CLAIMS

What is claimed is:

1. A process comprising,

   (a) converting a tetrafluoroethane feed selected from one of a 1,1,1,2-tetrafluoroethane (HFC-134a) feed or a 1,1,2,2-tetrafluoroethane (HFC-134) feed to a first product mixture comprising 1,1,2-trifluoroethylene (HFO-1123),

   (b) contacting the first product mixture comprising HFO-1123 and hydrogen to form a second product mixture comprising 1,1,1-trifluoroethane (HFC-143), and

   (c) converting the second product mixture comprising HFC-143 to a third product mixture comprising E-1,2-difluoroethylene (HFO-E-1132) and Z-1,2-difluoroethylene (HFO-Z-1132).

2. The process of claim 1, wherein the third product mixture comprises one of:

   i. HFO-E-1132 and one or more additional compounds selected from the group consisting of 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-1,1,2-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) in an amount between ≥ 0 and <100 ppm, 1,1,2-trifluoroethane (HFC-143), fluoromethane (HFC-41), chlorodifluoromethane (HCFC-22), ethylene, 1-chloro-1,2-difluoroethane (HCFC-142a), 1,1-difluoroethylene (HFO-1132a), vinyl chloride (HCO-1140), 1-chloro-1-fluoroethene (HCFO-1131a), E-1-chloro-2-fluoroethene (HCFO-E-1131), Z-1-chloro-2-fluoroethene (HCFO-Z-1131), and 1-chloro-2,2-difluoroethylene (HCFO-1122), or

   ii. HFO-Z-1132 and one or more additional compounds selected from the group consisting of HFO-E-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-1,1,2-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) in an amount between ≥0 and <100 ppm, 1,1,2-trifluoroethane (HFC-143), fluoromethane (HFC-41), chlorodifluoromethane (HCFC-22), ethylene, 1-chloro-1,2-difluoroethane (HCFC-142a), 1,1-difluoroethylene (HFO-1132a), vinyl chloride (HCO-1140), 1-chloro-1-fluoroethene (HCFO-1131a), E-1-chloro-2-fluoroethene (HCFO-E-1131), Z-1-chloro-2-fluoroethene (HCFO-Z-1131), and 1-chloro-2,2-difluoroethylene (HCFO-1122).

3. The process of claim 1 or claim 2, wherein at least a portion of the Z-1,2-difluoroethylene (HFO-Z-1132) in the third product mixture is isomerized to E-1,2-difluoroethylene (HFO-E-1132) to form an isomerized mixture having a greater E/Z ratio compared to the third product mixture.

4. The process of claim 3, wherein the isomerization is conducted at a temperature between 600°C and 800°C; and/or wherein the isomerization is conducted in the presence of a catalyst.

5. The process of claim 4, wherein the catalyst comprises a material selected from the group consisting of Cr_2O_3, fluorided Cr_2O_3, Al_2O_3, fluorided Al_2O_3, AlF_3, chromium supported on alumina, and cobalt- or nickel-substituted chromium oxide.

6. The process of any one of claims 3 to 5, wherein the amount of each of vinyl chloride (HCO-1140), acetylene, fluoroacetylene, and fluoroethylene (HFO-1141) present in one of the third product mixture or the isomerized mixture, is selected from one of <200 ppm, <100 ppm, <50 ppm, <10 ppm, or <5 ppm, preferably ≤10 ppm, ≤5 ppm, ≤4 ppm, ≤3 ppm, ≤2 ppm, or ≤1 ppm.

7. The process of any one of claims 1 to 6, wherein the converting the 1,1,1,2-tetrafluoroethane (HFC-134a) feed or the 1,1,2,2-tetrafluoroethane (HFC-134) feed comprises dehydrofluorination, optionally in the presence of HF, to form the first 1,1,2-trifluoroethylene (HFO-1123) product mixture.

8. The process of claim 7, wherein the dehydrofluorination is conducted in the gas phase at a temperature of between 200°C and 500°C; and/or wherein the dehydrofluorination is conducted in the presence of a catalyst.

9. The process of claim 8, wherein the catalyst comprises a material selected from the group consisting of chromium (III) oxide (Cr_2O_3), aluminum oxide (alumina, Al_2O_3), aluminum fluoride (AlF_3), fluorided alumina, chromium oxide/aluminum oxide mixtures, chromium oxide supported on AlF_3, chromium fluoride and cubic chromium fluoride, preferably one of aluminum oxide (alumina, Al_2O_3), aluminum fluoride (AlF_3), or fluorided alumina.

10. The process of any one of claims 1 to 9, wherein the contacting of HFO-1123 and hydrogen is conducted in a liquid phase or vapor phase and comprises hydrogenation of the first product mixture comprising 1,1,2-trifluoroethylene to the second product mixture comprising 1,1,1-trifluoroethane (HFC-143).

11. The process of claim 10, wherein the contacting of HFO-1123 and hydrogen is conducted in the liquid phase.

12. The process of claim 11, wherein the hydrogenation is conducted in the liquid phase at a temperature between 30°C and 150°C.

13. The process of claim 10, wherein the contacting of the 1,1,2-trifluoroethylene (HFO-1123) and hydrogen is conducted in the vapor phase in the presence of a catalyst, optionally supported on carbon.

14. The process of claim 13, wherein the hydrogenation is conducted in the vapor phase at a temperature between 50°C and 200°C.

15. The process of any one of claims 1 to 14, wherein the converting of the second product mixture comprising HFC-143 involves dehydrofluorination conducted in a liquid phase or vapor phase to form the third product mixture of Z-1,2-difluoroethylene (HFO-Z-1132) and E-1,2-difluoroethylene (HFO-E-1132).

16. The process of claim 15, wherein dehydrofluorination of 1,1,2-trifluoroethane (HFC-143) in the second product mixture is conducted in the liquid phase at a temperature between -20°C and 150°C or at a temperature between -20°C and 100°C.

17. The process of claim 15, wherein dehydrofluorination of 1,1,2-trifluoroethane (HFC-143) in the second mixture is conducted in the vapor phase at a temperature between 150°C and 400°C.

18. The process of claim 15, where dehydrofluorination of 1,1,2-trifluoroethane (HFC-143) is conducted in the gas phase in the presence of a catalyst which may be the same or different than catalyst used for converting 1,1,1,2-tetrafluoroethane (HFC-134a) or 1,1,2,2-tetrafluoroethane (HFC-134).

19. The process of claim 18, wherein the catalyst for converting HFC-143 comprises a material selected from the group consisting of chromium (III) oxide (Cr_2O_3), aluminum oxide (alumina, Al_2O_3), aluminum fluoride (AlF_3), fluorided alumina, chromium oxide/aluminum oxide mixtures, chromium oxide supported on AlF_3, chromium fluoride and cubic chromium fluoride, preferably one of aluminum oxide (alumina, Al_2O_3), aluminum fluoride (AlF_3), or fluorided alumina.

20. An HFO-E/Z-1132 composition comprising at least one compound selected from fluoroacetylene, HFO-1141, HCO-1140, or acetylene, each compound, if present, is contained in the composition in an amount selected from one of <200 ppm, <100 ppm, <50 ppm, <10 ppm, or <5 ppm, preferably ≤10 ppm, ≤5 ppm, ≤4 ppm, ≤3 ppm, ≤2 ppm, or ≤1 ppm.

21. An HFO-E-1132 composition comprising at least one compound selected from fluoroacetylene, HFO-1141, HCO-1140, or acetylene, each compound, if present, is contained in the composition in an amount selected from one of ≤10 ppm, ≤5 ppm, ≤4 ppm, ≤3 ppm, ≤2 ppm, or ≤1 ppm.

22. An HFO-Z-1132 composition comprising at least one compound selected from fluoroacetylene, HFO-1141, HCO-1140, or acetylene, each compound, if present, is contained in the composition in an amount selected from one of ≤10 ppm, ≤5 ppm, ≤4 ppm, ≤3 ppm, ≤2 ppm, or ≤1 ppm.

23. A composition comprising one of:

    (i) HFO-1123 which comprises one or more additional compounds selected from the group consisting of 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);

(ii) HFC-143 which comprises one or more additional compounds selected from the group consisting of 1,1,2-trifluoroethylene (HFO-1123), 1,1,1,2-tetrafluoroethane (HFC-134a), 1,1-difluoroethane (HFC-152a), 1,1,1,3,3,3-hexafluoropropane (HFC-236fa), HFO-Z-1132, HCFO-E-1122a, HCFO-Z-1122a, vinyl chloride (HCO-1140), HCFC-133b, HCFC-133, Z-1-chloro-2-fluoroethylene (HCFO-Z-1131), E-1-chloro-2-fluoroethylene (HCFO-E-1131), HCFC-151a, HCC-160, CFC-113, 1,1-difluoroethylene (HFO-1132a), 1,1,1-trifluoromethane (HFC-143a), 1-chloro-l,2,2-trifluoroethylene (CFO-1113), 1-chloro-1-fluoroethylene (HCFO-1131a), 1,2-difluoroethane (HFC-152) in an amount between ≥0 and <100 ppm, 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), E/Z-1-chloro-1,2-difluoroethylene (HCFO-E/Z-1122a), fluoroethylene (HFO-1141), dichlorofluoromethane (HCFC-21), chlorodifluoromethane (HCFC-22), trifluoromethane, (HFC-23), ethylene, and acetylene;

(iii) HFO-E-1132 which comprises (i) two or more additional compounds selected from the group consisting of 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) in an amount between ≥0 and <100 ppm, 1,1,2-trifluoroethane (HFC-143), fluoromethane (HFC-41), chlorodifluoromethane (HCFC-22), ethylene,1-chloro-1,2-difluoroethane (HCFC-142a), 1,1-difluoroethylene (HFO-1132a), vinyl chloride (HCO-1140), 1-chloro-1-fluoroethene (HCFO-1131a), E-1-chloro-2-fluoroethene (HCFO-E-1131), Z-1-chloro-2-fluoroethene (HCFO-Z-1131), and 1-chloro-2,2-difluoroethylene (HCFO-

1122), and (ii) optionally fluoroethylene (HFO-1141), HCO-1140, fluoroacetylene or acetylene, each in an amount which is selected from one of <200 ppm, <100 ppm, <50 ppm, <10 ppm, or <5 ppm, preferably ≤10 ppm, ≤5 ppm, ≤4 ppm, ≤3 ppm, ≤2 ppm, or ≤1 ppm, if present; or

(iv) HFO-Z-1132 which comprises (i) one or more additional compounds, preferably two or more additional compounds, selected from the group consisting of HFO-E-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-1,1,2-trifluoroethane (HCFC-133b), 1-chloro-1,2,2-trifluoroethane (HCFC-133), 1,1-dichloro-2,2,2-trifluoroethane (HCFC-123), 1,2-difluoroethane (HFC-152) in an amount between ≥0 and <100 ppm, 1,1,2-trifluoroethane (HFC-143), fluoromethane (HFC-41), chlorodifluoromethane (HCFC-22), ethylene,1-chloro-1,2-difluoroethane (HCFC-142a), 1,1-difluoroethylene (HFO-1132a), vinyl chloride (HCO-1140), 1-chloro-1-fluoroethene (HCFO-1131a), E-1-chloro-2-fluoroethene (HCFO-E-1131), Z-1-chloro-2-fluoroethene (HCFO-Z-1131), and 1-chloro-2,2-difluoroethylene (HCFO-1122), and (ii) optionally fluoroethylene (HFO-1141), HCO-1140, fluoroacetylene or acetylene, each in an amount which is selected from one of one of <200 ppm, <100 ppm, <50 ppm, <10 ppm, or <5 ppm, preferably ≤10 ppm, ≤5 ppm, ≤4 ppm, ≤3 ppm, ≤2 ppm, or ≤1 ppm, if present.

24. The composition of claim 23 comprising **(iii)**, wherein the amount of each of fluoroethylene (HFO-1141), HCO-1140, fluoroacetylene or acetylene is selected from one of <100 ppm, <50 ppm, <10 ppm, or <5 ppm, preferably one of ≤10 ppm, ≤5 ppm, ≤4 ppm, ≤3 ppm, ≤2 ppm, or ≤1 ppm.

25. The composition of claim 23, wherein composition **(iii)** is an isomerized composition and the amount of each of fluoroethylene (HFO-1141), HCO-1140, fluoroacetylene or acetylene is selected from one of <100 ppm, <50 ppm, <10 ppm, or <5 ppm, preferably one of ≤10 ppm, ≤5 ppm, ≤4 ppm, ≤3 ppm, ≤2 ppm, or ≤1 ppm.