

TITLE OF THE INVENTION

PROCESS FOR PURIFYING CO-PRODUCED 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 63/541,393 filed September 29, 2023, the disclosure of which is incorporated herein by reference in its entirety.

BACKGROUND OF THE INVENTION

[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 (CH_2F_2), HFC-125 (C_2HF_5), and HFC-134a (CH_2FCF_3) 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. 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 HFO-1132 which are suitable as blending components given its environmentally friendly decomposition profile in 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 candidate remains.

SUMMARY OF THE INVENTION

[0003] The present invention relates to process for reducing the content of at least one of acetylene, fluoroacetylene, fluoroethylene (HFO-1141) and vinyl chloride in a 1,2-difluoroethylene product stream comprising one of an HFO-E/Z-1132 mixture, HFO-E-1132, or HFO- Z-1132 by distillation and one or more treatment operations, and compositions thereof.

[0004] In certain embodiments disclosed herein a 1,2-difluoroethylene composition comprising one of an HFO-E/Z-1132 mixture, HFO-E-1132, or HFO-Z-1132 is substantially free of at least one of acetylene, fluoroacetylene, fluoroethylene (HFO-1141) and vinyl chloride, and preferably free of each of acetylene, fluoroacetylene, fluoroethylene (HFO-1141) and vinyl chloride.

[0005] In another embodiment disclosed herein the HFO-E/Z-1132 composition to be treated comprises, consists essentially of, or consists of the 1,2-difluoroethylene in an amount of at least 98% by weight, 98.5% by weight, 99% by weight, or 99.5% by weight based on the total amount of the composition; vinyl fluoride (HFO-1141); and at least one additional compound selected from fluoromethane (HFC-41), difluoromethane (HFC-32), 1-chloro-1,2-difluoroethane (HCFC-142a), 1,1,1-trifluoroethane (HFC-143a), tetrafluoroethylene (FCO-1114), 1-chloro-2,2-difluoroethylene (HCFO-1122), acetylene, ethylene, 1,2-dichloro-1,2-difluoroethane (HCFC-132), 1,1,2-trifluoroethane (HFC-143), 1-chloro-1,2-difluoroethylene (HCFO-1122a), trifluoroethylene (HFO-1123), E/Z-1-chloro-2-fluoroethylene (HCFO-E/Z-1131), and combinations thereof, wherein the additional compounds are present in an amount of greater than 0 and, in some cases, at least 0.1% by weight based on the total amount of the composition. In some embodiments, the 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, preferably <1000 ppm, more preferably <100 ppm.

[0006] In another embodiment disclosed herein a mixture of HFO-E/Z-1132E composition to be treated comprises vinyl fluoride (HFO-1141) and at least one additional compound selected from the group consisting of, trifluoromethane (HFC-23), difluoromethane (HFC-32), 1-chloro-1,2-difluoroethane (HCFC-142a), 1,1,1-trifluoroethane (HFC-143a), tetrafluoroethylene (CFO-1114), 1-chloro-2,2-difluoroethylene (HCFO-1122), acetylene, ethylene, 1,2-dichloro-1,2-difluoroethane (HCFC-132), 1,1,2-trifluoroethane (HFC-143), 1-chloro-1,2-difluoroethylene (HCFO-1122a), trifluoroethylene (HFO-1123), E/Z-1-chloro-2-fluoroethylene (HCFO-1131) and at least one additional component selected from E-1,1,1,3-tetrafluoropropene (HFO-E-1234ze), 2,3,3,3-tetrafluoropropene (HFO-1234yf), 1,1,2,2-tetrafluoroethane (HFC-134), 1,1,1,2-tetrafluoroethane (HFC-134a), Z-1-chloro-2,3,3,3-tetrafluoropropene (HCFO-Z-1224yd), E-1,1,1,4,4,4-hexafluoro-2-butene

(HFO-E-1336mzz), 1,1-difluoroethane (HFC-152a), and Z-1,1,1,3-tetrafluoropropene HFO-Z-1234ze. In some embodiments, the 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, preferably <1000 ppm, more preferably <100 ppm.

[0007] In certain embodiments disclosed herein the HFO-1132 composition to be treated comprises, consists essentially of, or consists of, at least one of HFO-E-1132 or HFO-Z-1132, and one or more additional compounds selected from 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 (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). Preferably the amount of 1,2-difluoroethane (HFC-152) is selected from one of between ≥ 0 and <100 ppm, <100 ppm, <50 ppm, <10 ppm, <5 ppm, or 1 ppm. In some embodiments, the 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, preferably <1000 ppm, more preferably <100 ppm.

[0008] In certain embodiments disclosed herein the HFO-1132 composition to be treated comprises HFO-E-1132, and one or more additional compounds selected from HFO-Z-1132, 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 (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 further comprises at least one additional component selected from one of HFO-E-1234ze, HFC-134, HFC-134a, and HFO-1234yf. Preferably the amount of 1,2-difluoroethane (HFC-152) is selected from one of between ≥ 0 and < 100 ppm, < 100 ppm, < 50 ppm, < 10 ppm, < 5 ppm, or 1 ppm. In some embodiments, the 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, preferably < 1000 ppm, more preferably < 100 ppm.

[0009] In certain embodiments disclosed herein the composition comprises HFO-Z-1132, one or more additional compounds selected from 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 (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 at least one additional component selected from HFO-E-1234ze, 1,1,2,2-tetrafluoroethane (HFC-134), 1,1,1,2-tetrafluoroethane (HFC-134a), HFO-1234yf, Z-1-chloro-2,3,3,3-tetrafluoropropene (HCFO-Z-1224yd), E-1,1,1,4,4,4-hexafluoro-2-butene (HFO-E-1336mzz), 1,1-difluoroethane (HFC-152a) and HFO-Z-1234ze. Preferably the amount of 1,2-difluoroethane (HFC-152) is selected from one of between ≥ 0 and < 100 ppm, < 100 ppm, < 50 ppm, < 10 ppm, < 5 ppm, or 1 ppm.

[0010] One embodiment disclosed herein relates to purification of a process stream derived from (1) making 1,2-difluoroethylene by contacting a 1,2-dichloro-1,2-difluoroethane (HCFC-132) feed with a reactive metal in the liquid phase in which the HCFC-132 feed preferably a HCFC-132 feed composition or (2) a process stream derived from making 1,2-difluoroethylene by dehydrofluorination of a 1,1,2-trifluoroethane (CHF₂CH₂F) feed composition in the gas or liquid phase.

[0011] In certain embodiments disclosed herein the 1,2-dichloro-1,2-difluoroethane (HCFC-132) feed composition comprises, consists essentially of or consists of HCFC-132 as the main component, preferably present in amounts of >99 % by weight based on the total amount of the composition and at least one or more additional compounds selected from 1, 2-difluoroethane (HFC-152, CH₂FCH₂F), 1-chloro-1, 2-difluoroethane (HCFC-142a, CH₂FCHClF), 1,1-dichloro-1, 2-difluoroethane (HCFC-132c, CH₂FCCL₂F), 1,2-dichloro-1,1-difluoroethane (HCFC-132b, CH₂ClCClF₂), 1,1,2-trichloro-1, 2-difluoroethane (HCFC-122a, CHClFCCl₂F) and 1,1,2,2-tetrachloro-1,2-difluoroethane (CFC-112, CCl₂FCCL₂F), wherein the total amount of additional compounds is selected from one of <0.5 % by weight, <0.4 % by weight, <0.3 % by weight, <0.2 % by weight, or <0.1 % by weight based on the total amount of the composition. Preferably the amount of 1,2-difluoroethane (HFC-152) is selected from one of between ≥0 and <100 ppm, <100 ppm, <50 ppm, <10 ppm, <5 ppm, or 1 ppm.

[0012] In certain embodiments disclosed herein the HFC-143 feed composition comprises, consists essentially of, or consists of HFC-143 as the main component, preferably present in amount of >99 % by weight based on the total amount of the composition and at least one or more additional compounds selected from: (1) HFO-1123, HFC-134a, HFC-152a, HFC-236fa, HFO-Z-1132, HCFO-E-1122a, HCFO-Z-1122a, HCFO-1140, HCFC-123a, HCFC-133b, HCFC-133, HCFO-Z-1131, HCFO-E-1131, HCFC-151a, HCC-160, and CFC-113, or (2) 1,1-difluoroethylene (HFO-1132a), 1,1,1-trifluoromethane (HFC-143a), 1-chloro-1,2,2-trifluoroethylene (CFO-1113), 1-chloro-1-fluoroethylene (HCFO-1131a), 1,2-difluoroethane (HFC-152), fluoroethane (HFC-161), 1,2-dichloro-1-fluoroethane (HCFC-141), 1,1-dichloro-2,2,2-trifluoroethane (HCFC-123), 1-chloro-2,2-difluoroethane (HCFC-142), 1-chloro-1,2-difluoroethane (HCFC-142a), 1-chloro-2,2-difluoroethylene (HCFO-1122), 1-chloro-1,2-difluoroethylene (HCFO-1122a), fluoroethylene (HFO-1141), dichlorofluoromethane (HCFC-21), chlorodifluoromethane (HCFC-22), trifluoromethane (HFC-23), ethylene, and acetylene. Preferably the amount of 1,2-difluoroethane (HFC-152) is selected from one of between ≥0 and <100 ppm, <100 ppm, <50 ppm, <10 ppm, <5 ppm, or 1 ppm. Another embodiment disclosed herein relates to purification of a process stream derived from making 1,2-difluoroethylene by dehydrofluorination of a 1,1,2-trifluoroethane (HFC-143) feed in

the gas or liquid phase, wherein the HFC-143 feed comprises, consists essentially of, or consists of HFC-143 as the main component, preferably present in amount of >99 % by weight based on the total amount of the composition and at least one or more additional compounds selected from (1) HFO-1123, HFC-134a, HFC-152a, HFC-236fa, HFO-Z-1132, HCFO-E-1122a, HCFO-Z-1122a, HCFO-1140, HCFC-123a, HCFC-133b, HCFC-133, HCFO-Z-1131, HCFO-E-1131, HCFC-151a, HCC-160, and CFC-113, or (2) 1,1-difluoroethylene (HFO-1132a), 1,1,1-trifluoromethane (HFC-143a), 1-chloro-1,2,2-trifluoroethylene (CFO-1113), 1-chloro-1-fluoroethylene (HCFO-1131a), 1,2-difluoroethane (HFC-152), fluoroethane (HFC-161), 1,2-dichloro-1-fluoroethane (HCFC-141), 1,1-dichloro-2,2,2-trifluoroethane (HCFC-123), 1-chloro-2,2-difluoroethane (HCFC-142), 1-chloro-1,2-difluoroethane (HCFC-142a), 1-chloro-2,2-difluoroethylene (HCFO-1122), 1-chloro-1,2-difluoroethylene (HCFO-1122a), fluoroethylene (HFO-1141), dichlorofluoromethane (HCFC-21), chlorodifluoromethane (HCFC-22), trifluoromethane (HFC-23), ethylene, and acetylene. Preferably the amount of 1,2-difluoroethane (HFC-152) is selected from one of between ≥ 0 and <100 ppm, <100 ppm, <50 ppm, <10 ppm, <5 ppm, or 1 ppm.

[0013] In certain embodiments, gas phase conversion of one of the HFC-143 compositions is conducted in the presence of a catalyst is selected from the group consisting of aluminum fluoride, fluorided alumina, a metal supported on a trivalent aluminum compound containing fluoride anion (e.g., aluminum fluoride and/or fluorided alumina), lanthanum fluoride, fluorided lanthanum oxide, metal supported on a trivalent lanthanum compound containing fluoride anion (e.g., lanthanum fluoride and/or fluorided lanthanum oxide), trivalent chromium compounds (e.g., Cr₂O₃) wherein the said metal is selected from the group consisting of one or more of chromium, manganese, iron, cobalt, nickel, magnesium, and zinc. Other suitable catalysts comprise cobalt- or nickel-substituted chromium oxide catalysts prepared as disclosed in U.S. 7,217,678, the disclosure of which is incorporated herein by reference in its entirety.

[0014] In certain embodiments disclosed herein the HFC-143 feed, in which HFC-143 is the main component preferably present in amount of >99 % by weight based on the total amount of the composition, includes at least one or more additional compounds selected from (1) HFO-1123, HFC-134a, HFC-152a, HFC-236fa, HFO-Z-1132, HCFO-E-1122a, HCFO-Z-1122a, HCFO-1140, HCFC-123a, HCFC-133b,

HCFC-133, HCFO-Z-1131, HCFO-E-1131, HCFC-151a, HCC-160, and CFC-113, or (2) 1,1-difluoroethylene (HFO-1132a), 1,1,1-trifluoromethane (HFC-143a), 1-chloro-1,2,2-trifluoroethylene (CFO-1113), 1-chloro-1-fluoroethylene (HCFO-1131a), 1,2-difluoroethane (HFC-152), fluoroethane (HFC-161), 1,2-dichloro-1-fluoroethane (HCFC-141), 1,1-dichloro-2,2,2-trifluoroethane (HCFC-123), 1-chloro-2,2-difluoroethane (HCFC-142), 1-chloro-1,2-difluoroethane (HCFC-142a), 1-chloro-2,2-difluoroethylene (HCFO-1122), 1-chloro-1,2-difluoroethylene (HCFO-1122a) and fluoroethylene (HFO-1141) is converted to an HFO-Z/E-1132 product mixture in the gas phase, at a temperature between 150°C and 400°C, and in the presence of a catalyst. HFC-143 feed preferably comprises HFC-143 and one or more additional compounds selected from: HFO-1123, CFO-1113, HFC-134, HFC-134a, HCFO-1131a, HCFC-142, HCFC-142a, HCFO-1122, HCFO-1122a, HCFC-133, HCFC-133b, and HCO-1140.

[0015] One embodiment disclosed herein relates to a process of subjecting a 1,2-difluoroethylene product stream to fractional distillation to remove acetylene, fluoroacetylene, fluoroethylene (HFO-1141) or vinyl chloride (HCO-1140).

[0016] One embodiment disclosed herein relates to a process of subjecting a 1,2-difluoroethylene fraction to distillation to reduce the total amount of acetylene, fluoroacetylene, vinyl chloride (HCO-1140), and/or fluoroethylene (HFO-1141) in a 1,2-difluoroethylene isomer mixture to a level of less than one of <1000 ppm, <500 ppm, <400 ppm, <300 ppm, <200 ppm, <100 ppm, <50 ppm, <10 ppm, and <5 ppm, preferably to respective acetylene, fluoroacetylene, vinyl chloride (HCO-1140), and/or fluoroethylene (HFO-1141) levels of <1 ppm, and most preferably to 1,2-difluoroethylene isomer mixture fraction which is substantially free of any one of acetylene, fluoroacetylene, vinyl chloride (HCO-1140), and/or fluoroethylene (HFO-1141). In some embodiments, the 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, preferably <1000 ppm, more preferably <100 ppm.

[0017] One embodiment disclosed herein relates to a process of subjecting a product mixture comprising at least one of E-1,2-difluoroethylene and Z-1,2-difluoroethylene, and first amounts of at least one of acetylene and fluoroethylene (HFO-1141) to fractional distillation, and one of (i) withdrawing a mixture comprising

at least one of E-1,2-difluoroethylene and Z-1,2-difluoroethylene and second, lower amounts of at least one of acetylene and fluoroethylene, or (ii) a fraction rich in at least one of acetylene and fluoroethylene, preferably the fraction rich in at least one of acetylene and fluoroethylene is substantially free of HFO-E-1132 or completely free of HFO-E-1132. In some embodiments, the 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, preferably <1000 ppm, more preferably <100 ppm.

[0018] Another embodiment disclosed herein relates to a process of subjecting a product mixture comprising at least one of E-1,2-difluoroethylene and Z-1,2-difluoroethylene, and first amounts of acetylene and fluoroethylene (HFO-1141) to fractional distillation and withdrawing a fraction rich in at least one of acetylene and fluoroethylene, preferably the fraction rich in at least one of acetylene and fluoroethylene is substantially free of HFO-E-1132, or completely free of HFO-E-1132.

[0019] Another embodiment disclosed herein relates to a process of subjecting a product mixture comprising at least one of E-1,2-difluoroethylene and Z-1,2-difluoroethylene, and first amounts of acetylene and fluoroethylene (HFO-1141) to fractional distillation, and withdrawing an acetylene and fluoroethylene rich fraction. , preferably the fraction rich in acetylene and fluoroethylene is substantially free of HFO-E-1132, or completely free of HFO-E-1132.

[0020] One embodiment disclosed herein relates to a process of subjecting a product mixture comprising at least one of E-1,2-difluoroethylene and Z-1,2-difluoroethylene, and first amounts of at least one of acetylene and fluoroethylene (HFO-1141) to fractional distillation, and producing an E-1,2-difluoroethylene and Z-1,2-difluoroethylene rich fraction and an acetylene and fluoroethylene rich fraction, wherein the acetylene and fluoroethylene rich fraction is preferably substantially free of HFO-E-1132, or completely free of HFO-E-1132.

[0021] One embodiment disclosed herein relates to a process of subjecting a 1,2-difluoroethylene fraction from a distillation system to scrubbing to reduce the total amount of acetylene, fluoroacetylene, vinyl chloride (HCO-1140), and/or fluoroethylene (HFO-1141) in a 1,2-difluoroethylene isomer mixture to a level of less than one of <1000 ppm, <500 ppm, <400 ppm, <300 ppm, <200 ppm, <100 ppm,

<50 ppm, <10 ppm, and <5 ppm, preferably to respective acetylene, fluoroacetylene, vinyl chloride (HCO-1140), and/or fluoroethylene (HFO-1141) levels of <1 ppm, and most preferably to a scrubbed HFO-E/Z-1132 fraction which is substantially free of any one of acetylene, fluoroacetylene, vinyl chloride (HCO-1140), and/or fluoroethylene (HFO-1141). In some embodiments, the 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, preferably <1000 ppm, more preferably <100 ppm.

[0022] One embodiment disclosed herein relates to a process wherein scrubbing a 1,2-difluoroethylene fraction from a distillation system provides a 1,2-difluoroethylene composition comprising amounts of acetylene and fluoroethylene (HFO-1141) which are at least 50% lower than a pre-scrubbed 1,2-difluoroethylene product stream. In some embodiments, the 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, preferably <1000 ppm, more preferably <100 ppm.

[0023] Other embodiments disclosed herein relates to processes of subjecting a distilled 1,2-difluoroethylene fraction to one or more of:

- a. treatment with hydrogen halides selected from one of hydrofluoric acid, hydrochloric acid, hydrobromic acid and hydroiodic acid,
- b. treatment with one of sulfuric acid or sodium hypochlorite,
- c. treatment with a silica gel, or silica gel impregnated with sulfuric acid or a protic acid, or
- d. treatment with a solvent selected from one of acetone, methanol, ethanol, N,N-dimethylformamide, and N-methyl-pyrrolidinone.

[0024] Another embodiment disclosed herein relates to processes of treating a mixture of 1,2-difluoroethylene isomers to reduce levels of acetylene, fluoroacetylene, vinyl chloride (HCO-1140), and/or fluoroethylene (HFO-1141) to levels 50% lower than the amount of acetylene, fluoroacetylene, vinyl chloride (HCO-1140), and/or fluoroethylene (HFO-1141) in the 1,2-difluoroethylene isomer mixture prior to treatment.

[0025] Another embodiment disclosed herein relates to processes of treating a mixture of 1,2-difluoroethylene isomers to reduce levels of acetylene, fluoroacetylene, vinyl chloride (HCO-1140), and/or fluoroethylene (HFO-1141) to levels 50% lower than the amount of acetylene, fluoroacetylene, vinyl chloride (HCO-1140), and/or fluoroethylene (HFO-1141) in an untreated 1,2-difluoroethylene isomer mixture, to contain less than one of <1000 ppm, <500 ppm, <400 ppm, <300 ppm, <200 ppm, <100 ppm, <50 ppm, <10 ppm, and <5 ppm acetylene, fluoroacetylene, vinyl chloride (HCO-1140), and/or fluoroethylene (HFO-1141). In some embodiments, the 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, preferably <1000 ppm, more preferably <100 ppm.

[0026] Another embodiment disclosed herein relates to processes of treating a mixture of 1,2-difluoroethylene isomers to reduce levels of acetylene, fluoroacetylene, vinyl chloride (HCO-1140), and/or fluoroethylene (HFO-1141) to levels 50% lower than the amount of acetylene, fluoroacetylene, vinyl chloride (HCO-1140), and/or fluoroethylene (HFO-1141) in an untreated 1,2-difluoroethylene isomer mixture, wherein the treating comprises distillation and scrubbing.

[0027] Another embodiment disclosed herein relates to processes of treating a mixture of 1,2-difluoroethylene isomers to reduce levels of acetylene, fluoroacetylene, vinyl chloride (HCO-1140), and/or fluoroethylene (HFO-1141) to levels 50% lower than the amount of acetylene, fluoroacetylene, vinyl chloride (HCO-1140), and/or fluoroethylene (HFO-1141) in an untreated 1,2-difluoroethylene isomer mixture, wherein the treating comprises distillation and at least one of:

- a. treatment with hydrogen halides selected from one of hydrofluoric acid, hydrochloric acid, hydrobromic acid and hydroiodic acid,
- b. treatment with one of sulfuric acid or sodium hypochlorite,
- c. treatment with a silica gel, or silica gel impregnated with sulfuric acid or a protic acid, or
- d. treatment with a solvent selected from one of acetone, methanol, ethanol, N,N-dimethylformamide, and N-methyl-pyrrolidinone.

[0028] One embodiment disclosed herein relates to a process of treating and purifying a product stream derived from converting a 1,2-dichloro-1,2-difluoroethane

(HCFC-132) feed with a reactive metal in the liquid phase, wherein the feed comprises 1,2-dichloro-1,2-difluoroethane (HCFC-132) and at least one 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, $\text{CCl}_2\text{FCCl}_2\text{F}$).

[0029] One embodiment disclosed herein relates to a process of treating and purifying a product stream derived from contacting a 1,2-dichloro-1,2-difluoroethane feed with a reactive metal selected from magnesium, zinc, and cadmium.

[0030] One embodiment disclosed herein relates to a process of treating and purifying a product stream derived from contacting a 1,2-dichloro-1,2-difluoroethane feed with a reactive 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.

[0031] One embodiment disclosed herein relates to a process of treating and purifying a product stream derived from contacting a 1,2-dichloro-1,2-difluoroethane feed with a reactive metal zinc, optionally in the presence of an activator selected from one of bromine, iodine, bromoethane, iodomethane, 1,2-dibromoethane, 1,2-diiodoethane, or 1,2-dibromotetrachloroethane.

[0032] One embodiment disclosed herein relates to a process of treating and purifying a product stream derived from contacting a 1,2-dichloro-1,2-difluoroethane feed with a reactive metal promoted by an activator in the presence of a solvent selected from a cyclic ether, an acyclic ether, or a polar aprotic solvent.

[0033] One embodiment disclosed herein relates to a process of treating and purifying a product stream derived from contacting 1,2-dichloro-1,2-difluoroethane with a reactive 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.

[0034] Another embodiment disclosed herein relates to a process of treating and purifying a product stream derived from contacting a 1,1,2-trifluoroethane ($\text{CHF}_2\text{CH}_2\text{F}$) feed with a base in the presence of one of an aqueous solvent or an aprotic solvent.

[0035] One embodiment disclosed herein relates to a process of treating and purifying a product stream from making 1,2-difluoroethylene by contacting a 1,1,2-trifluoroethane (HFC-143) feed in the liquid phase, with a base comprising strong bases, 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).

[0036] One embodiment disclosed herein relates to a process of treating and purifying a product stream from making 1,2-difluoroethylene by contacting a 1,1,2-trifluoroethane (HFC-143) feed which is conducted in the gas phase, at a temperature between 150°C and 400°C and in the presence of a catalyst selected from the group consisting of aluminum fluoride, fluorided alumina, a metal supported on a trivalent aluminum compound containing fluoride anion (e.g., aluminum fluoride and/or fluorided alumina), lanthanum fluoride, fluorided lanthanum oxide, metal supported on a trivalent lanthanum compound containing fluoride anion (e.g., lanthanum fluoride and/or fluorided lanthanum oxide), trivalent chromium compounds (e.g., Cr_2O_3) wherein the said metal is selected from the group consisting of one or more of chromium, manganese, iron, cobalt, nickel, magnesium, and zinc. Other suitable catalysts comprise cobalt- or nickel-substituted chromium

oxide catalysts prepared as disclosed in U.S. 7,217,678, the disclosure of which is incorporated herein by reference in its entirety.

[0037] One embodiment disclosed herein relates to a process of treating and purifying a product stream from making 1,2-difluoroethylene by contacting a 1,1,2-trifluoroethane (HFC-143) feed 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).

[0038] One embodiment disclosed herein relates to a process of treating and purifying a product stream obtained by thermally converting a mixture containing HFO-Z-1132 and HFO-E-1132 to a mixture of HFO-Z-1132 to HFO-E-1132 having a greater E/Z molar ratio at temperature range from about 600°C to about 800°C. In some embodiments, the 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, preferably <1000 ppm, more preferably <100 ppm.

[0039] One embodiment disclosed herein relates to processes of treating and purifying a product stream derived from the conversion of a 1,1,2-trifluoroethane (HFC-143) feed which also 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), 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/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).

[0040] Another embodiment disclosed herein relates to processes of treating and purifying a product stream derived from the conversion of a 1,1,2-trifluoroethane (HFC-143) feed to a product mixture comprising, consisting essentially of, or consisting of at least one of (i) E-1,2-difluoroethylene, (ii) Z-1,2-difluoroethylene and (iii) an E and Z difluoroethylene isomer mixture, and at least one, two, three or more additional compounds comprising, consisting essentially of, or consisting 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-1,1,2-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-1-fluoroethene (HCFO-Z-1131), and (v) 1-chloro-2,2-difluoroethylene (HCFO-1122) to reduce levels of acetylene, fluoroacetylene, vinyl chloride (HCO-1140), and/or fluoroethylene (HFO-1141). In some embodiments, the 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, preferably <1000 ppm, more preferably <100 ppm.

[0041] Another embodiment disclosed herein relates to processes of treating and purifying a product stream derived from the conversion of a 1,1,2-trifluoroethane (HFC-143) feed also comprising 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), 1-chloro-2-fluoroethylene (HCFO-1131), 1-chloro-1-fluoroethane (HCFC-151a), chloroethane (HCC-160) and 1,1,2-trichloro-1,2,2-trifluoroethane (CFC-113) to a product mixture comprising, consisting essentially of, or consisting of at least one of (i) E-1,2-difluoroethylene, (ii) Z-1,2-

difluoroethylene and (iii) an E and Z difluoroethylene isomer mixture, and at least one, two, three or more additional compounds comprising, consisting essentially of, or consisting 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-1,1,2-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-1-fluoroethene (HCFO-Z-1131), and (v) 1-chloro-2,2-difluoroethylene (HCFO-1122) to reduce levels of acetylene, fluoroacetylene, vinyl chloride (HCO-1140), and/or fluoroethylene (HFO-1141). In some embodiments, the amount of HFO-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, preferably <1000 ppm, more preferably <100 ppm.

[0042] Another embodiment disclosed herein relates to processes of treating a mixture of 1,2-difluoroethylene isomers, and one, two, three or more additional compounds comprising, consisting essentially of, or consisting 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-1,1,2-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-1-fluoroethene (HCFO-Z-1131), and (v) 1-chloro-2,2-difluoroethylene (HCFO-1122) to reduce levels of acetylene, fluoroacetylene, vinyl chloride (HCO-1140), fluoroethylene (HFO-1141), to reduce

levels of acetylene, fluoroacetylene, vinyl chloride (HCO-1140), and/or fluoroethylene (HFO-1141) wherein the total amount of at least one of acetylene, fluoroacetylene, vinyl chloride (HCO-1140), and/or fluoroethylene (HFO-1141) in the treated 1,2-difluoroethylene isomer mixture is at least less than 50% lower than the amount of the 1,2-difluoroethylene isomer mixture prior to treatment. In some embodiments, the amount of HFO-Z-1132, prior to or after treatment, 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, preferably <1000 ppm, more preferably <100 ppm.

[0043] Another embodiment disclosed herein relates to processes of treating a mixture of 1,2-difluoroethylene isomers, and one, two, three or more compounds comprising, consisting essentially of, or consisting 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-1,1,2-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-1-fluoroethene (HCFO-Z-1131), and (v) 1-chloro-2,2-difluoroethylene (HCFO-1122) to reduce levels of acetylene, fluoroacetylene, vinyl chloride (HCO-1140), and/or fluoroethylene (HFO-1141) wherein the total amount of at least one of acetylene, fluoroacetylene, vinyl chloride (HCO-1140), and/or fluoroethylene (HFO-1141) in the treated 1,2-difluoroethylene isomer mixture is at least less than 50% lower than the amount of the 1,2-difluoroethylene isomer mixture prior to treatment, and with concentrations selected from one of <1000 ppm, <500 ppm, <400 ppm, <300 ppm, <200 ppm, <100 ppm, <50 ppm, <10 ppm, and <5 ppm acetylene, fluoroacetylene, vinyl chloride (HCO-1140), and/or fluoroethylene (HFO-1141). In some embodiments, the amount of HFO-Z-1132, prior to or after treatment, 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, preferably <1000 ppm, more preferably <100 ppm.

[0044] Another embodiment disclosed herein relates to compositions comprising, consisting essentially of, or consisting of E-1,2-difluoroethylene, 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), 1-chloro-1-fluoroethene (HCFO-1131a), (u) E-1-chloro-2-fluoroethene (HCFO-E-1131), (v) Z-1-chloro-1-fluoroethene (HCFO-Z-1131), and (w) 1-chloro-2,2-difluoroethylene (HCFO-1122), wherein the total amount of acetylene and fluoroethylene is selected from one of <2000 ppm, <1000 ppm, <500 ppm, <400 ppm, <300 ppm, <200 ppm, <100 ppm, <50 ppm, <10 ppm, and <5 ppm, and the composition is substantially or completely free of trifluoroacetic acid (TFA). In some embodiments, the 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, preferably <1000 ppm, more preferably <100 ppm.

[0045] In certain embodiments E- and/or Z- 1,2-difluoroethylene isomers and mixture are preferably free of Group A Fluorinated Substances. In one embodiment, as used herein, " Group A Fluorinated Substances" includes any substance that (i) contains at least one fully fluorinated methyl (–CF₃) or methylene (–CF₂–) carbon atom (without any H/Cl/Br/I attached to it); and (ii) meets the criterion for persistence in soil/sediment and water established in Annex XIII (Section 1.1.1) of the European Union's REACH Regulation (<https://reachonline.eu/reach/en/annex-xiii-1-1.1-1.1.1.html> as accessed on May 2, 2023) and referenced in the Annex XV Restriction Report dated March 22, 2023, the disclosure of which is hereby incorporated by reference (<https://echa.europa.eu/documents/10162/f605d4b5-7c17-7414-8823-b49b9fd43aea> as accessed on May 2, 2023).

[0046] In one embodiment, Group A Fluorinated Substances include, but are not limited to, trifluoroacetic acid (TFA).

[0047] In one embodiment disclosed herein, "Group A Fluorinated Substances" includes any substance that has a Henry's Law constant $<250 \text{ Pa}\cdot\text{m}^3/\text{mol}$ and contains at least one fully fluorinated methyl ($-\text{CF}_3$) or methylene ($-\text{CF}_2-$) carbon atom (without any H/Cl/Br/I attached to it). In one embodiment, Group A Fluorinated Substances include, but are not limited to, trifluoroacetic acid (TFA).

[0048] According to one embodiment, compositions of the present invention are free of or substantially free of Group A Fluorinated Substances, such as trifluoroacetic acid. The phrase "free of" as used herein with respect to the presence of Group A Fluorinated Substances in the present compositions means that the amount of such substances in the compositions is sufficiently low so as to not be detectable, including but not limited to 0%, when measured by gas chromatography with a flame ionization detector, gas chromatography with a mass detector by analysis of a gas sample or liquid sample, and/or ion chromatography by analysis of a water sample after bubbling the thermal fluid through water. Such methodologies are well known to those skilled in the art. The phrase "substantially free of" as used herein with respect to the presence of Group A Fluorinated Substances in the present compositions means that the amount of such substances in the compositions is $>0 \text{ wt.}\%$ and $<5 \text{ wt.}\%$, or $>0 \text{ wt.}\%$ and $<4 \text{ wt.}\%$, or $>0 \text{ wt.}\%$ and $<3 \text{ wt.}\%$, or $>0 \text{ wt.}\%$ and $<2 \text{ wt.}\%$, or $>0 \text{ wt.}\%$ and $<1 \text{ wt.}\%$, and all values and ranges therebetween, when measured by gas chromatographic (GC) techniques, for example gas chromatography (GC) with a flame ionization or electron-capture detector, or GC coupled with a mass detector (gas chromatography/mass spectral (GC/MS) method), by ion chromatograph(IC) or ion chromatography mass spectrometry (IC-MS) techniques, or by high-performance liquid chromatography (HPLC) or high-performance liquid chromatography mass spectrometry (HPLC-MS) techniques. The TFA analytical standard may be used in either gas chromatography or ion chromatography and is available from, for example, Sigma Aldrich.

[0049] In one embodiment, degradation products of compositions according to the present invention are free of or substantially free of Group A Fluorinated Substances, such as TFA. The phrase "free of" as used herein with respect to the formation of Group A Fluorinated Substances by the present compositions means that the theoretical molar yield of such substances in environmental compartments of air, soil/sediment and water produced during tropospheric degradation of the

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

[0050] Another embodiment disclosed herein relates to compositions comprising, consisting essentially of, or consisting of Z-1,2-difluoroethylene (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-1-fluoroethene (HCFO-Z-1131), and (v) 1-chloro-2,2-difluoroethylene (HCFO-1122), wherein the respective amount of fluoroethylene and acetylene is selected from one of <10 ppm, <5 ppm or 1 ppm or less.

[0051] Another embodiment disclosed herein relates to compositions comprising, consisting essentially of, or consisting of Z-1,2-difluoroethylene, 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-1-fluoroethene (HCFO-Z-1131), and (v) 1-chloro-2,2-difluoroethylene (HCFO-1122), wherein the total amount of acetylene and fluoroethylene is selected from one of <2000 ppm, <1000 ppm, <500 ppm, <400 ppm, <300 ppm, <200 ppm, <100 ppm, <50 ppm, <10 ppm, and <5 ppm.

[0052] Another embodiment disclosed herein relates to compositions comprising, consisting essentially of, or consisting of E-1,2-difluoroethylene (HFO-Z-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-1-fluoroethene (HCFO-Z-1131), and (v) 1-chloro-2,2-difluoroethylene (HCFO-1122), wherein the respective amount of fluoroethylene and acetylene is selected from one of <10 ppm, <5 ppm, or 1 ppm or less. In some embodiments, the 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, preferably <1000 ppm, more preferably <100 ppm.

[0053] One embodiment disclosed herein relates to compositions which comprises, consists essentially of, or consists of one of a HFO-E-1132E/HFO-Z-1132 mixture, HFO-E-1132, or HFO-Z-1132 which is substantially free of chlorine-containing molecules including at least one of **(1)** E-1-chloro-1,2-difluoroethylene

(HCFO-E-1122a), **(2)** Z-1-chloro-1,2-difluoroethylene (HCFO-Z-1122a), **(3)** 1-chloro-2,2-difluoroethylene (HCFO-1122), **(4)** 1-chloro-1,2,2-trifluoroethane (HCFC-133), **(5)** 1-chloro-1,1,2-trifluoroethane (HCFC-133b), **(6)** chlorodifluoromethane (HCFC-22), **(7)** 1-chloro-1,2-difluoroethane (HCFC-142a), **(8)** vinyl chloride (HCO-1140), **(9)** 1-chloro-1-fluoroethene (HCFO-1131a), **(10)** E-1-chloro-2-fluoroethene (HCFO-E-1131), and **(11)** Z-1-chloro-1-fluoroethene (HCFO-Z-1131). In some embodiments, the 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, preferably <1000 ppm, more preferably <100 ppm.

[0054] One embodiment disclosed herein relates to compositions which comprises, consists essentially of, or consists of one of a HFO-E-1132E/HFO-Z-1132 mixture, HFO-E-1132, or HFO-Z-1132 substantially free of chlorine-containing molecules including at least one of **(1)** E-1-chloro-1,2-difluoroethylene (HCFO-E-1122a), **(2)** Z-1-chloro-1,2-difluoroethylene (HCFO-Z-1122a), **(3)** 1-chloro-2,2-difluoroethylene (HCFO-1122), **(4)** 1-chloro-1,2,2-trifluoroethane (HCFC-133), **(5)** 1-chloro-1,1,2-trifluoroethane (HCFC-133b), **(6)** chlorodifluoromethane (HCFC-22), **(7)** 1-chloro-1,2-difluoroethane (HCFC-142a), **(8)** vinyl chloride (HCO-1140), **(9)** 1-chloro-1-fluoroethene (HCFO-1131a), **(10)** E-1-chloro-2-fluoroethene (HCFO-E-1131), and **(11)** Z-1-chloro-1-fluoroethene (HCFO-Z-1131) and is substantially free of fluoroethylene, fluoroacetylene, acetylene, and 1141. In some embodiments, the 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, preferably <1000 ppm, more preferably <100 ppm.

[0055] Certain embodiments disclosed herein relate to compositions which comprises, consists essentially of, or consists of one of an HFO-E-1132E/HFO-Z-1132 mixture, HFO-E-1132, or HFO-Z-1132 wherein the purity of HFO-E-1132E/HFO-Z-1132 mixture, HFO-E-1132, or HFO-Z-1132 is selected from one of >99.5%, 99.6%, 99.7%, >99.8%, >99.9%, >99.95%, or >99.99% by weight based on the total amount of the composition, and is free of chlorine-containing compounds as well as fluoroacetylene, fluoroethylene and acetylene. In some embodiments, the 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, preferably <1000 ppm, more preferably <100 ppm.

[0056] Certain embodiments disclosed herein relate to compositions which comprises, consists essentially of, or consists of one of an HFO-E-1132E/HFO-Z-1132 mixture, HFO-E-1132, or HFO-Z-1132 wherein the purity of HFO-E-1132E/HFO-Z-1132 mixture, HFO-E-1132, or HFO-Z-1132 is selected from one of 99.5%, 99.6%, >99.7%, >99.8%, >99.9%, >99.95%, or >99.99% by weight based on the total amount of the composition and is completely free of chlorine-containing compounds as well as fluoroacetylene, fluoroethylene and acetylene. In some embodiments, the 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, preferably <1000 ppm, more preferably <100 ppm.

[0057] Certain embodiments disclosed herein relate to compositions which comprises, consists essentially of, or consists of one of a mixture of HFO-E-1132E/HFO-Z-1132 mixture, HFO-E-1132 or HFO-Z-1132 wherein the purity of HFO-E-1132E/HFO-Z-1132 mixture, HFO-E-1132 or HFO-Z-1132 is selected from one of 99.5%, 99.6%, >99.7%, >99.8%, >99.9%, >99.95%, or >99.99% by weight based on the total amount of the composition, and contains less than 0.01 ppm of any chlorine-containing compound, as well as fluoroacetylene, fluoroethylene and acetylene. In some embodiments, the 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, preferably <1000 ppm, more preferably <100 ppm.

DETAILED DESCRIPTION

[0058] The present invention relates to processes for reducing at least the acetylene and fluoroethylene content of an 1,2-difluoroethylene isomer mixtures, HFO-E-1132 and HFO-Z-1132, by treating with one or more separating operations, including but not limited to, distilling, scrubbing, reaction, decantation treatments to reduce the total amount of, e.g., acetylene and fluoroethylene by at least 50% relative to the untreated isomer mixture, to levels selected from one of <2000 ppm, <1000 ppm, <500 ppm, <400 ppm, <300 ppm, <200 ppm, <100 ppm, <50 ppm, <10 ppm, and <5 ppm. In some embodiments, the 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, preferably <1000 ppm, more preferably <100 ppm.

[0059] The present invention also relates to treated 1,2-difluoroethylene isomer mixtures, HFO-E-1132, and HFO-Z-1132 containing acetylene at (i) levels at least 50% lower relative to the untreated isomer mixture, and/or (ii) levels selected from one of <2000 ppm, <1000 ppm, <500 ppm, <400 ppm, <300 ppm, <200 ppm, <100 ppm, <50 ppm, <10 ppm, and <5 ppm. In some embodiments, the 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, preferably <1000 ppm, more preferably <100 ppm.

[0060] Before addressing details of embodiments described herein, some terms are defined or clarified as follows.

[0061] 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.

[0062] 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.

[0063] The term “hydrohaloalkene” is intended to mean a chemical compound selected from the classes of hydrofluoroolefms (HFOs) and hydrochlorofluoroolefins (HCFOs) which include a double bond between adjacent carbon atoms and can contain 1 to 8 carbon atoms.

[0064] 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.

[0065] 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.

[0066] 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.

[0067] 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).

[0068] 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.

[0069] 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.'

[0070] 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."

[0071] 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.

[0072] 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.

[0073] 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.

[0074] 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

[0075] As used herein, the term “substantially free” means that less than about 0.0001 percent by weight is present (1 ppm).

[0076] 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.

TABLE OF COMPOUNDS

[0077] By way of example, mention is made of the following compounds:

	acetylene	$\text{CH}\equiv\text{CH}$
	fluoroacetylene	$\text{CH}\equiv\text{CF}$
HCC-22	chlorodifluoromethane	CHClF_2
HFC-23	trifluoromethane	CHF_3
HFC-32	difluoromethane	CH_2F_2
HFC-41	fluoromethane	CH_3F
CFC-112	1,1,2,2-tetrachloro-1,2-difluoroethane	$\text{CCl}_2\text{FCCl}_2\text{F}$
CFC-113	1,1,2-trichloro-1,2,2-trifluoroethane	$\text{CCl}_2\text{FCClF}_2$
HCFC-122a	1,1,2-trichloro-1,2-difluoroethane	$\text{CHClFCCl}_2\text{F}$
HCFC-123	1,1-dichloro-2,2,2-trifluoroethane	CHCl_2CF_3
HCFC-123a	1,2-dichloro-1,1,2-trifluoroethane	CHClFCClF_2
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	CH_2FCHClF
HCFC-142b	1-chloro-1,1-difluoroethane	CH_3CClF_2
HFC-143	1,1,2-trifluoroethane	$\text{CHF}_2\text{CH}_2\text{F}$
HFC-143a	1,1,1-trifluoroethane	CH_3CF_3
HFC-151a	1-chloro-1-fluoroethane	CH_3CHClF

HFC-152	1,2-difluoroethane	$\text{CH}_2\text{FCH}_2\text{F}$
HFC-152a	1,1-difluoroethane	CH_3CHF_2
HCC-160	chloroethane	$\text{CH}_3\text{CH}_2\text{Cl}$
HFC-236fa	1,1,1,3,3,3-hexafluoropropane	$\text{CF}_3\text{CH}_2\text{CF}_3$
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	$\text{CH}_2=\text{CHCl}$
HCFO-1224yd	1-chloro-2,3,3,3-tetrafluoro-1-propene	$\text{CHCl}=\text{CFCF}_3$
HFO-1234yf	2,3,3,3-tetrafluoro-1-propene	$\text{CH}_2=\text{CFCF}_3$
HFO-1234ze	1,3,3,3-tetrafluoro-1-propene	$\text{CHF}=\text{CHCF}_3$
HFO-1336mzz	E/Z-1,1,1,4,4,4-hexafluoro-2-butene	$\text{E/Z-CF}_3\text{CH}=\text{CHCF}_3$

[0078] Some of the compounds present in the compositions of the present invention identified in Table 1 may exist as different configurational isomers or stereoisomers. The present invention is intended to include all single configurational isomers, single stereoisomers or any combination or mixture thereof. For instance, 1,2-difluoroethylene (HFO-1132) is meant to represent the cis-isomer (Z), trans-isomer (E), or any combination or mixture of both isomers in any ratio. Similarly, 1-chloro-1,2-difluoroethylene (HFO-1122a) exists as a Z-isomer, an E-isomer, or any combination or mixture of both isomers in any ratio. Single isomers or multiple isomers of the same compound may be used in any proportion.

[0079] Another embodiment disclosed herein relates to a process comprising, consisting essentially of, or consisting of converting 1,2-dichloro-1,2-difluoroethane to a mixture of E-1,2-difluoroethylene and Z-1,2-difluoroethylene at a Z/E ratio of ratio is at least 1:1, and between 1:1 to 9:1. In some embodiments, the amount of HFO-Z-1132 in the mixture 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, preferably <1000 ppm, more preferably <100 ppm.

[0080] In certain embodiments disclosed herein the 1,2-dichloro-1,2-difluoroethane (HCFC-132) feed composition comprises, consists essentially of or consists of HCFC-132 as the main component, preferably present in amounts of >99 % by weight based on the total amount of the composition and at least one or more additional compounds selected from 1, 2-difluoroethane (HFC-152, CH₂FCH₂F), 1-chloro-1, 2-difluoroethane (HCFC-142a, CH₂FCHClF), 1,1-dichloro-1, 2-difluoroethane (HCFC-132c, CH₂FCCL₂F), 1,2-dichloro-1,1-difluoroethane (HCFC-132b, CH₂ClCClF₂), 1,1,2-trichloro-1, 2-difluoroethane (HCFC-122a, CHClFCCl₂F) and 1,1,2,2-tetrachloro-1,2-difluoroethane (CFC-112, CCl₂FCCL₂F), wherein the total amount of additional compounds is selected from one of <0.5 % by weight, <0.4 % by weight, <0.3 % by weight, <0.2 % by weight, or <0.1 % by weight.

[0081] Another embodiment disclosed herein relates to a process comprising, consisting essentially of, or consisting of converting 1,1,2-trifluoroethane to a mixture of E-1,2-difluoroethylene and Z-1,2-difluoroethylene where the Z/E ratio is at least 1:1, and between 1:1 to 9:1. In some embodiments, the amount of HFO-Z-1132 in the mixture 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, preferably <1000 ppm, more preferably <100 ppm.

[0082] Certain embodiments disclosed herein relate to a process comprising, consisting essentially of or, or consisting of dehydrofluorinating 1,1,2-trifluoroethane to E-1,2-difluoroethylene, Z-1,2-difluoroethylene and mixtures thereof.

[0083] In certain embodiments disclosed herein an HFC-143 feed is converted to an HFO-Z/E-1132 product mixture in the gas phase, at a temperature between 150°C and 400°C, and in the presence of a catalyst. The HFC-143 feed preferably comprises HFC-143 and one or more additional compounds selected from: HFO-1123, CFO-1113, HFC-134, HFC-134a, HCFO-1131a, HCFC-142, HCFC-142a, HCFO-1122, HCFO-1122a, HCFC-133, HCFC-133b, and HCO-1140. The catalyst is selected from the group consisting of aluminum fluoride, fluorided alumina, a metal supported on a trivalent aluminum compound containing fluoride anion (e.g., aluminum fluoride and/or fluorided alumina), lanthanum fluoride, fluorided lanthanum

oxide, metal supported on a trivalent lanthanum compound containing fluoride anion (e.g., lanthanum fluoride and/or fluorided lanthanum oxide), trivalent chromium compounds (e.g., Cr_2O_3) wherein the said metal is selected from the group consisting of one or more of chromium, manganese, iron, cobalt, nickel, magnesium, and zinc. Other suitable catalysts comprise cobalt- or nickel-substituted chromium oxide catalysts prepared as disclosed in U.S. 7,217,678, the disclosure of which is incorporated herein by reference in its entirety.

[0084] In certain gas phase dehydrofluorinations of HFC-143 the reaction is conducted at a temperature between 150°C and 400°C, including but not limited to 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, or 400°C or and ranges between 250°C and 400°C, including but not limited to 250°C to 375°C, 250°C to 350°C, 250°C to 325°C, 250°C to 300°C, 275°C to 375°C, 275°C to 350°C, 275°C to 325°C, 275°C to 300°C, 300°C to 400°C, 300°C to 375°C.

[0085] In certain embodiments disclosed herein the conversion of 1,1,2-trifluoroethane (HFC-143) to 1,2-difluoroethylene is conducted in the liquid phase by contacting an HFC-143 feed composition in the liquid phase, with a base comprising strong bases, at a temperature between -20°C and 100°C. The HFC-143 feed preferably comprises HFC-143 and one or more additional compounds selected from: HFO-1123, CFO-1113, HFC-134, HFC-134a, HCFO-1131a, HCFC-142, HCFC-142a, HCFO-1122, HCFO-1122a, HCFC-133, HCFC-133b, and HCO-1140. 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).

[0086] In certain embodiments disclosed herein dehydrofluorination of HFC-143 is conducted in the liquid phase at a temperature between -20°C and 150°C, in the presence of a strong base, a polar solvent, and optionally a phase transfer catalyst, wherein the strong base comprises an alkaline 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, and the solvent comprises an organic solvent comprising an acyclic or cyclic ether. Generally liquid phase dehydrofluorination is conducted at a temperature between -20 °C and 150°C, including but not limited to -20°C, -10°C, 0°C, 10°C, 20°C, 30°C, 40°C, 50°C, 60°C, 70°C, 80°C, 90°C, 100°C, 110°C, 120°C, 130°C, 140°C, or 150°C, and all ranges between -20 °C and 150°C.

[0087] One embodiment disclosed herein relates to a process of making 1,2-difluoroethylene by contacting 1,1,2-trifluoroethane (HFC-143) feed 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). The HFC-143 feed preferably comprising HFC-143 and one or more additional compounds selected from: HFO-1123, CFO-1113, HFC-134, HFC-134a, HCFO-1131a, HCFC-142, HCFC-142a, HCFO-1122, HCFO-1122a, HCFC-133, HCFC-133b, and HCO-1140.

[0088] Certain embodiments disclosed herein relate to a process comprising, consisting essentially of or, or consisting of dechlorinating 1,2-dichloro-1,2-difluoroethane to form E-1,2-difluoroethylene, Z-1,2-difluoroethylene and mixtures thereof.

[0089] One embodiment disclosed herein relates to a process for increasing the amount of HFO-E-1132 by isomerizing HFO-Z-1132 in a mixture at temperature $\geq 600^{\circ}\text{C}$, or in the presence of a catalyst to isomerize at least a portion of HFO-Z-1132 into HFO-E-1132. In some embodiments, the amount of HFO-Z-1132 in the resulting composition 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, preferably <1000 ppm, more preferably <100 ppm.

[0090] One embodiment disclosed herein relates to producing an HFO-E-1132 product mixture 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 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. In some embodiments, the 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, preferably <1000 ppm, more preferably <100 ppm.

[0091] 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 of 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), 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), and if present, fluoroethylene (HFO-1141) in an amount of <50 ppm, <10 ppm, <5 ppm, <1 ppm, or <0.1 ppm. In some embodiments, the 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, preferably <1000 ppm, more preferably <100 ppm.

[0092] One embodiment disclosed herein relates to composition which comprises, consists essentially of, or consists of HFO-Z-1132 and one, two, three, four or five or more of Z-1,2-difluoroethylene (HFO-E-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), and if present, fluoroethylene (HFO-1141) in an amount of <50 ppm, <10 ppm, <5 ppm, <1 ppm, or <0.1 ppm.

[0093] 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-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, <1 ppm, or <0.1 ppm. In some embodiments, the 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, preferably <1000 ppm, more preferably <100 ppm.

[0094] One embodiment disclosed herein relates to composition which comprises, consists essentially of, or consists of HFO-Z-1132 and one or more of 1,1,2-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, <1 ppm, or <0.1 ppm.

[0095] One embodiment disclosed herein relates to HFO-E-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 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 HCO-1140, respectively, in an amount of <50 ppm, <10 ppm, <5 ppm, <1 ppm, or <0.1 ppm. In some embodiments, the 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, preferably <1000 ppm, more preferably <100 ppm.

[0096] One embodiment disclosed herein relates to producing an HFO-Z-1132 product mixture 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 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.

[0097] One embodiment disclosed herein relates 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 at least two additional compounds selected from: 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.

[0098] 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.

[0099] 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.

[0100] 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.

[0101] 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.

[0102] 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.

[0103] One embodiment disclosed herein relates to a process of subjecting a product mixture comprising at least one of E-1,2-difluoroethylene and Z-1,2-difluoroethylene, and first amounts of at least one of acetylene and fluoroethylene (HFO-1141) to fractional distillation, and one of (i) withdrawing a mixture comprising at least one of E-1,2-difluoroethylene and Z-1,2-difluoroethylene and second, lower amounts of at least one of acetylene and fluoroethylene, or (ii) a fraction rich in at least one of acetylene and fluoroethylene, preferably the of acetylene and/or fluoroethylene rich fraction is substantially free of HFO-E-1132 or completely free of HFO-E-1132.

[0104] One embodiment disclosed herein relates to a process of subjecting a product mixture comprising at least one of E-1,2-difluoroethylene and Z-1,2-difluoroethylene, and first amounts of at least one of acetylene and fluoroethylene (HFO-1141) to fractional distillation, withdrawing a mixture comprising at least one of E-1,2-difluoroethylene and Z-1,2-difluoroethylene and second, lower amounts of at least one of acetylene and fluoroethylene, preferably the of acetylene and/or fluoroethylene rich fraction is substantially free of HFO-E-1132 or completely free of HFO-E-1132.

[0105] One embodiment disclosed herein relates to a process of subjecting a product mixture comprising at least one of E-1,2-difluoroethylene and Z-1,2-difluoroethylene, and first amounts of at least one of acetylene and fluoroethylene (HFO-1141) to fractional distillation and withdrawing a fraction rich in at least one of

acetylene and fluoroethylene, preferably the of acetylene and/or fluoroethylene rich fraction is substantially free of HFO-E-1132 or completely free of HFO-E-1132.

[0106] Another embodiment disclosed herein relates to a process of subjecting a product mixture comprising at least one of E-1,2-difluoroethylene and Z-1,2-difluoroethylene, and first amounts of acetylene and fluoroethylene (HFO-1141) to fractional distillation, and withdrawing an acetylene and fluoroethylene rich fraction, preferably the of acetylene and/or fluoroethylene rich fraction is substantially free of HFO-E-1132 or completely free of HFO-E-1132.

[0107] One embodiment disclosed herein relates to a process of subjecting a product mixture comprising at least one of E-1,2-difluoroethylene and Z-1,2-difluoroethylene, and first amounts of acetylene and fluoroethylene (HFO-1141) to fractional distillation, and withdrawing a fraction rich in at least one of acetylene and fluoroethylene comprising second higher amounts of at least one of acetylene and fluoroethylene, preferably the of acetylene and/or fluoroethylene rich fraction is substantially free of HFO-E-1132 or completely free of HFO-E-1132.

[0108] Certain embodiments disclosed herein relate to a process comprising, consisting essentially of, or consisting of purifying E-1,2-difluoroethylene and/or Z-1,2-difluoroethylene by contacting a product mixture comprising HFO-E-1132 and/or HFO-Z-1132, optionally including one of acetylene and fluoroethylene with a scrubbing media to convert the acetylene to vinyl halide, and separating the vinyl halide, HFO-E-1132 and HFO-Z-1132 by distillation, and recovering HFO-E-1132 and HFO-Z-1132. In some embodiments, the amount of HFO-Z-1132 in the recovered composition 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, preferably <1000 ppm, more preferably <100 ppm.

[0109] Certain embodiments disclosed herein relate to a process comprising, consisting essentially of, or consisting of purifying E-1,2-difluoroethylene in a product mixture comprising HFO-E-1132 and/or HFO-Z-1132, and acetylene with a scrubbing media to convert the acetylene to vinyl halide, and separating the vinyl halide, HFO-E-1132 and HFO-Z-1132 by distillation, and recovering HFO-E-1132 and HFO-Z-1132. In some embodiments, the amount of HFO-Z-1132 in the recovered composition 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, preferably <1000 ppm, more preferably <100 ppm.

[0110] Certain embodiments disclosed herein relate processes for reducing the content of at least one of acetylene, fluoroacetylene, fluoroethylene (HFO-1141) and vinyl chloride in 1,2-difluoroethylene blends, wherein the blended component comprises one or more component compounds selected from HFO-E-1234ze, HFO-Z-1234ze, HFC-32, HFC-134, HFC-134a, HFC-125, HFO-1123, HFO-1234yf, HFO-1224yd (Z), HFO-E-1336mzzE, HFC-152a, HFO-1132a, and HFC-227ea.

[0111] In certain embodiments disclosed herein the blend component is selected from and comprises at least one of:

- a. 1234zeE and at least one of HFC-134a, HFO-1225zc, HFO-1234yf, HFC-245cb, HFC-236fa, HFO-1234ze(Z), HFO-1225ye(E), HFO-1225ye(Z), HFC-245fa, HCFC-124, CFC-114, HFC-152a, HFO-1243zf, R-2223, HFO-1234zc, HCFO-1223zd(E), HCFO-1233zd(Z), HCFO-1233x,f and HFC-263fb;
- b. 1234zeZ and at least one of HFO-1234ze(E), HFC-263fb, HFO-1234zc, HFC-245fa, HFO-1233zdHCFO-1233zd(E), HFO-1233zdHCFO-1233zd(Z), HCFO-1233xf, HCFC-124, HCC-40, CFC-114, HCFC-1131(E), CFC-114a, HCFC-124a, HFC-227ca, HFO-1234yf, HFC-152a, HFO-1243zf and HFC-245cb
- c. 1234yf and at least one of R-1225zcez, R-1225ye(Z), R-1225yf€, R-245cb, R-245eb, R-1243zf, F-40, R-244bb, R-254eb, R-134a, R-134, 2R-152a, R-2223, R-1234ze€, R-124, R-1131a, R-142b, and R-1131(E),
- d. HFC-32 and at least one of HFC-23 (trifluoromethane), HCFC-31 (chlorofluoromethane), HFC-41 (fluoromethane), HFC-143a (1,1,1-trifluoroethane), HCFC-22 (chlorodifluoromethane), CFC-12 (dichlorodifluoromethane), HCC-40 (chloromethane), and HFC-134a (1,1,1,2-tetrafluoroethane),
- e. HFC-134 and one or more additional compounds selected from HFC-134a, HCFC-124, HCFC-124a, HCFO-1122, HFC-143a, HCFC-31, HFC-32, HFC-125, CFC-114, CFC-114a, FCO-1114, HFC-152a, FCO-1318my, HFC-245cb, FC-C318, and HFC-161,

- f. HFC-134a, and one of more additional compounds selected from HFC-134, HCFC-124, HCFO-1122, HFC-143a, HCFC-31, HFC-32, HFC-125, CFC-114 and CFC-114a, and
- g. HFO-1123 and one of more additional compounds selected from 1-chloro-1,2,2-trifluoroethene (CFO-1113), 1,1,1,2-tetrafluoroethane (HFC-134a), 1,1,2,2-tetrafluoroethane (HFC-134), fluoroethylene (HFO-1141), 1,1-difluoroethylene (HFO-1132a), 1-chloro-2,2-difluoroethylene (HCFO-1122).

[0112] Certain embodiments disclosed herein relates to 1,2-difluoroethylene blend compositions, wherein the blended component comprises one or more component compounds selected from HFO-E-1234ze, HFO-Z-1234ze, HFC-32, HFC-134, HFC-134a, HFC-125, HFO-1123, HFO-1234yf, HFO-1224yd (Z), HFO-E-1336mzz, HFC-152a, and HFC- 227ea, having reduced levels of at least one of acetylene, fluoroacetylene, fluoroethylene (HFO-1141) and vinyl chloride comprising one of:

- a. acetylene and fluoroethylene are present 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,
- b. (ii) the total amount of at least one of acetylene, fluoroacetylene, vinyl chloride (HCO-1140), and/or fluoroethylene (HFO-1141) in the 1,2-difluoroethylene isomer mixture is selected from one of <1000 ppm, <500 ppm, <400 ppm, <300 ppm, <200 ppm, <100 ppm, <50 ppm, <10 ppm, and <5 ppm,
- c. the amount of 1,2-difluoroethane (HFC-152) is selected from one of between ≥ 0 and <100 ppm, <100 ppm, <50 ppm, <10 ppm, <5 ppm, or 1 ppm.
- d. the E- and/or Z- 1,2-difluoroethylene isomers and mixture or blends with HFO and/or HFC compound is substantially free of one or more of (i) fluoroethylene, (ii) acetylene, (iii) fluoroacetylene, (iv) vinyl chloride and (v) 1,2-difluoroethane, preferably containing <0.1 ppm, or <0.01 ppm of at least one of (i)-(v), most preferably between ≥ 0 and <100 ppm, <50 ppm, <10 ppm, <1 ppm, or <0.1 ppm, or
- e. the E- and/or Z- 1,2-difluoroethylene isomers and mixture or blends with HFO and/or HFC compounds is completely free of vinyl chloride and 1,2-difluoroethane.

[0113] In some embodiments, for any of the foregoing compositions, the 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, preferably <1000 ppm, more preferably <100 ppm.

EXAMPLES

Example 1:

[0114] HCFC-132 was prepared by chlorination of HFC-152 as reported by Nappa and Sievert (*J. Fluorine Chem.*, Vol. 62, pages 111-118 (1993)).

[0115] Preferred reactive metals for the process of the invention may include a reducing or dehalogenating metal such as zinc, magnesium, or cadmium. Optionally, dehalogenating metal may be promoted with a metal chloride such as ZnCl₂, MgCl₂, or CdCl₂. Said dehalogenating 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 (Br₂), iodine (I₂), 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).

[0116] Reactive dehalogenating 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 dehalogenating metal is typically suspended in the solvent under an atmosphere of nitrogen with rapid stirring. The amount of dehalogenating 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 dehalogenating 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 of isolated HFO-E/Z-1132 product 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.

[0117] 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 (HCFC-132) 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% HFC-Z-1132, 27% HFC-E-1132, 4% acetylene, 0.6% E/Z-1-chloro-2-fluoro-ethene, and 2% tetrahydrofuran. Other low-level impurities are ethylene, ethane, vinyl fluoride, and 1-chloro-1-fluoroethene.

Example 2:

[0118] 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% HFC-Z-1132, 30% HFC-E-1132, 4% acetylene, 1% *E/Z*-1-chloro-2-fluoro-ethene, and 1% tetrahydrofuran. Other low-level impurities are ethylene, ethane, vinyl fluoride, and 1-chloro-1-fluoroethene.

Example 3:

[0119] 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 HFO-E-1132 is about 9:1.

Example 3A:

[0120] An Inconel® pipe (0.5-inch OD, 10-inch length, 0.35 in wall thickness) is filled with 2 cc of chromium oxide catalyst. The reactor is heated to 375°C, optionally with an oxygen containing gas. HFC-143 is fed at 4.23 mL/hr via an ISCO pump via a vaporizer controlled at 20°C. The pressure of the reaction is varied from 0 to 50 psig. The effluent of the reactor is analyzed online using an Agilent® 7890 GC/5971 MS. The HFC-143 conversion is 53% with 90% HFO-1132 selectivity. The molar ratio of Z-1132 to E-1132 ratio is about 4 to 1.

Example 4:

[0121] 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.

Example 4A:

[0122] 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 Cr₂O₃ 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.

Example 5:

[0123] A mixture of HFO-Z-1132 and HFO-E-1132 having a mol ratio of 1/1500 having 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 is increased: 0.8 to 1, 0.9:1, 1:1, 1.2:1, 1.3 to 1, 1.4:1.

Example 5A:

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 Cr₂O₃ catalyst. The catalyst is activated with anhydrous HF at 300°C. A mixture of HFO-Z-1132 and HFO-E-1132 having a mol ratio of 1/15, optionally in the presence of an oxygen containing gas, 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 is increased is obtained from. 0.5:1 to about 2 :1 obtained

PURIFICATION**Examples 5-7**

[0124] The purification of an HFO-E/Z-1132 mixture, HFO-E-1132, or HFO-Z-1132 can be achieved by fractional distillation to remove acetylene, fluoroacetylene, HCO-1140 and HFO-1141. Alternatively, acetylene may be removed by scrubbing. .

Preferred scrubbing media for removal of acetylene from HFO-E/Z-1132 mixtures, HFO-E-1132, or HFO-Z-1132 are hydrogen halides, sulfur-containing acids, solvents, or hydrogen halides or sulfur-containing acids dissolved in a solvent.

[0125] Preferred hydrogen halide scrubbing mixtures include hydrofluoric acid, hydrochloric acid, hydrobromic acid, and hydroiodic acid. Contact of a hydrogen halide or aqueous hydrogen halide with an HFO-E/Z-1132/C₂H₂ mixture under mild conditions converts at least a portion of the acetylene component to a vinyl halide which may be safely separated from HFO-E/Z-1132 by distillation. Preferred sulfur-containing acids include sulfuric acid, methanesulfonic acid, ethanesulfonic acid, p-toluene sulfonic acid, fluorosulfonic acid, chlorosulfonic acid, and trifluoromethanesulfonic acid. Said sulfur-containing acid may be supported on a carrier such as silica gel as reported by Riego, et. al. in *Tetrahedron Letters*, Vol. 37, pages 513-516 (1996). Preferred solvents for scrubbing acetylene from mixtures with HFO-1132 include acetone, 2-butanone, 3-pentanone, methanol, ethanol, ethyl acetate, formamide, N-methylformamide, N,N-dimethylformamide, N-methylpyrrolidinone, and 1,3-dimethyl-2-imidazolidinone.

Example 5:

[0126] Neat HFO-E-1132 (27 g) containing 3000 ppm acetylene, and 1000 ppm 1141 is passed through concentrated sulfuric acid (98%). The effluent is examined by GC/GC-MS and shows acetylene reduction to <10 ppm, and HFO-1141 reduction to 100 ppm.

Example 6:

[0127] Neat HFO-E-1132 (27 g) containing 1000 ppm acetylene and 500 ppm fluoroethylene is passed through a bed of silica gel (1 inch diameter, 20 inches length). The effluent is examined by GC/GC-MS and shows both compound reduction to <10 ppm.

Example 7:

[0128] Neat HFO-E-1132 (27 g) containing 1000 ppm acetylene is passed through a scrubber containing N-methyl-pyrrolidinone. The effluent is examined by GC/GC-MS and shows both compound's reduction to <10 ppm.

THERMAL STABILITY TESTING

Examples 8-11

[0129] Mixtures containing HFO-E/Z-1132 are heated in the presence of 500 ppm water and 1000 ppm air and coupons (Zn, Brass, Copper, Stainless steel, and alumina) in an autoclave at various temperature for two weeks. Table data illustrates the effect of acetylene and fluoroethylene has on coupons at elevated temperature (a “Comparative” example) relative to the examples that are free of acetylene and fluoroethylene, in the presence of air and moisture. As the data shows, acetylene and fluoroethylene have a detrimental effect causing polymer formation, as well as coupon discoloration which is believed to indicate degradation of the sample components.

[0130] The following subjective scale was used to demonstrate the presence or absence of impurities, e.g., the purity of the HFO-1132:

1 = light changes on coupons

2 = light to moderate changes on coupons

3 = moderate to significant changes on coupons

4 = severe changes on coupons

5 = extreme changes on coupon, i.e., severe color change on coupons with many corrosion spots

Example 8:

[0131] Neat HFO-E-1132 (27 g) containing 500 ppm water and 1000 ppm air in a 300 mL autoclave was heated at 127°C for two weeks. The exposure data is illustrated in Table 1, below:

TABLE 1

Example	Acetylene (ppm)	1141 ppm	T (°C)	Polymer %	Coupon rating
Comparative 8	1700	2100	127	>95	4 for Cu, stainless steel and Zn; 3 for brass; 1 for Al
8	0	0	127	<0.3	2 for Zn; 1 for Cu, Brass, stainless steel

Examples 9-11:

[0132] The mixture of HFO-E-1132 (10 g) and HFO-1234yf (34 g) containing 500 ppm water and 1000 ppm air in a 300 mL autoclave was heated at various temperatures for two weeks. The exposure data is illustrated in **Table 2**, below:

TABLE 2

Example	Acetylene (ppm)	1141 (ppm)	T (°C)	Coupon rating
Comparative 9	390	480	127	3 for Cu, stainless steel and Zn; 1 for brass and Al
9	0	0	127	1 for all coupons
Comparative 10	390	480	150	4 for Cu, stainless steel and Zn; 2 for brass and Al
10	0	0	150	1 for all coupons
Comparative 11	390	480	175	5 for Cu, stainless steel and Zn; 3 for brass; 2 for Al
11	0	0	175	2 for Zn and Cu; 1 for Al, stainless steel

Example 12:

[0133] Neat HFO-E-1132 (100 g) containing 500 ppm vinyl chloride is passed through a bed of silica gel (1 inch diameter, 20 inches length). The effluent is examined by GC/GC-MS and shows reduction of both compounds to <1 ppm.

Example 13:

[0134] Neat HFO-E-1132 (100 g) containing 500 ppm vinyl chloride is passed through a bed of 4A molecular sieves (1 inch diameter, 20 inches length). The effluent is examined by GC/GC-MS and shows reduction of both compounds to <1 ppm.

Example 14:

[0135] Neat HFO-E-1132 (100 g) containing 500 ppm vinyl chloride is passed through a bed of activated carbon (1 inch diameter, 20 inches length). The effluent is examined by GC/GC-MS and shows reduction of both compounds to <1 ppm.

Example 15-17:

[0136] The data of Tables 3-8 reveals that the thermal stability of refrigerant-lubricant mixtures are detrimentally effected by the presence of ppm levels of acetylene and fluoroethylene in the presence of metal coupons, air and moisture.

[0137] A mixture of POERL32-3MAF (44 g), HFO-E-1132 (10 g), and HFO-1234yf (34 g) containing 500 ppm water and 1000 ppm air in a 300 mL autoclave is heated at various temperatures for two weeks. The exposure data is illustrated in Table 3, below:

TABLE 3

Example	Acetylene (ppm)	1141 (ppm)	T °(C)	Coupon rating
Comparative 15	390	480	127	3 for Cu, stainless steel and Zn; 1 for brass and Al
15	0	0	127	1 for all coupons
Comparative 16	390	480	150	4 for Cu, stainless steel and Zn; 2 for brass and Al
16	0	0	150	1 for all coupons
Comparative 17	390	480	175	5 for Cu, stainless steel and Zn; 3 for brass; 2 for Al
17	0	0	175	2 for Zn and Cu; 1 for Al, stainless steel

[0138] The thermal stability of refrigerant-lubricant mixture is detrimentally effected by the presence of acetylene and fluoroethylene based on the level of coupon discoloration.

Example 18-20:

[0139] A mixture of POE ND-11 (45 g), HFO-E-1132 (10 g), and HFO-1234yf (34 g) containing 500 ppm water and 1000 ppm air in a 300 mL autoclave is heated at various temperatures for two weeks. The exposure data is illustrated in Table 4, below:

TABLE 4

Example	Acetylene (ppm)	1141 (ppm)	T °(C)	Coupon rating
Comparative 18	390	480	127	3 for Cu, stainless steel and Zn; 1 for brass and Al
18	0	0	127	1 for all coupons
Comparative 19	390	480	150	4 for Cu, stainless steel and Zn; 2 for brass and Al
19	0	0	150	1 for all coupons
Comparative 20	390	480	175	5 for Cu, stainless steel and Zn; 3 for brass; 2 for Al
20	0	0	175	2 for Zn and Cu; 1 for Al, stainless steel

[0140] The thermal stability of refrigerant-lubricant mixture is detrimentally effected by the presence of acetylene and fluoroethylene based on the level of coupon discoloration.

Example 21-23:

[0141] A mixture of PAG ND-12 (45 g), HFO-E-1132 (10 g), and HFO-1234yf (34 g) containing 500 ppm water and 1000 ppm air in a 300 mL autoclave is heated at various temperatures for two weeks. The exposure data is illustrated in Table 5, below:

TABLE 5

Example	Acetylene (ppm)	1141 (ppm)	T °(C)	Coupon rating
Comparative 21	390	480	127	3 for Cu, stainless steel and Zn; 1 for brass and Al
21	0	0	127	1 for all coupons
Comparative 22	390	480	150	4 for Cu, stainless steel and Zn; 2 for brass and Al
22	0	0	150	1 for all coupons
Comparative 23	390	480	175	5 for Cu, stainless steel and Zn; 3 for brass; 2 for Al
23	0	0	175	2 for Zn and Cu; 1 for Al, stainless steel

[0142] The thermal stability of refrigerant-lubricant mixture is detrimentally effected by the presence of acetylene and fluoroethylene based on the level of coupon discoloration.

Example 24-26:

[0143] A mixture of PVE-FAD68C (45 g), HFO-E-1132 (10 g), and HFO-1234yf (34 g) containing 500 ppm water and 1000 ppm air in a 300 mL autoclave is heated at various temperatures for two weeks. The exposure data is illustrated in Table 7, below:

TABLE 7

Example	Acetylene (ppm)	1141 (ppm)	T °(C)	Coupon rating
Comparative 24	390	480	127	3 for Cu, stainless steel and Zn; 1 for brass and Al
24	0	0	127	1 for all coupons
Comparative 25	390	480	150	4 for Cu, stainless steel and Zn; 2 for brass and Al
25	0	0	150	1 for all coupons
Comparative 26	390	480	175	5 for Cu, stainless steel and Zn; 3 for brass; 2 for Al
26	0	0	175	2 for Zn and Cu; 1 for Al, stainless steel

[0144] The thermal stability of refrigerant-lubricant mixture is detrimentally effected by the presence of acetylene and fluoroethylene based on the level of coupon discoloration.

Example 27-30:

[0145] A mixture of HFO-E-1132 (13 g) and HFO-E-1234ze (31 g) containing 500 ppm water and 1000 ppm air in a 300 mL autoclave is heated at various temperatures for two weeks. The exposure data is illustrated in Table 8, below:

TABLE 8

Example	Acetylene (ppm)	1141 (ppm)	T °(C)	Coupon rating
Comparative 27	507	624	127	4 for Cu, stainless steel and Zn; 2 for brass and Al
27	0	0	127	1 for all coupons
Comparative 28	507	624	150	5 for Cu, stainless steel and Zn; 3 for brass and Al
28	0	0	150	1 for all coupons
Comparative 29	507	624	175	5 for Cu, stainless steel, Zn, and brass; 4 for Al
29	0	0	175	2 for Zn and Cu; 1 for Al, stainless steel

[0146] The thermal stability of refrigerant-lubricant mixture is detrimentally effected by the presence of acetylene and fluoroethylene based on the level of coupon discoloration.

Example 31-32:

[0147] A mixture of POERL32-3MAF (44 g), HFO-E-1132 (13 g), and HFO-1234ze (31 g) containing 500 ppm water and 1000 ppm air in a 300 mL autoclave is heated at various temperatures for two weeks. The exposure data is illustrated in Table 9, below:

TABLE 9

Example	Acetylene (ppm)	1141 (ppm)	T °(C)	Coupon rating
Comparative 30	507	624	127	4 for Cu, stainless steel and Zn; 2 for brass and Al
30	0	0	127	1 for all coupons
Comparative 31	507	624	150	5 for Cu, stainless steel and Zn; 3 for brass and Al
31	0	0	150	1 for all coupons
Comparative 32	507	624	175	5 for Cu, stainless steel, Zn, and brass; 4 for Al
32	0	0	175	2 for Zn and Cu; 1 for Al, stainless steel

[0148] The thermal stability of refrigerant-lubricant mixture is detrimentally effected by the presence of acetylene and fluoroethylene based on the level of coupon discoloration.

Example 33-35:

[0149] A mixture of HFO-E-1132 (13 g) and HFC-32 (31 g) containing 500 ppm water and 1000 ppm air in a 300 mL autoclave is heated at various temperatures for two weeks. The exposure data is illustrated in Table 8, below:

TABLE 8

Example	Acetylene (ppm)	1141 (ppm)	T °(C)	Coupon rating
Comparative 33	507	624	127	3 for Cu, stainless steel and Zn; 1 for brass and Al
33	0	0	127	1 for all coupons
Comparative 34	507	624	150	4 for Cu, stainless steel and Zn; 2 for brass and Al
34	0	0	150	1 for all coupons
Comparative 35	507	624	175	5 for Cu, stainless steel, Zn; 3 for brass and Al
35	0	0	175	2 for Zn and Cu; 1 for Al, stainless steel

[0150] The thermal stability of refrigerant-lubricant mixture is detrimentally effected by the presence of acetylene and fluoroethylene based on the level of coupon discoloration.

[0151] 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 "INVENTIVE" EMBODIMENTS (OE):

- OE1.** Compositions which comprise HFO-E-1,2-difluoroethylene (HFO-E-1132) two or more of the following compounds: 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-1-fluoroethene (HCFO-Z-1131), or (o) 1-chloro-2,2-difluoroethylene (HCFO-1122). Preferably the amount of 1,2-difluoroethane (HFC-152) is selected from one of between ≥ 0 and < 100 ppm, < 100 ppm, < 50 ppm, < 10 ppm, < 5 ppm, or 1 ppm.
- OE2.** Embodiments disclosed herein relate to compositions which comprise E-1,2-difluoroethylene (HFO-E-1132) containing three or more of the following compounds: 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-1-fluoroethene (HCFO-Z-1131), or (o) 1-chloro-2,2-difluoroethylene (HCFO-1122).

- OE3.** 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 <0.01 ppm of fluoroethylene and acetylene, and completely free of vinyl chloride.
- OE4.** Embodiments disclosed herein relate to producing HFO-E-1132 that is substantially free of acetylene and/or vinyl chloride, preferably containing <0.1 ppm, <0.01ppm or no acetylene and vinyl chloride
- OE5.** Embodiments disclosed herein relate to producing HFO-E-1132 containing less than 10ppm, 1 ppm, or 0.1 ppm acetylene.
- OE6.** Embodiments disclosed herein relate to producing HFO-E-1132 that is substantially free of fluoroethylene.
- OE7.** Embodiments disclosed herein relate to producing HFO-E-1132 containing less than 10ppm, 1 ppm, or 0.1 ppm fluoroethylene.
- OE8.** Embodiments disclosed herein relate to producing HFO-E-1132 that is substantially free of acetylene and fluoroethylene.
- OE9.** Embodiments disclosed herein relate to producing HFO-E-1132 containing acetylene and fluoroethylene in amounts 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: 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) 1-chloro-1-fluoroethene (HCFO-E-1131a), (m) E-1-chloro-2-fluoroethene (HCFO-E-1131), (n) Z-1-chloro-2-fluoroethene (HCFO-Z-1131), and (o) 1-chloro-2,2-difluoroethylene (HCFO-1122).

- OE10.** Embodiments disclosed herein relate to HFO-E-1132 compositions which comprise acetylene and fluoroethylene in amounts 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: HCFO-E-1122a, HCFO-Z-1122a, HFC-125, HFC-32, HFC-1123, HFC-1141, HCFO-1131a, 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) 1-chloro-1-fluoroethylene (HCFO-1131a), (m) E-1-chloro-2-fluoroethene (HCFO-E-1131), (n) Z-1-chloro-1-fluoroethene (HCFO-Z-1131), and (o) 1-chloro-2,2-difluoroethylene (HCFO-1122).
- OE11.** Compositions comprising one of HFO-E-1132, HFO-Z-1132 and mixtures of HFO-E-1132 and HFO-Z-1132 that is substantially free of fluoroethylene, acetylene, fluoroacetylene, and/ or vinyl chloride, preferably containing <0.1 ppm, or <0.01ppm of fluoroethylene and acetylene, and completely free of each of vinyl chloride.
- OE12.** A process of providing one of HFO-E-1132, HFO-Z-1132, and mixtures of HFO-E-1132 and HFO-Z-1132 that are substantially free of acetylene, preferably containing acetylene in amount of <0.1 ppm, or <0.01 ppm.

- OE13.** A process of providing one of HFO-E-1132, HFO-Z-1132, and mixtures of HFO-E-1132 and HFO-Z-1132 that are substantially free of fluoroacetylene, preferably containing fluoroacetylene in amount of <0.1 ppm, or <0.01 ppm.
- OE14.** A process of providing one of HFO-E-1132, HFO-Z-1132, and mixtures of HFO-E-1132 and HFO-Z-1132 that are substantially free of fluoroethylene, preferably containing fluoroethylene in amount of <0.1 ppm, or <0.01 ppm.
- OE15.** A process of providing one of HFO-E-1132, HFO-Z-1132, and mixtures of HFO-E-1132 and HFO-Z-1132 that are substantially free of vinyl chloride, preferably containing vinyl chloride in amount of <0.1 ppm, or <0.01 ppm.
- OE16.** A process of providing one of HFO-E-1132, HFO-Z-1132, and mixtures of HFO-E-1132 and HFO-Z-1132, wherein the amount of acetylene and fluoroethylene is selected from one of <2000 ppm, <1000 ppm, <500 ppm, <400 ppm, <300 ppm, <200 ppm, <100 ppm, <50 ppm, <10 ppm, <5 ppm, and wherein one of HFO-E-1132, HFO-Z-1132, and mixtures of HFO-E-1132 and HFO-Z-1132 further contains at least two additional components selected from:
- a) HCFO-E-1122a, HCFO-Z-1122a, HFC-125, HFC-32, HFC-1123, HFC-1141, HCFO-1131a, HCO-1140, HFC-134, and HCFO-1122, or
 - b) 1-chloro-1,1,2-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-fluoroethylene, (m) E-1-chloro-2-fluoroethene (HCFO-E-1131), (n) Z-1-chloro-1-fluoroethene (HCFO-Z-1131), and (o) 1-chloro-2,2-difluoroethylene (HCFO-1122).
- OE17.** A composition comprising one of HFO-E-1132, HFO-Z-1132, and mixtures of HFO-E-1132 and HFO-Z-1132, alone or including at least two additional compounds selected from: 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-1,1,2-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) 1-chloro-1,2-difluoroethane (HCFC-142a), (i) 1,1-difluoroethylene (HFO-1132a), (j) E-1-chloro-2-fluoroethene (HCFO-E-1131), (k) Z-1-chloro-2-fluoroethene (HCFO-Z-1131), and (l) 1-chloro-2,2-difluoroethylene (HCFO-1122).

- OE18.** The process of subjecting a product mixture comprising one of (i) HFO-E-1132, (ii) HFO-Z-1132, and (iii) mixtures of HFO-E-1132 and HFO-Z-1132 to fractional distillation and removing a fraction containing one of (i) HFO-E-1132, (ii) HFO-Z-1132, and (iii) mixtures of HFO-E-1132 and HFO-Z-1132 and containing at least first amounts of acetylene and fluoroethylene.
- OE19.** The process of subjecting a product mixture comprising one of (i) HFO-E-1132, (ii) HFO-Z-1132, and (iii) mixtures of HFO-E-1132 and HFO-Z-1132 to fractional distillation, and removing a fraction containing one of (i) HFO-E-1132, (ii) HFO-Z-1132, and (iii) mixtures of HFO-E-1132 and HFO-Z-1132 containing at least first amounts of acetylene and fluoroethylene, and treating said fraction with a hydrogen halide selected from one of hydrofluoric acid, hydrochloric acid, hydrobromic acid and hydroiodic acid,
- OE20.** The process of subjecting a product mixture comprising one of (i) HFO-E-1132, (ii) HFO-Z-1132, and (iii) mixtures of HFO-E-1132 and HFO-Z-1132 to fractional distillation and removing a fraction containing one of (i) HFO-E-1132, (ii) HFO-Z-1132, and (iii) mixtures of HFO-E-1132 and HFO-Z-1132 containing at least first amounts of acetylene and fluoroethylene and treating said fraction with one of sulfuric acid or sodium hypochlorite.
- OE21.** The process of subjecting a product mixture comprising one of (i) HFO-E-1132, (ii) HFO-Z-1132, and (iii) mixtures of HFO-E-1132 and HFO-Z-1132 to fractional distillation, and removing a fraction containing one of (i) HFO-E-1132, (ii) HFO-Z-1132, and (iii) mixtures of HFO-E-1132 and HFO-Z-1132 containing at least first amounts of acetylene and fluoroethylene and passing said fraction through silica gel, or silica gel impregnated with sulfuric acid or a protic acid.

- OE22.** The process of subjecting a product mixture comprising one of (i) HFO-E-1132, (ii) HFO-Z-1132, and (iii) mixtures of HFO-E-1132 and HFO-Z-1132 to fractional distillation, and removing a fraction containing one of (i) HFO-E-1132, (ii) HFO-Z-1132, and (iii) mixtures of HFO-E-1132 and HFO-Z-1132, and at least first amounts of acetylene and fluoroethylene and treating the said fraction with a solvent selected from one of acetone, 2-butanone, 3-pentanone, methanol, ethanol, N,N-dimethylformamide, and N-methyl-pyrrolidinone and reduce the amount of acetylene and fluoroethylene to one of <100 ppm, <90 ppm, <80 ppm, <70 ppm, <60 ppm, <50 ppm, <40 ppm, <30 ppm, <20 ppm, and <10 ppm.
- OE23.** A process comprising,
- a) producing a product mixture comprising E-1,2-difluoroethylene and Z-1,2-difluoroethylene, and acetylene and fluoroacetylene at a first level, and
 - b) treating the product mixture to reduce the amount of acetylene and fluoroacetylene to a level less than the first level wherein the amount of acetylene and fluoroacetylene is selected from one of <100 ppm, <25 ppm, or <10 ppm, wherein the treating includes at least distillation to form a first fraction.
- OE24.** The process of OE23 wherein the treating additionally comprises scrubbing.
- OE25.** The process of OE 24 wherein the scrubbing comprises one of
- (a) treatment with hydrogen halides selected from one of hydrofluoric acid, hydrochloric acid, hydrobromic acid and hydroiodic acid,
 - (b) treatment with one of sulfuric acid or sodium hypochlorite,
 - (c) treatment with a silica gel, or silica gel impregnated with sulfuric acid or protic acid, or
 - (d) treatment with a solvent selected from one of acetone, 2-butanone, 3-pentanone, methanol, ethanol, N,N-dimethylformamide, and N-methyl-pyrrolidinone.

OE26. The process of OE23-25 wherein the product mixture further comprises one of:

- a. at least one additional compound selected from 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), (i) 1-chloro-1,2,2-trifluoroethane (HCFC-133), (j) 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), 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-1-fluoroethene (HCFO-Z-1131), and 1-chloro-2,2-difluoroethylene (HCFO-1122);
- b. at least two additional compounds selected from 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), 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-1-fluoroethene (HCFO-Z-1131), and 1-chloro-2,2-difluoroethylene (HCFO-1122);
- c. at least three additional compounds selected from at least one additional compound selected from 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), 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-1-fluoroethene (HCFO-Z-1131), and 1-chloro-2,2-difluoroethylene (HCFO-1122);
- d. at least four additional compounds selected from at least one additional compound selected from 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), (i) 1-chloro-1,2,2-trifluoroethane (HCFC-133), (j) 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), 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-1-fluoroethene (HCFO-Z-1131), and 1-chloro-2,2-difluoroethylene (HCFO-1122);
- e. at least five additional compounds selected from at least one additional compound selected from 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), 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-1-fluoroethene (HCFO-Z-1131), and 1-chloro-2,2-difluoroethylene (HCFO-1122); and

- f. at least one, two, three or four additional compounds selected from HFO-1141, HFO-1123, HFO-Z-1132, HCFO-E-1131, HFC-125, HFC-32, HCFO-1131a, HCFO-Z-1122a, HCFO-E-1122a, and HCFO-1122.

OE27. The scrubbing of OE25 wherein the scrubbed fraction contains amounts of acetylene and fluoroethylene (HFO-1141) that are at least 50% lower than that found in the product mixture prior to distillation, and/or after distillation.

OE28. The process comprising subjecting a product mixture comprising at least one of E-1,2-difluoroethylene and Z-1,2-difluoroethylene, and first amounts of acetylene and fluoroethylene (HFO-1141) to fractional distillation, withdrawing an E-1,2-difluoroethylene fraction containing at least second amounts of acetylene and fluoroethylene less than said first amounts.

OE29. The process comprising subjecting a product mixture comprising at least one of E-1,2-difluoroethylene and Z-1,2-difluoroethylene, and first amounts of acetylene and fluoroethylene (HFO-1141) to fractional distillation, withdrawing an E-1,2-difluoroethylene fraction and scrubbing the fraction to provide a first scrubbed fraction containing second amounts of acetylene and fluoroethylene (HFO-1141) which are at least 30% lower than the first amounts.

OE30. The process of OE19 or OE20 wherein the second amounts are at least 50% lower than the first amounts of acetylene and fluoroethylene (HFO-1141), the second amounts of acetylene, fluoroacetylene, vinyl chloride (HCO-1140), and/or fluoroethylene (HFO-1141) are(is) selected from one of <1000 ppm, <500 ppm, <400 ppm, <300 ppm, <200 ppm, <100 ppm, <50 ppm, <10 ppm, <5 ppm, <1 ppm, or substantially free of any one of acetylene, fluoroacetylene, vinyl chloride (HCO-1140), and/or fluoroethylene (HFO-1141) containing ≤ 0.9 ppm including 0 ppm.

- OE31.** A composition from any of OE1-OE18 wherein HFO-E-1132, HFO-Z-1132 or mixtures of HFO-E-1132 and HFO-Z-1132 are substantially free of acetylene and/or vinyl chloride, preferably containing <0.1 ppm or <0.01 ppm acetylene and vinyl chloride.
- OE32.** A composition from any of OE1-OE18 wherein HFO-E-1132, HFO-Z-1132 or mixtures of HFO-E-1132 and HFO-Z-1132 are substantially free of acetylene and/or vinyl chloride, preferably containing <0.1 ppm or, <0.01 ppm, or 0 ppm of acetylene and/or vinyl chloride.
- OE33.** One embodiment disclosed herein relates to a process of subjecting a product mixture comprising at least one of E-1,2-difluoroethylene and Z-1,2-difluoroethylene, and first amounts of at least one of acetylene and fluoroethylene (HFO-1141) to fractional distillation, and one of (i) withdrawing a mixture comprising at least one of E-1,2-difluoroethylene and Z-1,2-difluoroethylene and second, lower amounts of at least one of acetylene and fluoroethylene, or (ii) a fraction rich in at least one of acetylene and fluoroethylene, preferably the of acetylene and/or fluoroethylene rich fraction is substantially free of HFO-E-1132 or completely free of HFO-E-1132.
- OE34.** A process comprising subjecting a product mixture comprising at least one of E-1,2-difluoroethylene and Z-1,2-difluoroethylene, and first amounts of acetylene and fluoroethylene (HFO-1141) to fractional distillation and withdrawing a fraction containing at least one of acetylene and fluoroethylene.
- OE35.** OE33 process wherein the fraction contains both acetylene and fluoroethylene.
- OE36.** OE33 process wherein the fraction consists essentially of one of acetylene and fluoroethylene.
- OE37.** A process comprising subjecting a product mixture comprising at least one of E-1,2-difluoroethylene and Z-1,2-difluoroethylene, and first amounts of acetylene and fluoroethylene (HFO-1141) to fractional distillation and withdrawing a fraction rich in at least one of acetylene and fluoroethylene,

preferably the of acetylene and/or fluoroethylene rich fraction is substantially free of HFO-E-1132 or completely free of HFO-E-1132.

OE38. HFO-E-1132, HFO-Z-1132, or HFO-E/Z-1132 blends, wherein the blended component comprises one or more component compounds selected from HFO-E-1234ze, HFO-Z-1234ze, HFC-32, HFC-134, HFC-134a, HFC-125, HFO-1123, HFO-1234yf, HFO-1224yd (Z), HFO-E-1336mzz, HFC-152a, and HFC- 227ea, and the level of at least one of acetylene, fluoroacetylene, fluoroethylene (HFO-1141) and vinyl chloride in the blend comprises one of:

- a. <2000 ppm, <1000 ppm, <500 ppm, <400 ppm, <300 ppm, <200 ppm, <100 ppm, <50 ppm, <10 ppm, or <5 ppm of acetylene and fluoroethylene,
- b. the total amount of at least one of acetylene, fluoroacetylene, vinyl chloride (HFO-1140), and/or fluoroethylene (HFO-1141) in the 1,2-difluoroethylene isomer mixture is selected from one of <1000 ppm, <500 ppm, <400 ppm, <300 ppm, <200 ppm, <100 ppm, <50 ppm, <10 ppm, and <5 ppm,
- c. the amount of 1,2-difluoroethane (HFC-152) is selected from one of between ≥ 0 and <100 ppm, <100 ppm, <50 ppm, <10 ppm, <5 ppm, or 1 ppm.
- d. the E- and/or Z- 1,2-difluoroethylene isomers and mixture or blends with HFO and/or HFC compound is substantially free of one or more of (i) fluoroethylene, (ii) acetylene, (iii) fluoroacetylene, (iv) vinyl chloride and (v) 1,2-difluoroethane, preferably containing <0.1 ppm, or <0.01 ppm of at least one of (i)-(v), most preferably between ≥ 0 and <100 ppm, <50 ppm, <10 ppm, <1 ppm, or <0.1 ppm, or
- e. the E- and/or Z- 1,2-difluoroethylene isomers and mixture or blends with HFO and/or HFC compounds is completely free of vinyl chloride and 1,2-difluoroethane.

OE39. Processes for reducing the content of at least one of acetylene, fluoroacetylene, fluoroethylene (HFO-1141) and vinyl chloride in 1,2-difluoroethylene blends, wherein the blended component comprises one or

more component compounds selected from HFO-E-1234ze, HFO-Z-1234ze, HFC-32, HFC-134, HFC-134a, HFC-125, HFO-1123, HFO-1234yf, HFO-1224yd (Z), HFO-E-1336mzz, HFC-152a, HFO-1132a, and HFC-227ea.

OE40. Processes disclosed herein wherein reducing the content of at least one of acetylene, fluoroacetylene, fluoroethylene (HFO-1141) and vinyl chloride is reduced in an HFO-E/Z-1132 blend wherein the blended component is selected from and comprises at least one of:

- a. 1234zeE and at least one of HFC-134a, HFO-1225zc, HFO-1234yf, HFC-245cb, HFC-236fa, HFO-1234ze(Z), HFO-1225ye(E), HFO-1225ye(Z), HFC-245fa, HCFC-124, CFC-114, HFC-152a, HFO-1243zf, R-2223, HFO-1234zc, HCFO-1223zd(E), HCFO-1233zd(Z), HCFO-1233xf and HFC-263fb;
- b. 1234zeZ and at least one of HFO-1234ze(E), HFC-263fb, HFO-1234zc, HFC-245fa, HFO-1233zdHCFO-1233zd(E), HFO-1233zdHCFO-1233zd(Z), HCFO-1233xf, HCFC-124, HCC-40, CFC-114, HCFC-1131(E), CFC-114a, HCFC-124a, HFC-227ca, HFO-1234yf, HFC-152a, HFO-1243zf and HFC-245cb
- c. 1234yf and at least one of R-1225zcez, R-1225ye(Z), R-1225yf(E), R-245cb, R-245eb, R-1243zf, F-40, R-244bb, R-254eb, R-134a, R-134, 2R-152a, R-2223, R-1234zeE, R-124, R-1131a, R-142b, R-1131(E),
- d. HFC-32 and at least one of HFC-23 (trifluoromethane), HCFC-31 (chlorofluoromethane), HFC-41 (fluoromethane), HFC-143a (1,1,1-trifluoroethane), HCFC-22 (chlorodifluoromethane), CFC-12 (dichlorodifluoromethane), HCC-40 (chloromethane), and HFC-134a (1,1,1,2-tetrafluoroethane),
- e. HFC-134 and one of more additional compounds selected from HFC-134a, HCFC-124, HCFC-124a, HCFO-1122, HFC-143a, HCFC-31, HFC-32, HFC-125, CFC-114, CFC-114a, FCO-1114, HFC-152a, FCO-1318my, HFC-245cb, FC-C318, and HFC-161,

- f. HFC-134a, and one of more additional compounds selected from HFC-134, HCFC-124, HCFO-1122, HFC-143a, HCFC-31, HFC-32, HFC-125, CFC-114 and CFC-114a, and
- g. HFO-1123 and one of more additional compounds selected from 1-chloro-1,2,2-trifluoroethene (CFO-1113), 1,1,1,2-tetrafluoroethane (HFC-134a), 1,1,2,2-tetrafluoroethane (HFC-134), fluoroethylene (HFO-1141), 1,1-difluoroethylene (HFO-1132a), and 1-chloro-2,2-difluoroethylene (HCFO-1122).

OE41. For the composition or mixture of any of the foregoing embodiments OE1-OE40, the 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, preferably <1000 ppm, more preferably <100 ppm.

[0152] 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. The process comprising subjecting a product mixture comprising at least one of E-1,2-difluoroethylene and Z-1,2-difluoroethylene, and first amounts of acetylene and fluoroethylene (HFO-1141) to fractional distillation, withdrawing an E-1,2-difluoroethylene fraction containing at least second amounts of acetylene and fluoroethylene less than said first amounts.
2. The process comprising subjecting a product mixture comprising at least one of E-1,2-difluoroethylene and Z-1,2-difluoroethylene, and first amounts of acetylene and fluoroethylene (HFO-1141) to fractional distillation, withdrawing an E-1,2-difluoroethylene fraction and scrubbing the fraction to provide a first scrubbed fraction containing second amounts of acetylene and fluoroethylene (HFO-1141) which are at least 30% lower than the first amounts.
3. The process of any of claims 1 or 2 wherein the second amounts are at least 50% lower than the first amounts of acetylene and fluoroethylene (HFO-1141).
4. The process of claim 2 wherein the scrubbing comprises contacting the product mixture with hydrogen halides selected from one of hydrofluoric acid, hydrochloric acid, hydrobromic acid and hydroiodic acid.
5. The process of claim 2 wherein the scrubbing comprises contacting the product mixture with one of sulfuric acid or sodium hypochlorite.
6. The process of claim 2 wherein the scrubbing comprises contacting the product mixture with one of a silica gel, a silica gel impregnated with sulfuric acid, or a silica gel impregnated with protic acid.
7. The process of claim 2 wherein the scrubbing comprises contacting the product mixture with one acetone, methanol, ethanol, N,N-dimethylformamide, and N-methyl-pyrrolidinone.
8. A composition formed by the process of any one of claims 1-7.
9. The composition of claim 8 wherein the amount of acetylene comprises one of <200ppm, <100ppm, <25ppm, <10ppm, or 1ppm or less, and the amount of

fluoroethylene (HFO-1141) comprises one of <200ppm, <100ppm, <25ppm, <10ppm, or 1 ppm or less.

10. The composition of claim 8 or claim 9, wherein the 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, preferably <1000 ppm, more preferably <100 ppm.
11. A process comprising,
 - a) contacting one of (i) 1,2-dichloro-1,2-difluoroethane (HFC-132) and (ii) 1,1,1,2-tetrafluoroethane in the liquid phase, a dehydrohalogenating agent, and a solvent,
 - b) producing a product mixture comprising at least one of E-1,2-difluoroethylene and Z-1,2-difluoroethylene, and one or more 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-1-fluoroethene (HCFO-Z-1131), and (v) 1-chloro-2,2-difluoroethylene (HCFO-1122), and wherein acetylene and fluoroacetylene are present at a first level, and
 - c) treating the product mixture to reduce the amount of acetylene and fluoroacetylene to a level less than the first level wherein the amount of acetylene and fluoroacetylene are respectively one of <100ppm, <50 ppm, <25ppm, <10ppm or <1 ppm.

12. The process of claim 11, wherein the treating comprises distilling the product mixture and forming a 1,2-difluoroethylene fraction, and scrubbing the 1,2-difluoroethylene fraction.
13. The process of claim 12, wherein the scrubbing comprises contacting the product mixture with hydrogen halides selected from one of hydrofluoric acid, hydrochloric acid, hydrobromic acid and hydroiodic acid.
14. The process of claim 12, wherein the scrubbing comprises contacting the product mixture with one of sulfuric acid or sodium hypochlorite.
15. The process of claim 12, wherein the scrubbing comprises contacting the product mixture with one of a silica gel, a silica gel impregnated with sulfuric acid, or a silica gel impregnated with protic acid.
16. The process of claim 12, wherein the scrubbing comprises contacting the product mixture with one acetone, methanol, ethanol, N,N-dimethylformamide, and N-methyl-pyrrolidinone.
17. The process of any of claims 2 or 12, wherein the treating comprises passing the fraction through a bed of silica gel.
18. The process of any of claims 2 or 12, wherein the treating comprises contacting the fraction with sulfuric acid.
19. The process of any of claims 2 or 12, wherein the treating comprises contacting the fraction with N-methyl-pyrrolidinone.
20. The process of claim 17, wherein passage through a bed of silica gel reduces at least one of the acetylene and fluoroethylene (HFO-1141) to an amount <10 ppm or substantially free of at least one of the acetylene and fluoroethylene (HFO-1141).
21. The process of claim 18, wherein contacting the fraction with sulfuric acid reduces at least one of the acetylene and fluoroethylene (HFO-1141) to an amount of <10 ppm or substantially free of at least one of the acetylene and fluoroethylene (HFO-1141).
22. The process of claim 19, wherein contacting the fraction with N-methyl-pyrrolidinone reduces at least one of the acetylene and fluoroethylene (HFO-

- 1141) to an amount selected from one of <10 ppm or substantially free of at least one of the acetylene and fluoroethylene (HFO-1141).
23. A composition formed by the process of any one of claims 1-22.
24. The composition of claim 23, wherein the 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, preferably <1000 ppm, more preferably <100 ppm.
25. A process comprising subjecting a product mixture comprising at least one of E-1,2-difluoroethylene and Z-1,2-difluoroethylene, and first amounts of at least one of acetylene and fluoroethylene (HFO-1141) to fractional distillation.
26. The process of claim 25 further comprising distilling at least one of (i) a mixture comprising at least one of E-1,2-difluoroethylene and Z-1,2-difluoroethylene and second, lower amounts of at least one of acetylene and fluoroethylene, or (ii) a fraction rich in at least one of acetylene and fluoroethylene.
27. The process of claim 25 comprising distilling and withdrawing a fraction rich in at least one of acetylene and fluoroethylene., wherein the acetylene and/or fluoroethylene rich fraction is optionally selected from one substantially free of HFO-E-1132 or completely free of HFO-E-1132.
28. The process of claim 25 comprising distilling and withdrawing a E-1,2-difluoroethylene and Z-1,2-difluoroethylene rich fraction and an acetylene and fluoroethylene rich fraction, wherein the acetylene and/or fluoroethylene rich fraction is optionally selected from one substantially free of HFO-E-1132 or completely free of HFO-E-1132.
29. A process comprising:
- a) providing comprising E-1,2-difluoroethylene or Z-1,2-difluoroethylene or a mixture of E-1,2-difluoroethylene, Z-1,2-difluoroethylene, at least acetylene, fluoroacetylene, and optionally one or more additional compounds selected from HFO-1141, HCFO-E-1131, HCFO-E-1122a, HCFO-Z-1122a, HCFO-1131a, HCFO-E-1131, HCFO-Z-1131, HCO-1140, HFC-134, and HCFO-1122, wherein the at least acetylene and fluoroacetylene are at a first level,

- b) subject the mixture to fraction distillation to produce a first fraction,
- c) scrubbing the first fraction wherein each of the amounts of acetylene and fluoroethylene (HFO-1141) is present in an amount that is at least one of at least 50% lower, at least 60% lower, at least 70% lower than said first level,

wherein the scrubbing is selected from one of:

- d) treatment with hydrogen halides selected from one of hydrofluoric acid, hydrochloric acid, hydrobromic acid and hydroiodic acid,
 - e) treatment with one of sulfuric acid or sodium hypochlorite,
 - f) treatment with a silica gel, or silica gel impregnated with sulfuric acid or protic acid, or
 - g) treatment with a solvent selected from one of acetone, methanol, ethanol, N,N-dimethylformamide, and N-methyl-pyrrolidinone.
30. The process of any of claims 1-22 wherein level of less acetylene, fluoroacetylene, vinyl chloride (HCO-1140), and/or fluoroethylene (HFO-1141) is selected from one of <1000 ppm, <500 ppm, <400 ppm, <300 ppm, <200 ppm, <100 ppm, <50 ppm, <10 ppm, <5 ppm, <1 ppm, or substantially free of any one of acetylene, fluoroacetylene, vinyl chloride (HCO-1140), and/or fluoroethylene (HFO-1141) containing <0.9 ppm including 0 ppm.