CLAIMS OF THE INVENTION

What is claimed is:

1. A process of preparing a mixture comprising Z-1,3,3,3-tetrafluoropropene and E-1,3,3,3-tetrafluoropropene, the process comprising:

   (i) reacting vinyl chloride (CH_2=CHCl) and carbon tetrachloride (CCl_4) in the presence of catalyst system comprising a metal-containing compound and a phosphorus-containing compound to make a product comprising 1,1,1,3,3-pentachloropropane ($CCl_3CH_2CHCl_2$, HCC-240fa);

   (ii) fluorinating the HCC-240fa with a fluorination agent in the presence of a fluorination catalyst to produce a product comprising 1,1,1,3,3-pentafluoropropane ($CF_3CH_2CHF_2$, HFC-245fa); and

   (iii) contacting HFC-245fa in the gas phase with a catalyst, in the presence of an oxygen containing gas, to form a reaction mixture comprising Z-1,3,3,3-tetrafluoropropene and E-1,3,3,3-tetrafluoropropene.

2. The process of claim 1, wherein a feed composition comprising the carbon tetrachloride further comprises one or more additional compounds selected from the group consisting of trichloroethylene ($CClH=CCl_2$), tetrachloroethylene ($CCl_2=CCl_2$), hexachloroethane (CCl_3CCl_3), bromotrichloromethane (CCl_3Br), chloroform (CCl_3H), 1,1,1-trichloroethane (CCl_3CH_3), 1,1,2-trichloroethane ($CHCl_2CH_2Cl$), trans-1,2-dichloroethylene (E-CHCl=CHCl), cis-1,2-dichloroethylene (Z-CHCl=CHCl) and 1,1-dichloroethylene ($CH_2=CCl_2$).

3. The process of claim 1 or claim 2, wherein the product comprising HCC-240fa further comprises one or more additional compounds selected from the group consisting of 1-chlorobutane; 1,2,3-trichloropropene ($CHCl=CCl-CH_2Cl$, HCO-1240xd); HCO-1230xd ($CHCl=CCl-CHCl_2$, 1,2,3,3-tetrachloropropene); 1,1,1,3-tetrachloropropane (CCl_3-CH_2-CH_3, HCC-250fb); 1,4 dichlorobutane; 1,2-dichloro-cyclobutane, 1,1,4,4-tetrachlorobutadiene; 1,1,3,4 tetrachlorobutadiene; 1,1,1,2,3-pentachloropropane (HCC-240db); $C_5H_7Cl_3$ isomer(s) and $C_4H_7Cl_3$ isomer(s).

4. The process of any one of claims 1 to 3,

wherein the metal-containing compound of the catalyst system of step (i) comprises an iron-containing compound; and/or

wherein the phosphorous-containing compound of the catalyst system comprises a phosphine, preferably triphenyl phosphine or tributyl phosphine, or a phosphate, preferably tributyl phosphate; and/or

wherein the fluorination catalyst is a Lewis acid catalyst, preferably selected from the group consisting of $SbCl_5$, $SbCl_3$, SbF_5, $SnCl_4$, $TiCl_4$, NiF_5, $FeCl_3$, and combinations of two or more thereof; and/or

wherein the catalyst of step (iii) comprises chromium.

5. The process of any one of claims 1 to 4, wherein the product comprising HFC-245fa further comprises two or more additional compounds selected from the group consisting of:

   (i) HFC-143a, HFC-1225zc, HFC-236fa, HFO-E/Z-1234ze, HCFC-22, CFC-12, HCFC-142b, HCFC-133a, HCFC-1224, HCFC-235fa, HCFC-1233, HCFC-235da, HCFC-123, HCFC-141b, HCFC-234fb, HCFC-1223xd, HCC-20, HCFC-224aa, CFC-1213xa, HCFC-233da, and HCFC-223aa; or

   (ii) HFO-1234ze(E), HFC-338mf, HFC-356mff, HFO-1234ze(Z), HFO-1234zc, HFC-347 isomer, HCFC-133a, HCFC-244bb, HCFC-235fa, HCFO-1326mxz(Z), HCFO-1224yd, HCFO-123zd(E), HCFO-1224zc, HCC-160, HCFC-244, HCFO-1335, HCFC-123, HCFC-123a, HCFO-123zd(Z), 1233zd (Br), CFO-1214ya, HCC-30, CFC-113, HCFO-1223xd, HCO-1130a and HCO-1130.

6. The process of any one of claims 1 to 5, wherein an E:Z ratio of the reaction mixture is from about 10:1 to about 3:1.

7. A composition comprising HFO-1234ze(E) and HFO-1234ze(Z), the composition being produced by the process of any one of claims 1 to 6, the composition further comprising one or more additional compounds selected from the group consisting of HFC-134a, HFO-1225zc, HFO-1234yf, HFC-245cb, HFC-236fa, HFC-1225ye(E), HFO-1234zc, HFC-245fa, HCFC-124, CFC-114, trifluoropropyne, HFC-152a, HFC-1225ye(Z), HFC-1225ye(E),

HCFO-1233xf, HFC-263fb, HFO-1243zf and HCFO-1233zd(E); and one or more additional compounds selected from the group consisting of HFC-263fb, HFO-1234zc, HFC-245fa, HCFO-1233zd(E), HCFO-1233zd(Z), HCFO-1233xf, HCFC-124, HCC-40, CFC-114, HCFC-1131(E), CFC-114a, HCFC-124a, HFC-227ca, HFO-1234yf, HFC-152a, HFO-1234zf, HFC-134 and HFC-245cb.

8. A composition comprising (a) HFO-1234ze(E), HFO-1234ze(Z) and HFC-245fa; (b) HFO-1234ze(Z), HFO-1234ze(E), HFO-1233zd(E) and HFC-245fa; or (c) HFO-1234ze(Z) and HFC-245fa;

wherein the composition (a) further comprises (i) one or more additional compounds selected from the group consisting of HFC-134a, HFO-1225zc, HFO-1234yf, HFC-245cb, HFC-236fa, HFC-1225ye(E), HFO-1234zc, HCFC-124, CFC-114, trifluoropropyne, HFC-152a, HFC-1225ye(Z), HFC-1225ye(E), HCFO-1233xf, HFC-263fb, HFO-1243zf and HCFO-1233zd(E); (ii) one or more additional compounds selected from the group consisting of HFC-263fb, HFO-1234zc, HCFO-1233zd(E), HCFO-1233zd(Z), HCFO-1233xf, HCFC-124, HCC-40, CFC-114, HCFC-1131(E), CFC-114a, HCFC-124a, HFC-227ca, HFO-1234yf, HFC-152a, HFO-1234zf, HFC-134 and HFC-245cb; and (iii) one or more additional compounds selected from the group consisting of HFC-143a, HFC-1225zc, HFC-236fa, HCFC-22, CFC-12, HCFC-142b, HCFC-133a, HCFC-1224, HCFC-235fa, HCFC-1233, HCFC-235da, HCFC-123, HCFC-141b, HCFC-234fb, HCFC-1223xd, HCC-20, HCFC-224aa, CFC-1213xa, HCFC-233da, and HCFC-223aa, or one or more additional compounds selected from the group consisting of HFC-338mf, HFC-356mff, HFO-1234zc, HFC-347 isomer, HCFC-133a, HCFC-244bb, HCFC-235fa, HCFO-1326mxz(Z), HCFO-1224yd, HCFO-123zd(E), HCFO-1224zc, HCC-160, HCFC-244, HCFO-1335, HCFC-123, HCFC-123a, HCFO-123zd(Z), 1233zd (Br), CFO-1214ya, HCC-30, CFC-113, HCFO-1223xd, HCO-1130a and HCO-1130;

wherein the composition (b) further comprises (i) one or more additional compounds selected from the group consisting of HFC-263fb, HFO-1234zc, HCFO-1233zd(Z), HCFO-1233xf, HCFC-124, HCC-40, CFC-114, HCFC-1131(E), CFC-114a, HCFC-124a, HFC-227ca, HFO-1234yf, HFC-152a, HFO-1234zf, HFC-134 and HFC-245cb; (ii) one or more additional

compounds selected from the group consisting of Z-HFO-1234ze, E-HFO-1234ze and HFC-245fa; (iii) one or more additional compounds selected from the group consisting of HFC-134a, HFO-1225zc, HFO-1234yf, HFC-245cb, HFC-236fa, HFC-1225ye(E), HFO-1234zc, HCFC-124, CFC-114, trifluoropropyne, HFC-152a, HFC-1225ye(Z), HFC-1225ye(E), HCFO-1233xf, HFC-263fb andHFO-1243zf; and (iv) one or more additional compounds selected from the group consisting of HFC-143a, HFC-1225zc, HFC-236fa, HCFC-22, CFC-12, HCFC-142b, HCFC-133a, HCFC-1224, HCFC-235fa, HCFC-1233, HCFC-235da, HCFC-123, HCFC-141b, HCFC-234fb, HCFC-1223xd, HCC-20, HCFC-224aa, CFC-1213xa, HCFC-233da, and HCFC-223aa, or one or more additional compounds selected from the group consisting of HFC-338mf, HFC-356mff, HFO-1234zc, HFC-347 isomer, HCFC-133a, HCFC-244bb, HCFC-235fa, HCFO-1326mxz(Z), HCFO-1224yd, HCFO-1224zc, HCC-160, HCFC-244, HCFO-1335, HCFC-123, HCFC-123a, HCFO-123zd(Z), 1233zd (Br), CFO-1214ya, HCC-30, CFC-113, HCFO-1223xd, HCO-1130a and HCO-1130; or

wherein the composition (c) further comprises (i) one or more additional compounds selected from the group consisting of HFO-1234ze(E), HFC-263fb, HFO-1234zc, HCFO-1233zd(E), HCFO-1233zd(Z), HCFO-1233xf, HCFC-124, HCC-40, CFC-114, HCFC-1131(E), CFC-114a, HCFC-124a, HFC-227ca, HFO-1234yf, HFC-152a, HFO-1234zf, HFC-134 and HFC-245cb; and (ii) one or more additional compounds selected from the group consisting of HFC-143a, HFC-1225zc, HFC-236fa, HFO-1234ze(E), HCFC-22, CFC-12, HCFC-142b, HCFC-133a, HCFC-1224, HCFC-235fa, HCFC-1233, HCFC-235da, HCFC-123, HCFC-141b, HCFC-234fb, HCFC-1223xd, HCC-20, HCFC-224aa, CFC-1213xa, HCFC-233da, and HCFC-223aa, or one or more additional compounds selected from the group consisting of HFO-1234ze(E), HFC-338mf, HFC-356mff, HFO-1234zc, HFC-347 isomer, HCFC-133a, HCFC-244bb, HCFC-235fa, HCFO-1326mxz(Z), HCFO-1224yd, HCFO-123zd(E), HCFO-1224zc, HCC-160, HCFC-244, HCFO-1335, HCFC-123, HCFC-123a, HCFO-123zd(Z), 1233zd (Br), CFO-1214ya, HCC-30, CFC-113, HCFO-1223xd, HCO-1130a and HCO-1130.

9. A composition comprising HFO-1234ze(Z) and at least one compound selected from the group consisting of HFO-1234ze(E), HFO-1233zd(E), HFC-245fa, HFO-1336mzz(E), HFO-1336mzz(Z), HFC-227ea, HFC-134a and HFC-134; the composition further comprising one or more additional compounds selected from the group consisting of HFO-1234ze(E), HFC-263fb, HFO-1234zc, HFC-245fa, HCFO-1233zd(E), HCFO-1233zd(Z), HCFO-1233xf, HCFC-124, HCC-40, CFC-114, HCFC-1131(E), CFC-114a, HCFC-124a, HFC-227ca, HFO-1234yf, HFC-152a, HFO-1234zf, HFC-134 and HFC-245cb.

10. A composition comprising one of:

(a) HFO-1234ze(Z), HFO-1234ze(E) and HFC-227ea, and further comprising (i) one or more additional compounds selected from the group consisting of HFO-1234ze(E), HFC-263fb, HFO-1234zc, HFC-245fa, HCFO-1233zd(E), HCFO-1233zd(Z), HCFO-1233xf, HCFC-124, HCC-40, CFC-114, HCFC-1131(E), CFC-114a, HCFC-124a, HFC-227ca, HFO-1234yf, HFC-152a, HFO-1234zf, HFC-134 and HFC-245cb; (ii) one or more additional compounds selected from the group consisting of HFC-134a, HFO-1225zc, HFO-1234yf, HFC-245cb, HFC-236fa, HFC-1225ye(E), HFO-1234zc, HFC-245fa, HCFC-124, HFO-1234ze(Z), CFC-114, trifluoropropyne, HFC-152a, HFC-1225ye(Z), HFC-1225ye(E), HCFO-1233xf, HFC-263fb, HFO-1243zf and HCFO-1233zd(E); and (iii) one or more additional compounds selected from the group consisting of FC-1216 and HCFC-124;

(b) HFO-1234ze(Z), HFO-1234ze(E), and HFC-134a, and further comprising (i) one or more additional compounds selected from the group consisting of HFO-1234ze(E), HFC-263fb, HFO-1234zc, HFC-245fa, HCFO-1233zd(E), HCFO-1233zd(Z), HCFO-1233xf, HCFC-124, HCC-40, CFC-114, HCFC-1131(E), CFC-114a, HCFC-124a, HFC-227ca, HFO-1234yf, HFC-152a, HFO-1234zf, HFC-134 and HFC-245cb, (ii) one or more additional compounds selected from the group consisting of HFC-134a, HFO-1225zc, HFO-1234yf, HFC-245cb, HFC-236fa, HFC-1225ye(E), HFO-1234zc, HFC-245fa, HCFC-124, HFO-1234ze(Z), CFC-114, trifluoropropyne, HFC-152a, HFC-1225ye(Z), HFC-1225ye(E), HCFO-1233xf, HFC-263fb, HFO-1243zf and HCFO-1233zd(E), and (iii) one or more additional compounds selected from the group

consisting of HFC-134, HCFC-124, HCFO-1122, HFC-143a, HCFC-31, HFC-32, HFC-125, CFC-114 and CFC-114a;

(c) HFO-1234ze(Z) and HFO-1336mzz(Z), and further comprising (i) one or more additional compounds selected from the group consisting of HFO-1336mzz(E), HFO-1327mz, HFO-1326mxz(Z), HFO-1326mxz(E), HFC-356mff, CHFC-346mdf, and HFC-263fb, and (ii) one or more additional compounds selected from the group consisting of HFO-1234ze(E), HFC-263fb, HFO-1234zc, HFC-245fa, HCFO-1233zd(E), HCFO-1233zd(Z), HCFO-1233xf, HCFC-124, HCC-40, CFC-114, HCFC-1131(E), CFC-114a, HCFC-124a, HFC-227ca, HFO-1234yf, HFC-152a, HFO-1234zf and HFC-245cb;

(d) HFO-1234ze(Z), HFO-1336mzz(E) and HFO-1336mzz(Z), and further comprising (i) one or more additional compounds selected from the group consisting of HFO-1327mz, HFO-1326mxz(Z), HFO-1326mxz(E), HFC-356mff, CHFC-346mdf, and HFC-263fb, (ii) one or more additional compounds selected from the group consisting of C-30, HCFC-114, HCFC-114a, HCFC-133, HCFC-133a, HFC-245fa, HFC-338mee, HFC-338mf, HFC-347mef, HCO-1140, HCFO-1224 isomers, HCFO-1224yd, HCFO-1224yb, HCFO-1233xf, HCFO-1233zd, HFO-1243zf, HFO-1327mz, HFO-1336ft and HCFO-1326mxz, and (iii) one or more additional compounds selected from the group consisting ofHFO-1234ze(E), HFC-263fb, HFO-1234zc, HFC-245fa, HCFO-1233zd(E), HCFO-1233zd(Z), HCFO-1233xf, HCFC-124, HCC-40, CFC-114, HCFC-1131(E), CFC-114a, HCFC-124a, HFC-227ca, HFO-1234yf, HFC-152a, HFO-1234zf and HFC-245cb;

(e) HFO-1234ze(Z), HFO-1234ze(E) and HFC-134, and further comprising (i) one or more additional compounds selected from the group consisting of HFC-263fb, HFO-1234zc, HFC-245fa, HCFO-1233zd(E), HCFO-1233zd(Z), HCFO-1233xf, HCFC-124, HCC-40, CFC-114, HCFC-1131(E), CFC-114a, HCFC-124a, HFC-227ca, HFO-1234yf, HFC-152a, HFO-1234zf and HFC-245cb, (ii) one or more additional compounds selected from the group consisting of HFC-134a, HFO-1225zc, HFO-1234yf, HFC-245cb, HFC-236fa, HFC-1225ye(E), HFO-1234zc, HFC-245fa, HCFC-124, CFC-114, trifluoropropyne, HFC-152a, HFC-1225ye(Z), HFC-1225ye(E), HCFO-1233xf, HFC-263fb, HFO-1243zf and

HCFO-1233zd(E), and (iii) one or more additional compounds selected from the group consisting of 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 HC-161;

(f) HFO-1234ze(Z), HFO-1234ze(E) and HFO-1336mzz(E), and further comprising (i) one or more additional compounds selected from the group consisting of HFC-263fb, HFO-1234zc, HFC-245fa, HCFO-1233zd(E), HCFO-1233zd(Z), HCFO-1233xf, HCFC-124, HCC-40, CFC-114, HCFC-1131(E), CFC-114a, HCFC-124a, HFC-227ca, HFO-1234yf, HFC-152a, HFO-1234zf and HFC-245cb, (ii) one or more additional compounds selected from the group consisting of HFC-134a, HFO-1225zc, HFO-1234yf, HFC-245cb, HFC-236fa, HFC-1225ye(E), HFO-1234zc, HFC-245fa, HCFC-124, CFC-114, trifluoropropyne, HFC-152a, HFC-1225ye(Z), HFC-1225ye(E), HCFO-1233xf, HFC-263fb, HFO-1243zf and HCFO-1233zd(E), and (iii) one or more additional compounds selected from the group consisting of C-30, HCFC-114, HCFC-114a, HCFC-133, HCFC-133a, HFC-245fa, HFC-338mee, HFC-338mf, HFC-347mef, HCO-1140, HCFO-1224 isomers, HCFO-1224yd, HCFO-1224yb, HCFO-1233xf, HCFO-1233zd, HFO-1243zf, HFO-1327mz, HFO-1336ft and HCFO-1326mxz; or

(g) HFO-1234ze(Z), HFO-1234ze(E), HFO-1336mzz(E) and HFO-1336mzz(E), and further comprising (i) one or more additional compounds selected from the group consisting of HFC-263fb, HFO-1234zc, HFC-245fa, HCFO-1233zd(E), HCFO-1233zd(Z), HCFO-1233xf, HCFC-124, HCC-40, CFC-114, HCFC-1131(E), CFC-114a, HCFC-124a, HFC-227ca, HFO-1234yf, HFC-152a, HFO-1234zf and HFC-245cb, (ii) one or more additional compounds selected from the group consisting of HFC-134a, HFO-1225zc, HFO-1234yf, HFC-245cb, HFC-236fa, HFC-1225ye(E), HFO-1234zc, HFC-245fa, HCFC-124, CFC-114, trifluoropropyne, HFC-152a, HFC-1225ye(Z), HFC-1225ye(E), HCFO-1233xf, HFC-263fb, HFO-1243zf and HCFO-1233zd(E), (iii) one or more additional compounds selected from the group consisting of C-30, HCFC-114, HCFC-114a, HCFC-133, HCFC-133a, HFC-245fa, HFC-338mee, HFC-338mf, HFC-347mef, HCO-1140, HCFO-1224 isomers, HCFO-1224yd, HCFO-1224yb, HCFO-1233xf, HCFO-1233zd, HFO-1243zf, HFO-1327mz, HFO-1336ft and

HCFO-1326mxz, and (iv) one or more additional compounds selected from the group consisting of HFO-1327mz, HFO-1326mxz(Z), HFO-1326mxz(E), HFC-356mff, CHFC-346mdf, and HFC-263fb.

11. A method for producing heating in a high temperature heat pump, the method comprising condensing the composition of any one of claims 7 to 10 in a condenser, wherein the high temperature heat pump uses condenser operating temperatures greater than about 55°C, preferably from about 55°C to about 150°C.

12. A high temperature heat pump comprising a condenser and the composition of any one of claims 7 to 10, wherein an operating temperature of the condenser is greater than about 55°C, preferably from about 55°C to about 150°C, more preferably greater than about 150°C.

13. The process of any one of claims 1 to 6, wherein a feed composition for (iii) comprises HFC-245fa, and one or more additional compounds selected from the group consisting of HFC-143a, HFC-1225zc, HFC-236fa, HFO-E/Z-1234ze, HCFC-22, CFC-12, HCFC-142b, HCFC-133a, HCFC-1224, HCFC-235fa, HCFC-1233, HCFC-235da, HCFC-123, HCFC-141b, HCFC-234fb, HCFC-1223xd, HCC-20, HCFC-224aa, CFC-1213xa, HCFC-233da, and HCFC-223aa, or one or more additional compounds selected from the group consisting of HFO-1234ze(E), HFC-338mf, HFC-356mff, HFO-1234ze(Z), HFO-1234zc, HFC-347 isomer, HCFC-133a, HCFC-244bb, HCFC-235fa, HCFO-1326mxz(Z), HCFO-1224yd, HCFO-123zd(E), HCFO-1224zc, HCC-160, HCFC-244, HCFO-1335, HCFC-123, HCFC-123a, HCFO-123zd(Z), 1233zd (Br), CFO-1214ya, HCC-30, CFC-113, HCFO-1223xd, HCO-1130a and HCO-1130, and

wherein the feed composition has a moisture content of less than about 50 ppm, preferably less than about 20 ppm, more preferably less than about 10 ppm, and a non-absorbable gases (NAG) content of greater than zero and less than about 10%, preferably less than about 5%, more preferably less than about 3%, most preferably less than about 1.5%.