, HFO-1216, HCFO-1224yd, HFO-1252 isomers, HFC-143a, HCFC-225 isomers, HFC-254eb, HFC-263fb, HFC-236fa, HCFC-142b, HCFC-244cc, HCFO-1223, HFO-1132a and HCC-40; and a second refrigerant portion comprising at least one compound selected from the group consisting of pentafluoroethane (HFC-125), 1,1,1,2-tetrafluoroethane (HFC-134a), chlorodifluoromethane (HCFC-22), chloropentafluoroethane (CFC-115), E-1,3,3,3-tetrafluoro-1-propene (E-HFO-1234ze) and 1,1,1-trifluoroethane (HFC-143a).

**[0566]** Embodiment 42. A composition comprising: a first refrigerant portion comprising (i) one of (a) difluoromethane (HFC-32), CO<sub>2</sub> and 2,3,3,3-tetrafluoro-1-propene (HFO-1234yf), or (b) R-455A (21.5% HFC-32 / 3% CO<sub>2</sub> / 75.5% HFO-1234yf); and (ii) at least one additional compound selected from the group consisting of HFC-143a, HFC-245cb and HFO-1243zf; and a second refrigerant portion comprising at least one compound selected from the group consisting of pentafluoroethane (HFC-125), 1,1,1,2-tetrafluoroethane (HFC-134a), chlorodifluoromethane (HCFC-22), chloropentafluoroethane (CFC-115), E-1,3,3,3-tetrafluoro-1-propene (E-HFO-1234ze) and 1,1,1-trifluoroethane (HFC-143a).

**[0567]** Embodiment 43. A composition comprising (i) one of (a) difluoromethane (HFC-32), pentafluoroethane (HFC-125), 1,1,1,2-tetrafluoroethane (HFC-134a), 2,3,3,3-tetrafluoro-1-propene (HFO-1234yf), E-1,3,3,3-tetrafluoro-1-propene (E-HFO-1234ze), or (b) R-448A (26% HFC-32 / 26% HFC-125 / 21% HFC-134a / 20% HFO-1234yf / 7% E-HFO-1234ze); and (ii) at least one residual refrigerant selected from the group consisting of chlorodifluoromethane (HCFC-22), chloropentafluoroethane (CFC-115) and 1,1,1-trifluoroethane (HFC-143a).

**[0568]** Embodiment 44. A composition comprising (i) one of (a) difluoromethane (HFC-32), pentafluoroethane (HFC-125), 1,1,1,2-tetrafluoroethane (HFC-134a), 2,3,3,3-tetrafluoro-1-propene (HFO-1234yf), E-1,3,3,3-tetrafluoro-1-propene (E-HFO-1234ze), or (b) R-448A (26% HFC-32 / 26% HFC-125 / 21% HFC-134a / 20% HFO-1234yf / 7% E-HFO-1234ze); (ii) at least one residual refrigerant selected from the group consisting of chlorodifluoromethane (HCFC-22), chloropentafluoroethane (CFC-115) and 1,1,1-trifluoroethane (HFC-143a); (iii) at least one additional compound selected from the group consisting of HFC-143a, HFC-41, HFC-134a, HCFC-22, CFC-12 and HCC-40; (iv) at least one additional compound selected from the group consisting of HFC-23, HFC-32, HFC-143a, HFC-134a, CFC-115, CFO-1113 and HCC-40; (v) at least one additional compound selected from the group consisting of HFC-143a, HFO-1225zc, HFC-245cb, HFC-134, HFC-152a, HFO-1225ye, HFC-161, E-HFO-1234ze, HCFC-22, HFO-1243zf, CHFC-124, HCC-40, CHFO-1122, HCFC-31, CFC-114, CFC-114a and HCO-1140; (vi) at least one additional compound selected from the group consisting of HFO-1225ye, HFO-1243zf, E-HFO-1234ze, HFC-236ea, HCFC-244bb, HFC-245fa, HFC-245eb, HFC-245cb, 3,3,3-trifluoropropyne, HFC-152a, FO-1114, HFO-1123, HCFO-1131a, trans-HCFO-1131, HCO-1140, HCFO-1214ya, HFO-1216, HCFO-1224yd, HFO-1252 isomers, HFC-143a, HCFC-225 isomers, HFC-254eb, HFC-263fb, HFC-236fa, HCFC-142b, HCFC-244cc, HCFO-1223, HFO-1132a and HCC-40; and (vii) at least one additional compound selected from the group consisting of HFO-1234yf, HFC-245cb, HFO-1225ye(E), HFO-1225ye(Z), HFO-1225zc, HFC-236fa, HFC-152a, HFC-143a, HFC-125, HFC-134a, HFO-1234zc, HFO-1233xf, HFO-1233zd, CFC-114, HCFC-124, 3,3,3-trifluoropropyne, HFO-1234ze(Z), HFC-245fa, HFC-227ea, HFO-1243zf, HFC-263fb and HFC-134.

**[0569]** Embodiment 45. A composition comprising (i) one of (a) difluoromethane (HFC-32), pentafluoroethane (HFC-125), 1,1,1,2-tetrafluoroethane (HFC-134a), 2,3,3,3-tetrafluoro-1-propene (HFO-1234yf), E-1,3,3,3-tetrafluoro-1-propene (E-HFO-1234ze), or (b) R-448A (26% HFC-32 / 26% HFC-125 / 21% HFC-134a / 20% HFO-1234yf / 7% E-HFO-1234ze); (ii) at least one residual refrigerant selected from the group consisting of chlorodifluoromethane (HCFC-22), chloropentafluoroethane (CFC-115) and 1,1,1-trifluoroethane (HFC-143a); and (iii) at

least one additional compound selected from the group consisting of HFC-134a, HFC-245cb and HFO-1243zf.

**[0570]** Embodiment 46. A composition comprising: a first refrigerant portion comprising one of (a) difluoromethane (HFC-32), pentafluoroethane (HFC-125), 1,1,1,2-tetrafluoroethane (HFC-134a), 2,3,3,3-tetrafluoro-1-propene (HFO-1234yf), E-1,3,3,3-tetrafluoro-1-propene (E-HFO-1234ze), or (b) R-448A (26% HFC-32 / 26% HFC-125 / 21% HFC-134a / 20% HFO-1234yf / 7% E-HFO-1234ze); and a second refrigerant portion comprising at least one compound selected from the group consisting of chlorodifluoromethane (HCFC-22), chloropentafluoroethane (CFC-115) and 1,1,1-trifluoroethane (HFC-143a).

**[0571]** Embodiment 47. A composition comprising: a first refrigerant portion comprising (i) one of (a) difluoromethane (HFC-32), pentafluoroethane (HFC-125), 1,1,1,2-tetrafluoroethane (HFC-134a), 2,3,3,3-tetrafluoro-1-propene (HFO-1234yf), E-1,3,3,3-tetrafluoro-1-propene (E-HFO-1234ze), or (b) R-448A (26% HFC-32 / 26% HFC-125 / 21% HFC-134a / 20% HFO-1234yf / 7% E-HFO-1234ze); (ii) at least one additional compound selected from the group consisting of HFC-143a, HFC-41, HFC-134a, HCFC-22, CFC-12 and HCC-40; (iii) at least one additional compound selected from the group consisting of HFC-23, HFC-32, HFC-143a, HFC-134a, CFC-115, CFO-1113 and HCC-40; (iv) at least one additional compound selected from the group consisting of HFC-143a, HFO-1225zc, HFC-245cb, HFC-134, HFC-152a, HFO-1225ye, HFC-161, E-HFO-1234ze, HCFC-22, HFO-1243zf, HCFC-124, HCC-40, HCFO-1122, HCFC-31, CFC-114, CFC-114a and HCO-1140; (v) at least one additional compound selected from the group consisting of HFO-1225ye, HFO-1243zf, E-HFO-1234ze, HFC-236ea, HCFC-244bb, HFC-245fa, HFC-245eb, HFC-245cb, 3,3,3-trifluoropropyne, HFC-152a, FO-1114, HFO-1123, HCFO-1131a, trans-HCFO-1131, HCO-1140, HCFO-1214ya, HFO-1216, HCFO-1224yd, HFO-1252 isomers, HFC-143a, HCFC-225 isomers, HFC-254eb, HFC-263fb, HFC-236fa, HCFC-142b, HCFC-244cc, HCFO-1223, HFO-1132a and HCC-40; and (vi) at least one additional compound selected from the group consisting of HFO-1234yf, HFC-245cb, HFO-1225ye(E), HFO-1225ye(Z), HFO-1225zc, HFC-236fa, HFC-152a, HFC-143a, HFC-125, HFC-134a, HFO-1234zc, HFO-1233xf, HFO-1233zd, CFC-114, HCFC-124, 3,3,3-trifluoropropyne, HFO-1234ze(Z), HFC-245fa, HFC-227ea, HFO-1243zf, HFC-263fb and HFC-134; and a second refrigerant portion comprising

at least one compound selected from the group consisting of chlorodifluoromethane (HCFC-22), chloropentafluoroethane (CFC-115) and 1,1,1-trifluoroethane (HFC-143a).

**[0572]** Embodiment 48. A composition comprising: a first refrigerant portion comprising (i) one of (a) difluoromethane (HFC-32), pentafluoroethane (HFC-125), 1,1,1,2-tetrafluoroethane (HFC-134a), 2,3,3,3-tetrafluoro-1-propene (HFO-1234yf), E-1,3,3,3-tetrafluoro-1-propene (E-HFO-1234ze), or (b) R-448A (26% HFC-32 / 26% HFC-125 / 21% HFC-134a / 20% HFO-1234yf / 7% E-HFO-1234ze); and (ii) at least one additional compound selected from the group consisting of HFC-134a, HFC-245cb and HFO-1243zf; and a second refrigerant portion comprising at least one compound selected from the group consisting of chlorodifluoromethane (HCFC-22), chloropentafluoroethane (CFC-115) and 1,1,1-trifluoroethane (HFC-143a).

**[0573]** Embodiment 49. A composition comprising (i) one of (a) difluoromethane (HFC-32), pentafluoroethane (HFC-125), 1,1,1,2-tetrafluoroethane (HFC-134a) and 2,3,3,3-tetrafluoro-1-propene (HFO-1234yf), or (b) R-449A (24.3% HFC-32 / 24.7% HFC-125 / 25.7% HFC-134a / 25.3% HFO-1234yf); and (ii) at least one residual refrigerant selected from the group consisting of chlorodifluoromethane (HCFC-22), chloropentafluoroethane (CFC-115), E-1,3,3,3-tetrafluoro-1-propene (E-HFO-1234ze) and 1,1,1-trifluoroethane (HFC-143a).

**[0574]** Embodiment 50. A composition comprising (i) one of (a) difluoromethane (HFC-32), pentafluoroethane (HFC-125), 1,1,1,2-tetrafluoroethane (HFC-134a) and 2,3,3,3-tetrafluoro-1-propene (HFO-1234yf), or (b) R-449A (24.3% HFC-32 / 24.7% HFC-125 / 25.7% HFC-134a / 25.3% HFO-1234yf); (ii) at least one residual refrigerant selected from the group consisting of chlorodifluoromethane (HCFC-22), chloropentafluoroethane (CFC-115), E-1,3,3,3-tetrafluoro-1-propene (E-HFO-1234ze) and 1,1,1-trifluoroethane (HFC-143a); (iii) at least one additional compound selected from the group consisting of HFC-143a, HFC-41, HFC-134a, HCFC-22, CFC-12 and HCC-40; (iv) at least one additional compound selected from the group consisting of HFC-23, HFC-32, HFC-143a, HFC-134a, CFC-115, CFO-1113 and HCC-40; (v) at least one additional compound selected from the group consisting of HFC-143a, HFO-1225zc, HFC-245cb, HFC-134, HFC-152a, HFO-1225ye, HFC-161, E-HFO-1234ze, HCFC-22, HFO-1243zf, CHFC-124, HCC-40, CHFO-1122, HCFC-

31, CFC-114, CFC-114a and HCO-1140; and (vi) at least one additional compound selected from the group consisting of HFO-1225ye, HFO-1243zf, E-HFO-1234ze, HFC-236ea, HCFC-244bb, HFC-245fa, HFC-245eb, HFC-245cb, 3,3,3-trifluoropropyne, HFC-152a, FO-1114, HFO-1123, HCFO-1131a, trans-HCFO-1131, HCO-1140, HCFO-1214ya, HFO-1216, HCFO-1224yd, HFO-1252 isomers, HFC-143a, HCFC-225 isomers, HFC-254eb, HFC-263fb, HFC-236fa, HCFC-142b, HCFC-244cc, HCFO-1223, HFO-1132a and HCC-40.

**[0575]** Embodiment 51. A composition comprising (i) one of (a) difluoromethane (HFC-32), pentafluoroethane (HFC-125), 1,1,1,2-tetrafluoroethane (HFC-134a) and 2,3,3,3-tetrafluoro-1-propene (HFO-1234yf), or (b) R-449A (24.3% HFC-32 / 24.7% HFC-125 / 25.7% HFC-134a / 25.3% HFO-1234yf); (ii) at least one residual refrigerant selected from the group consisting of chlorodifluoromethane (HCFC-22), chloropentafluoroethane (CFC-115), E-1,3,3,3-tetrafluoro-1-propene (E-HFO-1234ze) and 1,1,1-trifluoroethane (HFC-143a); and (iii) at least one additional compound selected from the group consisting of HFC-134a, HFC-245cb and HFO-1243zf.

**[0576]** Embodiment 52. A composition comprising: a first refrigerant portion comprising one of (a) difluoromethane (HFC-32), pentafluoroethane (HFC-125), 1,1,1,2-tetrafluoroethane (HFC-134a) and 2,3,3,3-tetrafluoro-1-propene (HFO-1234yf), or (b) R-449A (24.3% HFC-32 / 24.7% HFC-125 / 25.7% HFC-134a / 25.3% HFO-1234yf); and a second refrigerant portion comprising at least one compound selected from the group consisting of chlorodifluoromethane (HCFC-22), chloropentafluoroethane (CFC-115), E-1,3,3,3-tetrafluoro-1-propene (E-HFO-1234ze) and 1,1,1-trifluoroethane (HFC-143a).

**[0577]** Embodiment 53. A composition comprising: a first refrigerant portion comprising (i) one of (a) difluoromethane (HFC-32), pentafluoroethane (HFC-125), 1,1,1,2-tetrafluoroethane (HFC-134a) and 2,3,3,3-tetrafluoro-1-propene (HFO-1234yf), or (b) R-449A (24.3% HFC-32 / 24.7% HFC-125 / 25.7% HFC-134a / 25.3% HFO-1234yf); (ii) at least one additional compound selected from the group consisting of HFC-143a, HFC-41, HFC-134a, HCFC-22, CFC-12 and HCC-40; (iii) at least one additional compound selected from the group consisting of HFC-23, HFC-32, HFC-143a, HFC-134a, CFC-115, CFO-1113 and HCC-40; (iv) at least one

additional compound selected from the group consisting of HFC-143a, HFO-1225zc, HFC-245cb, HFC-134, HFC-152a, HFO-1225ye, HFC-161, E-HFO-1234ze, HCFC-22, HFO-1243zf, CHFC-124, HCC-40, CHFO-1122, HCFC-31, CFC-114, CFC-114a and HCO-1140; and (v) at least one additional compound selected from the group consisting of HFO-1225ye, HFO-1243zf, E-HFO-1234ze, HFC-236ea, HCFC-244bb, HFC-245fa, HFC-245eb, HFC-245cb, 3,3,3-trifluoropropyne, HFC-152a, FO-1114, HFO-1123, HCFO-1131a, trans-HCFO-1131, HCO- 1140, HCFO-1214ya, HFO-1216, HCFO-1224yd, HFO-1252 isomers, HFC-143a, HCFC-225 isomers, HFC-254eb, HFC-263fb, HFC- 236fa, HCFC-142b, HCFC-244cc, HCFO-1223, HFO-1132a and HCC-40; and a second refrigerant portion comprising at least one compound selected from the group consisting of chlorodifluoromethane (HCFC-22), chloropentafluoroethane (CFC-115), E-1,3,3,3-tetrafluoro-1-propene (E-HFO-1234ze) and 1,1,1-trifluoroethane (HFC-143a).

**[0578]** Embodiment 54. A composition comprising: a first refrigerant portion comprising (i) one of (a) difluoromethane (HFC-32), pentafluoroethane (HFC-125), 1,1,1,2-tetrafluoroethane (HFC-134a) and 2,3,3,3-tetrafluoro-1-propene (HFO-1234yf), or (b) R-449A (24.3% HFC-32 / 24.7% HFC-125 / 25.7% HFC-134a / 25.3% HFO-1234yf); and (ii) at least one additional compound selected from the group consisting of HFC-134a, HFC-245cb and HFO-1243zf; and a second refrigerant portion comprising at least one compound selected from the group consisting of chlorodifluoromethane (HCFC-22), chloropentafluoroethane (CFC-115), E-1,3,3,3-tetrafluoro-1-propene (E-HFO-1234ze) and 1,1,1-trifluoroethane (HFC-143a).

**[0579]** Embodiment 55. A composition comprising (i) one of (a) 1,1,1-trifluoroethane (HFC-143a), pentafluoroethane (HFC-125) and 1,1,1,2-tetrafluoroethane (HFC-134a), or (b) R-404A (44% HFC-125 / 4% HFC-134a / 52% HFC-143a), and (ii) at least one residual refrigerant selected from the group consisting of chlorodifluoromethane (HCFC-22) and chloropentafluoroethane (CFC-115).

**[0580]** Embodiment 56. A composition comprising (i) one of (a) 1,1,1-trifluoroethane (HFC-143a), pentafluoroethane (HFC-125) and 1,1,1,2-tetrafluoroethane (HFC-134a), or (b) R-404A (44% HFC-125 / 4% HFC-134a / 52% HFC-143a); (ii) at least one residual refrigerant selected from the group consisting of

chlorodifluoromethane (HCFC-22) and chloropentafluoroethane (CFC-115); (iii) at least one additional compound selected from the group consisting of HFC-23, HFC-32, HFC-143a, HFC-134a, CFC-115, CFO-1113 and HCC-40; (iv) at least one additional compound selected from the group consisting of HFC-143a, HFO-1225zc, HFC-245cb, HFC-134, HFC-152a, HFO-1225ye, HFC-161, E-HFO-1234ze, HCFC-22, HFO-1243zf, CHFC-124, HCC-40, CHFO-1122, HCFC-31, CFC-114, CFC-114a and HCO-1140; and (v) at least one additional compound selected from the group consisting of CFC-115, HFC-134a, HFC-152a, HCFC-22, CFC-12, HCFC-124, CFC-114a and HCFC-133a.

**[0581]** Embodiment 57. A composition comprising (i) one of (a) 1,1,1-trifluoroethane (HFC-143a), pentafluoroethane (HFC-125) and 1,1,1,2-tetrafluoroethane (HFC-134a), or (b) R-404A (44% HFC-125 / 4% HFC-134a / 52% HFC-143a); (ii) at least one residual refrigerant selected from the group consisting of chlorodifluoromethane (HCFC-22) and chloropentafluoroethane (CFC-115); and (iii) at least one additional compound selected from the group consisting of HFC-134, HCC-40 and CFC-114a.

**[0582]** Embodiment 58. A composition comprising: a first refrigerant portion comprising one of (a) 1,1,1-trifluoroethane (HFC-143a), pentafluoroethane (HFC-125) and 1,1,1,2-tetrafluoroethane (HFC-134a), or (b) R-404A (44% HFC-125 / 4% HFC-134a / 52% HFC-143a); and a second refrigerant portion comprising at least one compound selected from the group consisting of chlorodifluoromethane (HCFC-22) and chloropentafluoroethane (CFC-115).

**[0583]** Embodiment 59. A composition comprising: a first refrigerant portion comprising (i) one of (a) 1,1,1-trifluoroethane (HFC-143a), pentafluoroethane (HFC-125) and 1,1,1,2-tetrafluoroethane (HFC-134a), or (b) R-404A (44% HFC-125 / 4% HFC-134a / 52% HFC-143a); (ii) at least one additional compound selected from the group consisting of HFC-23, HFC-32, HFC-143a, HFC-134a, CFC-115, CFO-1113 and HCC-40; (iii) at least one additional compound selected from the group consisting of HFC-143a, HFO-1225zc, HFC-245cb, HFC-134, HFC-152a, HFO-1225ye, HFC-161, E-HFO-1234ze, HCFC-22, HFO-1243zf, CHFC-124, HCC-40, CHFO-1122, HCFC-31, CFC-114, CFC-114a and HCO-1140; and (iv) at least one additional compound selected from the group consisting of CFC-115, HFC-134a,

HFC-152a, HCFC-22, CFC-12, HCFC-124, CFC-114a and HCFC-133a; and a second refrigerant portion comprising at least one compound selected from the group consisting of chlorodifluoromethane (HCFC-22) and chloropentafluoroethane (CFC-115).

**[0584]** Embodiment 60. A composition comprising: a first refrigerant portion comprising (i) one of (a) 1,1,1-trifluoroethane (HFC-143a), pentafluoroethane (HFC-125) and 1,1,1,2-tetrafluoroethane (HFC-134a), or (b) R-404A (44% HFC-125 / 4% HFC-134a / 52% HFC-143a); and (ii) at least one additional compound selected from the group consisting of HFC-134, HCC-40 and CFC-114a; and a second refrigerant portion comprising at least one compound selected from the group consisting of chlorodifluoromethane (HCFC-22) and chloropentafluoroethane (CFC-115).

**[0585]** Embodiment 61. A composition comprising (i) one of (a) 1,1,1-trifluoroethane (HFC-143a) and pentafluoroethane (HFC-125), or (b) R-507 (50% HFC-125 / 50% HFC-143a); and (ii) at least one residual refrigerant selected from the group consisting of chlorodifluoromethane (HCFC-22) and chloropentafluoroethane (CFC-115).

**[0586]** Embodiment 62. A composition comprising (i) one of (a) 1,1,1-trifluoroethane (HFC-143a) and pentafluoroethane (HFC-125), or (b) R-507 (50% HFC-125 / 50% HFC-143a); (ii) at least one residual refrigerant selected from the group consisting of chlorodifluoromethane (HCFC-22) and chloropentafluoroethane (CFC-115); (iii) at least one additional compound selected from the group consisting of HFC-23, HFC-32, HFC-143a, HFC-134a, CFC-115, CFO-1113 and HCC-40; and (iv) at least one additional compound selected from the group consisting of CFC-115, HFC-134a, HFC-152a, HCFC-22, CFC-12, HCFC-124, CFC-114a and HCFC-133a.

**[0587]** Embodiment 63. A composition comprising (i) one of (a) 1,1,1-trifluoroethane (HFC-143a) and pentafluoroethane (HFC-125), or (b) R-507 (50% HFC-125 / 50% HFC-143a); (ii) at least one residual refrigerant selected from the group consisting of chlorodifluoromethane (HCFC-22) and chloropentafluoroethane (CFC-115); and (iii) at least one additional compound selected from the group consisting of HFC-134a and HCC-40.

**[0588]** Embodiment 64. A composition comprising: a first refrigerant portion comprising one of (a) 1,1,1-trifluoroethane (HFC-143a) and pentafluoroethane (HFC-



125), or (b) R-507 (50% HFC-125 / 50% HFC-143a); and a second refrigerant portion comprising at least one compound selected from the group consisting of chlorodifluoromethane (HCFC-22) and chloropentafluoroethane (CFC-115).

**[0589]** Embodiment 65. A composition comprising: a first refrigerant portion comprising (i) one of (a) 1,1,1-trifluoroethane (HFC-143a) and pentafluoroethane (HFC-125), or (b) R-507 (50% HFC-125 / 50% HFC-143a); (ii) at least one additional compound selected from the group consisting of HFC-23, HFC-32, HFC-143a, HFC-134a, CFC-115, CFO-1113 and HCC-40; and (iii) at least one additional compound selected from the group consisting of CFC-115, HFC-134a, HFC-152a, HCFC-22, CFC-12, HCFC-124, CFC-114a and HCFC-133a; and a second refrigerant portion comprising at least one compound selected from the group consisting of chlorodifluoromethane (HCFC-22) and chloropentafluoroethane (CFC-115).

**[0590]** Embodiment 66. A composition comprising: a first refrigerant portion comprising (i) one of (a) 1,1,1-trifluoroethane (HFC-143a) and pentafluoroethane (HFC-125), or (b) R-507 (50% HFC-125 / 50% HFC-143a); and (ii) at least one additional compound selected from the group consisting of HFC-134a and HCC-40; and a second refrigerant portion comprising at least one compound selected from the group consisting of chlorodifluoromethane (HCFC-22) and chloropentafluoroethane (CFC-115).

**[0591]** Embodiment 67. A composition comprising (i) one of (a) difluoromethane (HFC-32) and 2,3,3,3-tetrafluoro-1-propene (HFO-1234yf), or (b) R-454A (35% HFC-32 / 65% HFO-1234yf), or (c) R-454C (21.5% HFC-32 / 78.5% HFO-1234yf); and (ii) at least one residual refrigerant selected from the group consisting of chlorodifluoromethane (HCFC-22), dichlorodifluoromethane (CFC-12), chloropentafluoroethane (CFC-115), pentafluoroethane (HFC-125), 1,1,1,2-tetrafluoroethane (HFC-134a) and 1,1,1-trifluoroethane (HFC-143a).

**[0592]** Embodiment 68. A composition comprising (i) one of (a) difluoromethane (HFC-32) and 2,3,3,3-tetrafluoro-1-propene (HFO-1234yf), or (b) R-454A (35% HFC-32 / 65% HFO-1234yf), or (c) R-454C (21.5% HFC-32 / 78.5% HFO-1234yf); (ii) at least one residual refrigerant selected from the group consisting of chlorodifluoromethane (HCFC-22), dichlorodifluoromethane (CFC-12), chloropentafluoroethane (CFC-115), pentafluoroethane (HFC-125), 1,1,1,2-

tetrafluoroethane (HFC-134a) and 1,1,1-trifluoroethane (HFC-143a); (iii) at least one additional compound selected from the group consisting of HFC-143a, HFC-41, HFC-134a, HCFC-22, CFC-12 and HCC-40; and (iv) at least one additional compound selected from the group consisting of HFO-1225ye, HFO-1243zf, E-HFO-1234ze, HFC-236ea, HCFC-244bb, HFC-245fa, HFC-245eb, HFC-245cb, 3,3,3-trifluoropropyne, HFC-152a, FO-1114, HFO-1123, HCFO-1131a, trans-HCFO-1131, HCO-1140, HCFO-1214ya, HFO-1216, HCFO-1224yd, HFO-1252 isomers, HFC-143a, HCFC-225 isomers, HFC-254eb, HFC-263fb, HFC-236fa, HCFC-142b, HCFC-244cc, HCFO-1223, HFO-1132a and HCC-40.

**[0593]** Embodiment 69. A composition comprising (i) one of (a) difluoromethane (HFC-32) and 2,3,3,3-tetrafluoro-1-propene (HFO-1234yf), or (b) R-454A (35% HFC-32 / 65% HFO-1234yf), or (c) R-454C (21.5% HFC-32 / 78.5% HFO-1234yf); (ii) at least one residual refrigerant selected from the group consisting of chlorodifluoromethane (HCFC-22), dichlorodifluoromethane (CFC-12), chloropentafluoroethane (CFC-115), pentafluoroethane (HFC-125), 1,1,1,2-tetrafluoroethane (HFC-134a) and 1,1,1-trifluoroethane (HFC-143a); and (iii) at least one additional compound selected from the group consisting of HFC-143a, HFC-245cb, HFO-1243zf and E-HFO-1234ze.

**[0594]** Embodiment 70. A composition comprising: a first refrigerant portion comprising one of (a) difluoromethane (HFC-32) and 2,3,3,3-tetrafluoro-1-propene (HFO-1234yf), or (b) R-454A (35% HFC-32 / 65% HFO-1234yf), or (c) R-454C (21.5% HFC-32 / 78.5% HFO-1234yf); and a second refrigerant portion comprising at least one compound selected from the group consisting of chlorodifluoromethane (HCFC-22), dichlorodifluoromethane (CFC-12), chloropentafluoroethane (CFC-115), pentafluoroethane (HFC-125), 1,1,1,2-tetrafluoroethane (HFC-134a) and 1,1,1-trifluoroethane (HFC-143a).

**[0595]** Embodiment 71. A composition comprising: a first refrigerant portion comprising (i) one of (a) difluoromethane (HFC-32) and 2,3,3,3-tetrafluoro-1-propene (HFO-1234yf), or (b) R-454A (35% HFC-32 / 65% HFO-1234yf), or (c) R-454C (21.5% HFC-32 / 78.5% HFO-1234yf); (ii) at least one additional compound selected from the group consisting of HFC-143a, HFC-41, HFC-134a, HCFC-22, CFC-12 and HCC-40; and (iii) at least one additional compound selected from the group

consisting of HFO-1225ye, HFO-1243zf, E-HFO-1234ze, HFC-236ea, HCFC-244bb, HFC-245fa, HFC-245eb, HFC-245cb, 3,3,3-trifluoropropyne, HFC-152a, FO-1114, HFO-1123, HCFO-1131a, trans-HCFO-1131, HCO- 1140, HCFO-1214ya, HFO-1216, HCFO-1224yd, HFO-1252 isomers, HFC-143a, HCFC-225 isomers, HFC-254eb, HFC-263fb, HFC- 236fa, HCFC-142b, HCFC-244cc, HCFO-1223, HFO-1132a and HCC-40; and a second refrigerant portion comprising at least one compound selected from the group consisting of chlorodifluoromethane (HCFC-22), dichlorodifluoromethane (CFC-12), chloropentafluoroethane (CFC-115), pentafluoroethane (HFC-125), 1,1,1,2-tetrafluoroethane (HFC-134a) and 1,1,1-trifluoroethane (HFC-143a).

**[0596]** Embodiment 72. A composition comprising: a first refrigerant portion comprising (i) one of (a) difluoromethane (HFC-32) and 2,3,3,3-tetrafluoro-1-propene (HFO-1234yf), or (b) R-454A (35% HFC-32 / 65% HFO-1234yf), or (c) R-454C (21.5% HFC-32 / 78.5% HFO-1234yf); and (ii) at least one additional compound selected from the group consisting of HFC-143a, HFC-245cb, HFO-1243zf and E-HFO-1234ze; and a second refrigerant portion comprising at least one compound selected from the group consisting of chlorodifluoromethane (HCFC-22), dichlorodifluoromethane (CFC-12), chloropentafluoroethane (CFC-115), pentafluoroethane (HFC-125), 1,1,1,2-tetrafluoroethane (HFC-134a) and 1,1,1-trifluoroethane (HFC-143a).

**[0597]** Embodiment 73. A composition comprising (i) one of (a) 1,1,1,2,3,3,3-heptafluoropropane (HFC-227ea), E-1,3,3,3-tetrafluoro-1-propene (E-HFO-1234ze) and E-1,1,1,4,4,4-hexafluoro-2-butene (E-HFO-1336mzz), or (b) R-471A (4.3% HFC-227ea / 78.7% HFO-1234ze(E) / 17% HFO-1336mzz(E)); and (ii) at least one residual refrigerant selected from the group consisting of chlorodifluoromethane (HCFC-22), dichlorodifluoromethane (CFC-12), chloropentafluoroethane (CFC-115), pentafluoroethane (HFC-125), 1,1,1,2-tetrafluoroethane (HFC-134a) and 1,1,1-trifluoroethane (HFC-143a).

**[0598]** Embodiment 74. A composition comprising (i) one of (a) 1,1,1,2,3,3,3-heptafluoropropane (HFC-227ea), E-1,3,3,3-tetrafluoro-1-propene (E-HFO-1234ze) and E-1,1,1,4,4,4-hexafluoro-2-butene (E-HFO-1336mzz), or (b) R-471A (4.3% HFC-227ea / 78.7% HFO-1234ze(E) / 17% HFO-1336mzz(E)); (ii) at least one residual

refrigerant selected from the group consisting of chlorodifluoromethane (HCFC-22), dichlorodifluoromethane (CFC-12), chloropentafluoroethane (CFC-115), pentafluoroethane (HFC-125), 1,1,1,2-tetrafluoroethane (HFC-134a) and 1,1,1-trifluoroethane (HFC-143a); (iii) at least one additional compound selected from the group consisting of HFC-23, FC-1216, HFC-143a, HFC-134a, HCFC-22, HCFC-124, FC-218, HFC-236fa and HFO-1225zc; (iv) at least one additional compound selected from the group consisting of HFO-1234yf, HFC-245cb, HFO-1225ye(E), HFO-1225ye(Z), HFO-1225zc, HFC-236fa, HFC-152a, HFC-143a, HFC-125, HFC-134a, HFO-1234zc, HFO-1233xf, HFO-1233zd, CFC-114, HCFC-124, 3,3,3-trifluoropropyne, HFO-1234ze(Z), HFC-245fa, HFC-227ea, HFO-1243zf, HFC-263fb and HFC-134; and (v) at least one additional compound selected from the group consisting of C-30, HCFC-114, HCFC-114a, HCFC-133, HCFC-133a, HFC-245fa, HFC-338mee, HFC-338mf, HFC-347mef, HCO-1140, HCFO-1224 isomers, HCFO-1224yd, HCFO-1224yb, HCFO-1233xf, HCFO-1233zd, HFO-1243zf, HFO-1327mz, HFO-1336ft and HCFO-1326mxz.

**[0599]** Embodiment 75. A composition comprising (i) one of (a) 1,1,1,2,3,3,3-heptafluoropropane (HFC-227ea), E-1,3,3,3-tetrafluoro-1-propene (E-HFO-1234ze) and E-1,1,1,4,4,4-hexafluoro-2-butene (E-HFO-1336mzz), or (b) R-471A (4.3% HFC-227ea / 78.7% HFO-1234ze(E) / 17% HFO-1336mzz(E)); (ii) at least one residual refrigerant selected from the group consisting of chlorodifluoromethane (HCFC-22), dichlorodifluoromethane (CFC-12), chloropentafluoroethane (CFC-115), pentafluoroethane (HFC-125), 1,1,1,2-tetrafluoroethane (HFC-134a) and 1,1,1-trifluoroethane (HFC-143a); and (iii) at least one additional compound selected from the group consisting of HCFC-133, HFO-1234yf, HFO-1225zc and HFO-1336ft.

**[0600]** Embodiment 76. A composition comprising: a first refrigerant portion comprising one of (a) 1,1,1,2,3,3,3-heptafluoropropane (HFC-227ea), E-1,3,3,3-tetrafluoro-1-propene (E-HFO-1234ze) and E-1,1,1,4,4,4-hexafluoro-2-butene (E-HFO-1336mzz), or (b) R-471A (4.3% HFC-227ea / 78.7% HFO-1234ze(E) / 17% HFO-1336mzz(E)); and a second refrigerant portion comprising at least one compound selected from the group consisting of chlorodifluoromethane (HCFC-22), dichlorodifluoromethane (CFC-12), chloropentafluoroethane (CFC-115), pentafluoroethane (HFC-125), 1,1,1,2-tetrafluoroethane (HFC-134a) and 1,1,1-trifluoroethane (HFC-143a).

**[0601]** Embodiment 77. A composition comprising: a first refrigerant portion comprising (i) one of (a) 1,1,1,2,3,3,3-heptafluoropropane (HFC-227ea), E-1,3,3,3-tetrafluoro-1-propene (E-HFO-1234ze) and E-1,1,1,4,4,4-hexafluoro-2-butene (E-HFO-1336mzz), or (b) R-471A (4.3% HFC-227ea / 78.7% HFO-1234ze(E) / 17% HFO-1336mzz(E)); (ii) at least one additional compound selected from the group consisting of HFC-23, FC-1216, HFC-143a, HFC-134a, HCFC-22, HCFC-124, FC-218, HFC-236fa and HFO-1225zc; (iii) at least one additional compound selected from the group consisting of HFO-1234yf, HFC-245cb, HFO-1225ye(E), HFO-1225ye(Z), HFO-1225zc, HFC-236fa, HFC-152a, HFC-143a, HFC-125, HFC-134a, HFO-1234zc, HFO-1233xf, HFO-1233zd, CFC-114, HCFC-124, 3,3,3-trifluoropropyne, HFO-1234ze(Z), HFC-245fa, HFC-227ea, HFO-1243zf, HFC-263fb and HFC-134; and (iv) at least one additional compound selected from the group consisting of C-30, HCFC-114, HCFC-114a, HCFC-133, HCFC-133a, HFC-245fa, HFC-338mee, HFC-338mf, HFC-347mef, HCO-1140, HCFO-1224 isomers, HCFO-1224yd, HCFO-1224yb, HCFO-1233xf, HCFO-1233zd, HFO-1243zf, HFO-1327mz, HFO-1336ft and HCFO-1326mxz; and a second refrigerant portion comprising at least one compound selected from the group consisting of chlorodifluoromethane (HCFC-22), dichlorodifluoromethane (CFC-12), chloropentafluoroethane (CFC-115), pentafluoroethane (HFC-125), 1,1,1,2-tetrafluoroethane (HFC-134a) and 1,1,1-trifluoroethane (HFC-143a).

**[0602]** Embodiment 78. A composition comprising: a first refrigerant portion comprising (i) one of (a) 1,1,1,2,3,3,3-heptafluoropropane (HFC-227ea), E-1,3,3,3-tetrafluoro-1-propene (E-HFO-1234ze) and E-1,1,1,4,4,4-hexafluoro-2-butene (E-HFO-1336mzz), or (b) R-471A (4.3% HFC-227ea / 78.7% HFO-1234ze(E) / 17% HFO-1336mzz(E)); and (ii) at least one additional compound selected from the group consisting of HCFC-133, HFO-1234yf, HFO-1225zc and HFO-1336ft; and a second refrigerant portion comprising at least one compound selected from the group consisting of chlorodifluoromethane (HCFC-22), dichlorodifluoromethane (CFC-12), chloropentafluoroethane (CFC-115), pentafluoroethane (HFC-125), 1,1,1,2-tetrafluoroethane (HFC-134a) and 1,1,1-trifluoroethane (HFC-143a).

**[0603]** Embodiment 79. A composition comprising (i) one of (a) 1,1,1,2-tetrafluoroethane (HFC-134a), E-1,3,3,3-tetrafluoro-1-propene (E-HFO-1234ze) and E-1,1,1,4,4,4-hexafluoro-2-butene (E-HFO-1336mzz), or (b) R-476A (10% HFC-134a

/ 78% HFO-1234ze(E) / 12% HFO-1336mzz(E)); and (ii) at least one residual refrigerant selected from the group consisting of chlorodifluoromethane (HCFC-22), dichlorodifluoromethane (CFC-12), chloropentafluoroethane (CFC-115), pentafluoroethane (HFC-125) and 1,1,1-trifluoroethane (HFC-143a).

**[0604]** Embodiment 80. A composition comprising (i) one of (a) 1,1,1,2-tetrafluoroethane (HFC-134a), E-1,3,3,3-tetrafluoro-1-propene (E-HFO-1234ze) and E-1,1,1,4,4,4-hexafluoro-2-butene (E-HFO-1336mzz), or (b) R-476A (10% HFC-134a / 78% HFO-1234ze(E) / 12% HFO-1336mzz(E)); (ii) at least one residual refrigerant selected from the group consisting of chlorodifluoromethane (HCFC-22), dichlorodifluoromethane (CFC-12), chloropentafluoroethane (CFC-115), pentafluoroethane (HFC-125) and 1,1,1-trifluoroethane (HFC-143a); (iii) at least one additional compound selected from the group consisting of HFC-143a, HFO-1225zc, HFC-245cb, HFC-134, HFC-152a, HFO-1225ye, HFC-161, E-HFO-1234ze, HCFC-22, HFO-1243zf, CHFC-124, HCC-40, CHFO-1122, HCFC-31, CFC-114, CFC-114a and HCO-1140; (iv) at least one additional compound selected from the group consisting of HFO-1234yf, HFC-245cb, HFO-1225ye(E), HFO-1225ye(Z), HFO-1225zc, HFC-236fa, HFC-152a, HFC-143a, HFC-125, HFC-134a, HFO-1234zc, HFO-1233xf, HFO-1233zd, CFC-114, HCFC-124, 3,3,3-trifluoropropyne, HFO-1234ze(Z), HFC-245fa, HFC-227ea, HFO-1243zf, HFC-263fb and HFC-134; and (v) at least one additional compound selected from the group consisting of C-30, HCFC-114, HCFC-114a, HCFC-133, HCFC-133a, HFC-245fa, HFC-338mee, HFC-338mf, HFC-347mef, HCO-1140, HCFO-1224 isomers, HCFO-1224yd, HCFO-1224yb, HCFO-1233xf, HCFO-1233zd, HFO-1243zf, HFO-1327mz, HFO-1336ft and HCFO-1326mxz.

**[0605]** Embodiment 81. A composition comprising (i) one of (a) 1,1,1,2-tetrafluoroethane (HFC-134a), E-1,3,3,3-tetrafluoro-1-propene (E-HFO-1234ze) and E-1,1,1,4,4,4-hexafluoro-2-butene (E-HFO-1336mzz), or (b) R-476A (10% HFC-134a / 78% HFO-1234ze(E) / 12% HFO-1336mzz(E)); (ii) at least one residual refrigerant selected from the group consisting of chlorodifluoromethane (HCFC-22), dichlorodifluoromethane (CFC-12), chloropentafluoroethane (CFC-115), pentafluoroethane (HFC-125) and 1,1,1-trifluoroethane (HFC-143a); and (iii) at least one additional compound selected from the group consisting of HFC-134a, HFC-245cb, HFO-1234yf, HFO-1225zc and HFO-1336ft.

**[0606]** Embodiment 82. A composition comprising: a first refrigerant portion comprising one of (a) 1,1,1,2-tetrafluoroethane (HFC-134a), E-1,3,3,3-tetrafluoro-1-propene (E-HFO-1234ze) and E-1,1,1,4,4,4-hexafluoro-2-butene (E-HFO-1336mzz), or (b) R-476A (10% HFC-134a / 78% HFO-1234ze(E) / 12% HFO-1336mzz(E)); and a second refrigerant portion comprising at least one compound selected from the group consisting of chlorodifluoromethane (HCFC-22), dichlorodifluoromethane (CFC-12), chloropentafluoroethane (CFC-115), pentafluoroethane (HFC-125) and 1,1,1-trifluoroethane (HFC-143a).

**[0607]** Embodiment 83. A composition comprising: a first refrigerant portion comprising (i) one of (a) 1,1,1,2-tetrafluoroethane (HFC-134a), E-1,3,3,3-tetrafluoro-1-propene (E-HFO-1234ze) and E-1,1,1,4,4,4-hexafluoro-2-butene (E-HFO-1336mzz), or (b) R-476A (10% HFC-134a / 78% HFO-1234ze(E) / 12% HFO-1336mzz(E)); (ii) at least one additional compound selected from the group consisting of HFC-143a, HFO-1225zc, HFC-245cb, HFC-134, HFC-152a, HFO-1225ye, HFC-161, E-HFO-1234ze, HCFC-22, HFO-1243zf, CHFC-124, HCC-40, CHFO-1122, HCFC-31, CFC-114, CFC-114a and HCO-1140; (iii) at least one additional compound selected from the group consisting of HFO-1234yf, HFC-245cb, HFO-1225ye(E), HFO-1225ye(Z), HFO-1225zc, HFC-236fa, HFC-152a, HFC-143a, HFC-125, HFC-134a, HFO-1234zc, HFO-1233xf, HFO-1233zd, CFC-114, HCFC-124, 3,3,3-trifluoropropyne, HFO-1234ze(Z), HFC-245fa, HFC-227ea, HFO-1243zf, HFC-263fb and HFC-134; and (iv) at least one additional compound selected from the group consisting of C-30, HCFC-114, HCFC-114a, HCFC-133, HCFC-133a, HFC-245fa, HFC-338mee, HFC-338mf, HFC-347mef, HCO-1140, HCFO-1224 isomers, HCFO-1224yd, HCFO-1224yb, HCFO-1233xf, HCFO-1233zd, HFO-1243zf, HFO-1327mz, HFO-1336ft and HCFO-1326mxz; and a second refrigerant portion comprising at least one compound selected from the group consisting of chlorodifluoromethane (HCFC-22), dichlorodifluoromethane (CFC-12), chloropentafluoroethane (CFC-115), pentafluoroethane (HFC-125) and 1,1,1-trifluoroethane (HFC-143a).

**[0608]** Embodiment 84. A composition comprising: a first refrigerant portion comprising (i) one of (a) 1,1,1,2-tetrafluoroethane (HFC-134a), E-1,3,3,3-tetrafluoro-1-propene (E-HFO-1234ze) and E-1,1,1,4,4,4-hexafluoro-2-butene (E-HFO-1336mzz), or (b) R-476A (10% HFC-134a / 78% HFO-1234ze(E) / 12% HFO-

1336mzz(E)); and (ii) at least one additional compound selected from the group consisting of HFC-134a, HFC-245cb, HFO-1234yf, HFO-1225zc and HFO-1336ft; and a second refrigerant portion comprising at least one compound selected from the group consisting of chlorodifluoromethane (HCFC-22), dichlorodifluoromethane (CFC-12), chloropentafluoroethane (CFC-115), pentafluoroethane (HFC-125) and 1,1,1-trifluoroethane (HFC-143a).

**[0609]** Embodiment 85. A composition comprising (i) one of (a) 1,1,1,2-tetrafluoroethane (HFC-134a), E-1,3,3,3-tetrafluoro-1-propene (E-HFO-1234ze) and Z-1-chloro-2,3,3,3-tetrafluoropropene (Z-HFO-1224yd), or (b) R-482A (10% HFC-134a / 83.5% HFO-1234ze(E) / 6.5% HFO-1224yd(Z)); and (ii) at least one residual refrigerant selected from the group consisting of chlorodifluoromethane (HCFC-22), dichlorodifluoromethane (CFC-12), chloropentafluoroethane (CFC-115), pentafluoroethane (HFC-125) and 1,1,1-trifluoroethane (HFC-143a).

**[0610]** Embodiment 86. A composition comprising (i) one of (a) 1,1,1,2-tetrafluoroethane (HFC-134a), E-1,3,3,3-tetrafluoro-1-propene (E-HFO-1234ze) and Z-1-chloro-2,3,3,3-tetrafluoropropene (Z-HFO-1224yd), or (b) R-482A (10% HFC-134a / 83.5% HFO-1234ze(E) / 6.5% HFO-1224yd(Z)); (ii) at least one residual refrigerant selected from the group consisting of chlorodifluoromethane (HCFC-22), dichlorodifluoromethane (CFC-12), chloropentafluoroethane (CFC-115), pentafluoroethane (HFC-125) and 1,1,1-trifluoroethane (HFC-143a); (iii) at least one additional compound selected from the group consisting of HFC-143a, HFO-1225zc, HFC-245cb, HFC-134, HFC-152a, HFO-1225ye, HFC-161, E-HFO-1234ze, HCFC-22, HFO-1243zf, CHFC-124, HCC-40, CHFO-1122, HCFC-31, CFC-114, CFC-114a and HCO-1140; (iv) at least one additional compound selected from the group consisting of HFO-1234yf, HFC-245cb, HFO-1225ye(E), HFO-1225ye(Z), HFO-1225zc, HFC-236fa, HFC-152a, HFC-143a, HFC-125, HFC-134a, HFO-1234zc, HFO-1233xf, HFO-1233zd, CFC-114, HCFC-124, 3,3,3-trifluoropropyne, HFO-1234ze(Z), HFC-245fa, HFC-227ea, HFO-1243zf, HFC-263fb and HFC-134; and (v) at least one additional compound selected from the group consisting of HFO-1234yf, HFO-1234ze(E), HFO-1243zf, HFC-263fb, HFC-254eb, HFO-1215yb, HCFC-244bb, HCFO-1224yd(E), HCFO-1224 isomer(s), CFO-1112a, HFC-225ca, HFC-225cb and HFC-234bb.



**[0611]** Embodiment 87. A composition comprising (i) one of (a) 1,1,1,2-tetrafluoroethane (HFC-134a), E-1,3,3,3-tetrafluoro-1-propene (E-HFO-1234ze) and Z-1-chloro-2,3,3,3-tetrafluoropropene (Z-HFO-1224yd), or (b) R-482A (10% HFC-134a / 83.5% HFO-1234ze(E) / 6.5% HFO-1224yd(Z)); (ii) at least one residual refrigerant selected from the group consisting of chlorodifluoromethane (HCFC-22), dichlorodifluoromethane (CFC-12), chloropentafluoroethane (CFC-115), pentafluoroethane (HFC-125) and 1,1,1-trifluoroethane (HFC-143a); and (iii) at least one additional compound selected from the group consisting of HFC-134a, HFC-245cb, HFO-1234yf and HFO-1243zf.

**[0612]** Embodiment 88. A composition comprising: a first refrigerant portion comprising one of (a) 1,1,1,2-tetrafluoroethane (HFC-134a), E-1,3,3,3-tetrafluoro-1-propene (E-HFO-1234ze) and Z-1-chloro-2,3,3,3-tetrafluoropropene (Z-HFO-1224yd), or (b) R-482A (10% HFC-134a / 83.5% HFO-1234ze(E) / 6.5% HFO-1224yd(Z)); and a second refrigerant portion comprising at least one compound selected from the group consisting of chlorodifluoromethane (HCFC-22), dichlorodifluoromethane (CFC-12), chloropentafluoroethane (CFC-115), pentafluoroethane (HFC-125) and 1,1,1-trifluoroethane (HFC-143a).

**[0613]** Embodiment 89. A composition comprising: a first refrigerant portion comprising (i) one of (a) 1,1,1,2-tetrafluoroethane (HFC-134a), E-1,3,3,3-tetrafluoro-1-propene (E-HFO-1234ze) and Z-1-chloro-2,3,3,3-tetrafluoropropene (Z-HFO-1224yd), or (b) R-482A (10% HFC-134a / 83.5% HFO-1234ze(E) / 6.5% HFO-1224yd(Z)); (ii) at least one additional compound selected from the group consisting of HFC-143a, HFO-1225zc, HFC-245cb, HFC-134, HFC-152a, HFO-1225ye, HFC-161, E-HFO-1234ze, HCFC-22, HFO-1243zf, CHFC-124, HCC-40, CHFO-1122, HCFC-31, CFC-114, CFC-114a and HCO-1140; (iii) at least one additional compound selected from the group consisting of HFO-1234yf, HFC-245cb, HFO-1225ye(E), HFO-1225ye(Z), HFO-1225zc, HFC-236fa, HFC-152a, HFC-143a, HFC-125, HFC-134a, HFO-1234zc, HFO-1233xf, HFO-1233zd, CFC-114, HCFC-124, 3,3,3-trifluoropropyne, HFO-1234ze(Z), HFC-245fa, HFC-227ea, HFO-1243zf, HFC-263fb and HFC-134; and (iv) at least one additional compound selected from the group consisting of HFO-1234yf, HFO-1234ze(E), HFO-1243zf, HFC-263fb, HFC-254eb, HFO-1215yb, HCFC-244bb, HCFO-1224yd(E), HCFO-1224 isomer(s), CFO-1112a, HFC-225ca, HFC-225cb and HFC-234bb; and a second refrigerant

portion comprising at least one compound selected from the group consisting of chlorodifluoromethane (HCFC-22), dichlorodifluoromethane (CFC-12), chloropentafluoroethane (CFC-115), pentafluoroethane (HFC-125) and 1,1,1-trifluoroethane (HFC-143a).

**[0614]** Embodiment 90. A composition comprising: a first refrigerant portion comprising (i) one of (a) 1,1,1,2-tetrafluoroethane (HFC-134a), E-1,3,3,3-tetrafluoro-1-propene (E-HFO-1234ze) and Z-1-chloro-2,3,3,3-tetrafluoropropene (Z-HFO-1224yd), or (b) R-482A (10% HFC-134a / 83.5% HFO-1234ze(E) / 6.5% HFO-1224yd(Z)); and (ii) at least one additional compound selected from the group consisting of HFC-134a, HFC-245cb, HFO-1234yf and HFO-1243zf; and a second refrigerant portion comprising at least one compound selected from the group consisting of chlorodifluoromethane (HCFC-22), dichlorodifluoromethane (CFC-12), chloropentafluoroethane (CFC-115), pentafluoroethane (HFC-125) and 1,1,1-trifluoroethane (HFC-143a).

**[0615]** Embodiment 91. A composition comprising (i) one of (a) 1,1,1,2,3,3,3-heptafluoropropane (HFC-227ea) and E-1,3,3,3-tetrafluoro-1-propene (E-HFO-1234ze), or (b) R-515B (8.9% HFC-227ea / 91.1% E-HFO-1234ze); and (ii) at least one residual refrigerant selected from the group consisting of trichlorofluoromethane (CFC-11) and 1,1,1,2-tetrafluoroethane (HFC-134a).

**[0616]** Embodiment 92. A composition comprising (i) one of (a) 1,1,1,2,3,3,3-heptafluoropropane (HFC-227ea) and E-1,3,3,3-tetrafluoro-1-propene (E-HFO-1234ze), or (b) R-515B (8.9% HFC-227ea / 91.1% E-HFO-1234ze); (ii) at least one residual refrigerant selected from the group consisting of trichlorofluoromethane (CFC-11) and 1,1,1,2-tetrafluoroethane (HFC-134a); (iii) at least one additional compound selected from the group consisting of HFC-23, FC-1216, HFC-143a, HFC-134a, HCFC-22, HCFC-124, FC-218, HFC-236fa and HFO-1225zc; and (iv) at least one additional compound selected from the group consisting of HFO-1234yf, HFC-245cb, HFO-1225ye(E), HFO-1225ye(Z), HFO-1225zc, HFC-236fa, HFC-152a, HFC-143a, HFC-125, HFC-134a, HFO-1234zc, HFO-1233xf, HFO-1233zd, CFC-114, HCFC-124, 3,3,3-trifluoropropyne, HFO-1234ze(Z), HFC-245fa, HFC-227ea, HFO-1243zf, HFC-263fb and HFC-134.

**[0617]** Embodiment 93. A composition comprising (i) one of (a) 1,1,1,2,3,3,3-heptafluoropropane (HFC-227ea) and E-1,3,3,3-tetrafluoro-1-propene (E-HFO-1234ze), or (b) R-515B (8.9% HFC-227ea / 91.1% E-HFO-1234ze); (ii) at least one residual refrigerant selected from the group consisting of trichlorofluoromethane (CFC-11) and 1,1,1,2-tetrafluoroethane (HFC-134a); and (iii) at least one additional compound selected from the group consisting of HFC-245cb, HFO-1234yf, HFO-1225zc and FC-1216.

**[0618]** Embodiment 94. A composition comprising: a first refrigerant portion comprising one of (a) 1,1,1,2,3,3,3-heptafluoropropane (HFC-227ea) and E-1,3,3,3-tetrafluoro-1-propene (E-HFO-1234ze), or (b) R-515B (8.9% HFC-227ea / 91.1% E-HFO-1234ze); and a second refrigerant portion comprising at least one compound selected from the group consisting of trichlorofluoromethane (CFC-11) and 1,1,1,2-tetrafluoroethane (HFC-134a).

**[0619]** Embodiment 95. A composition comprising: a first refrigerant portion comprising (i) one of (a) 1,1,1,2,3,3,3-heptafluoropropane (HFC-227ea) and E-1,3,3,3-tetrafluoro-1-propene (E-HFO-1234ze), or (b) R-515B (8.9% HFC-227ea / 91.1% E-HFO-1234ze); (ii) at least one additional compound selected from the group consisting of HFC-23, FC-1216, HFC-143a, HFC-134a, HCFC-22, HCFC-124, FC-218, HFC-236fa and HFO-1225zc; and (iii) at least one additional compound selected from the group consisting of HFO-1234yf, HFC-245cb, HFO-1225ye(E), HFO-1225ye(Z), HFO-1225zc, HFC-236fa, HFC-152a, HFC-143a, HFC-125, HFC-134a, HFO-1234zc, HFO-1233xf, HFO-1233zd, CFC-114, HCFC-124, 3,3,3-trifluoropropyne, HFO-1234ze(Z), HFC-245fa, HFC-227ea, HFO-1243zf, HFC-263fb and HFC-134; and a second refrigerant portion comprising at least one compound selected from the group consisting of trichlorofluoromethane (CFC-11) and 1,1,1,2-tetrafluoroethane (HFC-134a).

**[0620]** Embodiment 96. A composition comprising: a first refrigerant portion comprising (i) one of (a) 1,1,1,2,3,3,3-heptafluoropropane (HFC-227ea) and E-1,3,3,3-tetrafluoro-1-propene (E-HFO-1234ze), or (b) R-515B (8.9% HFC-227ea / 91.1% E-HFO-1234ze); and (ii) at least one additional compound selected from the group consisting of HFC-245cb, HFO-1234yf, HFO-1225zc and FC-1216; and a second refrigerant portion comprising at least one compound selected from the

group consisting of trichlorofluoromethane (CFC-11) and 1,1,1,2-tetrafluoroethane (HFC-134a).

**[0621]** Embodiment 97. A composition comprising (i) one of (a) Z-1,1,1,4,4,4-hexafluoro-2-butene (Z-HFO-1336mzz) and trans-1,2-dichloroethylene (t-DCE), or (b) R-514A (74.7% Z-HFO-1336mzz / 25.3% t-DCE); and (ii) at least one residual refrigerant selected from the group consisting of trichlorofluoromethane (CFC-11) and 1,1-dichloro-2,2,2-trifluoroethane (HFC-123).

**[0622]** Embodiment 98. A composition comprising (i) one of (a) Z-1,1,1,4,4,4-hexafluoro-2-butene (Z-HFO-1336mzz) and trans-1,2-dichloroethylene (t-DCE), or (b) R-514A (74.7% Z-HFO-1336mzz / 25.3% t-DCE); (ii) at least one residual refrigerant selected from the group consisting of trichlorofluoromethane (CFC-11) and 1,1-dichloro-2,2,2-trifluoroethane (HFC-123); (iii) at least one additional compound selected from the group consisting of HFO-1326mxzE, HFO-1326nxzZ, HFC-346mdf, HFC-356mff and HFO-1336mzz(E); and (iv) at least one additional compound selected from the group consisting of HCC-2120, HCC-1140, HCO-1130a, HCC-30, HCC-150a, cis-DCE, HCC-20, HCC-140a and HCO-1120.

**[0623]** Embodiment 99. A composition comprising (i) one of (a) Z-1,1,1,4,4,4-hexafluoro-2-butene (Z-HFO-1336mzz) and trans-1,2-dichloroethylene (t-DCE), or (b) R-514A (74.7% Z-HFO-1336mzz / 25.3% t-DCE); (ii) at least one residual refrigerant selected from the group consisting of trichlorofluoromethane (CFC-11) and 1,1-dichloro-2,2,2-trifluoroethane (HFC-123); and (iii) at least one additional compound selected from the group consisting of HFO-1326mxz(E), HFO-1326mxz(Z), HCC-2120, HCC-1140, HCO-1130a, cis-DCE and HCC-30.

**[0624]** Embodiment 100. A composition comprising: a first refrigerant portion comprising one of (a) Z-1,1,1,4,4,4-hexafluoro-2-butene (Z-HFO-1336mzz) and trans-1,2-dichloroethylene (t-DCE), or (b) R-514A (74.7% Z-HFO-1336mzz / 25.3% t-DCE); and a second refrigerant portion comprising at least one compound selected from the group consisting of trichlorofluoromethane (CFC-11) and 1,1-dichloro-2,2,2-trifluoroethane (HFC-123).

**[0625]** Embodiment 101. A composition comprising: a first refrigerant portion comprising (i) one of (a) Z-1,1,1,4,4,4-hexafluoro-2-butene (Z-HFO-1336mzz) and trans-1,2-dichloroethylene (t-DCE), or (b) R-514A (74.7% Z-HFO-1336mzz / 25.3% t-

DCE); (ii) at least one additional compound selected from the group consisting of HFO-1326mxzE, HFO-1326nxzZ, HFC-346mdf, HFC-356mff and HFO-1336mzz(E); and (iii) at least one additional compound selected from the group consisting of HCC-2120, HCC-1140, HCO-1130a, HCC-30, HCC-150a, cis-DCE, HCC-20, HCC-140a and HCO-1120; and a second refrigerant portion comprising at least one compound selected from the group consisting of trichlorofluoromethane (CFC-11) and 1,1-dichloro-2,2,2-trifluoroethane (HFC-123).

**[0626]** Embodiment 102. A composition comprising: a first refrigerant portion comprising (i) one of (a) Z-1,1,1,4,4,4-hexafluoro-2-butene (Z-HFO-1336mzz) and trans-1,2-dichloroethylene (t-DCE), or (b) R-514A (74.7% Z-HFO-1336mzz / 25.3% t-DCE); and (ii) at least one additional compound selected from the group consisting of HFO-1326mxz(E), HFO-1326mxz(Z), HCC-2120, HCC-1140, HCO-1130a, cis-DCE and HCC-30; and a second refrigerant portion comprising at least one compound selected from the group consisting of trichlorofluoromethane (CFC-11) and 1,1-dichloro-2,2,2-trifluoroethane (HFC-123).

**[0627]** Embodiment 103. A composition comprising (i) one of (a) difluoromethane (HFC-32), 1,1-difluoroethane (HFC-152a), E-1,3,3,3-tetrafluoro-1-propene (E-HFO-1234ze), or (b) R-444A (12% HFC-32 / 5% HFC-152a / 83% E-HFO-1234ze); and (ii) at least one residual refrigerant selected from the group consisting of dichlorodifluoromethane (CFC-12), 1,1,1,2-tetrafluoroethane (HFC-134a) and 2,3,3,3-tetrafluoro-1-propene (HFO-1234yf).

**[0628]** Embodiment 104. A composition comprising (i) one of (a) difluoromethane (HFC-32), 1,1-difluoroethane (HFC-152a), E-1,3,3,3-tetrafluoro-1-propene (E-HFO-1234ze), or (b) R-444A (12% HFC-32 / 5% HFC-152a / 83% E-HFO-1234ze); (ii) at least one residual refrigerant selected from the group consisting of dichlorodifluoromethane (CFC-12), 1,1,1,2-tetrafluoroethane (HFC-134a) and 2,3,3,3-tetrafluoro-1-propene (HFO-1234yf); (iii) at least one additional compound selected from the group consisting of HFC-143a, HFC-41, HFC-134a, HCFC-22, CFC-12 and HCC-40; (iv) at least one additional compound selected from the group consisting of HFC-161, HCC-40, isobutane, HCO-1140, HCC-160 and CFC-114a; and (v) at least one additional compound selected from the group consisting of HFO-1234yf, HFC-245cb, HFO-1225ye(E), HFO-1225ye(Z), HFO-1225zc, HFC-236fa,

HFC-152a, HFC-143a, HFC-125, HFC-134a, HFO-1234zc, HFO-1233xf, HFO-1233zd, CFC-114, HCFC-124, 3,3,3-trifluoropropyne, HFO-1234ze(Z), HFC-245fa, HFC-227ea, HFO-1243zf, HFC-263fb and HFC-134.

**[0629]** Embodiment 105. A composition comprising (i) one of (a) difluoromethane (HFC-32), 1,1-difluoroethane (HFC-152a), E-1,3,3,3-tetrafluoro-1-propene (E-HFO-1234ze), or (b) R-444A (12% HFC-32 / 5% HFC-152a / 83% E-HFO-1234ze); (ii) at least one residual refrigerant selected from the group consisting of dichlorodifluoromethane (CFC-12), 1,1,1,2-tetrafluoroethane (HFC-134a) and 2,3,3,3-tetrafluoro-1-propene (HFO-1234yf); and (iii) at least one additional compound selected from the group consisting of HFC-143a, HFC-245cb and HFO-1225zc.

**[0630]** Embodiment 106. A composition comprising: a first refrigerant portion comprising one of (a) difluoromethane (HFC-32), 1,1-difluoroethane (HFC-152a), E-1,3,3,3-tetrafluoro-1-propene (E-HFO-1234ze), or (b) R-444A (12% HFC-32 / 5% HFC-152a / 83% E-HFO-1234ze); and a second refrigerant portion comprising at least one compound selected from the group consisting of dichlorodifluoromethane (CFC-12), 1,1,1,2-tetrafluoroethane (HFC-134a) and 2,3,3,3-tetrafluoro-1-propene (HFO-1234yf).

**[0631]** Embodiment 107. A composition comprising: a first refrigerant portion comprising (i) one of (a) difluoromethane (HFC-32), 1,1-difluoroethane (HFC-152a), E-1,3,3,3-tetrafluoro-1-propene (E-HFO-1234ze), or (b) R-444A (12% HFC-32 / 5% HFC-152a / 83% E-HFO-1234ze); (ii) at least one additional compound selected from the group consisting of HFC-143a, HFC-41, HFC-134a, HCFC-22, CFC-12 and HCC-40; (iii) at least one additional compound selected from the group consisting of HFC-161, HCC-40, isobutane, HCO-1140, HCC-160 and CFC-114a; and (iv) at least one additional compound selected from the group consisting of HFO-1234yf, HFC-245cb, HFO-1225ye(E), HFO-1225ye(Z), HFO-1225zc, HFC-236fa, HFC-152a, HFC-143a, HFC-125, HFC-134a, HFO-1234zc, HFO-1233xf, HFO-1233zd, CFC-114, HCFC-124, 3,3,3-trifluoropropyne, HFO-1234ze(Z), HFC-245fa, HFC-227ea, HFO-1243zf, HFC-263fb and HFC-134; and a second refrigerant portion comprising at least one compound selected from the group consisting of

dichlorodifluoromethane (CFC-12), 1,1,1,2-tetrafluoroethane (HFC-134a) and 2,3,3,3-tetrafluoro-1-propene (HFO-1234yf).

**[0632]** Embodiment 108. A composition comprising: a first refrigerant portion comprising (i) one of (a) difluoromethane (HFC-32), 1,1-difluoroethane (HFC-152a), E-1,3,3,3-tetrafluoro-1-propene (E-HFO-1234ze), or (b) R-444A (12% HFC-32 / 5% HFC-152a / 83% E-HFO-1234ze); and (ii) at least one additional compound selected from the group consisting of HFC-143a, HFC-245cb and HFO-1225zc; and a second refrigerant portion comprising at least one compound selected from the group consisting of dichlorodifluoromethane (CFC-12), 1,1,1,2-tetrafluoroethane (HFC-134a) and 2,3,3,3-tetrafluoro-1-propene (HFO-1234yf).

**[0633]** Embodiment 109. The composition according to any one of Embodiments 1-3, 7-9, 13-15, 19-21, 25-27, 31-33, 37-39, 43-45, 49-51, 55-57, 61-63, 67-69, 73-75, 79-81, 85-87, 91-93, 97-99 and 103-105, wherein a total amount of the residual refrigerants is from about 0.00001 to about 2 weight percent, preferably about 0.00001 to about 0.5 weight percent, based on a total weight of the composition.

**[0634]** Embodiment 110. The composition according to any one of Embodiments 4-6, 10-12, 16-18, 22-24, 28-30, 34-36, 40-42, 46-48, 52-54, 58-60, 64-66, 70-72, 76-78, 82-84, 88-90, 94-96, 100-102, and 106-108, wherein an amount of the second refrigerant portion is from about 0.00001 to about 0.5 weight percent, preferably from about 0.0001 to about 0.5 weight percent, based on a total weight of the composition.

**[0635]** Embodiment 111. A heat transfer system comprising the composition of any of Embodiments 1 to 108.

**[0636]** Embodiment 112. The heat transfer system of Embodiment 111, wherein said heat transfer system is designed for use with or previously contained at least one of the residual refrigerants.

**[0637]** Embodiment 113. The heat transfer system of any of Embodiments 111-112, wherein the heat transfer system comprises at least one member selected from the group consisting of air conditioners, freezers, refrigerators, heat pumps, water chillers, flooded evaporator chillers, direct expansion chillers, walk-in coolers, heat pumps, mobile refrigerators, mobile air conditioning units and combinations thereof;

and wherein the heat transfer system comprises a working fluid comprising the composition of any one of Embodiments 1 to 110.

**[0638]** Embodiment 114. The heat transfer system of any of Embodiments 111-113, comprising a commercial refrigeration system.

**[0639]** Embodiment 115. The heat transfer system of any of Embodiments 111-113, comprising a medium or low temperature refrigeration system.

**[0640]** Embodiment 116. The heat transfer system of any of Embodiments 111-113, comprising a residential refrigerator or freezer.

**[0641]** Embodiment 117. The heat transfer system of any of Embodiments 111-113, comprising a heat pump.

**[0642]** Embodiment 118. The heat transfer system of any of Embodiments 111-113, comprising a high temperature heat pump.

**[0643]** Embodiment 119. The heat transfer system of any of Embodiments 111-113, comprising a chiller.

**[0644]** Embodiment 120. The heat transfer system of any of Embodiments 111-113, comprising an air conditioning system.

**[0645]** Embodiment 121. The heat transfer system of any of Embodiments 111-113, comprising an automotive air conditioning system.

**[0646]** Embodiment 122. A container or cylinder, preferably a recovery container or recovery cylinder, containing the composition of any of Embodiments 1 to 110.

**[0647]** Embodiment 123. A RRR machine containing the composition of any of Embodiments 1 to 110.

**[0648]** Embodiment 124. The composition of any of Embodiments 1 to 110, wherein the composition is a spent or used thermal management fluid.

**[0649]** Embodiment 125. The composition of any of Embodiments 1 to 110, wherein the composition is recovered thermal management fluid.

**[0650]** Embodiment 126. The composition of any of Embodiments 1 to 110, wherein the composition is a recycled thermal management fluid.



**[0651]** Embodiment 127. The composition of any of Embodiments 1 to 110, wherein the composition is a reclaimed thermal management fluid.

**[0652]** Embodiment 128. The composition of any of Embodiments 1 to 110, wherein at least a portion of the composition is a reclaimed thermal management fluid.

**[0653]** Embodiment 129. The composition of any of Embodiments 13-24, 37-54, and 67-109, the composition further comprising an effective amount of at least one inhibitor, such that the composition remains substantially free of oligomeric, homopolymeric, or other polymeric products derived from hydrofluoroolefin refrigerants of the composition.

**[0654]** Embodiment 130. The composition of Embodiment 129, wherein the at least one inhibitor is selected from the group consisting of hydrocarbons including at least one of cyclic monoterpene; lipophilic organic compounds including tocopherols such as  $\alpha$ -tocopherol; phenols and aromatic organic compounds having at least one chemical moiety  $-C_6H_4(OH)$ .

**[0655]** Embodiment 131. The composition of any of Embodiments 129-130, wherein the at least one inhibitor comprises a member selected from the group consisting of limonene,  $\alpha$ -pinene,  $\beta$ -pinene,  $\alpha$ -terpinene,  $\alpha$ -tocopherol, butylated hydroxytoluene (BHT), 4-methoxyphenol, and benzene-1,4-diol.

**[0656]** Embodiment 132. A method of obtaining the composition of any of Embodiments 1 to 110, the method comprising removing the composition from a heat transfer system.

**[0657]** Embodiment 133. The method of Embodiment 132, wherein the at least one residual refrigerant is not separated from the composition after removal from the heat transfer system.

**[0658]** Embodiment 134. The method of Embodiment 132, wherein the second refrigerant portion is not separated from the first refrigerant portion after removal from the heat transfer system.

**[0659]** Embodiment 135. The method of Embodiment 132, wherein said heat transfer system is designed for use with or previously contained at least one of the residual refrigerants.

**[0660]** Embodiment 136. The method of Embodiment 132, wherein the heat transfer system comprises at least one member selected from the group consisting of air conditioners, freezers, refrigerators, heat pumps, water chillers, flooded evaporator chillers, direct expansion chillers, walk-in coolers, heat pumps, mobile refrigerators, mobile air conditioning units and combinations thereof.

**[0661]** Embodiment 137. A method for replacing an original refrigerant with a replacement refrigerant in a heat transfer system that uses, used or was designed to use the original refrigerant, the method comprising charging the heat transfer system with the replacement refrigerant, wherein at least some of the original refrigerant remains in the heat transfer system as a residual refrigerant, and wherein:

- (i) the original refrigerant comprises, consists essentially of or consists of at least one of HCFC-22, HFC-32, HFC-125 and combinations thereof; and the replacement refrigerant comprises, consists essentially of or consists of at least R-410A;
- (ii) the original refrigerant comprises, consists essentially of or consists of at least HCFC-22, HFC-32, HFC-125, HFC-134a, HFC-143a and combinations thereof; and the replacement refrigerant comprises, consists essentially of or consists of at least one of R-407C, R-404A, R-507 and combinations thereof;
- (iii) the original refrigerant comprises, consists essentially of or consists of at least one of HCFC-22, HFC-32, HFC-125, HFC-134a, HFC-143a, HFO-1234yf and combinations thereof; and the replacement refrigerant comprises, consists essentially of or consists of at least one of R-452B, R-454B and combinations thereof;
- (iv) the original refrigerant comprises, consists essentially of or consists of at least one of CFC-12, HFC-134a, HFO-1234yf and combinations thereof; and the replacement refrigerant comprises, consists essentially of or consists of at least R-513A;
- (v) the original refrigerant comprises, consists essentially of or consists of at least one of CFC-12, HFC-32, HFC-134a, HFC-227ea, E-HFO-1234ze, HFO-

1234yf, E-HFO-1336mzz, Z-HFO-1224yd and combinations thereof, and the replacement refrigerant comprises, consists essentially of or consists of at least one of R-454A, R-454C, R-471A, R-476A, R-482A and combinations thereof;

- (vi) the original refrigerant comprises, consists essentially of or consists of HCFC-22, CFC-115, CFC-125, HFC-134a, HFC-143a and combinations thereof, and the replacement refrigerant comprises, consists essentially of or consists of at least one of R-404A, R-507 and combinations thereof;
- (vii) the original refrigerant comprises, consists essentially of or consists of at least one of CFC-11, HFC-134a, HFO-1234yf and combinations thereof, and the replacement refrigerant comprises, consists essentially of or consists of at least one of R-513A, R-515B and combinations thereof;
- (viii) the original refrigerant comprises, consists essentially of or consists of at least one of HFC-32, HFC-125, HFC-134a, E-HFO-1234ze, HCFC-22, CFC-115, HFC-143a, HFO-1234yf and combinations thereof, and the replacement refrigerant comprises, consists essentially of or consists of at least R-455A;
- (ix) the original refrigerant comprises, consists essentially of or consists of at least one of HCFC-22, CFC-115, HFC-32, HFC-143a, HFC-125, HFC-134a, HFO-1234yf, E-HFO-1234ze, CO<sub>2</sub> and combinations thereof, and the replacement refrigerant comprises, consists essentially of or consists of at least one of R-448A, R-449A, R-407 and combinations thereof;
- (x) the original refrigerant comprises, consists essentially of or consists of at least one of HCFC-22, CFC-115, HFC-143a, HFC-125, HFC-134a, E-HFO-1234ze, HFC-32, HFO-1234yf, CO<sub>2</sub> and combinations thereof, and the replacement refrigerant comprises, consists essentially of or consists of at least one of R-454C, R-455A, R-454A, and combinations thereof;
- (xi) the original refrigerant comprises, consists essentially of or consists of at least one of CFC-11, HCFC-123, t-DCE, Z-HFO-1336mzz and combinations thereof, and the replacement refrigerant comprises, consists essentially of or consists of at least R-514A; or
- (xii) the original refrigerant comprises, consists essentially of or consists of at least one of CFC-12, HFC-32, HFC-134a, HFC-152a, HFO-1234yf, HFO-

1132(E), E-HFO-1234ze and combinations thereof, and the replacement refrigerant comprises, consists essentially of or consists of at least R-444A.

**[0662]** Embodiment 138. A method for replacing an original refrigerant with a replacement refrigerant in a heat transfer system that uses, used or was designed to use the original refrigerant, the method comprising removing a substantial portion of the original refrigerant from the heat transfer system, optionally retaining a substantial portion of any lubricant present in the system, and charging the heat transfer system with the replacement refrigerant, wherein at least a portion of the original refrigerant remains in the heat transfer system as a residual refrigerant, and wherein:

- (i) the original refrigerant comprises, consists essentially of or consists of at least one of HCFC-22, HFC-32, HFC-125 and combinations thereof; and the replacement refrigerant comprises, consists essentially of or consists of at least R-410A;
- (ii) the original refrigerant comprises, consists essentially of or consists of at least HCFC-22, HFC-32, HFC-125, HFC-134a, HFC-143a and combinations thereof, and the replacement refrigerant comprises, consists essentially of or consists of at least one of R-407C, R-404A, R-507 and combinations thereof;
- (iii) the original refrigerant comprises, consists essentially of or consists of at least one of HCFC-22, HFC-32, HFC-125, HFC-134a, HFC-143a, HFO-1234yf and combinations thereof, and the replacement refrigerant comprises, consists essentially of or consists of at least one of R-452B, R-454B and combinations thereof;
- (iv) the original refrigerant comprises, consists essentially of or consists of at least one of CFC-12, HFC-134a, HFO-1234yf and combinations thereof, and the replacement refrigerant comprises, consists essentially of or consists of at least R-513A;
- (v) the original refrigerant comprises, consists essentially of or consists of at least one of CFC-12, HFC-32, HFC-134a, HFC-227ea, E-HFO-1234ze, HFO-1234yf, E-HFO-1336mzz, Z-HFO-1224yd and combinations thereof, and the replacement refrigerant comprises, consists essentially of or consists of at

least one of R-454A, R-454C, R-471A, R-476A, R-482A and combinations thereof;

- (vi) the original refrigerant comprises, consists essentially of or consists of HCFC-22, CFC-115, CFC-125, HFC-134a, HFC-143a and combinations thereof, and the replacement refrigerant comprises, consists essentially of or consists of at least one of R-404A, R-507 and combinations thereof;
- (vii) the original refrigerant comprises, consists essentially of or consists of at least one of CFC-11, HFC-134a, HFO-1234yf and combinations thereof, and the replacement refrigerant comprises, consists essentially of or consists of at least one of R-513A, R-515B and combinations thereof;
- (viii) the original refrigerant comprises, consists essentially of or consists of at least one of HFC-32, HFC-125, HFC-134a, E-HFO-1234ze, HCFC-22, CFC-115, HFC-143a, HFO-1234yf and combinations thereof, and the replacement refrigerant comprises, consists essentially of or consists of at least R-455A;
- (ix) the original refrigerant comprises, consists essentially of or consists of at least one of HCFC-22, CFC-115, HFC-32, HFC-143a, HFC-125, HFC-134a, HFO-1234yf, E-HFO-1234ze, CO<sub>2</sub> and combinations thereof, and the replacement refrigerant comprises, consists essentially of or consists of at least one of R-448A, R-449A, R-407 and combinations thereof;
- (x) the original refrigerant comprises, consists essentially of or consists of at least one of HCFC-22, CFC-115, HFC-143a, HFC-125, HFC-134a, E-HFO-1234ze, HFC-32, HFO-1234yf, CO<sub>2</sub> and combinations thereof, and the replacement refrigerant comprises, consists essentially of or consists of at least one of R-454C, R-455A, R-454A, and combinations thereof;
- (xi) the original refrigerant comprises, consists essentially of or consists of at least one of CFC-11, HCFC-123, t-DCE, Z-HFO-1336mzz and combinations thereof, and the replacement refrigerant comprises, consists essentially of or consists of at least R-514A; or
- (xii) the original refrigerant comprises, consists essentially of or consists of at least one of CFC-12, HFC-32, HFC-134a, HFC-152a, HFO-1234yf, HFO-1132(E), E-HFO-1234ze and combinations thereof, and the replacement refrigerant comprises, consists essentially of or consists of at least R-444A.

**[0663]** Embodiment 139. The composition of any of Embodiments 137-138, wherein the replacement refrigerant is recovered thermal management fluid.

**[0664]** Embodiment 140. The composition of any of Embodiments 137-138, wherein the replacement refrigerant is a recycled thermal management fluid.

**[0665]** Embodiment 141. The composition of any of Embodiments 137-138, wherein the replacement refrigerant is a reclaimed thermal management fluid.

**[0666]** Embodiment 142. The composition of any of Embodiments 137-138, wherein at least a portion of the replacement refrigerant is a reclaimed thermal management fluid.

**[0667]** Embodiment 143. A method of reclaiming refrigerant, the method comprising: removing a refrigerant composition from a heat transfer system, the refrigerant composition being one of the compositions of any of Embodiments 1-3, 7-9, 13-15, 19-21, 25-27, 31-33, 37-39, 43-45, 49-51, 55-57, 61-63, 67-69, 73-75, 79-81, 85-87, 91-93, 97-99 and 103-105; performing at least one treatment selected from transferring, blending, distillation, nitrogen purging, filtration, dehydration, moisture removal, acid removal, oil removal, caustic scrubbing, decanting, composition ratio adjustment and combinations thereof to form a partially reclaimed refrigerant composition or a reclaimed refrigerant composition, wherein the at least one treatment does not involve removal or separation of the residual refrigerants; and either storing the partially reclaimed refrigerant composition or a reclaimed refrigerant composition in a container for use in another system or introducing the partially reclaimed refrigerant composition or a reclaimed refrigerant composition back into the heat transfer system.

**[0668]** Embodiment 144. A method of reclaiming refrigerant, the method comprising: removing a refrigerant composition from a heat transfer system, the refrigerant composition being one of the compositions of any of Embodiments 4-6, 10-12, 16-18, 22-24, 28-30, 34-36, 40-42, 46-48, 52-54, 58-60, 64-66, 70-72, 76-78, 82-84, 88-90, 94-96, 100-102, and 106-108; performing at least one treatment selected from transferring, blending, distillation, nitrogen purging, filtration, dehydration, caustic scrubbing, moisture removal, acid removal, oil removal, decanting, composition ratio adjustment and combinations thereof to form a partially reclaimed refrigerant composition or a reclaimed refrigerant composition, wherein the

at least one treatment does not involve separation of the second refrigerant portion from the first refrigerant portion; and either storing the partially reclaimed refrigerant composition or a reclaimed refrigerant composition in a container for use in another system or introducing the partially reclaimed refrigerant composition or a reclaimed refrigerant composition back into the heat transfer system.

### CLAIMS

What is claimed is:

1. A composition comprising (i) one of (a) difluoromethane (HFC-32) and pentafluoroethane (HFC-125), or (b) R-410A (50% HFC-125 / 50% HFC-32), and (ii) at least one residual refrigerant selected from the group consisting of chlorodifluoromethane (HCFC-22) and 1,1,1,2-tetrafluoroethane (HFC-134a).
2. A composition comprising (i) one of (a) difluoromethane (HFC-32) and pentafluoroethane (HFC-125), or (b) R-410A (50% HFC-125 / 50% HFC-32); (ii) at least one residual refrigerant selected from the group consisting of chlorodifluoromethane (HCFC-22) and 1,1,1,2-tetrafluoroethane (HFC-134a); (iii) at least one additional compound selected from the group consisting of HFC-23, HFC-32, HFC-143a, HFC-134a, CFC-115, CFO-1113 and HCC-40; and (iv) at least one additional compound selected from the group consisting of HFC-143a, HFC-41, HFC-134a, HCFC-22, CFC-12 and HCC-40.
3. A composition comprising (i) one of (a) difluoromethane (HFC-32) and pentafluoroethane (HFC-125), or (b) R-410A (50% HFC-125 / 50% HFC-32); (ii) at least one residual refrigerant selected from the group consisting of chlorodifluoromethane (HCFC-22) and 1,1,1,2-tetrafluoroethane (HFC-134a); and (iii) at least one additional compound selected from the group consisting of CFC-115, HFC-143a and HCFC-22.
4. A composition comprising:
  - a first refrigerant portion comprising one of (a) difluoromethane (HFC-32) and pentafluoroethane (HFC-125), or (b) R-410A (50% HFC-125 / 50% HFC-32); and
  - a second refrigerant portion comprising at least one compound selected from the group consisting of chlorodifluoromethane (HCFC-22) and 1,1,1,2-tetrafluoroethane (HFC-134a).
5. A composition comprising:
  - a first refrigerant portion comprising (i) one of (a) difluoromethane (HFC-32) and pentafluoroethane (HFC-125), or (b) R-410A (50% HFC-125 / 50% HFC-32); (ii) at least one additional compound selected from the group consisting of HFC-23, HFC-32, HFC-143a, HFC-134a, CFC-115, CFO-1113 and HCC-



40; and (iii) at least one additional compound selected from the group consisting of HFC-143a, HFC-41, HFC-134a, HCFC-22, CFC-12 and HCC-40; and

a second refrigerant portion comprising at least one compound selected from the group consisting of chlorodifluoromethane (HCFC-22) and 1,1,1,2-tetrafluoroethane (HFC-134a).

6. A composition comprising:

a first refrigerant portion comprising (i) one of (a) difluoromethane (HFC-32) and pentafluoroethane (HFC-125), or (b) R-410A (50% HFC-125 / 50% HFC-32); and (ii) at least one additional compound selected from the group consisting of CFC-115, HFC-143a and HCFC-22; and

a second refrigerant portion comprising at least one compound selected from the group consisting of chlorodifluoromethane (HCFC-22) and 1,1,1,2-tetrafluoroethane (HFC-134a).

7. A composition comprising (i) one of (a) difluoromethane (HFC-32), pentafluoroethane (HFC-125) and 1,1,1,2-tetrafluoroethane (HFC-134a), or (b) R-407C (25% HFC-125 / 23% HFC-32 / 52% HFC-134a), and (ii) at least one residual refrigerant of chlorodifluoromethane (HCFC-22).

8. A composition comprising (i) one of (a) difluoromethane (HFC-32), pentafluoroethane (HFC-125) and 1,1,1,2-tetrafluoroethane (HFC-134a), or (b) R-407C (25% HFC-125 / 23% HFC-32 / 52% HFC-134a); (ii) at least one residual refrigerant of chlorodifluoromethane (HCFC-22); (iii) at least one additional compound selected from the group consisting of HFC-23, HFC-32, HFC-143a, HFC-134a, CFC-115, CFO-1113 and HCC-40; (iv) at least one additional compound selected from the group consisting of HFC-143a, HFO-1225zc, HFC-245cb, HFC-134, HFC-152a, HFO-1225ye, HFC-161, E-HFO-1234ze, HCFC-22, HFO-1243zf, CHFC-124, HCC-40, CHFO-1122, HCFC-31, CFC-114, CFC-114a and HCO-1140; and (v) at least one additional compound selected from the group consisting of HFC-143a, HFC-41, HFC-134a, HCFC-22, CFC-12 and HCC-40.

9. A composition comprising (i) one of (a) difluoromethane (HFC-32), pentafluoroethane (HFC-125) and 1,1,1,2-tetrafluoroethane (HFC-134a), or (b) R-407C (25% HFC-125 / 23% HFC-32 / 52% HFC-134a); (ii) at least one residual refrigerant of chlorodifluoromethane (HCFC-22); and (iii) at least one additional compound selected from the group consisting of HFC-134a, HFC-143a and CFC-115.
10. A composition comprising:
- a first refrigerant portion comprising one of (a) difluoromethane (HFC-32), pentafluoroethane (HFC-125) and 1,1,1,2-tetrafluoroethane (HFC-134a), or (b) R-407C (25% HFC-125 / 23% HFC-32 / 52% HFC-134a); and
  - a second refrigerant portion comprising at least chlorodifluoromethane (HCFC-22).
11. A composition comprising:
- a first refrigerant portion comprising (i) one of (a) difluoromethane (HFC-32), pentafluoroethane (HFC-125) and 1,1,1,2-tetrafluoroethane (HFC-134a), or (b) R-407C (25% HFC-125 / 23% HFC-32 / 52% HFC-134a); (ii) at least one additional compound selected from the group consisting of HFC-23, HFC-32, HFC-143a, HFC-134a, CFC-115, CFO-1113 and HCC-40; (iii) at least one additional compound selected from the group consisting of HFC-143a, HFO-1225zc, HFC-245cb, HFC-134, HFC-152a, HFO-1225ye, HFC-161, E-HFO-1234ze, HCFC-22, HFO-1243zf, CHFC-124, HCC-40, CHFO-1122, HCFC-31, CFC-114, CFC-114a and HCO-1140; and (iv) at least one additional compound selected from the group consisting of HFC-143a, HFC-41, HFC-134a, HCFC-22, CFC-12 and HCC-40; and
  - a second refrigerant portion comprising at least chlorodifluoromethane (HCFC-22).
12. A composition comprising:
- a first refrigerant portion comprising (i) one of (a) difluoromethane (HFC-32), pentafluoroethane (HFC-125) and 1,1,1,2-tetrafluoroethane (HFC-134a), or (b) R-407C (25% HFC-125 / 23% HFC-32 / 52% HFC-134a); and (ii) at least

one additional compound selected from the group consisting of HFC-134a, HFC-143a and CFC-115; and

a second refrigerant portion comprising at least chlorodifluoromethane (HCFC-22).

13. A composition comprising (i) one of (a) difluoromethane (HFC-32), pentafluoroethane (HFC-125) and 2,3,3,3-tetrafluoro-1-propene (HFO-1234yf), or (b) R-452B (67% HFC-32 / 7% HFC-125 / 26% HFO-1234yf), and (ii) at least one residual refrigerant selected from the group consisting of chlorodifluoromethane (HCFC-22), 1,1,1,2-tetrafluoroethane (HFC-134a) and CO<sub>2</sub>.
14. A composition comprising (i) one of (a) difluoromethane (HFC-32), pentafluoroethane (HFC-125) and 2,3,3,3-tetrafluoro-1-propene (HFO-1234yf), or (b) R-452B (67% HFC-32 / 7% HFC-125 / 26% HFO-1234yf); (ii) at least one residual refrigerant selected from the group consisting of chlorodifluoromethane (HCFC-22), 1,1,1,2-tetrafluoroethane (HFC-134a) and CO<sub>2</sub>; (iii) at least one additional compound selected from the group consisting of HFC-143a, HFC-41, HFC-134a, HCFC-22, CFC-12 and HCC-40; (iv) at least one additional compound selected from the group consisting of HFC-23, HFC-32, HFC-143a, HFC-134a, CFC-115, CFO-1113 and HCC-40; and (v) at least one additional compound selected from the group consisting of HFO-1225ye, HFO-1243zf, E-HFO-1234ze, HFC-236ea, HCFC-244bb, HFC-245fa, HFC-245eb, HFC-245cb, 3,3,3-trifluoropropyne, HFC-152a, FO-1114, HFO-1123, HCFO-1131a, trans-HCFO-1131, HCO-1140, HCFO-1214ya, HFO-1216, HCFO-1224yd, HFO-1252 isomers, HFC-143a, HCFC-225 isomers, HFC-254eb, HFC-263fb, HFC-236fa, HCFC-142b, HCFC-244cc, HCFO-1223, HFO-1132a and HCC-40.
15. A composition comprising (i) one of (a) difluoromethane (HFC-32), pentafluoroethane (HFC-125) and 2,3,3,3-tetrafluoro-1-propene (HFO-1234yf), or (b) R-452B (67% HFC-32 / 7% HFC-125 / 26% HFO-1234yf); (ii) at least one residual refrigerant selected from the group consisting of chlorodifluoromethane (HCFC-22), 1,1,1,2-tetrafluoroethane (HFC-134a) and

CO<sub>2</sub>; and (iii) at least one additional compound selected from the group consisting of HFC-143a and HFO-1234zf.

16. A composition comprising:

a first refrigerant portion comprising one of (a) difluoromethane (HFC-32), pentafluoroethane (HFC-125) and 2,3,3,3-tetrafluoro-1-propene (HFO-1234yf), or (b) R-452B (67% HFC-32 / 7% HFC-125 / 26% HFO-1234yf); and  
a second refrigerant portion comprising at least one compound selected from the group consisting of chlorodifluoromethane (HCFC-22), 1,1,1,2-tetrafluoroethane (HFC-134a) and CO<sub>2</sub>.

17. A composition comprising:

a first refrigerant portion comprising (i) one of (a) difluoromethane (HFC-32), pentafluoroethane (HFC-125) and 2,3,3,3-tetrafluoro-1-propene (HFO-1234yf), or (b) R-452B (67% HFC-32 / 7% HFC-125 / 26% HFO-1234yf); (ii) at least one additional compound selected from the group consisting of HFC-143a, HFC-41, HFC-134a, HCFC-22, CFC-12 and HCC-40; (iii) at least one additional compound selected from the group consisting of HFC-23, HFC-32, HFC-143a, HFC-134a, CFC-115, CFO-1113 and HCC-40; and (iv) at least one additional compound selected from the group consisting of HFO-1225ye, HFO-1243zf, E-HFO-1234ze, HFC-236ea, HCFC-244bb, HFC-245fa, HFC-245eb, HFC-245cb, 3,3,3-trifluoropropyne, HFC-152a, FO-1114, HFO-1123, HCFO-1131a, trans-HCFO-1131, HCO-1140, HCFO-1214ya, HFO-1216, HCFO-1224yd, HFO-1252 isomers, HFC-143a, HCFC-225 isomers, HFC-254eb, HFC-263fb, HFC-236fa, HCFC-142b, HCFC-244cc, HCFO-1223, HFO-1132a and HCC-40; and

a second refrigerant portion comprising at least one compound selected from the group consisting of chlorodifluoromethane (HCFC-22), 1,1,1,2-tetrafluoroethane (HFC-134a) and CO<sub>2</sub>.

18. A composition comprising:

a first refrigerant portion comprising (i) one of (a) difluoromethane (HFC-32), pentafluoroethane (HFC-125) and 2,3,3,3-tetrafluoro-1-propene (HFO-1234yf), or (b) R-452B (67% HFC-32 / 7% HFC-125 / 26% HFO-1234yf); and

(ii) at least one additional compound selected from the group consisting of HFC-143a and HFO-1234zf; and

a second refrigerant portion comprising at least one compound selected from the group consisting of chlorodifluoromethane (HCFC-22), 1,1,1,2-tetrafluoroethane (HFC-134a) and CO<sub>2</sub>.

19. A composition comprising (i) one of (a) difluoromethane (HFC-32) and 2,3,3,3-tetrafluoro-1-propene (HFO-1234yf), or (b) R-454B (68.9% HFC-32 / 31.1% HFO-1234yf); and (ii) at least one residual refrigerant selected from the group consisting of chlorodifluoromethane (HCFC-22), pentafluoroethane (HFC-125), 1,1,1,2-tetrafluoroethane (HFC-134a) and CO<sub>2</sub>.
20. A composition comprising (i) one of (a) difluoromethane (HFC-32) and 2,3,3,3-tetrafluoro-1-propene (HFO-1234yf), or (b) R-454B (68.9% HFC-32 / 31.1% HFO-1234yf); (ii) at least one residual refrigerant selected from the group consisting of chlorodifluoromethane (HCFC-22), pentafluoroethane (HFC-125), 1,1,1,2-tetrafluoroethane (HFC-134a) and CO<sub>2</sub>; (iii) at least one additional compound selected from the group consisting of HFC-143a, HFC-41, HFC-134a, HCFC-22, CFC-12 and HCC-40; and (iv) at least one additional compound selected from the group consisting of HFO-1225ye, HFO-1243zf, E-HFO-1234ze, HFC-236ea, HCFC-244bb, HFC-245fa, HFC-245eb, HFC-245cb, 3,3,3-trifluoropropyne, HFC-152a, FO-1114, HFO-1123, HCFO-1131a, trans-HCFO-1131, HCO-1140, HCFO-1214ya, HFO-1216, HCFO-1224yd, HFO-1252 isomers, HFC-143a, HCFC-225 isomers, HFC-254eb, HFC-263fb, HFC-236fa, HCFC-142b, HCFC-244cc, HCFO-1223, HFO-1132a and HCC-40.
21. A composition comprising (i) one of (a) difluoromethane (HFC-32) and 2,3,3,3-tetrafluoro-1-propene (HFO-1234yf), or (b) R-454B (68.9% HFC-32 / 31.1% HFO-1234yf); (ii) at least one residual refrigerant selected from the group consisting of chlorodifluoromethane (HCFC-22), pentafluoroethane (HFC-125), 1,1,1,2-tetrafluoroethane (HFC-134a) and CO<sub>2</sub>; and (iii) at least one additional compound selected from the group consisting of HFC-143a, HFC-245cb and HFO-1243zf.

22. A composition comprising:
- a first refrigerant portion comprising one of (a) difluoromethane (HFC-32) and 2,3,3,3-tetrafluoro-1-propene (HFO-1234yf), or (b) R-454B (68.9% HFC-32 / 31.1% HFO-1234yf); and
  - a second refrigerant portion comprising at least one compound selected from the group consisting of chlorodifluoromethane (HCFC-22), pentafluoroethane (HFC-125), 1,1,1,2-tetrafluoroethane (HFC-134a) and CO<sub>2</sub>.
23. A composition comprising:
- a first refrigerant portion comprising (i) one of (a) difluoromethane (HFC-32) and 2,3,3,3-tetrafluoro-1-propene (HFO-1234yf), or (b) R-454B (68.9% HFC-32 / 31.1% HFO-1234yf); (ii) at least one additional compound selected from the group consisting of HFC-143a, HFC-41, HFC-134a, HCFC-22, CFC-12 and HCC-40; and (iii) at least one additional compound selected from the group consisting of HFO-1225ye, HFO-1243zf, E-HFO-1234ze, HFC-236ea, HCFC-244bb, HFC-245fa, HFC-245eb, HFC-245cb, 3,3,3-trifluoropropyne, HFC-152a, FO-1114, HFO-1123, HCFO-1131a, trans-HCFO-1131, HCO-1140, HCFO-1214ya, HFO-1216, HCFO-1224yd, HFO-1252 isomers, HFC-143a, HCFC-225 isomers, HFC-254eb, HFC-263fb, HFC-236fa, HCFC-142b, HCFC-244cc, HCFO-1223, HFO-1132a and HCC-40; and
  - a second refrigerant portion comprising at least one compound selected from the group consisting of chlorodifluoromethane (HCFC-22), pentafluoroethane (HFC-125), 1,1,1,2-tetrafluoroethane (HFC-134a) and CO<sub>2</sub>.
24. A composition comprising:
- a first refrigerant portion comprising (i) one of (a) difluoromethane (HFC-32) and 2,3,3,3-tetrafluoro-1-propene (HFO-1234yf), or (b) R-454B (68.9% HFC-32 / 31.1% HFO-1234yf); and (ii) at least one additional compound selected from the group consisting of HFC-143a, HFC-245cb and HFO-1243zf; and
  - a second refrigerant portion comprising at least one compound selected from the group consisting of chlorodifluoromethane (HCFC-22), pentafluoroethane (HFC-125), 1,1,1,2-tetrafluoroethane (HFC-134a) and CO<sub>2</sub>.

25. A composition comprising (i) one of (a) difluoromethane (HFC-32), pentafluoroethane (HFC-125) and 1,1,1,2-tetrafluoroethane (HFC-134a), or (b) R-407A (20% HFC-32 / 40% HFC-125 / 40% HFC-134a); and (ii) at least one residual refrigerant selected from the group consisting of chlorodifluoromethane (HCFC-22) and 1,1,1-trifluoroethane (HFC-143a).
26. A composition comprising (i) one of (a) difluoromethane (HFC-32), pentafluoroethane (HFC-125) and 1,1,1,2-tetrafluoroethane (HFC-134a), or (b) R-407A (20% HFC-32 / 40% HFC-125 / 40% HFC-134a); (ii) at least one residual refrigerant selected from the group consisting of chlorodifluoromethane (HCFC-22) and 1,1,1-trifluoroethane (HFC-143a); (iii) at least one additional compound selected from the group consisting of HFC-23, HFC-32, HFC-143a, HFC-134a, CFC-115, CFO-1113 and HCC-40; (iv) at least one additional compound selected from the group consisting of HFC-143a, HFO-1225zc, HFC-245cb, HFC-134, HFC-152a, HFO-1225ye, HFC-161, E-HFO-1234ze, HCFC-22, HFO-1243zf, CHFC-124, HCC-40, CHFO-1122, HCFC-31, CFC-114, CFC-114a and HCO-1140; and (v) at least one additional compound selected from the group consisting of HFC-143a, HFC-41, HFC-134a, HCFC-22, CFC-12 and HCC-40.
27. A composition comprising (i) one of (a) difluoromethane (HFC-32), pentafluoroethane (HFC-125) and 1,1,1,2-tetrafluoroethane (HFC-134a), or (b) R-407A (20% HFC-32 / 40% HFC-125 / 40% HFC-134a); (ii) at least one residual refrigerant selected from the group consisting of chlorodifluoromethane (HCFC-22) and 1,1,1-trifluoroethane (HFC-143a); and (iii) at least one additional compound selected from the group consisting of HFC-134a and CFC-115.
28. A composition comprising:
- a first refrigerant portion comprising one of (a) difluoromethane (HFC-32), pentafluoroethane (HFC-125) and 1,1,1,2-tetrafluoroethane (HFC-134a), or (b) R-407A (20% HFC-32 / 40% HFC-125 / 40% HFC-134a); and
  - a second refrigerant portion comprising at least one compound selected from the group consisting of chlorodifluoromethane (HCFC-22) and 1,1,1-trifluoroethane (HFC-143a).

29. A composition comprising:
- a first refrigerant portion comprising (i) one of (a) difluoromethane (HFC-32), pentafluoroethane (HFC-125) and 1,1,1,2-tetrafluoroethane (HFC-134a), or (b) R-407A (20% HFC-32 / 40% HFC-125 / 40% HFC-134a); (ii) at least one additional compound selected from the group consisting of HFC-23, HFC-32, HFC-143a, HFC-134a, CFC-115, CFO-1113 and HCC-40; (iii) at least one additional compound selected from the group consisting of HFC-143a, HFO-1225zc, HFC-245cb, HFC-134, HFC-152a, HFO-1225ye, HFC-161, E-HFO-1234ze, HCFC-22, HFO-1243zf, CHFC-124, HCC-40, CHFO-1122, HCFC-31, CFC-114, CFC-114a and HCO-1140; and (iv) at least one additional compound selected from the group consisting of HFC-143a, HFC-41, HFC-134a, HCFC-22, CFC-12 and HCC-40; and
  - a second refrigerant portion comprising at least one compound selected from the group consisting of chlorodifluoromethane (HCFC-22) and 1,1,1-trifluoroethane (HFC-143a).
30. A composition comprising:
- a first refrigerant portion comprising (i) one of (a) difluoromethane (HFC-32), pentafluoroethane (HFC-125) and 1,1,1,2-tetrafluoroethane (HFC-134a), or (b) R-407A (20% HFC-32 / 40% HFC-125 / 40% HFC-134a); and (ii) at least one additional compound selected from the group consisting of HFC-134a and CFC-115; and
  - a second refrigerant portion comprising at least one compound selected from the group consisting of chlorodifluoromethane (HCFC-22) and 1,1,1-trifluoroethane (HFC-143a).
31. A composition comprising a mixture of R-407A (20% HFC-32 / 40% HFC-125 / 40% HFC-134a) and R-407C (25% HFC-125 / 23% HFC-32 / 52% HFC-134a); and at least one residual refrigerant selected from the group consisting of chlorodifluoromethane (HCFC-22) and 1,1,1-trifluoroethane (HFC-143a); and optionally one or more members selected from the group consisting of R-407B, R-407D, R-407E, R-407F, R-407G, R-407H and R-407I.
32. A composition comprising (i) a mixture of R-407A (20% HFC-32 / 40% HFC-125 / 40% HFC-134a) and R-407C (25% HFC-125 / 23% HFC-32 / 52%



- HFC-134a); (ii) at least one residual refrigerant selected from the group consisting of chlorodifluoromethane (HCFC-22) and 1,1,1-trifluoroethane (HFC-143a); (iii) at least one additional compound selected from the group consisting of HFC-23, HFC-32, HFC-143a, HFC-134a, CFC-115, CFO-1113 and HCC-40; (iv) at least one additional compound selected from the group consisting of HFC-143a, HFO-1225zc, HFC-245cb, HFC-134, HFC-152a, HFO-1225ye, HFC-161, E-HFO-1234ze, HCFC-22, HFO-1243zf, CHFC-124, HCC-40, CHFO-1122, HCFC-31, CFC-114, CFC-114a and HCO-1140; and (v) at least one additional compound selected from the group consisting of HFC-143a, HFC-41, HFC-134a, HCFC-22, CFC-12 and HCC-40.
33. A composition comprising (i) a mixture of R-407A (20% HFC-32 / 40% HFC-125 / 40% HFC-134a) and R-407C (25% HFC-125 / 23% HFC-32 / 52% HFC-134a); (ii) at least one residual refrigerant selected from the group consisting of chlorodifluoromethane (HCFC-22) and 1,1,1-trifluoroethane (HFC-143a); and (iii) at least one additional compound selected from the group consisting of HFC-134a, HFC-143a and CFC-115.
34. A composition comprising:
- a first refrigerant portion comprising a mixture of R-407A (20% HFC-32 / 40% HFC-125 / 40% HFC-134a) and R-407C (25% HFC-125 / 23% HFC-32 / 52% HFC-134a); and
  - a second refrigerant portion comprising at least one compound selected from the group consisting of chlorodifluoromethane (HCFC-22) and 1,1,1-trifluoroethane (HFC-143a).
35. A composition comprising:
- a first refrigerant portion comprising (i) a mixture of R-407A (20% HFC-32 / 40% HFC-125 / 40% HFC-134a) and R-407C (25% HFC-125 / 23% HFC-32 / 52% HFC-134a); (ii) at least one additional compound selected from the group consisting of HFC-23, HFC-32, HFC-143a, HFC-134a, CFC-115, CFO-1113 and HCC-40; (iii) at least one additional compound selected from the group consisting of HFC-143a, HFO-1225zc, HFC-245cb, HFC-134, HFC-152a, HFO-1225ye, HFC-161, E-HFO-1234ze, HCFC-22, HFO-1243zf, CHFC-124, HCC-40, CHFO-1122, HCFC-31, CFC-114, CFC-114a and HCO-

1140; and (iv) at least one additional compound selected from the group consisting of HFC-143a, HFC-41, HFC-134a, HCFC-22, CFC-12 and HCC-40; and

a second refrigerant portion comprising at least one compound selected from the group consisting of chlorodifluoromethane (HCFC-22) and 1,1,1-trifluoroethane (HFC-143a).

36. A composition comprising:

a first refrigerant portion comprising (i) a mixture of R-407A (20% HFC-32 / 40% HFC-125 / 40% HFC-134a) and R-407C (25% HFC-125 / 23% HFC-32 / 52% HFC-134a); and (ii) at least one additional compound selected from the group consisting of HFC-134a, HFC-143a and CFC-115; and

a second refrigerant portion comprising at least one compound selected from the group consisting of chlorodifluoromethane (HCFC-22) and 1,1,1-trifluoroethane (HFC-143a).

37. A composition comprising (i) one of (a) difluoromethane (HFC-32), CO<sub>2</sub> and 2,3,3,3-tetrafluoro-1-propene (HFO-1234yf), or (b) R-455A (21.5% HFC-32 / 3% CO<sub>2</sub> / 75.5% HFO-1234yf); and (ii) at least one residual refrigerant selected from the group consisting of pentafluoroethane (HFC-125), 1,1,1,2-tetrafluoroethane (HFC-134a), chlorodifluoromethane (HCFC-22), chloropentafluoroethane (CFC-115), E-1,3,3,3-tetrafluoro-1-propene (E-HFO-1234ze) and 1,1,1-trifluoroethane (HFC-143a).

38. A composition comprising (i) one of (a) difluoromethane (HFC-32), CO<sub>2</sub> and 2,3,3,3-tetrafluoro-1-propene (HFO-1234yf), or (b) R-455A (21.5% HFC-32 / 3% CO<sub>2</sub> / 75.5% HFO-1234yf); (ii) at least one residual refrigerant selected from the group consisting of pentafluoroethane (HFC-125), 1,1,1,2-tetrafluoroethane (HFC-134a), chlorodifluoromethane (HCFC-22), chloropentafluoroethane (CFC-115), E-1,3,3,3-tetrafluoro-1-propene (E-HFO-1234ze) and 1,1,1-trifluoroethane (HFC-143a); (iii) at least one additional compound selected from the group consisting of HFC-143a, HFC-41, HFC-134a, HCFC-22, CFC-12 and HCC-40; (iv) at least one additional compound selected from the group consisting of N<sub>2</sub>, Ar, CO and O<sub>2</sub>; and (v) at least one additional compound selected from the group consisting of HFO-1225ye, HFO-

1243zf, E-HFO-1234ze, HFC-236ea, HCFC-244bb, HFC-245fa, HFC-245eb, HFC-245cb, 3,3,3-trifluoropropyne, HFC-152a, FO-1114, HFO-1123, HCFO-1131a, trans-HCFO-1131, HCO-1140, HCFO-1214ya, HFO-1216, HCFO-1224yd, HFO-1252 isomers, HFC-143a, HCFC-225 isomers, HFC-254eb, HFC-263fb, HFC-236fa, HCFC-142b, HCFC-244cc, HCFO-1223, HFO-1132a and HCC-40.

39. A composition comprising (i) one of (a) difluoromethane (HFC-32), CO<sub>2</sub> and 2,3,3,3-tetrafluoro-1-propene (HFO-1234yf), or (b) R-455A (21.5% HFC-32 / 3% CO<sub>2</sub> / 75.5% HFO-1234yf); (ii) at least one residual refrigerant selected from the group consisting of pentafluoroethane (HFC-125), 1,1,1,2-tetrafluoroethane (HFC-134a), chlorodifluoromethane (HCFC-22), chloropentafluoroethane (CFC-115), E-1,3,3,3-tetrafluoro-1-propene (E-HFO-1234ze) and 1,1,1-trifluoroethane (HFC-143a); and (iii) at least one additional compound selected from the group consisting of HFC-143a, HFC-245cb and HFO-1243zf.
40. A composition comprising:
  - a first refrigerant portion comprising one of (a) difluoromethane (HFC-32), CO<sub>2</sub> and 2,3,3,3-tetrafluoro-1-propene (HFO-1234yf), or (b) R-455A (21.5% HFC-32 / 3% CO<sub>2</sub> / 75.5% HFO-1234yf); and
  - a second refrigerant portion comprising at least one compound selected from the group consisting of pentafluoroethane (HFC-125), 1,1,1,2-tetrafluoroethane (HFC-134a), chlorodifluoromethane (HCFC-22), chloropentafluoroethane (CFC-115), E-1,3,3,3-tetrafluoro-1-propene (E-HFO-1234ze) and 1,1,1-trifluoroethane (HFC-143a).
41. A composition comprising:
  - a first refrigerant portion comprising (i) one of (a) difluoromethane (HFC-32), CO<sub>2</sub> and 2,3,3,3-tetrafluoro-1-propene (HFO-1234yf), or (b) R-455A (21.5% HFC-32 / 3% CO<sub>2</sub> / 75.5% HFO-1234yf); (ii) at least one additional compound selected from the group consisting of HFC-143a, HFC-41, HFC-134a, HCFC-22, CFC-12 and HCC-40; (iii) at least one additional compound selected from the group consisting of N<sub>2</sub>, Ar, CO and O<sub>2</sub>; and (iv) at least one additional compound selected from the group consisting of HFO-1225ye, HFO-1243zf,

E-HFO-1234ze, HFC-236ea, HCFC-244bb, HFC-245fa, HFC-245eb, HFC-245cb, 3,3,3-trifluoropropyne, HFC-152a, FO-1114, HFO-1123, HCFO-1131a, trans-HCFO-1131, HCO-1140, HCFO-1214ya, HFO-1216, HCFO-1224yd, HFO-1252 isomers, HFC-143a, HCFC-225 isomers, HFC-254eb, HFC-263fb, HFC-236fa, HCFC-142b, HCFC-244cc, HCFO-1223, HFO-1132a and HCC-40; and

a second refrigerant portion comprising at least one compound selected from the group consisting of pentafluoroethane (HFC-125), 1,1,1,2-tetrafluoroethane (HFC-134a), chlorodifluoromethane (HCFC-22), chloropentafluoroethane (CFC-115), E-1,3,3,3-tetrafluoro-1-propene (E-HFO-1234ze) and 1,1,1-trifluoroethane (HFC-143a).

42. A composition comprising:

a first refrigerant portion comprising (i) one of (a) difluoromethane (HFC-32), CO<sub>2</sub> and 2,3,3,3-tetrafluoro-1-propene (HFO-1234yf), or (b) R-455A (21.5% HFC-32 / 3% CO<sub>2</sub> / 75.5% HFO-1234yf); and (ii) at least one additional compound selected from the group consisting of HFC-143a, HFC-245cb and HFO-1243zf; and

a second refrigerant portion comprising at least one compound selected from the group consisting of pentafluoroethane (HFC-125), 1,1,1,2-tetrafluoroethane (HFC-134a), chlorodifluoromethane (HCFC-22), chloropentafluoroethane (CFC-115), E-1,3,3,3-tetrafluoro-1-propene (E-HFO-1234ze) and 1,1,1-trifluoroethane (HFC-143a).

43. A composition comprising (i) one of (a) difluoromethane (HFC-32), pentafluoroethane (HFC-125), 1,1,1,2-tetrafluoroethane (HFC-134a), 2,3,3,3-tetrafluoro-1-propene (HFO-1234yf), E-1,3,3,3-tetrafluoro-1-propene (E-HFO-1234ze), or (b) R-448A (26% HFC-32 / 26% HFC-125 / 21% HFC-134a / 20% HFO-1234yf / 7% E-HFO-1234ze); and (ii) at least one residual refrigerant selected from the group consisting of chlorodifluoromethane (HCFC-22), chloropentafluoroethane (CFC-115) and 1,1,1-trifluoroethane (HFC-143a).

44. A composition comprising (i) one of (a) difluoromethane (HFC-32), pentafluoroethane (HFC-125), 1,1,1,2-tetrafluoroethane (HFC-134a), 2,3,3,3-tetrafluoro-1-propene (HFO-1234yf), E-1,3,3,3-tetrafluoro-1-propene (E-HFO-

- 1234ze), or (b) R-448A (26% HFC-32 / 26% HFC-125 / 21% HFC-134a / 20% HFO-1234yf / 7% E-HFO-1234ze); (ii) at least one residual refrigerant selected from the group consisting of chlorodifluoromethane (HCFC-22), chloropentafluoroethane (CFC-115) and 1,1,1-trifluoroethane (HFC-143a); (iii) at least one additional compound selected from the group consisting of HFC-143a, HFC-41, HFC-134a, HCFC-22, CFC-12 and HCC-40; (iv) at least one additional compound selected from the group consisting of HFC-23, HFC-32, HFC-143a, HFC-134a, CFC-115, CFO-1113 and HCC-40; (v) at least one additional compound selected from the group consisting of HFC-143a, HFO-1225zc, HFC-245cb, HFC-134, HFC-152a, HFO-1225ye, HFC-161, E-HFO-1234ze, HCFC-22, HFO-1243zf, CHFC-124, HCC-40, CHFO-1122, HCFC-31, CFC-114, CFC-114a and HCO-1140; (vi) at least one additional compound selected from the group consisting of HFO-1225ye, HFO-1243zf, E-HFO-1234ze, HFC-236ea, HCFC-244bb, HFC-245fa, HFC-245eb, HFC-245cb, 3,3,3-trifluoropropyne, HFC-152a, FO-1114, HFO-1123, HCFO-1131a, trans-HCFO-1131, HCO-1140, HCFO-1214ya, HFO-1216, HCFO-1224yd, HFO-1252 isomers, HFC-143a, HCFC-225 isomers, HFC-254eb, HFC-263fb, HFC-236fa, HCFC-142b, HCFC-244cc, HCFO-1223, HFO-1132a and HCC-40; and (vii) at least one additional compound selected from the group consisting of HFO-1234yf, HFC-245cb, HFO-1225ye(E), HFO-1225ye(Z), HFO-1225zc, HFC-236fa, HFC-152a, HFC-143a, HFC-125, HFC-134a, HFO-1234zc, HFO-1233xf, HFO-1233zd, CFC-114, HCFC-124, 3,3,3-trifluoropropyne, HFO-1234ze(Z), HFC-245fa, HFC-227ea, HFO-1243zf, HFC-263fb and HFC-134.
45. A composition comprising (i) one of (a) difluoromethane (HFC-32), pentafluoroethane (HFC-125), 1,1,1,2-tetrafluoroethane (HFC-134a), 2,3,3,3-tetrafluoro-1-propene (HFO-1234yf), E-1,3,3,3-tetrafluoro-1-propene (E-HFO-1234ze), or (b) R-448A (26% HFC-32 / 26% HFC-125 / 21% HFC-134a / 20% HFO-1234yf / 7% E-HFO-1234ze); (ii) at least one residual refrigerant selected from the group consisting of chlorodifluoromethane (HCFC-22), chloropentafluoroethane (CFC-115) and 1,1,1-trifluoroethane (HFC-143a); and (iii) at least one additional compound selected from the group consisting of HFC-134a, HFC-245cb and HFO-1243zf.

## 46. A composition comprising:

a first refrigerant portion comprising one of (a) difluoromethane (HFC-32), pentafluoroethane (HFC-125), 1,1,1,2-tetrafluoroethane (HFC-134a), 2,3,3,3-tetrafluoro-1-propene (HFO-1234yf), E-1,3,3,3-tetrafluoro-1-propene (E-HFO-1234ze), or (b) R-448A (26% HFC-32 / 26% HFC-125 / 21% HFC-134a / 20% HFO-1234yf / 7% E-HFO-1234ze); and

a second refrigerant portion comprising at least one compound selected from the group consisting of chlorodifluoromethane (HCFC-22), chloropentafluoroethane (CFC-115) and 1,1,1-trifluoroethane (HFC-143a).

## 47. A composition comprising:

a first refrigerant portion comprising (i) one of (a) difluoromethane (HFC-32), pentafluoroethane (HFC-125), 1,1,1,2-tetrafluoroethane (HFC-134a), 2,3,3,3-tetrafluoro-1-propene (HFO-1234yf), E-1,3,3,3-tetrafluoro-1-propene (E-HFO-1234ze), or (b) R-448A (26% HFC-32 / 26% HFC-125 / 21% HFC-134a / 20% HFO-1234yf / 7% E-HFO-1234ze); (ii) at least one additional compound selected from the group consisting of HFC-143a, HFC-41, HFC-134a, HCFC-22, CFC-12 and HCC-40; (iii) at least one additional compound selected from the group consisting of HFC-23, HFC-32, HFC-143a, HFC-134a, CFC-115, CFO-1113 and HCC-40; (iv) at least one additional compound selected from the group consisting of HFC-143a, HFO-1225zc, HFC-245cb, HFC-134, HFC-152a, HFO-1225ye, HFC-161, E-HFO-1234ze, HCFC-22, HFO-1243zf, CHFC-124, HCC-40, CHFO-1122, HCFC-31, CFC-114, CFC-114a and HCO-1140; (v) at least one additional compound selected from the group consisting of HFO-1225ye, HFO-1243zf, E-HFO-1234ze, HFC-236ea, HCFC-244bb, HFC-245fa, HFC-245eb, HFC-245cb, 3,3,3-trifluoropropyne, HFC-152a, FO-1114, HFO-1123, HCFO-1131a, trans-HCFO-1131, HCO-1140, HCFO-1214ya, HFO-1216, HCFO-1224yd, HFO-1252 isomers, HFC-143a, HCFC-225 isomers, HFC-254eb, HFC-263fb, HFC-236fa, HCFC-142b, HCFC-244cc, HCFO-1223, HFO-1132a and HCC-40; and (vi) at least one additional compound selected from the group consisting of HFO-1234yf, HFC-245cb, HFO-1225ye(E), HFO-1225ye(Z), HFO-1225zc, HFC-236fa, HFC-152a, HFC-143a, HFC-125, HFC-134a, HFO-1234zc, HFO-1233xf, HFO-1233zd, CFC-

114, HCFC-124, 3,3,3-trifluoropropyne, HFO-1234ze(Z), HFC-245fa, HFC-227ea, HFO-1243zf, HFC-263fb and HFC-134; and

a second refrigerant portion comprising at least one compound selected from the group consisting of chlorodifluoromethane (HCFC-22), chloropentafluoroethane (CFC-115) and 1,1,1-trifluoroethane (HFC-143a).

48. A composition comprising:

a first refrigerant portion comprising (i) one of (a) difluoromethane (HFC-32), pentafluoroethane (HFC-125), 1,1,1,2-tetrafluoroethane (HFC-134a), 2,3,3,3-tetrafluoro-1-propene (HFO-1234yf), E-1,3,3,3-tetrafluoro-1-propene (E-HFO-1234ze), or (b) R-448A (26% HFC-32 / 26% HFC-125 / 21% HFC-134a / 20% HFO-1234yf / 7% E-HFO-1234ze); and (ii) at least one additional compound selected from the group consisting of HFC-134a, HFC-245cb and HFO-1243zf; and

a second refrigerant portion comprising at least one compound selected from the group consisting of chlorodifluoromethane (HCFC-22), chloropentafluoroethane (CFC-115) and 1,1,1-trifluoroethane (HFC-143a).

49. A composition comprising (i) one of (a) difluoromethane (HFC-32), pentafluoroethane (HFC-125), 1,1,1,2-tetrafluoroethane (HFC-134a) and 2,3,3,3-tetrafluoro-1-propene (HFO-1234yf), or (b) R-449A (24.3% HFC-32 / 24.7% HFC-125 / 25.7% HFC-134a / 25.3% HFO-1234yf); and (ii) at least one residual refrigerant selected from the group consisting of chlorodifluoromethane (HCFC-22), chloropentafluoroethane (CFC-115), E-1,3,3,3-tetrafluoro-1-propene (E-HFO-1234ze) and 1,1,1-trifluoroethane (HFC-143a).

50. A composition comprising (i) one of (a) difluoromethane (HFC-32), pentafluoroethane (HFC-125), 1,1,1,2-tetrafluoroethane (HFC-134a) and 2,3,3,3-tetrafluoro-1-propene (HFO-1234yf), or (b) R-449A (24.3% HFC-32 / 24.7% HFC-125 / 25.7% HFC-134a / 25.3% HFO-1234yf); (ii) at least one residual refrigerant selected from the group consisting of chlorodifluoromethane (HCFC-22), chloropentafluoroethane (CFC-115), E-1,3,3,3-tetrafluoro-1-propene (E-HFO-1234ze) and 1,1,1-trifluoroethane (HFC-143a); (iii) at least one additional compound selected from the group consisting

of HFC-143a, HFC-41, HFC-134a, HCFC-22, CFC-12 and HCC-40; (iv) at least one additional compound selected from the group consisting of HFC-23, HFC-32, HFC-143a, HFC-134a, CFC-115, CFO-1113 and HCC-40; (v) at least one additional compound selected from the group consisting of HFC-143a, HFO-1225zc, HFC-245cb, HFC-134, HFC-152a, HFO-1225ye, HFC-161, E-HFO-1234ze, HCFC-22, HFO-1243zf, CHFC-124, HCC-40, CHFO-1122, HCFC-31, CFC-114, CFC-114a and HCO-1140; and (vi) at least one additional compound selected from the group consisting of HFO-1225ye, HFO-1243zf, E-HFO-1234ze, HFC-236ea, HCFC-244bb, HFC-245fa, HFC-245eb, HFC-245cb, 3,3,3-trifluoropropyne, HFC-152a, FO-1114, HFO-1123, HCFO-1131a, trans-HCFO-1131, HCO-1140, HCFO-1214ya, HFO-1216, HCFO-1224yd, HFO-1252 isomers, HFC-143a, HCFC-225 isomers, HFC-254eb, HFC-263fb, HFC-236fa, HCFC-142b, HCFC-244cc, HCFO-1223, HFO-1132a and HCC-40.

51. A composition comprising (i) one of (a) difluoromethane (HFC-32), pentafluoroethane (HFC-125), 1,1,1,2-tetrafluoroethane (HFC-134a) and 2,3,3,3-tetrafluoro-1-propene (HFO-1234yf), or (b) R-449A (24.3% HFC-32 / 24.7% HFC-125 / 25.7% HFC-134a / 25.3% HFO-1234yf); (ii) at least one residual refrigerant selected from the group consisting of chlorodifluoromethane (HCFC-22), chloropentafluoroethane (CFC-115), E-1,3,3,3-tetrafluoro-1-propene (E-HFO-1234ze) and 1,1,1-trifluoroethane (HFC-143a); and (iii) at least one additional compound selected from the group consisting of HFC-134a, HFC-245cb and HFO-1243zf.
52. A composition comprising:
  - a first refrigerant portion comprising one of (a) difluoromethane (HFC-32), pentafluoroethane (HFC-125), 1,1,1,2-tetrafluoroethane (HFC-134a) and 2,3,3,3-tetrafluoro-1-propene (HFO-1234yf), or (b) R-449A (24.3% HFC-32 / 24.7% HFC-125 / 25.7% HFC-134a / 25.3% HFO-1234yf); and
  - a second refrigerant portion comprising at least one compound selected from the group consisting of chlorodifluoromethane (HCFC-22), chloropentafluoroethane (CFC-115), E-1,3,3,3-tetrafluoro-1-propene (E-HFO-1234ze) and 1,1,1-trifluoroethane (HFC-143a).



## 53. A composition comprising:

a first refrigerant portion comprising (i) one of (a) difluoromethane (HFC-32), pentafluoroethane (HFC-125), 1,1,1,2-tetrafluoroethane (HFC-134a) and 2,3,3,3-tetrafluoro-1-propene (HFO-1234yf), or (b) R-449A (24.3% HFC-32 / 24.7% HFC-125 / 25.7% HFC-134a / 25.3% HFO-1234yf); (ii) at least one additional compound selected from the group consisting of HFC-143a, HFC-41, HFC-134a, HCFC-22, CFC-12 and HCC-40; (iii) at least one additional compound selected from the group consisting of HFC-23, HFC-32, HFC-143a, HFC-134a, CFC-115, CFO-1113 and HCC-40; (iv) at least one additional compound selected from the group consisting of HFC-143a, HFO-1225zc, HFC-245cb, HFC-134, HFC-152a, HFO-1225ye, HFC-161, E-HFO-1234ze, HCFC-22, HFO-1243zf, CHFC-124, HCC-40, CHFO-1122, HCFC-31, CFC-114, CFC-114a and HCO-1140; and (v) at least one additional compound selected from the group consisting of HFO-1225ye, HFO-1243zf, E-HFO-1234ze, HFC-236ea, HCFC-244bb, HFC-245fa, HFC-245eb, HFC-245cb, 3,3,3-trifluoropropyne, HFC-152a, FO-1114, HFO-1123, HCFO-1131a, trans-HCFO-1131, HCO-1140, HCFO-1214ya, HFO-1216, HCFO-1224yd, HFO-1252 isomers, HFC-143a, HCFC-225 isomers, HFC-254eb, HFC-263fb, HFC-236fa, HCFC-142b, HCFC-244cc, HCFO-1223, HFO-1132a and HCC-40; and

a second refrigerant portion comprising at least one compound selected from the group consisting of chlorodifluoromethane (HCFC-22), chloropentafluoroethane (CFC-115), E-1,3,3,3-tetrafluoro-1-propene (E-HFO-1234ze) and 1,1,1-trifluoroethane (HFC-143a).

## 54. A composition comprising:

a first refrigerant portion comprising (i) one of (a) difluoromethane (HFC-32), pentafluoroethane (HFC-125), 1,1,1,2-tetrafluoroethane (HFC-134a) and 2,3,3,3-tetrafluoro-1-propene (HFO-1234yf), or (b) R-449A (24.3% HFC-32 / 24.7% HFC-125 / 25.7% HFC-134a / 25.3% HFO-1234yf); and (ii) at least one additional compound selected from the group consisting of HFC-134a, HFC-245cb and HFO-1243zf; and

a second refrigerant portion comprising at least one compound selected from the group consisting of chlorodifluoromethane (HCFC-22),

chloropentafluoroethane (CFC-115), E-1,3,3,3-tetrafluoro-1-propene (E-HFO-1234ze) and 1,1,1-trifluoroethane (HFC-143a).

55. A composition comprising (i) one of (a) 1,1,1-trifluoroethane (HFC-143a), pentafluoroethane (HFC-125) and 1,1,1,2-tetrafluoroethane (HFC-134a), or (b) R-404A (44% HFC-125 / 4% HFC-134a / 52% HFC-143a), and (ii) at least one residual refrigerant selected from the group consisting of chlorodifluoromethane (HCFC-22) and chloropentafluoroethane (CFC-115).
56. A composition comprising (i) one of (a) 1,1,1-trifluoroethane (HFC-143a), pentafluoroethane (HFC-125) and 1,1,1,2-tetrafluoroethane (HFC-134a), or (b) R-404A (44% HFC-125 / 4% HFC-134a / 52% HFC-143a); (ii) at least one residual refrigerant selected from the group consisting of chlorodifluoromethane (HCFC-22) and chloropentafluoroethane (CFC-115); (iii) at least one additional compound selected from the group consisting of HFC-23, HFC-32, HFC-143a, HFC-134a, CFC-115, CFO-1113 and HCC-40; (iv) at least one additional compound selected from the group consisting of HFC-143a, HFO-1225zc, HFC-245cb, HFC-134, HFC-152a, HFO-1225ye, HFC-161, E-HFO-1234ze, HCFC-22, HFO-1243zf, CHFC-124, HCC-40, CHFO-1122, HCFC-31, CFC-114, CFC-114a and HCO-1140; and (v) at least one additional compound selected from the group consisting of CFC-115, HFC-134a, HFC-152a, HCFC-22, CFC-12, HCFC-124, CFC-114a and HCFC-133a.
57. A composition comprising (i) one of (a) 1,1,1-trifluoroethane (HFC-143a), pentafluoroethane (HFC-125) and 1,1,1,2-tetrafluoroethane (HFC-134a), or (b) R-404A (44% HFC-125 / 4% HFC-134a / 52% HFC-143a); (ii) at least one residual refrigerant selected from the group consisting of chlorodifluoromethane (HCFC-22) and chloropentafluoroethane (CFC-115); and (iii) at least one additional compound selected from the group consisting of HFC-134, HCC-40 and CFC-114a.
58. A composition comprising:
  - a first refrigerant portion comprising one of (a) 1,1,1-trifluoroethane (HFC-143a), pentafluoroethane (HFC-125) and 1,1,1,2-tetrafluoroethane (HFC-134a), or (b) R-404A (44% HFC-125 / 4% HFC-134a / 52% HFC-143a); and

a second refrigerant portion comprising at least one compound selected from the group consisting of chlorodifluoromethane (HCFC-22) and chloropentafluoroethane (CFC-115).

59. A composition comprising:

a first refrigerant portion comprising (i) one of (a) 1,1,1-trifluoroethane (HFC-143a), pentafluoroethane (HFC-125) and 1,1,1,2-tetrafluoroethane (HFC-134a), or (b) R-404A (44% HFC-125 / 4% HFC-134a / 52% HFC-143a); (ii) at least one additional compound selected from the group consisting of HFC-23, HFC-32, HFC-143a, HFC-134a, CFC-115, CFO-1113 and HCC-40; (iii) at least one additional compound selected from the group consisting of HFC-143a, HFO-1225zc, HFC-245cb, HFC-134, HFC-152a, HFO-1225ye, HFC-161, E-HFO-1234ze, HCFC-22, HFO-1243zf, CHFC-124, HCC-40, CHFO-1122, HCFC-31, CFC-114, CFC-114a and HCO-1140; and (iv) at least one additional compound selected from the group consisting of CFC-115, HFC-134a, HFC-152a, HCFC-22, CFC-12, HCFC-124, CFC-114a and HCFC-133a; and

a second refrigerant portion comprising at least one compound selected from the group consisting of chlorodifluoromethane (HCFC-22) and chloropentafluoroethane (CFC-115).

60. A composition comprising:

a first refrigerant portion comprising (i) one of (a) 1,1,1-trifluoroethane (HFC-143a), pentafluoroethane (HFC-125) and 1,1,1,2-tetrafluoroethane (HFC-134a), or (b) R-404A (44% HFC-125 / 4% HFC-134a / 52% HFC-143a); and (ii) at least one additional compound selected from the group consisting of HFC-134, HCC-40 and CFC-114a; and

a second refrigerant portion comprising at least one compound selected from the group consisting of chlorodifluoromethane (HCFC-22) and chloropentafluoroethane (CFC-115).

61. A composition comprising (i) one of (a) 1,1,1-trifluoroethane (HFC-143a) and pentafluoroethane (HFC-125), or (b) R-507 (50% HFC-125 / 50% HFC-143a); and (ii) at least one residual refrigerant selected from the group consisting of chlorodifluoromethane (HCFC-22) and chloropentafluoroethane (CFC-115).

62. A composition comprising (i) one of (a) 1,1,1-trifluoroethane (HFC-143a) and pentafluoroethane (HFC-125), or (b) R-507 (50% HFC-125 / 50% HFC-143a); (ii) at least one residual refrigerant selected from the group consisting of chlorodifluoromethane (HCFC-22) and chloropentafluoroethane (CFC-115); (iii) at least one additional compound selected from the group consisting of HFC-23, HFC-32, HFC-143a, HFC-134a, CFC-115, CFO-1113 and HCC-40; and (iv) at least one additional compound selected from the group consisting of CFC-115, HFC-134a, HFC-152a, HCFC-22, CFC-12, HCFC-124, CFC-114a and HCFC-133a.
63. A composition comprising (i) one of (a) 1,1,1-trifluoroethane (HFC-143a) and pentafluoroethane (HFC-125), or (b) R-507 (50% HFC-125 / 50% HFC-143a); (ii) at least one residual refrigerant selected from the group consisting of chlorodifluoromethane (HCFC-22) and chloropentafluoroethane (CFC-115); and (iii) at least one additional compound selected from the group consisting of HFC-134a and HCC-40.
64. A composition comprising:
- a first refrigerant portion comprising one of (a) 1,1,1-trifluoroethane (HFC-143a) and pentafluoroethane (HFC-125), or (b) R-507 (50% HFC-125 / 50% HFC-143a); and
  - a second refrigerant portion comprising at least one compound selected from the group consisting of chlorodifluoromethane (HCFC-22) and chloropentafluoroethane (CFC-115).
65. A composition comprising:
- a first refrigerant portion comprising (i) one of (a) 1,1,1-trifluoroethane (HFC-143a) and pentafluoroethane (HFC-125), or (b) R-507 (50% HFC-125 / 50% HFC-143a); (ii) at least one additional compound selected from the group consisting of HFC-23, HFC-32, HFC-143a, HFC-134a, CFC-115, CFO-1113 and HCC-40; and (iii) at least one additional compound selected from the group consisting of CFC-115, HFC-134a, HFC-152a, HCFC-22, CFC-12, HCFC-124, CFC-114a and HCFC-133a; and

a second refrigerant portion comprising at least one compound selected from the group consisting of chlorodifluoromethane (HCFC-22) and chloropentafluoroethane (CFC-115).

66. A composition comprising:

a first refrigerant portion comprising (i) one of (a) 1,1,1-trifluoroethane (HFC-143a) and pentafluoroethane (HFC-125), or (b) R-507 (50% HFC-125 / 50% HFC-143a); and (ii) at least one additional compound selected from the group consisting of HFC-134a and HCC-40; and

a second refrigerant portion comprising at least one compound selected from the group consisting of chlorodifluoromethane (HCFC-22) and chloropentafluoroethane (CFC-115).

67. A composition comprising (i) one of (a) difluoromethane (HFC-32) and 2,3,3,3-tetrafluoro-1-propene (HFO-1234yf), or (b) R-454A (35% HFC-32 / 65% HFO-1234yf), or (c) R-454C (21.5% HFC-32 / 78.5% HFO-1234yf); and (ii) at least one residual refrigerant selected from the group consisting of chlorodifluoromethane (HCFC-22), dichlorodifluoromethane (CFC-12), chloropentafluoroethane (CFC-115), pentafluoroethane (HFC-125), 1,1,1,2-tetrafluoroethane (HFC-134a) and 1,1,1-trifluoroethane (HFC-143a).

68. A composition comprising (i) one of (a) difluoromethane (HFC-32) and 2,3,3,3-tetrafluoro-1-propene (HFO-1234yf), or (b) R-454A (35% HFC-32 / 65% HFO-1234yf), or (c) R-454C (21.5% HFC-32 / 78.5% HFO-1234yf); (ii) at least one residual refrigerant selected from the group consisting of chlorodifluoromethane (HCFC-22), dichlorodifluoromethane (CFC-12), chloropentafluoroethane (CFC-115), pentafluoroethane (HFC-125), 1,1,1,2-tetrafluoroethane (HFC-134a) and 1,1,1-trifluoroethane (HFC-143a); (iii) at least one additional compound selected from the group consisting of HFC-143a, HFC-41, HFC-134a, HCFC-22, CFC-12 and HCC-40; and (iv) at least one additional compound selected from the group consisting of HFO-1225ye, HFO-1243zf, E-HFO-1234ze, HFC-236ea, HCFC-244bb, HFC-245fa, HFC-245eb, HFC-245cb, 3,3,3-trifluoropropyne, HFC-152a, FO-1114, HFO-1123, HCFO-1131a, trans-HCFO-1131, HCO-1140, HCFO-1214ya, HFO-1216, HCFO-1224yd, HFO-1252 isomers, HFC-143a, HCFC-225 isomers, HFC-

254eb, HFC-263fb, HFC- 236fa, HCFC-142b, HCFC-244cc, HCFO-1223, HFO-1132a and HCC-40.

69. A composition comprising (i) one of (a) difluoromethane (HFC-32) and 2,3,3,3-tetrafluoro-1-propene (HFO-1234yf), or (b) R-454A (35% HFC-32 / 65% HFO-1234yf), or (c) R-454C (21.5% HFC-32 / 78.5% HFO-1234yf); (ii) at least one residual refrigerant selected from the group consisting of chlorodifluoromethane (HCFC-22), dichlorodifluoromethane (CFC-12), chloropentafluoroethane (CFC-115), pentafluoroethane (HFC-125), 1,1,1,2-tetrafluoroethane (HFC-134a) and 1,1,1-trifluoroethane (HFC-143a); and (iii) at least one additional compound selected from the group consisting of HFC-143a, HFC-245cb, HFO-1243zf and E-HFO-1234ze.
70. A composition comprising:  
a first refrigerant portion comprising one of (a) difluoromethane (HFC-32) and 2,3,3,3-tetrafluoro-1-propene (HFO-1234yf), or (b) R-454A (35% HFC-32 / 65% HFO-1234yf), or (c) R-454C (21.5% HFC-32 / 78.5% HFO-1234yf); and  
a second refrigerant portion comprising at least one compound selected from the group consisting of chlorodifluoromethane (HCFC-22), dichlorodifluoromethane (CFC-12), chloropentafluoroethane (CFC-115), pentafluoroethane (HFC-125), 1,1,1,2-tetrafluoroethane (HFC-134a) and 1,1,1-trifluoroethane (HFC-143a).
71. A composition comprising:  
a first refrigerant portion comprising (i) one of (a) difluoromethane (HFC-32) and 2,3,3,3-tetrafluoro-1-propene (HFO-1234yf), or (b) R-454A (35% HFC-32 / 65% HFO-1234yf), or (c) R-454C (21.5% HFC-32 / 78.5% HFO-1234yf); (ii) at least one additional compound selected from the group consisting of HFC-143a, HFC-41, HFC-134a, HCFC-22, CFC-12 and HCC-40; and (iii) at least one additional compound selected from the group consisting of HFO-1225ye, HFO-1243zf, E-HFO-1234ze, HFC-236ea, HCFC-244bb, HFC-245fa, HFC-245eb, HFC-245cb, 3,3,3-trifluoropropyne, HFC-152a, FO-1114, HFO-1123, HCFO-1131a, trans-HCFO-1131, HCO- 1140, HCFO-1214ya, HFO-1216, HCFO-1224yd, HFO-1252 isomers, HFC-143a,

HCFC-225 isomers, HFC-254eb, HFC-263fb, HFC- 236fa, HCFC-142b, HCFC-244cc, HCFO-1223, HFO-1132a and HCC-40; and

a second refrigerant portion comprising at least one compound selected from the group consisting of chlorodifluoromethane (HCFC-22), dichlorodifluoromethane (CFC-12), chloropentafluoroethane (CFC-115), pentafluoroethane (HFC-125), 1,1,1,2-tetrafluoroethane (HFC-134a) and 1,1,1-trifluoroethane (HFC-143a).

72. A composition comprising:

a first refrigerant portion comprising (i) one of (a) difluoromethane (HFC-32) and 2,3,3,3-tetrafluoro-1-propene (HFO-1234yf), or (b) R-454A (35% HFC-32 / 65% HFO-1234yf), or (c) R-454C (21.5% HFC-32 / 78.5% HFO-1234yf); and (ii) at least one additional compound selected from the group consisting of HFC-143a, HFC-245cb, HFO-1243zf and E-HFO-1234ze; and

a second refrigerant portion comprising at least one compound selected from the group consisting of chlorodifluoromethane (HCFC-22), dichlorodifluoromethane (CFC-12), chloropentafluoroethane (CFC-115), pentafluoroethane (HFC-125), 1,1,1,2-tetrafluoroethane (HFC-134a) and 1,1,1-trifluoroethane (HFC-143a).

73. A composition comprising (i) one of (a) 1,1,1,2,3,3,3-heptafluoropropane (HFC-227ea), E-1,3,3,3-tetrafluoro-1-propene (E-HFO-1234ze) and E-1,1,1,4,4,4-hexafluoro-2-butene (E-HFO-1336mzz), or (b) R-471A (4.3% HFC-227ea / 78.7% HFO-1234ze(E) / 17% HFO-1336mzz(E)); and (ii) at least one residual refrigerant selected from the group consisting of chlorodifluoromethane (HCFC-22), dichlorodifluoromethane (CFC-12), chloropentafluoroethane (CFC-115), pentafluoroethane (HFC-125), 1,1,1,2-tetrafluoroethane (HFC-134a) and 1,1,1-trifluoroethane (HFC-143a).

74. A composition comprising (i) one of (a) 1,1,1,2,3,3,3-heptafluoropropane (HFC-227ea), E-1,3,3,3-tetrafluoro-1-propene (E-HFO-1234ze) and E-1,1,1,4,4,4-hexafluoro-2-butene (E-HFO-1336mzz), or (b) R-471A (4.3% HFC-227ea / 78.7% HFO-1234ze(E) / 17% HFO-1336mzz(E)); (ii) at least one residual refrigerant selected from the group consisting of chlorodifluoromethane (HCFC-22), dichlorodifluoromethane (CFC-12), chloropentafluoroethane

(CFC-115), pentafluoroethane (HFC-125), 1,1,1,2-tetrafluoroethane (HFC-134a) and 1,1,1-trifluoroethane (HFC-143a); (iii) at least one additional compound selected from the group consisting of HFC-23, FC-1216, HFC-143a, HFC-134a, HCFC-22, HCFC-124, FC-218, HFC-236fa and HFO-1225zc; (iv) at least one additional compound selected from the group consisting of HFO-1234yf, HFC-245cb, HFO-1225ye(E), HFO-1225ye(Z), HFO-1225zc, HFC-236fa, HFC-152a, HFC-143a, HFC-125, HFC-134a, HFO-1234zc, HFO-1233xf, HFO-1233zd, CFC-114, HCFC-124, 3,3,3-trifluoropropyne, HFO-1234ze(Z), HFC-245fa, HFC-227ea, HFO-1243zf, HFC-263fb and HFC-134; and (v) at least one additional compound selected from the group consisting of C-30, HCFC-114, HCFC-114a, HCFC-133, HCFC-133a, HFC-245fa, HFC-338mee, HFC-338mf, HFC-347mef, HCO-1140, HCFO-1224 isomers, HCFO-1224yd, HCFO-1224yb, HCFO-1233xf, HCFO-1233zd, HFO-1243zf, HFO-1327mz, HFO-1336ft and HCFO-1326mxz.

75. A composition comprising (i) one of (a) 1,1,1,2,3,3,3-heptafluoropropane (HFC-227ea), E-1,3,3,3-tetrafluoro-1-propene (E-HFO-1234ze) and E-1,1,1,4,4,4-hexafluoro-2-butene (E-HFO-1336mzz), or (b) R-471A (4.3% HFC-227ea / 78.7% HFO-1234ze(E) / 17% HFO-1336mzz(E)); (ii) at least one residual refrigerant selected from the group consisting of chlorodifluoromethane (HCFC-22), dichlorodifluoromethane (CFC-12), chloropentafluoroethane (CFC-115), pentafluoroethane (HFC-125), 1,1,1,2-tetrafluoroethane (HFC-134a) and 1,1,1-trifluoroethane (HFC-143a); and (iii) at least one additional compound selected from the group consisting of HCFC-133, HFO-1234yf, HFO-1225zc and HFO-1336ft.

76. A composition comprising:

a first refrigerant portion comprising one of (a) 1,1,1,2,3,3,3-heptafluoropropane (HFC-227ea), E-1,3,3,3-tetrafluoro-1-propene (E-HFO-1234ze) and E-1,1,1,4,4,4-hexafluoro-2-butene (E-HFO-1336mzz), or (b) R-471A (4.3% HFC-227ea / 78.7% HFO-1234ze(E) / 17% HFO-1336mzz(E)); and

a second refrigerant portion comprising at least one compound selected from the group consisting of chlorodifluoromethane (HCFC-22),



dichlorodifluoromethane (CFC-12), chloropentafluoroethane (CFC-115), pentafluoroethane (HFC-125), 1,1,1,2-tetrafluoroethane (HFC-134a) and 1,1,1-trifluoroethane (HFC-143a).

77. A composition comprising:

a first refrigerant portion comprising (i) one of (a) 1,1,1,2,3,3,3-heptafluoropropane (HFC-227ea), E-1,3,3,3-tetrafluoro-1-propene (E-HFO-1234ze) and E-1,1,1,4,4,4-hexafluoro-2-butene (E-HFO-1336mzz), or (b) R-471A (4.3% HFC-227ea / 78.7% HFO-1234ze(E) / 17% HFO-1336mzz(E)); (ii) at least one additional compound selected from the group consisting of HFC-23, FC-1216, HFC-143a, HFC-134a, HCFC-22, HCFC-124, FC-218, HFC-236fa and HFO-1225zc; (iii) at least one additional compound selected from the group consisting of HFO-1234yf, HFC-245cb, HFO-1225ye(E), HFO-1225ye(Z), HFO-1225zc, HFC-236fa, HFC-152a, HFC-143a, HFC-125, HFC-134a, HFO-1234zc, HFO-1233xf, HFO-1233zd, CFC-114, HCFC-124, 3,3,3-trifluoropropyne, HFO-1234ze(Z), HFC-245fa, HFC-227ea, HFO-1243zf, HFC-263fb and HFC-134; and (iv) at least one additional compound selected from the group consisting of C-30, HCFC-114, HCFC-114a, HCFC-133, HCFC-133a, HFC-245fa, HFC-338mee, HFC-338mf, HFC-347mef, HCO-1140, HCFO-1224 isomers, HCFO-1224yd, HCFO-1224yb, HCFO-1233xf, HCFO-1233zd, HFO-1243zf, HFO-1327mz, HFO-1336ft and HCFO-1326mxz; and

a second refrigerant portion comprising at least one compound selected from the group consisting of chlorodifluoromethane (HCFC-22), dichlorodifluoromethane (CFC-12), chloropentafluoroethane (CFC-115), pentafluoroethane (HFC-125), 1,1,1,2-tetrafluoroethane (HFC-134a) and 1,1,1-trifluoroethane (HFC-143a).

78. A composition comprising:

a first refrigerant portion comprising (i) one of (a) 1,1,1,2,3,3,3-heptafluoropropane (HFC-227ea), E-1,3,3,3-tetrafluoro-1-propene (E-HFO-1234ze) and E-1,1,1,4,4,4-hexafluoro-2-butene (E-HFO-1336mzz), or (b) R-471A (4.3% HFC-227ea / 78.7% HFO-1234ze(E) / 17% HFO-1336mzz(E));

and (ii) at least one additional compound selected from the group consisting of HCFC-133, HFO-1234yf, HFO-1225zc and HFO-1336ft; and

a second refrigerant portion comprising at least one compound selected from the group consisting of chlorodifluoromethane (HCFC-22), dichlorodifluoromethane (CFC-12), chloropentafluoroethane (CFC-115), pentafluoroethane (HFC-125), 1,1,1,2-tetrafluoroethane (HFC-134a) and 1,1,1-trifluoroethane (HFC-143a).

79. A composition comprising (i) one of (a) 1,1,1,2-tetrafluoroethane (HFC-134a), E-1,3,3,3-tetrafluoro-1-propene (E-HFO-1234ze) and E-1,1,1,4,4,4-hexafluoro-2-butene (E-HFO-1336mzz), or (b) R-476A (10% HFC-134a / 78% HFO-1234ze(E) / 12% HFO-1336mzz(E)); and (ii) at least one residual refrigerant selected from the group consisting of chlorodifluoromethane (HCFC-22), dichlorodifluoromethane (CFC-12), chloropentafluoroethane (CFC-115), pentafluoroethane (HFC-125) and 1,1,1-trifluoroethane (HFC-143a).
80. A composition comprising (i) one of (a) 1,1,1,2-tetrafluoroethane (HFC-134a), E-1,3,3,3-tetrafluoro-1-propene (E-HFO-1234ze) and E-1,1,1,4,4,4-hexafluoro-2-butene (E-HFO-1336mzz), or (b) R-476A (10% HFC-134a / 78% HFO-1234ze(E) / 12% HFO-1336mzz(E)); (ii) at least one residual refrigerant selected from the group consisting of chlorodifluoromethane (HCFC-22), dichlorodifluoromethane (CFC-12), chloropentafluoroethane (CFC-115), pentafluoroethane (HFC-125) and 1,1,1-trifluoroethane (HFC-143a); (iii) at least one additional compound selected from the group consisting of HFC-143a, HFO-1225zc, HFC-245cb, HFC-134, HFC-152a, HFO-1225ye, HFC-161, E-HFO-1234ze, HCFC-22, HFO-1243zf, CHFC-124, HCC-40, CHFO-1122, HCFC-31, CFC-114, CFC-114a and HCO-1140; (iv) at least one additional compound selected from the group consisting of HFO-1234yf, HFC-245cb, HFO-1225ye(E), HFO-1225ye(Z), HFO-1225zc, HFC-236fa, HFC-152a, HFC-143a, HFC-125, HFC-134a, HFO-1234zc, HFO-1233xf, HFO-1233zd, CFC-114, HCFC-124, 3,3,3-trifluoropropylene, HFO-1234ze(Z), HFC-245fa, HFC-227ea, HFO-1243zf, HFC-263fb and HFC-134; and (v) at least one additional compound selected from the group consisting of C-30, HCFC-114, HCFC-114a, HCFC-133, HCFC-133a, HFC-245fa, HFC-338mee, HFC-338mf, HFC-347mef, HCO-1140, HCFO-1224 isomers, HCFO-1224yd,

HCFO-1224yb, HCFO-1233xf, HCFO-1233zd, HFO-1243zf, HFO-1327mz, HFO-1336ft and HCFO-1326mxz.

81. A composition comprising (i) one of (a) 1,1,1,2-tetrafluoroethane (HFC-134a), E-1,3,3,3-tetrafluoro-1-propene (E-HFO-1234ze) and E-1,1,1,4,4,4-hexafluoro-2-butene (E-HFO-1336mzz), or (b) R-476A (10% HFC-134a / 78% HFO-1234ze(E) / 12% HFO-1336mzz(E)); (ii) at least one residual refrigerant selected from the group consisting of chlorodifluoromethane (HCFC-22), dichlorodifluoromethane (CFC-12), chloropentafluoroethane (CFC-115), pentafluoroethane (HFC-125) and 1,1,1-trifluoroethane (HFC-143a); and (iii) at least one additional compound selected from the group consisting of HFC-134a, HFC-245cb, HFO-1234yf, HFO-1225zc and HFO-1336ft.
82. A composition comprising:
  - a first refrigerant portion comprising one of (a) 1,1,1,2-tetrafluoroethane (HFC-134a), E-1,3,3,3-tetrafluoro-1-propene (E-HFO-1234ze) and E-1,1,1,4,4,4-hexafluoro-2-butene (E-HFO-1336mzz), or (b) R-476A (10% HFC-134a / 78% HFO-1234ze(E) / 12% HFO-1336mzz(E)); and
  - a second refrigerant portion comprising at least one compound selected from the group consisting of chlorodifluoromethane (HCFC-22), dichlorodifluoromethane (CFC-12), chloropentafluoroethane (CFC-115), pentafluoroethane (HFC-125) and 1,1,1-trifluoroethane (HFC-143a).
83. A composition comprising:
  - a first refrigerant portion comprising (i) one of (a) 1,1,1,2-tetrafluoroethane (HFC-134a), E-1,3,3,3-tetrafluoro-1-propene (E-HFO-1234ze) and E-1,1,1,4,4,4-hexafluoro-2-butene (E-HFO-1336mzz), or (b) R-476A (10% HFC-134a / 78% HFO-1234ze(E) / 12% HFO-1336mzz(E)); (ii) at least one additional compound selected from the group consisting of HFC-143a, HFO-1225zc, HFC-245cb, HFC-134, HFC-152a, HFO-1225ye, HFC-161, E-HFO-1234ze, HCFC-22, HFO-1243zf, CHFC-124, HCC-40, CHFO-1122, HCFC-31, CFC-114, CFC-114a and HCO-1140; (iii) at least one additional compound selected from the group consisting of HFO-1234yf, HFC-245cb, HFO-1225ye(E), HFO-1225ye(Z), HFO-1225zc, HFC-236fa, HFC-152a, HFC-143a, HFC-125, HFC-134a, HFO-1234zc, HFO-1233xf, HFO-1233zd, CFC-114,

HCFC-124, 3,3,3-trifluoropropyne, HFO-1234ze(Z), HFC-245fa, HFC-227ea, HFO-1243zf, HFC-263fb and HFC-134; and (iv) at least one additional compound selected from the group consisting of C-30, HCFC-114, HCFC-114a, HCFC-133, HCFC-133a, HFC-245fa, HFC-338mee, HFC-338mf, HFC-347mef, HCO-1140, HCFO-1224 isomers, HCFO-1224yd, HCFO-1224yb, HCFO-1233xf, HCFO-1233zd, HFO-1243zf, HFO-1327mz, HFO-1336ft and HCFO-1326mxz; and

a second refrigerant portion comprising at least one compound selected from the group consisting of chlorodifluoromethane (HCFC-22), dichlorodifluoromethane (CFC-12), chloropentafluoroethane (CFC-115), pentafluoroethane (HFC-125) and 1,1,1-trifluoroethane (HFC-143a).

84. A composition comprising:

a first refrigerant portion comprising (i) one of (a) 1,1,1,2-tetrafluoroethane (HFC-134a), E-1,3,3,3-tetrafluoro-1-propene (E-HFO-1234ze) and E-1,1,1,4,4,4-hexafluoro-2-butene (E-HFO-1336mzz), or (b) R-476A (10% HFC-134a / 78% HFO-1234ze(E) / 12% HFO-1336mzz(E)); and (ii) at least one additional compound selected from the group consisting of HFC-134a, HFC-245cb, HFO-1234yf, HFO-1225zc and HFO-1336ft; and

a second refrigerant portion comprising at least one compound selected from the group consisting of chlorodifluoromethane (HCFC-22), dichlorodifluoromethane (CFC-12), chloropentafluoroethane (CFC-115), pentafluoroethane (HFC-125) and 1,1,1-trifluoroethane (HFC-143a).

85. A composition comprising (i) one of (a) 1,1,1,2-tetrafluoroethane (HFC-134a), E-1,3,3,3-tetrafluoro-1-propene (E-HFO-1234ze) and Z-1-chloro-2,3,3,3-tetrafluoropropene (Z-HFO-1224yd), or (b) R-482A (10% HFC-134a / 83.5% HFO-1234ze(E) / 6.5% HFO-1224yd(Z)); and (ii) at least one residual refrigerant selected from the group consisting of chlorodifluoromethane (HCFC-22), dichlorodifluoromethane (CFC-12), chloropentafluoroethane (CFC-115), pentafluoroethane (HFC-125) and 1,1,1-trifluoroethane (HFC-143a).

86. A composition comprising (i) one of (a) 1,1,1,2-tetrafluoroethane (HFC-134a), E-1,3,3,3-tetrafluoro-1-propene (E-HFO-1234ze) and Z-1-chloro-2,3,3,3-tetrafluoropropene (Z-HFO-1224yd), or (b) R-482A (10% HFC-134a / 83.5%

HFO-1234ze(E) / 6.5% HFO-1224yd(Z)); (ii) at least one residual refrigerant selected from the group consisting of chlorodifluoromethane (HCFC-22), dichlorodifluoromethane (CFC-12), chloropentafluoroethane (CFC-115), pentafluoroethane (HFC-125) and 1,1,1-trifluoroethane (HFC-143a); (iii) at least one additional compound selected from the group consisting of HFC-143a, HFO-1225zc, HFC-245cb, HFC-134, HFC-152a, HFO-1225ye, HFC-161, E-HFO-1234ze, HCFC-22, HFO-1243zf, CHFC-124, HCC-40, CHFO-1122, HCFC-31, CFC-114, CFC-114a and HCO-1140; (iv) at least one additional compound selected from the group consisting of HFO-1234yf, HFC-245cb, HFO-1225ye(E), HFO-1225ye(Z), HFO-1225zc, HFC-236fa, HFC-152a, HFC-143a, HFC-125, HFC-134a, HFO-1234zc, HFO-1233xf, HFO-1233zd, CFC-114, HCFC-124, 3,3,3-trifluoropropyne, HFO-1234ze(Z), HFC-245fa, HFC-227ea, HFO-1243zf, HFC-263fb and HFC-134; and (v) at least one additional compound selected from the group consisting of HFO-1234yf, HFO-1234ze(E), HFO-1243zf, HFC-263fb, HFC-254eb, HFO-1215yb, HCFC-244bb, HCFO-1224yd(E), HCFO-1224 isomer(s), CFO-1112a, HFC-225ca, HFC-225cb and HFC-234bb.

87. A composition comprising (i) one of (a) 1,1,1,2-tetrafluoroethane (HFC-134a), E-1,3,3,3-tetrafluoro-1-propene (E-HFO-1234ze) and Z-1-chloro-2,3,3,3-tetrafluoropropene (Z-HFO-1224yd), or (b) R-482A (10% HFC-134a / 83.5% HFO-1234ze(E) / 6.5% HFO-1224yd(Z)); (ii) at least one residual refrigerant selected from the group consisting of chlorodifluoromethane (HCFC-22), dichlorodifluoromethane (CFC-12), chloropentafluoroethane (CFC-115), pentafluoroethane (HFC-125) and 1,1,1-trifluoroethane (HFC-143a); and (iii) at least one additional compound selected from the group consisting of HFC-134a, HFC-245cb, HFO-1234yf and HFO-1243zf.
88. A composition comprising:
  - a first refrigerant portion comprising one of (a) 1,1,1,2-tetrafluoroethane (HFC-134a), E-1,3,3,3-tetrafluoro-1-propene (E-HFO-1234ze) and Z-1-chloro-2,3,3,3-tetrafluoropropene (Z-HFO-1224yd), or (b) R-482A (10% HFC-134a / 83.5% HFO-1234ze(E) / 6.5% HFO-1224yd(Z)); and

a second refrigerant portion comprising at least one compound selected from the group consisting of chlorodifluoromethane (HCFC-22), dichlorodifluoromethane (CFC-12), chloropentafluoroethane (CFC-115), pentafluoroethane (HFC-125) and 1,1,1-trifluoroethane (HFC-143a).

89. A composition comprising:

a first refrigerant portion comprising (i) one of (a) 1,1,1,2-tetrafluoroethane (HFC-134a), E-1,3,3,3-tetrafluoro-1-propene (E-HFO-1234ze) and Z-1-chloro-2,3,3,3-tetrafluoropropene (Z-HFO-1224yd), or (b) R-482A (10% HFC-134a / 83.5% HFO-1234ze(E) / 6.5% HFO-1224yd(Z)); (ii) at least one additional compound selected from the group consisting of HFC-143a, HFO-1225zc, HFC-245cb, HFC-134, HFC-152a, HFO-1225ye, HFC-161, E-HFO-1234ze, HCFC-22, HFO-1243zf, HCFC-124, HCC-40, CHFO-1122, HCFC-31, CFC-114, CFC-114a and HCO-1140; (iii) at least one additional compound selected from the group consisting of HFO-1234yf, HFC-245cb, HFO-1225ye(E), HFO-1225ye(Z), HFO-1225zc, HFC-236fa, HFC-152a, HFC-143a, HFC-125, HFC-134a, HFO-1234zc, HFO-1233xf, HFO-1233zd, CFC-114, HCFC-124, 3,3,3-trifluoropropyne, HFO-1234ze(Z), HFC-245fa, HFC-227ea, HFO-1243zf, HFC-263fb and HFC-134; and (iv) at least one additional compound selected from the group consisting of HFO-1234yf, HFO-1234ze(E), HFO-1243zf, HFC-263fb, HFC-254eb, HFO-1215yb, HCFC-244bb, HCFO-1224yd(E), HCFO-1224 isomer(s), CFO-1112a, HFC-225ca, HFC-225cb and HFC-234bb; and

a second refrigerant portion comprising at least one compound selected from the group consisting of chlorodifluoromethane (HCFC-22), dichlorodifluoromethane (CFC-12), chloropentafluoroethane (CFC-115), pentafluoroethane (HFC-125) and 1,1,1-trifluoroethane (HFC-143a).

90. A composition comprising:

a first refrigerant portion comprising (i) one of (a) 1,1,1,2-tetrafluoroethane (HFC-134a), E-1,3,3,3-tetrafluoro-1-propene (E-HFO-1234ze) and Z-1-chloro-2,3,3,3-tetrafluoropropene (Z-HFO-1224yd), or (b) R-482A (10% HFC-134a / 83.5% HFO-1234ze(E) / 6.5% HFO-1224yd(Z)); and (ii) at least one additional

compound selected from the group consisting of HFC-134a, HFC-245cb, HFO-1234yf and HFO-1243zf; and

a second refrigerant portion comprising at least one compound selected from the group consisting of chlorodifluoromethane (HCFC-22), dichlorodifluoromethane (CFC-12), chloropentafluoroethane (CFC-115), pentafluoroethane (HFC-125) and 1,1,1-trifluoroethane (HFC-143a).

91. A composition comprising (i) one of (a) 1,1,1,2,3,3,3-heptafluoropropane (HFC-227ea) and E-1,3,3,3-tetrafluoro-1-propene (E-HFO-1234ze), or (b) R-515B (8.9% HFC-227ea / 91.1% E-HFO-1234ze); and (ii) at least one residual refrigerant selected from the group consisting of trichlorofluoromethane (CFC-11) and 1,1,1,2-tetrafluoroethane (HFC-134a).
92. A composition comprising (i) one of (a) 1,1,1,2,3,3,3-heptafluoropropane (HFC-227ea) and E-1,3,3,3-tetrafluoro-1-propene (E-HFO-1234ze), or (b) R-515B (8.9% HFC-227ea / 91.1% E-HFO-1234ze); (ii) at least one residual refrigerant selected from the group consisting of trichlorofluoromethane (CFC-11) and 1,1,1,2-tetrafluoroethane (HFC-134a); (iii) at least one additional compound selected from the group consisting of HFC-23, FC-1216, HFC-143a, HFC-134a, HCFC-22, HCFC-124, FC-218, HFC-236fa and HFO-1225zc; and (iv) at least one additional compound selected from the group consisting of HFO-1234yf, HFC-245cb, HFO-1225ye(E), HFO-1225ye(Z), HFO-1225zc, HFC-236fa, HFC-152a, HFC-143a, HFC-125, HFC-134a, HFO-1234zc, HFO-1233xf, HFO-1233zd, CFC-114, HCFC-124, 3,3,3-trifluoropropylene, HFO-1234ze(Z), HFC-245fa, HFC-227ea, HFO-1243zf, HFC-263fb and HFC-134.
93. A composition comprising (i) one of (a) 1,1,1,2,3,3,3-heptafluoropropane (HFC-227ea) and E-1,3,3,3-tetrafluoro-1-propene (E-HFO-1234ze), or (b) R-515B (8.9% HFC-227ea / 91.1% E-HFO-1234ze); (ii) at least one residual refrigerant selected from the group consisting of trichlorofluoromethane (CFC-11) and 1,1,1,2-tetrafluoroethane (HFC-134a); and (iii) at least one additional compound selected from the group consisting of HFC-245cb, HFO-1234yf, HFO-1225zc and FC-1216.

94. A composition comprising:
- a first refrigerant portion comprising one of (a) 1,1,1,2,3,3,3-heptafluoropropane (HFC-227ea) and E-1,3,3,3-tetrafluoro-1-propene (E-HFO-1234ze), or (b) R-515B (8.9% HFC-227ea / 91.1% E-HFO-1234ze); and
  - a second refrigerant portion comprising at least one compound selected from the group consisting of trichlorofluoromethane (CFC-11) and 1,1,1,2-tetrafluoroethane (HFC-134a).
95. A composition comprising:
- a first refrigerant portion comprising (i) one of (a) 1,1,1,2,3,3,3-heptafluoropropane (HFC-227ea) and E-1,3,3,3-tetrafluoro-1-propene (E-HFO-1234ze), or (b) R-515B (8.9% HFC-227ea / 91.1% E-HFO-1234ze); (ii) at least one additional compound selected from the group consisting of HFC-23, FC-1216, HFC-143a, HFC-134a, HCFC-22, HCFC-124, FC-218, HFC-236fa and HFO-1225zc; and (iii) at least one additional compound selected from the group consisting of HFO-1234yf, HFC-245cb, HFO-1225ye(E), HFO-1225ye(Z), HFO-1225zc, HFC-236fa, HFC-152a, HFC-143a, HFC-125, HFC-134a, HFO-1234zc, HFO-1233xf, HFO-1233zd, CFC-114, HCFC-124, 3,3,3-trifluoropropyne, HFO-1234ze(Z), HFC-245fa, HFC-227ea, HFO-1243zf, HFC-263fb and HFC-134; and
  - a second refrigerant portion comprising at least one compound selected from the group consisting of trichlorofluoromethane (CFC-11) and 1,1,1,2-tetrafluoroethane (HFC-134a).
96. A composition comprising:
- a first refrigerant portion comprising (i) one of (a) 1,1,1,2,3,3,3-heptafluoropropane (HFC-227ea) and E-1,3,3,3-tetrafluoro-1-propene (E-HFO-1234ze), or (b) R-515B (8.9% HFC-227ea / 91.1% E-HFO-1234ze); and (ii) at least one additional compound selected from the group consisting of HFC-245cb, HFO-1234yf, HFO-1225zc and FC-1216; and
  - a second refrigerant portion comprising at least one compound selected from the group consisting of trichlorofluoromethane (CFC-11) and 1,1,1,2-tetrafluoroethane (HFC-134a).



97. A composition comprising (i) one of (a) Z-1,1,1,4,4,4-hexafluoro-2-butene (Z-HFO-1336mzz) and trans-1,2-dichloroethylene (t-DCE), or (b) R-514A (74.7% Z-HFO-1336mzz / 25.3% t-DCE); and (ii) at least one residual refrigerant selected from the group consisting of trichlorofluoromethane (CFC-11) and 1,1-dichloro-2,2,2-trifluoroethane (HFC-123).
98. A composition comprising (i) one of (a) Z-1,1,1,4,4,4-hexafluoro-2-butene (Z-HFO-1336mzz) and trans-1,2-dichloroethylene (t-DCE), or (b) R-514A (74.7% Z-HFO-1336mzz / 25.3% t-DCE); (ii) at least one residual refrigerant selected from the group consisting of trichlorofluoromethane (CFC-11) and 1,1-dichloro-2,2,2-trifluoroethane (HFC-123); (iii) at least one additional compound selected from the group consisting of HFO-1326mxzE, HFO-1326nxzZ, HFC-346mdf, HFC-356mff and HFO-1336mzz(E); and (iv) at least one additional compound selected from the group consisting of HCC-2120, HCC-1140, HCO-1130a, HCC-30, HCC-150a, cis-DCE, HCC-20, HCC-140a and HCO-1120.
99. A composition comprising (i) one of (a) Z-1,1,1,4,4,4-hexafluoro-2-butene (Z-HFO-1336mzz) and trans-1,2-dichloroethylene (t-DCE), or (b) R-514A (74.7% Z-HFO-1336mzz / 25.3% t-DCE); (ii) at least one residual refrigerant selected from the group consisting of trichlorofluoromethane (CFC-11) and 1,1-dichloro-2,2,2-trifluoroethane (HFC-123); and (iii) at least one additional compound selected from the group consisting of HFO-1326mxz(E), HFO-1326mxz(Z), HCC-2120, HCC-1140, HCO-1130a, cis-DCE and HCC-30.
100. A composition comprising:
- a first refrigerant portion comprising one of (a) Z-1,1,1,4,4,4-hexafluoro-2-butene (Z-HFO-1336mzz) and trans-1,2-dichloroethylene (t-DCE), or (b) R-514A (74.7% Z-HFO-1336mzz / 25.3% t-DCE); and
  - a second refrigerant portion comprising at least one compound selected from the group consisting of trichlorofluoromethane (CFC-11) and 1,1-dichloro-2,2,2-trifluoroethane (HFC-123).
101. A composition comprising:
- a first refrigerant portion comprising (i) one of (a) Z-1,1,1,4,4,4-hexafluoro-2-butene (Z-HFO-1336mzz) and trans-1,2-dichloroethylene (t-DCE), or

(b) R-514A (74.7% Z-HFO-1336mzz / 25.3% t-DCE); (ii) at least one additional compound selected from the group consisting of HFO-1326mxzE, HFO-1326nxzZ, HFC-346mdf, HFC-356mff and HFO-1336mzz(E); and (iii) at least one additional compound selected from the group consisting of HCC-2120, HCC-1140, HCO-1130a, HCC-30, HCC-150a, cis-DCE, HCC-20, HCC-140a and HCO-1120; and

a second refrigerant portion comprising at least one compound selected from the group consisting of trichlorofluoromethane (CFC-11) and 1,1-dichloro-2,2,2-trifluoroethane (HFC-123).

102. A composition comprising:

a first refrigerant portion comprising (i) one of (a) Z-1,1,1,4,4,4-hexafluoro-2-butene (Z-HFO-1336mzz) and trans-1,2-dichloroethylene (t-DCE), or (b) R-514A (74.7% Z-HFO-1336mzz / 25.3% t-DCE); and (ii) at least one additional compound selected from the group consisting of HFO-1326mxz(E), HFO-1326mxz(Z), HCC-2120, HCC-1140, HCO-1130a, cis-DCE and HCC-30; and

a second refrigerant portion comprising at least one compound selected from the group consisting of trichlorofluoromethane (CFC-11) and 1,1-dichloro-2,2,2-trifluoroethane (HFC-123).

103. A composition comprising (i) one of (a) difluoromethane (HFC-32), 1,1-difluoroethane (HFC-152a), E-1,3,3,3-tetrafluoro-1-propene (E-HFO-1234ze), or (b) R-444A (12% HFC-32 / 5% HFC-152a / 83% E-HFO-1234ze); and (ii) at least one residual refrigerant selected from the group consisting of dichlorodifluoromethane (CFC-12), 1,1,1,2-tetrafluoroethane (HFC-134a) and 2,3,3,3-tetrafluoro-1-propene (HFO-1234yf).

104. A composition comprising (i) one of (a) difluoromethane (HFC-32), 1,1-difluoroethane (HFC-152a), E-1,3,3,3-tetrafluoro-1-propene (E-HFO-1234ze), or (b) R-444A (12% HFC-32 / 5% HFC-152a / 83% E-HFO-1234ze); (ii) at least one residual refrigerant selected from the group consisting of dichlorodifluoromethane (CFC-12), 1,1,1,2-tetrafluoroethane (HFC-134a) and 2,3,3,3-tetrafluoro-1-propene (HFO-1234yf); (iii) at least one additional compound selected from the group consisting of HFC-143a, HFC-41, HFC-134a, HCFC-22, CFC-12 and HCC-40; (iv) at least one additional compound

selected from the group consisting of HFC-161, HCC-40, isobutane, HCO-1140, HCC-160 and CFC-114a; and (v) at least one additional compound selected from the group consisting of HFO-1234yf, HFC-245cb, HFO-1225ye(E), HFO-1225ye(Z), HFO-1225zc, HFC-236fa, HFC-152a, HFC-143a, HFC-125, HFC-134a, HFO-1234zc, HFO-1233xf, HFO-1233zd, CFC-114, HCFC-124, 3,3,3-trifluoropropyne, HFO-1234ze(Z), HFC-245fa, HFC-227ea, HFO-1243zf, HFC-263fb and HFC-134.

105. A composition comprising (i) one of (a) difluoromethane (HFC-32), 1,1-difluoroethane (HFC-152a), E-1,3,3,3-tetrafluoro-1-propene (E-HFO-1234ze), or (b) R-444A (12% HFC-32 / 5% HFC-152a / 83% E-HFO-1234ze); (ii) at least one residual refrigerant selected from the group consisting of dichlorodifluoromethane (CFC-12), 1,1,1,2-tetrafluoroethane (HFC-134a) and 2,3,3,3-tetrafluoro-1-propene (HFO-1234yf); and (iii) at least one additional compound selected from the group consisting of HFC-143a, HFC-245cb and HFO-1225zc.
106. A composition comprising:
  - a first refrigerant portion comprising one of (a) difluoromethane (HFC-32), 1,1-difluoroethane (HFC-152a), E-1,3,3,3-tetrafluoro-1-propene (E-HFO-1234ze), or (b) R-444A (12% HFC-32 / 5% HFC-152a / 83% E-HFO-1234ze); and
  - a second refrigerant portion comprising at least one compound selected from the group consisting of dichlorodifluoromethane (CFC-12), 1,1,1,2-tetrafluoroethane (HFC-134a) and 2,3,3,3-tetrafluoro-1-propene (HFO-1234yf).
107. A composition comprising:
  - a first refrigerant portion comprising (i) one of (a) difluoromethane (HFC-32), 1,1-difluoroethane (HFC-152a), E-1,3,3,3-tetrafluoro-1-propene (E-HFO-1234ze), or (b) R-444A (12% HFC-32 / 5% HFC-152a / 83% E-HFO-1234ze); (ii) at least one additional compound selected from the group consisting of HFC-143a, HFC-41, HFC-134a, HCFC-22, CFC-12 and HCC-40; (iii) at least one additional compound selected from the group consisting of HFC-161, HCC-40, isobutane, HCO-1140, HCC-160 and CFC-114a; and (iv) at least

one additional compound selected from the group consisting of HFO-1234yf, HFC-245cb, HFO-1225ye(E), HFO-1225ye(Z), HFO-1225zc, HFC-236fa, HFC-152a, HFC-143a, HFC-125, HFC-134a, HFO-1234zc, HFO-1233xf, HFO-1233zd, CFC-114, HCFC-124, 3,3,3-trifluoropropyne, HFO-1234ze(Z), HFC-245fa, HFC-227ea, HFO-1243zf, HFC-263fb and HFC-134; and

a second refrigerant portion comprising at least one compound selected from the group consisting of dichlorodifluoromethane (CFC-12), 1,1,1,2-tetrafluoroethane (HFC-134a) and 2,3,3,3-tetrafluoro-1-propene (HFO-1234yf).

108. A composition comprising:

a first refrigerant portion comprising (i) one of (a) difluoromethane (HFC-32), 1,1-difluoroethane (HFC-152a), E-1,3,3,3-tetrafluoro-1-propene (E-HFO-1234ze), or (b) R-444A (12% HFC-32 / 5% HFC-152a / 83% E-HFO-1234ze); and (ii) at least one additional compound selected from the group consisting of HFC-143a, HFC-245cb and HFO-1225zc; and

a second refrigerant portion comprising at least one compound selected from the group consisting of dichlorodifluoromethane (CFC-12), 1,1,1,2-tetrafluoroethane (HFC-134a) and 2,3,3,3-tetrafluoro-1-propene (HFO-1234yf).

109. The composition according to any one of claims 1-3, 7-9, 13-15, 19-21, 25-27, 31-33, 37-39, 43-45, 49-51, 55-57, 61-63, 67-69, 73-75, 79-81, 85-87, 91-93, 97-99 and 103-105, wherein a total amount of the residual refrigerants is from about 0.00001 to about 2 weight percent, preferably about 0.00001 to about 0.5 weight percent, based on a total weight of the composition.

110. The composition according to any one of claims 4-6, 10-12, 16-18, 22-24, 28-30, 34-36, 40-42, 46-48, 52-54, 58-60, 64-66, 70-72, 76-78, 82-84, 88-90, 94-96, 100-102, and 106-108, wherein an amount of the second refrigerant portion is from about 0.00001 to about 0.5 weight percent, preferably from about 0.0001 to about 0.5 weight percent, based on a total weight of the composition.

111. A heat transfer system comprising the composition of any of claims 1 to 108.

112. The heat transfer system of claim 111, wherein said heat transfer system is designed for use with or previously contained at least one of the residual refrigerants.
113. The heat transfer system of any of claims 111-112, wherein the heat transfer system comprises at least one member selected from the group consisting of air conditioners, freezers, refrigerators, heat pumps, water chillers, flooded evaporator chillers, direct expansion chillers, walk-in coolers, heat pumps, mobile refrigerators, mobile air conditioning units and combinations thereof; and wherein the heat transfer system comprises a working fluid comprising the composition of any one of claims 1 to 110.
114. The heat transfer system of any of claims 111-113, comprising a commercial refrigeration system.
115. The heat transfer system of any of claims 111-113, comprising a medium or low temperature refrigeration system.
116. The heat transfer system of any of claims 111-113, comprising a residential refrigerator or freezer.
117. The heat transfer system of any of claims 111-113, comprising a heat pump.
118. The heat transfer system of any of claims 111-113, comprising a high temperature heat pump.
119. The heat transfer system of any of claims 111-113, comprising a chiller.
120. The heat transfer system of any of claims 111-113, comprising an air conditioning system.
121. The heat transfer system of any of claims 111-113, comprising an automotive air conditioning system.
122. A container or cylinder, preferably a recovery container or recovery cylinder, containing the composition of any of claims 1 to 110.
123. A RRR machine containing the composition of any of claims 1 to 110.
124. The composition of any of claims 1 to 110, wherein the composition is a spent or used thermal management fluid.

125. The composition of any of claims 1 to 110, wherein the composition is recovered thermal management fluid.
126. The composition of any of claims 1 to 110, wherein the composition is a recycled thermal management fluid.
127. The composition of any of claims 1 to 110, wherein the composition is a reclaimed thermal management fluid.
128. The composition of any of claims 1 to 110, wherein at least a portion of the composition is a reclaimed thermal management fluid.
129. The composition of any of claims 13-24, 37-54, and 67-109, the composition further comprising an effective amount of at least one inhibitor, such that the composition remains substantially free of oligomeric, homopolymeric, or other polymeric products derived from hydrofluoroolefin refrigerants of the composition.
130. The composition of claim 129, wherein the at least one inhibitor is selected from the group consisting of hydrocarbons including at least one of cyclic monoterpene; lipophilic organic compounds including tocopherols such as  $\alpha$ -tocopherol; phenols and aromatic organic compounds having at least one chemical moiety  $-C_6H_4(OH)$ .
131. The composition of any of claims 129-130, wherein the at least one inhibitor comprises a member selected from the group consisting of limonene,  $\alpha$ -pinene,  $\beta$ -pinene,  $\alpha$ -terpinene,  $\alpha$ -tocopherol, butylated hydroxytoluene (BHT), 4-methoxyphenol, and benzene-1,4-diol.
132. A method of obtaining the composition of any of claims 1 to 110, the method comprising removing the composition from a heat transfer system.
133. The method of claim 132, wherein the at least one residual refrigerant is not separated from the composition after removal from the heat transfer system.
134. The method of claim 132, wherein the second refrigerant portion is not separated from the first refrigerant portion after removal from the heat transfer system.

135. The method of claim 132, wherein said heat transfer system is designed for use with or previously contained at least one of the residual refrigerants.
136. The method of claim 132, wherein the heat transfer system comprises at least one member selected from the group consisting of air conditioners, freezers, refrigerators, heat pumps, water chillers, flooded evaporator chillers, direct expansion chillers, walk-in coolers, heat pumps, mobile refrigerators, mobile air conditioning units and combinations thereof.
137. A method for replacing an original refrigerant with a replacement refrigerant in a heat transfer system that uses, used or was designed to use the original refrigerant, the method comprising charging the heat transfer system with the replacement refrigerant, wherein at least some of the original refrigerant remains in the heat transfer system as a residual refrigerant, and wherein:
- (i) the original refrigerant comprises, consists essentially of or consists of at least one of HCFC-22, HFC-32, HFC-125 and combinations thereof; and the replacement refrigerant comprises, consists essentially of or consists of at least R-410A;
  - (ii) the original refrigerant comprises, consists essentially of or consists of at least HCFC-22, HFC-32, HFC-125, HFC-134a, HFC-143a and combinations thereof, and the replacement refrigerant comprises, consists essentially of or consists of at least one of R-407C, R-404A, R-507 and combinations thereof;
  - (iii) the original refrigerant comprises, consists essentially of or consists of at least one of HCFC-22, HFC-32, HFC-125, HFC-134a, HFC-143a, HFO-1234yf and combinations thereof, and the replacement refrigerant comprises, consists essentially of or consists of at least one of R-452B, R-454B and combinations thereof;
  - (iv) the original refrigerant comprises, consists essentially of or consists of at least one of CFC-12, HFC-134a, HFO-1234yf and combinations thereof, and the replacement refrigerant comprises, consists essentially of or consists of at least R-513A;
  - (v) the original refrigerant comprises, consists essentially of or consists of at least one of CFC-12, HFC-32, HFC-134a, HFC-227ea, E-HFO-

- 1234ze, HFO-1234yf, E-HFO-1336mzz, Z-HFO-1224yd and combinations thereof, and the replacement refrigerant comprises, consists essentially of or consists of at least one of R-454A, R-454C, R-471A, R-476A, R-482A and combinations thereof;
- (vi) the original refrigerant comprises, consists essentially of or consists of HCFC-22, CFC-115, CFC-125, HFC-134a, HFC-143a and combinations thereof, and the replacement refrigerant comprises, consists essentially of or consists of at least one of R-404A, R-507 and combinations thereof;
- (vii) the original refrigerant comprises, consists essentially of or consists of at least one of CFC-11, HFC-134a, HFO-1234yf and combinations thereof, and the replacement refrigerant comprises, consists essentially of or consists of at least one of R-513A, R-515B and combinations thereof;
- (viii) the original refrigerant comprises, consists essentially of or consists of at least one of HFC-32, HFC-125, HFC-134a, E-HFO-1234ze, HCFC-22, CFC-115, HFC-143a, HFO-1234yf and combinations thereof, and the replacement refrigerant comprises, consists essentially of or consists of at least R-455A;
- (ix) the original refrigerant comprises, consists essentially of or consists of at least one of HCFC-22, CFC-115, HFC-32, HFC-143a, HFC-125, HFC-134a, HFO-1234yf, E-HFO-1234ze, CO<sub>2</sub> and combinations thereof, and the replacement refrigerant comprises, consists essentially of or consists of at least one of R-448A, R-449A, R-407 and combinations thereof;
- (x) the original refrigerant comprises, consists essentially of or consists of at least one of HCFC-22, CFC-115, HFC-143a, HFC-125, HFC-134a, E-HFO-1234ze, HFC-32, HFO-1234yf, CO<sub>2</sub> and combinations thereof, and the replacement refrigerant comprises, consists essentially of or consists of at least one of R-454C, R-455A, R-454A, and combinations thereof;



- (xi) the original refrigerant comprises, consists essentially of or consists of at least one of CFC-11, HCFC-123, t-DCE, Z-HFO-1336mzz and combinations thereof, and the replacement refrigerant comprises, consists essentially of or consists of at least R-514A; or
  - (xii) the original refrigerant comprises, consists essentially of or consists of at least one of CFC-12, HFC-32, HFC-134a, HFC-152a, HFO-1234yf, HFO-1132(E), E-HFO-1234ze and combinations thereof, and the replacement refrigerant comprises, consists essentially of or consists of at least R-444A.
138. A method for replacing an original refrigerant with a replacement refrigerant in a heat transfer system that uses, used or was designed to use the original refrigerant, the method comprising removing a substantial portion of the original refrigerant from the heat transfer system, optionally retaining a substantial portion of any lubricant present in the system, and charging the heat transfer system with the replacement refrigerant, wherein at least a portion of the original refrigerant remains in the heat transfer system as a residual refrigerant, and wherein:
- (i) the original refrigerant comprises, consists essentially of or consists of at least one of HCFC-22, HFC-32, HFC-125 and combinations thereof; and the replacement refrigerant comprises, consists essentially of or consists of at least R-410A;
  - (ii) the original refrigerant comprises, consists essentially of or consists of at least HCFC-22, HFC-32, HFC-125, HFC-134a, HFC-143a and combinations thereof, and the replacement refrigerant comprises, consists essentially of or consists of at least one of R-407C, R-404A, R-507 and combinations thereof;
  - (iii) the original refrigerant comprises, consists essentially of or consists of at least one of HCFC-22, HFC-32, HFC-125, HFC-134a, HFC-143a, HFO-1234yf and combinations thereof, and the replacement refrigerant comprises, consists essentially of or consists of at least one of R-452B, R-454B and combinations thereof;

- (iv) the original refrigerant comprises, consists essentially of or consists of at least one of CFC-12, HFC-134a, HFO-1234yf and combinations thereof, and the replacement refrigerant comprises, consists essentially of or consists of at least R-513A;
- (v) the original refrigerant comprises, consists essentially of or consists of at least one of CFC-12, HFC-32, HFC-134a, HFC-227ea, E-HFO-1234ze, HFO-1234yf, E-HFO-1336mzz, Z-HFO-1224yd and combinations thereof, and the replacement refrigerant comprises, consists essentially of or consists of at least one of R-454A, R-454C, R-471A, R-476A, R-482A and combinations thereof;
- (vi) the original refrigerant comprises, consists essentially of or consists of HCFC-22, CFC-115, CFC-125, HFC-134a, HFC-143a and combinations thereof, and the replacement refrigerant comprises, consists essentially of or consists of at least one of R-404A, R-507 and combinations thereof;
- (vii) the original refrigerant comprises, consists essentially of or consists of at least one of CFC-11, HFC-134a, HFO-1234yf and combinations thereof, and the replacement refrigerant comprises, consists essentially of or consists of at least one of R-513A, R-515B and combinations thereof;
- (viii) the original refrigerant comprises, consists essentially of or consists of at least one of HFC-32, HFC-125, HFC-134a, E-HFO-1234ze, HCFC-22, CFC-115, HFC-143a, HFO-1234yf and combinations thereof, and the replacement refrigerant comprises, consists essentially of or consists of at least R-455A;
- (ix) the original refrigerant comprises, consists essentially of or consists of at least one of HCFC-22, CFC-115, HFC-32, HFC-143a, HFC-125, HFC-134a, HFO-1234yf, E-HFO-1234ze, CO<sub>2</sub> and combinations thereof, and the replacement refrigerant comprises, consists essentially of or consists of at least one of R-448A, R-449A, R-407 and combinations thereof;

- (x) the original refrigerant comprises, consists essentially of or consists of at least one of HCFC-22, CFC-115, HFC-143a, HFC-125, HFC-134a, E-HFO-1234ze, HFC-32, HFO-1234yf, CO<sub>2</sub> and combinations thereof, and the replacement refrigerant comprises, consists essentially of or consists of at least one of R-454C, R-455A, R-454A, and combinations thereof;
  - (xi) the original refrigerant comprises, consists essentially of or consists of at least one of CFC-11, HCFC-123, t-DCE, Z-HFO-1336mzz and combinations thereof, and the replacement refrigerant comprises, consists essentially of or consists of at least R-514A; or
  - (xii) the original refrigerant comprises, consists essentially of or consists of at least one of CFC-12, HFC-32, HFC-134a, HFC-152a, HFO-1234yf, HFO-1132(E), E-HFO-1234ze and combinations thereof, and the replacement refrigerant comprises, consists essentially of or consists of at least R-444A.
139. The composition of any of claims 137-138, wherein the replacement refrigerant is recovered thermal management fluid.
140. The composition of any of claims 137-138, wherein the replacement refrigerant is a recycled thermal management fluid.
141. The composition of any of claims 137-138, wherein the replacement refrigerant is a reclaimed thermal management fluid.
142. The composition of any of claims 137-138, wherein at least a portion of the replacement refrigerant is a reclaimed thermal management fluid.
143. A method of reclaiming refrigerant, the method comprising:
- removing a refrigerant composition from a heat transfer system, the refrigerant composition being one of the compositions of any of claims 1-3, 7-9, 13-15, 19-21, 25-27, 31-33, 37-39, 43-45, 49-51, 55-57, 61-63, 67-69, 73-75, 79-81, 85-87, 91-93, 97-99 and 103-105;
  - performing at least one treatment selected from transferring, blending, distillation, nitrogen purging, filtration, dehydration, caustic scrubbing, moisture removal, acid removal, oil removal, decanting, composition ratio

adjustment and combinations thereof to form a partially reclaimed refrigerant composition or a reclaimed refrigerant composition, wherein the at least one treatment does not involve removal or separation of the residual refrigerants; and

either storing the partially reclaimed refrigerant composition or a reclaimed refrigerant composition in a container for use in another system or introducing the partially reclaimed refrigerant composition or a reclaimed refrigerant composition back into the heat transfer system.

144. A method of reclaiming refrigerant, the method comprising:

removing a refrigerant composition from a heat transfer system, the refrigerant composition being one of the compositions of any of claims 4-6, 10-12, 16-18, 22-24, 28-30, 34-36, 40-42, 46-48, 52-54, 58-60, 64-66, 70-72, 76-78, 82-84, 88-90, 94-96, 100-102, and 106-108;

performing at least one treatment selected from transferring, blending, distillation, nitrogen purging, filtration, dehydration, caustic scrubbing, moisture removal, acid removal, oil removal, decanting, composition ratio adjustment and combinations thereof to form a partially reclaimed refrigerant composition or a reclaimed refrigerant composition, wherein the at least one treatment does not involve separation of the second refrigerant portion from the first refrigerant portion; and

either storing the partially reclaimed refrigerant composition or a reclaimed refrigerant composition in a container for use in another system or introducing the partially reclaimed refrigerant composition or a reclaimed refrigerant composition back into the heat transfer system.