

TITLE OF THE INVENTION

A PROCESS TO PRODUCE HFO-1252ZC THROUGH DEHYDROHALOGENATION REACTION OF HFC-263FB AND HCFC-262FC AND COMPOSITIONS THEREOF

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit of priority of U.S. Provisional Application 63/527,133 filed July 17, 2023, and U.S. Provisional Application 63/565,018 filed March 14, 2024, the disclosure of each of which is incorporated herein by reference in its entirety.

FIELD OF THE INVENTION

[0002] The present invention is directed to processes for producing difluoroolefins, compositions and uses thereof.

BACKGROUND OF THE INVENTION

[0003] Many industries have been working for the past few decades to find replacements for the ozone depleting chlorofluorocarbons (CFCs) and hydrochlorofluorocarbons (HCFCs). The CFCs and HCFCs have been employed in a wide range of applications, including their use as aerosol propellants, refrigerants, cleaning agents, expansion agents for thermoplastic and thermoset foams, heat transfer media, gaseous dielectrics, fire extinguishing and suppression agents, power cycle working fluids, polymerization media, particulate removal fluids, carrier fluids, buffing abrasive agents, and displacement drying agents. In the search for replacements for these versatile compounds, many industries have turned to the use of hydrofluorocarbons (HFCs).

[0004] Although HFCs do not contribute to the destruction of stratospheric ozone, they contribute to the "greenhouse effect," i.e., global warming. As a result of their contribution to global warming, HFCs have come under scrutiny, and their widespread use may also be limited in the future.

[0005] This regulatory landscape is continuously evolving, taking into consideration properties beyond just ozone depletion potential (ODP) and global warming potential (GWP). More particularly, there is a need for refrigerant compositions that not only

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

[0006] There is a need in this art for new refrigerants that meet evolving regulations as well as provide heat transfer and refrigerant characteristics that meet or exceed the effectiveness of conventional refrigerants.

[0007] Some fluoropropenes, such as 1,1-difluoropropene (HFO-1252zc), are such potential new refrigerants. There continues to be need for effective and efficient processes for preparing 1,1-difluoropropene (HFO-1252zc) and intermediates and compositions thereof.

SUMMARY OF THE INVENTION

[0008] The present invention relates to processes of making 1,1-difluoropropene ($\text{CF}_2=\text{CHCH}_3$, HFO-1252zc).

[0009] Certain embodiments relate to processes of making 1,1-difluoropropene (HFO-1252zc) by first hydrogenating compounds defined by the formula $\text{CF}_2\text{XCY}=\text{CH}_2$ (e.g., 3,3,3-trifluoropropene, $\text{CF}_3\text{CH}=\text{CH}_2$, HFO-1243zf; 3-chloro-3,3-difluoropropene, $\text{CClF}_2\text{CH}=\text{CH}_2$, HCFO-1242zf; 2,3-dichloro-3,3-difluoropropene, $\text{CClF}_2\text{CCl}=\text{CH}_2$, HCFO-1232xf), wherein X is one of Cl, Br, F or I, and Y is one of H, Cl, Br, F or I, with hydrogen to produce compounds defined by the formula $\text{CF}_2\text{XCH}_2\text{CH}_3$, wherein X is as defined above. Dehydrohalogenating $\text{CF}_2\text{XCH}_2\text{CH}_3$ in the presence or absence of a catalyst, or in the liquid phase in the presence of a strong base, in the presence or absence of a solvent, in the presence or absence of a phase transfer catalyst, forms a double bond between the C1 and C2 carbons of the halopropane molecule and produces product mixtures containing HFO-1252zc. Examples of compounds of formula $\text{CF}_2\text{XCH}_2\text{CH}_3$ include, but are not limited to, 1,1,1-trifluoropropane ($\text{CF}_3\text{CH}_2\text{CH}_3$, HFC-263fb) or 1-chloro-1,1-difluoropropane ($\text{CF}_2\text{ClCH}_2\text{CH}_3$, HCFC-262fc).

[0010] One embodiment of the invention disclosed herein relates to processes for making HFO-1252zc from one of HFC-263fb or HCFC-262fc in the presence or absence of a catalyst, or in the presence of a strong base.

[0011] Another embodiment of the invention disclosed herein relates to processes for converting HCFC-262fc to HFO-1252zc in the presence or absence of a catalyst.

[0012] One embodiment of the invention disclosed herein relates to processes of making (producing) compounds defined by the formula $\text{CF}_2\text{XCH}_2\text{CH}_3$, wherein X is at least one of chlorine, fluorine, bromine, and iodine. The process comprises contacting compounds by defined by the formula $\text{CF}_2\text{XCH}=\text{CH}_2$ with hydrogen, wherein X is selected from one of chlorine, fluorine, bromine and iodine.

[0013] Certain embodiments of the invention relate to processes for producing trihalopropanes of the formula $\text{CXF}_2\text{CH}_2\text{CH}_3$, where X is one of F, Cl, Br, and I, such as HFC-263fb where $\text{X}=\text{F}$ and HCFC-262fc where $\text{X}=\text{Cl}$.

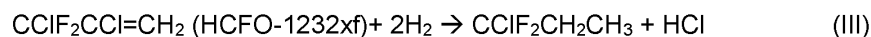
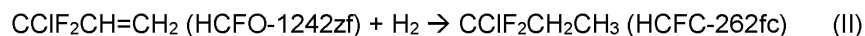
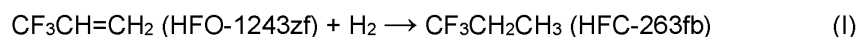
[0014] Another embodiment of the invention disclosed herein relates to processes of contacting compounds, including, but not limited to HFO-1243zf or HCFO-1242zf with hydrogen to respectively form HFC-263fb or HCFC-262fc.

[0015] One embodiment of the invention relates to processes for producing trihalopropanes of the formula $\text{CF}_2\text{XCH}_2\text{CH}_3$, where X is F, i.e., HFC-263fb.

[0016] Another embodiment of the invention relates to processes for producing trihalopropanes of the formula $\text{CF}_2\text{XCH}_2\text{CH}_3$, where X is chlorine, i.e., HCFC-262fc.

[0017] In certain embodiments disclosed herein, the process comprises contacting a first compound with hydrogen, in the vapor or liquid phase, to produce a first product mixture comprising a second compound and dehydrohalogenating the second compound to form a second product mixture comprising HFO-1252zc, and optionally recovering and recycling any unreacted first compound and/or unreacted second compound to produce additional HFO-1252zc.

[0018] One embodiment disclosed herein relates to processes for making compounds defined by the formula $\text{CXF}_2\text{CH}_2\text{CH}_3$, wherein X is at least one of chlorine, fluorine, bromine and iodine, according to any of the following hydrogenation reactions:



[0019] One embodiment disclosed herein relates to a process of making HFC-263fb according to reaction (I).

[0020] One embodiment disclosed herein relates to a process of making HCFC-262fc according to reactions (II) or (III).

[0021] In certain embodiments disclosed herein, reactions (I), (II) or (III) can be conducted in the vapor phase or in the liquid phase in the presence of a catalyst.

[0022] One embodiment disclosed herein relates to hydrogenation of HFO-1243zf in the vapor or liquid phase.

[0023] One embodiment disclosed herein relates to hydrogenation of HFO-1243zf in the vapor phase at a temperature ranging between about 30°C and about 100°C, including but not limited to about 30°C, about 35°C, about 40°C, about 45°C, about 50°C, about 55°C, about 60°C, about 65°C, about 70°C, about 75°C, about 80°C, about 85°C, about 90°C, about 95°C or about 100°C, and all values and ranges between about 30°C and about 100°C.

[0024] One embodiment disclosed herein relates to hydrogenation of HFO-1243zf in the liquid phase at a temperature ranging between about 20°C and about 100°C, including but not limited to about 20°C, about 25°C, about 30°C, about 35°C, about 40°C, about 45°C, about 50°C, about 55°C, about 60°C, about 65°C, about 70°C, about 75°C, about 80°C, about 85°C, about 90°C, about 95°C or about 100°C, and all values and ranges between about 20°C and about 100°C.

[0025] One embodiment disclosed herein relates to hydrogenation of HCFO-1242zf in the vapor or liquid phase.

[0026] One embodiment disclosed herein relates to hydrogenation of HCFO-1242zf in the vapor phase at a temperature ranging between about 30°C and about 90°C, including but not limited to about 30°C, about 35°C, about 40°C, about 45°C, about 50°C, about 55°C, about 60°C, about 65°C, about 70°C, about 75°C, about 80°C, about 85°C or about 90°C, and all values and ranges between about 30°C and about 90°C.

[0027] One embodiment disclosed herein relates to hydrogenation of HCFO-1242zf in the liquid phase at a temperature ranging between about 30°C and about 100°C,

including but not limited to about 30°C, about 35°C, about 40°C, about 45°C, about 50°C, about 55°C, about 60°C, about 65°C, about 70°C, about 75°C, about 80°C, about 85°C, about 90°C, about 95°C or about 100°C, and all values and ranges between about 30°C and about 100°C.

[0028] One embodiment disclosed herein relates to hydrogenation of HCFO-1232xf in the vapor or liquid phase.

[0029] One embodiment disclosed herein relates to hydrogenation of HCFO-1232xf in the vapor phase at a temperature ranging between about 40°C and about 100°C, including but not limited to about 40°C, about 45°C, about 50°C, about 55°C, about 60°C, about 65°C, about 70°C, about 75°C, about 80°C, about 85°C, about 90°C, about 95°C or about 100°C, and all values and ranges between about 40°C and about 100°C.

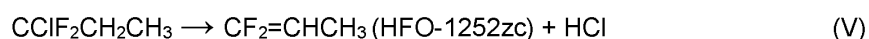
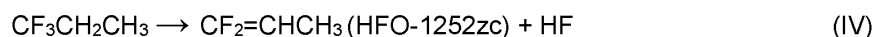
[0030] One embodiment disclosed herein relates to hydrogenation of HCFO-1232xf in the liquid phase at a temperature ranging between about 40°C and about 100°C, including but not limited to about 40°C, about 45°C, about 50°C, about 55°C, about 60°C, about 65°C, about 70°C, about 75°C, about 80°C, about 85°C, about 90°C, about 95°C or about 100°C, and all values and ranges between about 40°C and about 100°C.

[0031] In certain embodiments disclosed herein, the hydrogenation catalyst for reactions (I), (II) or (III), conducted in the vapor phase or liquid phase, comprises a metal selected from iron (Fe), cobalt (Co), nickel (Ni), ruthenium (Ru), rhodium (Rh), palladium (Pd), osmium (Os), iridium (Ir), rhenium (Re) and platinum (Pt).

[0032] In one embodiment, the metal is carried on a support comprising, for example, aluminum oxide, aluminum fluoride or carbon. In certain embodiments, the metal catalyst is supported on carbon and the carbon support/carrier comprises carbon, acid-washed carbon, activated carbon, and/or three-dimensional matrix carbonaceous materials. In one embodiment, the catalyst is Pd/carbon or Pd/Al₂O₃.

[0033] Another embodiment disclosed herein relates to making HFO-1252zc from compounds defined by the formula CXF₂CH₂CH₃, wherein X is at least one of chlorine, fluorine, bromine, and iodine, including but not limited to, HFC-263fb or HCFC-262fc, which can be formed from hydrogenating precursor compounds such

as HFO-1243zf, HCFO-1232xf and HCFO-1242zf. HFC-263fb or HCFC-262fc are dehydrohalogenated to form HFO-1252zc according to one of the following reactions:



[0034] In certain embodiments disclosed herein, the process of making HFO-1252zc, such as by reaction (IV), comprises first making HFC-263fb by the hydrogenation of HFO-1243zf which can be conducted in the vapor phase at a temperature of about 30°C to about 100°C or in the liquid phase at a temperature of about 20°C to about 100°C and produces a product mixture comprising at least HFC-263fb and HFO-1243zf, and then dehydrohalogenating the HFC-263fb to form a product mixture comprising the HFO-1252zc.

[0035] In certain embodiments disclosed herein, the process of making HFO-1252zc, such as by reaction (V), comprises first making HCFC-262fc by the hydrogenation of HCFO-1232xf, which can be conducted in the vapor phase at a temperature of about 40°C to about 100°C or in the liquid phase at a temperature of about 40°C to about 100°C, or by the hydrogenation of HCFO-1242zf, which can be conducted in the vapor phase at a temperature of about 30°C to about 90°C or in the liquid phase at a temperature of about 30°C to about 100°C, to form a product mixture comprising HCFC-262fc, and then dehydrohalogenating the HCFC-262fc to form a product mixture comprising the HFO-1252zc.

[0036] In certain embodiments disclosed herein, the process of making HFO-1252zc, e.g., reaction (IV), comprises first making HFC-263fb by the hydrogenation of HFO-1243zf in the presence of a hydrogenation catalyst, such as a supported metal selected from Fe, Co, Ni, Ru, Rh, Pd, Os, Ir, Re and Pt.

[0037] In certain embodiments disclosed herein, the process of making HFO-1252zc, e.g., reaction (V), comprises first making HCFC-262fc by the hydrogenation of either HCFO-1242zf or HCFO-1232xf in the presence of a hydrogenation catalyst, such as a supported metal selected from Fe, Co, Ni, Ru, Rh, Pd, Os, Ir, Re and Pt.

[0038] In certain embodiments disclosed herein, the process of making HFO-1252zc, e.g., reaction (IV) and/or (V), is conducted in the presence of a partially

fluorided metal oxide catalyst, including but not limited to, Pd, Pt, Rh, Fe, Co, Ni, Cu, Mo, Cr, Mn, and combinations of the foregoing as alloys or mixtures. In one embodiment, the catalyst may be supported or unsupported, such as Zn-doped chromium oxide. Vapor phase temperatures in the presence of a partially fluorided metal oxide catalyst range from 300°C to 500°C, including 310°C, 320°C, 330°C, 340°C, 350°C, 360°C, 370°C, 380°C, 390°C, 400°C, 410°C, 420°C, 430°C, 440°C, 450°C, 460°C, 470°C, 480°C, 490°C, 500°C, 510°C, 520°C, 530°C, 540°C, and 550°C, and all values and ranges therebetween including 375°C to 475°C or 350°C to 450°C.

[0039] In certain embodiments disclosed herein, the process of making HFO-1252zc, e.g., reaction (IV) and/or (V), is conducted in the vapor phase in the presence of an activated carbon supported catalyst, including but not limited to Co, Ni, Cu, Mo, Cr, Mn, and combinations of the foregoing as alloys or mixtures, optionally doped with Zn. Vapor phase temperatures in the presence of an activated carbon supported catalyst range from 150°C to 300°C, including 150°C, 160°C, 170°C, 180°C, 190°C, 200°C, 210°C, 220°C, 230°C, 240°C, 250°C, 260°C, 270°C, 280°C, 290°C, 300°C, 155°C, 165°C, 175°C, 185°C, 195°C, 205°C, 215°C, 225°C, 235°C, 245°C, 255°C, 265°C, 275°C, 285°C, 295°C, and all values and ranges therebetween including 150°C, 160°C, 170°C, 180°C, or 190°C to 220°C, 230°C, 240°C, 250°C, 260°C, 270°C, 280°C, or 290°C.

[0040] In certain embodiments, the process of making HFO-1252zc, e.g., reaction (IV) and/or (V), is conducted in the presence of a packing material, e.g., an alloy metal packing such as Monel, Hastelloy C, at a temperature in the range of 400-700°C, and a pressure in the range of atmosphere pressure to 80 psig. The reaction temperature may be between about 450°C to about 700°C, or between about 500°C to about 650°C, including, 450°C, 460°C, 470°C, 480°C, 490°C, 500°C, 510°C, 520°C, 530°C, 540°C, 550°C, 560°C, 570°C, 580°C, 590°C, 600°C, 610°C, 620°C, 630°C, 640°C, 650°C, 660°C, 670°C, 680°C, 690° and 700°C, preferably 475°C to 675°C.

[0041] In certain embodiments, the process of making HFO-1252zc, e.g., reaction (IV) and/or (V), is conducted in the absence of a catalyst or packing material, e.g., under pyrolysis conditions, at temperature between about 400°C to about 900°C, or

at a temperature between about 450°C to about 800°C, including, 400°C, 410°, 420°, 430°, 440°450°, 460°, 470°, 480°, 490°C, 500°C, 500°C, 510°C, 520°C, 530°C, 540°C, 550°C, 560°C, 570°C, 580°C, 590°C, 600°C, 610°C, 620°C, 630°C, 640°C, 650°C, 660°C, 670°C, 680°C, 690°, 700°C, 710°C, 720°C, 730°C, 740°C, or 750°C and less than 900°C, or less than 850°C, or less than 800°C, and all values and ranges therebetween.

[0042] In certain embodiments disclosed herein, reaction (IV) and (V) are independently conducted in: (i) the vapor phase in the presence of a metal oxide catalyst, (ii) the vapor phase in the absence of a catalyst or packing material, ((iii) the vapor phase in the presence of a metal alloy packing material; (iv) the liquid phase in the presence of a strong base, (v) the liquid phase in the presence of a strong base and the presence or absence of an aprotic solvent, or (vi) the liquid phase in the presence of a strong base, the presence or absence of an aprotic solvent and the presence or absence of a phase transfer catalyst.

[0043] In certain liquid phase embodiments disclosed herein, the process of making HFO-1252zc is conducted in the presence of a *t*-butoxide conjugate, such as potassium *t*-butoxide or sodium *t*-butoxide, at a temperature between -30°C and 100°C, in the presence of an aprotic solvent, with or without catalyst, such as crown ether. Suitable solvents include, but are not limited to, polar organic solvents, such as alcohol (as methyl alcohol, ethanol, normal propyl alcohol, isopropyl alcohol, *n*-butanol, isobutanol and the *tert*-butyl alcohol), dimethylformamide (DMF), dimethylacetamide (DMAc), dimethyl sulfoxide (DMSO) or methyl pyrrolidine (MP),

[0044] In other embodiments, HFO-1252zc is made from one of $\text{CF}_3\text{CH}_2\text{CH}_3$ and $\text{CClF}_2\text{CH}_2\text{CH}_3$ in the vapor phase in the presence or absence of a catalyst.

[0045] In another embodiment, HFO-1252zc is made by dehydrohalogenating HFC-263fb or HCFC-262fc in the liquid phase in the presence of a strong base.

[0046] In another embodiment, HFO-1252zc is made by dehydrohalogenating HFC-263fb or HCFC-262fc in the liquid phase in the presence of a *t*-butoxide conjugate, such as potassium *t*-butoxide or sodium *t*-butoxide.

[0047] In a still further embodiment of the invention, the process of making HFO-1252zc involves thermally dehydrohalogenating HFC-263fb or HCFC-262fc in the presence or absence of a catalyst.

[0048] In certain embodiments disclosed herein, the process of making HFO-1252zc comprises dehydrochlorination of HCFC-262fc or dehydrofluorination of HFC-263fb, in the vapor phase at a temperature selected from one of between about 400°C to about 700°C or between about 500°C to about 900°C, respectively, at a pressure of between atmospheric pressure and 80 psig.

[0049] In certain embodiments, the process disclosed herein comprises first hydrogenating a first compound to produce a second compound, dehydrohalogenating the second compound to produce HFO-1252zc.

[0050] In certain embodiments, the process disclosed herein for producing HFO-1252zc is an integrated process.

[0051] In certain embodiments, the process disclosed herein for producing HFO-1252zc comprises at least two process steps.

[0052] In another embodiment disclosed herein, HFO-1243zf is hydrogenated to HFC-263fb. In another embodiment disclosed herein, HCFO-1242zf or HCFO-1232xf is hydrogenated to HCFC-262fc.

[0053] In another embodiment disclosed herein, the invention relates to processes of subjecting one of HFC-263fb or HCFC-262fc to dehydrohalogenation.

[0054] In certain embodiment disclosed herein, the dehydrofluorination of HFC-263fb to HFO-1252zc and/or the dehydrochlorination of HCFC-262fc to HFO-1252zc is conducted in the presence or absence of a catalyst.

[0055] In certain embodiments disclosed herein, the dehydrofluorination of HFC-263fb and/or the dehydrochlorination of HCFC-262fc is conducted in the absence of a catalyst.

[0056] In certain embodiments disclosed herein, the dehydrofluorination of HFC-263fb and/or the dehydrochlorination of HCFC-262fc is conducted in the presence of a suitable packing such as Monel™ or Hastelloy™ nickel alloy turnings or wool, or other material inert to HCl and HF which allows efficient mixing of starting materials.

[0057] In the dehydrofluorination reaction embodiments and dehydrochlorination reaction embodiments disclosed herein, the reaction is conducted at a temperature selected from one of (I) between about 300°C to about 500°C, (II) between about 400°C to about 800°C, and (III) between about 500°C to about 800°C, each respectively at a pressure range between atmospheric pressure to 80 psig and all values and ranges therebetween.

[0058] In certain embodiments, dehydrofluorination of HFC-263fb and/or dehydrochlorination of HCFC-262fc is conducted at a temperature between about 300°C to about 500°C at a pressure range between atmospheric pressure to 80 psig and all values and ranges therebetween.

[0059] In certain embodiments, dehydrofluorination of HFC-263fb dehydrochlorination of HCFC-262fc is conducted at a temperature between about 400°C to about 700°C at a pressure range between atmospheric pressure to 80 psig and all values and ranges therebetween.

[0060] In certain embodiments, dehydrofluorination of HFC-263fb dehydrochlorination of HCFC-262fc is conducted at a temperature between about 500°C to about 800°C at a pressure range between atmospheric pressure to 80 psig and all values and ranges therebetween.

[0061] In certain embodiments disclosed herein, HFC-263fb or HCFC-262fc is exposed to sufficient temperature to effect dehydrohalogenation, wherein the temperature is selected from one of:

from between greater than 300°C, 310°C, 320°C, 330°C, 340°C, 350°C, 360°C, 370°C, 380°C, 390°C, 400°C, 410°C, 420°C, 430°C, 440°C, 450°C, 460°C, 470°C, 480°C, 490°C and 500°C,

from between greater than 400°C, 410°C, 420°C, 430°C, 440°C, 450°C, 460°C, 470°C, 480°C, 490°C, 500°C 510°C, 520°C, 530°C, 540°C, 550°C, 560°C, 570°C, 580°C, 590°C, 600°C, 610°C, 620°C, 630°C, 640°C, 650°C, 660°C, 670°C, 680°C, 690°C and 700°C, 710°C, 720°C, 730°C, 740°C, 750°C 760°C, 770°C, 780°C, 790°C and to less than about 800°C, or

from between greater than 500°C, 510°C, 520°C, 530°C, 540°C, 550°C, 560°C, 570°C, 580°C, 590°C, 600°C, 610°C, 620°C, 630°C, 640°C, 650°C, 660°C, 670°C, 680°C, 690°, 700°C and to less than about 750°C.

[0062] In certain embodiments, dehydrohalogenation is conducted in the absence of a catalyst, in the presence of a metal alloy packing, in the presence of a strong base, in the presence of a supported or unsupported fluorided transition metal oxide, nickel-based alloy or nickel-chromium-based alloy (e.g., Inconel™) catalyst, or pyrolytically in a catalyst free or packing material free reactor.

[0063] In certain embodiments described herein, catalytic dehydrohalogenation of hydrofluorocarbons or hydrofluorochlorocarbons to produce hydrofluoroolefins is ordinarily conducted in the vapor phase using a dehydrohalogenation catalyst. Suitable dehydrohalogenation catalysts can include, but are not limited to, chromium oxides, fluorided chromium oxides doped with a metal, e.g., zinc. Other suitable catalysts include, but are not limited to, aluminum fluoride; fluorided alumina; metals on aluminum fluoride; metals on fluorided alumina; oxides, fluorides, and oxyfluorides of magnesium, zinc and mixtures of magnesium and zinc and/or aluminum; lanthanum oxide and fluorided lanthanum oxide; chromium oxides, fluorided chromium oxides, and cubic chromium trifluoride; carbon, acid-washed carbon, activated carbon, three dimensional matrix carbonaceous materials; and metal compounds supported on carbon. The metal compounds are oxides, fluorides, and oxyfluorides of at least one metal selected from the group consisting of sodium, potassium, rubidium, cesium, yttrium, lanthanum, cerium, praseodymium, neodymium, samarium, chromium, iron, cobalt, rhodium, nickel, copper, zinc, and mixtures thereof.

[0064] In certain embodiments, liquid phase dehydrohalogenation is conducted in the present of a strong base, including, but not limited, to alkali metal conjugates, including but limited to sodium t-butoxide (NaOtBu), and potassium t-butoxide ((CH₃)₃COK, KOtBu)), i.e., where the alkali metal is a Group 1A metal of the Periodic Table excluding hydrogen.

[0065] Certain embodiments of the invention disclosed herein relate to compositions comprising, consisting essentially of, or consisting of HFO-1252zc isomers including at least HFO-1252zc, HFO-1234yf, HFO-1243zf and HFC-263fb.

[0066] Certain embodiments of the invention disclosed herein relate to compositions comprising, consisting essentially of, or consisting of HFO-1252zc isomers including at least HFO-1252zc, HFO-1234yf, HFO-1243zf and HFC-263fb, and at least one additional compound from Table 1 other than HFO-1252zc, HFO-1234yf, HFO-1243zf and HFC-263fb.

[0067] Certain embodiments of the invention disclosed herein relate to compositions comprising, consisting essentially of, or consisting of HFO-1252zc isomers including at least HFO-1252zc, HFO-1261ze (E/Z isomers), HFO-1234yf, HFO-1243zf and HCFC-262fc.

[0068] Certain embodiments of the invention disclosed herein relate to compositions comprising, consisting essentially of, or consisting of HFC-263fb, HCFC-262fc and/or HFO-1252zc, wherein of HFC-263fb, HCFC-262fc and/or HFO-1252zc, and are free of or substantially free of Group A Fluorinated Substances. In one embodiment, as used herein, "Group A Fluorinated Substances" includes any substance that (i) contains at least one fully fluorinated methyl ($-\text{CF}_3$) or methylene ($-\text{CF}_2-$) carbon atom (without any H/Cl/Br/I attached to it); and (ii) meets the criterion for persistence in soil/sediment and water established in Annex XIII (Section 1.1.1) of the European Union's REACH Regulation (<https://reachonline.eu/reach/en/annex-xiii-1-1.1-1.1.1.html> as accessed on May 2, 2023) and referenced in the Annex XV Restriction Report dated March 22, 2023, the disclosure of which is hereby incorporated by reference (<https://echa.europa.eu/documents/10162/f605d4b5-7c17-7414-8823-b49b9fd43aea> as accessed on May 2, 2023).

[0069] In another embodiment, as used herein, "Group A Fluorinated Substances" includes any substance that has a Henry's Law constant $\leq 250 \text{ Pa}\cdot\text{m}^3/\text{mol}$ and contains at least one fully fluorinated methyl ($-\text{CF}_3$) or methylene ($-\text{CF}_2-$) carbon atom (without any H/Cl/Br/I attached to it).

[0070] In embodiments, Group A Fluorinated Substances include, but are not limited to, TFA.

[0071] The phrase "free of" as used herein with respect to the presence of Group A Fluorinated Substances in the present compositions means that the amount of such substances in the compositions is sufficiently low so as to not be detectable, including but not limited to 0%, when measured by gas chromatography with a flame

ionization detector, gas chromatography with a mass detector by analysis of a gas sample or liquid sample, and/or ion chromatography by analysis of a water sample after bubbling the thermal fluid through water. Such methodologies are well known to those skilled in the art. The phrase "substantially free of" as used herein with respect to the presence of Group A Fluorinated Substances in the present compositions means that the amount of such substances in the compositions is > 0 wt.% and ≤ 5 wt.%, or > 0 wt.% and ≤ 4 wt.%, or > 0 wt.% and ≤ 3 wt.%, or > 0 wt.% and ≤ 2 wt.%, or > 0 wt.% and ≤ 1 wt.%, and all values and ranges therebetween, when measured by gas chromatographic (GC) techniques, for example gas chromatography (GC) with a flame ionization or electron-capture detector, or GC coupled with a mass detector (gas chromatography/mass spectral (GC/MS) method), by ion chromatograph(IC) or ion chromatography mass spectrometry (IC-MS) techniques, or by high-performance liquid chromatography (HPLC) or high-performance liquid chromatography mass spectrometry (HPLC-MS) techniques. The TFA analytical standard may be used in either gas chromatography or ion chromatography and is available from, for example, Sigma Aldrich.

[0072] In a preferred embodiment, degradation products of compositions according to the present invention are free of or substantially free of Group A Fluorinated Substances. The phrase "free of" as used herein with respect to the formation of Group A Fluorinated Substances as degradation products of the present compositions means that the theoretical molar yield of such substances in environmental compartments of air, soil/sediment and water produced during tropospheric degradation of the compositions is sufficiently low so as to not be detectable, including but not limited to 0%, when measured by GC techniques, for example GC with a flame ionization or electron-capture detector or GC/MS method, by IC or IC-MS techniques, or by HPLC or HPLC-MS techniques. The phrase "substantially free of" as used herein with respect to the formation of Group A Fluorinated Substances by the present compositions means that the theoretical molar yield of such substances in environmental compartments of air, soil/sediment and water produced during tropospheric degradation of the compositions is $> 0\%$ and $\leq 5\%$, or $> 0\%$ and $\leq 4\%$, or $> 0\%$ and $\leq 3\%$, or $> 0\%$ and $\leq 2\%$, or $> 0\%$ and $\leq 1\%$, and all values and ranges therebetween, when measured by GC techniques, for

example GC with a flame ionization or electron-capture detector or GC/MS method, by IC or IC-MS techniques, or by HPLC or HPLC-MS techniques.

[0073] Certain embodiments of the invention disclosed herein relates to compositions comprising, consisting essentially of, or consisting of HFC-263fb, HCFC-262fc and/or HFO-1252zc, and further including one or more additional members comprising hydrofluorocarbons (HFCs), hydrochlorocarbons (HCC's), hydrofluorochlorocarbons (HCFCs), hydrofluoroolefins (HFOs), hydrofluorochloroolefins (HFCOs), C₂-C₄ alkanes, C₂-C₄ alkenes and t-butoxypropenes. In some embodiments, such compositions are free of or substantially free of Group A Fluorinated Substances and/or degradation products of such compositions are free of or substantially free of Group A Fluorinated Substances, as defined herein.

[0074] Certain embodiments of the invention disclosed herein relate to compositions comprising, consisting essentially of, or consisting of HFC-263fb, HCFC-262fc and/or HFO-1252zc, and which further include one or more additional compounds identified in Table 1 other than HFC-263fb, HCFC-262fc and/or HFO-1252zc.

[0075] In one embodiment of the invention disclosed herein is a composition comprising, consisting essentially of, or consisting of HFC-263fb, and one or more additional members comprising at least one of HFC-152a, HFC-254fb, HCFO-1233xf, HFO-1243zf, HFC-143a, HFC-245cb, and HCFC-253db, wherein the amount of HFC-263fb, based on the total amount of the composition, is at least one of 50%, 60%, 70%, 80%, 90%, 95% or 99% of the total amount of the composition, and all values and ranges therebetween, e.g., at least between about 95% to less than 100%.

[0076] In one embodiment of the invention disclosed herein is a composition comprising, consisting essentially of, or consisting of HFC-263fb, and at least one additional member selected from HFO-1132a, HFC-125, HFC-143a, HFO-1225zc, HFC-152a, HFO-1252ze, HFO-1252yf, HFO-1252zf, and HFO-1252ye.

[0077] Another embodiment of the invention disclosed herein is a composition comprising, consisting essentially of, or consisting of HFC-263fb and one or more additional members or compounds comprising at least one of HFC-152a, HFC-

254fb, HCFO-1233xf, HFO-1243zf, HFC-143a, HFC-245cb and HCFC-253db, wherein the amount of additional members or each additional member comprises one of greater than 0 and less than 0.1%, greater than 0 and less than 0.01%, greater than 0 and less than 0.002%, greater than 0 and less than 0.003%, greater than 0 and less than 0.004%, and greater than 0 and less than 0.005%, and all values and ranges therebetween with the proviso that the total amount of the composition is 100%.

[0078] A further embodiment of the invention disclosed herein is a composition comprising, consisting essentially of, or consisting of HFC-263fb and HFO-1252zc, and at least one additional member or compound comprising at least one of HFC-152a, HFC-254fb, HCFO-1233xf, HFO-1243zf, HFC-143a, HFC-245cb and HCFC-253db, wherein the total amount of the additional members is between greater than 0 and less than about 15%, 14%, 13%, 12%, 11%, 10%, 9%, 8%, 7%, 6%, 5%, 4%, 3%, 2% or 1%, and all values and ranges therebetween.

[0079] A still further embodiment of the invention disclosed herein is a composition comprising, consisting essentially of, or consisting of HCFC-262fc and HFO-1252zc, and at least one an additional member from methane, ethylene, ethane, HFC-32, HFO-1132a, HCC-40, HCFC-22, HFO-1261ze-E, HFC-263fb, HFO-1252 isomer, HFC-281fa, HCC-30, C₄H₃ClF₄, E-HFO-1251zb, Z-HFO-1251zb, HFO-1252 dimers, wherein the total amount of additional members is between greater than 0 and less than about 10%, between greater than 0.001% and less than 10%, 9%, 8%, 7%, 6%, 5%, 4%, 3%, 2% or 1%, and all values and ranges therebetween.

[0080] One embodiment of the invention disclosed herein is a composition comprising, consisting essentially of, or consisting of HFO-1252zc and one or more members selected from methane, ethylene, ethane, HFC-23, HFC-125, HFC-143a, HFO-1141, propane, propylene, HFO-1234yf, allene, C₃H₄F₂, HFO-1261ze-E, HFO-1261ze-Z, HFC-263fb, 2-butene, cyclobutene, 2-methyl-1-propene, HFC-272fb, HCFO-1233, HCO-1260, HFC-374, HFO-1345 isomer, HCFO-1251zb-E, HCFO-1251zb-Z, HFC-32, HFO-1132a, HCC-40, HCFC-22, HFO-1261ze-E, HFC-263fb, HFO-1252 isomer, HFC-281fa, HCC-30, C₄H₃ClF₄, and HFO-1252 dimers, wherein HFO-1252zc is present in an amount greater than 20% or greater than 30% and less than 100%, or between 30% and 99%, or between greater than 30% and less than

99.5%, or between greater than 30% and less than 99.6%, or between greater than 30% and less than 99.7%, or between greater than 30% and less than 99.8% or between greater than 30% and less than 99.9%, and all values and ranges therebetween.

[0081] One embodiment of the invention disclosed herein is a composition comprising, consisting essentially of, or consisting of HCFC-262fc and one or more compounds selected from propane, propylene, HFO-1261ze-E, HFO-1252zc, HFC-272fb, HCFO-1251zb-E, HCFO-1251zb-Z, HCFC-262 isomer, HCFC-252dc, HCO-1250, and HCC-260.

[0082] One embodiment of the invention disclosed herein is a composition comprising, consisting essentially of, or consisting of HCFC-262fc and one or more compounds selected from propane, HFO-1243zf, HFO-1252zc, HFO-1261ze-E, HCFO-1242zf, HCFO-1251zb-E, HCFO-1251zb-Z, HCFO-1242 isomer, HCFC-262 isomer, HCFO-1232, HCFC-252 isomer, HCFC-252dc, HCO-1250 and HCC-260.

[0083] One embodiment of the invention disclosed herein is a composition comprising, consisting essentially of, or consisting of HCFO-1242zf and one or more compounds selected from ethane, HFC-152a, HFO-1243zf, HFO-1252zc, HCFC-253db, HCFC-262fc, HCFO-1242 isomer and HCFO-1232.

[0084] One embodiment of the invention disclosed herein is a composition comprising, consisting essentially of, or consisting of HCFO-1242zf and one or more compounds selected from HFO-1252zc, HCFC-253db, HCFC-262fc, HCFO-1242 isomer and HCFO-1232.

[0085] One embodiment of the invention disclosed herein is a composition comprising, consisting essentially of, or consisting of HCFC-262fc, HFO-1252zc and one or more compounds selected from propane, propylene, HFO-1261ze-E, HFC-272fb, HCFO-1251 isomer, HCFC-262 isomer, HCFC-252dc, HCO-1250, and HCC-260.

[0086] One embodiment of the invention disclosed herein is a composition comprising, consisting essentially of, or consisting of HCFC-262fc, HCFO-1242zf and one or more compounds selected from propane, HFO-1243zf, HFO-1252zc,

HFO-1261, HCFO-1251 isomer, HCFO-1242 isomer, HCFC-262 isomer, HCFO-1232, HCFC-252, HCFC-252dc, HCO-1250 and HCC-260.

[0087] One embodiment of the invention disclosed herein is a composition comprising, consisting essentially of, or consisting of HCFO-1242zf, HFO-1252zc and one or more compounds selected from ethane, HFC-152a, HFO-1243zf, HCFC-253db, HCFC-262fc, HCFO-1242 isomer and HCFO-1232.

[0088] One embodiment of the invention disclosed herein is a composition comprising, consisting essentially of, or consisting of HCFO-1242zf, HCFC-262fc and one or more compounds selected from HFO-1252zc, HCFC-253db, HCFO-1242 isomer and HCFO-1232.

[0089] One embodiment of the invention disclosed herein is a composition comprising, consisting essentially of, or consisting of at least three members selected from 1,1-difluoro-1-propene (HFO-1252zc), trifluoromethane (HFC-23), dichloromethane (HCC-30), chlorofluoromethane (HCFC-31), difluoromethane (HFC-32), ethylene, ethane, chlorodifluoromethane (HCFC-22), methyl chloride (HCC-40), dichloromethane (HCC-30), methane, 1,1,2,2,2-pentafluoroethane (HFC-125), 1,1,2-trifluoroethane (HFC-143), 1,1,1-trifluoroethane (HFC-143a), 1,1-difluoroethane (HFC-152a), 1,1,1,2,2-pentafluoropropane (HFC-245cb), 2-chloro-1,1,1-trifluoropropane (HCFC-253db), 1,1,1,3-tetrafluoropropane (HFC-254fb), 1,1,1-trichloropropane (HCC-260fb), 1,1-dichloro-1-fluoropropane (HCFC-261fc), 1,1-difluoropropane (HFC-272fb), propane (HC-290), tetrafluorobutene (HFO-374), butane (HC-600), allene, 2-butene, cyclobutene, 2-methylpropene, 1-chloro-2,2-difluoroethylene (HCFO-1122), 1,2-difluoroethene (HFO-1132), 1,1-difluoroethene (HFO-1132a), fluoroethene (HFO-1141), ethylene (HO-1150), 1,1,2-trichloro-3,3,3-trifluoropropene (CFO-1213xa), 2-chloro-3,3,3-trifluoropropene (HCFO-1233xf), 2,3,3,3-tetrafluoropropene (HFO-1234yf), 3-chloro-3,3-difluoropropene (HCFO-1242zf), 3,3,3-trifluoropropene (HFO-1243zf), E-1-chloro-1-fluoro-1-propene (E-HCFO-1251zb), Z-1-chloro-1-fluoro-1-propene (Z-HCFO-1251zb), 3-chloropropene (HCO-1260zf), 3-fluoro-1-propene (E-HFO-1261zf), E-1-fluoro-1-propene (E-1261ze), 1-fluoropropane (HFC-281fa), 1,1-difluoropropane (HFC-272fb), tetrafluorobutane (C₄H₆F₄), HFO-1252-dimers (C₆F₄H₈), propylene (HO-1270), pentafluorobutene (HFO-1345), HFO-1252 isomer, C₄H₃ClF₄, and E/Z-t-BuO-

$\text{CF}=\text{CH}-\text{CH}_3$, wherein at least one of the three members comprises one of 1-chloro-1,1-difluoropropane (HCFC-262fc) or 1,1,1-trifluoropropane (HFC-263fb).

[0090] One embodiment of the invention disclosed herein is a composition comprising, consisting essentially of, or consisting of HFO-1252 isomers and at least HFO-1252zc, one of HFC-263fb or HCFC-262fc, and one or more members selected from trifluoromethane (HFC-23), dichloromethane (HCC-30), chlorodifluoromethane (HCFC-31), difluoromethane (HFC-32), ethylene, ethane, chlorodifluoromethane (HCFC-22), methyl chloride (HCC-40), dichloromethane (HCC-30), methane, 1,1,2,2,2-pentafluoroethane (HFC-125), 1,1,2-trifluoroethane (HFC-143), 1,1,1-trifluoroethane (HFC-143a), 1,1,1-difluoroethane (HFC-152a), 1,1,1,2,2-pentafluoropropane (HFC-245cb), 2-chloro-1,1,1-trifluoropropane (HCFC-253db), 1,1,1,3-tetrafluoropropane (HFC-254fb), 1,1,1-trichloropropane (HCC-260fb), 1,1-dichloro-1-fluoropropane (HCFC-261fc), 1,1-difluoropropane (HFC-272fb), propane (HC-290), tetrafluorobutene (HFO-374), butane (HC-600), allene, 2-butene, cyclobutene, 2-methylpropene, 1-chloro-2,2-difluoroethylene (HCFO-1122), 1,2-difluoroethene (HFO-1132), 1,1-difluoroethene (HFO-1132a), fluoroethene (HFO-1141), ethylene (HO-1150), 1,1,2-trichloro-3,3,3-trifluoropropene (CFO-1213xa), 2-chloro-3,3,3-trifluoropropene (HCFO-1233xf), 2,3,3,3-tetrafluoropropene (HFO-1234yf), 3-chloro-3,3-difluoropropene (HCFO-1242zf), 3,3,3-trifluoropropene (HFO-1243zf), 1,1-difluoro-1-propene (1252zc), E-1-chloro-1-fluoro-1-propene (E-HCFO-1251zb), Z-1-chloro-1-fluoro-1-propene (Z-HCFO-1251zb), 3-chloropropene (HCO-1260zf), 3-fluoro-1-propene (HFO-1261zf), E-1-fluoro-1-propene (E-1261ze), 1-fluoropropane (281fa), 1,1-difluoropropane (272fb), tetrafluorobutane ($\text{C}_4\text{H}_6\text{F}_4$), 1252-dimers ($\text{C}_6\text{F}_4\text{H}_8$), propylene (HO-1270), pentafluorobutene (HFO-1345), and E/Z-t-BuO-CF=CH-CH₃, wherein HFO-1252zc is present in an amount greater than 20%, greater than 30%, between 30% and 99 %, between 30% and 99.5%, between 30% and 99.6%, between 30% and 99.7%, between 30% and 99.8%, or between 30% and 99.9% of the total amount of the composition, and all values and ranges therebetween.

[0091] One embodiment of the invention disclosed herein is a composition comprising, consisting essentially of, or consisting of HFO-1252zc and one or more additional members selected from trifluoromethane (HFC-23), dichloromethane (HCC-30), chlorodifluoromethane (HCFC-31), difluoromethane (HFC-32), ethylene,

ethane, chlorodifluoromethane (HCFC-22), methyl chloride (HCC-40), dichloromethane (HCC-30), methane, 1,1,2,2,2-pentafluoroethane (HFC-125), 1,1,2-trifluoroethane (HFC-143), 1,1,1-trifluoroethane (HFC-143a), 1,1-difluoroethane (HFC-152a), 1,1,1,2,2-pentafluoropropane (HFC-245cb), 2-chloro-1,1,1-trifluoropropane (HCFC-253db), 1,1,1,3-tetrafluoropropane (HFC-254fb), 1,1,1-trichloropropane (HCC-260fb), 1,1-dichloro-1-fluoropropane (HCFC-261fc), 1,1-difluoropropane (HFC-272fb), propane (HC-290), tetrafluorobutene (HFO-374), butane (HC-600), allene, 2-butene, cyclobutene, 2-methylpropene, 1-chloro-2,2-difluoroethylene (HCFO-1122), 1,2-difluoroethene (HFO-1132), 1,1-difluoroethene (HFO-1132a), fluoroethene (HFO-1141), ethylene (HO-1150), 1,1,2-trichloro-3,3,3-trifluoropropene (CFO-1213xa), 2-chloro-3,3,3-trifluoropropene (HCFO-1233xf), 2,3,3,3-tetrafluoropropene (HFO-1234yf), 3-chloro-3,3-difluoropropene (HCFO-1242zf), 3,3,3-trifluoropropene (HFO-1243zf), 1,1-difluoro-1-propene (1252zc), E-1-chloro-1-fluoro-1-propene (E-HCFO-1251zb), Z-1-chloro-1-fluoro-1-propene (Z-HCFO-1251zb), 3-chloropropene (HCO-1260zf), E-1-fluoro-1-propene (E-HFO-1261ze), 3-fluoro-1-propene (1261zf), 1-fluoropropane (281fa), 1,1-difluoropropane (272fb), tetrafluorobutane (C₄H₆F₄), 1252-dimers (C₆F₄H₈), propylene (HO-1270), pentafluorobutene (HFO-1345), and E/Z-t-BuO-CF=CH-CH₃, wherein one of the additional members comprises one of HCFC-262fc or HFC-263fb, and the additional members are present in an amount greater than 20%, greater than 30%, between 30% and 99 %, between 30% and 99.5%, between 30% and 99.6%, between 30% and 99.7%, between 30% and 99.8%, or between 30% and 99.9% of the total amount of the composition, and all values and ranges therebetween.

[0092] In certain embodiments disclosed herein the composition comprises, consists essentially of, or consists of at least one of HFC-263fb and HCFC-262fc, HFO-1252zc and one or more additional members selected from ethylene, HFC-23, HFO-1132a, propane, HFO-1234yf, E-HFO-1261ze, HFC-143a, HCFO-1233, and HFO-374, wherein HFO-1252zc is present in an amount greater than 20%, greater than 30%, between 30% and 99 %, between 30% and 99.5%, between 30% and 99.6%, between 30% and 99.7%, between 30% and 99.8%, or between 30% and 99.9% of the total amount of the composition, and all values and ranges therebetween

[0093] One embodiment of the invention disclosed herein is a composition comprising, consisting essentially or consisting of HFC-263fb, and one or more additional compounds selected from 1,1,difluoroethane (HFC-152a), 1,1,1,3-tetrafluoropropane (HFC-254fb), 2-chloro-3,3,3-trifluoropropene (HCFO-1233xf), $\text{CF}_3\text{CH}=\text{CH}_2$ (HFO-1243zf), 1,1,1-trifluoroethane (HFC-143a), 1,1,1,2,2-pentafluoropropane (HFC-245cb), and 2-chloro-1,1,1-trifluoropropane (HCFC-253db), wherein the total amount additional compounds is between greater than 0 and less than 1%, between greater than 0 and less than 0.5%, between greater than 0 and less than 0.1%. of the total amount of the composition and all values and ranges therebetween.

[0094] Another embodiment of the invention disclosed herein is a composition comprising, consisting essentially or consisting substantially of HFC-263fb, and the remainder selected from one or more additional compounds selected from 1,1,difluoroethane (HFC-152a), 1,1,1,3-tetrafluoropropane (HFC-254fb), 2-chloro-3,3,3-trifluoropropene (HCFO-1233xf), $\text{CF}_3\text{CH}=\text{CH}_2$ (HFO-1243zf), 1,1,1-trifluoroethane (HFC-143a), 1,1,1,2,2-pentafluoropropane (HFC-245cb), and 2-chloro-1,1,1-trifluoropropane (HCFC-253db), wherein the total amount of the remainder between greater than 0 and less than 0.5% or between greater than 0 and less than 0.1% of the total amount of the composition and all values and ranges therebetween.

[0095] Another embodiment of the invention disclosed herein is a composition comprising, consisting essentially of, or consisting of 99% HFC-263fb and the balance of the product comprises one or more compounds selected from 1,1,difluoroethane (HFC-152a), 1,1,1,3-tetrafluoropropane (HFC-254fb), 2-chloro-3,3,3-trifluoropropene (HCFO-1233xf), $\text{CF}_3\text{CH}=\text{CH}_2$ (HFO-1243zf), 1,1,1-trifluoroethane (HFC-143a), 1,1,1,2,2-pentafluoropropane (HFC-245cb), and HCFC-253db.

[0096] In certain embodiments, a feed composition comprises predominantly HFC-263fb, and the remainder comprises one or more compounds selected from 1,1,difluoroethane (HFC-152a), 1,1,1,3-tetrafluoropropane (HFC-254fb), 2-chloro-3,3,3-trifluoropropene (HCFO-1233xf), $\text{CF}_3\text{CH}=\text{CH}_2$ (HFO-1243zf), 1,1,1-trifluoroethane (HFC-143a), 1,1,1,2,2-pentafluoropropane (HFC-245cb), and 2-

chloro-1,1,1-trifluoropropane (HCFC-253db), preferably at least 99.9% HFC-263fb based on the total amount of the composition.

[0097] In another embodiment disclosed herein a feed composition comprises predominantly HFC-263fb, and the total amount of other compounds comprising one or more of 1,1-difluoroethane (HFC-152a), 1,1,1,3-tetrafluoropropane (HFC-254fb), 2-chloro-3,3,3-trifluoropropene (HCFO-1233xf), $\text{CF}_3\text{CH}=\text{CH}_2$ (HFO-1243zf), 1,1,1-trifluoroethane (HFC-143a), 1,1,1,2,2-pentafluoropropane (HFC-245cb), and HCFC-253db, is less than about 0.3 percent, less than about 0.2 percent, less than about 0.1 percent, less than about 0.09 percent, or less than about 0.05 percent of the total amount of the composition and all values and ranges therebetween.

[0098] In another embodiment disclosed herein, the HFC-263fb composition results from hydrogenation of HFO-1243zf.

[0099] One embodiment of the invention disclosed herein is a composition comprising, consisting essentially or consisting of HCFC-262fc and one or more additional compounds selected from 1,1,1-trifluoropropane (HFC-263fb), 1,1-dichloro-1-fluoropropane (HCFC-261fc), 1,1,1-trichloropropane (HCC-260fb), 3-chloro-3,3-difluoropropene (HCFO-1242zf), 3,3,3-trifluoropropene (HFO-1243zf) and 1,1-difluoropropane (HFC-272fb), chlorofluoropropenes (HCFO-1251), dichloropropene (HCFO-1250), 1,1-difluoro-1-propene (HFO-1252zc) wherein the total amount additional compounds is between greater than 0 and less than 1%, between greater than 0 and less than 0.5%, between greater than 0 and less than 0.1%.

[0100] In certain embodiments disclosed herein a composition is produced by hydrogenating HFO-1243zf and the hydrogenated composition is fed to a reactor for producing HFO-1252zc.

[0101] In another embodiment disclosed herein a feed composition comprises at least about 60% 1,1,1-trifluoropropane (HFC-263fb) defined by the GC/FID area.

[0102] In certain embodiments disclosed herein a composition is produced by hydrogenating HCFO-1242zf or HCFO-1232xf, and the hydrogenated composition is fed to a reactor for producing HFO-1252zc.

[0103] In another embodiment disclosed herein a feed composition comprises at least about 60% 1-chloro-1,1-difluoropropane (HCFC-262fc) defined by the GC/FID area.

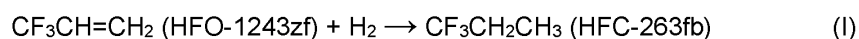
[0104] Unless otherwise defined, all technical and scientific terms used herein have the same meaning as commonly understood by one of ordinary skill in the art to which this invention belongs. In case of conflict, the present specification, including definitions, will control. Although methods and materials similar or equivalent to those described herein can be used in the practice or testing of embodiments of the present invention, suitable methods and materials are described below. In addition, the materials, methods, and examples are illustrative only and not intended to be limiting.

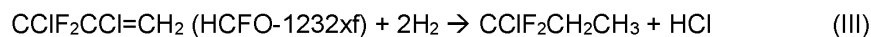
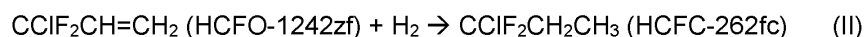
DETAILED DESCRIPTION OF THE INVENTION

[0105] The foregoing summary and the following detailed description are exemplary and explanatory only and are not restrictive of the invention, as defined in the appended claims. Other features and benefits of any one or more of the embodiments will be apparent from the following detailed description, and from the claims.

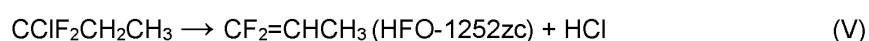
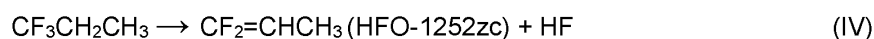
[0106] The present invention relates to processes for making HFO-1252zc, HFC-263fb and/or HCFC-262fc. More specifically the processes comprise, consist essentially of, or consist of making trihalopropanes defined by the formula $\text{CF}_2\text{XCH}_2\text{CH}_3$, wherein X is at least one of Cl, F, Br or I, by hydrogenation of compounds defined by the formula $\text{CF}_2\text{XCY}=\text{CH}_2$ (e.g., HFO-1243zf, HCFO-1242zf or HCFO-1232xf), wherein X is one of Cl, F, Br or I and Y is one of H, Cl, F, Br or I. In one embodiment, the trihalopropane of the formula $\text{CF}_2\text{XCH}_2\text{CH}_3$ comprises one of HFC-263fb or HCFC-262fc.

[0107] More specifically, the inventions disclosed herein relate to processes for making HFO-1252zc, HFC-263fb and/or HCFC-262fc according to the following reactions, which can be conducted in the vapor or liquid phase, preferably in the presence of a catalyst:





[0108] The HFC-263fb or HCFC-262fc compounds respectively prepared according to hydrogenation reaction (I), (II) or (III) are subsequently dehydrohalogenated to form HFO-1252zc according to the following reactions, which can be conducted in the vapor or liquid phase, in the presence or absence of a catalyst.



[0109] Before addressing details of embodiments described herein, certain terms are defined or clarified as follows.

[0110] The term “hydro(halo)alkane,” as used herein means a molecule containing hydrogen, carbon, and optionally fluorine and/or chlorine and/or bromine and/or iodine, with no carbon-carbon double bond (halo, fluoro, chloro, bromo, iodo). Examples are described throughout the instant specification. The term hydro(halo)alkane encompasses both alkanes and halogen substituted alkanes.

[0111] The term “dehydrohalogenation,” as used herein, means loss of HX from a hydrohaloalkane, where X=F, Cl, Br, I, where H and X are on adjacent carbons in the hydrohaloalkane. For example, the term “dehydrofluorination,” “dehydrofluorinating” or “dehydrofluorinated,” as used herein, means a process during which hydrogen and fluorine on adjacent carbons in a molecule are removed; the term “dehydrochlorination,” “dehydrochlorinating,” or “dehydrochlorinated,” as used herein, means a process during which hydrogen and chlorine on adjacent carbons in a molecule are removed.

[0112] As disclosed herein, conversion of $\text{CF}_3\text{CH}_2\text{CH}_3$ is conducted in the vapor phase at temperatures between about 300°C and about 800°C dependent on the absence or presence of a catalyst, and/or the absence or presence of an alloy packing material, and generally is conducted as a continuous process. A number of vapor phase reactor configurations are possible including packed bed tubes or column reactors, operated in a continuous mode.

[0113] In contrast, liquid phase reactions are generally conducted at lower temperatures, e.g., ranging between -40°C and 100°C and generally operated in either batch or semi-batch, although liquid phase operation can be operated by continuously feed reactants and withdrawing products from the reaction, often fitted with mechanical agitation for reaction uniformity. Liquid phase reactors can be provided with suitable agitation equipment to increase contact between fluids and can be similarly operated in batch, semi-batch and continuous modes. In addition to the reactors disclosed herein, preheaters and vaporizers, heat exchangers, feed and effluent lines, units associated with mass transfer, contacting vessels (pre-mixers), distillation columns, and valving associated with reactors, heat exchangers, vessels, columns, and units that are used in the processes of various embodiments disclosed herein should be constructed of materials resistant to corrosion.

[0114] 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 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 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 is true (or present).

[0115] 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.”

[0116] 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.

[0117] 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.”

[0118] 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.

[0119] 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/or 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.

[0120] As used herein, GC/FID peak area correlates to the amount of a compound present as a proportion of the total area of all detected peaks. FID area% can be converted to mol% using a response factor either calculated or measured, see e.g., <https://www.chromatographytoday.com/news/gc-mdgc/32/breaking-news/what-is-a-response-factor/31169>.

[0121] As used herein, the term “about” is meant to account for variations due to experimental error (e.g., plus or minus approximately 10% of the indicated value. $\pm 1\%$, $\pm 2\%$, ± 3 , ... $\pm 10\%$). All measurements reported herein are understood to be modified by the term “about,” whether or not the term is explicitly used, unless explicitly stated otherwise.

[0122] Compounds referred to in this disclosure may be referred to by code, based on fluorochemical naming convention, chemical structure and/or chemical name. For convenience and reference, selected compounds with codes, structures and chemical names are provided in Table 1.

TABLE 1

Code	Name-ASHRAE Designation (Code)	Formula
R-23	trifluoromethane (HFC-23)	CHF ₃
R-30	dichloromethane (HCC-30)	CH ₂ Cl ₂
R-31	chlorofluoromethane (HCFC-31)	CH ₂ FCI
R-40	methyl chloride (HCC-40)	CH ₃ Cl
R-50	methane	CH ₄
R-170	ethane	C ₂ H ₆
R-125	1,1,2,2,2-pentafluoroethane (HFC-125)	CHF ₂ CF ₃
R-132	1,2-dichloro-1,2-difluoroethane (HCFC-132)	CHClF-CHClF
R-143	1,1,2-trifluoroethane (HFC-143)	CHF ₂ CH ₂ F
R-143a	1,1,1-trifluoroethane (HFC-143a)	CF ₃ CH ₃
R-152a	1,1,1-difluoroethane (HFC-152a)	CHF ₂ CH ₃
R-243	Dichlorotrifluoropropane (HCFC-243)	C ₃ H ₃ Cl ₂ F ₃
R-245cb	1,1,1,2,2-pentafluoropropane (HFC-245cb)	CF ₃ CF ₂ CH ₃
R-252dc	1,2-dichloro-1,1-difluoropropane (HCFC-252dc)	CF ₂ CHClCHCl ₂
R-253db	2-chloro-1,1,1-trifluoropropane (HCFC-253db)	CF ₃ CHClCH ₃
R-254fb	1,1,1,3-tetrafluoropropane (HFC-254fb)	CF ₃ CH ₂ CH ₂ F
R-260fb	1,1,1-trichloropropane (HCC-260fb)	CCl ₃ CH ₂ CH ₃
R-261fc	1,1-dichloro-1-fluoropropane (HCFC-261fc)	CCl ₂ FCH ₂ CH ₃
R-262fc	1-chloro-1,1-difluoropropane (HCFC-262fc)	CClF ₂ CH ₂ CH ₃
R-263fb	1,1,1-trifluoropropane (HFC-263fb)	CF ₃ CH ₂ CH ₃
R-272fb	1,1-difluoropropane (HFC-272fb)	CHF ₂ CH ₂ CH ₃
R-290	propane (HC-290)	CH ₃ CH ₂ CH ₃
R-374	tetrafluorobutene (HFO-374)	C ₄ H ₆ F ₄
R-600	butane (HC-600)	CH ₃ CH ₂ CH ₂ CH ₃
	Allene	H ₂ C=C=CH ₂
	2-butene	CC ₃ CH=CHCH ₃
	Cyclobutene	Cyclic-C ₄ H ₆
	2-methylpropene	CH ₃ (CH ₃)C=CH ₂
R-1122	1-chloro-2,2-difluoroethylene (HCFO-1122)	CHCl=CF ₂
R-1132	1,2-difluoroethene (HFO-1132)	CHF=CHF
R-1132a	1,1-difluoroethene (HFO-1132a)	CH ₂ =CF ₂
R-1141	fluoroethene (HFO-1141)	CH ₂ =CHF
R-1150	ethylene (HO-1150)	CH ₂ =CH ₂
R-1232	dichlorodifluoropropene (HCFO-1232 isomers)	C ₃ H ₂ Cl ₂ F ₂
R-1232xf	2,3-dichloro-3,3-difluoropropene	CClF ₂ CCl=CH ₂
R-1233xf	2-chloro-3,3,3-trifluoropropene (HCFO-1233xf)	CF ₃ CCl=CH ₂

Code	Name-ASHRAE Designation (Code)	Formula
R-1234yf	2,3,3,3-tetrafluoropropene (HFO-1234yf)	$\text{CF}_3\text{CH}=\text{CHF}$
R-1241xb	1,2dichloro-1-fluoro-1-propene	$\text{CFCl}=\text{CClCH}_3$
R-1242zf	3-chloro-3,3-difluoropropene (HCFO-1242zf)	$\text{CClF}_2\text{CH}=\text{CH}_2$
R-1243zf	3,3,3-trifluoropropene (HFO-1243zf)	$\text{CF}_3\text{CH}=\text{CH}_2$
R-1250	Dichloropropene (HCO-1250)	$\text{C}_3\text{H}_4\text{Cl}_2$
R-1251	chlorofluoropropene (HCFO-1251 isomer)	$\text{C}_3\text{H}_4\text{FCI}$
R-1251	chlorofluoropropene (HCFO-1251) isomer	$\text{C}_3\text{H}_4\text{FCI}$
R-1251zb	1-chloro-1-fluoro-1-propene (HCFO-1251zb)	$\text{CClF}=\text{CHCH}_3$
R-1252ze	1,3-difluoropropene (HFO-1252ze)	$\text{CH}_2\text{FCH}=\text{CHF}$
R-1252yf	2,3-difluoropropene (HFO-1252yf)	$\text{CH}_2\text{FCF}=\text{CH}_2$
R-1252zf	3,3-difluoropropene (HFO-1252zf)	$\text{CHF}_2\text{CH}=\text{CH}_2$
R-1252ye	1,2-difluoropropene (HFO-1252ye)	$\text{CH}_3\text{CF}=\text{CHF}$
R-1252zc	1,1-difluoropropene (HFO-1252zc)	$\text{CH}_3\text{CH}=\text{CF}_2$
R-1260zf	3-chloropropene (HCO-1260zf)	$\text{CH}_2\text{ClCH}=\text{CH}_2$
R-1261	3-fluoro-1-propene (HFO-1261)	$\text{CH}_2\text{FCH}=\text{CH}_2$
R-1270	propylene, propene (HO-1270)	$\text{CH}_3\text{CH}=\text{CH}_2$
R-1345	pentafluorobutene (HFO-1345)	$\text{C}_4\text{H}_3\text{F}_5$
	E/Z- <i>t</i> -BuO-CF=CH-CH ₃	E/Z- <i>t</i> -BuO-CF=CH-CH ₃
1252-dimers	tetrafluorohexene	$\text{C}_6\text{F}_4\text{H}_8$
281fa	1-fluoropropane (281fa)	C_3FH_7

[0123] Some of the compounds present in the compositions of the present invention identified in Table 1 may exist as different configurational isomers or stereoisomers. The present invention is intended to include all single configurational isomers, single stereoisomers or any combination or mixture thereof. For instance, *t*-BuO-CF=CH-CH₃ is meant to represent the cis-isomer (Z), trans-isomer (E), or any combination or mixture of both isomers in any ratio. Single isomers or multiple isomers of the same compound may be used in any proportion.

[0124] In certain embodiments, HFC-263fb is made by contacting HFO-1243zf with hydrogen in the presence of a metal catalyst. In other embodiments, HCFC-262fc is made by contacting either HCFO-1232xf or HCFO-1242zf with hydrogen in the presence of a metal catalyst.

[0125] In one embodiment, for hydrogenation of HFO-1243zf to HFC-263fb and/or hydrogenation of HCFO-1232xf or HCFO-1242zf to HCFC-262fc, the metal is carried on a support, for example, Pd is carried on aluminum oxide, aluminum fluoride or carbon. In other embodiments, the metal is a group VIII metal or rhenium. In certain embodiments disclosed herein, the hydrogenation catalyst comprises a metal selected from Fe, Co, Ni, Ru, Rh, Pd, Os, Ir and Pt.

[0126] In certain embodiments, the metal catalyst for hydrogenation of HFO-1243zf to HFC-263fb and/or hydrogenation of HCFO-1232xf or HCFO-1242zf to HCFC-262fc is supported on carbon and the carbon support/carrier comprises carbon, acid-washed carbon, activated carbon, three-dimensional matrix carbonaceous materials. In one embodiment, the catalyst/catalyzer for converting HFO-1243zf to HFC-263fb and/or for converting either HCFO-1232xf or HCFO-1242zf to HCFC-262fc is Pd/carbon or Pd/Al₂O₃.

[0127] In certain embodiments, HFC-263fb is made by contacting HFO-1243zf with hydrogen in the presence of a metal catalyst, in the vapor phase, at a temperature ranging between about 30°C and about 100°C, including but not limited to about 30°C, about 35°C, about 40°C, about 45°C, about 50°C, about 55°C, about 60°C, about 65°C, about 70°C, about 75°C, about 80°C, about 85°C, about 90°C, about 95°C or about 100°C, and all values and ranges between about 30°C and about 100°C.

[0128] In certain embodiments, HFC-263fb is made by contacting HFO-1243zf with hydrogen in the presence of a metal catalyst, in the liquid phase, at a temperature ranging between about 20°C and about 100°C, including but not limited to about 20°C, about 25°C, about 30°C, about 35°C, about 40°C, about 45°C, about 50°C, about 55°C, about 60°C, about 65°C, about 70°C, about 75°C, about 80°C, about 85°C, about 90°C, about 95°C or about 100°C, and all values and ranges between about 20°C and about 100°C.

[0129] In certain embodiments, HCFC-262fc is made by contacting HCFO-1242zf with hydrogen in the presence of a metal catalyst, in the vapor phase, at a temperature ranging between about 30°C and about 90°C, including but not limited to about 30°C, about 35°C, about 40°C, about 45°C, about 50°C, about 55°C, about 60°C, about 65°C, about 70°C, about 75°C, about 80°C, about 85°C or about 90°C, and all values and ranges between about 30°C and about 90°C.

[0130] In certain embodiments, HCFC-262fc is made by contacting HCFO-1242zf with hydrogen in the presence of a metal catalyst, in the liquid phase, at a temperature ranging between about 30°C and about 100°C, including but not limited to about 30°C, about 35°C, about 40°C, about 45°C, about 50°C, about 55°C, about 60°C, about 65°C, about 70°C, about 75°C, about 80°C, about 85°C, about 90°C,

about 95°C or about 100°C, and all values and ranges between about 30°C and about 100°C.

[0131] In certain embodiments, HCFC-262fc is made by contacting HCFO-1232xf with hydrogen in the presence of a metal catalyst, in the vapor phase, at a temperature ranging between about 40°C and about 100°C, including but not limited to about 40°C, about 45°C, about 50°C, about 55°C, about 60°C, about 65°C, about 70°C, about 75°C, about 80°C, about 85°C, about 90°C, about 95°C or about 100°C, and all values and ranges between about 40°C and about 100°C.

[0132] In certain embodiments, HCFC-262fc is made by contacting HCFO-1232xf with hydrogen in the presence of a metal catalyst, in the liquid phase, at a temperature ranging between about 40°C and about 100°C, including but not limited to about 40°C, about 45°C, about 50°C, about 55°C, about 60°C, about 65°C, about 70°C, about 75°C, about 80°C, about 85°C, about 90°C, about 95°C or about 100°C, and all values and ranges between about 40°C and about 100°C.

[0133] In certain embodiments, dehydrohalogenation is conducted (I) in the absence of a catalyst, or (II) HF/HCl inert packing material such as packed with a metal alloy packing such as Monel™ or Hastelloy™ nickel alloy turnings or wool, or other material inert to HCl and HF, (II) in the presence of a supported or unsupported partially fluorinated transition metal oxide, nickel-based alloy or nickel-chromium-based alloy (e.g., Inconel™) catalyst, wherein the support comprises one of carbon, silicon carbide, or alumina, or (III) inert packing material such as packed with a metal alloy packing such as Monel™ or Hastelloy™ nickel alloy turnings or wool, or other material inert to HCl and HF.

[0134] In certain embodiments, dehydrohalogenation is conducted in the liquid phase, the presence of a strong base at temperature less than 100°C, less than 80°C, less than 60°C, less than 40°C, or less than 20°C, but greater than about 0°C.

[0135] In certain embodiments, dehydrohalogenation of HFC-263fb or HCFC-262fc is conducted in the absence of a catalyst.

[0136] In certain embodiments, dehydrohalogenation of HFC-263fb or HCFC-262fc is conducted in the absence of both a catalyst and an alloy packing material.

[0137] In certain embodiments, dehydrohalogenation of HFC-263fb or HCFC-262fc is conducted in the absence of a catalyst but in the presence of a packing material.

[0138] In the vapor phase dehydrohalogenation reaction embodiments disclosed herein, the reaction is conducted at temperature selected from one of between about 300°C to about 800°C between about 300°C to about 500°C, between about 400°C to about 700°C, between about 400°C to about 800°C, or between about 500°C to about 750°C.

[0139] In certain HFC-263fb and/or HCFC-262fc dehydrohalogenation embodiments disclosed herein, the reaction is conducted at a temperature between about 300°C to about 500°C.

[0140] In certain embodiments, HFC-263fb and/or HCFC-262fc is exposed to a sufficient temperature to effect dehydrohalogenation which ranges from about 400°C to about 700°C.

[0141] In certain embodiments, dehydrofluorination of HFC-263fb is conducted at a temperature between about 500°C to about 750°C.

[0142] In certain embodiments liquid phase dehydrohalogenation is conducted in the present of a strong base conjugate with an alkali metal, including, but not limited, to sodium t-butoxide (NaOtBu), and potassium t-butoxide ((CH₃)₃COK, KOtBu).

[0143] In some embodiments, the dehydrohalogenation, dehydrofluorination (e.g., dehydrofluorination of HFC-263fb to form HFO-1252zc) or dehydrochlorination (e.g. dehydrochlorination of HCFC-262fc to form HFO-1252zc) is conducted in the vapor phase by pyrolysis, preferably in the absence of a catalyst and/or packing material. Preferably, the pyrolysis is conducted at a temperature between about 400°C to about 900°C, or between about 450°C to about 800°C.

[0144] In certain embodiments disclosed herein, the composition comprises, consists essentially of, or consists of HFO-1252zc, HCFC-262fc or HFC-263fb, and one or more additional members or compounds selected from methane, ethylene, trifluoromethane (HFC-23), fluoroethene (HFO-1141), propane (HC-290), propylene (HO-1270), 2,3,3,3-tetrafluoropropene (HFO-1234yf), allene, allene, C₃H₄F₂, 3-fluoro-1-propene (HFO-1261), 3-fluoro-1-propene (HFO-1261), 2-butene, 2-butene, cyclobutene, 2-methyl-1-propene, 1,1-difluoropropane (272fb), 2-chloro-3,3,3-

trifluoropropene (HCFO-1233xf), 3-chloropropene (HCO-1260zf), C₃H₄FCI (I) (HCFO-1251 isomer), and C₃H₄FCI (II) (HCFO-isomer 1251).

[0145] In certain embodiments disclosed herein, the composition comprises, consists essentially of, or consists of HFO-1252zc, HFC-263fb, and (1) one or more additional members or compounds selected from methane, ethylene, trifluoromethane (HFC-23), fluoroethene (HFO-1141), propane (HC-290), propylene (HO-1270), 2,3,3,3-tetrafluoropropene (HFO-1234yf), allene, allene, C₃H₄F₂, 3-fluoro-1-propene (HFO-1261), 3-fluoro-1-propene (HFO-1261), 2-butene, cyclobutene, 2-methyl-1-propene, 1,1-difluoropropane, 2-chloro-3,3,3-trifluoropropene (HCFO-1233xf), 3-chloropropene (HCO-1260zf), C₃H₄FCI (I) (HCFO-1251-isomer), and C₃H₄FCI (II) (HCFO-1251-isomer), or (2) at least one additional member selected from HFO-1132a, HFC-125, HFC-143a, HFO-1225zc, HFC-152a, HFO-1252ze, HFO-1252yf, HFO-1252zf, and HFO-1252ye.

[0146] In certain embodiments disclosed herein, the composition comprises, consists essentially of, or consists of at least one of HFO-1252zc, HCFC-262fc or HFC-263fb, and one or more additional members selected from methane, ethylene, ethane, HFC-23, HFC-125, HFC-143a, HFO-1141, propane, propylene, HFO-1234yf, allene, C₃H₄F₂, HFO-1261ze-E, HFO-1261ze-Z, HFC-263fb, 2-butene, cyclobutene, 2-methyl-1-propene, HFC-272fb, HCFO-1233, HCO-1260, HFC-374, HFO-1345 isomer, HCFO-1251zb-E, HCFO-1251zb-Z, HFC-32, HFO-1132a, HCC-40, HCFC-22, HFO-1261ze-E, HFC-263fb, HFO-1252 isomer, HFC-281fa, HCC-30, C₄H₃ClF₄, and HFO-1252 dimers.

[0147] In certain embodiments disclosed herein, the composition comprises, consists essentially of, or consists of at least one of 1,1-difluoropropene (HFO-1252zc), 1,1,1-trifluoropropane (HFC-263fb), and one or more additional members selected from methane, ethylene, ethane, HFC-23, HFC-125, HFC-143a, HFO-1141, propane, propylene, HFO-1234yf, allene, C₃H₄F₂, HFO-1261ze-E, HFO-1261ze-Z, HFC-263fb, 2-butene, cyclobutene, 2-methyl-1-propene, HFC-272fb, HCFO-1233, HCO-1260, HFC-374, HFO-1345 isomer, HCFO-1251zb-E, HCFO-1251zb-Z, HFC-32, HFO-1132a, HCC-40, HCFC-22, HFO-1261ze-E, HFC-263fb, HFO-1252 isomer, HFC-281fa, HCC-30, C₄H₃ClF₄, and HFO-1252 dimers.

[0148] In certain embodiments disclosed herein, the composition comprises, consists essentially of, or consists of at least one of HFO-1252zc, HCFC-262fc and HFC-263fb, and one or more additional members selected from methane, ethylene, ethane, HFC-23, HFC-125, HFC-143a, HFO-1141, propane, propylene, HFO-1234yf, allene, C₃H₄F₂, HFO-1261ze-E, HFO-1261ze-Z, HFC-263fb, 2-butene, cyclobutene, 2-methyl-1-propene, HFC-272fb, HCFO-1233, HCO-1260, HFC-374, HFO-1345 isomer, HCFO-1251zb-E, HCFO-1251zb-Z, HFC-32, HFO-1132a, HCC-40, HCFC-22, HFO-1261ze-E, HFC-263fb, HFO-1252 isomer, HFC-281fa, HCC-30, C₄H₃ClF₄, and HFO-1252 dimers.

[0149] In certain embodiments disclosed herein, the composition comprises, consists essentially of, or consists of at least one of HFO-1252zc, HFC-263fb, and one or more additional members selected from ethylene, trifluoromethane (HFC-23), 1,1-difluoroethene (HFO-1132a), fluoroethene (HFO-1141), 1,1,2,2,2-pentafluoroethane (HFC-125), propane (HC-290), 1,1,2-trifluoroethane (HFC-143), 2,3,3,3-tetrafluoropropene (HFO-1234yf), 1,1,1-difluoroethane (HFC-152a), 3-fluoro-1-propene (HFO-1261zf), 1,1,1-trifluoroethane (HFC-143a), difluoropropane, chlorotrifluoropropene, pentafluorobutene (HFO-1345) and C₄H₆F₄ (HFC-374).

[0150] In certain embodiments disclosed herein, the composition comprises, consists essentially of, or consists of at least one of HFO-1252zc, HCFC-262fc and HFC-263fb, and one or more additional members selected from trifluoromethane (HFC-23), dichloromethane (HCC-30), chlorofluoromethane (HCFC-31), difluoromethane (HFC-32), ethylene, ethane, chlorodifluoromethane (HCFC-22), methyl chloride (HCC-40), dichloromethane (HCC-30), methane, 1,1,2,2,2-pentafluoroethane (HFC-125), 1,1,2-trifluoroethane (HFC-143), 1,1,1-trifluoroethane (HFC-143a), 1,1,1-difluoroethane (HFC-152a), 1,1,1,2,2-pentafluoropropane (HFC-245cb), 2-chloro-1,1,1-trifluoropropane (HCFC-253db), 1,1,1,3-tetrafluoropropane (HFC-254fb), 1,1,1-trichloropropane (HCC-260fb), 1,1-dichloro-1-fluoropropane (HCFC-261fc), 1,1-difluoropropane (HFC-272fb), propane (HC-290), tetrafluorobutene (HFO-374), butane (HC-600), allene, 2-butene, cyclobutene, 2-methylpropene, 1-chloro-2,2-difluoroethylene (HCFO-1122), 1,2-difluoroethene (HFO-1132), 1,1-difluoroethene (HFO-1132a), fluoroethene (HFO-1141), ethylene (HFO-1150), 1,1,2-trichloro-3,3,3-trifluoropropene (CFO-1213xa), 2-chloro-3,3,3-trifluoropropene (HCFO-1233xf), 2,3,3,3-tetrafluoropropene (HFO-

1234yf), 3-chloro-3,3-difluoropropene (HCFO-1242zf), 3,3,3-trifluoropropene (HFO-1243zf), 1,1-difluoro-1-propene (1252zc), E-1-chloro-1-fluoro-1-propene (E-HCFO-1251zb), Z-1-chloro-1-fluoro-1-propene (Z-HCFO-1251zb), 3-chloropropene (HCO-1260zf), E-1-fluoro-1-propene (E-HFO-1261ze), 3-fluoro-1-propene (1261zf), 1-fluoropropane (281fa), 1,1-difluoropropane (272fb), tetrafluorobutane (C₄H₆F₄), 1252-dimers (C₆F₄H₈), propylene (HO-1270), pentafluorobutene (HFO-1345), and E/Z-t-BuO-CF=CH-CH₃.

[0151] In certain embodiments disclosed herein, the composition comprises, consists essentially of, or consists of 1,1-difluoropropene (HFO-1252zc), 3,3,3-trifluoropropene (HFO-1243zf), and one or more members selected from the group consisting of trifluoromethane (HFC-23), dichloromethane (HCC-30), chlorofluoromethane (HCFC-31), difluoromethane (HFC-32), ethylene, ethane, chlorodifluoromethane (HCFC-22), methyl chloride (HCC-40), dichloromethane (HCC-30), methane, 1,1,2,2,2-pentafluoroethane (HFC-125), 1,1,2-trifluoroethane (HFC-143), 1,1,1-trifluoroethane (HFC-143a), 1,1,1-difluoroethane (HFC-152a), 1,1,1,2,2-pentafluoropropane (HFC-245cb), 2-chloro-1,1,1-trifluoropropane (HCFC-253db), 1,1,1,3-tetrafluoropropane (HFC-254fb), 1,1,1-trichloropropane (HCC-260fb), 1,1-dichloro-1-fluoropropane (HCFC-261fc), 1,1-difluoropropane (HFC-272fb), propane (HC-290), tetrafluorobutene (HFO-374), butane (HC-600), allene, 2-butene, cyclobutene, 2-methylpropene, 1-chloro-2,2-difluoroethylene (HCFO-1122), 1,2-difluoroethene (HFO-1132), 1,1-difluoroethene (HFO-1132a), fluoroethene (HFO-1141), ethylene (HO-1150), 1,1,2-trichloro-3,3,3-trifluoropropene (CFO-1213xa), 2-chloro-3,3,3-trifluoropropene (HCFO-1233xf), 2,3,3,3-tetrafluoropropene (HFO-1234yf), 3-chloro-3,3-difluoropropene (HCFO-1242zf), E-1-chloro-1-fluoro-1-propene (E-HCFO-1251zb), Z-1-chloro-1-fluoro-1-propene (Z-HCFO-1251zb), 3-chloropropene (HCO-1260zf), 3-fluoro-1-propene (HFO-1261zf), E-1-fluoro-1-propene (E-HFO-1261ze), 1-fluoropropane (HFC-281fa), 1,1-difluoropropane (272fb), tetrafluorobutane (C₄H₆F₄), 1252-dimers (C₆F₄H₈), propylene (HO-1270), pentafluorobutene (HFO-1345), and E/Z-t-BuO-CF=CH-CH₃, 1,1,1-trifluoropropane (HFC-263fb), and 1-chloro-1,1-difluoropropane (HCFC-262fc).

[0152] In certain embodiments disclosed herein, the composition comprises, consists essentially of, or consists of 1,1-difluoropropene (HFO-1252zc), E-1-fluoro-1-propene (E-HFO-1261ze), and one or more members selected from the group

consisting of trifluoromethane (HFC-23), dichloromethane (HCC-30), chlorofluoromethane (HCFC-31), difluoromethane (HFC-32), ethylene, ethane, chlorodifluoromethane (HCFC-22), methyl chloride (HCC-40), dichloromethane (HCC-30), methane, 1,1,2,2,2-pentafluoroethane (HFC-125), 1,1,2-trifluoroethane (HFC-143), 1,1,1-trifluoroethane (HFC-143a), 1,1,difluoroethane (HFC-152a), 1,1,1,2,2-pentafluoropropane (HFC-245cb), 2-chloro-1,1,1-trifluoropropane (HCFC-253db), 1,1,1,3-tetrafluoropropane (HFC-254fb), 1,1,1-trichloropropane (HCC-260fb), 1,1-dichloro-1-fluoropropane (HCFC-261fc), 1,1-difluoropropane (HFC-272fb), propane (HC-290), tetrafluorobutene (HFO-374), butane (HC-600), allene, 2-butene, cyclobutene, 2-methylpropene, 1-chloro-2,2-difluoroethylene (HCFO-1122), 1,2-difluoroethene (HFO-1132), 1,1-difluoroethene (HFO-1132a), fluoroethene (HFO-1141), ethylene (HO-1150), 1,1,2-trichloro-3,3,3-trifluoropropene (CFO-1213xa), 2-chloro-3,3,3-trifluoropropene (HCFO-1233xf), 2,3,3,3-tetrafluoropropene (HFO-1234yf), 3-chloro-3,3-difluoropropene (HCFO-1242zf), 3,3,3-trifluoropropene (HFO-1243zf), E-1-chloro-1-fluoro-1-propene (E-HCFO-1251zb), Z-1-chloro-1-fluoro-1-propene (Z-HCFO-1251zb), 3-chloropropene (HCO-1260zf), 3-fluoro-1-propene (HFO-1261zf), 1-fluoropropane (HFC-281fa), 1,1-difluoropropane (272fb), tetrafluorobutane (C₄H₆F₄), 1252-dimers (C₆F₄H₈), propylene (HO-1270), pentafluorobutene (HFO-1345), and E/Z-t-BuO-CF=CH-CH₃, 1,1,1-trifluoropropane (HFC-263fb), and 1-chloro-1,1,-difluoropropane (HCFC-262fc).

[0153] In certain embodiments disclosed herein, the composition comprises, consists essentially of, or consists of 1,1-difluoropropene (HFO-1252zc), 3,3,3-trifluoropropene (HFO-1243zf), E-1-fluoro-1-propene (E-HFO-1261ze), and one or more members selected from the group consisting of trifluoromethane (HFC-23), dichloromethane (HCC-30), chlorofluoromethane (HCFC-31), difluoromethane (HFC-32), ethylene, ethane, chlorodifluoromethane (HCFC-22), methyl chloride (HCC-40), dichloromethane (HCC-30), methane, 1,1,2,2,2-pentafluoroethane (HFC-125), 1,1,2-trifluoroethane (HFC-143), 1,1,1-trifluoroethane (HFC-143a), 1,1,difluoroethane (HFC-152a), 1,1,1,2,2-pentafluoropropane (HFC-245cb), 2-chloro-1,1,1-trifluoropropane (HCFC-253db), 1,1,1,3-tetrafluoropropane (HFC-254fb), 1,1,1-trichloropropane (HCC-260fb), 1,1-dichloro-1-fluoropropane (HCFC-261fc), 1,1-difluoropropane (HFC-272fb), propane (HC-290), tetrafluorobutene (HFO-374), butane (HC-600), allene, 2-butene, cyclobutene, 2-methylpropene, 1-chloro-2,2-

difluoroethylene (HCFO-1122), 1,2-difluoroethene (HFO-1132), 1,1-difluoroethene (HFO-1132a), fluoroethene (HFO-1141), ethylene (HO-1150), 1,1,2-trichloro-3,3,3-trifluoropropene (CFO-1213xa), 2-chloro-3,3,3-trifluoropropene (HCFO-1233xf), 2,3,3,3-tetrafluoropropene (HFO-1234yf), 3-chloro-3,3-difluoropropene (HCFO-1242zf), E-1-chloro-1-fluoro-1-propene (E-HCFO-1251zb), Z-1-chloro-1-fluoro-1-propene (Z-HCFO-1251zb), 3-chloropropene (HCO-1260zf), 3-fluoro-1-propene (HFO-1261zf), 1-fluoropropane (HFC-281fa), 1,1-difluoropropane (272fb), tetrafluorobutane (C₄H₆F₄), 1252-dimers (C₆F₄H₈), propylene (HO-1270), pentafluorobutene (HFO-1345), and E/Z-t-BuO-CF=CH-CH₃, 1,1,1-trifluoropropane (HFC-263fb), and 1-chloro-1,1,-difluoropropane (HCFC-262fc).

[0154] In certain embodiments disclosed herein, the composition comprises, consists essentially of, or consists of 1,1-difluoropropane (HFO-1252zc), 1-chloro-1,1,-difluoropropane (HCFC-262fc) and one or more members selected from the group consisting of trifluoromethane (HFC-23), dichloromethane (HCC-30), chlorofluoromethane (HCFC-31), difluoromethane (HFC-32), ethylene, ethane, chlorodifluoromethane (HCFC-22), methyl chloride (HCC-40), dichloromethane (HCC-30), methane, 1,1,2,2,2-pentafluoroethane (HFC-125), 1,1,2-trifluoroethane (HFC-143), 1,1,1-trifluoroethane (HFC-143a), 1,1,difluoroethane (HFC-152a), 1,1,1,2,2-pentafluoropropane (HFC-245cb), 2-chloro-1,1,1-trifluoropropane (HCFC-253db), 1,1,1,3-tetrafluoropropane (HFC-254fb), 1,1,1-trichloropropane (HCC-260fb), 1,1-dichloro-1-fluoropropane (HCFC-261fc), 1,1-difluoropropane (HFC-272fb), propane (HC-290), tetrafluorobutene (HFO-374), butane (HC-600), allene, 2-butene, cyclobutene, 2-methylpropene, 1-chloro-2,2-difluoroethylene (HCFO-1122), 1,2-difluoroethene (HFO-1132), 1,1-difluoroethene (HFO-1132a), fluoroethene (HFO-1141), ethylene (HO-1150), 1,1,2-trichloro-3,3,3-trifluoropropene (CFO-1213xa), 2-chloro-3,3,3-trifluoropropene (HCFO-1233xf), 2,3,3,3-tetrafluoropropene (HFO-1234yf), 3-chloro-3,3-difluoropropene (HCFO-1242zf), 3,3,3-trifluoropropene (HFO-1243zf), E-1-chloro-1-fluoro-1-propene (E-HCFO-1251zb), Z-1-chloro-1-fluoro-1-propene (Z-HCFO-1251zb), 3-chloropropene (HCO-1260zf), 3-fluoro-1-propene (HFO-1261zf), E-1-fluoro-1-propene (E-HFO-1261ze), 1-fluoropropane (HFC-281fa), 1,1-difluoropropane (272fb), tetrafluorobutane (C₄H₆F₄), 1252-dimers (C₆F₄H₈), propylene (HO-1270), pentafluorobutene (HFO-1345), and E/Z-t-BuO-CF=CH-CH₃, and 1,1,1-trifluoropropane (HFC-263fb).

[0155] In certain embodiments disclosed herein, the composition comprises, consists essentially of, or consists of 1,1-difluoropropene (HFO-1252zc), 1,1,1-trifluoropropane (HFC-263fb) and one or more members selected from the group consisting of trifluoromethane (HFC-23), dichloromethane (HCC-30), chlorofluoromethane (HCFC-31), difluoromethane (HFC-32), ethylene, ethane, chlorodifluoromethane (HCFC-22), methyl chloride (HCC-40), dichloromethane (HCC-30), methane, 1,1,2,2,2-pentafluoroethane (HFC-125), 1,1,2-trifluoroethane (HFC-143), 1,1,1-trifluoroethane (HFC-143a), 1,1,1-difluoroethane (HFC-152a), 1,1,1,2,2-pentafluoropropane (HFC-245cb), 2-chloro-1,1,1-trifluoropropane (HCFC-253db), 1,1,1,3-tetrafluoropropane (HFC-254fb), 1,1,1-trichloropropane (HCC-260fb), 1,1-dichloro-1-fluoropropane (HCFC-261fc), 1,1-difluoropropane (HFC-272fb), propane (HC-290), tetrafluorobutene (HFO-374), butane (HC-600), allene, 2-butene, cyclobutene, 2-methylpropene, 1-chloro-2,2-difluoroethylene (HCFO-1122), 1,2-difluoroethene (HFO-1132), 1,1-difluoroethene (HFO-1132a), fluoroethene (HFO-1141), ethylene (HO-1150), 1,1,2-trichloro-3,3,3-trifluoropropene (CFO-1213xa), 2-chloro-3,3,3-trifluoropropene (HCFO-1233xf), 2,3,3,3-tetrafluoropropene (HFO-1234yf), 3-chloro-3,3-difluoropropene (HCFO-1242zf), 3,3,3-trifluoropropene (HFO-1243zf), E-1-chloro-1-fluoro-1-propene (E-HCFO-1251zb), Z-1-chloro-1-fluoro-1-propene (Z-HCFO-1251zb), 3-chloropropene (HCO-1260zf), 3-fluoro-1-propene (HFO-1261zf), E-1-fluoro-1-propene (E-HFO-1261ze), 1-fluoropropane (HFC-281fa), 1,1-difluoropropane (272fb), tetrafluorobutane (C₄H₆F₄), 1252-dimers (C₆F₄H₈), propylene (HO-1270), pentafluorobutene (HFO-1345), and E/Z-t-BuO-CF=CH-CH₃, and 1-chloro-1,1,-difluoropropane (HCFC-262fc).

[0156] In certain embodiments disclosed herein, the composition comprises, consists essentially of, or consists of at least one of HFO-1252zc, HFC-263fb, and one or more additional members selected from HFO-1243zf, HFO-1234yf, allene, HFO-1252ye and HFO-1252yf.

[0157] In certain embodiments disclosed herein, the composition comprises, consists essentially of, or consists of HFO-1252zc and at least one of HFC-263fb, HCFC-262fc, and one or more additional members selected from ethylene, HFC-23, HFO-1132a, propane, HFO-1234yf, HFO-1261, HFC-143a, HCFO-1233, and HFO-374.

[0158] One embodiment of the invention disclosed herein is a composition comprising, consisting essentially of, or consisting of HCFC-262fc and one or more compounds selected from propane, propylene, HFO-1243zf, HFO-1261, HFO-1252zc, HFC-272fb, HFO-1252zc, HCFO-1251 (I) isomer, HCFO-1242 isomer, HCFO-1251 (II) isomer, HCFC-262 isomer, HCFC-252dc, HCO-1250, and HCC-260.

[0159] One embodiment of the invention disclosed herein is a composition comprising, consisting essentially of, or consisting of HCFC-262fc and one or more compounds selected from propane, R-1243zf, HFO-1252zc, HFO-1261, HCFO-1242zf, HCFO-1251 (I) isomer, HCFO-1251 (II) isomer, HCFO-1242 isomer, HCFC-262 isomer, HCFO-1232 isomer, HCFC-252, HCFC-252dc, HCO-1250 and HCC-260.

[0160] One embodiment of the invention disclosed herein is a composition comprising, consisting essentially of, or consisting of HCFO-1242zf and one or more compounds selected from ethane, HFC-152a, HFO-1243zf, HFO-1252zc, HCFC-253db, HCFC-262fc, HCFO-1242 isomer and HCFO-1232.

[0161] One embodiment of the invention disclosed herein is a composition comprising, consisting essentially of, or consisting of HCFO-1242zf and one or more compounds selected from HFO-1252zc, HCFC-253db, HCFC-262fc, HCFO-1242 isomer and HCFO-1232.

[0162] One embodiment of the invention disclosed herein is a composition comprising, consisting essentially of, or consisting of HCFC-262fc, HFO-1252zc and one or more compounds selected from propane, propylene, HFO-1261, HFO-1252zc, HFC-272fb, HCFO-1251 (I) isomer, HCFO-1251 (II) isomer, HCFC-262 isomer, HCFC-252dc, HCO-1250, and HCC-260.

[0163] One embodiment of the invention disclosed herein is a composition comprising, consisting essentially of, or consisting of HCFC-262fc, HCFO-1242zf and one or more compounds selected from propane, R-1243zf, HFO-1252zc, HFO-1261, HCFO-1251 (I) isomer, HCFO-1251 (II) isomer, HCFO-1242 isomer, HCFC-262 isomer, HCFO-1232, HCFC-252, HCFC-252dc, HCO-1250 and HCC-260.

[0164] One embodiment of the invention disclosed herein is a composition comprising, consisting essentially of, or consisting of HCFO-1242zf, HFO-1252zc

and one or more compounds selected from ethane, HFC-152a, HFO-1243zf, HCFC-253db, HCFC-262fc, HCFO-1242 isomer and HCFO-1232.

[0165] One embodiment of the invention disclosed herein is a composition comprising, consisting essentially of, or consisting of HCFO-1242zf, HCFC-262fc and one or more compounds selected from HFO-1252zc, HCFC-253db, HCFO-1242 isomer and HCFO-1232.

[0166] In certain embodiment disclosed herein, (1) the total amount of additional compounds/members (compounds other than HFC-263fb and HFO-1252zc) is selected from between: greater than 0 and less than 0.5 percent, greater than 0 and less than 0.4 percent, greater than 0 and less than 0.2 percent, greater than 0 and less than 0.2 percent, greater than 0 and less than about 0.1 percent, or greater than 0 and less than about 0.01 percent based on the total amount of the composition, with the *proviso* that the total amount of the composition is 100%, and/or (2) the amount of an additional compound/member is selected from one of greater than 0 and less than about 0.2 percent, greater than 0 and less than about 0.1 mole, greater than 0 and less than about 0.01 percent, greater than 0 and less than about 0.001 based, or greater than 0 and less than about 0.0001 percent based on the total amount of the composition, and/or (3) the respective amount of an additional compound/member is independently selected from one of greater than 0 and less than about 0.2 percent, greater than 0 and less than about 0.1 mole, greater than 0 and less than about 0.01 percent, greater than 0 and less than about 0.001 based, or greater than 0 and less than about 0.0001 percent based on the total amount of the composition, with the proviso that the total amount of the composition is 100%.

[0167] In one composition embodiment disclosed herein, the total amount of compounds other than HFC-263fb, i.e., the additional compounds, is between greater than 0 and less than about 15%, expressed by GC-FID peak area percent, based on the total amount of the composition, and all values and ranges therebetween.

[0168] In other embodiments disclosed herein, the total amount of the additional compounds other than HFC-263fb is between greater than 0 and less than one of 15 percent, 14 percent, 13 percent, 12 percent, 11 percent, 10 percent, 9 percent, 9

percent, 7 percent, 6 percent, 5 percent, 4 percent, 3 percent, 2 percent, or 1 percent and all values and ranges therebetween.

[0169] In other embodiments disclosed herein, the total amount of the additional compounds other than HFC-263fb is between greater than 0 and less than 0.1 percent, greater than 0 and less than 0.01 percent, between greater than 0.0001 and less than 0.3 percent, greater than 0.0001 and less than 0.2 percent, greater than 0.0001 and less than 0.1 percent, greater than 0.0001 and less than 0.01 percent, or greater than 0.0001 and less than 0.001 percent, based on the total amount of the composition and all values and ranges therebetween.

[0170] In certain embodiments disclosed herein, the compositions comprise (1) HFO-1252zc, (2) one of HFC-263fb or HCFC-262fc, and (3) one or more additional compounds identified in Table 1, other than HFO-1252zc, HFC-263fb, and HCFC-262fc, wherein each additional compound is present in an amount of between:

- a) greater than 0 and less than 20 percent
- b) greater than 0 and less than 15 percent
- c) greater than 0 and less than 10 percent
- d) greater than 0 and less than 4 percent,
- e) greater than 0 and less than 3 percent,
- f) greater than 0 and less than 2 percent,
- g) greater than 0 and less than 1 percent,
- h) greater than 0 and less than 0.5 percent,
- i) greater than 0 and less than 0.1 percent,
- j) greater than 0 and less than 0.01 percent,
- k) greater than 0 and less than 0.005 percent,
- l) greater than 0.001 and less than 4 percent,
- m) greater than 0.001 and less than 3 percent,
- n) greater than 0.001 and less than 2 percent,
- o) greater than 0.001 and less than 1 percent,
- p) greater than 0.001 and less than 0.5 percent,

- q) greater than 0.001 and less than 0.1 percent,
- r) greater than 0.001 and less than 0.01 percent, or
- s) greater than 0.001 and less than 0.005 percent,

based on the total amount of the composition *with the proviso* that the total amount of compounds other than HFO-1252zc, HFC-263fb, and HCFC-262fc is greater than 0.0001 and less than 15%, greater than 0.0001 and less than 10%, greater than 0.0001 and less than 8%, greater than 0.0001 and less than 7%, greater than 0.0001 and less than 6%, greater than 0.0001 and less than 5%, greater than 0.0001 and less than 4%, greater than 0.0001 and less than 3%, greater than 0.0001 and less than 2%, greater than 0.0001 and less than 1%, greater than 0.0001 and less than 0.5%, or greater than 0.0001 and less than 0.1.

[0171] In certain embodiments disclosed herein the compositions comprise (1) HFO-1252zc, (2) one of HFC-263fb or HCFC-262fc, and (3) one or more C₂-C₆ alkenes selected from ethylene, propylene, butylene, allene, and cyclobutene, each in an amount of between: greater than 15 percent, greater than 0 and less than 4 percent, greater than 0 and less than 3 percent, greater than 0 and less than 2 percent, greater than 0 and less than 1 percent, greater than 0 and less than 0.5 percent, greater than 0 and less than 0.1 percent, greater than 0 and less than 0.01 percent, and greater than 0 and less than 0.005 percent based on the total amount of the composition *with the proviso* that the total amount of compounds other than HFO-1252zc, HFC-263fb, and HCFC-262fc is greater than 0.0001 and less than 10% or 15%, greater than 0.0001 and less than 9%, greater than 0.0001 and less than 8%, greater than 0.0001 and less than 7%, greater than 0.0001 and less than 6%, greater than 0.0001 and less than 5%, greater than 0.0001 and less than 4%, greater than 0.0001 and less than 3%, greater than 0.0001 and less than 2%, greater than 0.0001 and less than 1%, greater than 0.0001 and less than 0.5%, or greater than 0.0001 and less than 0.1.

[0172] In certain embodiments disclosed herein, the compositions comprise (1) HFO-1252zc, and (2) one of HFC-263fb or HCFC-262fc, and are free of or substantially free of Group A Fluorinated Substances. In some embodiments, compositions of the present invention comprise, consist essentially of, or consist of HFO-1252zc and one of HFC-263fb or HCFC-262fc, and degradation products of

such compositions are free of or substantially free of Group A Fluorinated Substances, as defined herein.

EXAMPLES

Example 1: Liquid Phase Hydrogenation of HFO-1243zf

[0173] 5g 0.5%Pd/C was loaded into a 400ml Hastelloy C shaker tube. Then, the shaker tube was chilled to -30°C and vacuumed. 40g of HFO-1243zf was charged into the shaker tube, and heated back to 55°C. At 55°C, H₂ was added slowly to 250 psig pressure. The pressure drop quickly indicated the reaction happened at this condition. H₂ was further added until the pressure of reactor does not drop anymore; about 1g of H₂ was added at end of the reaction. The product of reaction was analyzed by GC-MS-FID and the contents are identified in Table 2 below.

Table 2

Compound	FID/GC Area %
1,1,difluoroethane (HFC-152a)	0.0011%
1,1,1-trifluoropropane (HFC-263fb)	99.9642%
1,1,1,3-tetrafluoropropane (HFC-254fb)	0.0162%
2-chloro-3,3,3-trifluoropropene (HCFO-1233xf)	0.0053%
2-chloro-1,1,1-trifluoropropane (HCFC-253db)	0.0062%
Others	0.0070%

Example 2: Hydrogenation of 1243zf to 263fb in vapor phase by 0.5% Pd/Al₂O₃

[0174] In a 12-inch long ½" OD Monel reactor, 5ml 0.5% Pd/Al₂O₃ was loaded. The catalyst was treated at 200°C by a flow of H₂ for 1 hour. Then, the reactor was heated to 50°C. HFO-1243zf, H₂ and N₂ feeds were controlled by a mass flow controller. The reaction test conditions are listed in Table 3 below. The reactor effluent was analyzed by online GC-MS-FID at time indicated in Table 3 below. The results of the analysis are listed in Table 3 below which shows complete conversion of HFO-1243zf to HFC-263fb with selectivity >99%.

Table 3

Time	Furnace	1243zf	H2	N2	Pressure		Mole Percent	
min	TempC	sccm	sccm	sccm	psi	Others	1243zf	263fb
50	50	6.00	11.05	10.02	10.0	0.27%	0.00%	99.73%
100	50	6.00	11.00	10.02	10.0	0.18%	0.00%	99.82%
150	50	6.00	11.00	10.02	10.0	0.15%	0.00%	99.85%
200	60	6.00	11.01	10.02	10.0	0.10%	0.00%	99.90%
250	60	6.00	11.80	10.02	10.0	0.09%	0.00%	99.91%
300	60	6.00	11.03	10.02	10.0	0.11%	0.00%	99.89%
350	65	6.00	11.03	10.02	10.0	0.07%	0.00%	99.93%
400	65	6.00	11.03	10.02	10.0	0.09%	0.00%	99.91%
450	65	6.00	11.03	10.02	10.0	0.08%	0.00%	99.92%
500	45	6.00	11.01	10.02	10.0	0.08%	0.00%	99.92%
550	45	6.00	11.01	10.02	10.0	0.09%	0.00%	99.91%
600	45	6.00	11.05	10.02	10.0	0.09%	0.00%	99.91%
650	40	6.00	11.05	10.02	10.0	0.08%	0.00%	99.92%
700	40	6.00	11.06	10.02	10.0	0.08%	0.00%	99.92%
750	40	6.00	11.06	10.02	10.0	0.09%	0.00%	99.91%

Example 3: Hydrogenation of 1243zf to 263fb in vapor phase by 0.04% Pd/Al₂O₃

[0175] In a 12-inche long ½" OD Monel reactor, 4ml 0.04% Pd/Al₂O₃ was loaded. The catalyst was treated at 200°C by a flow H₂ for 1 hour. Then, the reactor was heated to 50°C. HFO-1243zf, H₂ and N₂ feeds were controlled by a mass flow controller. The reaction test conditions are listed in Table 4 below. The reactor effluent was analyzed by online GC-MS-FID at the time indicated in Table 4 below. The results of the analysis are listed in Table 4 below which shows high conversion of HFO-1243zf to HFC-263fb with selectivity >99%.

Table 4

Time	Temp	1243zf	N2	H2	Pressure	Mol percent		
min	C	sccm	sccm	sccm	psi	others	1243zf	263fb
50	30	6.00	10.04	11.02	10.0	0.02%	0.10%	99.88%
100	30	6.00	10.04	11.02	10.0	0.02%	0.03%	99.95%
150	30	6.00	10.04	11.02	10.0	0.01%	0.02%	99.96%
200	40	6.00	10.04	11.02	10.0	0.04%	0.02%	99.94%
250	40	6.00	10.04	11.02	10.0	0.00%	0.02%	99.98%
300	50	6.00	10.04	11.02	10.0	0.00%	0.02%	99.98%
350	50	6.00	10.04	11.02	10.0	0.00%	0.02%	99.98%
400	60	6.00	10.04	11.01	10.0	0.00%	0.02%	99.98%
450	60	6.00	10.04	11.01	10.0	0.00%	0.02%	99.98%
500	30	6.00	10.04	7.08	10.0	0.07%	0.02%	99.91%
550	30	6.00	10.04	7.07	10.0	0.07%	0.02%	99.92%
600	30	6.00	10.04	7.07	10.0	0.07%	0.02%	99.92%

Time	Temp	1243zf	N2	H2	Pressure	Mol percent		
min	C	sccm	sccm	sccm	psi	others	1243zf	263fb
650	40	6.00	10.04	7.04	10.0	0.06%	0.02%	99.92%
700	40	6.00	10.04	7.03	10.0	0.06%	0.02%	99.92%
750	50	6.00	10.04	7.04	10.0	0.07%	0.02%	99.92%
800	50	6.00	10.04	7.03	10.0	0.07%	0.02%	99.92%
850	60	6.00	10.04	7.06	10.0	0.03%	0.02%	99.96%
900	60	6.00	10.04	7.08	10.0	0.06%	0.01%	99.92%

Example 4: Hydrogenation of 1242zf to 262fc in vapor phase by 0.02% Pd/Al₂O₃

[0176] In a 12-inch long ½" OD Monel reactor, 6ml 0.02% Pd/Al₂O₃ was loaded. The catalyst was treated at 200°C by a flow of H₂ for 1 hour. Then, the reactor was heated to 50°C. HFO-1243zf, H₂ and N₂ feeds were controlled by a mass flow controller. The reaction test conditions are listed in Table 5 below. The reactor effluent was analyzed by online GC-MS-FID at the times indicated in Tables 6-7 below. The results of the analysis are listed in Tables 6 and 7 below, which show high conversion of HCFO-1242zf to HCFC-262fc and selectivity of HCFC-262fc can reach 93%.

Table 5

Hours	C	psig	cc/hr	sccm	sccm	conversion	Selectivity
1.0	50	25.0	0.60	10.32	8.05	100%	91%
2.0	50	25.0	0.60	10.32	8.05	100%	91%
3.0	50	25.0	0.60	10.32	8.05	100%	91%
4.0	60	25.0	0.60	10.32	8.05	100%	90%
5.0	60	25.0	0.60	10.32	8.05	100%	91%
6.0	70	25.0	0.60	10.32	8.10	100%	90%
7.0	70	25.0	0.60	10.32	8.10	100%	89%
8.0	80	25.0	0.60	10.32	8.10	100%	88%
9.0	80	25.0	0.60	10.32	8.10	100%	89%
10.0	40	25.0	0.60	10.34	8.09	100%	93%
11.0	40	25.0	0.60	10.34	8.09	94%	91%
12.5	40	25.0	0.60	10.34	8.09	92%	90%
13.5	40	25.0	0.60	10.34	8.09	97%	93%
14.5	40	25.0	0.60	10.33	8.04	100%	92%
15.5	40	25.0	0.60	10.33	8.04	94%	93%
16.5	45	25.0	1.00	10.33	8.04	85%	89%
17.5	45	25.0	0.60	10.33	8.04	95%	93%
18.5	45	25.0	0.60	10.33	8.04	91%	92%
19.5	45	25.0	0.60	10.33	8.04	89%	92%

Table 6: Detail GC analysis of product at 6hr of reaction time of Example 4

Compounds	GC FID area%
Propane	0.1118%
Propylene	0.5485%
1261ze-E	0.0219%
1252zc	4.5950%
272fb	0.6380%
262fc	90.9433%
1251zb-E	0.4455%
1251zb-Z	0.4488%
262 isomer	1.3037%
252dc	0.6352%
1250	0.0301%
260	0.2284%
Others	0.0497%

Table 7: Detail GC analysis of product at 19.5hr of reaction time of Example 4

Compounds	GC FID area%
Propane	0.0295%
1243zf	2.2838%
1252zc	1.7754%
1261 isomer	0.1237%
1242zf	11.0944%
262fc	81.6127%
1251zb	0.3956%
1251zb	0.5558%
1242 isomer	0.5186%
262 isomer	0.7944%
1232	0.5621%
252	0.0269%
252dc	0.0414%
1250	0.0695%
260	0.0741%
Others	0.0422%

Example 5: Liquid Phase Hydrogenation of 1242zf

[0177] 0.25g 0.5%Pd/C was loaded into a 10ml Hastelloy C shaker tube. Then, the shaker tube was chilled to -30°C and vacuumed. 5g of HCFO-1242zf was charged into shaker, and heated back to 65°C. At 65°C, H₂ was added slowly to 300psig pressure. The pressure drop quickly indicated the reaction happened at these

conditions. H₂ was further added until the pressure of reactor does not drop anymore. Both the vapor phase and liquid phase of reaction mixture were analyzed by GC-MS-FID and the contents are identified in Tables 8 and 9 below.

Table 8: GC analysis of Vapor phase of reaction mixture of Example 5

Compounds	GC FID area%
ethane	0.0453%
152a	0.1359%
1243zf	0.4647%
1252zc	11.8858%
1242zf	79.7319%
253db	0.5287%
262fc	6.9624%
1242isomer	0.0824%
1232	0.1630%

Table 9: GC analysis of Liquid phase of reaction mixture of Example 5

Compounds	GC FID area%
1252zc	0.1286%
1242zf	83.5625%
253db	1.6333%
262fc	12.5316%
1242 isomer	0.4363%
1232	1.7078%

Example 6: Dehydrofluorination of 263fb by Zn doped chromium oxide

[0178] An Inconel (0.5-inch OD) tube reactor was loaded with 8 ml of 12-20 mesh JM62-3 chrome catalyst. The catalyst was activated by HF starting from 150°C to 450°C. HFC-263fb was fed by a pump and went through a vaporizer at 150°C with 9 sccm N₂ and then mixed with HF. The reaction conditions are identified in Table 10 below. The reaction mixture flowed through the catalyst bed of the reactor. The reactor effluent was passed through a caustic scrubber and then collected in a sample bag (not shown). The sample in the sample bag was analyzed by GC-MS-FID. The results of the GC analysis are listed in Table 11 below.

Table 10

263fb ml/hr	N2 Sccm	Air sccm	T °C	P psig	GC FID area%		
					1252zc	263fb	others
0.4	9	3	400	30	18.53%	76.96%	4.51%
0.4	9	3	425	30	26.67%	64.63%	8.70%
0.4	9	3	450	30	33.56%	57.04%	9.40%

Table 11: GC analysis of Example 6 product produced at 450°C

Methane	0.5039%
Ethylene	3.3200%
trifluoromethane (HFC-23)	1.2594%
fluoroethene (HFO-1141)	0.0500%
Propane	0.4312%
propylene (HO-1270)	0.2542%
1234yf	0.0118%
Allene	0.0659%
1,1-difluoropropene (HFO-1252zc)	34.4573%
Allene	0.2414%
C3H4F2	0.0833%
3-fluoro-1-propene (HFO-1261)	0.0528%
1,1,1-trifluoropropane (HFC-263fb)	58.1340%
3-fluoro-1-propene (HFO-1261)	0.0331%
2-butene	0.0328%
2-butene	0.0084%
Cyclobutene	0.0048%
2-methyl-1-propene	0.0350%
1,1-difluoropropane (HFC-272fb)	0.0202%
2-chloro-3,3,3-trifluoropropene (HCFO-1233xf)	0.0152%
3-chloropropene (HCO-1260zf)	0.0338%
C3H4FCl (HCFO-1251)(I)	0.4195%
C3H4FCl (HCFO-1251)(II)	0.4815%
Others	0.0506%

Example 7: Pyrolysis of 263fb to 1252zc

[0179] HFC-263fb was fed by pump with N₂ into an empty 12 inches long ½" OD Monel reactor (neither catalyst nor a packing material is present). Under N₂ purge, the reactor was heated up to 630°C and above. The reaction condition was list on Table 12 below. The reactor effluent was passed through KOH scrubber and then collected in a Teddlar bag at each test condition (not shown). The sample was analyzed by GC-MS-FID. The results of the analysis are listed in Table 13 below.

Table 12

263fb ml/hr	N2 sccm	Air sccm	T °C	P psig	GC FID area%		
					1252zc	263fb	others
0.5	5	0	630	0	20.95%	73.47%	5.58%
0.2	5	0	650	0	18.40%	76.03%	5.58%
0.2	5	0	670	0	31.11%	62.15%	6.74%

Table 13: GC analysis of product produced at 670°C of Example 7

	GC FID area%
ethylene	1.5882%
trifluoromethane (HFC-23)	0.2506%
1,1-difluoroethene ((HFO-1132a)a	1.3986%
fluoroethene (HFC-1141)	0.1177%
1,1,2,2,2-pentafluoroethane (HFC-125)	0.0103%
propane (HC-290)	0.1424%
1,1,2-trifluoroethane (HFC-143)	0.4038%
1,1-difluoropropene (HFO-1252zc)	0.0093%
1,1-difluoropropene (HFO-1252zc)	0.4063%
1,1-difluoropropene (HFO-1252zc)	31.1494%
2,3,3,3-tetrafluoropropene(HFO-1234yf)	0.0593%
1,1,difluoroethane (HFC-152a)	0.0283%
3-fluoro-1-propene (HFO-1261zf)	0.1013%
1,1,1-trifluoropropane (HFC-263fb)	62.2297%
1,1,1-trifluoroethane(HFC-143a)	0.1238%
3-fluoro-1-propene (HFO-1261zf)	0.0647%
difluoropropene	0.1020%
chlorotrifluoropropene (HCFO-1233xf)	0.0957%
pentafluorobutene (HFO-1345)	0.0751%
C ₄ H ₆ F ₄ (HFC-374)	0.0345%
Others	1.6088%

Example 8: Pyrolysis of 263fb to 1252zc with Monel packing

[0180] A 12-inch long ½" OD Monel reactor was loaded with 10ml Monel distillation packing. Under N₂ purge, the reactor was heated up to 500°C. HFC-263fb was fed by pump with N₂ into the reactor. The reaction conditions are listed in Table 14 below. The reactor effluent was passed through KOH scrubber and then collected in a Teddler bag (not shown) at each test condition. The sample is analyzed by GC-MS-FID. The results of the analysis are listed in Table 15 below.

Table 14

263fb ml/hr	N2 Sccm	Air sccm	T °C	P psig	GC FID area%		
					1252zc	263fb	others
0.5	5	0	500	0	1.07%	97.31%	1.62%
0.2	5	0	550	0	1.58%	96.49%	1.93%
0.2	5	0	600	0	6.69%	91.27%	2.04%
0.2	5	0	650	0	27.25%	70.59%	2.16%

Table 15: GC analysis of product produced at 650°C of Example 10

Compounds	GC-FID area%
UK	0.4593%
Ethylene	0.3256%
23	0.0956%
1132a	0.3718%
UK	0.0189%
propane	0.3092%
1252zc	0.0907%
1252zc	27.2473%
1234	0.0172%
UK	0.0078%
1261	0.1299%
263fb	70.5933%
143a	0.1171%
1261	0.0163%
UK	0.0104%
UK	0.0075%
1252	0.0343%
UK	0.0034%
UK	0.0126%
1233	0.0794%
UK	0.0116%
UK	0.0030%
374	0.0377%

Example 9: Liquid Phase Dehydrofluorination HFC-263fb

[0181] A mixture of $\text{CF}_3\text{-CH}_2\text{-CH}_3$ (6.2 g, 63 mmol) and KOtBu (7.1 g, 6.3 mmol) in dry DMF (30 ml) was stirred in a 100 mL flask at 0°C. Gas chromatography was used to monitor the reaction. After 1 hour, 1.3 g product $\text{CF}_2=\text{CH-CH}_2$ (conversion 30%, selectivity 86%) was collected in dry ice trap.

Example 10 Pyrolysis of 262fc to 1252zc in empty gold-lined reactor tube

[0182] HCFC-262fc was fed by pump into an empty 10 inches long ½” OD Gold-lined tube reactor. The reaction test conditions are listed in Table 16 below. The reactor effluent was analyzed by online GC-MS-FID at each test condition. The results of analysis are listed in Table 17.

Table 16

T °C	262fc cc/hr	P psig	N2 sccm	GC-FID						
				1252zc	263fb	262fc	E- 1251zb	Z- 1251zb	272fb	others
100	0.50	5.0	4.97	3.13%	1.47%	91.80%	0.99%	1.17%	0.86%	0.58%
100	0.50	5.1	4.96	3.12%	1.48%	91.91%	0.98%	1.16%	0.83%	0.52%
460	0.50	4.9	4.97	7.96%	2.22%	85.27%	1.44%	1.66%	0.96%	0.48%
460	0.50	5.0	5.00	6.71%	1.89%	87.35%	1.26%	1.44%	0.88%	0.47%
460	0.50	5.0	5.00	6.52%	1.97%	87.24%	1.32%	1.51%	0.89%	0.54%
460	0.50	5.0	4.97	6.04%	1.75%	88.56%	1.08%	1.23%	0.84%	0.50%
480	0.50	5.0	5.00	9.38%	1.89%	84.89%	1.17%	1.33%	0.83%	0.51%
480	0.50	5.0	5.00	9.24%	1.77%	85.44%	1.04%	1.18%	0.77%	0.56%
480	0.50	4.7	4.98	8.85%	1.71%	86.03%	1.00%	1.13%	0.75%	0.54%
500	0.50	5.2	5.00	17.19%	1.86%	77.28%	1.13%	1.27%	0.67%	0.59%
500	0.50	5.2	5.00	17.63%	1.93%	76.75%	1.15%	1.29%	0.68%	0.57%
500	0.50	5.1	5.00	16.50%	1.86%	78.16%	1.07%	1.21%	0.68%	0.52%
509	0.50	5.0	5.01	23.51%	1.90%	71.12%	1.08%	1.21%	0.62%	0.58%
507	0.50	5.3	5.01	20.99%	1.72%	74.26%	0.91%	1.02%	0.59%	0.51%
503	0.50	5.0	5.01	18.34%	1.76%	76.86%	0.91%	1.04%	0.62%	0.47%
450	1.00	30.0	0.00	7.54%	1.38%	87.97%	0.74%	0.87%	0.70%	0.81%
450	1.00	30.0	0.00	6.83%	1.26%	89.09%	0.65%	0.76%	0.66%	0.75%
450	1.00	30.0	0.00	6.57%	1.26%	89.32%	0.68%	0.78%	0.63%	0.76%
460	1.00	30.0	0.00	8.76%	1.32%	86.98%	0.69%	0.79%	0.61%	0.84%
460	1.00	30.0	0.00	8.07%	1.25%	87.95%	0.62%	0.71%	0.60%	0.81%
470	1.00	30.0	0.00	11.34%	1.31%	84.50%	0.63%	0.72%	0.57%	0.95%
470	1.00	30.0	0.00	10.74%	1.29%	85.17%	0.61%	0.70%	0.56%	0.93%
480	1.00	30.0	0.00	12.29%	1.35%	83.53%	0.56%	0.66%	0.62%	0.99%
459	1.50	60.0	0.00	18.46%	1.59%	74.90%	0.44%	0.51%	0.53%	3.59%
459	1.50	60.0	0.00	9.56%	0.88%	87.60%	0.31%	0.35%	0.40%	0.89%
459	1.50	60.0	0.00	7.20%	0.82%	90.19%	0.31%	0.35%	0.38%	0.75%
459	1.50	60.0	0.00	7.64%	0.76%	89.88%	0.28%	0.32%	0.35%	0.76%
470	1.50	60.0	0.00	14.57%	0.87%	82.11%	0.30%	0.34%	0.33%	1.49%
470	1.50	60.0	0.00	12.81%	0.81%	84.09%	0.29%	0.33%	0.31%	1.35%
470	1.50	60.0	0.00	12.39%	0.77%	84.60%	0.26%	0.31%	0.28%	1.39%
480	1.50	60.0	0.00	17.73%	0.82%	78.24%	0.27%	0.32%	0.27%	2.35%
480	1.50	60.0	0.00	17.80%	0.86%	78.32%	0.27%	0.31%	0.25%	2.19%
480	1.50	60.0	0.00	17.78%	0.80%	78.20%	0.25%	0.29%	0.24%	2.43%
490	1.50	60.0	0.00	22.80%	0.87%	72.28%	0.26%	0.30%	0.23%	3.26%
490	1.50	60.0	0.00	21.78%	0.81%	73.69%	0.24%	0.28%	0.22%	2.97%

Table 17 Detailed GC analysis of product produced at 490C

Compounds	GC-FID area%
methane	0.0771%
HFC-32	0.0008%
ethylene	0.0425%
ethane	0.0097%
1132a	0.0026%
HCC-40	0.0048%
HCFC-22	0.0098%
ethylene oxide	0.0017%
HFO-1261ze-E	0.0278%
1252zc	23.1407%
263fb	0.2173%
1252 isomer	0.1365%
281fa	0.2447%
HCC-30	0.0282%
C4H3ClF4	0.0168%
262fc	73.3758%
E-1251zb	0.1832%
Z-1251zb	0.1794%
272fb	0.1632%
C4H6F4	0.0248%
C4H6F4	0.0501%
C6F12	0.0458%
1252-dimer	0.7631%
1252dimer	1.0084%
others	0.2454%

Example 11 Pyrolysis of 262fc to 1252zc in empty Inconel 625 reactor tube

[0183] HCFC-262fc was fed by pump into an empty 10 inches long ½" OD Inconel 625 tube reactor. The reaction test conditions are listed in Table 18 below. The reactor effluent was analyzed by online GC-MS-FID at each test condition. The results of analysis are listed in Table 19.

Table 18

T °C	P psig	262fc cc/hr	GC-FID area%								
			1252zc	263fb	262fc	E- 1251zb	Z- 1251zb	272fb	1252- dimer	1252- dimer	others
460	49.9	1.50	14.40%	0.82%	83.08%	0.35%	0.39%	0.17%	0.31%	0.49%	0.00%
460	50.0	1.50	12.25%	0.72%	85.61%	0.32%	0.37%	0.16%	0.24%	0.34%	0.00%
470	50.1	1.50	13.95%	0.69%	84.11%	0.30%	0.35%	0.15%	0.21%	0.24%	0.00%
470	50.4	1.50	13.21%	0.65%	84.60%	0.28%	0.33%	0.15%	0.34%	0.43%	0.00%
470	50.0	1.50	14.02%	0.66%	84.06%	0.27%	0.31%	0.14%	0.25%	0.30%	0.00%
480	49.8	1.50	17.72%	0.63%	79.59%	0.26%	0.30%	0.13%	0.63%	0.74%	0.00%
480	50.0	1.50	19.21%	0.65%	78.24%	0.25%	0.29%	0.13%	0.57%	0.66%	0.00%
480	49.8	1.50	18.12%	0.63%	79.24%	0.22%	0.22%	0.12%	0.67%	0.78%	0.00%
490	50.1	1.50	22.08%	0.69%	75.45%	0.21%	0.21%	0.12%	0.60%	0.64%	0.00%

490	50.0	1.50	24.01%	0.66%	72.98%	0.21%	0.21%	0.12%	0.81%	0.85%	0.15%
490	49.8	1.50	25.07%	0.65%	71.48%	0.21%	0.21%	0.12%	1.03%	1.06%	0.18%
469	33.0	1.09	16.47%	0.83%	81.59%	0.26%	0.27%	0.15%	0.21%	0.22%	0.00%
469	33.0	1.09	14.85%	0.65%	82.84%	0.21%	0.21%	0.11%	0.35%	0.38%	0.39%
469	33.0	1.09	15.49%	0.68%	82.02%	0.18%	0.19%	0.10%	0.42%	0.49%	0.43%
480	33.0	1.09	18.64%	0.65%	78.33%	0.18%	0.18%	0.10%	0.61%	0.71%	0.58%
480	33.0	1.09	18.34%	0.63%	78.59%	0.17%	0.17%	0.10%	0.64%	0.78%	0.58%
480	33.0	1.09	18.09%	0.61%	78.64%	0.20%	0.22%	0.09%	0.68%	0.84%	0.63%
490	33.0	1.09	25.32%	0.69%	70.46%	0.18%	0.18%	0.08%	1.04%	1.11%	0.94%
490	33.0	1.09	25.45%	0.68%	70.33%	0.18%	0.17%	0.08%	1.05%	1.11%	0.95%
500	33.0	1.09	33.11%	0.71%	60.21%	0.19%	0.20%	0.08%	1.84%	1.96%	1.69%
500	33.0	1.09	32.55%	0.69%	60.99%	0.18%	0.19%	0.08%	1.78%	1.89%	1.64%

Table 19 Detailed GC analysis of product produced at 490C

Compounds	GC-FID area%
methane	0.0183%
HFC-32	0.0006%
ethylene	0.0612%
ethane	0.0147%
1132a	0.0161%
HCC-40	0.0035%
HCFC-22	0.0081%
HFO-1261ze-E	0.0286%
1252zc	25.2162%
263fb	0.3565%
1252 isomer	0.3004%
281fa	0.2090%
HCC-30	0.0306%
C4H3ClF4	0.0260%
262fc	70.3866%
E-1251zb	0.2122%
Z-1251zb	0.2319%
272fb	0.0931%
C4H6F4	0.0281%
C4H6F4	0.0422%
C6F12	0.0521%
1252-dimer	1.0604%
1252dimer	1.1227%
others	0.4806%

[0184] Certain system, apparatus and process embodiments disclosed herein include first and second zones of discrete reactors.

[0185] Certain system, apparatus and process embodiments disclosed herein include first and second zones located in discrete reactors, one of which is configured for a vapor phase reaction.

[0186] Certain system, apparatus and process embodiments disclosed herein include first and second zones located in discrete reactors, one of which is configured for a vapor phase reaction, wherein the vapor phase reactor includes a catalyst, a packing material, or neither.

[0187] Certain system, apparatus and process embodiments disclosed herein include first and second zone defined by discrete reactors each configured for vapor phase reactions, and the second vapor phase reactor includes a catalyst, a packing material, or neither.

[0188] Certain system, apparatus and process embodiments disclosed herein include first and second zone of discrete reactors, wherein a first reactor is configured for liquid phase reaction involving agitation/mixing. The liquid phase reaction is preferably conducted in the presence of a solvent, including but not limited to polar aprotic solvents such as DMF, DMAc, DMSO, MP or tert-butyl alcohol, with or without a catalyst, such as crown ether, at temperatures between -40°C and 100°C, -30°C and 100°C, -30°C and 90°C, -40°C and 80°C, 40°C and 0°C, -30°C and 60°C, and all values and ranges therebetween.

[0189] Certain system, apparatus and process embodiments disclosed herein include first and second discrete reactions zones, vaporizers to preheat reactant feeds, scrubbers to remove inorganic acids, distillation systems to isolate and/or recover intermediate compounds, products, and facilitate recycling of recovered compounds.

OTHER EMBODIMENTS

[0190] **Composition Embodiment A** comprising, consisting essentially of, or consisting of,

HFO-1252zc,

HFC-263fb,

optionally at least one of ethylene, propylene, butylene, allene, and cyclobutene,

optionally at least one of HFC-23, HFC-123, HFC-143a, HFC-152a, HFO-374, HFO-1141, HFO-1234, HFO-1261, HCFO-1233, HCFO-1251 and HFO-1260; and

optionally one of HFC-23, HFO-1132, HFO-1141, HFC-125, HFC-143a, HFO-1234, HFO-1261, HCFO-1233, HCFO-1251, and HFO-1260.

[0191] Composition Embodiment A(1) comprising, consisting essentially of, or consisting of,

HFO-1252zc,

HFC-263fb,

at least one of ethylene, propylene, butylene, allene, and cyclobutene, and

at least one of HFC-23, HFC-123, HFC-143a, HFC-152a, HFO-374, HFO-1141, HFO-1234, HFO-1261, HCFO-1233, HCFO-1251, and HFO-1260; or at least one of HFC-23, HFO-1132, HFO-1141, HFC-125, HFC-143a, HFO-1234, HFO-1261, HCFO-1233, HCFO-1251, and HFO-1260.

[0192] Any of foregoing Composition **Embodiments A** and **A(1)** further comprising HFC-23.

[0193] Any of foregoing Composition **Embodiments A** and **A(1)** further comprising HC-290.

[0194] Any of foregoing Composition **Embodiments A** and **A(1)** further comprising HFO-1150.

[0195] Any of foregoing Composition **Embodiments A** and **A(1)** further comprising HCFO-1233.

[0196] Any of foregoing Composition **Embodiments A** and **A(1)** further comprising HFO-1234.

[0197] Any of foregoing Composition **Embodiments A** and **A(1)** further comprising HFO-1260.

[0198] Any of foregoing Composition **Embodiments A** and **A(1)** further comprising HFO-1261.

[0199] Any of Composition **Embodiments A** and **A(1)** further comprising HFC-23 and HFO-1261.

[0200] Any of foregoing Composition **Embodiments A** and **A(1)** further comprising HFC-23, HC-290 and HFO-1261.

[0201] Any of foregoing Composition **Embodiments A** and **A(1)** further comprising HFC-23, HC-290, HCFO-1233, and HFO-1261.

[0202] Any of foregoing Composition **Embodiments A** and **A(1)** further comprising HFC-23, HC-290, HCFO-1233, HFO-1234 and HFO-1261.

[0203] Any of foregoing Composition **Embodiments A** and **A(1)** further comprising HFC-23, HC-290, HFO-1150, HCFO-1233, HFO-1234 and HFO-1261.

[0204] Any of foregoing Composition **Embodiments A** and **A(1)** wherein HCFO-1233 is HCFO-1233xf.

[0205] Any of foregoing Composition **Embodiments A** and **A(1)** wherein HFO-1234 is HFO-1234yf.

[0206] Each and every foregoing Composition **Embodiments A** and **A(1)** wherein the amount of HFO-1252zc comprises at least one of greater than 30%, 35%, 40%, 50%, 60%, 70%, 80%, 99% percent, based on the total amount of the composition

[0207] **Composition Embodiment B** comprising HFC-263fb, HFC-152a, HFC-254fb, HCFO-1233xf, and HCFC-253db.

[0208] Foregoing **Composition Embodiment B** comprising greater than 60% HFC-263fb.

[0209] Foregoing **Composition Embodiment B** comprising greater than 70% HFC-263fb.

[0210] **Process Embodiment A** comprising hydrogenating a fluoroolefin defined by the formula $\text{CF}_2\text{XCH}_2=\text{CH}$, wherein X is at least one of chlorine, fluorine, and combinations thereof, preferably X= F or Cl as is in 3,3,3-trifluoropropene or 1-chloro-1,1-difluoropropene.

[0211] **Process Embodiment B** comprising hydrogenating a first compound to produce a first product mixture and dehydrogenating the first product mixture to

produce a second product mixture, wherein the first compound is defined by the formula $\text{CF}_2\text{XC}\text{Y}=\text{CH}_2$ (e.g., $\text{CF}_3\text{CH}=\text{CH}_2$ (HFO-1243zf), $\text{CClF}_2\text{CH}=\text{CH}_2$ (HCFO-1242zf), $\text{CClF}_2\text{CCl}=\text{CH}_2$ (HCFO-1232xf)), wherein X is at least one of chlorine, fluorine, bromine and iodine, and Y is H, Cl, F, Br or I, and wherein the first product mixture comprises a product compound defined by the formula $\text{CF}_2\text{XCH}_2\text{CH}_3$ (e.g., $\text{CF}_3\text{CH}_2\text{CH}_3$, $\text{CF}_2\text{ClCH}_2\text{CH}_3$) wherein X is one of Cl, F, Br or I and the second product mixture comprises 1,1-difluoropropene (HFO-1252zc).

[0212] Process Embodiment C comprising making HFO-1252zc by dehydrohalogenating a compound defined by the formula $\text{CF}_2\text{XCH}_2\text{CH}_3$, wherein X is one of Cl, F, Br or I in the vapor phase or the liquid phase.

[0213] Process Embodiment C2 comprising making HFO-1252zc by dehydrohalogenating a compound defined by the formula $\text{CF}_2\text{XCH}_2\text{CH}_3$, wherein X is one of Cl, F, Br or I in the vapor phase, in the presence of a catalyst, in the presence of a metal alloy packing, or in the absence of both a catalyst and a metal alloy packing.

[0214] Process Embodiment C3 comprising making HFO-1252zc by dehydrohalogenating a compound defined by the formula $\text{CXF}_2\text{CHYCH}_3$, wherein X is one of Cl, F, Br or I and Y is H, Cl, F, Br or I, in the liquid phase.

[0215] Foregoing **Process Embodiment C** wherein the dehydrohalogenation is conducted in the vapor phase at a temperature selected from one of:

- a. between greater than 300°C and less than about 500°C,
- b. between greater than 400°C and less than about 700°C, or
- c. between greater than about 450°C and less than about 900°C.

[0216] Any of foregoing **Process Embodiment C** wherein the dehydrohalogenation is conducted in the presence of a catalyst comprising a supported or unsupported fluorided transition metal oxide, nickel-based alloy or nickel-chromium-based alloy (e.g., Inconel™), in the vapor phase. Dehydrohalogenation catalysts include, but are not limited to, nickel-based alloys, nickel-chromium-based alloys, alumina, aluminum fluoride, fluorided alumina, preferably one of chromium oxides, fluorided chromium oxides, and cubic chromium trifluoride; alone or supported on carbon, acid-washed carbon, activated carbon, three-dimensional matrix

carbonaceous materials; and metal compounds supported on carbon.

The metal compounds are preferably transition metals of the Periodic Table, such as scandium (Sc), titanium (Ti), vanadium (V), chromium (Cr), manganese (Mn), iron (Fe), cobalt (Co), nickel (Ni), copper (Cu), and zinc (Zn).

[0217] Process Embodiment D comprising converting $\text{CF}_3\text{CH}=\text{CH}_2$ (HFO-1243zf) to $\text{CF}_3\text{CH}_2\text{CH}_3$ (HFC-263fb), and dehydrofluorinating HFC-263fb to form a product comprising $\text{CF}_2=\text{CHCH}_3$ (HFO-1252zc).

[0218] Process Embodiment E comprising making $\text{CF}_2=\text{CHCH}_3$ (HFO-1252zc) by first hydrogenating $\text{CClF}_2\text{CH}=\text{CH}_2$ to $\text{CClF}_2\text{CH}_2\text{CH}_3$ (HCFC-262fc), and dehydrochlorinating HCFC-262fc to make HFO-1252zc.

[0219] Foregoing **Process Embodiment D** comprising making $\text{CF}_2=\text{CHCH}_3$ (HFO-1252zc) by first hydrogenating $\text{CF}_3\text{CH}=\text{CH}_2$ (HFO-1243zf) to form $\text{CF}_3\text{CH}_2\text{CH}_3$ (HFC-263fb) following by dehydrofluorinating HFC-263fb to make HFO-1252zc.

[0220] Foregoing **Process Embodiments D or E** wherein the dehydrohalogenation is conducted in the presence or absence of a catalyst.

[0221] Foregoing **Process Embodiments D or E** wherein the dehydrohalogenation is conducted in the presence of a catalyst, preferably the catalyst which comprises a supported or unsupported fluorided or partially fluorided transition metal oxide, nickel-based alloy or nickel-chromium-based alloy. In one embodiment, the metal of the catalyst is selected from at least one of scandium (Sc), titanium (Ti), vanadium (V), chromium (Cr), manganese (Mn), iron (Fe), cobalt (Co), nickel (Ni), copper (Cu), and zinc (Zn).

[0222] Foregoing **Process Embodiments D or E** wherein dehydrohalogenation is conducted in the liquid phase, preferably in the presence of a conjugated *t*-butoxide, most preferably an alkali metal *t*-butoxide selected from sodium or potassium *t*-butoxide.

[0223] Foregoing **Process Embodiments D or E** wherein dehydrohalogenation is conducted in the gas phase.

[0224] Each and every **Process Embodiments D or E** wherein the dehydrohalogenation is conducted at a temperature between greater than 300°C to about 900°C., or selected from one of:

- a. between greater than about 300°C and less than about 500°C,
- b. between greater than about 400°C and less than about 700°C, or
- c. between greater than about 500°C and less than about 900°C.

[0225] Each and every **Process Embodiment B-E** wherein HFO-1252zc comprises at least one of greater than 15, 20, 25, 30, 35, 40, 50, 60, 70 and 80 percent based on the total amount of the composition.

[0226] A composition formed by each and every **Process Embodiment A-E** above.

[0227] A **COMPOSITION EMBODIMENT A'** comprising HFC-263fb and two or more additional compounds selected from HFC-152a, HFC-254fb, HCFO-1233xf, HFO-1243zf and HCFC-253db.

[0228] The **COMPOSITION EMBODIMENT A'** containing at least 99 percent HFC-263fb.

[0229] The **COMPOSITION EMBODIMENT A'** wherein the total amount of additional compounds is selected from one of between greater than 0 and less than 0.5 percent, between greater than 0 and less than 0.4 percent, between greater than 0 and less than 0.3 percent, between greater than 0 and less than 0.2 percent, between greater than 0 and less than 0.1 percent such that the total amount of the composition is 100 percent.

[0230] **COMPOSITION EMBODIMENT B'**, comprising HFO-1252zc, HFC-263fb, optionally at least one of ethylene, propylene, butylene, allene, and cyclobutene, optionally at least one of HFC-23, HFC-123, HFC-143a, HFC-152a, HFO-374, HFO-1141, HFO-1234yf, HFO-1261, HCFO-1233, HCFO-1251, and HFO-1260; and optionally one of HFC-23, HFO-1132, HFO-1141, R-125, HFC-143a, HFO-1234yf, HFO-1261, HCFO-1233, HCFO-1251, and HFO-1260.

[0231] COMPOSITION EMBODIMENT B(1)' comprising,

HFO-1252zc,

HFC-263fb,

at least one of ethylene, propylene, butylene, allene, and cyclobutene, and,

at least one of HFC-23, HFC-123, HFC-143a, HFC-152a, HFO-374, HFO-1141, HFO-1234yf, HFO-1261, HCFO-1233, HCFO-1251, and HFO-1260, or at least one of HFC-23, HFO-1132, HFO-1141, HFC-125, HFC-143a, HFO-1234yf, HFO-1261, HCFO-1233, HCFO-1251, and HFO-1260.

[0232] COMPOSITION EMBODIMENT C' comprising 1,1-difluoropropene (HFO-1252zc) and one of more members selected from methane, ethylene, ethane, HFC-23, HFC-125, HFC-143a, HFO-1141, propane, propylene, HFO-1234yf, allene, C₃H₄F₂, HFO-1261ze-E, HFO-1261ze-Z, HFC-263fb, HCFC-262fc, 2-butene, cyclobutene, 2-methyl-1-propene, HFC-272fb, HCFC-262fc, HCFO-1233, HCO-1260, HFC-374, HFO-1345 isomer, HCFO-1251zb-E, HCFO-1251zb-Z, HFC-32, HFO-1132a, HCC-40, HCFC-22, HFO-1261ze-E, HFO-1252 isomer, HFC-281fa, HCC-30, C₄H₃ClF₄, HFO-1252 dimers.

[0233] COMPOSITION EMBODIMENT D' comprising 1,1-difluoropropene (HFO-1252zc) and one of more members selected from ethylene (HFO-1150), trifluoromethane (HFC-23), 1,1-dichloroethylene (HCO-1132a), fluoroethane (HFC-1141), 1,1,2,2,2-pentafluoroethane (HFC-125), propane (HFC-290), 1,1,2-trifluoroethane (HFC-143), 1,1-difluoropropene (HFO-1252zc), HFO-1234, 1,1,1-difluoroethane (HFC-152a), 3-fluoro-1-propene (HFO-1261), 1,1,1-trifluoropropane (HCC-263fb), 1,1,1-trichloroethane (HCC-143a), 3-fluoro-1-propene (HFO-1261), HFO-1252 isomer, chloro-3,3,3-trifluoropropene (HCFO-1233), or pentafluorobutene (HFO-374).

[0234] COMPOSITION EMBODIMENT E', comprising 1,1-difluoropropene (HFO-1252zc) and one of more members selected from methane, ethylene, ethane, HFC-23, HFC-125, HFC-143a, HFO-1141, propane, propylene, HFO-1234yf, allene, C₃H₄F₂, HFO-1261ze-E, HFO-1261ze-Z, HFC-263fb, 2-butene, cyclobutene, 2-methyl-1-propene, HFC-272fb, HCFC-262fc, HCFO-1233, HCO-1260, HFC-374, HFO-1345 isomer, HCFO-1251zb-E, HCFO-1251zb-Z, HFC-32, HFO-1132a, HCC-

40, HCFC-22, HFO-1261ze-E, 263fb, HFO-1252 isomer, HFC-281fa, HCC-30, C₄H₃ClF₄, HFO-1252 dimers.

[0235] COMPOSITION EMBODIMENT F', comprising 1,1-difluoropropene (HFO-1252zc) and 1,1,1-trifluoropropane (HFC-263b), and one of more members selected from ethylene and propane, and an additional member selected from HFC-23, HFO-1132a, HFO-1234, HFO-1261, HFC-263fb, HFC-143a, HFO-1252 isomer.

[0236] COMPOSITION EMBODIMENT F(1)', comprising 1,1-difluoropropene (HFO-1252zc) and 1,1,1-trifluoropropane (HFC-263b), and one of more members selected from Table 1 other than 1,1-difluoropropene (HFO-1252zc) and 1,1,1-trifluoropropane (HFC-263fb)

[0237] COMPOSITION EMBODIMENT G', comprising 1,1-difluoropropene (HFO-1252zc), HFO-1261, and HFC-263fb one of more of trifluoromethane (HFC-23), dichloromethane (HCC-30), chlorofluoromethane (HCFC-31), difluoromethane (HFC-32), ethylene, ethane, chlorodifluoromethane (HCFC-22), methyl chloride (HCC-40), dichloromethane (HCC-30), methane, 1,1,2,2,2-pentafluoroethane (HFC-125), 1,1,2-trifluoroethane (HFC-143), 1,1,1-trifluoroethane (HFC-143a), 1,1,1-difluoroethane (HFC-152a), 1,1,1,2,2-pentafluoropropane (HFC-245cb), 2-chloro-1,1,1-trifluoropropane (HCFC-253db), 1,1,1,3-tetrafluoropropane (HFC-254fb), 1,1,1-trichloropropane (HCC-260fb), 1,1-dichloro-1-fluoropropane (HCFC-261fc), 1,1-difluoropropane (HFC-272fb), propane (HC-290), tetrafluorobutene (HFO-374), butane (HC-600), allene, 2-butene, cyclobutene, 2-methylpropene, 1-chloro-2,2-difluoroethylene (HCFO-1122), 1,2-difluoroethene (HFO-1132), 1,1-difluoroethene (HFO-1132a), fluoroethene (HFO-1141), ethylene (HO-1150), 1,1,2-trichloro-3,3,3-trifluoropropene (CFO-1213xa), 2-chloro-3,3,3-trifluoropropene (HCFO-1233xf), 2,3,3,3-tetrafluoropropene (HFO-1234yf), 3-chloro-3,3-difluoropropene (HCFO-1242zf), 3,3,3-trifluoropropene (HFO-1243zf), 1,1-difluoro-1-propene (1252zc), E-1-chloro-1-fluoro-1-propene (E-HCFO-1251zb), Z-1-chloro-1-fluoro-1-propene (Z-HCFO-1251zb), 3-chloropropene (HCO-1260zf), E-1-fluoro-1-propene (E-HFO-1261ze), 3-fluoro-1-propene (1261zf), 1-fluoropropane (281fa), 1,1-difluoropropane (272fb), tetrafluorobutane (C₄H₆F₄), 1252-dimers (C₆F₄H₈), propylene (HO-1270), pentafluorobutene (HFO-1345), and E/Z-t-BuO-CF=CH-CH₃,

[0238] COMPOSITION EMBODIMENT H' comprising each and every COMPOSITION EMBODIMENT A-G wherein the amount of HFO-1252zc comprises at least one of greater than 10%, 15%, 20%, 30%, 35%, 40%, 50%, 60%, 70%, 80% or 90% based on the total amount of the composition.

[0239] COMPOSITION EMBODIMENT I' and each and every COMPOSITION EMBODIMENTS B'-H' wherein the compositions comprises (1) HFO-1252zc, (2) one of HFC-263fb or HCFC-262fc, and (3) one or more additional members comprising the compounds identified in Table 1, other than HFO-1252zc, HFC-263fb, and HCFC-262fc, which is present in an amount of between:

- greater than 0 and $\leq$ 10 percent,
- greater than 0 and $\leq$ 8 percent,
- greater than 0 and less than 4 percent,
- greater than 0 and less than 3 percent,
- greater than 0 and less than 2 percent,
- greater than 0 and less than 1 percent,
- greater than 0 and less than 0.5 percent,
- greater than 0 and less than 0.1 percent,
- greater than 0 and less than 0.01 percent,
- greater than 0 and less than 0.005 percent,
- greater than 0.001 and less than 4 percent,
- greater than 0.001 and less than 3 percent,
- greater than 0.001 and less than 2 percent,
- greater than 0.001 and less than 1 percent,
- greater than 0.001 and less than 0.5 percent,
- greater than 0.001 and less than 0.1 percent,
- greater than 0.001 and less than 0.01 percent, or
- greater than 0.001 and less than 0.005 percent;

based on the total amount of the composition *with the proviso* that the total amount of compounds other than HFO-1252zc, HFC-263fb, and HCFC-262fc is greater than 0.0001 and less than 15%, greater than 0.0001 and less than 10%, greater than 0.0001 and less than 8%, greater than 0.0001 and less than 7%, greater than 0.0001 and less than 6%, greater than 0.0001 and less than 5%, greater than 0.0001 and less than 4%, greater than 0.0001 and less than 3%, greater than 0.0001 and less than 2%, greater than 0.0001 and less than 1%, greater than 0.0001 and less than 0.5%, or greater than 0.0001 and less than 0.1%.

[0240] A system and apparatus for process embodiments disclosed herein include first and second discrete reactions zones, vaporizers to preheat reactant feeds, scrubbers to remove inorganic acids, distillation systems to isolate and/or recover intermediate compounds, products, and facilitate recycling of recovered compounds, optionally wherein the system and apparatus for all process embodiments disclosed herein include reactant supplies or and/or form at least one of $\text{CF}_2\text{XCXCH}_3$, $\text{CF}_2\text{XCH}_2\text{CH}_3$ and/or $\text{CF}_2=\text{CHCH}_3$ wherein X is at least one of Cl, F, Br or I; and Y=H, Cl, F, Br or I.

Claim Embodiments (CE):

[0241] Claim Embodiment (CE) 1. A method of producing a compound defined by the formula $\text{CF}_2\text{XCH}_2\text{CH}_3$, wherein X is one of Cl, F, Br, or I, the method comprising contacting a haloolefin defined by the formula $\text{CF}_2\text{XCX}=\text{CH}_2$ with hydrogen to form a first product mixture comprising $\text{CF}_2\text{XCH}_2\text{CH}_3$, wherein X is as defined above and Y is one of H, Cl, F, Br, or I.

[0242] Claim Embodiment (CE) 2. A method of producing 1,1,1-trifluoropropane (HFC-263fb, $\text{CF}_3\text{CH}_2\text{CH}_3$), the method comprising contacting 3,3,3-trifluoropropene (HFO-1243zf, $\text{CF}_3\text{CH}=\text{CH}_2$) with hydrogen to form a first product mixture comprising HFC-263fb.

[0243] Claim Embodiment (CE) 3. A method of producing 1-chloro-1,1-difluoropropane (HCFC-262fc, $\text{CClF}_2\text{CH}_2\text{CH}_3$), the method comprising contacting 3-chloro-3,3-difluoropropene (HCFO-1242zf, $\text{CClF}_2\text{CH}=\text{CH}_2$) with hydrogen to form a first product mixture comprising HCFC-262fc.

[0244] Claim Embodiment (CE) 4. A method of producing 1-chloro-1,1-difluoropropane (HCFC-262fc, $\text{CClF}_2\text{CH}_2\text{CH}_3$), the method comprising contacting 2,3-dichloro-3,3-difluoropropene (HFCO-1232xf, $\text{CClF}_2\text{CCl}=\text{CH}_2$) with hydrogen to form a first product mixture comprising HCFC-262fc.

[0245] Claim Embodiment (CE) 5. The method of any of CEs 1-4 wherein the contacting occurs in the liquid or vapor phase.

[0246] Claim Embodiment (CE) 6. The method of CE 5, wherein the catalyst comprises a hydrogenation catalyst selected from one of iron (Fe), cobalt (Co) and nickel (Ni), ruthenium (Ru), rhodium (Rh) or palladium (Pd) on aluminum oxide, aluminum fluoride or carbon.

[0247] Claim Embodiment (CE) 7. A method of producing 1,1-difluoropropene (HFO-1252zc, $\text{CF}_2=\text{CHCH}_3$), the method comprising dehydrohalogenating a compound defined by the formula $\text{CF}_2\text{XCH}_2\text{CH}_3$, wherein X is one of Cl, F, Br, or I, to form a product mixture comprising HFO-1252zc.

[0248] Claim Embodiment (CE) 8. A method of producing 1,1-difluoropropene (HFO-1252zc, $\text{CF}_2=\text{CHCH}_3$), the method comprising dehydrofluorinating 1,1,1-trifluoropropane (HFC-263fb, $\text{CF}_3\text{CH}_2\text{CH}_3$) to form a product mixture comprising HFO-1252zc.

[0249] Claim Embodiment (CE) 9. A method of producing 1,1-difluoropropene (HFO-1252zc, $\text{CF}_2=\text{CHCH}_3$), the method comprising dehydrochlorinating 1-chloro-1,1-difluoropropane (HCFC-262fc, $\text{CClF}_2\text{CH}_2\text{CH}_3$) to form a product mixture comprising HFO-1252zc.

[0250] Claim Embodiment (CE) 10. The method of any of CEs 7 to 9, wherein the dehydrohalogenation, dehydrofluorination or dehydrochlorination is conducted in the liquid or vapor phase.

[0251] Claim Embodiment (CE) 11. The method of CE 10, wherein the dehydrohalogenation, dehydrofluorination or dehydrochlorination is conducted in the vapor phase by pyrolysis.

[0252] Claim Embodiment (CE) 12. The method of any of CEs 9 to 11, wherein the dehydrochlorination of HCFC-262fc to form HFO-1252zc is conducted in the vapor phase by pyrolysis.

[0253] Claim Embodiment (CE) 13. The method of CE 7, further comprising contacting a (halo)olefin comprising one of 3,3,3-trifluoropropene (HFO-1243zf, $\text{CF}_3\text{CH}=\text{CH}_2$), 3-chloro-3,3-difluoropropene (HCFO-1242zf, $\text{CClF}_2\text{CH}=\text{CH}_2$), or 2,3-dichloro-3,3-difluoropropene (HCFO-1232xf, $\text{CClF}_2\text{CCl}=\text{CH}_2$) with hydrogen to form an intermediate product mixture comprising the $\text{CF}_2\text{XCH}_2\text{CH}_3$ compound.

[0254] Claim Embodiment (CE) 14. A method of producing 1,1-difluoropropene (HFO-1252zc, $\text{CF}_2=\text{CHCH}_3$), the method comprising:

- a. contacting a (halo)olefin comprising one of 3,3,3-trifluoropropene (HFO-1243zf, $\text{CF}_3\text{CH}=\text{CH}_2$), 3-chloro-3,3-difluoropropene (HCFO-1242zf, $\text{CClF}_2\text{CH}=\text{CH}_2$), or 2,3-dichloro-3,3-difluoropropene (HCFO-1232xf, $\text{CClF}_2\text{CCl}=\text{CH}_2$) with hydrogen to form a first product mixture comprising a compound defined by the formula $\text{CF}_2\text{XCH}_2\text{CH}_3$, wherein X is one of Cl, F, Br, or I; and
- b. dehydrohalogenating the $\text{CF}_2\text{XCH}_2\text{CH}_3$ compound of the first mixture to form a second product mixture comprising HFO-1252zc.

[0255] Claim Embodiment (CE) 15. The method of any of CEs 7-14, wherein the dehydrohalogenation is conducted in the vapor phase in the presence or absence of a catalyst or metal alloy packing material.

[0256] Claim Embodiment (CE) 16. The method of any of CEs 7-15, wherein the dehydrohalogenation is conducted in the presence of a catalyst comprising a supported or unsupported partially fluorinated transition metal oxide, nickel-based alloy or nickel-chromium-based alloy.

[0257] Claim Embodiment (CE) 17. The method of any of CEs 7-15, wherein the dehydrohalogenation is conducted by thermal pyrolysis in the absence of a catalyst.

[0258] Claim Embodiment (CE) 18. The method of any of CEs 7-14, wherein the dehydrohalogenation is conducted in the liquid phase.

[0259] Claim Embodiment (CE) 19. The method of any of CEs 7-14 and 18, wherein the dehydrohalogenation is conducted in the presence of a strong base, optionally (1) in the presence or absence of a catalyst, and (2) in the presence or absence of an aprotic solvent.

[0260] Claim Embodiment (CE) 20. The method of CE 19, wherein the base comprises K_{OT}Bu.

[0261] Claim Embodiment (CE) 21. The method of any of CEs 19 to 20, wherein a solvent is present and comprises one of dimethylformamide (DMF), dimethylacetamide (DMAc), dimethyl sulfoxide (DMSO), methyl pyrrolidine (MP) or tert-butyl alcohol, optionally in the presence of a catalyst.

[0262] Claim Embodiment (CE) 22. The method of any of CEs 19 to 21, wherein K_{OT}Bu is continuously added to the mixture to be dehydrohalogenated and/or HFO-1252zc is continuously removed.

[0263] Claim Embodiment (CE) 23. The method of any of CEs 7-14 and 18-22, wherein the liquid phase dehydrohalogenation is conducted at a temperature between about -30°C and about 100°C.

[0264] Claim Embodiment (CE) 24. The method of any of CEs 7-17, wherein the dehydrohalogenation is conducted in the vapor phase at a temperature selected from:

- a. between about 300°C and about 500°C,
- b. between about 400°C and about 700°C, or
- c. between about 450°C and about 750°C.

[0265] Claim Embodiment (CE) 25. The method of CE 24, wherein the dehydrohalogenation is conducted in the presence of a catalyst comprising a supported or unsupported partially fluorinated transition metal oxide, nickel-based or nickel-chromium alloy.

[0266] Claim Embodiment (CE) 26. The method of CE 24, wherein the dehydrohalogenation is conducted in the absence of a catalyst.

[0267] Claim Embodiment (CE) 27. The method of any of CEs 7 and 9 to 26, wherein HCFC-262fc is dehydrochlorinated to HFO-1252zc.

[0268] Claim Embodiment (CE) 28. The method of CE 27, wherein the dehydrochlorination of HCFC-262fc to HFO-1252zc is conducted in the temperature range of about 450°C to about 550°C.

[0269] Claim Embodiment (CE) 29. The method of any of CEs 27 to 28, wherein the dehydrochlorination of HCFC-262fc to HFO-1252zc is conducted in the pressure range of 0 about to about 150 psig.

[0270] Claim Embodiment (CE) 30. The method any of CEs 1 to 6 and 13 to 29, wherein the contacting with hydrogen occurs under hydrogenation conditions.

[0271] Claim Embodiment (CE) 31. The method of any of CEs 1 to 6 and 13 to 30, wherein hydrogenation is conducted in the liquid or vapor phase.

[0272] Claim Embodiment (CE) 32. The method of any of CEs 1 to 6 and 13 to 31, wherein the hydrogenation is conducted in the presence of a catalyst comprising Pd carried on one of aluminum oxide, aluminum fluoride or carbon.

[0273] Claim Embodiment (CE) 33. The method any of CEs 7 to 32, wherein the amount of HFO-1252zc comprises at least one of greater than 10, 15, 20, 25, 30, 35, 40, 50, 60, 70 and 80 percent, based on the total amount of the composition.

[0274] Claim Embodiment (CE) 34. A composition formed by the method of any of CEs 1 to 33.

[0275] Claim Embodiment (CE) 35. A composition comprising HFC-263fb and two or more additional compounds selected from the group consisting of HFC-143a, HFC-152a, HFC-245cb, HFC-254fb, HCFO-1233xf and HCFC-253db.

[0276] Claim Embodiment (CE) 36. The composition of CE 35, wherein the composition contains at least 99 percent HFC-263fb.

[0277] Claim Embodiment (CE) 37. The composition of any of CEs 35 to 36, wherein the total amount of additional compounds is selected from one of between about 0 and about 0.5 percent, between about 0 and about 0.4 percent, between about 0 and about 0.3 percent, between about 0 and about 0.2 percent, between about 0 and about 0.1 percent, and wherein the total amount of the composition is 100 percent.

[0278] Claim Embodiment (CE) 38. A composition comprising,

- a. HFO-1252zc,
- b. HFC-263fb,
- c. HFO-1234yf
- d. optionally at least one compound selected from the group consisting of ethylene, propylene, butylene, allene, and cyclobutene,
- e. optionally at least one compound selected from the group consisting of HFC-23, R-123, HFC-143a, HFC-152a, R-272fb, HFO-374, R1141, HFO-1234yf, HFO-1261, HCFO-1233, HCFO-1251, and HFO-1260; and
- f. optionally at least one compound selected from the group consisting of HFC-23, HFO-1132, HFO-1141, R-125, HFC-143a, HFO-1234yf, HFO-1261, HCFO-1233, HCFO-1251, and HFO-1260.

[0279] Claim Embodiment (CE) 39. The composition of CE 34 comprising,

- a. HFO-1252zc,
- b. HFC-263fb,
- c. at least one compound selected from the group consisting of ethylene, propylene, butylene, allene, and cyclobutene, and,
- d. at least one compound selected from the group consisting of HFC-23, R-123, HFC-143a, HFC-152a, R-272fb, HFO-374, R1141, HFO-1234yf, HFO-1261, HCFO-1233, HCFO-1251, and HFO-1260 or at least one of HFC-23, HFO-1132, HFO-1141, R-125, HFC-143a, R-1243zf, HFO-1234yf, HFO-1261, HCFO-1233, HCFO-1251, and HFO-1260.

[0280] Claim Embodiment (CE) 40. A composition comprising 1,1-difluoropropene (HFO-1252zc) and one or more members selected from the group consisting of trifluoromethane (HFC-23), dichloromethane (HCC-30), chlorofluoromethane (HCFC-31), difluoromethane (HFC-32), ethylene, ethane, chlorodifluoromethane (HCFC-22), methyl chloride (HCC-40), dichloromethane (HCC-30), methane, 1,1,2,2,2-pentafluoroethane (HFC-125), 1,1,2-trifluoroethane (HFC-143), 1,1,1-trifluoroethane (HFC-143a), 1,1,difluoroethane (HFC-152a), 1,1,1,2,2-pentafluoropropane (HFC-245cb), 2-chloro-1,1,1-trifluoropropane (HCFC-253db), 1,1,1,3-tetrafluoropropane (HFC-254fb), 1,1,1-trichloropropane (HCC-260fb), 1,1-dichloro-1-fluoropropane (HCFC-261fc), 1,1-difluoropropane (HFC-272fb), propane

(HC-290), tetrafluorobutene (HFO-374), butane (HC-600), allene, 2-butene, cyclobutene, 2-methylpropene, 1-chloro-2,2-difluoroethylene (HCFO-1122), 1,2-difluoroethene (HFO-1132), 1,1-difluoroethene (HFO-1132a), fluoroethene (HFO-1141), ethylene (HO-1150), 1,1,2-trichloro-3,3,3-trifluoropropene (CFO-1213xa), 2-chloro-3,3,3-trifluoropropene (HCFO-1233xf), 2,3,3,3-tetrafluoropropene (HFO-1234yf), 3-chloro-3,3-difluoropropene (HCFO-1242zf), 3,3,3-trifluoropropene (HFO-1243zf), E-1-chloro-1-fluoro-1-propene (E-HCFO-1251zb), Z-1-chloro-1-fluoro-1-propene (Z-HCFO-1251zb), 3-chloropropene (HCO-1260zf), 3-fluoro-1-propene (HFO-1261zf), E-1-fluoro-1-propene (E-HFO-1261ze), 1-fluoropropane (HFC-281fa), 1,1-difluoropropane (272fb), tetrafluorobutane (C₄H₆F₄), 1252-dimers (C₆F₄H₈), propylene (HO-1270), pentafluorobutene (HFO-1345), and E/Z-t-BuO-CF=CH-CH₃, 1,1,1-trifluoropropane (HFC-263fb), and 1-chloro-1,1,-difluoropropane (HCFC-262fc).

[0281] Claim Embodiment (CE) 41. A composition comprising 1,1-difluoropropene (HFO-1252zc), 3,3,3-trifluoropropene (HFO-1243zf), and one or more members selected from the group consisting of trifluoromethane (HFC-23), dichloromethane (HCC-30), chlorofluoromethane (HCFC-31), difluoromethane (HFC-32), ethylene, ethane, chlorodifluoromethane (HCFC-22), methyl chloride (HCC-40), dichloromethane (HCC-30), methane, 1,1,2,2,2-pentafluoroethane (HFC-125), 1,1,2-trifluoroethane (HFC-143), 1,1,1-trifluoroethane (HFC-143a), 1,1,difluoroethane (HFC-152a), 1,1,1,2,2-pentafluoropropane (HFC-245cb), 2-chloro-1,1,1-trifluoropropane (HCFC-253db), 1,1,1,3-tetrafluoropropane (HFC-254fb), 1,1,1-trichloropropane (HCC-260fb), 1,1-dichloro-1-fluoropropane (HCFC-261fc), 1,1-difluoropropane (HFC-272fb), propane (HC-290), tetrafluorobutene (HFO-374), butane (HC-600), allene, 2-butene, cyclobutene, 2-methylpropene, 1-chloro-2,2-difluoroethylene (HCFO-1122), 1,2-difluoroethene (HFO-1132), 1,1-difluoroethene (HFO-1132a), fluoroethene (HFO-1141), ethylene (HO-1150), 1,1,2-trichloro-3,3,3-trifluoropropene (CFO-1213xa), 2-chloro-3,3,3-trifluoropropene (HCFO-1233xf), 2,3,3,3-tetrafluoropropene (HFO-1234yf), 3-chloro-3,3-difluoropropene (HCFO-1242zf), E-1-chloro-1-fluoro-1-propene (E-HCFO-1251zb), Z-1-chloro-1-fluoro-1-propene (Z-HCFO-1251zb), 3-chloropropene (HCO-1260zf), 3-fluoro-1-propene (HFO-1261zf), E-1-fluoro-1-propene (E-HFO-1261ze), 1-fluoropropane (HFC-281fa), 1,1-difluoropropane (272fb), tetrafluorobutane (C₄H₆F₄), 1252-dimers (C₆F₄H₈),

propylene (HO-1270), pentafluorobutene (HFO-1345), and E/Z-t-BuO-CF=CH-CH₃, 1,1,1-trifluoropropane (HFC-263fb), and 1-chloro-1,1,-difluoropropane (HCFC-262fc).

[0282] Claim Embodiment (CE) 42. A composition comprising 1,1-difluoropropene (HFO-1252zc), E-1-fluoro-1-propene (E-HFO-1261ze), and one or more members selected from the group consisting of trifluoromethane (HFC-23), dichloromethane (HCC-30), chlorofluoromethane (HCFC-31), difluoromethane (HFC-32), ethylene, ethane, chlorodifluoromethane (HCFC-22), methyl chloride (HCC-40), dichloromethane (HCC-30), methane, 1,1,2,2,2-pentafluoroethane (HFC-125), 1,1,2-trifluoroethane (HFC-143), 1,1,1-trifluoroethane (HFC-143a), 1,1,difluoroethane (HFC-152a), 1,1,1,2,2-pentafluoropropane (HFC-245cb), 2-chloro-1,1,1-trifluoropropane (HCFC-253db), 1,1,1,3-tetrafluoropropane (HFC-254fb), 1,1,1-trichloropropane (HCC-260fb), 1,1-dichloro-1-fluoropropane (HCFC-261fc), 1,1-difluoropropane (HFC-272fb), propane (HC-290), tetrafluorobutene (HFO-374), butane (HC-600), allene, 2-butene, cyclobutene, 2-methylpropene, 1-chloro-2,2-difluoroethylene (HCFO-1122), 1,2-difluoroethene (HFO-1132), 1,1-difluoroethene (HFO-1132a), fluoroethene (HFO-1141), ethylene (HO-1150), 1,1,2-trichloro-3,3,3-trifluoropropene (CFO-1213xa), 2-chloro-3,3,3-trifluoropropene (HCFO-1233xf), 2,3,3,3-tetrafluoropropene (HFO-1234yf), 3-chloro-3,3-difluoropropene (HCFO-1242zf), 3,3,3-trifluoropropene (HFO-1243zf), E-1-chloro-1-fluoro-1-propene (E-HCFO-1251zb), Z-1-chloro-1-fluoro-1-propene (Z-HCFO-1251zb), 3-chloropropene (HCO-1260zf), 3-fluoro-1-propene (HFO-1261zf), 1-fluoropropane (HFC-281fa), 1,1-difluoropropane (272fb), tetrafluorobutane (C₄H₆F₄), 1252-dimers (C₆F₄H₈), propylene (HO-1270), pentafluorobutene (HFO-1345), and E/Z-t-BuO-CF=CH-CH₃, 1,1,1-trifluoropropane (HFC-263fb), and 1-chloro-1,1,-difluoropropane (HCFC-262fc).

[0283] Claim Embodiment (CE) 43. A composition comprising 1,1-difluoropropene (HFO-1252zc), 3,3,3-trifluoropropene (HFO-1243zf), E-1-fluoro-1-propene (E-HFO-1261ze), and one or more members selected from the group consisting of trifluoromethane (HFC-23), dichloromethane (HCC-30), chlorofluoromethane (HCFC-31), difluoromethane (HFC-32), ethylene, ethane, chlorodifluoromethane (HCFC-22), methyl chloride (HCC-40), dichloromethane (HCC-30), methane, 1,1,2,2,2-pentafluoroethane (HFC-125), 1,1,2-trifluoroethane (HFC-143), 1,1,1-trifluoroethane (HFC-143a), 1,1,difluoroethane (HFC-152a), 1,1,1,2,2-pentafluoropropane (HFC-245cb), 2-chloro-1,1,1-trifluoropropane (HCFC-253db),

1,1,1,3-tetrafluoropropane (HFC-254fb), 1,1,1-trichloropropane (HCC-260fb), 1,1-dichloro-1-fluoropropane (HCFC-261fc), 1,1-difluoropropane (HFC-272fb), propane (HC-290), tetrafluorobutene (HFO-374), butane (HC-600), allene, 2-butene, cyclobutene, 2-methylpropene, 1-chloro-2,2-difluoroethylene (HCFO-1122), 1,2-difluoroethene (HFO-1132), 1,1-difluoroethene (HFO-1132a), fluoroethene (HFO-1141), ethylene (HO-1150), 1,1,2-trichloro-3,3,3-trifluoropropene (CFO-1213xa), 2-chloro-3,3,3-trifluoropropene (HCFO-1233xf), 2,3,3,3-tetrafluoropropene (HFO-1234yf), 3-chloro-3,3-difluoropropene (HCFO-1242zf), E-1-chloro-1-fluoro-1-propene (E-HCFO-1251zb), Z-1-chloro-1-fluoro-1-propene (Z-HCFO-1251zb), 3-chloropropene (HCO-1260zf), 3-fluoro-1-propene (HFO-1261zf), 1-fluoropropane (HFC-281fa), 1,1-difluoropropane (272fb), tetrafluorobutane (C₄H₆F₄), 1252-dimers (C₆F₄H₈), propylene (HO-1270), pentafluorobutene (HFO-1345), and E/Z-t-BuO-CF=CH-CH₃, 1,1,1-trifluoropropane (HFC-263fb), and 1-chloro-1,1-difluoropropane (HCFC-262fc).

[0284] Claim Embodiment (CE) 44. A composition comprising 1,1-difluoropropene (HFO-1252zc), 1-chloro-1,1-difluoropropane (HCFC-262fc) and one or more members selected from the group consisting of trifluoromethane (HFC-23), dichloromethane (HCC-30), chlorofluoromethane (HCFC-31), difluoromethane (HFC-32), ethylene, ethane, chlorodifluoromethane (HCFC-22), methyl chloride (HCC-40), dichloromethane (HCC-30), methane, 1,1,2,2,2-pentafluoroethane (HFC-125), 1,1,2-trifluoroethane (HFC-143), 1,1,1-trifluoroethane (HFC-143a), 1,1-difluoroethane (HFC-152a), 1,1,1,2,2-pentafluoropropane (HFC-245cb), 2-chloro-1,1,1-trifluoropropane (HCFC-253db), 1,1,1,3-tetrafluoropropane (HFC-254fb), 1,1,1-trichloropropane (HCC-260fb), 1,1-dichloro-1-fluoropropane (HCFC-261fc), 1,1-difluoropropane (HFC-272fb), propane (HC-290), tetrafluorobutene (HFO-374), butane (HC-600), allene, 2-butene, cyclobutene, 2-methylpropene, 1-chloro-2,2-difluoroethylene (HCFO-1122), 1,2-difluoroethene (HFO-1132), 1,1-difluoroethene (HFO-1132a), fluoroethene (HFO-1141), ethylene (HO-1150), 1,1,2-trichloro-3,3,3-trifluoropropene (CFO-1213xa), 2-chloro-3,3,3-trifluoropropene (HCFO-1233xf), 2,3,3,3-tetrafluoropropene (HFO-1234yf), 3-chloro-3,3-difluoropropene (HCFO-1242zf), 3,3,3-trifluoropropene (HFO-1243zf), E-1-chloro-1-fluoro-1-propene (E-HCFO-1251zb), Z-1-chloro-1-fluoro-1-propene (Z-HCFO-1251zb), 3-chloropropene (HCO-1260zf), 3-fluoro-1-propene (HFO-1261zf), E-1-fluoro-1-propene (E-HFO-

1261ze), 1-fluoropropane (HFC-281fa), 1,1-difluoropropane (272fb), tetrafluorobutane (C₄H₆F₄), 1252-dimers (C₆F₄H₈), propylene (HO-1270), pentafluorobutene (HFO-1345), and E/Z-t-BuO-CF=CH-CH₃, and 1,1,1-trifluoropropane (HFC-263fb).

[0285] Claim Embodiment (CE) 45. A composition comprising 1,1-difluoropropene (HFO-1252zc), 1,1,1-trifluoropropane (HFC-263fb) and one or more members selected from the group consisting of trifluoromethane (HFC-23), dichloromethane (HCC-30), chlorofluoromethane (HCFC-31), difluoromethane (HFC-32), ethylene, ethane, chlorodifluoromethane (HCFC-22), methyl chloride (HCC-40), dichloromethane (HCC-30), methane, 1,1,2,2,2-pentafluoroethane (HFC-125), 1,1,2-trifluoroethane (HFC-143), 1,1,1-trifluoroethane (HFC-143a), 1,1-difluoroethane (HFC-152a), 1,1,1,2,2-pentafluoropropane (HFC-245cb), 2-chloro-1,1,1-trifluoropropane (HCFC-253db), 1,1,1,3-tetrafluoropropane (HFC-254fb), 1,1,1-trichloropropane (HCC-260fb), 1,1-dichloro-1-fluoropropane (HCFC-261fc), 1,1-difluoropropane (HFC-272fb), propane (HC-290), tetrafluorobutene (HFO-374), butane (HC-600), allene, 2-butene, cyclobutene, 2-methylpropene, 1-chloro-2,2-difluoroethylene (HCFO-1122), 1,2-difluoroethene (HFO-1132), 1,1-difluoroethene (HFO-1132a), fluoroethene (HFO-1141), ethylene (HO-1150), 1,1,2-trichloro-3,3,3-trifluoropropene (CFO-1213xa), 2-chloro-3,3,3-trifluoropropene (HCFO-1233xf), 2,3,3,3-tetrafluoropropene (HFO-1234yf), 3-chloro-3,3-difluoropropene (HCFO-1242zf), 3,3,3-trifluoropropene (HFO-1243zf), E-1-chloro-1-fluoro-1-propene (E-HCFO-1251zb), Z-1-chloro-1-fluoro-1-propene (Z-HCFO-1251zb), 3-chloropropene (HCO-1260zf), 3-fluoro-1-propene (HFO-1261zf), E-1-fluoro-1-propene (E-HFO-1261ze), 1-fluoropropane (HFC-281fa), 1,1-difluoropropane (272fb), tetrafluorobutane (C₄H₆F₄), 1252-dimers (C₆F₄H₈), propylene (HO-1270), pentafluorobutene (HFO-1345), and E/Z-t-BuO-CF=CH-CH₃, and 1-chloro-1,1-difluoropropane (HCFC-262fc).

[0286] Claim Embodiment (CE) 46. A composition comprising 1,1-difluoropropene (HFO-1252zc) and one or more members selected from the group consisting of ethylene (HO-1150), trifluoromethane (HFC-23), 1,1-dichloroethylene (HCO-1132a), fluoroethane (HFC-1141), 1,1,2,2,2-pentafluoroethane (HFC-125), propane (HC-290), 1,1,2-trifluoroethane (HFC-143), 1,1-difluoropropene (HFO-1252zc), HFO-1234, 1,1-difluoroethane (HFC-152a), 3-fluoro-1-propene (HFO-1261), 1,1,1-

trifluoropropane (HCC-263fb), 1,1,1-trichloroethane (HCC-143a), 3-fluoro-1-propene (HFO-1261), HFO-1252, chloro-3,3,3-trifluoropropene (HCFO-1233), and pentafluorobutene (HFO-374).

[0287] Claim Embodiment (CE) 47. A composition comprising 1,1-difluoropropene (HFO-1252zc) and one or more members selected from the group consisting of ethylene, HFC-23, HFO-1132a, propane, HFO-1234, HFO-1261, HFC-263fb, HFC-143a and HFO-1252 isomers.

[0288] Claim Embodiment (CE) 48. A composition comprising 1,1-difluoropropene (HFO-1252zc) and 1,1,1-trifluoropropane (HFC-263fb), and one or more members selected from the group consisting of ethylene and propane, and an additional member selected from the group consisting of HFC-23, HFO-1132a, HFO-1234, HFO-1261, HFC-263fb, HFC-143a and HFO-1252 isomers.

[0289] Claim Embodiment (CE) 49. A composition comprising 1,1-difluoropropene (HFO-1252zc), HFO-1261, and HFC-263fb.

[0290] Claim Embodiment (CE) 50. The composition of any of CEs 34-49 wherein the amount of 1,1-difluoropropene (HFO-1252zc) comprises at least one of greater than 10, 15, 20, 25, 30, 35, 40, 50, 60, 70 and 80 percent, based on the total amount of the composition.

[0291] Claim Embodiment (CE) 51. The method of any of CEs 14 to 33, wherein unreacted (halo)olefin of step (a) is recycled.

[0292] Claim Embodiment (CE) 52. The method of any of CEs 14 to 33, wherein unreacted $\text{CF}_2\text{XCH}_2\text{CH}_3$ compound of step (b) is recycled.

[0293] Claim Embodiment (CE) 53. The method of any of CEs 14 to 33, further comprising separating the $\text{CF}_2\text{XCH}_2\text{CH}_3$ compound from the first product mixture produced by step (a) prior to dehydrohalogenation of the $\text{CF}_2\text{XCH}_2\text{CH}_3$ compound in step (b).

[0294] Claim Embodiment (CE) 54. A system comprising:

first and second discrete reactions zones, the first reaction zone being configured for hydrogenation in the liquid or vapor phase, and the second reaction zone being configured for dehydrohalogenation in one of a vapor phase

with a catalyst or a metal alloy packing, a vapor phase without catalyst or a metal alloy packing, or a liquid phase,

vaporizers to preheat feeds for said discrete reactions zones,

scrubbers to remove inorganic acids from one of said first and second discrete reactions zones,

optional recycle lines to recycle unreacted feeds to the first and second reaction zones, and

contained supplies of one or more of 1,1,1-trifluoropropene, 3-chloro-3,3-difluoropropene, 2,3-dichloro-3,3-difluoropropene and hydrogen.

[0295] Claim Embodiment (CE) 55. The system of CE 54, further comprising one or more distillation systems to isolate and/or recover compounds comprising 1,1,1-trifluoropropane or 1-chloro-1,1-difluoropropane.

[0296] Claim Embodiment (CE) 56. The system of CE 54, further comprising flow lines for recycling unconverted compounds.

[0297] Claim Embodiment (CE) 57. A composition comprising HCFC-262fc and one or more compounds selected from the group consisting of (a) propane, propylene, HFO-1261, HFO-1252zc, HFC-272fb, HFO-1252zc, HCFO-1251 (I) isomer, HCFO-1251 (II) isomer, HCFC-262 isomer, HCFC-252dc, HCO-1250 and HCC-260, or (b) HFO-1243zf, HFO-1252zc, HFO-1261, HCFO-1242zf, HCFO-1251 (I) isomer, HCFO-1251 (II) isomer, HCFO-1242 isomer, HCFC-262 isomer, HCFO-1232, HCFC-252, HCFC-252dc, HCO-1250 and HCC-260.

[0298] Claim Embodiment (CE) 58. A composition comprising HCFO-1242zf and one or more compounds selected from the group consisting of (a) ethane, HFC-152a, HFO-1243zf, HFO-1252zc, HCFC-253db, HCFC-262fc, HCFO-1242 isomer and HCFO-1232, or (b) HFO-1252zc, HCFC-253db, HCFC-262fc, HCFO-1242 isomer and HCFO-1232.

[0299] Claim Embodiment (CE) 59. A composition comprising HCFC-262fc, HFO-1252zc and one or more compounds selected from the group consisting of methane, ethylene, ethane, HFC-23, HFC-125, HFC-143a, HFO-1141, propane, propylene, HFO-1234yf, allene, C₃H₄F₂, HFO-1261ze-E, HFO-1261ze-Z, HFC-263fb, HCFC-262fc, 2-butene, cyclobutene, 2-methyl-1-propene, HFC-272fb, HCFC-262fc,

HCFO-1233, HCO-1260, HFC-374, HFO-1345 isomer, HCFO-1251zb-E, HCFO-1251zb-Z, HFC-32, HFO-1132a, HCC-40, HCFC-22, HFO-1261ze-E, HFO-1252 isomer, HFC-281fa, HCC-30, C₄H₃ClF₄, HFO-1252-dimers.

[0300] Claim Embodiment (CE) 60. A composition comprising HCFO-1242zf, HFO-1252zc and one or more compounds selected from the group consisting of ethane, HFC-152a, HFO-1243zf, HCFC-253db, HCFC-262fc, HCFO-1242 isomer and HCFO-1232 or (b) HCFC-253db, HCFO-1242 isomer and HCFO-1232.

[0301] Although certain aspects, embodiments and principals have been described above, it is understood that this description is made only way of example and not as limitation of the scope of the invention or appended claims. The foregoing various aspects, embodiments and principals can be used alone and in combinations with each other.

CLAIMS

What is claimed is:

1. A method of producing a compound defined by the formula $\text{CF}_2\text{XCH}_2\text{CH}_3$, the method comprising contacting a haloolefin defined by the formula $\text{CF}_2\text{XCY}=\text{CH}_2$ with hydrogen to form a first product mixture comprising $\text{CF}_2\text{XCH}_2\text{CH}_3$, wherein X is one of Cl, F, Br, or I, and wherein Y is one of H, Cl, F, Br, or I.
2. A method of producing 1,1,1-trifluoropropane (HFC-263fb, $\text{CF}_3\text{CH}_2\text{CH}_3$), the method comprising contacting 3,3,3-trifluoropropene (HFO-1243zf, $\text{CF}_3\text{CH}=\text{CH}_2$) with hydrogen to form a first product mixture comprising HFC-263fb.
3. A method of producing 1-chloro-1,1-difluoropropane (HCFC-262fc, $\text{CClF}_2\text{CH}_2\text{CH}_3$), the method comprising contacting 3-chloro-3,3-difluoropropene (HCFO-1242zf, $\text{CClF}_2\text{CH}=\text{CH}_2$) with hydrogen to form a first product mixture comprising HCFC-262fc.
4. A method of producing 1-chloro-1,1-difluoropropane (HCFC-262fc, $\text{CClF}_2\text{CH}_2\text{CH}_3$), the method comprising contacting 2,3-dichloro-3,3-difluoropropene (HCFO-1232xf, $\text{CClF}_2\text{CCl}=\text{CH}_2$) with hydrogen to form a first product mixture comprising HCFC-262fc.
5. The method of any of claims 1-4 wherein the contacting occurs in the liquid or vapor phase.
6. The method of claim 5, wherein the catalyst comprises a hydrogenation catalyst selected from the group consisting of iron (Fe), cobalt (Co) and nickel (Ni), ruthenium (Ru), rhodium (Rh) or palladium (Pd) on aluminum oxide, aluminum fluoride or carbon.
7. A method of producing 1,1-difluoropropene (HFO-1252zc, $\text{CF}_2=\text{CHCH}_3$), the method comprising dehydrohalogenating a compound defined by the formula $\text{CF}_2\text{XCH}_2\text{CH}_3$, wherein X is one of Cl, F, Br, or I, to form a product mixture comprising HFO-1252zc.

8. A method of producing 1,1-difluoropropene (HFO-1252zc, $\text{CF}_2=\text{CHCH}_3$), the method comprising dehydrofluorinating 1,1,1-trifluoropropane (HFC-263fb, $\text{CF}_3\text{CH}_2\text{CH}_3$) to form a product mixture comprising HFO-1252zc.
9. A method of producing 1,1-difluoropropene (HFO-1252zc, $\text{CF}_2=\text{CHCH}_3$), the method comprising dehydrochlorinating 1-chloro-1,1-difluoropropane (HCFC-262fc, $\text{CClF}_2\text{CH}_2\text{CH}_3$) to form a product mixture comprising HFO-1252zc.
10. The method of any of claims 7 to 9, wherein the dehydrohalogenation, dehydrofluorination or dehydrochlorination is conducted in the liquid or vapor phase.
11. The method of claim 10, wherein the dehydrohalogenation, dehydrofluorination or dehydrochlorination is conducted in the vapor phase by pyrolysis.
12. The method of claim 9, wherein the dehydrochlorination of HCFC-262fc to form HFO-1252zc is conducted in the vapor phase by pyrolysis.
13. The method of claim 7, further comprising contacting a (halo)olefin with hydrogen to form an intermediate product mixture comprising the $\text{CF}_2\text{XCH}_2\text{CH}_3$ compound, the (halo)olefin being selected from the group consisting of 3,3,3-trifluoropropene (HFO-1243zf, $\text{CF}_3\text{CH}=\text{CH}_2$), 3-chloro-3,3-difluoropropene (HCFO-1242zf, $\text{CClF}_2\text{CH}=\text{CH}_2$), and 2,3-dichloro-3,3-difluoropropene (HCFO-1232xf, $\text{CClF}_2\text{CCl}=\text{CH}_2$).
14. A method of producing 1,1-difluoropropene (HFO-1252zc, $\text{CF}_2=\text{CHCH}_3$), the method comprising:
 - a. contacting a (halo)olefin comprising one of 3,3,3-trifluoropropene (HFO-1243zf, $\text{CF}_3\text{CH}=\text{CH}_2$), 3-chloro-3,3-difluoropropene (HCFO-1242zf, $\text{CClF}_2\text{CH}=\text{CH}_2$), or 2,3-dichloro-3,3-difluoropropene (HCFO-1232xf, $\text{CClF}_2\text{CCl}=\text{CH}_2$) with hydrogen to form a first product mixture comprising a compound defined by the formula $\text{CF}_2\text{XCH}_2\text{CH}_3$, wherein X is one of Cl, F, Br, or I; and
 - b. dehydrohalogenating the $\text{CF}_2\text{XCH}_2\text{CH}_3$ compound of the first product mixture to form a second product mixture comprising HFO-1252zc.

15. The method of any of claims 7-14, wherein the dehydrohalogenation is conducted in the vapor phase in the presence or absence of a catalyst or metal alloy packing material.
16. The method of any of claims 7-15, wherein the dehydrohalogenation is conducted in the presence of a catalyst comprising a supported or unsupported partially fluorinated transition metal oxide, nickel-based alloy or nickel-chromium-based alloy.
17. The method of any of claims 7-15, wherein the dehydrohalogenation is conducted by thermal pyrolysis in the absence of a catalyst.
18. The method of any of claims 7-14, wherein the dehydrohalogenation is conducted in the liquid phase.
19. The method of any of claims 7-14 and 18, wherein the dehydrohalogenation is conducted in the presence of a strong base, optionally (1) in the presence or absence of a catalyst, and (2) in the presence or absence of an aprotic solvent.
20. The method of claim 19, wherein the base comprises K_{OT}Bu t-BuOK.
21. The method of any of claims 19 to 20, wherein a solvent is present and comprises one of dimethylformamide (DMF), dimethylacetamide (DMAc), dimethyl sulfoxide (DMSO), methyl pyrrolidine (MP) or tert-butyl alcohol, optionally in the presence of a catalyst.
22. The method of any of claims 19 to 21, wherein K_{OT}Bu is continuously added to the mixture to be dehydrohalogenated and/or HFO-1252zc is continuously removed.
23. The method of any of claims 7-14 and 18-22, wherein the liquid phase dehydrohalogenation is conducted at a temperature between about -30°C and about 100°C.
24. The method of any of claims 7-17, wherein the dehydrohalogenation is conducted in the vapor phase at a temperature selected from:
 - a. between about 300°C and about 500°C,

- b. between about 400°C and about 700°C, or
 - c. between about 450°C and about 750°C.
25. The method of claim 24, wherein the dehydrohalogenation is conducted in the presence of a catalyst comprising a supported or unsupported partially fluorinated transition metal oxide, nickel-based or nickel-chromium alloy.
26. The method of claim 24, wherein the dehydrohalogenation is conducted in the absence of a catalyst.
27. The method of any of claims 7 and 9 to 26, wherein HCFC-262fc is dehydrochlorinated to HFO-1252zc.
28. The method of claim 27, wherein the dehydrochlorination of HCFC-262fc to HFO-1252zc is conducted in the temperature range of about 450°C to about 550°C.
29. The method of any of claims 27 to 28, wherein the dehydrochlorination of HCFC-262fc to HFO-1252zc is conducted in the pressure range of 0 about to about 150 psig.
30. The method any of claims 1 to 6 and 13 to 29, wherein the contacting with hydrogen occurs under hydrogenation conditions.
31. The method of any of claims 1 to 6 and 13 to 30, wherein hydrogenation is conducted in the liquid or vapor phase.
32. The method of any of claims 1 to 6 and 13 to 31, wherein the hydrogenation is conducted in the presence of a catalyst comprising Pd carried on one of aluminum oxide, aluminum fluoride or carbon.
33. The method any of claims 7 to 32, wherein the amount of HFO-1252zc comprises at least one of greater than 10, 15, 20, 25, 30, 35, 40, 50, 60, 70 and 80 percent, based on the total amount of the composition.
34. The method of any of claims 14 to 33, wherein unreacted (halo)olefin of step (a) is recycled.
35. The method of any of claims 14 to 33, wherein unreacted $\text{CF}_2\text{XCH}_2\text{CH}_3$ compound of step (b) is recycled.

36. The method of any of claims 14 to 33, further comprising separating the $\text{CF}_2\text{XCH}_2\text{CH}_3$ compound from the first product mixture produced by step (a) prior to dehydrohalogenation of the $\text{CF}_2\text{XCH}_2\text{CH}_3$ compound in step (b).
37. A composition formed by the method of any of claims 1 to 36.
38. A composition comprising HFC-263fb and one or more additional compounds, preferably two or more additional compounds, selected from the group consisting of HFC-143a, HFC-152a, HFC-245cb, HFC-254fb, HCFO-1233xf and HCFC-253db.
39. The composition of claim 38, wherein the composition contains at least 99 weight percent HFC-263fb.
40. The composition of any of claims 38 to 39, wherein the total amount of additional compounds is selected from one of between about 0 and about 0.5 weight percent, between about 0 and about 0.4 weight percent, between about 0 and about 0.3 weight percent, between about 0 and about 0.2 weight percent, between about 0 and about 0.1 weight percent, and based on a total amount of the composition.
41. A composition comprising,
- HFO-1252zc,
 - HFC-263fb,
 - HFO-1234yf
 - optionally at least one compound selected from the group consisting of ethylene, propylene, butylene, allene, and cyclobutene,
 - optionally at least one compound selected from the group consisting of HFC-23, HCFC-123, HFC-143a, HFC-152a, HFC-272fb, HFO-374, HFO-1141, HFO-1234yf, HFO-1261, HCFO-1233, HCFO-1251, and HFO-1260; and
 - optionally at least one compound selected from the group consisting of HFC-23, HFO-1132, HFO-1141, HFC-125, HFC-143a, HFO-1234yf, HFO-1261, HCFO-1233, HCFO-1251, and HFO-1260.
42. The composition of claim 37 comprising,

- a. HFO-1252zc;
 - b. HFC-263fb;
 - c. at least one compound selected from the group consisting of ethylene, propylene, butylene, allene, and cyclobutene; and
 - d. at least one compound selected from the group consisting of HFC-23, HCFC-123, HFC-143a, HFC-152a, HFC-272fb, HFO-374, HFO-1141, HFO-1234yf, HFO-1261, HCFO-1233, HCFO-1251, and HFO-1260 or at least one compound selected from the group consisting of HFC-23, HFO-1132, HFO-1141, HFC-125, HFC-143a, HFO-1243zf, HFO-1234yf, HFO-1261, HCFO-1233, HCFO-1251, and HFO-1260.
43. A composition comprising 1,1-difluoropropene (HFO-1252zc) and one or more additional compounds selected from the group consisting of trifluoromethane (HFC-23), dichloromethane (HCC-30), chlorodifluoromethane (HCFC-31), difluoromethane (HFC-32), ethylene, ethane, chlorodifluoromethane (HCFC-22), methyl chloride (HCC-40), dichloromethane (HCC-30), methane, 1,1,2,2,2-pentafluoroethane (HFC-125), 1,1,2-trifluoroethane (HFC-143), 1,1,1-trifluoroethane (HFC-143a), 1,1,1-difluoroethane (HFC-152a), 1,1,1,2,2-pentafluoropropane (HFC-245cb), 2-chloro-1,1,1-trifluoropropane (HCFC-253db), 1,1,1,3-tetrafluoropropane (HFC-254fb), 1,1,1-trichloropropane (HCC-260fb), 1,1-dichloro-1-fluoropropane (HCFC-261fc), 1,1-difluoropropane (HFC-272fb), propane (HC-290), tetrafluorobutene (HFO-374), butane (HC-600), allene, 2-butene, cyclobutene, 2-methylpropene, 1-chloro-2,2-difluoroethylene (HCFO-1122), 1,2-difluoroethene (HFO-1132), 1,1-difluoroethene (HFO-1132a), fluoroethene (HFO-1141), ethylene (HO-1150), 1,1,2-trichloro-3,3,3-trifluoropropene (CFO-1213xa), 2-chloro-3,3,3-trifluoropropene (HCFO-1233xf), 2,3,3,3-tetrafluoropropene (HFO-1234yf), 3-chloro-3,3-difluoropropene (HCFO-1242zf), 3,3,3-trifluoropropene (HFO-1243zf), E-1-chloro-1-fluoro-1-propene (E-HCFO-1251zb), Z-1-chloro-1-fluoro-1-propene (Z-HCFO-1251zb), 3-chloropropene (HCO-1260zf), 3-fluoro-1-propene (HFO-1261zf), E-1-fluoro-1-propene (E-HFO-1261ze), 1-fluoropropane (HFC-281fa), 1,1-difluoropropane (272fb), tetrafluorobutane (C₄H₆F₄), 1252-dimers (C₆F₄H₈), propylene (HO-1270), pentafluorobutene (HFO-1345), and E/Z-t-BuO-CF=CH-CH₃, 1,1,1-trifluoropropane (HFC-263fb), and 1-chloro-1,1,1-difluoropropane (HCFC-262fc).

44. A composition comprising 1,1-difluoropropene (HFO-1252zc), 3,3,3-trifluoropropene (HFO-1243zf), and one or more additional compounds selected from the group consisting of trifluoromethane (HFC-23), dichloromethane (HCC-30), chlorofluoromethane (HCFC-31), difluoromethane (HFC-32), ethylene, ethane, chlorodifluoromethane (HCFC-22), methyl chloride (HCC-40), dichloromethane (HCC-30), methane, 1,1,2,2,2-pentafluoroethane (HFC-125), 1,1,2-trifluoroethane (HFC-143), 1,1,1-trifluoroethane (HFC-143a), 1,1,1-difluoroethane (HFC-152a), 1,1,1,2,2-pentafluoropropane (HFC-245cb), 2-chloro-1,1,1-trifluoropropane (HCFC-253db), 1,1,1,3-tetrafluoropropane (HFC-254fb), 1,1,1-trichloropropane (HCC-260fb), 1,1-dichloro-1-fluoropropane (HCFC-261fc), 1,1-difluoropropane (HFC-272fb), propane (HC-290), tetrafluorobutene (HFO-374), butane (HC-600), allene, 2-butene, cyclobutene, 2-methylpropene, 1-chloro-2,2-difluoroethylene (HCFO-1122), 1,2-difluoroethene (HFO-1132), 1,1-difluoroethene (HFO-1132a), fluoroethene (HFO-1141), ethylene (HO-1150), 1,1,2-trichloro-3,3,3-trifluoropropene (CFO-1213xa), 2-chloro-3,3,3-trifluoropropene (HCFO-1233xf), 2,3,3,3-tetrafluoropropene (HFO-1234yf), 3-chloro-3,3-difluoropropene (HCFO-1242zf), E-1-chloro-1-fluoro-1-propene (E-HCFO-1251zb), Z-1-chloro-1-fluoro-1-propene (Z-HCFO-1251zb), 3-chloropropene (HCO-1260zf), 3-fluoro-1-propene (HFO-1261zf), E-1-fluoro-1-propene (E-HFO-1261ze), 1-fluoropropane (HFC-281fa), 1,1-difluoropropane (272fb), tetrafluorobutane (C₄H₆F₄), 1252-dimers (C₆F₄H₈), propylene (HO-1270), pentafluorobutene (HFO-1345), and E/Z-t-BuO-CF=CH-CH₃, 1,1,1-trifluoropropane (HFC-263fb), and 1-chloro-1,1,-difluoropropane (HCFC-262fc).
45. A composition comprising 1,1-difluoropropene (HFO-1252zc), E-1-fluoro-1-propene (E-HFO-1261ze), and one or more additional compounds selected from the group consisting of trifluoromethane (HFC-23), dichloromethane (HCC-30), chlorofluoromethane (HCFC-31), difluoromethane (HFC-32), ethylene, ethane, chlorodifluoromethane (HCFC-22), methyl chloride (HCC-40), dichloromethane (HCC-30), methane, 1,1,2,2,2-pentafluoroethane (HFC-125), 1,1,2-trifluoroethane (HFC-143), 1,1,1-trifluoroethane (HFC-143a), 1,1,1-difluoroethane (HFC-152a), 1,1,1,2,2-pentafluoropropane (HFC-245cb), 2-chloro-1,1,1-trifluoropropane (HCFC-253db), 1,1,1,3-tetrafluoropropane (HFC-

254fb), 1,1,1-trichloropropane (HCC-260fb), 1,1-dichloro-1-fluoropropane (HCFC-261fc), 1,1-difluoropropane (HFC-272fb), propane (HC-290), tetrafluorobutene (HFO-374), butane (HC-600), allene, 2-butene, cyclobutene, 2-methylpropene, 1-chloro-2,2-difluoroethylene (HCFO-1122), 1,2-difluoroethene (HFO-1132), 1,1-difluoroethene (HFO-1132a), fluoroethene (HFO-1141), ethylene (HO-1150), 1,1,2-trichloro-3,3,3-trifluoropropene (CFO-1213xa), 2-chloro-3,3,3-trifluoropropene (HCFO-1233xf), 2,3,3,3-tetrafluoropropene (HFO-1234yf), 3-chloro-3,3-difluoropropene (HCFO-1242zf), 3,3,3-trifluoropropene (HFO-1243zf), E-1-chloro-1-fluoro-1-propene (E-HCFO-1251zb), Z-1-chloro-1-fluoro-1-propene (Z-HCFO-1251zb), 3-chloropropene (HCO-1260zf), 3-fluoro-1-propene (HFO-1261zf), 1-fluoropropane (HFC-281fa), 1,1-difluoropropane (272fb), tetrafluorobutane (C₄H₆F₄), 1252-dimers (C₆F₄H₈), propylene (HO-1270), pentafluorobutene (HFO-1345), and E/Z-t-BuO-CF=CH-CH₃, 1,1,1-trifluoropropane (HFC-263fb), and 1-chloro-1,1,-difluoropropane (HCFC-262fc).

46. A composition comprising 1,1-difluoropropene (HFO-1252zc), 3,3,3-trifluoropropene (HFO-1243zf), E-1-fluoro-1-propene (E-HFO-1261ze), and one or more additional compounds selected from the group consisting of trifluoromethane (HFC-23), dichloromethane (HCC-30), chlorofluoromethane (HCFC-31), difluoromethane (HFC-32), ethylene, ethane, chlorodifluoromethane (HCFC-22), methyl chloride (HCC-40), dichloromethane (HCC-30), methane, 1,1,2,2,2-pentafluoroethane (HFC-125), 1,1,2-trifluoroethane (HFC-143), 1,1,1-trifluoroethane (HFC-143a), 1,1,1-difluoroethane (HFC-152a), 1,1,1,2,2-pentafluoropropane (HFC-245cb), 2-chloro-1,1,1-trifluoropropane (HCFC-253db), 1,1,1,3-tetrafluoropropane (HFC-254fb), 1,1,1-trichloropropane (HCC-260fb), 1,1-dichloro-1-fluoropropane (HCFC-261fc), 1,1-difluoropropane (HFC-272fb), propane (HC-290), tetrafluorobutene (HFO-374), butane (HC-600), allene, 2-butene, cyclobutene, 2-methylpropene, 1-chloro-2,2-difluoroethylene (HCFO-1122), 1,2-difluoroethene (HFO-1132), 1,1-difluoroethene (HFO-1132a), fluoroethene (HFO-1141), ethylene (HO-1150), 1,1,2-trichloro-3,3,3-trifluoropropene (CFO-1213xa), 2-chloro-3,3,3-trifluoropropene (HCFO-1233xf), 2,3,3,3-tetrafluoropropene (HFO-1234yf), 3-chloro-3,3-difluoropropene (HCFO-1242zf), E-1-chloro-1-fluoro-1-propene (E-

HCFO-1251zb), Z-1-chloro-1-fluoro-1-propene (Z-HCFO-1251zb), 3-chloropropene (HCO-1260zf), 3-fluoro-1-propene (HFO-1261zf), 1-fluoropropane (HFC-281fa), 1,1-difluoropropane (272fb), tetrafluorobutane (C₄H₆F₄), 1252-dimers (C₆F₄H₈), propylene (HO-1270), pentafluorobutene (HFO-1345), and E/Z-t-BuO-CF=CH-CH₃, 1,1,1-trifluoropropane (HFC-263fb), and 1-chloro-1,1-difluoropropane (HCFC-262fc).

47. A composition comprising 1,1-difluoropropane (HFO-1252zc), 1-chloro-1,1-difluoropropane (HCFC-262fc) and one or more additional compounds selected from the group consisting of trifluoromethane (HFC-23), dichloromethane (HCC-30), chlorofluoromethane (HCFC-31), difluoromethane (HFC-32), ethylene, ethane, chlorodifluoromethane (HCFC-22), methyl chloride (HCC-40), dichloromethane (HCC-30), methane, 1,1,2,2,2-pentafluoroethane (HFC-125), 1,1,2-trifluoroethane (HFC-143), 1,1,1-trifluoroethane (HFC-143a), 1,1,1-difluoroethane (HFC-152a), 1,1,1,2,2-pentafluoropropane (HFC-245cb), 2-chloro-1,1,1-trifluoropropane (HCFC-253db), 1,1,1,3-tetrafluoropropane (HFC-254fb), 1,1,1-trichloropropane (HCC-260fb), 1,1-dichloro-1-fluoropropane (HCFC-261fc), 1,1-difluoropropane (HFC-272fb), propane (HC-290), tetrafluorobutene (HFO-374), butane (HC-600), allene, 2-butene, cyclobutene, 2-methylpropene, 1-chloro-2,2-difluoroethylene (HCFO-1122), 1,2-difluoroethene (HFO-1132), 1,1-difluoroethene (HFO-1132a), fluoroethene (HFO-1141), ethylene (HO-1150), 1,1,2-trichloro-3,3,3-trifluoropropene (CFO-1213xa), 2-chloro-3,3,3-trifluoropropene (HCFO-1233xf), 2,3,3,3-tetrafluoropropene (HFO-1234yf), 3-chloro-3,3-difluoropropene (HCFO-1242zf), 3,3,3-trifluoropropene (HFO-1243zf), E-1-chloro-1-fluoro-1-propene (E-HCFO-1251zb), Z-1-chloro-1-fluoro-1-propene (Z-HCFO-1251zb), 3-chloropropene (HCO-1260zf), 3-fluoro-1-propene (HFO-1261zf), E-1-fluoro-1-propene (E-HFO-1261ze), 1-fluoropropane (HFC-281fa), 1,1-difluoropropane (272fb), tetrafluorobutane (C₄H₆F₄), 1252-dimers (C₆F₄H₈), propylene (HO-1270), pentafluorobutene (HFO-1345), and E/Z-t-BuO-CF=CH-CH₃, and 1,1,1-trifluoropropane (HFC-263fb).
48. A composition comprising 1,1-difluoropropane (HFO-1252zc), 1,1,1-trifluoropropane (HFC-263fb) and one or more additional compounds selected from the group consisting of trifluoromethane (HFC-23), dichloromethane (HCC-

30), chlorofluoromethane (HCFC-31), difluoromethane (HFC-32), ethylene, ethane, chlorodifluoromethane (HCFC-22), methyl chloride (HCC-40), dichloromethane (HCC-30), methane, 1,1,2,2,2-pentafluoroethane (HFC-125), 1,1,2-trifluoroethane (HFC-143), 1,1,1-trifluoroethane (HFC-143a), 1,1,1-difluoroethane (HFC-152a), 1,1,1,2,2-pentafluoropropane (HFC-245cb), 2-chloro-1,1,1-trifluoropropane (HCFC-253db), 1,1,1,3-tetrafluoropropane (HFC-254fb), 1,1,1-trichloropropane (HCC-260fb), 1,1-dichloro-1-fluoropropane (HCFC-261fc), 1,1-difluoropropane (HFC-272fb), propane (HC-290), tetrafluorobutene (HFO-374), butane (HC-600), allene, 2-butene, cyclobutene, 2-methylpropene, 1-chloro-2,2-difluoroethylene (HCFO-1122), 1,2-difluoroethene (HFO-1132), 1,1-difluoroethene (HFO-1132a), fluoroethene (HFO-1141), ethylene (HO-1150), 1,1,2-trichloro-3,3,3-trifluoropropene (CFO-1213xa), 2-chloro-3,3,3-trifluoropropene (HCFO-1233xf), 2,3,3,3-tetrafluoropropene (HFO-1234yf), 3-chloro-3,3-difluoropropene (HCFO-1242zf), 3,3,3-trifluoropropene (HFO-1243zf), E-1-chloro-1-fluoro-1-propene (E-HCFO-1251zb), Z-1-chloro-1-fluoro-1-propene (Z-HCFO-1251zb), 3-chloropropene (HCO-1260zf), 3-fluoro-1-propene (HFO-1261zf), E-1-fluoro-1-propene (E-HFO-1261ze), 1-fluoropropane (HFC-281fa), 1,1-difluoropropane (272fb), tetrafluorobutane (C₄H₆F₄), 1252-dimers (C₆F₄H₈), propylene (HO-1270), pentafluorobutene (HFO-1345), and E/Z-t-BuO-CF=CH-CH₃, and 1-chloro-1,1,-difluoropropane (HCFC-262fc).

49. A composition comprising 1,1-difluoropropene (HFO-1252zc) and one or more members additional compounds from the group consisting of ethylene (HO-1150), trifluoromethane (HFC-23), 1,1-difluoroethylene (HCO-1132a), fluoroethane (HFC-1141), 1,1,2,2,2-pentafluoroethane (HFC-125), propane (HC-290), 1,1,2-trifluoroethane (HFC-143), 1,1-difluoropropene (HFO-1252zc), HFO-1234, 1,1,1-difluoroethane (HFC-152a), 3-fluoro-1-propene (HFO-1261), 1,1,1-trifluoropropane (HCC-263fb), 1,1,1-trichloroethane (HCC-143a), 3-fluoro-1-propene (HFO-1261), HFO-1252, chloro-3,3,3-trifluoropropene (HCFO-1233), and pentafluorobutene (HFO-374).
50. A composition comprising 1,1-difluoropropene (HFO-1252zc) and one or more additional compounds selected from the group consisting of ethylene, HFC-23,

HFO-1132a, propane, HFO-1234, HFO-1261, HFC-263fb, HFC-143a and HFO-1252 isomers.

51. A composition comprising 1,1-difluoropropene (HFO-1252zc); 1,1,1-trifluoropropane (HFC-263fb); one or more additional compounds selected from the group consisting of ethylene and propane; and one or more additional compounds selected from the group consisting of HFC-23, HFO-1132a, HFO-1234, HFO-1261, HFC-263fb, HFC-143a and HFO-1252 isomers.
52. A composition comprising 1,1-difluoropropene (HFO-1252zc), HFO-1261, and HFC-263fb.
53. The composition of any of claims 37-52, wherein the amount of HFO-1252zc comprises greater than about 10 wt.%, or greater than about 15 wt.%, or greater than about 20 wt.%, or greater than about 25 wt.%, or greater than about 30 wt.%, or greater than about 35 wt.%, or greater than about 40 wt.%, or greater than about 50 wt.%, or greater than about 60 wt.%, or greater than about 70 wt.%, or greater than about 80 wt.%, based on the total amount of the composition.
54. The composition of any of claims 37-53, wherein the total amount of the additional compounds is between about 0 and about 0.5 weight percent, or between about 0 and about 0.4 weight percent, or between about 0 and about 0.3 weight percent, or between about 0 and about 0.2 weight percent, or between about 0 and about 0.1 weight percent, based on a total amount of the composition
55. A system comprising:
 - first and second discrete reactions zones, the first reaction zone being configured for hydrogenation in the liquid or vapor phase, and the second reaction zone being configured for dehydrohalogenation in one of a vapor phase with a catalyst or a metal alloy packing, a vapor phase without catalyst or a metal alloy packing, or a liquid phase,
 - vaporizers to preheat feeds for said discrete reactions zones,
 - scrubbers to remove inorganic acids from one of said first and second discrete reactions zones,

optional recycle lines to recycle unreacted feeds to the first and second reaction zones, and

contained supplies of one or more of 1,1,1-trifluoropropene, 3-chloro-3,3-difluoropropene, 2,3-dichloro-3,3-difluoropropene and hydrogen.

56. The system of claim 55, further comprising one or more distillation systems to isolate and/or recover compounds comprising 1,1,1-trifluoropropane or 1-chloro-1,1-difluoropropane.
57. The system of any of claims 55-56, further comprising flow lines for recycling unconverted compounds.
58. A composition comprising HCFC-262fc and one or more compounds selected from the group consisting of (a) propane, propylene, HFO-1261, HFO-1252zc, HFC-272fb, HFO-1252zc, HCFO-1251 (I) isomer, HCFO-1251 (II) isomer, HCFC-262 isomer, HCFC-252dc, HCO-1250 and HCC-260, or (b) HFO-1243zf, HFO-1252zc, HFO-1261, HCFO-1242zf, HCFO-1251 (I) isomer, HCFO-1251 (II) isomer, HCFO-1242 isomer, HCFC-262 isomer, HCFO-1232, HCFC-252, HCFC-252dc, HCO-1250 and HCC-260.
59. A composition comprising HCFO-1242zf and one or more compounds selected from the group consisting of (a) ethane, HFC-152a, HFO-1243zf, HFO-1252zc, HCFC-253db, HCFC-262fc, HCFO-1242 isomer and HCFO-1232, or (b) HFO-1252zc, HCFC-253db, HCFC-262fc, HCFO-1242 isomer and HCFO-1232.
60. A composition comprising HCFC-262fc, HFO-1252zc and one or more compounds selected from the group consisting of methane, ethylene, ethane, HFC-23, HFC-125, HFC-143a, HFO-1141, propane, propylene, HFO-1234yf, allene, C₃H₄F₂, HFO-1261ze-E, HFO-1261ze-Z, HFC-263fb, HCFC-262fc, 2-butene, cyclobutene, 2-methyl-1-propene, HFC-272fb, HCFC-262fc, HCFO-1233, HCO-1260, HFC-374, HFO-1345 isomer, HCFO-1251zb-E, HCFO-1251zb-Z, HFC-32, HFO-1132a, HCC-40, HCFC-22, HFO-1261ze-E, HFO-1252 isomer, HFC-281fa, HCC-30, C₄H₃ClF₄, HFO-1252-dimers.

60. A composition comprising HCFO-1242zf, HFO-1252zc and one or more compounds selected from the group consisting of ethane, HFC-152a, HFO-1243zf, HCFC-253db, HCFC-262fc, HCFO-1242 isomer and HCFO-1232 or (b) HCFC-253db, HCFO-1242 isomer and HCFO-1232.