

TITLE

PROCESS FOR CO-PRODUCING HFO-E/Z-1132
AND COMPOSITIONS THEREOF

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit of priority of U.S. Provisional Application 63/541,320 filed September 29, 2023, the disclosure of which is incorporated herein by reference in its entirety.

BACKGROUND

[0002] Hydrofluoroolefins (HFOs) having low ozone depletion potential (ODP) and low global warming potential (GWP) have been replacing saturated CFCs (chlorofluorocarbons), HCFCs (hydrochlorofluorocarbons), and HFCs (hydrofluorocarbons) in a variety of applications for several years because saturated hydrohalocarbons tend to have high GWP values. For example, HFC-32 (CH₂F₂), HFC-125 (C₂HF₅), and HFC-134a (CH₂FCF₃) have GWPs of 675, 3500 and 1430, respectively. As a result, low ODP and low GWP materials continue to be of interest for use as refrigerants, solvents, foam expansion agents, cleaning agents, aerosol propellants, dielectrics, fire extinguishants, and power cycle working fluids.

[0003] The regulatory landscape is continuously evolving, taking into consideration properties beyond just ODP and GWP. More particularly, there is a need for refrigerant compositions that not only meet low ODP standards and have low global warming potentials, but that also exhibit low or no flammability, provide superior performance in a variety of applications and which meet the standards of evolving regulations.

[0004] 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.

[0005] In particular, to meet these increasing demands, existing and new haloolefins continue to be developed, evaluated, and produced with more efficient processes. One such candidate is the E- and/or Z-isomers of 1,2-difluoroethylene (HFO-1132). HFO-E-1132 and HFO-Z-1132 are suitable, for example, as blending

components given their environmentally friendly decomposition profiles in the atmosphere. Current processing generally favors the production of the Z-isomer, which requires significant amounts to be isomerized to the E-isomer. Thus, the need for new processes to produce these new candidates remains.

SUMMARY OF THE INVENTION

[0006] The present invention relates to processes for producing the E- and Z-isomers of 1,2-difluoroethylene (HFO-E-1132, HFO-Z-1132), compositions thereof, methods of using and purifying of the same.

[0007] The present invention relates to processes for producing the E- and Z-isomers of 1,2-difluoroethylene, in which the Z/E isomer ratio is at least 1:1, and preferably between 1:1 to 9:1.

[0008] One embodiment disclosed herein relates to a process of making 1,2-difluoroethylene by contacting a 1,2-dichloro-1,2-difluoroethane (HCFC-132) feed with a reducing metal in the liquid phase. In some embodiments, the feed comprises HCFC-132 and at least one additional compound selected from 1,2-difluoroethane (HFC-152, $\text{CH}_2\text{FCH}_2\text{F}$), 1-chloro-1,2-difluoroethane (HCFC-142a, CH_2FCHClF), 1,1-dichloro-1,2-difluoroethane (HCFC-132c, $\text{CH}_2\text{FCCl}_2\text{F}$), 1,2-dichloro-1,1-difluoroethane (HCFC-132b, $\text{CH}_2\text{ClCClF}_2$), 1,1,2-trichloro-1,2-difluoroethane (HCFC-122a, $\text{CHClFCCl}_2\text{F}$) and 1,1,2,2-tetrachloro-1,2-difluoroethane (CFC-112, $\text{CCl}_2\text{FCCl}_2\text{F}$).

[0009] One embodiment disclosed herein relates to a process of making 1,2-difluoroethylene by contacting HCFC-132 with a reducing metal selected from magnesium, zinc, cadmium and combinations thereof.

[0010] One embodiment disclosed herein relates to a process of making 1,2-difluoroethylene by contacting HCFC-132 with a reducing metal, optionally in the presence of an activator selected from bromine, iodine, a bromoalkane, an iodoalkane, a vicinal dibromoalkane, a vicinal diiodoalkane, or a vicinal dihalochlorocarbon.

[0011] One embodiment disclosed herein relates to a process of making 1,2-difluoroethylene by contacting HCFC-132 in the presence of a reducing metal

comprising zinc, optionally in the presence of an activator selected from one of bromine, iodine, bromoethane, iodoethane, 1,2-dibromoethane, 1,2-diiodoethane, or 1,2-dibromotetrachloroethane.

[0012] One embodiment disclosed herein relates to a process of making 1,2-difluoroethylene by contacting HCFC-132 with a reducing metal promoted by an activator in the presence of a solvent selected from a cyclic ether, an acyclic ether, or a polar aprotic solvent.

[0013] One embodiment disclosed herein relates to a process of making 1,2-difluoroethylene by contacting HCFC-132 with a reducing metal promoted by an activator in the presence of an aprotic solvent selected from one of diethyl ether, ethylene glycol dimethyl ether, diethylene glycol dimethyl ether, tetraethylene glycol dimethyl ether, tetrahydrofuran, dioxane, dimethylsulfoxide, N,N-dimethylformamide, and N-methylpyrrolidinone.

[0014] One embodiment disclosed herein relates to a process of making 1,2-difluoroethylene by contacting 1,1,2-trifluoroethane ($\text{CHF}_2\text{CH}_2\text{F}$, HFC-143) in the liquid phase with a base in the presence of one of an aqueous solvent or an aprotic solvent.

[0015] One embodiment disclosed herein relates to a process of making 1,2-difluoroethylene by contacting HFC-143 in the liquid phase, with a base comprising at least one strong base, at a temperature between -20°C and 100°C . Suitable bases include, but are not limited to, an alkali metal or alkaline-earth metal alkoxide, an alkaline or alkaline-earth metal hydride, an organometallic lithium compound, or an alkaline or an alkaline-earth metal amide, wherein the alkaline metal is a Group 1A metal of the Periodic Table excluding hydrogen, and the alkaline-earth metal is a Group 2A metal of the Periodic Table excluding beryllium. Examples of alkaline metal or alkaline-earth metal alkoxide include lithium methoxide, sodium methoxide, sodium ethoxide, potassium tert-butoxide, sodium tert-butoxide, sodium isopropoxide, or magnesium ethoxide. Examples of alkaline or alkaline-earth metal hydrides include lithium hydride, sodium hydride, potassium hydride, or calcium hydride. Examples of organometallic lithium compounds include n-butyl lithium, methyl lithium, or isopropyl lithium. Examples of alkaline or an alkaline-earth metal amides

include lithium dimethylamide, lithium diethylamide, lithium diisopropylamide, or magnesium bis(diisopropylamide).

[0016] One embodiment disclosed herein relates to a process of making 1,2-difluoroethylene by contacting HFC-143 in the liquid phase, in the presence of a base and an aprotic solvent, at a temperature between -20°C and 100°C. Suitable solvents include, but are not limited to ethers (e.g., diethyl ether, ethylene glycol dimethyl ether, diethylene glycol dimethyl ether, tetraethylene glycol dimethyl ether) or cyclic ethers (e.g., tetrahydrofuran, dioxane). Optionally, a catalyst may be added which comprises a crown ether selected from one of 1,4,7,10,13-pentaoxacyclopentadecane (15-crown-5) and 1,4,7,10,13,16-hexaoxacyclooctadecane (18-crown-6) or a cryptand comprising 4,7,13,16,21,24-hexaoxa-1,10-diazabicyclo-(8.8.8)hexacosane (also known as 2,2,2-cryptand).

[0017] One embodiment disclosed herein relates to a process for thermally converting a mixture containing HFO-Z-1132 and HFO-E-1132 isomers to a mixture comprising HFO-Z-1132 and HFO-E-1132 and having a, E/Z molar ratio greater than 1:1 at a temperature range from about 600°C to about 800°C.

[0018] One embodiment disclosed herein relates to a process comprising, consisting essentially of, or consisting of converting a tetrahaloethane composition selected from CHXFCHYF wherein X and Y are independently selected from Cl, Br, or I, and wherein the tetrahaloethane component in the composition is at least 90 weight percent of the total composition, to a mixture of E-1,2-difluoroethylene and Z-1,2-difluoroethylene at a Z:E ratio of >1:1, preferably >1.1:1, more preferably from about 1:1 to about 9:1..

[0019] One embodiment disclosed herein relates to compositions comprising, consisting essentially of, or consisting of HFC-143 and at least one additional compound selected from 1,1,2-trifluoroethylene (HFO-1123), 1,1,2,2-tetrafluoroethane (HFC-134), 1,1,1,2-tetrafluoroethane (HFC-134a), 1,1-difluoroethane (HFC-152a), 1,1,1,3,3,3-hexafluoropropane HFC-236fa), E-1,2-difluoroethylene (HFO-E-1132), Z-1,2-difluoroethylene (HFO-Z-1132), E-1-chloro-1,2-difluoroethylene (HCFO-E-1122a), Z-1-chloro-1,2-difluoroethylene (HCFO-Z-1122a), fluoroethylene (HFO-1141), 1-chloro-1,1,2-trifluoroethane (HCFC-133b), 1-chloro-1,2,2-trifluoroethane (HCFC-133), E-1-chloro-2-fluoroethylene (HCFO-E-

1131), Z-1-chloro-2-fluoroethylene (HCFO-Z-1131), 1-chloro-1-fluoroethane (HCFC-151a), chloroethane (HCC-160) and 1,1,2-trichloro-1,2,2-trifluoroethane (CFC-113) and wherein,

- the amount of 1,2-difluoroethane (HFC-152) is selected from one of <100 ppm, <50 ppm, <10 ppm, <5 ppm, <1 ppm, or <0.1 ppm or equal to 0, and/or
- the amount of additional compounds comprises no more than 2 weight percent of the total amount of the composition.

[0020] Another embodiment disclosed herein relates to a process of contacting a composition comprising, consisting essentially of, or consisting of 1,1,2-trifluoroethane (HFC-143) and at least one additional compound selected from 1,1,2-trifluoroethylene (HFO-1123), 1,1,2,2-tetrafluoroethane (HFC-134), 1,1,1,2-tetrafluoroethane (HFC-134a), 1,1-difluoroethane (HFC-152a), 1,1,1,3,3,3-hexafluoropropane HFC-236fa), E-1,2-difluoroethylene (HFO-E-1132), Z-1,2-difluoroethylene (HFO-Z-1132), E-1-chloro-1,2-difluoroethylene (HCFO-E-1122a), Z-1-chloro-1,2-difluoroethylene (HCFO-Z-1122a), fluoroethylene (HFO-1141), 1-chloro-1,1,2-trifluoroethane (HCFC-133b), 1-chloro-1,2,2-trifluoroethane (HCFC-133), E-1-chloro-2-fluoroethylene (HCFO-E-1131), Z-1-chloro-2-fluoroethylene (HCFO-Z-1131), 1-chloro-1-fluoroethane (HCFC-151a), chloroethane (HCC-160) and 1,1,2-trichloro-1,2,2-trifluoroethane (CFC-113) in the liquid phase, with a base comprising at a temperature between -20°C and 100°C.

[0021] In certain reactions disclosed herein, the feed compositions respectively include HCFC-132 or HFC-143 as the main component and one or more additional compounds, wherein the amount of each of the HCFC-132 and HFC-143 components and corresponding additional compounds is independently selected from one of:

- (a) >95 weight percent main component and <5 weight percent additional compounds, based on the total weight of the composition,
- (b) >96 weight percent main component and <4 weight percent additional compounds, based on the total weight of the composition,
- (c) >97 weight percent main component and <3 weight percent additional compounds, based on the total weight of the composition,

- (d) >98 weight percent main component and <2 weight percent additional compounds, based on the total weight of the composition, and
- (e) >99 weight percent main component and <1 weight percent additional compounds, based on the total weight of the composition.

[0022] Another embodiment disclosed herein relates to compositions comprising, consisting essentially of, or consisting of HFO-E-1132, and one or more additional compounds selected from HFO-Z-1132, (a) acetylene, (b) fluoroacetylene, (c) difluoromethane (HFC-32), (d) 1,1,1,2,2-pentafluoroethane (HFC-125), (e) E-1-chloro-1,2-difluoroethylene (HCFO-E-1122a), (f) Z-1-chloro-1,2-difluoroethylene (HCFO-Z-1122a), (g) 1,1,2-trifluoroethylene (HFO-1123), (h) fluoroethylene (HFO-1141), (i) 1-chloro-1,1,2-trifluoroethane (HCFC-133), (j) 1-chloro-1,1,2-trifluoroethane (HCFC-133b), (k) 1,1-dichloro-2,2,2-trifluoroethane (HCFC-123), (l) 1,2-difluoroethane (HFC-152), (m) 1,1,2-trifluoroethane (HFC-143), (n) fluoromethane (HFC-41), (o) chlorodifluoromethane (HCFC-22), (p) vinyl chloride (HCO-1140), (q) 1-chloro-1,2-difluoroethane (HCFC-142a), (r) 1,1-difluoroethylene (HFO-1132a), (s) 1-chloro-1-fluoroethene (HCFO-1131a), (t) E-1-chloro-2-fluoroethene (HCFO-E-1131), (u) Z-1-chloro-2-fluoroethene (HCFO-Z-1131), and (v) 1-chloro-2,2-difluoroethylene (HCFO-1122) and wherein,

- the total amount of additional compounds comprises no more than 2 weight percent of the total composition, and/or
- the total amount of acetylene and fluoroethylene, if present, is selected from one of <2000 ppm, <1000 ppm, <500 ppm, <400 ppm, <300 ppm, <200 ppm, <100 ppm, <50 ppm, <10 ppm, or <5 ppm, and/or
- the amount of 1,2-difluoroethane (HFC-152), if present, is selected from one of <100 ppm, <50 ppm, <10 ppm, <5 ppm, <1 ppm, or <0.1 ppm, or equal to 0.

[0023] Another embodiment disclosed herein relates to compositions comprising, consisting essentially of, or consisting of HFO-Z-1132, and one or more additional compounds selected from HFO-E-1132, (a) acetylene, (b) fluoroacetylene, (c) difluoromethane (HFC-32), (d) 1,1,1,2,2-pentafluoroethane (HFC-125), (e) E-1-chloro-1,2-difluoroethylene (HCFO-E-1122a), (f) Z-1-chloro-1,2-difluoroethylene (HCFO-Z-1122a), (g) 1,1,2-trifluoroethylene (HFO-1123), (h) fluoroethylene (HFO-

1141), (i) 1-chloro-1,2,2-trifluoroethane (HCFC-133), (j) 1-chloro-1,1,2-trifluoroethane (HCFC-133b), (k) 1,1-dichloro-2,2,2-trifluoroethane (HCFC-123), (l) 1,2-difluoroethane (HFC-152), (m) 1,1,2-trifluoroethane (HFC-143), (n) fluoromethane (HFC-41), (o) chlorodifluoromethane (HCFC-22), (p) vinyl chloride (HCO-1140), (q) 1-chloro-1,2-difluoroethane (HCFC-142a), (r) 1,1-difluoroethylene (HFO-1132a), (s) 1-chloro-1-fluoroethene (HCFO-1131a), (t) E-1-chloro-2-fluoroethene (HCFO-E-1131), (u) Z-1-chloro-2-fluoroethene (HCFO-Z-1131), and (v) 1-chloro-2,2-difluoroethylene (HCFO-1122), wherein,

- the total amount of additional compounds comprises no more than 2 weight percent of the total composition, and/or
- the total amount of acetylene and fluoroethylene, if present, is selected from one of <2000 ppm, <1000pp, <500 ppm, <400 ppm, <300 ppm, <200 ppm, <100 ppm, <50 ppm, <10 ppm, or <5 ppm, and/or
- the amount of 1,2-difluoroethane (HFC-152), if present, is selected from one of <100 ppm, <50 ppm, <10 ppm, <5 ppm, <1 ppm, or <0.1 ppm or equal to 0.

[0024] Another embodiment disclosed herein relates to compositions comprising, consisting essentially of, or consisting of HFO-E-1132 and two or more additional compounds selected from Z-1,2-difluoroethylene (HFO-Z-1132) and (a) acetylene, (b) fluoroacetylene, (c) difluoromethane (HFC-32), (d) 1,1,1,2,2-pentafluoroethane (HFC-125), (e) E-1-chloro-1,2-difluoroethylene (HCFO-E-1122a), (f) Z-1-chloro-1,2-difluoroethylene (HCFO-Z-1122a), (g) 1,1,2-trifluoroethylene (HFO-1123), (h) fluoroethylene (HFO-1141), (i) 1-chloro-1,2,2-trifluoroethane (HCFC-133), (j) 1-chloro-1,1,2-trifluoroethane (HCFC-133b), (k) 1,1-dichloro-2,2,2-trifluoroethane (HCFC-123), (l) 1,2-difluoroethane (HFC-152), (m) 1,1,2-trifluoroethane (HFC-143), (n) fluoromethane (HFC-41), (o) chlorodifluoromethane (HCFC-22), (p) vinyl chloride (HCO-1140), (q) 1-chloro-1,2-difluoroethane (HCFC-142a), (r) 1,1-difluoroethylene (HFO-1132a), (s) 1-chloro-1-fluoroethene (HCFO-1131a), (t) E-1-chloro-2-fluoroethene (HCFO-E-1131), (u) Z-1-chloro-2-fluoroethene (HCFO-Z-1131), and (v) 1-chloro-2,2-difluoroethylene (HCFO-1122), and wherein,

- the total amount of additional compounds comprises no more than 2 weight percent of the total composition, and/or

- the total amount of acetylene and fluoroethylene, if present, is selected from one of <2000 ppm, <1000pp, <500 ppm, <400 ppm, <300 ppm, <200 ppm, <100 ppm, <50 ppm, <10 ppm, or <5 ppm, and/or
- the amount of 1,2-difluoroethane (HFC-152), if present, is selected from one of <100 ppm, <50 ppm, <10 ppm, <5 ppm, <1 ppm, or <0.1 ppm or equal to 0, and/or
- the total amount of HFO-Z-1132 is selected from one of <5000 ppm, <2000 ppm, <1000 ppm, <500 ppm, <100 ppm, <50 ppm, <10 pm, <5 ppm, or <1 ppm.

[0025] Another embodiment disclosed herein relates to compositions comprising, consisting essentially of, or consisting of HFO-E-1132 and one or more additional compounds selected from HFO-1123, acetylene, HFO-Z-1132, HFC-125, HFC-32, HCFO-Z-1122a, HCFO-E-1122a, fluoroethylene (HFO-1141), 1-chloro-1,2,2-trifluoroethane (HCFC-133), 1-chloro-1,1,2-trifluoroethane (HCFC-133b), 1,1-dichloro-2,2,2-trifluoroethane (HCFC-123), 1,2-difluoroethane (HFC-152), 1,1,2-trifluoroethane (HFC-143), fluoromethane (HFC-41), chlorodifluoromethane (HCFC-22), ethylene, 1-chloro-1,2-difluoroethane (HCFC-142a), 1,1-difluoroethylene (HFO-1132a), vinyl chloride (1140), 1-chloro-1-fluoroethene (HCFO-1131a), E-1-chloro-2-fluoroethene (HCFO-E-1131), Z-1-chloro-2-fluoroethene (HCFO-Z-1131), and 1-chloro-2,2-difluoroethylene (HCFO-1122) and wherein,

- the total amount of additional compounds comprises no more than 2 weight percent of the total composition, and/or
- the total amount of acetylene and fluoroethylene, if present, is selected from one of <2000 ppm, <1000pp, <500 ppm, <400 ppm, <300 ppm, <200 ppm, <100 ppm, <50 ppm, <10 ppm, or <5 ppm, and/or
- the amount of 1,2-difluoroethane (HFC-152), if present, is selected from one of <100 ppm, <50 ppm, <10 ppm, <5 ppm, <1 ppm, or <0.1 ppm, or is equal to 0.

[0026] Another embodiment disclosed herein relates to compositions comprising, consisting essentially of, or consisting of HFO-Z-1132 and one or more additional compounds selected from HFO-1123, acetylene, HFO-E-1132, HFC-125, HFC-32,

HCFO-Z-1122a, HCFO-E-1122a, fluoroethylene (HFO-1141), 1-chloro-1,2,2-trifluoroethane (HCFC-133), 1-chloro-1,1,2-trifluoroethane (HCFC-133b), 1,1-dichloro-2,2,2-trifluoroethane (HCFC-123), 1,2-difluoroethane (HFC-152), 1,1,2-trifluoroethane (HFC-143), fluoromethane (HFC-41), chlorodifluoromethane (HCFC-22), ethylene, 1-chloro-1,2-difluoroethane (HCFC-142a), 1,1-difluoroethylene (HFO-1132a), vinyl chloride (1140), 1-chloro-1-fluoroethene (HCFO-1131a), E-1-chloro-2-fluoroethene (HCFO-E-1131), Z-1-chloro-2-fluoroethene (HCFO-Z-1131), and 1-chloro-2,2-difluoroethylene (HCFO-1122) and wherein,

- the amount of additional compounds comprise no more than 2 weight percent of the total composition, and/or
- the total amount of acetylene and fluoroethylene, if present, is selected from one of <2000 ppm, <1000pp, <500 ppm, <400 ppm, <300 ppm, <200 ppm, <100 ppm, <50 ppm, <10 ppm, <5 ppm, and/or
- the amount of 1,2-difluoroethane (HFC-152), if present, is selected from one of <100 ppm, <50 ppm, <10 ppm, <5 ppm, <1 ppm, or <0.1 ppm or equal to 0.

[0027] Another embodiment disclosed herein relates to compositions comprising, consisting essentially of, or consisting of HFO-E-1132 and two or more additional compounds selected from HFO-1123, acetylene, HFO-Z-1132, HFC-125, HFC-32, HCFO-Z-1122a, HCFO-E-1122a, fluoroethylene (HFO-1141), 1-chloro-1,2,2-trifluoroethane (HCFC-133), 1-chloro-1,1,2-trifluoroethane (HCFC-133b), 1,1-dichloro-2,2,2-trifluoroethane (HCFC-123), 1,2-difluoroethane (HFC-152), 1,1,2-trifluoroethane (HFC-143), fluoromethane (HFC-41), chlorodifluoromethane (HCFC-22), ethylene, 1-chloro-1,2-difluoroethane (HCFC-142a), 1,1-difluoroethylene (HFO-1132a), vinyl chloride (1140), 1-chloro-1-fluoroethene (HCFO-1131a), E-1-chloro-2-fluoroethene (HCFO-E-1131), Z-1-chloro-2-fluoroethene (HCFO-Z-1131), and 1-chloro-2,2-difluoroethylene (HCFO-1122), and wherein,

- the total amount of additional compounds comprises no more than 2 weight percent of the total composition, and/or
- the total amount of acetylene and fluoroethylene, if present, is selected from one of <2000 ppm, <1000pp, <500 ppm, <400 ppm, <300 ppm, <200 ppm, <100 ppm, <50 ppm, <10 ppm, <5 ppm, and/or

- the amount of 1,2-difluoroethane (HFC-152), if present, is selected from one of <100 ppm, <50 ppm, <10 ppm, <5 ppm, <1 ppm, or <0.1 ppm, or is equal to 0, and/or
- the total amount of HFO-Z-1132 is selected from one of <5000 ppm, <2000 ppm, <1000 ppm, <500 ppm, <100 ppm, <50 ppm, <10 ppm, or <5 ppm, or <1 ppm.

[0028] Another embodiment disclosed herein relates to compositions comprising, consisting essentially of, or consisting of HFO-Z-1132 and two or more additional compounds selected from HFO-1123, acetylene, HFO-E-1132, HFC-125, HFC-32, HCFO-Z-1122a, HCFO-E-1122a, fluoroethylene (HFO-1141), 1-chloro-1,2,2-trifluoroethane (HCFC-133), 1-chloro-1,1,2-trifluoroethane (HCFC-133b), 1,1-dichloro-2,2,2-trifluoroethane (HCFC-123), 1,2-difluoroethane (HFC-152), 1,1,2-trifluoroethane (HFC-143), fluoromethane (HFC-41), chlorodifluoromethane (HCFC-22), ethylene, 1-chloro-1,2-difluoroethane (HCFC-142a), 1,1-difluoroethylene (HFO-1132a), vinyl chloride (HCO-1140), 1-chloro-1-fluoroethene (HCFO-1131a), E-1-chloro-2-fluoroethene (HCFO-E-1131), Z-1-chloro-2-fluoroethene (HCFO-Z-1131), and 1-chloro-2,2-difluoroethylene (HCFO-1122), and wherein,

- the total amount of additional compounds comprises no more than 2 weight percent of the total composition, and/or
- the total amount of acetylene and fluoroethylene, if present, is selected from one of <2000 ppm, <1000pp, <500 ppm, <400 ppm, <300 ppm, <200 ppm, <100 ppm, <50 ppm, <10 ppm, or <5 ppm, and/or
- the amount of 1,2-difluoroethane (HFC-152), if present, is selected from one of <100 ppm, <50 ppm, <10 ppm, <5 ppm, <1 ppm, or <0.1 ppm, or is equal to 0.

[0029] Another embodiment disclosed herein relates to a composition comprising, consisting essentially of, or consisting of HFO-E-1132 and three or more additional compounds selected from HFO-1141, HFO-1123, acetylene, HFO-Z-1132, HCFO-E-1131, HCFO-Z-1131, HFC-125, HFC-32, HCFO-1131a, HCFO-Z-1122a, HCFO-E-1122a, HCFO-1122, and HCO-1140.

[0030] Another embodiment disclosed herein relates to compositions comprising, consisting essentially of, or consisting of HFO-E-1132, and one or more additional compounds selected from HFO-Z-1132, (a) acetylene, (b) fluoroacetylene, (c) difluoromethane (HFC-32), (d) 1,1,1,2,2-pentafluoroethane (HFC-125), (e) E-1-chloro-1,2-difluoroethylene (HCFO-E-1122a), (f) Z-1-chloro-1,2-difluoroethylene (HCFO-Z-1122a), (g) 1,1,2-trifluoroethylene (HFO-1123), (h) fluoroethylene (HFO-1141), (i) 1-chloro-1,2,2-trifluoroethane (HCFC-133), (j) 1-chloro-1,1,2-trifluoroethane (HCFC-133b), (k) 1,1-dichloro-2,2,2-trifluoroethane (HCFC-123), (l) 1,2-difluoroethane (HFC-152), (m) 1,1,2-trifluoroethane (HFC-143), (n) fluoromethane (HFC-41), (o) chlorodifluoromethane (HCFC-22), (p) 1-chloro-1,2-difluoroethane (HCFC-142a), (q) 1,1-difluoroethylene (HFO-1132a), (r) vinyl chloride (HCO-1140), (s) 1-chloro-1-fluoroethene (HCFO-1131a), (t) E-1-chloro-2-fluoroethene (HCFO-E-1131), (u) Z-1-chloro-2-fluoroethene (HCFO-Z-1131), and (v) 1-chloro-2,2-difluoroethylene (HCFO-1122), and wherein,

- the total amount of additional compounds comprises no more than 2 weight percent of the total composition, and/or
- the total amount of acetylene and fluoroethylene, if present, is selected from one of <2000 ppm, <1000pp, <500 ppm, <400 ppm, <300 ppm, <200 ppm, <100 ppm, <50 ppm, <10 ppm, or <5 ppm, and/or
- the amount of 1,2-difluoroethane (HFC-152), if present, is selected from one of <100 ppm, <50 ppm, <10 ppm, <5 ppm, <1 ppm, or <0.1 ppm, or is equal to 0, and/or
- the total amount of HFO-Z-1132 is selected from one of <5000 ppm, <2000 ppm, <1000 ppm, <500 ppm, <100 ppm, <50 ppm, <10 ppm, or <5 ppm, or <1 ppm.

[0031] Another embodiment disclosed herein relates to compositions comprising, consisting essentially of, or consisting of HFO-Z-1132 and one or more additional compounds selected from HFO-E-1132, (a) acetylene, (b) fluoroacetylene, (c) difluoromethane (HFC-32), (d) 1,1,1,2,2-pentafluoroethane (HFC-125), (e) E-1-chloro-1,2-difluoroethylene (HCFO-E-1122a), (f) Z-1-chloro-1,2-difluoroethylene (HCFO-Z-1122a), (g) 1,1,2-trifluoroethylene (HFO-1123), (h) fluoroethylene (HFO-1141), (i) 1-chloro-1,2,2-trifluoroethane (HCFC-133), (j) 1-chloro-1,1,2-trifluoroethane

(HCFC-133b), (k) 1,1-dichloro-2,2,2-trifluoroethane (HCFC-123), (l) 1,2-difluoroethane (HFC-152), (m) 1,1,2-trifluoroethane (HFC-143), (n) fluoromethane (HFC-41), (o) chlorodifluoromethane (HCFC-22), (p) 1-chloro-1,2-difluoroethane (HCFC-142a), (q) 1,1-difluoroethylene (HFO-1132a), (r) vinyl chloride (HCO-1140), (s) 1-chloro-1-fluoroethene (HCFO-1131a), (t) E-1-chloro-2-fluoroethene (HCFO-E-1131), (u) Z-1-chloro-2-fluoroethene (HCFO-Z-1131), and (v) 1-chloro-2,2-difluoroethylene (HCFO-1122), and wherein,

- the total amount of additional compounds comprises no more than 2 weight percent of the total composition, and/or
- the total amount of acetylene and fluoroethylene is selected from one of <2000 ppm, <1000pp, <500 ppm, <400 ppm, <300 ppm, <200 ppm, <100 ppm, <50 ppm, <10 ppm, <5 ppm, and/or
- the amount of 1,2-difluoroethane (HFC-152) is selected from one of <100 ppm, <50 ppm, <10 ppm, <5 ppm, <1 ppm, or <0.1 ppm, or is equal to 0, and/or
- the total amount of HFO-E-1132 is selected from one of <5000 ppm, <2000 ppm, <1000 ppm, <500 ppm, <100 ppm, <50 ppm, <10 ppm, or <5 ppm, or <1 ppm.

[0032] Another embodiment disclosed herein relates to compositions comprising, consisting essentially of, or consisting of one of HFO-E-1132 and HFO-Z-1132 and one or more, two or more, or three or more additional compounds selected from (a) acetylene, (b) fluoroacetylene, (c) difluoromethane (HFC-32), (d) 1,1,1,2,2-pentafluoroethane (HFC-125), (e) E-1-chloro-1,2-difluoroethylene (HCFO-E-1122a), (f) Z-1-chloro-1,2-difluoroethylene (HCFO-Z-1122a), (g) 1,1,2-trifluoroethylene (HFO-1123), (h) fluoroethylene (HFO-1141), (i) 1-chloro-1,2,2-trifluoroethane (HCFC-133), (j) 1-chloro-1,1,2-trifluoroethane (HCFC-133b), (k) 1,1-dichloro-2,2,2-trifluoroethane (HCFC-123), (l) 1,2-difluoroethane (HFC-152), (m) 1,1,2-trifluoroethane (HFC-143), (n) fluoromethane (HFC-41), (o) chlorodifluoromethane (HCFC-22), (p) 1-chloro-1,2-difluoroethane (HCFC-142a), (q) 1,1-difluoroethylene (HFO-1132a), (r) vinyl chloride (HCO-1140), (s) E-1-chloro-1-fluoroethene (HCFO-1131a), (t) E-1-chloro-2-fluoroethene (HCFO-E-1131), (u) Z-1-chloro-2-fluoroethene (HCFO-Z-1131), and (v) 1-chloro-2,2-difluoroethylene (HCFO-1122), and wherein,

- the total amount of additional compounds comprises no more than 2 weight percent of the total composition, and/or
- the total amount of acetylene and fluoroethylene, if present, is selected from one of <2000 ppm, <1000pp, <500 ppm, <400 ppm, <300 ppm, <200 ppm, <100 ppm, <50 ppm, <10 ppm, or <5 ppm, and/or
- the amount of 1,2-difluoroethane (HFC-152), if present, is selected from one of <100 ppm, <50 ppm, <10 ppm, <5 ppm, <1 ppm, or <0.1 ppm, or is equal to 0, and/or
- the total amount of HFO-Z-1132 is selected from one of <5000 ppm, <2000 ppm, <1000 ppm, <500 ppm, <100 ppm, <50 ppm, <10 ppm, or <5 ppm, or <1 ppm.

[0033] Another embodiment disclosed herein relates to compositions comprising, consisting essentially of, or consisting of HFO-Z-1132, and one or more additional compounds selected from HFO-E-1132, (a) acetylene, (b) fluoroacetylene, (c) difluoromethane (HFC-32), (d) 1,1,1,2,2-pentafluoroethane (HFC-125), (e) E-1-chloro-1,2-difluoroethylene (HCFO-E-1122a), (f) Z-1-chloro-1,2-difluoroethylene (HCFO-Z-1122a), (g) 1,1,2-trifluoroethylene (HFO-1123), (h) fluoroethylene (HFO-1141), (i) 1-chloro-1,2,2-trifluoroethane (HCFC-133), (j) 1-chloro-1,1,2-trifluoroethane (HCFC-133b), (k) 1,1-dichloro-2,2,2-trifluoroethane (HCFC-123), (l) 1,2-difluoroethane (HFC-152), (m) 1,1,2-trifluoroethane (HFC-143), (n) fluoromethane (HFC-41), (o) chlorodifluoromethane (HCFC-22), (p) 1-chloro-1,2-difluoroethane (HCFC-142a), (q) 1,1-difluoroethylene (HFO-1132a), (r) vinyl chloride (HCO-1140), (s) 1-chloro-1-fluoroethene (HCFO-1131a), (t) E-1-chloro-2-fluoroethene (HCFO-E-1131), (u) Z-1-chloro-2-fluoroethene (HCFO-Z-1131), and (v) 1-chloro-2,2-difluoroethylene (HCFO-1122), and wherein,

- the total amount of additional compounds comprises no more than 2 weight percent, 1 weight percent or 0.5 weight percent of the total composition, and/or
- the total amount of acetylene and fluoroethylene, if present, is selected from one of <2000 ppm, <1000pp, <500 ppm, <400 ppm, <300 ppm, <200 ppm, <100 ppm, <50 ppm, <10 ppm, or <5 ppm, and/or

- the amount of 1,2-difluoroethane (HFC-152), if present, is selected from one of <100 ppm, <50 ppm, <10 ppm, <5 ppm, <1 ppm, or <0.1 ppm, or is equal to 0.

[0034] Another embodiment disclosed herein relates to compositions comprising, consisting essentially of, or consisting of HFO-Z-1132, and one or more additional compounds selected from HFO-E-1132, (a) acetylene, (b) fluoroacetylene, (c) difluoromethane (HFC-32), (d) 1,1,1,2,2-pentafluoroethane (HFC-125), (e) E-1-chloro-1,2-difluoroethylene (HCFO-E-1122a), (f) Z-1-chloro-1,2-difluoroethylene (HCFO-Z-1122a), (g) 1,1,2-trifluoroethylene (HFO-1123), (h) fluoroethylene (HFO-1141), (i) 1-chloro-1,2,2-trifluoroethane (HCFC-133), (j) 1-chloro-1,1,2-trifluoroethane (HCFC-133b), (k) 1,1-dichloro-2,2,2-trifluoroethane (HCFC-123), (l) 1,2-difluoroethane (HFC-152), (m) 1,1,2-trifluoroethane (HFC-143), (n) fluoromethane (HFC-41), (o) chlorodifluoromethane (HCFC-22), (p) 1-chloro-1,2-difluoroethane (HCFC-142a), (q) 1,1-difluoroethylene (HFO-1132a), (r) vinyl chloride (HCO-1140), (s) 1-chloro-1-fluoroethene (HCFO-1131a), (t) E-1-chloro-2-fluoroethene (HCFO-E-1131), (u) Z-1-chloro-2-fluoroethene (HCFO-Z-1131), and (v) 1-chloro-2,2-difluoroethylene (HCFO-1122), wherein

- the total amount of additional compounds comprises no more than 2 weight percent of the total composition, and/or
- the total amount of acetylene and fluoroethylene, if present, is selected from one of <2000 ppm, <1000pp, <500 ppm, <400 ppm, <300 ppm, <200 ppm, <100 ppm, <50 ppm, <10 ppm, or <5 ppm, and/or
- the amount of 1,2-difluoroethane (HFC-152), if present, is selected from one of <100 ppm, <50 ppm, <10 ppm, <5 ppm, <1 ppm, or <0.1 ppm, or is equal to 0.

[0035] In certain embodiments disclosed herein, HFO-E-1132 and/or HFO-Z-1132 is blended with at least one of:

- one or more HFC compounds selected from HFC-32, HFC-134, HFC-134a, HFC-125, HFC-152a, HFC-227ea and HFC-1123,
- one or more HFO compounds selected from and HFO-E-1234ze, HFO-Z-1234ze, HFO-1234yf, HFO-Z-1224yd and HFO-E-1336mzz.

[0036] In certain embodiments disclosed herein, HFO-E-1132 and/or HFO-Z-1132 blends containing one or more HFC and/or HFO compounds are used as refrigerants, solvents, foam expansion agents, cleaning agents, aerosol propellants, dielectrics, fire extinguishants, and power cycle working fluids.

[0037] Certain embodiments disclosed herein also relate to a system comprising a reactor configured to produce a product mixture comprising HFO-Z-1132 and HFO-E-1132 and having a Z:E ratio of between about 1:1 and about 9:1. The system further comprises a distillation column downstream of the reactor and a discharge line in flow communication with the reactor and the distillation column. The discharge line is configured to convey the product mixture from the reactor to the distillation column for distillation. The distillation column is configured to produce an overhead stream having a low Z:E isomer ratio and which is removed from the distillation column via an overhead line, and a bottoms stream of a high boiling fraction having a relatively higher Z:E ratio and which is removed from the distillation column via a bottoms line. The system further comprises an isomerization reactor which receives the bottoms stream via the bottoms line and converts, more particularly isomerizes, at least a portion of the Z isomer to the E isomer to produce a stream having a reduced Z:E ratio relative to the bottoms stream. The reduced Z:E ratio stream is then preferably conveyed or recycled to the distillation column via a recycle line in flow communication with the isomerization reactor and the distillation column.

[0038] In some embodiments, the present invention relates to a process comprising forming a composition comprising a mixture of HFO-Z-1132 and HFO-E-1132 and having a Z:E ratio of between about 1:1 and about 9:1. The process further comprises distilling the composition into a first stream and a second stream. The first stream has a low Z:E isomer ratio and is removed from the distillation column as an overhead stream. The second stream comprises a high boiling fraction having a relatively higher Z:E ratio and is removed from the distillation column as a bottoms stream. The process further comprises processing the second stream to convert, more particularly isomerize, at least a portion of the Z isomer to the E isomer to produce a third stream having a reduced Z:E ratio relative to the second stream. The reduced Z:E ratio stream (i.e., the third stream) is then

preferably conveyed or recycled to the distillation column and subjected to further distillation.

[0039] In another embodiment, the present invention relates to systems and processes comprising subjecting a composition comprising HFO-Z-1132 to free radical chlorination in a chlorination reactor which provides a mixture of enantiomers, and feeding the mixture of enantiomers to a dechlorination reactor together with HCFC-132 to effect dechlorination of the HCFC-132 to produce a composition comprising a mixture of HFO-Z-1132 and HFO-E-1132 and having a Z:E ratio of between about 2:1 and about 10:1.

[0040] 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.

BRIEF DESCRIPTION OF THE DRAWING

[0041] Fig. 1 is a schematic flow scheme illustrating the use of an isomerization reactor to alter the Z/E ratio of HFO-1132, according to some embodiments of the present invention; and

[0042] Fig. 2 is a schematic flow scheme illustrating the use of a chlorination reactor to effect free radical chlorination of HFO-Z-1132, according to some embodiments of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

[0043] The present invention relates to processes for producing E-1,2-difluoroethylene (HFO-E-1132) and Z-1,2-difluoroethylene (HFO-Z-1132), compositions comprising HFO-E-1132 and/or HFO-Z-1132, and methods of using such compositions.

[0044] The present invention relates to a process comprising, consisting essentially or, or consisting of converting a tetrahaloethane defined by the formula CHXFCHYF , wherein X and Y are independently selected from Cl, Br, or I, to a mixture of HFO-E-1132 and HFO-Z-1132 at a Z:E ratio of >1:1, preferably >1.1:1, more preferably from about 1:1 to about 9:1.

[0045] Before addressing details of embodiments described herein, some terms are defined or clarified as follows.

[0046] The term "compound" as used herein is meant to include all stereoisomers, geometric isomers, tautomers, and isotopes of the structures or chemical described. Compounds herein identified by name or structure as one particular tautomeric form are intended to include other tautomeric forms unless otherwise specified.

[0047] The term "hydrohaloalkane," as used herein means a molecule containing hydrogen, carbon, fluorine (HFCs) and/or chlorine (HCFCs) and/or bromine and/or iodine, with no carbon-carbon double bond (halo = fluoro, chloro, bromo, iodo). Examples are described throughout the instant specification.

[0048] The term "hydrohaloalkene" is intended to mean a chemical compound selected from the classes of hydrofluoroolefins (HFOs) and hydrochlorofluoroolefins (HCFOs) which include a double bond between adjacent carbon atoms and can contain 1 to 8 carbon atoms.

[0049] The term "isomerization process," as used herein, means a process for changing geometry of a molecule, e.g., from the cis- orientation to the trans- orientation. In an isomerization process the relative ratio of Z and E isomers in a mixture is changed.

[0050] The term "scrubbing" is meant to include any process wherein a mixture of species is contacted with a media in which one or more components of the mixture are selectively removed from the mixture via chemical reaction or dissolution.

[0051] In addition to the reactors disclosed herein, heat exchangers, effluent lines, units associated with mass transfer, contacting vessels (pre-mixers), distillation columns, and feed and material transfer lines associated with reactors, heat

exchangers, vessels, columns, and units that are used in the processes of embodiments disclosed herein should be constructed of materials resistant to corrosion. Preferably, the reactors and components are made of an acid resistant alloy, e.g., nickel, a nickel-based alloys (e.g., Hastelloy®, available from Special Metals Corp.), nickel-chromium alloys commercially available under the trade name of Inconel® (hereafter "Inconel®"), or nickel-copper alloys marketed under the trade name Monel®. Alternatively, containers, piping, or reactors fabricated from less corrosive-resistant metals such as stainless steel or carbon steel may be lined with a fluoropolymer such as poly(tetrafluoroethylene). 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.

[0052] 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).

[0053] 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.

[0054] 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.'

[0055] 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."

[0056] 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.

[0057] Where a range of numerical values is recited herein, unless otherwise stated, the range is intended to include the endpoints thereof, and all integers and fractions within the range. It is not intended that the scope of the invention be limited to the specific values recited when defining a range. Moreover, all ranges set forth herein are intended to include not only the particular ranges specifically described, but also any combination of values therein, including the minimum and maximum values recited.

[0058] 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.

[0059] 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.

[0060] As used herein, the term “substantially free” means that less than about 0.0001 percent by weight is present (1 ppm).

[0061] As used herein the term “about” in certain embodiments can be quantified to mean $\pm 1\%$, $\pm 2\%$, $\pm 3\%$ up to and including $\pm 10\%$ of the stated value, and all whole numbers and fractions therebetween.

[0062] By way of example, mention is made of the following compounds in Table 1.

Table 1

	acetylene	$\text{CH}\equiv\text{CH}$
	fluoroacetylene	$\text{CH}\equiv\text{CF}$
HFC-32	difluoromethane	CH_2F_2
CFC-112	1,1,2,2-tetrachloro-1,2-difluoroethane	$\text{CCl}_2\text{FCCl}_2\text{F}$
HCFC-122a	1,1,2-trichloro-1,2-difluoroethane	$\text{CHClFCCl}_2\text{F}$
HFC-125	1,1,1,2,2-pentafluoroethane	CF_3CHF_2
HCFC-132	1,2-dichloro-1,2-difluoroethane	CHClFCHClF
HCFC-132b	1,2-dichloro-1,1-difluoroethane	$\text{CH}_2\text{ClCClF}_2$
HCFC-132c	1,1-dichloro-1,2-difluoroethane	$\text{CH}_2\text{FCCl}_2\text{F}$
HCFC-133	1-chloro-1,2,2-trifluoroethane	CHClFCHF_2
HCFC-133b	1-chloro-1,1,2-trifluoroethane	$\text{CH}_2\text{FCClF}_2$
HFC-134	1,1,2,2-tetrafluoroethane	CHF_2CHF_2
HCFC-142a	1-chloro-1,2-difluoroethane	$\text{CHClFCH}_2\text{F}$
HFC-143	1,1,2-trifluoroethane	$\text{CHF}_2\text{CH}_2\text{F}$
HFC-152	1,2-difluoroethane	$\text{CH}_2\text{FCH}_2\text{F}$
HCFO-1122	1-chloro-2,2-difluoroethylene	$\text{CHCl}=\text{CF}_2$
HCFO-E-1122a	E-1-chloro-1,2-difluoroethylene	$\text{E-CClF}=\text{CHF}$
HCFO-Z-1122a	Z-1-chloro-1,2-difluoroethylene	$\text{Z-CClF}=\text{CHF}$
HFO-1123	1,1,2-trifluoroethylene	$\text{CF}_2=\text{CHF}$
HCFO-E-1131	E-1-chloro-2-fluoroethylene	$\text{E-CHCl}=\text{CHF}$
HCFO-Z-1131	Z-1-chloro-2-fluoroethylene	$\text{Z-CHCl}=\text{CHF}$
HCFO-1131a	1-chloro-1-fluoroethylene	$\text{CH}_2=\text{CClF}$
HFO-E-1132	E-1,2-difluoroethylene	$\text{E-CHF}=\text{CHF}$
HFO-Z-1132	Z-1,2-difluoroethylene	$\text{Z-CHF}=\text{CHF}$
HFO-1132a	1,1-difluoroethylene	$\text{CH}_2=\text{CF}_2$
HFO-1141	fluoroethylene	$\text{CHF}=\text{CH}_2$
HCO-1140	vinyl chloride	$\text{CH}_2=\text{CHCl}$
HFO-1234yf	2,3,3,3-tetrafluoro-1-propene	$\text{CH}_2=\text{CFCF}_3$

[0063] Some of the compounds present in the compositions of the present invention identified in Table 1 may exist as different configurational isomers or

stereoisomers. The present invention is intended to include all single configurational isomers, single stereoisomers or any combination or mixture thereof. For instance, 1-chloro-1,2-difluoroethylene (HFO-1122a) is meant to represent the cis-isomer (Z), trans-isomer (E), or any combination or mixture of both isomers in any ratio, unless otherwise specified. Single isomers or multiple isomers of the same compound may be used in any proportion, unless otherwise specified.

[0064] Another embodiment disclosed herein relates to a process comprising, consisting essentially of, or consisting of converting HCFC-132 to a mixture of HFO-E-1132 and HFO-Z-1132 at a Z:E ratio of at least 1:1, and preferably between about 1:1 to about 9:1, including but not limited to 2:1, 3:1, 4:1, 5:1, 6:1, 7:1, 8:2 and all values and ranges therebetween.

[0065] Another embodiment disclosed herein relates to a process comprising, consisting essentially of, or consisting of converting HFC-143 to a mixture of HFO-E-1132 and HFO-Z-1132 at a Z:E ratio of at least 1:1, and preferably between about 1:1 to about 9:1, including but not limited to 2:1, 3:1, 4:1, 5:1, 6:1, 7:1, 8:2 and all values and ranges therebetween.

[0066] In certain process embodiments disclosed herein, HCFC-132 or HFC-143 is the main feed or starting component, wherein the amount of each of the HCFC-132 and HFC-143 components and corresponding additional compounds are independently selected from one of:

- >95 weight percent main component and <5 weight percent additional compounds, based on the total weight of the composition,
- >96 weight percent main component and <4 weight percent additional compounds, based on the total weight of the composition,
- >97 weight percent main component and <3 weight percent additional compounds, based on the total weight of the composition,
- >98 weight percent main component and <2 weight percent additional compounds, based on the total weight of the composition, and
- >99 weight percent main component and <1 weight percent additional compounds, based on the total weight of the composition.

[0067] Certain embodiments disclosed herein relate to a process comprising, consisting essentially of or, or consisting of dechlorinating HCFC-132 to form HFO-E-1132, HFO-Z-1132 and mixtures thereof.

[0068] One embodiment disclosed herein relates to a process for increasing the amount of HFO-E-1132 by isomerizing HFO-Z-1132 in a mixture comprising HFO-E-1132 and HFO-Z-1132 at temperatures $\geq$ about 600°C, optionally in the presence of a catalyst, to isomerize at least a portion of the HFO-Z-1132 into HFO-E-1132.

[0069] One embodiment disclosed herein relates to producing an HFO-E-1132 product mixture which comprises acetylene, fluoroethylene in an amount of <2000 ppm, <1000ppm, <500 ppm, <400 ppm, <300 ppm, <200 ppm, <100 ppm, <50 ppm, <10 ppm, <5 ppm, and at least two of the following components: HFO-Z-1132, HCFO-E-1122a, HCFO-Z-1122a, HFC-125, HFC-32, HFO-1123, HFO-1141, HCFO-1131a, HCFO-E-1131, HCFO-Z-1131, HCO-1140, HFC-134, or HCFO-1122, wherein the other components comprise no more than 2 weight percent of the total composition. In one embodiment, the product mixture comprises less than about 1,000 ppm of HFO-Z-1132, preferably less than about 100 ppm of HFO-Z-1132.

[0070] One embodiment disclosed herein relates to composition which comprises, consists essentially of, or consists of HFO-E-1132 and one, two, three, four or five or more other components selected from HFO-Z-1132, E-1-chloro-1,2-difluoroethylene (HCFO-E-1122a), Z-1-chloro-1,2-difluoroethylene (HCFO-Z-1122a), 1,1,1,2,2-pentafluoroethane (HFC-125), difluoromethane (HFC-32), 1,1,2-trifluoroethylene (HFO-1123), 1-chloro-1-fluoroethylene (HCFO-1131a), E-1-chloro-2-fluoroethylene (HCFO-E-1131), Z-1-chloro-2-fluoroethylene (HCFO-Z-1131), 2-chloro-1,1-difluoroethylene, (HCFO-1122), if present, fluoroethylene (HFO-1141) in an amount of <50 ppm, <10 ppm, <5 ppm, <1ppm, or <0.1ppm, and wherein the other components comprise no more than 2 weight percent of the total composition.

[0071] One embodiment disclosed herein relates to composition which comprises, consists essentially of, or consists of HFO-E-1132 and one or more of 1,1,2,2-tetrafluoroethane (HFC-134), 2-chloro-1,1-difluoroethylene (HCFO-1122), E-1-chloro-2-fluoroethene (HCFO-E-1131), Z-1-chloro-2-fluoroethene (HCFO-Z-1131), 1-chloro-1-fluoroethene (HCFO-1131a), and if present, fluoroethylene (HFO-1141) in

an amount of <50 ppm, <10 ppm, <5 ppm, <1ppm, or <0.1ppm, wherein the other components comprise no more than 2 weight percent of the total composition.

[0072] One embodiment disclosed herein relates to HFO-E-1132 compositions which comprise acetylene, fluoroethylene in an amount of <2000 ppm, <1000 ppm, <500 ppm, <400 ppm, <300 ppm, <200 ppm, <100 ppm, <50 ppm, <10 ppm, or <5 ppm, and at least two additional compounds selected from: HFO-Z-1132, HCFO-E-1122a, HCFO-Z-1122a, HFC-125, HFC-32, HFO-1123, HCFO-1131a, HCFO-E-1131, HCFO-Z-1131, HFC-134, HCFO-1122 and if present, fluoroethylene (HFO-1141) and HFO-1140 respectively in an amount of <50 ppm, <10 ppm, <5 ppm, <1 ppm, or <0.1 ppm, wherein the other additional compounds comprise no more than 2 weight percent of the total composition.

[0073] One embodiment disclosed herein relates to producing an HFO-Z-1132 product mixture which comprises acetylene, fluoroethylene in an amount of <2000 ppm, <1000 ppm, <500 ppm, <400 ppm, <300 ppm, <200 ppm, <100 ppm, <50 ppm, <10 ppm, <5 ppm, and at least two of the following components: HFO-E-1132, HCFO-E-1122a, HCFO-Z-1122a, HFC-125, HFC-32, HFO-1123, HCFO-1131a, HCFO-E-1131, HCFO-Z-1131, HFC-134, and HCFO-1122, wherein the amount of other components is selected from one of no more than 2 weight percent of the total composition, <1.5 weight percent of the total composition, <1.0 weight percent of the total composition or 0.5 weight percent of the total composition.

[0074] One embodiment disclosed herein relates to HFO-E-1132 compositions which comprise acetylene, fluoroethylene in an amount of <2000 ppm, <1000 ppm, <500 ppm, <400 ppm, <300 ppm, <200 ppm, <100 ppm, <50 ppm, <10 ppm, or <5 ppm, and at least two additional compounds selected from: HFO-Z-1132, HCFO-E-1122a, HCFO-Z-1122a, HFC-125, HFC-32, HFO-1123, HCFO-1131a, HCFO-E-1131, HCFO-Z-1131, HFC-134, and HCFO-1122, wherein the other additional compounds comprise no more than 2 weight percent of the total composition wherein the amount of additional compounds is selected from one of no more than 2 weight percent of the total composition, <1.5 weight percent of the total composition, <1.0 weight percent of the total composition or 0.5 weight percent of the total composition.

[0075] In certain embodiment disclosed herein isomerization is conducted in the presence of a catalyst or at a temperature between 600°C and 800°C, from one of 600°C, 610°C, 620°C, 630°C, 640°C, 650°C, 660°C, 670°C, 680°C, 690°C to one of 700°C, 710°C, 720°C, 730°C, 740°C, 750°C, 760°C, 770°C, 780°C, 790°C or 800°C, and all values and ranges therebetween including 600°C to 690°C, 610°C to 690°C, 600°C to 680°C, 600°C to 670°C, 600°C to 660°C, 700°C to 800°C, 710°C to 790°C or 800°C, 720°C to 780°C, 790°C or 800°C, or 730°C to 750°C, 760°C, 770°C, 780°C, 790°C or 800°C.

[0076] In certain embodiment disclosed herein catalytic isomerization is conducted in the presence of a catalyst at a temperature between 100°C to about 500°C, including 100°C, 110°C, 120°C, 130°C, 140°C, 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, 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. In some embodiments, the temperature employed ranges from about 150°C to about 400°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, 310°C, 320°C, 330°C, 340°C, 350°C, 360°C, 370°C, 380°C, 390°C, and 400°C, or from about 300°C to about 400°C, including 300°C, 310°C, 320°C, 330°C, 340°C, 350°C, 360°C, 370°C, 380°C, 390°C, 400°C, and all values and ranges therebetween.

[0077] In certain embodiment disclosed herein isomerization is conducted in the presence of a catalyst including but not limited to fluorinated Al_2O_3 or Cr_2O_3 , or mixtures thereof. In some embodiments of this disclosure, a suitable catalyst for the isomerization comprises chromium. In some embodiments of this invention, the catalyst comprises a chromium catalyst obtained by reacting chromium oxide (Cr_2O_3) with hydrogen fluoride to form a chromium oxyfluoride. Typically, a chromium oxyfluoride catalyst is used in a gas phase isomerization process. A suitable catalyst comprising chromium oxyfluoride may further comprise other metals, such as, but not limited to cobalt, manganese, nickel, iron in the form of the metal, oxide, halide, oxyhalide or as other inorganic salts. Supports may be present, such as AlF_3 or carbon. Suitable catalyst compositions also comprise aluminum fluoride and fluorided alumina prepared as disclosed in U.S. Patent No. 5,396,000 which is incorporated in its entirety herein by reference.

[0078] Other suitable catalyst compositions suitable for isomerization include fluorided lanthanum oxide compositions which can be prepared in any manner analogous to those known to the art for the preparation of fluorided alumina. For example, the catalyst composition can be prepared by fluorination of lanthanum oxide impregnated with a solution of catalytic metal(s) (e.g., at least one chromium, nickel, manganese, zinc or cobalt compound) which may be in the form of the oxide, oxyhalide, halide, nitrate, sulfate or other compound of the metal. The halides include fluorides, chlorides and bromides.

[0079] Other suitable catalyst compositions suitable for isomerization can also be prepared by co-precipitation of the catalytic metal and the lanthanum as the hydroxides which are thereafter dried and calcined to form the mixed oxides, a technique well known to the art. Suitable metals for support on trivalent aluminum compounds containing fluoride anion or trivalent lanthanum compounds containing fluoride anion include chromium, magnesium (e.g., magnesium fluoride), Group VIIB metals (e.g., manganese, nickel, cobalt, zinc), and mixtures thereof (e.g., a mixture of chromium and zinc). The total content of catalytic metal(s) for these compositions (e.g., chromium, nickel, zinc, cobalt and/or magnesium) expressed as metal is typically not more than 50% by weight of the catalyst composition, and is preferably not more than 30% by weight of the catalyst composition; and is usually at least about 0.05% by weight of the catalyst composition, and is preferably at least about 0.1% by weight of the catalyst composition. A particularly preferred range is from 0.1 to 10% by weight of the catalyst composition. Preferably, the catalytic metals are present as halides, oxyhalides including mixed halides and oxyhalides such as metal chlorofluorides, and oxides. The preferred catalytic metals include chromium, nickel, zinc, cobalt and magnesium. Catalysts containing chromium or magnesium are especially preferred. Of note are cobalt- and nickel-substituted chromium oxide catalysts prepared according to U.S. 7,217,678 which is incorporated in its entirety herein by reference. The metal oxide catalysts are typically pre-fluorinated with a fluorinating agent such as hydrogen fluoride at temperatures which are increased from about 50°C to about 300°C prior to use.

[0080] Referring to Fig. 1, certain embodiments disclosed herein also relate to a system 10 comprising a reactor 12 configured to produce a product mixture comprising HFO-Z-1132 and HFO-E-1132 and having a Z:E ratio of between about

1:1 and about 9:1, for example by reaction of HCFC-132 with a reducing metal promoted by an activator in the presence of a solvent or by reaction of HFC-143 in the liquid phase with a base in the presence of a solvent. The system 10 further comprises a distillation column 14 downstream of the reactor 12 and a discharge line 16 in flow communication with the reactor and the distillation column. The discharge line 16 is configured to convey the product mixture from the reactor 12 to the distillation column 14 for distillation of the product mixture. Distillation of the product mixture in the distillation column 14 produces an overhead stream having a low Z:E isomer ratio and which is removed from the distillation column 14 via an overhead line 18, and a bottoms stream of a high boiling fraction having a relatively higher Z:E ratio and which is removed from the distillation column 14 via a bottoms line 20. For example, the overhead stream may have a Z:E isomer ratio of about 0.01:1 to about 0.1:1, while the bottoms stream may have a Z:E isomer ratio of about 10:1 to about 100:1. The system 10 further comprises an isomerization reactor 22 which receives the bottoms stream via the bottoms line 20 and converts, more particularly isomerizes, at least a portion of the Z isomer to the E isomer to produce a stream having a reduced Z:E ratio relative to the bottoms stream. For example, the stream produced by the isomerization reactor 22 may have a Z:E isomer ratio of about 1:1 to about 10:1. The reduced Z:E ratio stream is then preferably conveyed or recycled to the distillation column 14 via a recycle line 24 in flow communication with the isomerization reactor 22 and the distillation column 14.

[0081] Similarly, in some embodiments, referring to Fig. 1, the present invention relates to a process comprising forming a composition comprising a mixture of HFO-Z-1132 and HFO-E-1132 and having a Z:E ratio of between about 1:1 and about 9:1. The process further comprises distilling the composition into a first stream and a second stream. The first stream has a low Z:E isomer ratio, for example a Z:E isomer ratio of about 0.01:1 to about 0.1:1, and is removed from the distillation column as an overhead stream. The second stream comprises a high boiling fraction having a relatively higher Z:E ratio, for example a Z:E isomer ratio of about 10:1 to about 100:1, and is removed from the distillation column as a bottoms stream. The process further comprises processing the second stream to convert, more particularly isomerize, at least a portion of the Z isomer to the E isomer to produce a third stream having a reduced Z:E ratio relative to the second stream, for

example a Z:E isomer ratio of about 1:1 to about 10:1. The reduced Z:E ratio stream (i.e., the third stream) is then preferably conveyed or recycled to the distillation column and subjected to further distillation.

[0082] In another embodiment, as shown in Fig. 2, the present invention relates to a system comprising a reactor 32 configured to produce a product mixture comprising HFO-Z-1132 and HFO-E-1132 and having a Z:E ratio of between about 1:1 and about 10:1, preferably from about 2:1 to about 10:1, for example by dechlorination of HCFC-132. The system may optionally comprise an upstream reactor 34 for synthesis of feed material for the downstream reactor 32, such as synthesis of HCFC-132 via various reaction scenarios, and a transfer line 36 configured to convey the mixture synthesized in upstream reactor 34 to downstream reactor 32. In one embodiment, in the reactor 32, HCFC-132 is contacted with a reducing metal promoted by an activator in the presence of a solvent, provided to the reactor via a line 38, to effect dechlorination of the HCFC-132 to produce a product mixture comprising HFO-Z-1132 and HFO-E-1132 and having a Z:E ratio of between about 1:1 and about 10:1, preferably from about 2:1 to about 10:1, and zinc chloride which is removed from the reactor via a line 40. The system further comprises a distillation column 42 downstream of the reactor 32 and a discharge line 44 in flow communication with the reactor 32 and the distillation column 42. The discharge line 44 is configured to convey the product mixture from the reactor 32 to the distillation column 42 for distillation of the product mixture. Distillation of the product mixture in the distillation column 42 produces an overhead stream having a low Z:E isomer ratio and which is removed from the distillation column 42 via an overhead line 46, and a bottoms stream of a high boiling fraction having a relatively higher Z:E ratio and which is removed from the distillation column 42 via a bottoms line 48. For example, the overhead stream may have a Z:E isomer ratio of about 0.01:1 to about 0.1:1, while the bottoms stream may have a Z:E isomer ratio of about 10:1 to about 100:1. The system further comprises a chlorination reactor 50 which receives the bottoms stream via the bottoms line 48 and subjects the Z-isomer rich bottoms stream to effect free radical chlorination by contact with chloride optionally in the presence of an initiator, which produces a mixture of dl/meso-HCFC-132 enantiomers. The system further optionally comprises a recycle line 52 to convey

the mixture of dl/meso-HCFC-132 enantiomers from the chlorination reactor 50 to the reactor 32 for synthesis of HFO-E-1132 and HFO-Z-1132.

[0083] Similarly, in some embodiments, as shown in Fig. 2, the present invention relates to a process comprising producing a product mixture comprising HFO-Z-1132 and HFO-E-1132 and having a Z:E ratio of between about 1:1 and about 10:1, preferably from about 2:1 to about 10:1, in the reactor 32, for example by dechlorination of HCFC-132. The process may optionally comprise synthesis of the feed material for the downstream reactor 32 in an upstream reactor 34, such as synthesis of HCFC-132 via various reaction scenarios, and conveying the mixture synthesized in upstream reactor 34 to downstream reactor 32 via transfer line 36. In one embodiment, in the reactor 32, HCFC-132 is contacted with a reducing metal promoted by an activator in the presence of a solvent, provided to the reactor via a line 38, to effect dechlorination of the HCFC-132 to produce a product mixture comprising HFO-Z-1132 and HFO-E-1132 and having a Z:E ratio of between about 1:1 and about 10:1, preferably from about 2:1 to about 10:1, and zinc chloride which is removed from the reactor 32 via a line 40. The process further comprises distillation of the product mixture in a distillation column 42 downstream of the reactor 32 to produce an overhead stream having a low Z:E isomer ratio which is removed from the distillation column 42 via an overhead line 46, and a bottoms stream of a high boiling fraction having a relatively higher Z:E ratio which is removed from the distillation column 42 via a bottoms line 48. For example, the overhead stream may have a Z:E isomer ratio of about 0.01:1 to about 0.1:1, while the bottoms stream may have a Z:E isomer ratio of about 10:1 to about 100:1. The process further comprises subjecting the Z-isomer rich bottoms stream to free radical chlorination by contact with chloride optionally in the presence of an initiator, which produces a mixture of dl/meso-HCFC-132 enantiomers, and optionally recycling of the mixture of dl/meso-HCFC-132 enantiomers to the reactor 32 for synthesis of HFO-E-1132 and HFO-Z-1132.

EXAMPLES

Example 1:

[0084] HCFC-132 was prepared by chlorination of HFC-152 as reported by Nappa and Sievert (*J. Fluorine Chem.*, Vol. 62, pages 111-118 (1993)).

[0085] Preferred reducing metals for the process of the invention may include a reducing or dehalogenating metal such as zinc, magnesium, or cadmium. Optionally, the reducing metal may be promoted with a metal chloride such as ZnCl_2 , MgCl_2 , or CdCl_2 . The reducing metal is preferably activated. Activation of the reducing metal may be carried out by washing the reducing metal with aqueous hydrochloric acid having a concentration of 1M to about 5M followed by washing with water and acetone and vacuum drying. Other activators suitable for the process of the invention include bromine (Br_2), iodine (I_2), bromoalkanes (e.g., bromoethane), iodoalkanes (e.g., iodomethane), vicinal dibromoalkanes (e.g., 1,2-dibromoethane), vicinal diiodoalkanes (e.g., 1,2-diiodoethane), or vicinal dibromochlorocarbons (e.g., 1,2-dibromotetrachloroethane).

[0086] A reactive reducing metal may be generated by reaction of a metal chloride with an alkali metal such as sodium or potassium as generally described by R. D. Rieke in *Topics in Current Chemistry*, Vol. 59, pages 1-31 (1975) the teachings of which are incorporated by reference. Dehalogenation is typically conducted in a non-reactive solvent such as dimethylsulfoxide, N,N-dimethylformamide, N-methylpyrrolidinone, diethyl ether, tetrahydrofuran, dioxane, ethylene glycol dimethyl ether, diethylene glycol dimethyl ether, or dimethyl carbonate. The amount of solvent employed in the dehalogenation may vary from about 25 weight % to about 90 weight % of the total reaction mass. The reducing metal is typically suspended in the solvent under an atmosphere of nitrogen with rapid stirring. The amount of reducing metal employed is typically at least one mole per mole of HCFC-132 (1,2-dichloro-1,2-difluoroethane), to about eight moles, preferably from about two moles to about six moles of reducing metal for each mole of HCFC-132 to be dehalogenated. The HCFC-132 is then added to the dehalogenation reagent suspension and the reaction mixture is then heated with rapid stirring to a temperature of from about 20°C to about 120°C, preferably from about 40°C to about 100°C. Typically, the desired HFO-E/Z-1132 product boils out of the reaction as it is formed and is collected by

condensation in a suitable trap or vessel. Scrubbing isolated HFO-E-1132 or HFO-Z-1132 products to remove acetylene or vinyl fluoride may be carried as described herein. Final purification may be effected by distillation using methods well-known to those skilled in the art.

[0087] A 500 mL three-neck round bottom flask is equipped with a large stirring bar, a thermocouple well, an addition funnel, and a condenser connected in series to two traps resting in a dry ice/acetone bath followed by a nitrogen bubbler. The flask is charged with magnesium powder (9.0 g, 0.37 mole) and tetrahydrofuran (222.2 g) followed by a crystal of iodine as a magnesium activator. The addition funnel is charged with 1,2-dichloro-1,2-difluoroethane (42.0 g, 0.31 mole). The 1,2-dichloro-1,2-difluoroethane is added dropwise to the magnesium/THF mixture at an initial temperature of 22.6°C. After about 10 minutes, the temperature rises to about 42°C; the exotherm is regulated to within 40-47°C using an ice-water bath. The volatile reaction products (11.6 g) are collected in a cylinder. Analysis of the collected product by gas chromatography indicates it is about 67% HFO-Z-1132, 27% HFO-E-1132, 4% acetylene, 0.6% E/Z-1-chloro-2-fluoroethene, and 2% tetrahydrofuran. Other low-level impurities are ethylene, ethane, vinyl fluoride, and 1-chloro-1-fluoroethene.

Example 2:

[0088] A 500 mL three-neck round bottom flask is equipped with a large stirring bar, a thermocouple well, an addition funnel, and a condenser connected in series to two traps resting in a dry ice/acetone bath followed by a nitrogen bubbler. The flask is charged with HCl-washed zinc powder (24 g, 0.37 mole) and tetrahydrofuran (222 g). The addition funnel is charged with 1,2-dichloro-1,2-difluoroethane (42.0 g, 0.31 mole). The 1,2-dichloro-1,2-difluoroethane is added dropwise to the zinc/THF mixture at an initial temperature of 22.6°C. After about 10 minutes, the temperature rises to about 40°C; the exotherm is regulated an ice-water bath. The volatile reaction products (11 g) are collected in a cylinder. Analysis of the collected product by gas chromatography indicates that it is about 60% HFO-Z-1132, 30% HFO-E-1132, 4% acetylene, 1% E/Z-1-chloro-2-fluoroethene, and 1% tetrahydrofuran. Other low-level impurities are ethylene, ethane, vinyl fluoride, and 1-chloro-1-fluoroethene.

Example 3:

[0089] A mixture of CF_2HCFH_2 (84 g, 1 mol) and potassium tert-butoxide (80 g, 1 mmol) in anhydrous N,N-dimethylformamide (200 ml) is stirred in a 400 mL autoclave at 0°C . Gas chromatography is used to monitor the reaction. After 3 hours, 43 g product $\text{CFH}=\text{CFCH}$ (conversion 70%, selectivity 96%) is collected in dry ice trap. The ratio of HFO-Z-1132 to HFOE-1132 is about 9:1. In addition to unconverted HFC-143, other low-level impurities including $\text{CFH}=\text{CH}(\text{O-tert-C}_4\text{H}_9)$ (E, Z isomer), 1132a, acetylene, and fluoroacetylene.

Example 4:

[0090] A mixture of HFO-Z-1132 and HFO-E-1132 having a E/Z molar ratio of 1/100 is passed into a Hastelloy™ C tube (0.5-inch OD, 10-inch length, 0.35 in wall thickness) resting in an electrically heated tube furnace. The heated zone is held at a temperature between 600°C and 800°C with a residence time sufficient to produce a mixture of HFO-Z-1132 and HFO-E-1132 in which the Z/E ratio mixture of HFO-Z-1132 and HFO-E-1132 is at least 1:1, and between 1:1 to 9:1, including 1.2:1, 1.5:1, 1.6:1, 1.8:1, 1.9:1, 2.0:1, 3.0:1, 4.0:1, 5.0:1, 6.0:1, 7.1:0, 8.0:1 or 9.0:1, and all values and ranges between 1:1 to 9:1.

[0091] An Hastelloy™ C tube resting in a Lindberg furnace (0.5-inch OD, 15-inch length, 0.34 in wall thickness) is filled with 12 cc of Cr_2O_3 catalyst. The catalyst is activated with anhydrous HF at 300°C . A mixture of HFO-Z-1132 and HFO-E-1132 having a E/Z molar ratio of 1:100 is passed into the tube at a flow rate of 20 cc/min ($3.3(10)^{-7}\text{m}^3/\text{sec}$) along with a nitrogen co-feed of 20 cc/min. At a reaction zone temperature of 350°C , a new mixture of HFO-Z-1132 and HFO-E-1132 in which the Z/E ratio varies from about 1:1 to 9:1.

[0092] 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.

OTHER EMBODIMENTS:

[0093] Embodiments disclosed herein relate to compositions which comprise HFO-E-1,2-difluoroethylene (HFO-E-1132) containing two or more of the following additional compounds: HFO-Z-1,2-difluoroethylene (HFO-Z-1132), acetylene, fluoroacetylene, fluoroethylene (HFO-1141), E-1-chloro-2-fluoroethylene (HCFO-E-1131), E-1-chloro-1,2-difluoroethylene (HCFO-E-1122a), Z-1-chloro-1,2-difluoroethylene (HCFO-Z-1122a), as well as (a) 1-chloro-1,2,2-trifluoroethane (HCFC-133), (b) 1-chloro-1,1,2-trifluoroethane (HCFC-133b), (c) 1,1-dichloro-2,2,2-trifluoroethane (HCFC-123), (d) 1,2-difluoroethane (HFC-152), (e) 1,1,2-trifluoroethane (HFC-143), (f) fluoromethane (HFC-41), (g) chlorodifluoromethane (HCFC-22), (h) ethylene, (i) 1-chloro-1,2-difluoroethane (HCFC-142a), (j) 1,1-difluoroethylene (HFO-1132a), (k) vinyl chloride (HCO-1140), (l) 1-chloro-1-fluoroethene (HCFO-1131a), (m) E-1-chloro-2-fluoroethene (HCFO-E-1131), (n) Z-1-chloro-2-fluoroethene (HCFO-Z-1131), or (o) 1-chloro-2,2-difluoroethylene (HCFO-1122) wherein the amount of additional compounds is selected from one of no more than 2 weight percent of the total composition, <1.5 weight percent of the total composition, <1.0 weight percent of the total composition or 0.5 weight percent of the total composition.

[0094] Embodiments disclosed herein relate to compositions which comprise E-1,2-difluoroethylene (HFO-E-1132) containing three or more of the following additional compounds: Z-1,2-difluoroethylene (HFO-Z-1132), acetylene, fluoroacetylene, fluoroethylene (HFO-1141), E-1-chloro-2-fluoroethylene (HCFO-E-1131), E-1-chloro-1,2-difluoroethylene (HCFO-E-1122a), Z-1-chloro-1,2-difluoroethylene (HCFO-Z-1122a), as well as (a) 1-chloro-1,2,2-trifluoroethane (HCFC-133), (b) 1-chloro-1,1,2-trifluoroethane (HCFC-133b), (c) 1,1-dichloro-2,2,2-trifluoroethane (HCFC-123), (d) 1,2-difluoroethane (HFC-152), (e) 1,1,2-trifluoroethane (HFC-143), (f) fluoromethane (HFC-41), (g) chlorodifluoromethane (HCFC-22), (h) ethylene, (i) 1-chloro-1,2-difluoroethane (HCFC-142a), (j) 1,1-difluoroethylene (HFO-1132a), (k) vinyl chloride (HCO-1140), (l) 1-chloro-1-fluoroethene (HCFO-1131a), (m) E-1-chloro-2-fluoroethene (HCFO-E-1131), (n) Z-1-

chloro-2-fluoroethene (HCFO-Z-1131), or (o) 1-chloro-2,2-difluoroethylene (HCFO-1122) wherein the amount of additional compounds is selected from one of no more than 2 weight percent of the total composition, <1.5 weight percent of the total composition, <1.0 weight percent of the total composition or 0.5 weight percent of the total composition.

[0095] Embodiments disclosed herein relate to compositions which comprise HFO-Z-1,2-difluoroethylene (HFO-Z-1132) containing two or more of the following additional compounds: HFO-E-1,2-difluoroethylene (HFO-E-1132) acetylene, fluoroacetylene, fluoroethylene (HFO-1141), E-1-chloro-2-fluoroethylene (HCFO-E-1131), E-1-chloro-1,2-difluoroethylene (HCFO-E-1122a), Z-1-chloro-1,2-difluoroethylene (HCFO-Z-1122a), as well as (a) 1-chloro-1,2,2-trifluoroethane (HCFC-133), (b) 1-chloro-1,1,2-trifluoroethane (HCFC-133b), (c) 1,1-dichloro-2,2,2-trifluoroethane (HCFC-123), (d) 1,2-difluoroethane (HFC-152), (e) 1,1,2-trifluoroethane (HFC-143), (f) fluoromethane (HFC-41), (g) chlorodifluoromethane (HCFC-22), (h) ethylene, (i) 1-chloro-1,2-difluoroethane (HCFC-142a), (j) 1,1-difluoroethylene (HFO-1132a), (k) vinyl chloride (HCO-1140), (l) 1-chloro-1-fluoroethene (HCFO-1131a), (m) E-1-chloro-2-fluoroethene (HCFO-E-1131), n) Z-1-chloro-2-fluoroethene (HCFO-Z-1131), or (o) 1-chloro-2,2-difluoroethylene (HCFO-1122) wherein the amount of additional compounds is selected from one of no more than 2 weight percent of the total composition, <1.5 weight percent of the total composition, <1.0 weight percent of the total composition or 0.5 weight percent of the total composition.

[0096] Embodiments disclosed herein relate to compositions which comprise Z-1,2-difluoroethylene (HFO-Z-1132) containing three or more of the following additional compounds: E-1,2-difluoroethylene (HFO-E-1132), acetylene, fluoroacetylene, fluoroethylene (HFO-1141), E-1-chloro-2-fluoroethylene (HCFO-E-1131), E-1-chloro-1,2-difluoroethylene (HCFO-E-1122a), Z-1-chloro-1,2-difluoroethylene (HCFO-Z-1122a), as well as (a) 1-chloro-1,2,2-trifluoroethane (HCFC-133), (b) 1-chloro-1,1,2-trifluoroethane (HCFC-133b), (c) 1,1-dichloro-2,2,2-trifluoroethane (HCFC-123), (d) 1,2-difluoroethane (HFC-152), (e) 1,1,2-trifluoroethane (HFC-143), (f) fluoromethane (HFC-41), (g) chlorodifluoromethane (HCFC-22), (h) ethylene, (i) 1-chloro-1,2-difluoroethane (HCFC-142a), (j) 1,1-difluoroethylene (HFO-1132a), (k) vinyl chloride (HCO-1140), (l) 1-chloro-1-

fluoroethene (HCFO1131a), (m) E-1-chloro-2-fluoroethene (HCFO-E-1131), (n) Z-1-chloro-2-fluoroethene (HCFO-Z-1131), or (o) 1-chloro-2,2-difluoroethylene (HCFO-1122) wherein the amount of additional compounds is selected from one of no more than 2 weight percent of the total composition, <1.5 weight percent of the total composition, <1.0 weight percent of the total composition or 0.5 weight percent of the total composition.

[0097] Embodiments disclosed herein relate to producing HFO-E-1132 that is substantially free of fluoroethylene, acetylene, and/ or vinyl chloride, preferably containing <0.1 ppm, or <0.01ppm of fluoroethylene and acetylene, and completely free of vinyl chloride.

[0098] Embodiments disclosed herein relate to producing HFO-Z-1132 that is substantially free of acetylene and/or vinyl chloride, preferably containing <0.1 ppm, or <0.01ppm.

[0099] Embodiments disclosed herein relate to producing HFO-E-1132 that is substantially free of HFO-Z-1132, preferably containing HFO-Z-1132 in amount of <1.0 ppm, <0.1 ppm, or <0.01ppm.

[0100] Embodiments disclosed herein relate to producing HFO-E-1132 that is substantially free of HFO-Z-1132, acetylene, and/ or vinyl chloride, preferably containing <1.0, <0.1 ppm, or <0.01ppm of each of HFO-Z-1132.

[0101] Embodiments disclosed herein relate to producing HFO-E-1132 contains less than 10ppm, 1 ppm, or 0.1 ppm acetylene.

[0102] Embodiments disclosed herein relate to producing HFO-E-1132 that is substantially free of fluoroethylene.

[0103] Embodiments disclosed herein relate to producing HFO-E-1132 contains less than 10 ppm, 1 ppm, or 0.1 ppm fluoroethylene.

[0104] Embodiments disclosed herein relate to producing HFO-E-1132 contains less than 1 ppm, or 0.1 ppm HFO-Z-1132.

[0105] Embodiments disclosed herein relate to producing HFO-E-1132 that is substantially free of acetylene and fluoroethylene including HFO-Z-1132.

[0106] Embodiments disclosed herein relate to producing HFO-E-1132 which comprises acetylene and fluoroethylene in an amount of <2000 ppm, <1000 ppm, <500 ppm, <400 ppm, <300 ppm, <200 ppm, <100 ppm, <50 ppm, <10 ppm, <5 ppm, and containing at least two of the following components: HFO-Z-11132, HCFO-E-1122a, HCFO-Z-1122a, HFC-125, HFC-32, HFC-1123, HFC-1141, HCFO-1131a, HCO-1140, HFC-134, HCFO-1122, as well as (a) 1-chloro-1,2,2-trifluoroethane (HCFC-133), (b) 1-chloro-1,1,2-trifluoroethane (HCFC-133b), (c) 1,1-dichloro-2,2,2-trifluoroethane (HCFC-123), (d) 1,2-difluoroethane (HFC-152), (e) 1,1,2-trifluoroethane (HFC-143), (f) fluoromethane (HFC-41), (g) chlorodifluoromethane (HCFC-22), (h) ethylene, (i) 1-chloro-1,2-difluoroethane (HCFC-142a), (j) 1,1-difluoroethylene (HFO-1132a), (k) vinyl chloride (HCO-1140), (l) Z-1-chloro-2-fluoroethene (HCFO-Z-1131), and (m) 1-chloro-2,2-difluoroethylene (HCFO-1122), wherein the other components comprise no more than 2 weight percent of the total composition.

[0107] Embodiments disclosed herein relate to HFO-Z-1132 compositions which comprise acetylene and fluoroethylene in an amount of <2000 ppm, <1000 ppm, <500 ppm, <400 ppm, <300 ppm, <200 ppm, <100 ppm, <50 ppm, <10 ppm, or <5 ppm, and containing at least two additional compounds selected from: HFO-E-1132, HCFO-E-1122a, HCFO-Z-1122a, HFC-125, HFC-32, HFC-1123, HFC-1141, HCFO-1131a, HCO-1140, HFC-134, HCFO-1122 as well as (a) 1-chloro-1,2,2-trifluoroethane (HCFC-133), (b) 1-chloro-1,1,2-trifluoroethane (HCFC-133b), (c) 1,1-dichloro-2,2,2-trifluoroethane (HCFC-123), (d) 1,2-difluoroethane (HFC-152), (e) 1,1,2-trifluoroethane (HFC-143), (f) fluoromethane (HFC-41), (g) chlorodifluoromethane (HCFC-22), (h) ethylene, (i) 1-chloro-1,2-difluoroethane (HCFC-142a), (j) 1,1-difluoroethylene (HFO-1132a), (k) vinyl chloride (HCO-1140), (l) E-1-chloro-2-fluoroethene (HCFO-E-1131), (m) Z-1-chloro-2-fluoroethene (HCFO-Z-1131), and (n) 1-chloro-2,2-difluoroethylene (HCFO-1122), wherein the additional compounds comprise no more than 2 weight percent of the total composition.

[0108] Embodiment 1: Embodiments disclosed herein relate to a process comprising: forming a mixture comprising HFO-Z-1132 and HFO-E-1132 having a Z/E ratio of from about 1:1 to about 9:1; distilling the mixture into a first stream and a second stream, wherein the second stream has a Z:E ratio of from about 10:1 to

about 100:1; and isomerizing said second stream to reduce the Z:E ratio to be from about 1:1 to about 10:1.

[0109] Embodiment 2: The process of Embodiment 1, wherein the first stream has a Z:E ratio of from about 0.01:1 to about 0.1:1.

[0110] Embodiment 3: The process of Embodiment 1 or Embodiment 2, further comprising subjecting the isomerized stream to distillation.

[0111] Embodiment 4: The process of Embodiment 3, wherein the isomerized stream of step c is recycled to step b for the distillation.

[0112] Embodiment 5: A system comprising: a synthesis reactor configured to produce a product mixture comprising HFO-Z-1132 and HFO-E-1132 having a Z:E ratio of from about 1:1 to about 9:1; a distillation column configured to distill the product mixture into a first stream and a second stream, the first stream having a first Z:E ratio and the second stream having a second Z:E ratio which is higher than the first Z:E ratio; and an isomerization reactor configured to isomerize at least a portion of the HFO-Z-1132 of the second stream to HFO-E-1132 to produce an isomerized stream having a third Z:E ratio which is lower than the second Z:E ratio.

[0113] Embodiment 6: The system of Embodiment 5, wherein the first Z:E ratio is from about 0.01:1 to about 0.1:1, and wherein the second Z:E ratio is from about 10:1 to about 100:1.

[0114] Embodiment 7: The system of Embodiment 5 or 6, wherein the third Z:E ratio is from about 1:1 to about 10:1.

[0115] Embodiment 8: The system of any of Embodiments 5 to 7, further comprising a discharge line in flow communication with the synthesis reactor and the distillation column, the discharge line being configured to convey the product mixture from the synthesis reactor to the distillation column.

[0116] Embodiment 9: The system of any of Embodiments 5 to 8, further comprising a recycle line in flow communication with the isomerization reactor and the distillation column, the recycle line being configured to convey the isomerized stream from the isomerization reactor to the distillation column.

Other “Inventive” Embodiments (OE):

- OE1.** A process comprising,
- contacting 1,1,2-trifluoroethane (HFC-143), a dehydrohalogenating agent, and a solvent, and producing a product mixture comprising E-1,2-difluoroethylene and Z-1,2-difluoroethylene, and at least one additional compound comprising one or more of acetylene, fluoroacetylene, HFO-1141, HCFO-E-1122a, HCFO-Z-1122a, HCFO-1131a, HCFO-E-1131, HCFO-Z-1131, HCO-1140, HFC-134, and HCFO-1122.
- OE2.** A process comprising,
- contacting 1,2-dichloro-1,2-difluoroethane (HCFC-132), a dehalogenating agent, and a solvent, and producing a product mixture comprising E-1,2-difluoroethylene and Z-1,2-difluoroethylene, and at least one additional compound comprising one or more of acetylene, fluoroacetylene, HFO-1141, HCFO-E-1122a, HCFO-Z-1122a, HCFO-1131a, HCFO-E-1131, HCFO-Z-1131, HCO-1140, HFC-134, and HCFO-1122.
- OE3.** The process of OE2 wherein 1,2-dichloro-1,2-difluoroethane (HCFC-132) contacts a dehalogenating agent comprises a reducing metal, optionally in the presence of an activator.
- OE4.** The process of claim OE1 wherein 1,1,2-trifluoroethane contacts a dehydrohalogenating agent comprising a base.
- OE5.** The process of claim OE1 wherein a ratio of Z-1,2-difluoroethylene /E-1,2-difluoroethylene is selected from one of greater than 1:1, between 1:1 to about 2:1, at least about 2:1 or between >1:1 to 9:1.
- OE6.** The process of any of OE3 wherein the reducing metal which comprises magnesium, zinc, or cadmium.
- OE7.** The process of any of OE4 wherein the reducing metal comprises zinc.
- OE8.** The process of any of OE4 wherein the reducing metal comprises magnesium or cadmium.

OE9. The process of any of any of OE6-8 further comprising an activator selected from one of a halogen, bromoalkane, an iodoalkane, a vicinal dibromoalkane, a vicinal diiodoalkane, or a vicinal dihalochlorocarbon which is optional in the presence of zinc.

OE10. The process of OE9 wherein the activator comprises bromine, iodine, a bromoethane, iodomethane, 1,2-dibromoethane, 1,2-diiodoethane, 1,2-dibromotetrachloroethane.

OE11. The process any of OE1, 4, and 5 wherein the base comprises one of:

- a) an alkali metal alkoxide,
- b) an alkaline-earth metal alkoxide,
- c) an alkaline metal hydride
- d) an alkaline-earth metal hydride,
- e) an organometallic lithium compound,
- f) an alkaline metal amide, or
- g) an alkaline-earth metal amide, and

wherein the alkali or alkaline metal is a Group 1A metal of the Periodic Table excluding hydrogen, or the alkaline-earth metal is a Group 2A metal of the Periodic Table excluding beryllium.

OE12. The process of OE11 wherein the base comprises an alkaline metal or alkaline-earth metal alkoxide containing 1 to 4 carbons.

OE13. The process of OE11 wherein the base comprises an alkaline metal or alkaline-earth metal alkoxide and the metal is selected from Li, Na, K, or Mg.

OE14. The process of OE11 wherein the base comprises an alkaline metal or alkaline-earth metal alkoxide selected from one of lithium methoxide, sodium methoxide, sodium ethoxide, potassium tert-butoxide, sodium tert-butoxide, sodium isopropoxide, or magnesium ethoxide.

OE15. The process of OE11 wherein the base comprises an alkaline or alkaline-earth metal hydride selected from one of lithium hydride, sodium hydride, potassium hydride, or calcium hydride.

- OE16.** The process of OE11 wherein the base comprises an organometallic lithium compound selected from one of n-butyl lithium, methyl lithium, or isopropyl lithium.
- OE17.** The process of OE11 wherein the base comprises an alkaline or an alkaline-earth metal amide selected from one of lithium dimethylamide, lithium diethylamide, lithium diisopropylamide, or magnesium bis(diisopropylamide).
- OE18.** One embodiment disclosed herein relates to a process of making 1,2-difluoroethylene by contacting 1,1,2-trifluoroethane (HFC-143) in the liquid phase, with a base, at a temperature between -20°C and 100°C. Suitable bases include an alkali metal or alkaline-earth metal alkoxide, an alkaline or alkaline-earth metal hydride, an organometallic lithium compound, or an alkaline or an alkaline-earth metal amide, wherein the alkaline metal is a Group 1A metal of the Periodic Table excluding hydrogen, and the alkaline-earth metal is a Group 2A metal of the Periodic Table excluding beryllium. Examples of alkaline metal or alkaline-earth metal alkoxides include lithium methoxide, sodium methoxide, sodium ethoxide, potassium tert-butoxide, sodium tert-butoxide, sodium isopropoxide, or magnesium ethoxide. Examples of alkaline or alkaline-earth metal hydrides include lithium hydride, sodium hydride, potassium hydride, or calcium hydride. Examples of organometallic lithium compounds include n-butyl lithium, methyl lithium, or isopropyl lithium. Examples of alkaline or an alkaline-earth metal amides include lithium dimethylamide, lithium diethylamide, lithium diisopropylamide, or magnesium bis(diisopropylamide)
- OE19.** The process of OE18 wherein the solvent comprises one of an acyclic ether, a cyclic ether, or a polar aprotic solvent.
- OE20.** The process of OE19 wherein the alkaline metal alkoxide includes lithium methoxide, sodium methoxide, sodium ethoxide, potassium tert-butoxide, sodium tert-butoxide, sodium isopropoxide, or magnesium ethoxide.
- OE21.** The process of OE19 wherein the solvent comprises an acyclic ether.
- OE22.** The process of OE19 wherein the solvent comprises a cyclic ether.

- OE23.** The process of OE19 wherein the solvent comprises a polar aprotic solvent
- OE24.** The process of OE19 wherein the solvent comprises one of diethyl ether, ethylene glycol dimethyl ether, diethylene glycol dimethyl ether, tetraethylene glycol dimethyl ether, tetrahydrofuran, dioxane, dimethylsulfoxide, N,N-dimethylformamide, or N-methylpyrrolidinone.
- OE25.** The process of claim OE19 wherein the aprotic solvent comprises one of diethyl ether, ethylene glycol dimethyl ether, diethylene glycol dimethyl ether, tetraethylene glycol dimethyl ether, tetrahydrofuran or dioxane.
- OE26.** The process of any of OE1-25 wherein a portion of the Z-1,2-difluoroethylene in the product mixture is isomerized to E-1,2-difluoroethylene, optionally at a temperature between 600°C and 800°C.
- OE27.** The process of any of OE1-25 wherein a portion of the Z-1,2-difluoroethylene in the product mixture is catalytically isomerized to E-1,2-difluoroethylene.
- OE28.** The process of OE27 wherein the isomerization is conducted in the vapor phase at a temperature of between 300°C to 400°C in the presence of a catalyst.
- OE29.** The process of OE 27 wherein the catalyst is selected from one of:
- a catalyst includes but is not limited to fluorinated Al₂O₃ or Cr₂O₃, or mixtures thereof,
 - a catalyst which includes a chromium metal,
 - a catalyst which comprises chromium oxyfluoride, wherein the chromium oxyfluoride may further comprise other metals, such as, but not limited to cobalt, manganese, nickel, iron in the form of the metal, oxide, halide, oxyhalide or as other inorganic salts
 - a catalyst which comprises a chromium catalyst obtained by reacting chromium oxide (Cr₂O₃) with hydrogen fluoride to form a chromium oxyfluoride, wherein the chromium oxyfluoride may further comprise other metals, such as, but not limited to cobalt, manganese, nickel, iron in the form of the metal, oxide, halide, oxyhalide or as other inorganic salts,

- e) a catalyst which comprises chromium oxyfluoride is represented by the formula CrOF and optionally comprises other metals, such as, but not limited to cobalt, manganese, nickel, iron in the form of the metal, oxide, halide, oxyhalide or as other inorganic salts.
- f) any of catalysts OE29 (a)-(e) supported on AlF_3 or carbon,
- g) a fluorided lanthanum oxide compositions comprising fluorinated lanthanum oxide impregnated with a solution of catalytic metal(s) selected from one of at least one chromium, nickel, manganese, zinc or cobalt compound optionally in the form of the oxide, oxyhalide, halide, nitrate, or sulfate, wherein the halides include fluorides, chlorides and bromides, or
- h) a co-precipitated catalytic metal and lanthanum as the hydroxides which are thereafter dried and calcined to form the mixed oxides.
- i) a cobalt- or nickel-substituted chromium oxide.

OE30. The process of OE29 wherein total content of catalytic metal(s) is selected from one of not more than 50% by weight of the catalyst composition, not more than 30% by weight of the catalyst composition, preferably between 0.05% by weight and at least about 0.1% by weight of the catalyst composition, most preferably y from 0.1 to 10% by weight of the catalyst composition.

OE31. A composition formed by the method of any of claims 1-31.

OE32. A composition comprising HFO-E-1132, HFO-Z-1132, acetylene and fluoroacetylene, wherein acetylene and fluoroacetylene are respectively present in amount of between >0 and <200 ppm.

OE33. The OE-31 composition wherein the amount of acetylene comprises one of <200 ppm, <100 ppm, <25 ppm, or <10 ppm, and the amount of fluoroethylene comprises one of <200 ppm, <100 ppm, <25 ppm, or <10 ppm.

OE34. The OE32 composition further comprising at least one additional compound selected from HCFO-E-1122a, HCFO-Z-1122a, HFC-125, HFC-32, HFO-1123, HFO-1141, HCFO-1131a, HCFO-E-1131, HCFO-Z-1131, HFC-134,

and HCFO-1122, wherein the other additional compounds comprise no more than 2 weight percent of the total composition.

- OE35.** The OE32 composition further comprising at least one additional compound selected from (a) acetylene, (b) fluoroacetylene, (c) difluoromethane (HFC-32), (d) 1,1,1,2,2-pentafluoroethane (HFC-125), (e) E-1-chloro-1,2-difluoroethylene (HCFO-E-1122a), (f) Z-1-chloro-1,2-difluoroethylene (HCFO-Z-1122a), (g) 1,1,2-trifluoroethylene (HFO-1123), (h) fluoroethylene (HFO-1141), (i) 1-chloro-1,2,2-trifluoroethane (HCFC-133), (j) 1-chloro-1,1,2-trifluoroethane (HCFC-133b), (k) 1,1-dichloro-2,2,2-trifluoroethane (HCFC-123), (l) 1,2-difluoroethane (HFC-152), (m) 1,1,2-trifluoroethane (HFC-143), (n) fluoromethane (HFC-41), (o) chlorodifluoromethane (HCFC-22), (p) 1-chloro-1,2-difluoroethane (HCFC-142a), (q) 1,1-difluoroethylene (HFO-1132a), (r) vinyl chloride (HCO-1140), (s) 1-chloro-1-fluoroethene (HCFO-1131a), (t) E-1-chloro-2-fluoroethene (HCFO-E-1131), (u) Z-1-chloro-2-fluoroethene (HCFO-Z-1131), and (v) 1-chloro-2,2-difluoroethylene (HCFO-1122).
- OE36.** The OE31 composition further comprising at least two additional compounds selected from HCFO-1131a, HCFO-E-1131, HCFO-Z-1131, HCO-1140, HFC-134, and HCFO-1122, wherein if HCO-1140 is present, it is present in amounts of <10 ppm, <5 ppm, <1ppm, <0.1ppm, or 0.01ppm, wherein the other additional compounds comprise no more than 2 weight percent of the total composition.
- OE37.** The OE31 composition further comprising HFO-E-1132 or HFO-Z-1132 and at least three additional compounds selected from (a) acetylene, (b) fluoroacetylene, (c) difluoromethane (HFC-32), (d) 1,1,1,2,2-pentafluoroethane (HFC-125), (e) E-1-chloro-1,2-difluoroethylene (HCFO-E-1122a), (f) Z-1-chloro-1,2-difluoroethylene (HCFO-Z-1122a), (g) 1,1,2-trifluoroethylene (HFO-1123), (h) fluoroethylene (HFO-1141), (i) 1-chloro-1,2,2-trifluoroethane (HCFC-133), (j) 1-chloro-1,1,2-trifluoroethane (HCFC-133b), (k) 1,1-dichloro-2,2,2-trifluoroethane (HCFC-123), (l) 1,2-difluoroethane (HFC-152), (m) 1,1,2-trifluoroethane (HFC-143), (n) fluoromethane (HFC-41), (o) chlorodifluoromethane (HCFC-22), (p) 1-

chloro-1,2-difluoroethane (HCFC-142a), (q) 1,1-difluoroethylene (HFO-1132a), (r) vinyl chloride (HCO-1140), (s) 1-chloro-1-fluoroethene (HCFO-1131a), (t) E-1-chloro-2-fluoroethene (HCFO-E-1131), (u) Z-1-chloro-2-fluoroethene (HCFO-Z-1131), and (v) 1-chloro-2,2-difluoroethylene (HCFO-1122), wherein if HCO-1140 is present, it is present in amounts of <10 ppm, <5 ppm, <1ppm, <0.1ppm, or 0.01ppm, wherein the other additional compounds comprise no more than 2 weight percent of the total composition.

- OE38.** A process wherein the product mixture comprises HFO-E-1132 or HFO-Z-1132 and one or more of (a) acetylene, (b) fluoroacetylene, (c) difluoromethane (HFC-32), (d) 1,1,1,2,2-pentafluoroethane (HFC-125), (e) E-1-chloro-1,2-difluoroethylene (HCFO-E-1122a), (f) Z-1-chloro-1,2-difluoroethylene (HCFO-Z-1122a), (g) 1,1,2-trifluoroethylene (HFO-1123), (h) fluoroethylene (HFO-1141), (i) 1-chloro-1,2,2-trifluoroethane (HCFC-133), (j) 1-chloro-1,1,2-trifluoroethane (HCFC-133b), (k) 1,1-dichloro-2,2,2-trifluoroethane (HCFC-123), (l) 1,2-difluoroethane (HFC-152), (m) 1,1,2-trifluoroethane (HFC-143), (n) fluoromethane (HFC-41), (o) chlorodifluoromethane (HCFC-22), (p) 1-chloro-1,2-difluoroethane (HCFC-142a), (q) 1,1-difluoroethylene (HFO-1132a), (r) vinyl chloride (HCO-1140), (s) 1-chloro-1-fluoroethene (HCFO-1131a), (t) E-1-chloro-2-fluoroethene (HCFO-E-1131), (u) Z-1-chloro-2-fluoroethene (HCFO-Z-1131), and (v) 1-chloro-2,2-difluoroethylene (HCFO-1122), wherein if HCO-1140 is present, it is present in amounts of <10 ppm, <5 ppm, <1 ppm, <0.1 ppm, or 0.01 ppm, wherein the other components comprise no more than 2 weight percent of the total composition.
- OE39.** The process of OE1 wherein the dehydrohalogenation is conducted at a temperature selected from about -20°C to about 120°C.
- OE40.** The process of OE1 wherein the dehydrohalogenation is at a temperature selected from about -20°C to about 100°C.
- OE41.** A process of increasing the E-1,2-difluoroethylene content of a mixture of E-1,2-difluoroethylene, Z-1,2-difluoroethylene, and at least one of (a) acetylene, (b) fluoroacetylene, (c) difluoromethane (HFC-32), (d) 1,1,1,2,2-

pentafluoroethane (HFC-125), (e) E-1-chloro-1,2-difluoroethylene (HCFO-E-1122a), (f) Z-1-chloro-1,2-difluoroethylene (HCFO-Z-1122a), (g) 1,1,2-trifluoroethylene (HFO-1123), (h) fluoroethylene (HFO-1141), (i) 1-chloro-1,2,2-trifluoroethane (HCFC-133), (j) 1-chloro-1,1,2-trifluoroethane (HCFC-133b), (k) 1,1-dichloro-2,2,2-trifluoroethane (HCFC-123), (l) 1,2-difluoroethane (HFC-152), (m) 1,1,2-trifluoroethane (HFC-143), (n) fluoromethane (HFC-41), (o) chlorodifluoromethane (HCFC-22), (p) 1-chloro-1,2-difluoroethane (HCFC-142a), (q) 1,1-difluoroethylene (HFO-1132a), (r) vinyl chloride (HCO-1140), (s) 1-chloro-1-fluoroethene (HCFO-1131a), (t) E-1-chloro-2-fluoroethene (HCFO-E-1131), (u) Z-1-chloro-2-fluoroethene (HCFO-Z-1131), and (v) 1-chloro-2,2-difluoroethylene (HCFO-1122), wherein the at least acetylene and fluoroacetylene, if present, are present at levels of less than 10 ppm, 5 ppm or 1 ppm.

OE42. A composition comprising, consisting essentially of, or consisting of 1,1,2-trifluoroethane (HFC-143) and at least one additional compound selected from 1,1,2-trifluoroethylene (HFO-1123), 1,1,2,2-tetrafluoroethane (HFC-134), 1,1,1,2-tetrafluoroethane (HFC-134a), 1,1-difluoroethane (HFC-152a), 1,1,1,3,3,3-hexafluoropropane HFC-236fa), Z-1,2-difluoroethylene (HFO-Z-1132), E-1-chloro-1,2-difluoroethylene (HCFO-E-1122a), Z-1-chloro-1,2-difluoroethylene (HCFO-Z-1122a), fluoroethylene (HFO-1141), 1-chloro-1,1,2-trifluoroethane (HCFC-133b), 1-chloro-1,2,2-trifluoroethane (HCFC-133), E-1-chloro-2-fluoroethylene (HCFO-E-1131), Z-1-chloro-2-fluoroethylene (HCFO-Z-1131), 1-chloro-1-fluoroethane (HCFC-151a), chloroethane (HCC-160) and 1,1,2-trichloro-1,2,2-trifluoroethane (CFC-113), and if present, less than 10 ppm, 5 ppm or 1 ppm of acetylene and fluoroethylene, wherein the other components comprise no more than 2 weight percent of the total composition.

OE43. A process of contacting a composition comprising, consisting essentially of, or consisting of 1,1,2-trifluoroethane (HFC-143) and at least one additional compound selected from 1,1,2-trifluoroethylene (HFO-1123), 1,1,2,2-tetrafluoroethane (HFC-134), 1,1,1,2-tetrafluoroethane (HFC-134a), 1,1-difluoroethane (HFC-152a), 1,1,1,3,3,3-hexafluoropropane HFC-236fa), Z-1,2-difluoroethylene (HFO-Z-1132), E-1-chloro-1,2-difluoroethylene (HCFO-

E-1122a), Z-1-chloro-1,2-difluoroethylene (HCFO-Z-1122a), fluoroethylene (HFO-1141), 1-chloro-1,1,2-trifluoroethane (HCFC-133b), 1-chloro-1,2,2-trifluoroethane (HCFC-133), E-1-chloro-2-fluoroethylene (HCFO-E-1131), Z-1-chloro-2-fluoroethylene (HCFO-Z-1131), 1-chloro-1-fluoroethane (HCFC-151a), chloroethane (HCC-160) and 1,1,2-trichloro-1,2,2-trifluoroethane (CFC-113) in the liquid phase, with a base at a temperature between -20°C and 100°C.

OE44. A process comprising, consisting essentially or, or consisting of converting a tetrahaloethane selected from the group consisting of CHXFCHYF wherein X and Y are independently selected from the group consisting of Cl, Br, or I to a mixture of E-1,2-difluoroethylene and Z-1,2-difluoroethylene at a Z/E ratio of >1.1:1, preferably X and Y are independently Cl.

OE45. Composition embodiments **OE31-OE37** or **OE42** wherein,

- the total amount of acetylene and fluoroethylene, if present, is selected from one of <2000 ppm, <1000pp, <500 ppm, <400 ppm, <300 ppm, <200 ppm, <100 ppm, <50 ppm, <10 ppm, <5 ppm, preferably <1 ppm, or <0.1 ppm or equal to 0, and/or
- the amount of 1,2-difluoroethane (HFC-152), if present, is selected from one of <100 ppm, <50 ppm, <10 ppm, <5 ppm, <1 ppm, or <0.1 ppm or equal to 0, and/or
- the amount of additional compounds comprise no more than 2 weight percent of the total composition.

OE46. In any OE process above, the feed compositions of either HCFC-132 or HFC-143 as the main component further include one or more additional compounds, wherein the amount of each HCFC-132 and HFC-143 component and corresponding additional compounds are independently selected from one of:

- >95 weight percent main component and <5 weight percent additional compounds, based on the total weight of the composition,
- >96 weight percent main component and <4 weight percent additional compounds, based on the total weight of the composition,

- >97 weight percent main component and <3 weight percent additional compounds, based on the total weight of the composition,
- >98 weight percent main component and <2 weight percent additional compounds, and
- >99 weight percent main component and <1 weight percent additional compounds.

OE47. HFO-E-1132 and/or HFO-Z-1132 blends comprising at least one of:

- one or more HFC compounds selected from HFC-32, HFC-134, HFC-134a, HFC-125, HFC-152a, HFC-227ea and HFC-1123,
- one or more HFO compounds selected from and HFO-E-1234ze, HFO-Z-1234ze, HFO-1234yf, HFO-Z-1224yd and HFO-E-1336mzz.

OE48. Refrigerants, solvents, foam expansion agents, cleaning agents, aerosol propellants, dielectrics, fire extinguishants, and power cycle working fluids comprising HFO-E-1132 and/or HFO-Z-1132 blended with one or more HFC and/or HFO.

OE49. Methods comprising using HFO-E-1132 and/or HFO-Z-1132 blends comprising at least one of:

- one or more HFC compounds selected from HFC-32, HFC-134, HFC-134a, HFC-125, HFC-152a, HFC-227ea and HFC-1123, and
- one or more HFO compounds selected from and HFO-E-1234ze, HFO-Z-1234ze, HFO-1234yf, HFO-Z-1224yd and HFO-E-1336mzz.

as refrigerants, solvents, foam expansion agents, cleaning agents, aerosol propellants, dielectrics, fire extinguishants, and power cycle working fluids.

[0117] 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 process comprising,
 - (a) contacting one of (i) 1,2-dichloro-1,2-difluoroethane (HCFC-132) with a dehalogenating agent, or (ii) 1,1,2-trifluoroethane (HFC-143) with a dehydrofluorinating agent in the liquid phase and a solvent, and
 - (b) producing a product mixture comprising E-1,2-difluoroethylene and Z-1,2-difluoroethylene, and at least one additional compound comprising one or more of acetylene, fluoroacetylene, HFO-1141, CFC-113a, HCFO-E-1122a, HCFO-Z-1122a, HCFO-1131a, HCFO-E-1131, HCFO-Z-1131, HFO-1140, HFC-134, and HCFO-1122.
2. The process of claim 1 wherein (i) 1,2-dichloro-1,2-difluoroethane (HCFC-132) contacts a dehalogenating agent comprising a reducing metal, optionally in the presence of an activator.
3. The process of claim 1 wherein (ii) 1,1,2-trifluoroethane (HFC-143) contacts a dehydrofluorinating agent comprising a strong base.
4. The process of claim 1 wherein (ii) 1,1,2-trifluoroethane contacts a dehydrofluorinating agent comprising a base.
5. The process of claim 1 wherein a molar ratio of Z/E in the product mixture is selected from one of (i) greater than 1:1, (ii) between 1:1 to about 2:1, (iii) at least about 2:1, (iv) or between >1:1 to 9:1.
6. The process of claim 2 wherein the reducing metal which comprises magnesium, zinc, or cadmium.
7. The process of claim 2 wherein the reducing metal comprises zinc.
8. The process of claim 2 wherein the reducing metal comprises magnesium.
9. The process of claim 2 the reducing metal comprises cadmium.
10. The process of any of claims 2, 6, 7, or 8 wherein the activator is selected from one of a halogen, bromoalkane, an iodoalkane a vicinal dibromoalkane, a vicinal diiodoalkane, or a vicinal dihalochlorocarbon.

11. The process of claim 10 wherein the activator comprises bromine, iodine, a bromoethane, iodomethane, 1,2-dibromoethane, 1,2-diiodoethane, 1,2-dibromotetrachloroethane.
12. The process any of claims 1, 3 or 4 wherein the base comprises one of an alkaline or alkaline earth metal alkoxide, an alkyl lithium, or an alkaline metal amide.
13. The process of claim 12 wherein the base comprises one of an alkaline or alkaline earth metal alkoxide selected from one of lithium methoxide, sodium methoxide, sodium ethoxide, potassium tert-butoxide, sodium isopropoxide, or magnesium ethoxide.
14. The process of claim 13 wherein the base comprises potassium tert-butoxide.
15. The process of claim 1 comprises wherein the solvent comprises one of diethyl ether, ethylene glycol dimethyl ether, diethylene glycol dimethyl ether, tetraethylene glycol dimethyl ether, tetrahydrofuran, dioxane, dimethylsulfoxide, N,N-dimethylformamide, or N-methylpyrrolidinone.
16. The process of any of claims 2-4 wherein the solvent comprises one of an acyclic ether, a cyclic ether, or a polar aprotic solvent.
17. The process of claim 6 wherein the solvent comprises one of diethyl ether, ethylene glycol dimethyl ether, diethylene glycol dimethyl ether, tetraethylene glycol dimethyl ether, tetrahydrofuran, dioxane, dimethylsulfoxide, N,N-dimethylformamide, or N-methylpyrrolidinone.
18. The process of claim 13 wherein the solvent comprises one of diethyl ether, ethylene glycol dimethyl ether, diethylene glycol dimethyl ether, tetraethylene glycol dimethyl ether, tetrahydrofuran, dioxane, dimethylsulfoxide, N,N-dimethylformamide, or N-methylpyrrolidinone.
19. The process of any of claims 2-4 wherein the solvent comprises an organic solvent.
20. The process of any of claims 2-4 wherein the organic solvent comprises an acyclic or cyclic ether.

21. The process of any of claims 2 or 3 wherein a portion of the Z-1,2-difluoroethylene in the product mixture is isomerized to E-1,2-difluoroethylene, optionally at a temperature between 600°C and 800°C.
22. The process of and of claims 2 or 3 wherein a portion of the Z-1,2-difluoroethylene in the product mixture is catalytically isomerized to E-1,2-difluoroethylene.
23. The process of claim 22 wherein the catalytic isomerization is conducted in the vapor phase at a temperature of between 100°C and 500°C, in the presence of a catalyst.
24. The process of claim 22 wherein the catalyst is selected from one of fluorinated or partially fluorinated Al_2O_3 , Cr_2O_3 , a fluorinated chromium oxide, or a chromium oxyfluoride.
25. A composition comprising HFO-E-1132, HFO-Z-1132, or a mixture of HFO-E-1132 and HFO-Z-1132, and further comprising acetylene, fluoroacetylene, difluoromethane (HFC-32), 1,1,1,2,2-pentafluoroethane (HFC-125), E-1-chloro-1,2-difluoroethylene (HCFO-E-1122a), Z-1-chloro-1,2-difluoroethylene (HCFO-Z-1122a), 1,1,2-trifluoroethylene (HFO-1123), fluoroethylene (HFO-1141), 1-chloro-1,2,2-trifluoroethane (HCFC-133), 1-chloro-1,1,2-trifluoroethane (HCFC-133b), 1,1-dichloro-2,2,2-trifluoroethane (HCFC-123), 1,2-difluoroethane (HFC-152), 1,1,2-trifluoroethane (HFC-143), fluoromethane (HFC-41), chlorodifluoromethane (HCFC-22), ethylene, 1-chloro-1,2-difluoroethane (HCFC-142a), 1,1-difluoroethylene (HFO-1132a), vinyl chloride (HCO-1140), 1-chloro-1-fluoroethene (1131a), E-1-chloro-2-fluoroethene (HCFO-E-1131), Z-1-chloro-2-fluoroethene (HCFO-Z-1131), and 1-chloro-2,2-difluoroethylene (HCFO-1122), wherein, if present, the total amount of acetylene, fluoroacetylene, fluoroethylene and vinyl chloride comprises one of <200 ppm, <100 ppm, <25 ppm, <10 ppm, or 1 ppm or less, and the amount of fluoroethylene comprises one of <200 ppm, <100 ppm, <25 ppm, <10 ppm, or 1 ppm or less, and the respective amounts of acetylene, fluoroacetylene, fluoroethylene and vinyl chloride, if present is selected from at most one of <10 ppm, <1 ppm, <0.1 ppm or <0.01 ppm.

26. The composition of claim 25 wherein a molar ratio of HFO-Z-1132 to HFO-E-1132 comprises 1.1 to at least 9:1.
27. The composition of any of claims 25-26 comprising at least one additional compound selected from HFC-32, HFC-125, HFC-134, HFO-1123, HCFO-E-1122a, HCFO-Z-1122a, HFC-125, HFC-32, HFO-1123, HFO-1141, HCFO-1131a, HCFO-E-1131, HCFO-Z-1131, HCO-1140, HFC-134, and HCFO-1122 and wherein the amount of additional compounds comprise no more than 2 weight percent of the total composition.
28. The composition of any of claims 25-27 comprising at least one additional compound selected from HFC-32, HFC-125, HFC-134, HFO-1123, HCFO-1131a, HCFO-E-1131, HCFO-Z-1131, HCO-1140, HFC-134, and HCFO-1122 and wherein the amount of additional compounds comprise no more than 2 weight percent of the total composition.
29. The composition of any of claims 25-27 comprising at least two additional compounds selected from HFC-32, HFC-125, HFC-134, HFO-1123, HCFO-1131a, HCFO-E-1131, HCFO-Z-1131, HCO-1140, HFC-134, and HCFO-1122 and wherein the amount of additional compounds comprise no more than 2 weight percent of the total composition.
30. The composition of any of claims 25-27 comprising at least three additional compounds selected from HFC-32, HFC-125, HFO-1123, HFC-134, HCFO-1131a, HCFO-E-1131, HCFO-Z-1131, HCO-1140, HFC-134, and HCFO-1122 and wherein the amount of additional compounds comprise no more than 2 weight percent of the total composition.
31. A composition comprising 1,2-dichloro-1,2-difluoroethane (HCFC-132) and one or more compounds selected from of 1,2-difluoroethane (HFC-152, $\text{CH}_2\text{FCH}_2\text{F}$), 1-chloro-1,2-difluoroethane (HCFC-142a, CH_2FCHClF), 1,1-dichloro-1,2-difluoroethane (HCFC-132c, $\text{CH}_2\text{FCCl}_2\text{F}$), 1,2-dichloro-1,1-difluoroethane (HCFC-132b, $\text{CH}_2\text{ClCClF}_2$), 1,1,2-trichloro-1, 2-difluoroethane (HCFC-122a, $\text{CHClFCCl}_2\text{F}$) and 1,1,2,2-tetrachloro-1,2-difluoroethane (CFC-112, $\text{CCl}_2\text{FCCl}_2\text{F}$) and wherein the amount of the one or more compounds comprise no more than 2 weight percent of the total composition.

32. A process comprising,

- (a) contacting one of (i) a 1,2-dichloro-1,2-difluoroethane (HCFC-132) feed with a dehalogenating agent, or (ii) a 1,1,2-trifluoroethane (HFC-143) with a dehydrofluorinating agent in the liquid phase and a solvent, and
- (b) producing a product mixture comprising E-1,2-difluoroethylene and Z-1,2-difluoroethylene, and at least one additional compound comprising one or more of acetylene, fluoroacetylene, difluoromethane (HFC-32), 1,1,1,2,2-pentafluoroethane (HFC-125), E-1-chloro-1,2-difluoroethylene (HCFO-E-1122a), Z-1-chloro-1,2-difluoroethylene (HCFO-Z-1122a), 1,1,2-trifluoroethylene (HFO-1123), fluoroethylene (HFO-1141), 1-chloro-1,2,2-trifluoroethane (HCFC-133), 1-chloro-1,1,2-trifluoroethane (HCFC-133b), 1,1-dichloro-2,2,2-trifluoroethane (HCFC-123), 1,2-difluoroethane (HFC-152), 1,1,2-trifluoroethane (HFC-143), fluoromethane (HFC-41), chlorodifluoromethane (HCFC-22), ethylene, 1-chloro-1,2-difluoroethane (HCFC-142a), 1,1-difluoroethylene (HFO-1132a), vinyl chloride (HCO-1140), 1-chloro-1-fluoroethene (HCFO-1131a), E-1-chloro-2-fluoroethene (HCFO-E-1131), Z-1-chloro-2-fluoroethene (HCFO-Z-1131), and 1-chloro-2,2-difluoroethylene (HCFO-1122).

33. A process comprising,

- (a) contacting one of (i) 1,2-dichloro-1,2-difluoroethane (HCFC-132) with a dehalogenating agent, or (ii) 1,1,2-trifluoroethane (HFC-143) with a dehydrofluorinating agent in the liquid phase and a solvent, wherein (i) also comprises at least one additional compound selected from 1,2-difluoroethane (HFC-152, $\text{CH}_2\text{FCH}_2\text{F}$), 1-chloro-1,2-difluoroethane (HCFC-142a, CH_2FCHClF), 1,1-dichloro-1,2-difluoroethane (HCFC-132c, $\text{CH}_2\text{FCCl}_2\text{F}$), 1,2-dichloro-1,1-difluoroethane (HCFC-132b, $\text{CH}_2\text{ClCClF}_2$), 1,1,2-trichloro-1,2-difluoroethane (HCFC-122a, $\text{CHClFCCl}_2\text{F}$) and 1,1,2,2-tetrachloro-1,2-difluoroethane (CFC-112, $\text{CCl}_2\text{FCCl}_2\text{F}$) and (ii) comprises at least one additional compound selected from 1,1,2-trifluoroethylene (HFO-1123), 1,1,2,2-tetrafluoroethane (HFC-134), 1,1,1,2-tetrafluoroethane (HFC-134a), 1,1-difluoroethane (HFC-152a), 1,1,1,3,3,3-hexafluoropropane HFC-236fa, E-1-chloro-1,2-difluoroethylene (HCFO-E-1122a), Z-1-chloro-1,2-difluoroethylene

(HCFO-Z-1122a), fluoroethylene (HFO-1141), 1-chloro-1,1,2-trifluoroethane (HCFC-133b), 1-chloro-1,2,2-trifluoroethane (HCFC-133), E/Z-1-chloro-2-fluoroethylene (HCFO-E/Z-1131), 1-chloro-1-fluoroethane (HCFC-151a), chloroethane (HCC-160), and 1,1,2-trichloro-1,2,2-trifluoroethane (CFC-113).

- (b) producing a product mixture comprising E-1,2-difluoroethylene and Z-1,2-difluoroethylene, and at least one additional compound comprising one or more of acetylene, fluoroacetylene, difluoromethane (HFC-32), 1,1,1,2,2-pentafluoroethane (HFC-125), E-1-chloro-1,2-difluoroethylene (HCFO-E-1122a), Z-1-chloro-1,2-difluoroethylene (HCFO-Z-1122a), 1,1,2-trifluoroethylene (HFO-1123), fluoroethylene (HFO-1141), 1-chloro-1,2,2-trifluoroethane (HCFC-133), 1-chloro-1,1,2-trifluoroethane (HCFC-133b), 1,1-dichloro-2,2,2-trifluoroethane (HCFC-123), 1,2-difluoroethane (HFC-152), 1,1,2-trifluoroethane (HFC-143), fluoromethane (HFC-41), chlorodifluoromethane (HCFC-22), ethylene, 1-chloro-1,2-difluoroethane (HCFC-142a), 1,1-difluoroethylene (HFO-1132a), vinyl chloride (HCO-1140), 1-chloro-1-fluoroethene (HCFO-1131a), E-1-chloro-2-fluoroethene (HCFO-E-1131), Z-1-chloro-2-fluoroethene (HCFO-Z-1131), and 1-chloro-2,2-difluoroethylene (HCFO-1122).

34. The process of any of claim 32 or 33 wherein HCFC-132 or HFC-143 is the main component, wherein the amount of each HCFC-132 and HFC-143 component and corresponding additional compounds are independently selected from one of:

- >95 weight percent main component and <5 weight percent additional compounds, based on the total weight of the composition,
- >96 weight percent main component and <4 weight percent additional compounds, based on the total weight of the composition,
- >97 weight percent main component and <3 weight percent additional compounds, based on the total weight of the composition,

- >98 weight percent main component and <2 weight percent additional compounds, and
 - >99 weight percent main component and <1 weight percent additional compounds.
35. A process comprising:
- (a) forming a mixture comprising HFO-Z-1132 and HFO-E-1132 having a Z:E ratio of from about 1:1 to about 9:1;
 - (b) distilling the mixture into a first stream and a second stream, wherein the second stream has a Z:E ratio of from about 10:1 to about 100:1; and
 - (c) isomerizing said second stream to reduce the Z:E ratio to be from about 1:1 to about 10:1.
36. The process of claim 35, wherein the first stream has a Z:E ratio of from about 0.01:1 to about 0.1:1.
37. The process of claim 35 or claim 36, further comprising:
- (a) subjecting the isomerized stream of step c to distillation.
38. The process of claim 37, wherein the isomerized stream of step c is recycled to step b for the distillation.
39. A system comprising
- a synthesis reactor configured to produce a product mixture comprising HFO-Z-1132 and HFO-E-1132 having a Z:E ratio of from about 1:1 to about 9:1;
 - a distillation column configured to distill the product mixture into a first stream and a second stream, the first stream having a first Z:E ratio and the second stream having a second Z:E ratio which is higher than the first Z:E ratio; and
 - an isomerization reactor configured to isomerize at least a portion of the HFO-Z-1132 of the second stream to HFO-E-1132 to produce an isomerized stream having a third Z:E ratio which is lower than the second Z:E ratio.
40. The system of claim 39, wherein the first Z:E ratio is from about 0.01:1 to about 0.1:1, and wherein the second Z:E ratio is from about 10:1 to about 100:1.

41. The system of claim 39 or claim 40, wherein the third Z:E ratio is from about 1:1 to about 10:1.
42. The system of any of claims 39 to 41, further comprising a discharge line in flow communication with the synthesis reactor and the distillation column, the discharge line being configured to convey the product mixture from the synthesis reactor to the distillation column.
43. The system of any of claims 39 to 42, further comprising a recycle line in flow communication with the isomerization reactor and the distillation column, the recycle line being configured to convey the isomerized stream from the isomerization reactor to the distillation column.