

Azeotrope and Azeotrope-like Compositions Comprising
Neopentane and Isomers of HFO-1336mzz

TECHNICAL FIELD

The present application relates to azeotrope and azeotrope-like compositions comprising neopentane and a compound selected from E-1,1,1,4,4,4-hexafluoro-2-butene (HFO-1336mzz(E)) and Z-1,1,1,4,4,4-hexafluoro-2-butene (HFO-1336mzz(Z)). The compositions described herein may be useful in a variety of applications including, but not limited to, heat transfer applications, and refrigeration applications.

BACKGROUND

Many industries have been working for the past few decades to find replacements for the ozone depleting chlorofluorocarbons (CFCs) and hydrochlorofluorocarbons (HCFCs). The CFCs and HCFCs have been employed in a wide range of applications, including their use, for example, as aerosol propellants, refrigerants and heat transfer media. In the search for replacements for these versatile compounds, many industries have turned to the use of hydrofluoroolefins (HFOs).

SUMMARY

The present application provides, *inter alia*, compositions comprising:

- i) neopentane (*i.e.*, 2,2-dimethylpropane); and
- ii) a compound selected from E-1,1,1,4,4,4-hexafluoro-2-butene (*i.e.*, HFO-1336mzz(E)) and Z-1,1,1,4,4,4-hexafluoro-2-butene (*i.e.*, HFO-1336mzz(Z)),

wherein the E-1,1,1,4,4,4-hexafluoro-2-butene or Z-1,1,1,4,4,4-hexafluoro-2-butene is present in the composition in an amount effective to form an azeotrope composition or an azeotrope-like composition with the neopentane.

The present application further provides methods of using the compositions provided herein as propellants and heat transfer agents (*e.g.*, in refrigeration or heat transfer applications).

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. Methods and materials are described herein

for use in the present invention; other, suitable methods and materials known in the art can also be used. The materials, methods, and examples are illustrative only and not intended to be limiting. All publications, patent applications, patents, sequences, database entries, and other references mentioned herein are
5 incorporated by reference in their entirety. In case of conflict, the present specification, including definitions, will control.

DESCRIPTION OF DRAWINGS

FIG. 1 displays the vapor/liquid equilibrium curve for a mixture of E-HFO-1336mzz and neopentane at a temperature of 29.88°C, and shows the
10 formation of an azeotrope of composition 0.552 mole fraction E-HFO-1336mzz and 0.448 mole fraction neopentane, which has a vapor pressure of 41.8 psia.

FIG. 2 displays the vapor/liquid equilibrium curve for a mixture of Z-HFO-1336mzz and neopentane at a temperature of 29.90°C, and shows the formation of an azeotrope of composition 0.220 mole fraction Z-HFO-1336mzz
15 and 0.780 mole fraction neopentane, which has a vapor pressure of 31.8 psia.

DETAILED DESCRIPTION

The present application provides compositions comprising:

- i) neopentane (*i.e.*, 2,2-dimethylpropane); and
- ii) a compound selected from E-1,1,1,4,4,4-hexafluoro-2-butene (*i.e.*,
20 HFO-1336mzz(E)) and Z-1,1,1,4,4,4-hexafluoro-2-butene (*i.e.*, HFO-1336mzz(Z)),

wherein the E-1,1,1,4,4,4-hexafluoro-2-butene or Z-1,1,1,4,4,4-hexafluoro-2-butene is present in the composition in an amount effective to form an azeotrope composition or an azeotrope-like composition with the neopentane.

25 Definitions and Abbreviations

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
30 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 are true (or present).

As used herein, the term “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 “consists essentially of” or “consisting essentially of” occupies a middle ground between “comprising” and “consisting of”.

For example, in some embodiments the composition provided herein consists essentially of:

- i) neopentane;
- ii) a compound selected from E-1,1,1,4,4,4-hexafluoro-2-butene (HFO-1336mzz(E)) and Z-1,1,1,4,4,4-hexafluoro-2-butene (HFO-1336mzz(Z)), wherein the E-1,1,1,4,4,4-hexafluoro-2-butene or Z-1,1,1,4,4,4-hexafluoro-2-butene is present in the composition in an amount effective to form an azeotrope composition or an azeotrope-like composition with the neopentane; and
- iii) one or more additional components as described herein (wherein the one or more additional components do not materially affect the basic and novel characteristic(s) of the composition).

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.

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

As used herein, the term “azeotropic composition” refers to a composition where at a given temperature at equilibrium, the boiling point pressure (of the liquid phase) is identical to the dew point pressure (of the vapor phase), *i.e.*, $X_2 = Y_2$. One way to characterize an azeotropic composition is that the vapor produced
5 by partial evaporation or distillation of the liquid has the same composition as the liquid from which it was evaporated or distilled, that is, the admixture distills/refluxes without compositional change. Constant boiling compositions are characterized as azeotropic because they exhibit either a maximum or minimum boiling point, as compared with that of the non-azeotropic mixtures of the same
10 components. Azeotropic compositions are also characterized by a minimum or a maximum in the vapor pressure of the mixture relative to the vapor pressure of the neat components at a constant temperature.

As used herein, the terms “azeotrope-like composition” and “near-azeotropic composition” refer to a composition wherein the difference between
15 the bubble point pressure (“BP”) and dew point pressure (“DP”) of the composition at a particular temperature is less than or equal to 5 percent based upon the bubble point pressure, *i.e.*, $[(BP-DP)/BP] \times 100 \leq 5$. As used herein, the terms “3 percent azeotrope-like composition” and “3 percent near-azeotropic composition” shall be understood to mean a composition wherein the difference
20 between the bubble point pressure (“BP”) and dew point pressure (“DP”) of the composition at a particular temperature is less than or equal to 3 percent based upon the bubble point pressure, *i.e.*, $[(BP-DP)/BP] \times 100 \leq 3$.

Binary azeotropic or azeotrope-like compositions of substantially constant-boiling mixtures can be characterized, depending upon the conditions
25 chosen, in a number of ways. For example, it is well known by those skilled in the art, that, at different pressures the composition of a given azeotrope or azeotrope-like composition will vary at least to some degree, as will the boiling point temperature. Thus, an azeotropic or azeotrope-like composition of two compounds represents a unique type of relationship but with a variable composition that
30 depends on temperature and/or pressure. Therefore, compositional ranges, rather than fixed compositions, are often used to define azeotropes and azeotrope-like compositions.

For purposes of this invention, “effective amount” refers to the amount of each component of a composition provided herein which, when combined, results in the formation of an azeotropic or azeotrope-like composition. This definition includes the amounts of each component, which amounts may vary depending on the pressure applied to the composition so long as the azeotropic or azeotrope-like compositions continue to exist at the different pressures, but with possible different boiling points. Therefore, effective amount includes the amounts, such as may be expressed in weight percentages, of each component of the compositions of the instant invention which form azeotropic or azeotrope-like compositions at temperatures or pressures other than as described herein.

As used herein, the term “mole fraction” refers to the ratio of the number of moles of one component in the binary composition to the sum of the numbers of moles of each of the two components in said composition (*e.g.*, $X_2 = m_2/(m_1 + m_2)$).

To determine the relative volatility of any two compounds, a method known as the PTx method can be used. In this procedure, the total absolute pressure in a cell of known volume is measured at a constant temperature for various compositions of the two compounds. Use of the PTx Method is described in detail in “Phase Equilibrium in Process Design”, Wiley-Interscience Publisher, 1970, written by Harold R. Null, on pages 124 to 126; hereby incorporated by reference. The resulting pressure v. liquid composition data are alternately referred to as Vapor Liquid Equilibria data (or “VLE data.”)

These measurements can be converted into equilibrium vapor and liquid compositions in the PTx cell by using an activity coefficient equation model, such as the Non-Random, Two-Liquid (NRTL) equation, to represent liquid phase nonidealities. Use of an activity coefficient equation, such as the NRTL equation is described in detail in “The Properties of Gases and Liquids,” 4th edition, published by McGraw Hill, written by Reid, Prausnitz and Poling, on pages 241 to 387, and in “Phase Equilibria in Chemical Engineering,” published by Butterworth Publishers, 1985, written by Stanley M. Walas, pages 165 to 244. The collection of VLE data, the determination of interaction parameters by regression and the use of an equation of state to predict non-ideal behavior of a system are taught in “Double Azeotropy in Binary Mixtures of NH_3 and

CHF₂CF₂,” C.-P. Chai Kao, M.E. Paulaitis, A. Yokozeki, *Fluid Phase Equilibria*, 127 (1997) 191-203. All of the aforementioned references are hereby incorporated by reference. Without wishing to be bound by any theory or explanation, it is believed that the NRTL equation, together with the PTx cell data, can sufficiently predict the relative volatilities of the compositions provided herein and can therefore predict the behavior of these mixtures in multi-stage separation equipment such as distillation columns.

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.

Compositions

A composition, comprising:

- i) neopentane; and
- ii) a compound selected from E-1,1,1,4,4,4-hexafluoro-2-butene and Z-1,1,1,4,4,4-hexafluoro-2-butene.

In some embodiments, the composition provided herein is an azeotrope or azeotrope-like composition. In some embodiments, the composition provided herein is an azeotrope composition. In some embodiments, the composition provided herein is an azeotrope-like composition. In some embodiments, the E-1,1,1,4,4,4-hexafluoro-2-butene or Z-1,1,1,4,4,4-hexafluoro-2-butene is present in the composition in an amount effective to form an azeotrope composition or an azeotrope-like composition with the neopentane.

In some embodiments, the composition provided herein comprises neopentane and E-1,1,1,4,4,4-hexafluoro-2-butene, wherein the E-1,1,1,4,4,4-hexafluoro-2-butene is present in the composition in an amount effective to form an azeotrope composition or an azeotrope-like composition with the neopentane. In some embodiments, the composition comprising neopentane and E-1,1,1,4,4,4-hexafluoro-2-butene is an azeotrope composition (*i.e.*, an azeotropic composition).

In some embodiments, the composition comprising neopentane and E-1,1,1,4,4,4-hexafluoro-2-butene is an azeotrope-like composition.

5 In some embodiments, the composition comprising neopentane and E-1,1,1,4,4,4-hexafluoro-2-butene comprises from about 40 to about 60 mol% neopentane, for example, about 40 to about 55, about 40 to about 50, about 40 to about 45, about 45 to about 60, about 45 to about 55, about 45 to about 50, about 50 to about 60, about 50 to about 55, or about 55 to about 60 mol% neopentane. In some embodiments, the composition comprising neopentane and E-1,1,1,4,4,4-hexafluoro-2-butene comprises from about 40 to about 50 mol% neopentane.

10 In some embodiments, the composition comprising neopentane and E-1,1,1,4,4,4-hexafluoro-2-butene comprises from about 60 to about 40 mol% E-1,1,1,4,4,4-hexafluoro-2-butene, for example, about 60 to about 45, about 60 to about 50, about 60 to about 55, about 55 to about 40, about 55 to about 45, about 55 to about 50, about 50 to about 40, about 50 to about 45, or about 45 to about 40 mol% E-1,1,1,4,4,4-hexafluoro-2-butene. In some embodiments, the composition comprising neopentane and E-1,1,1,4,4,4-hexafluoro-2-butene comprises from 60 to about 50 mol% E-1,1,1,4,4,4-hexafluoro-2-butene.

20 In some embodiments, the composition comprises from about 40 to about 60 mol% neopentane and about 60 to about 40 mol% E-1,1,1,4,4,4-hexafluoro-2-butene. In some embodiments, the composition comprises from about 40 to about 60 mol% neopentane and about 60 to about 40 mol% E-1,1,1,4,4,4-hexafluoro-2-butene, and has a boiling point of from about -40°C to about 120°C at a pressure of from about 2 psi to about 390 psi.

25 In some embodiments, the composition comprises from about 40 to about 50 mol% neopentane and about 60 to about 50 mol% E-1,1,1,4,4,4-hexafluoro-2-butene. In some embodiments, the composition comprises from about 40 to about 50 mol% neopentane and about 60 to about 50 mol% E-1,1,1,4,4,4-hexafluoro-2-butene, and has a boiling point of from about 0.9°C to about 128°C at a pressure of from about 1 atm to about 30 atm.

30 In some embodiments, the composition comprising neopentane and E-1,1,1,4,4,4-hexafluoro-2-butene comprises 98.0 to about 99.9 mol% neopentane, for example, about 98.0 to about 99.8, about 98.0 to about 99.5, about 98.0 to about 99.3, about 98.0 to about 99.0, about 98.0 to about 98.8, about 98.0 to about

98.5, about 98.5 to about 99.9, about 98.5 to about 99.8, about 98.5 to about 99.5, about 98.5 to about 99.3, about 98.5 to about 99.0, about 98.5 to about 98.8, about 98.8 to about 99.9, about 98.8 to about 99.8, about 98.8 to about 99.5, about 98.8 to about 99.3, about 98.8 to about 99.0, about 99.0 to about 99.9, about 99.0 to about 99.8, about 99.0 to about 99.5, about 99.0 to about 99.3, about 99.3 to about 99.9, about 99.3 to about 99.8, about 99.3 to about 99.5, about 99.5 to about 99.9, about 99.5 to about 99.8, or about 99.8 to about 99.9 mol% neopentane. In some embodiments, the composition comprising neopentane and E-1,1,1,4,4,4-hexafluoro-2-butene comprises from about 98.2 to about 99.8 mol% neopentane.

10 In some embodiments, the composition comprising neopentane and E-1,1,1,4,4,4-hexafluoro-2-butene comprises about 2.0 to about 0.1 mol% E-1,1,1,4,4,4-hexafluoro-2-butene, for example, about 2.0 to about 0.2, about 2.0 to about 0.5, about 2.0 to about 0.7, about 2.0 to about 1.0, about 2.0 to about 1.2, about 2.0 to about 1.5, about 1.5 to about 0.1, about 1.5 to about 0.2, about 1.5 to about 0.5, about 1.5 to about 0.7, about 1.5 to about 1.0, about 1.5 to about 1.2, about 1.2 to about 0.1, about 1.2 to about 0.2, about 1.2 to about 0.5, about 1.2 to about 0.7, about 1.2 to about 1.0, about 1.0 to about 0.1, about 1.0 to about 0.2, about 1.0 to about 0.5, about 1.0 to about 0.7, about 0.7 to about 0.1, about 0.7 to about 0.2, about 0.7 to about 0.5, about 0.5 to about 0.1, about 0.5 to about 0.2, or about 0.2 to about 0.1 mol% E-1,1,1,4,4,4-hexafluoro-2-butene.

In some embodiments, the composition comprising neopentane and E-1,1,1,4,4,4-hexafluoro-2-butene comprises about 1.6 to about 0.2 mol% E-1,1,1,4,4,4-hexafluoro-2-butene.

25 In some embodiments, the composition comprising neopentane and E-1,1,1,4,4,4-hexafluoro-2-butene comprises from about 98.4 to about 99.8 mol% neopentane and about 1.6 to about 0.2 mol% E-1,1,1,4,4,4-hexafluoro-2-butene. In some embodiments, the composition comprising neopentane and E-1,1,1,4,4,4-hexafluoro-2-butene comprises from about 98.4 to about 99.8 mol% neopentane and about 1.6 to about 0.2 mol% E-1,1,1,4,4,4-hexafluoro-2-butene, and has a boiling point of from about 8.3°C to about 9.3°C at a pressure of about 1 atm.

30 In some embodiments, the composition comprising neopentane and E-1,1,1,4,4,4-hexafluoro-2-butene comprises from about 35 to about 65 mol% neopentane, for example, about 35 to about 60, about 35 to about 55, about 35 to

about 50, about 35 to about 45, about 35 to about 40, about 40 to about 65, about 40 to about 60, about 40 to about 55, about 40 to about 50, about 40 to about 45, about 45 to about 65, about 45 to about 60, about 45 to about 55, about 45 to about 50, about 50 to about 65, about 50 to about 60, about 50 to about 55, about 55 to about 65, about 55 to about 60, or about 60 to about 65 mol% neopentane. In some embodiments, the composition comprising neopentane and E-1,1,1,4,4,4-hexafluoro-2-butene comprises from about 38.4 to about 62.6 mol% neopentane.

In some embodiments, the composition comprising neopentane and E-1,1,1,4,4,4-hexafluoro-2-butene comprises from about 70 to about 35 mol% E-1,1,1,4,4,4-hexafluoro-2-butene, for example, about 70 to about 40, about 70 to about 45, about 70 to about 50, about 70 to about 55, about 70 to about 60, about 70 to about 65, about 65 to about 35, about 65 to about 40, about 65 to about 45, about 65 to about 50, about 65 to about 55, about 65 to about 60, about 60 to about 35, about 60 to about 40, about 60 to about 45, about 60 to about 50, about 60 to about 55, about 55 to about 35, about 55 to about 40, about 55 to about 45, about 55 to about 50, about 50 to about 35, about 50 to about 40, about 50 to about 45, about 45 to about 35, about 45 to about 40, or about 40 to about 35 mol% E-1,1,1,4,4,4-hexafluoro-2-butene. In some embodiments, the composition comprising neopentane and E-1,1,1,4,4,4-hexafluoro-2-butene comprises from about 65.2 to about 37.4 mol% E-1,1,1,4,4,4-hexafluoro-2-butene.

In some embodiments, the composition comprising neopentane and E-1,1,1,4,4,4-hexafluoro-2-butene comprises from about 38.4 to about 62.6 mol% neopentane and about 65.2 to about 37.4 mol% E-1,1,1,4,4,4-hexafluoro-2-butene. In some embodiments, the composition comprising neopentane and E-1,1,1,4,4,4-hexafluoro-2-butene comprises from about 38.4 to about 62.6 mol% neopentane and about 65.2 to about 37.4 mol% E-1,1,1,4,4,4-hexafluoro-2-butene, and has a boiling point of from about 0.9°C to about 1.2°C at a pressure of about 1 atm.

In some embodiments, the composition comprising neopentane and E-1,1,1,4,4,4-hexafluoro-2-butene comprises about 0.1 to about 3.0 mol% neopentane, for example, about 0.1 to about 2.8, about 0.1 to about 2.5, about 0.1 to about 2.0, about 0.1 to about 1.5, about 0.1 to about 1.0, about 0.1 to about 0.5, about 0.5 to about 3.0, about 0.5 to about 2.8, about 0.5 to about 2.5, about 0.5 to about 2.0, about 0.5 to about 1.5, about 0.5 to about 1.0, about 1.0 to about 3.0,

about 1.0 to about 2.8, about 1.0 to about 2.5, about 1.0 to about 2.0, about 1.0 to about 1.5, about 1.5 to about 3.0, about 1.5 to about 2.8, about 1.5 to about 2.5, about 1.5 to about 2.0, about 2.0 to about 3.0, about 2.0 to about 2.8, about 2.0 to about 2.5, about 2.5 to about 3.0, about 2.5 to about 2.8, or about 2.8 to about 3.0 mol% neopentane. In some embodiments, the composition comprising neopentane and E-1,1,1,4,4,4-hexafluoro-2-butene comprises from about 0.2 to about 2.8 mol% neopentane.

In some embodiments, the composition comprising neopentane and E-1,1,1,4,4,4-hexafluoro-2-butene comprises about 99.9 to about 97.0 mol% E-1,1,1,4,4,4-hexafluoro-2-butene, for example, about 99.9 to about 97.2, about 99.9 to about 97.5, about 99.9 to about 98.0, about 99.9 to about 98.5, about 99.9 to about 99.0, about 99.9 to about 99.8, about 99.8 to about 97.0, about 99.8 to about 97.2, about 99.8 to about 97.5, about 99.8 to about 98.0, about 99.8 to about 98.5, about 99.8 to about 99.0, about 99.0 to about 97.0, about 99.0 to about 97.2, about 99.0 to about 97.5, about 99.0 to about 98.0, about 99.0 to about 98.5, about 98.5 to about 97.0, about 98.5 to about 97.2, about 98.5 to about 97.5, about 98.5 to about 98.0, about 98.0 to about 97.0, about 98.0 to about 97.2, about 98.0 to about 97.5, about 97.5 to about 97.0, about 97.5 to about 97.2, or about 97.2 to about 97.0 mol% E-1,1,1,4,4,4-hexafluoro-2-butene. In some embodiments, the composition comprising neopentane and E-1,1,1,4,4,4-hexafluoro-2-butene comprises about 99.8 to about 97.2 mol% E-1,1,1,4,4,4-hexafluoro-2-butene.

In some embodiments, the composition comprising neopentane and E-1,1,1,4,4,4-hexafluoro-2-butene comprises from about 0.2 to about 2.8 mol% neopentane and about 99.8 to about 97.2 mol% E-1,1,1,4,4,4-hexafluoro-2-butene. In some embodiments, the composition comprising neopentane and E-1,1,1,4,4,4-hexafluoro-2-butene comprises from about 0.2 to about 2.8 mol% neopentane and about 99.8 to about 97.2 mol% E-1,1,1,4,4,4-hexafluoro-2-butene, and has a boiling point of from about 6.3°C to about 7.4°C at a pressure of about 1 atm.

In some embodiments, the composition comprising neopentane and E-1,1,1,4,4,4-hexafluoro-2-butene comprises:

from about 99.8 to about 98.2 mol% neopentane and about 0.2 to about 1.8 mol% E-1,1,1,4,4,4-hexafluoro-2-butene; or

- from about 71.6 to about 47.6 mol% neopentane and about 28.4 to about 52.4 mol% E-1,1,1,4,4,4-hexafluoro-2-butene; or
- from about 1.2 to about 0.2 mol% neopentane and about 98.8 to about 99.8 mol% E-1,1,1,4,4,4-hexafluoro-2-butene; or
- 5 from about 99.8 to about 98.4 mol% neopentane and about 0.2 to about 1.6 mol% E-1,1,1,4,4,4-hexafluoro-2-butene; or
- from about 66.6 to about 40.8 mol% neopentane and about 33.4 to about 59.2 mol% E-1,1,1,4,4,4-hexafluoro-2-butene; or
- from about 1.8 to about 0.2 mol% neopentane and about 98.2 to about 99.8 mol% E-1,1,1,4,4,4-hexafluoro-2-butene; or
- 10 from about 62.8 to about 35.2 mol% neopentane and about 37.2 to about 64.8 mol% E-1,1,1,4,4,4-hexafluoro-2-butene; or
- from about 2.6 to about 0.2 mol% neopentane and about 97.4 to about 99.8 mol% E-1,1,1,4,4,4-hexafluoro-2-butene; or
- 15 from about 59.8 to about 30.2 mol% neopentane and about 40.2 to about 69.8 mol% E-1,1,1,4,4,4-hexafluoro-2-butene; or
- from about 3.4 to about 0.2 mol% neopentane and about 96.6 to about 99.8 mol% E-1,1,1,4,4,4-hexafluoro-2-butene; or
- from about 58.4 to about 28.2 mol% neopentane and about 41.6 to about 71.8 mol% E-1,1,1,4,4,4-hexafluoro-2-butene; or
- 20 from about 3.8 to about 0.2 mol% neopentane and about 96.2 to about 99.8 mol% E-1,1,1,4,4,4-hexafluoro-2-butene; or
- from about 57.2 to about 26.4 mol% neopentane and about 42.8 to about 73.6 mol% E-1,1,1,4,4,4-hexafluoro-2-butene; or
- 25 from about 4.4 to about 0.2 mol% neopentane and about 95.6 to about 99.8 mol% E-1,1,1,4,4,4-hexafluoro-2-butene; or
- from about 55.4 to about 23.6 mol% neopentane and about 44.6 to about 76.4 mol% E-1,1,1,4,4,4-hexafluoro-2-butene; or
- from about 5.2 to about 99.1 mol% neopentane and about 94.8 to about 0.9 mol% E-1,1,1,4,4,4-hexafluoro-2-butene; or
- 30 from about 99.8 to about 98.6 mol% neopentane and about 0.2 to about 1.4 mol% E-1,1,1,4,4,4-hexafluoro-2-butene; or

from about 53.8 to about 23.2 mol% neopentane and about 46.2 to about 76.8 mol% E-1,1,1,4,4,4-hexafluoro-2-butene; or

from about 5.4 to about 0.2 mol% neopentane and about 94.6 to about 99.8 mol% E-1,1,1,4,4,4-hexafluoro-2-butene; or

5 from about 56 to about 24.4 mol% neopentane and about 44.0 to about 75.6 mol% E-1,1,1,4,4,4-hexafluoro-2-butene; or

from about 4.6 to about 0.2 mol% neopentane and about 95.4 to about 99.8 mol% E-1,1,1,4,4,4-hexafluoro-2-butene; or

10 from about 57.2 to about 3.8 mol% neopentane and about 42.8 to about 96.2 mol% E-1,1,1,4,4,4-hexafluoro-2-butene; or

from about 2.6 to about 0.2 mol% neopentane and about 97.4 to about 99.8 mol% E-1,1,1,4,4,4-hexafluoro-2-butene.

In some embodiments, the composition comprising neopentane and E-1,1,1,4,4,4-hexafluoro-2-butene comprises:

15 from about 99.8 to about 98.2 mol% neopentane and about 0.2 to about 1.8 mol% E-1,1,1,4,4,4-hexafluoro-2-butene; or

from about 71.6 to about 47.6 mol% neopentane and about 28.4 to about 52.4 mol% E-1,1,1,4,4,4-hexafluoro-2-butene; or

20 from about 1.2 to about 0.2 mol% neopentane and about 98.8 to about 99.8 mol% E-1,1,1,4,4,4-hexafluoro-2-butene; or

from about 99.8 to about 98.4 mol% neopentane and about 0.2 to about 1.6 mol% E-1,1,1,4,4,4-hexafluoro-2-butene; or

from about 66.6 to about 40.8 mol% neopentane and about 33.4 to about 59.2 mol% E-1,1,1,4,4,4-hexafluoro-2-butene; or

25 from about 1.8 to about 0.2 mol% neopentane and about 98.2 to about 99.8 mol% E-1,1,1,4,4,4-hexafluoro-2-butene; or

from about 62.8 to about 35.2 mol% neopentane and about 37.2 to about 64.8 mol% E-1,1,1,4,4,4-hexafluoro-2-butene; or

30 from about 2.6 to about 0.2 mol% neopentane and about 97.4 to about 99.8 mol% E-1,1,1,4,4,4-hexafluoro-2-butene; or

from about 59.8 to about 30.2 mol% neopentane and about 40.2 to about 69.8 mol% E-1,1,1,4,4,4-hexafluoro-2-butene; or

- from about 3.4 to about 0.2 mol% neopentane and about 96.6 to about 99.8 mol% E-1,1,1,4,4,4-hexafluoro-2-butene; or
- from about 58.4 to about 28.2 mol% neopentane and about 41.6 to about 71.8 mol% E-1,1,1,4,4,4-hexafluoro-2-butene; or
- 5 from about 3.8 to about 0.2 mol% neopentane and about 96.2 to about 99.8 mol% E-1,1,1,4,4,4-hexafluoro-2-butene; or
- from about 57.2 to about 26.4 mol% neopentane and about 42.8 to about 73.6 mol% E-1,1,1,4,4,4-hexafluoro-2-butene; or
- from about 4.4 to about 0.2 mol% neopentane and about 95.6 to about 99.8 mol% E-1,1,1,4,4,4-hexafluoro-2-butene; or
- 10 from about 55.4 to about 23.6 mol% neopentane and about 44.6 to about 76.4 mol% E-1,1,1,4,4,4-hexafluoro-2-butene; or
- from about 5.2 to about 99.1 mol% neopentane and about 94.8 to about 0.9 mol% E-1,1,1,4,4,4-hexafluoro-2-butene; or
- 15 from about 99.8 to about 98.6 mol% neopentane and about 0.2 to about 1.4 mol% E-1,1,1,4,4,4-hexafluoro-2-butene; or
- from about 53.8 to about 23.2 mol% neopentane and about 46.2 to about 76.8 mol% E-1,1,1,4,4,4-hexafluoro-2-butene; or
- from about 5.4 to about 0.2 mol% neopentane and about 94.6 to about 99.8 mol% E-1,1,1,4,4,4-hexafluoro-2-butene; or
- 20 from about 56 to about 24.4 mol% neopentane and about 44.0 to about 75.6 mol% E-1,1,1,4,4,4-hexafluoro-2-butene; or
- from about 4.6 to about 0.2 mol% neopentane and about 95.4 to about 99.8 mol% E-1,1,1,4,4,4-hexafluoro-2-butene; or
- 25 from about 57.2 to about 3.8 mol% neopentane and about 42.8 to about 96.2 mol% E-1,1,1,4,4,4-hexafluoro-2-butene; or
- from about 2.6 to about 0.2 mol% neopentane and about 97.4 to about 99.8 mol% E-1,1,1,4,4,4-hexafluoro-2-butene;
- wherein the composition has a boiling point of from about -40°C to about 120°C at a pressure of about 1 atm, for example, about -40°C to about 100°C, about -40°C to about 80°C, about -40°C to about 60°C, about -40°C to about 40°C, about -40°C to about 20°C, about -40°C to about 0°C, about -40°C to about -20°C, about -20°C to about 120°C, about -20°C to about 100°C, about -20°C to about
- 30

80°C, about -20°C to about 60°C, about -20°C to about 40°C, about -20°C to about 20°C, about -20°C to about 0°C, about 0°C to about 120°C, about 0°C to about 100°C, about 0°C to about 80°C, about 0°C to about 60°C, about 0°C to about 40°C, about 0°C to about 20°C, about 20°C to about 120°C, about 20°C to about 100°C, about 20°C to about 80°C, about 20°C to about 60°C, about 20°C to about 40°C, about 40°C to about 120°C, about 40°C to about 100°C, about 40°C to about 80°C, about 40°C to about 60°C, about 60°C to about 120°C, about 60°C to about 100°C, about 60°C to about 80°C, about 80°C to about 120°C, about 80°C to about 100°C, or about 100°C to about 120°C.

10 In some embodiments, the composition comprising neopentane and E-1,1,1,4,4,4-hexafluoro-2-butene has a boiling point of about -40°C at a pressure of about 1 atm.

In some embodiments, the composition comprising neopentane and E-1,1,1,4,4,4-hexafluoro-2-butene has a boiling point of about -20°C at a pressure of about 1 atm.

15 In some embodiments, the composition comprising neopentane and E-1,1,1,4,4,4-hexafluoro-2-butene has a boiling point of about 0°C at a pressure of about 1 atm.

In some embodiments, the composition comprising neopentane and E-1,1,1,4,4,4-hexafluoro-2-butene has a boiling point of about 20°C at a pressure of about 1 atm.

In some embodiments, the composition comprising neopentane and E-1,1,1,4,4,4-hexafluoro-2-butene has a boiling point of about 30°C at a pressure of about 1 atm.

25 In some embodiments, the composition comprising neopentane and E-1,1,1,4,4,4-hexafluoro-2-butene has a boiling point of about 40°C at a pressure of about 1 atm.

In some embodiments, the composition comprising neopentane and E-1,1,1,4,4,4-hexafluoro-2-butene has a boiling point of about 60°C at a pressure of about 1 atm.

30 In some embodiments, the composition comprising neopentane and E-1,1,1,4,4,4-hexafluoro-2-butene has a boiling point of about 80°C at a pressure of about 1 atm.

In some embodiments, the composition comprising neopentane and E-1,1,1,4,4,4-hexafluoro-2-butene has a boiling point of about 100°C at a pressure of about 1 atm.

5 In some embodiments, the composition comprising neopentane and E-1,1,1,4,4,4-hexafluoro-2-butene has a boiling point of about 120°C at a pressure of about 1 atm.

In some embodiments, the composition provided herein comprises neopentane and Z-1,1,1,4,4,4-hexafluoro-2-butene, wherein the Z-1,1,1,4,4,4-hexafluoro-2-butene is present in the composition in an amount effective to form
10 an azeotrope composition or an azeotrope-like composition with the neopentane. In some embodiments, the composition comprising neopentane and Z-1,1,1,4,4,4-hexafluoro-2-butene is an azeotrope composition (*i.e.*, an azeotropic composition). In some embodiments, the composition comprising neopentane and Z-1,1,1,4,4,4-hexafluoro-2-butene is an azeotrope-like composition.

15 In some embodiments, the composition comprising neopentane and Z-1,1,1,4,4,4-hexafluoro-2-butene comprises from about 60 to about 95 mol% neopentane, for example, about 60 to about 90, about 60 to about 85, about 60 to about 80, about 60 to about 75, about 60 to about 70, about 65 to about 95, about 65 to about 90, about 65 to about 85, about 65 to about 80, about 65 to about 75,
20 about 70 to about 95, about 70 to about 90, about 70 to about 85, about 70 to about 80, about 75 to about 95, about 75 to about 90, about 75 to about 85, about 80 to about 95, about 80 to about 90, or about 85 to about 95 mol% neopentane. In some embodiments, the composition comprising neopentane and Z-1,1,1,4,4,4-hexafluoro-2-butene comprises from about 60 to about 93 mol% neopentane.

25 In some embodiments, the composition comprising neopentane and Z-1,1,1,4,4,4-hexafluoro-2-butene comprises from about 40 to about 5 mol% Z-1,1,1,4,4,4-hexafluoro-2-butene, for example, about 40 to about 10, about 40 to about 15, about 40 to about 20, about 40 to about 25, about 40 to about 30, about 40 to about 35, about 35 to about 5, about 35 to about 10, about 35 to about 15,
30 about 35 to about 20, about 35 to about 25, about 35 to about 30, about 30 to about 5, about 30 to about 10, about 30 to about 15, about 30 to about 20, about 30 to about 25, about 25 to about 5, about 25 to about 10, about 25 to about 15, about 25 to about 20, about 20 to about 5, about 20 to about 10, about 20 to about

15, about 15 to about 5, about 15 to about 10, or about 10 to about 5 mol% Z-1,1,1,4,4,4-hexafluoro-2-butene. In some embodiments, the composition comprising neopentane and Z-1,1,1,4,4,4-hexafluoro-2-butene comprises from about 40 to about 7 mol% Z-1,1,1,4,4,4-hexafluoro-2-butene.

5 In some embodiments, the composition comprising neopentane and Z-1,1,1,4,4,4-hexafluoro-2-butene comprises from about 60 to about 93 mol% neopentane and about 40 to about 7 mol% Z-1,1,1,4,4,4-hexafluoro-2-butene. In some embodiments, the composition comprising neopentane and Z-1,1,1,4,4,4-hexafluoro-2-butene comprises from about 60 to about 93 mol% neopentane and
10 about 40 to about 7 mol% Z-1,1,1,4,4,4-hexafluoro-2-butene, and has a boiling point of from about -40°C to about 120°C at a pressure of from about 1.5 psi to about 310 psi.

In some embodiments, the composition comprising neopentane and Z-1,1,1,4,4,4-hexafluoro-2-butene comprises from about 50 to about 85 mol%
15 neopentane, for example, about 50 to about 80, about 50 to about 75, about 50 to about 70, about 50 to about 65, about 50 to about 60, about 50 to about 55, about 55 to about 85, about 55 to about 80, about 55 to about 75, about 55 to about 70, about 55 to about 65, about 55 to about 60, about 60 to about 85, about 60 to about 80, about 60 to about 75, about 60 to about 70, about 60 to about 65, about
20 65 to about 85, about 65 to about 80, about 65 to about 75, about 65 to about 70, about 70 to about 85, about 70 to about 80, about 70 to about 75, about 75 to about 85, about 75 to about 80, or about 80 to about 85 mol% neopentane. In some embodiments, the composition comprising neopentane and Z-1,1,1,4,4,4-hexafluoro-2-butene comprises from about 56 to about 83 mol% neopentane.

25 In some embodiments, the composition comprising neopentane and Z-1,1,1,4,4,4-hexafluoro-2-butene comprises from about 50 to about 15 mol% Z-1,1,1,4,4,4-hexafluoro-2-butene, for example, about 50 to about 20, about 50 to about 25, about 50 to about 30, about 50 to about 35, about 50 to about 40, about 50 to about 45, about 45 to about 15, about 45 to about 20, about 45 to about 25,
30 about 45 to about 30, about 45 to about 35, about 45 to about 40, about 40 to about 15, about 40 to about 20, about 40 to about 25, about 40 to about 30, about 40 to about 35, about 35 to about 15, about 35 to about 20, about 35 to about 25, about 35 to about 30, about 30 to about 15, about 30 to about 20, about 30 to

about 25, about 25 to about 15, about 25 to about 20, or about 20 to about 15 mol% Z-1,1,1,4,4,4-hexafluoro-2-butene. In some embodiments, the composition comprising neopentane and Z-1,1,1,4,4,4-hexafluoro-2-butene comprises from about 44 to about 17 mol% Z-1,1,1,4,4,4-hexafluoro-2-butene.

5 In some embodiments, the composition comprising neopentane and Z-1,1,1,4,4,4-hexafluoro-2-butene comprises from about 56 to about 83 mol% neopentane and about 44 to about 17 mol% Z-1,1,1,4,4,4-hexafluoro-2-butene. In some embodiments, the composition comprising neopentane and Z-1,1,1,4,4,4-hexafluoro-2-butene comprises from about 56 to about 83 mol% neopentane and
10 about 44 to about 17 mol% Z-1,1,1,4,4,4-hexafluoro-2-butene, and has a boiling point of from about 5°C to about 145°C at a pressure of from about 1 atm to about 30 atm.

 In some embodiments, the composition comprising neopentane and Z-1,1,1,4,4,4-hexafluoro-2-butene comprises from about 99.9 to about 75.0 mol%
15 neopentane, for example, about 99.9 to about 80.0, about 99.9 to about 85.0, about 99.9 to about 90.0, about 99.9 to about 95.0, about 99.9 to about 99.0, about 99.9 to about 99.6, about 99.6 to about 80.0, about 99.6 to about 85.0, about 99.6 to about 90.0, about 99.6 to about 95.0, about 99.6 to about 99.0, about 99.0 to about 80.0, about 99.0 to about 85.0, about 99.0 to about 90.0, about 99.0 to about 95,
20 about 95.0 to about 80.0, about 95.0 to about 85.0, about 95.0 to about 90.0, about 90.0 to about 80.0, about 90.0 to about 85.0, or about 85.0 to about 80.0 mol% neopentane. In some embodiments, the composition comprising neopentane and Z-1,1,1,4,4,4-hexafluoro-2-butene comprises from about about 99.6 to about 79.2 mol% neopentane.

25 In some embodiments, the composition comprising neopentane and Z-1,1,1,4,4,4-hexafluoro-2-butene comprises from about 0.1 to about 25.0 mol% Z-1,1,1,4,4,4-hexafluoro-2-butene, for example, about 0.1 to about 20.0, about 0.1 to about 15.0, about 0.1 to about 10.0, about 0.1 to about 5.0, about 0.1 to about 1.0, about 0.1 to about 0.4, about 0.4 to about 25.0, about 0.4 to about 20.0, about 0.4
30 to about 15.0, about 0.4 to about 10.0, about 0.4 to about 5.0, about 0.4 to about 1.0, about 1.0 to about 25.0, about 1.0 to about 20.0, about 1.0 to about 15.0, about 1.0 to about 10.0, about 1.0 to about 5.0, about 5.0 to about 25.0, about 5.0 to about 20.0, about 5.0 to about 15.0, about 5.0 to about 10.0, about 10.0 to about

25.0, about 10.0 to about 20.0, about 10.0 to about 15.0, about 15.0 to about 25.0, about 15.0 to about 20.0, or about 20.0 to about 25.0 mol% Z-1,1,1,4,4,4-hexafluoro-2-butene. In some embodiments, the composition comprising neopentane and Z-1,1,1,4,4,4-hexafluoro-2-butene comprises from about 0.4 to
5 about 20.8 mol% Z-1,1,1,4,4,4-hexafluoro-2-butene.

In some embodiments, the composition comprising neopentane and Z-1,1,1,4,4,4-hexafluoro-2-butene comprises from about 99.6 to about 79.2 mol% neopentane and about 0.4 to about 20.8 mol% Z-1,1,1,4,4,4-hexafluoro-2-butene. In some embodiments, the composition comprising neopentane and Z-1,1,1,4,4,4-
10 hexafluoro-2-butene comprises from about 99.6 to about 79.2 mol% neopentane and about 0.4 to about 20.8 mol% Z-1,1,1,4,4,4-hexafluoro-2-butene, and has a boiling point of from about 7.8°C to about 9.4°C at a pressure of about 1 atm.

In some embodiments, the composition comprising neopentane and Z-1,1,1,4,4,4-hexafluoro-2-butene comprises from about 4.0 to about 1.0 mol% neopentane, for example, about 4.0 to about 1.5, about 4.0 to about 2.0, about 4.0
15 to about 2.5, about 4.0 to about 3.0, about 4.0 to about 3.5, about 3.5 to about 1.0, about 3.5 to about 1.5, about 3.5 to about 2.0, about 3.5 to about 2.5, about 3.5 to about 3.0, about 3.0 to about 1.0, about 3.0 to about 1.5, about 3.0 to about 2.0, about 3.0 to about 2.5, about 2.5 to about 1.0, about 2.5 to about 1.5, about 2.5 to
20 about 2.0, about 2.0 to about 1.0, about 2.0 to about 1.5, or about 1.5 to about 1.0 mol% neopentane. In some embodiments, the composition comprising neopentane and Z-1,1,1,4,4,4-hexafluoro-2-butene comprises from about 3.2 to about 1.6 mol% neopentane.

In some embodiments, the composition comprising neopentane and Z-1,1,1,4,4,4-hexafluoro-2-butene comprises from about 96.0 to about 99.0 mol% Z-
25 1,1,1,4,4,4-hexafluoro-2-butene, for example, about 96.0 to about 98.5, about 96.0 to about 98.0, about 96.0 to about 97.5, about 96.0 to about 97.0, about 96.0 to about 96.5, about 96.5 to about 99.0, about 96.5 to about 98.5, about 96.5 to about 98.0, about 96.5 to about 97.5, about 96.5 to about 97.0, about 97.0 to about 99.0,
30 about 97.0 to about 98.5, about 97.0 to about 98.0, about 97.0 to about 97.5, about 97.5 to about 99.0, about 97.5 to about 98.5, about 97.5 to about 98.0, about 98.0 to about 99.0, about 98.0 to about 98.5, or about 98.5 to about 99.0 mol% Z-1,1,1,4,4,4-hexafluoro-2-butene. In some embodiments, the composition

comprising neopentane and Z-1,1,1,4,4,4-hexafluoro-2-butene comprises from about 96.8 to about 98.4 mol% Z-1,1,1,4,4,4-hexafluoro-2-butene.

In some embodiments, the composition comprising neopentane and Z-1,1,1,4,4,4-hexafluoro-2-butene comprises from about 3.2 to about 1.6 mol% neopentane and about 96.8 to about 98.4 mol% Z-1,1,1,4,4,4-hexafluoro-2-butene. In some embodiments, the composition comprising neopentane and Z-1,1,1,4,4,4-hexafluoro-2-butene comprises from about 3.2 to about 1.6 mol% neopentane and about 96.8 to about 98.4 mol% Z-1,1,1,4,4,4-hexafluoro-2-butene, and has a boiling point of from about 32.6°C to about 33.0°C at a pressure of about 1 atm.

In some embodiments, the composition comprising neopentane and Z-1,1,1,4,4,4-hexafluoro-2-butene comprises:

from about 99.8 to about 85.2 mol% neopentane and about 0.2 to about 14.8 mol% Z-1,1,1,4,4,4-hexafluoro-2-butene; or

from about 99.8 to about 80.8 mol% neopentane and about 0.2 to about 19.2 mol% Z-1,1,1,4,4,4-hexafluoro-2-butene; or

from about 99.8 to about 76.2 mol% neopentane and about 0.2 to about 23.8 mol% Z-1,1,1,4,4,4-hexafluoro-2-butene; or

from about 99.8 to about 61.8 mol% neopentane and about 0.2 to about 38.2 mol% Z-1,1,1,4,4,4-hexafluoro-2-butene; or

from about 0.4 to about 0.2 mol% neopentane and about 99.6 to about 99.8 mol% Z-1,1,1,4,4,4-hexafluoro-2-butene; or

from about 99.8 to about 69.8 mol% neopentane and about 0.2 to about 30.2 mol% Z-1,1,1,4,4,4-hexafluoro-2-butene; or

from about 99.8 to about 67.6 mol% neopentane and about 0.2 to about 32.4 mol% Z-1,1,1,4,4,4-hexafluoro-2-butene; or

from about 99.8 to about 95.0 mol% neopentane and about 0.2 to about 5 mol% Z-1,1,1,4,4,4-hexafluoro-2-butene; or

from about 86.4 to about 63.6 mol% neopentane and about 13.6 to about 36.4 mol% Z-1,1,1,4,4,4-hexafluoro-2-butene; or

from about 0.4 to about 0.2 mol% neopentane and about 99.6 to about 99.8 mol% Z-1,1,1,4,4,4-hexafluoro-2-butene; or

from about 99.8 to about 96.6 mol% neopentane and about 0.2 to about 3.4 mol% Z-1,1,1,4,4,4-hexafluoro-2-butene; or

- from about 80.6 to about 59.6 mol% neopentane and about 19.4 to about 40.4 mol% Z-1,1,1,4,4,4-hexafluoro-2-butene; or
- from about 99.8 to about 97.6 mol% neopentane and about 0.2 to about 2.4 mol% Z-1,1,1,4,4,4-hexafluoro-2-butene; or
- 5 from about 74.2 to about 56.0 mol% neopentane and about 25.8 to about 44.0 mol% Z-1,1,1,4,4,4-hexafluoro-2-butene; or
- from about 0.2 to about 0.8 mol% neopentane and about 99.2 to about 99.8 mol% Z-1,1,1,4,4,4-hexafluoro-2-butene; or
- from about 99.8 to about 98.2 mol% neopentane and about 0.2 to about 1.8
- 10 mol% Z-1,1,1,4,4,4-hexafluoro-2-butene; or
- from about 76.6 to about 50.0 mol% neopentane and about 23.4 to about 50.0 mol% Z-1,1,1,4,4,4-hexafluoro-2-butene; or
- from about 1.0 to about 0.2 mol% neopentane and about 99.0 to about 99.8 mol% Z-1,1,1,4,4,4-hexafluoro-2-butene.
- 15 In some embodiments, the composition comprising neopentane and Z-1,1,1,4,4,4-hexafluoro-2-butene comprises:
- from about 99.8 to about 85.2 mol% neopentane and about 0.2 to about 14.8 mol% Z-1,1,1,4,4,4-hexafluoro-2-butene; or
- from about 99.8 to about 80.8 mol% neopentane and about 0.2 to about
- 20 19.2 mol% Z-1,1,1,4,4,4-hexafluoro-2-butene; or
- from about 99.8 to about 76.2 mol% neopentane and about 0.2 to about 23.8 mol% Z-1,1,1,4,4,4-hexafluoro-2-butene; or
- from about 99.8 to about 61.8 mol% neopentane and about 0.2 to about 38.2 mol% Z-1,1,1,4,4,4-hexafluoro-2-butene; or
- 25 from about 0.4 to about 0.2 mol% neopentane and about 99.6 to about 99.8 mol% Z-1,1,1,4,4,4-hexafluoro-2-butene; or
- from about 99.8 to about 69.8 mol% neopentane and about 0.2 to about 30.2 mol% Z-1,1,1,4,4,4-hexafluoro-2-butene; or
- from about 99.8 to about 67.6 mol% neopentane and about 0.2 to about
- 30 32.4 mol% Z-1,1,1,4,4,4-hexafluoro-2-butene; or
- from about 99.8 to about 95.0 mol% neopentane and about 0.2 to about 5 mol% Z-1,1,1,4,4,4-hexafluoro-2-butene; or

from about 86.4 to about 63.6 mol% neopentane and about 13.6 to about 36.4 mol% Z-1,1,1,4,4,4-hexafluoro-2-butene; or

from about 0.4 to about 0.2 mol% neopentane and about 99.6 to about 99.8 mol% Z-1,1,1,4,4,4-hexafluoro-2-butene; or

5 from about 99.8 to about 96.6 mol% neopentane and about 0.2 to about 3.4 mol% Z-1,1,1,4,4,4-hexafluoro-2-butene; or

from about 80.6 to about 59.6 mol% neopentane and about 19.4 to about 40.4 mol% Z-1,1,1,4,4,4-hexafluoro-2-butene; or

10 from about 99.8 to about 97.6 mol% neopentane and about 0.2 to about 2.4 mol% Z-1,1,1,4,4,4-hexafluoro-2-butene; or

from about 74.2 to about 56.0 mol% neopentane and about 25.8 to about 44.0 mol% Z-1,1,1,4,4,4-hexafluoro-2-butene; or

from about 0.2 to about 0.8 mol% neopentane and about 99.2 to about 99.8 mol% Z-1,1,1,4,4,4-hexafluoro-2-butene; or

15 from about 99.8 to about 98.2 mol% neopentane and about 0.2 to about 1.8 mol% Z-1,1,1,4,4,4-hexafluoro-2-butene; or

from about 76.6 to about 50.0 mol% neopentane and about 23.4 to about 50.0 mol% Z-1,1,1,4,4,4-hexafluoro-2-butene; or

20 from about 1.0 to about 0.2 mol% neopentane and about 99.0 to about 99.8 mol% Z-1,1,1,4,4,4-hexafluoro-2-butene;

wherein the composition has a boiling point of from about -40°C to about 120°C at a pressure of about 1 atm, for example, wherein the composition has a boiling point of from about -40°C to about 120°C at a pressure of about 1 atm, for example, about -40°C to about 100°C, about -40°C to about 80°C, about -40°C to about 60°C, about -40°C to about 40°C, about -40°C to about 20°C, about -40°C to about 0°C, about -40°C to about -20°C, about -20°C to about 120°C, about -20°C to about 100°C, about -20°C to about 80°C, about -20°C to about 60°C, about -20°C to about 40°C, about -20°C to about 20°C, about -20°C to about 0°C, about 0°C to about 120°C, about 0°C to about 100°C, about 0°C to about 80°C, about 0°C to about 60°C, about 0°C to about 40°C, about 0°C to about 20°C, about 20°C to about 120°C, about 20°C to about 100°C, about 20°C to about 80°C, about 20°C to about 60°C, about 20°C to about 40°C, about 40°C to about 120°C, about 40°C to about 100°C, about 40°C to about 80°C, about 40°C to about 60°C

to about 120°C, about 60°C to about 100°C, about 60°C to about 80°C, about 80°C to about 120°C, about 80°C to about 100°C, or about 100°C to about 120°C.

In some embodiments, the composition comprising neopentane and Z-1,1,1,4,4,4-hexafluoro-2-butene has a boiling point of about -40°C at a pressure of about 1 atm.

In some embodiments, the composition comprising neopentane and Z-1,1,1,4,4,4-hexafluoro-2-butene has a boiling point of about -20°C at a pressure of about 1 atm.

In some embodiments, the composition comprising neopentane and Z-1,1,1,4,4,4-hexafluoro-2-butene has a boiling point of about 0°C at a pressure of about 1 atm.

In some embodiments, the composition comprising neopentane and Z-1,1,1,4,4,4-hexafluoro-2-butene has a boiling point of about 20°C at a pressure of about 1 atm.

In some embodiments, the composition comprising neopentane and Z-1,1,1,4,4,4-hexafluoro-2-butene has a boiling point of about 30°C at a pressure of about 1 atm.

In some embodiments, the composition comprising neopentane and Z-1,1,1,4,4,4-hexafluoro-2-butene has a boiling point of about 40°C at a pressure of about 1 atm.

In some embodiments, the composition comprising neopentane and Z-1,1,1,4,4,4-hexafluoro-2-butene has a boiling point of about 60°C at a pressure of about 1 atm.

In some embodiments, the composition comprising neopentane and Z-1,1,1,4,4,4-hexafluoro-2-butene has a boiling point of about 80°C at a pressure of about 1 atm.

In some embodiments, the composition comprising neopentane and Z-1,1,1,4,4,4-hexafluoro-2-butene has a boiling point of about 100°C at a pressure of about 1 atm.

In some embodiments, the composition comprising neopentane and Z-1,1,1,4,4,4-hexafluoro-2-butene has a boiling point of about 120°C at a pressure of about 1 atm.

In some embodiments, the compositions provided herein further comprise one or more additional components (*i.e.*, additives). In some embodiments, the one or more additional components are each independently selected from the group consisting of a lubricant, a pour point modifier, an anti-foam agent, a viscosity improver, an emulsifier, a dispersant, an oxidation inhibitor, an extreme pressure agent, a corrosion inhibitor, a detergent, a catalyst, a surfactant, a flame retardant, a preservative, a colorant, an antioxidant, a reinforcing agent, a filler, an antistatic agent, a solubilizing agents, an IR attenuating agent, a nucleating agent, a cell controlling agent, an extrusion aid, a stabilizing agent, a thermally insulating agent, a plasticizer, a viscosity modifier, an impact modifier, a gas barrier resin, a polymer modifier, a rheology modifier, an antibacterial agent, a vapor pressure modifier, a UV absorber, a cross-linking agent, a permeability modifier, a bitterant, a propellant, an acid catcher, or any mixture thereof.

Methods of Use

The inventive compositions can be used in a wide range of applications, including, but not limited to, use as aerosol propellants, refrigerants, and heat transfer media.

Uses as a Heat Transfer Medium

The compositions provided herein can act as a working fluid used to carry heat from a heat source to a heat sink. Such heat transfer compositions may also be useful as a refrigerant in a cycle wherein the fluid undergoes a phase change; that is, from a liquid to a gas and back, or vice versa.

Exemplary heat transfer systems include, but are not limited to, air conditioners, freezers, refrigerators, heat pumps, water chillers, flooded evaporator chillers, direct expansion chillers, walk-in coolers, heat pumps, mobile refrigerators, mobile air conditioning units, and combinations thereof.

In some embodiments, the compositions provided herein may be useful in mobile heat transfer systems, including refrigeration, air conditioning, or heat pump systems or apparatus. In some embodiments, the compositions provided herein may be useful in stationary heat transfer systems, including refrigeration, air conditioning, or heat pump systems or apparatus.

As used herein, the term “mobile heat transfer system” refers to any refrigeration, air conditioner, or heating apparatus incorporated into a

transportation unit for the road, rail, sea or air. In addition, mobile refrigeration or air conditioner units include those apparatus that are independent of any moving carrier and are known as “intermodal” systems. Such intermodal systems include “containers” (combined sea/land transport) as well as “swap bodies” (combined
5 road/rail transport).

As used herein, the term “stationary heat transfer system” refers to a system that is fixed in place during operation. A stationary heat transfer system may be located within or attached to a building, or may be a stand-alone device located out of doors, such as a soft drink vending machine. Such a stationary
10 application may be a stationary air conditioning device or heat pump, including but not limited to, a chiller, a high temperature heat pumps, which may be a trans-critical heat pump (*e.g.*, one that operates with a condenser temperature above 50°C, 70°C, 80°C, 100°C, 120°C, 140°C, 160°C, 180°C, or 200°C), a residential, commercial or industrial air conditioning system, and may be window-mounted,
15 ductless, ducted, packaged terminal, a chiller, and one that is exterior but connected to a building, such as a rooftop system. In stationary refrigeration applications, the compositions provided herein may be useful in high temperature, medium temperature and/or low temperature refrigeration equipment including commercial, industrial or residential refrigerators and freezers, ice machines, self-
20 contained coolers and freezers, flooded evaporator chillers, direct expansion chillers, walk-in and reach-in coolers and freezers, and combination systems. In some embodiments, the compositions provided herein may be used in supermarket refrigerator systems.

In some embodiments, the compositions provided herein may be useful in
25 methods for producing cooling, producing heating, and transferring heat.

In some embodiments, the present application provides a method for producing cooling, comprising evaporating a composition provided herein in the vicinity of a body to be cooled, and thereafter condensing said composition.

In some embodiments, the present application provides a method for
30 producing heating, comprising condensing a composition provided herein in the vicinity of a body to be heated, and thereafter evaporating said compositions.

In some embodiments, the present application provides a method of using a composition provided herein as a heat transfer fluid composition. In some

embodiments, the method comprises transporting said composition from a heat source to a heat sink.

Any of the compositions provided herein may be useful as a replacement for a currently used (“incumbent”) refrigerant, including, but not limited to, R-123
5 (or HFC-123, 2,2-dichloro-1,1,1-trifluoroethane), R-11 (or CFC-11, trichlorofluoromethane), R-12 (or CFC-12, dichlorodifluoromethane), R-22 (chlorodifluoromethane), R-245fa (or HFC-245fa, 1,1,1,3,3-pentafluoropropane), R-114 (or CFC-114, 1,2-dichloro-1,1,2,2-tetrafluoroethane), R-236fa (or HFC-236fa, 1,1,1,3,3,3-hexafluoropropane), R-236ea (or HFC-236ea, 1,1,1,2,3,3-
10 hexafluoropropane), and R-124 (or HCFC-124, 2-chloro-1,1,1,2-tetrafluoroethane), among others.

As used herein, the term “incumbent refrigerant” refers to the refrigerant for which the heat transfer system was designed to operate, or the refrigerant that is resident in the heat transfer system.

15 In some embodiments, the present application provides a method for operating a heat transfer system or for transferring heat that is designed to operate with an incumbent refrigerant by charging an empty system with a composition provided herein, or by substantially replacing said incumbent refrigerant with a composition provided herein.

20 As used herein, the term “substantially replacing” refers to allowing the incumbent refrigerant to drain from the system, or pumping the incumbent refrigerant from the system, and then charging the system with a composition of the present invention (*i.e.*, a composition provided herein). The system may be flushed with one or more quantities of the replacement refrigerant before being
25 charged. It shall be understood that some small quantity of the incumbent refrigerant may be present in the system after the system has been charged with the composition provided herein.

In some embodiments, the present application provides a method for recharging a heat transfer system comprising an incumbent refrigerant and a
30 lubricant, said method comprising substantially removing the incumbent refrigerant from the heat transfer system while retaining a substantial portion of the lubricant in said system and introducing a composition provided herein to the

heat transfer system. In some embodiments, the lubricant in the system is partially replaced.

In some embodiments, the compositions provided herein may be used to top-off a refrigerant charge in a chiller. For example, if a chiller using HCFC-123
5 has diminished performance due to leakage of refrigerant, the compositions provided herein may be added to bring performance back up to specification.

In some embodiments, a heat exchange system comprising a composition of the invention is provided, wherein said system is selected from the group consisting of air conditioners, freezers, refrigerators, heat pumps, water chillers,
10 flooded evaporator chillers, direct expansion chillers, walk-in coolers, heat pumps, mobile refrigerators, mobile air conditioning units, and systems having combinations thereof. In some embodiments, the composition provided herein may be useful in secondary loop systems wherein these compositions serve as the primary refrigerant thus providing cooling to a secondary heat transfer fluid that
15 thereby cools a remote location.

Each of a vapor-compression refrigeration system, an air conditioning system, and a heat pump system includes as components an evaporator, a compressor, a condenser, and an expansion device. A vapor-compression cycle re-uses refrigerant in multiple steps producing a cooling effect in one step and a
20 heating effect in a different step. The cycle can be described simply as follows. Liquid refrigerant enters an evaporator through an expansion device, and the liquid refrigerant boils in the evaporator, by withdrawing heat from the environment, at a low temperature to form a vapor and produce cooling. The low-pressure vapor enters a compressor where the vapor is compressed to raise its
25 pressure and temperature. The higher-pressure (compressed) vapor refrigerant then enters the condenser in which the refrigerant condenses and discharges its heat to the environment. The refrigerant returns to the expansion device through which the liquid expands from the higher-pressure level in the condenser to the low-pressure level in the evaporator, thus repeating the cycle.

30 In some embodiments, the present application provides a heat transfer system comprising a composition provided herein. In some embodiments, the present application provides a refrigeration, air-conditioning, or heat pump apparatus comprising a composition provided herein. In some embodiments, the

present application provides a stationary refrigeration or air-conditioning apparatus comprising a composition provided herein. In some embodiments, the present application provides a mobile refrigeration or air conditioning apparatus comprising a composition provided herein.

5 Propellants

In some embodiments, the present application provides a composition as described herein for use as a propellant (*e.g.*, in a sprayable composition). In some embodiments, the present application provides a sprayable composition comprising a composition provided herein. In some embodiments, the active
10 ingredient to be sprayed together with inert ingredients, solvents, and other materials may also be present in the sprayable composition. In some embodiments, the sprayable composition is an aerosol. Suitable active materials to be sprayed include, but are not limited to, cosmetic materials, such as deodorants, perfumes, hair sprays, cleaners, and polishing agents, as well as
15 medicinal materials such as anti-asthma and anti-halitosis medications.

In some embodiments, the present application provides a process for producing aerosol products. In some embodiments, the process comprises the step of adding a composition provided herein to one or more active ingredients in an aerosol container, wherein said composition functions as a propellant.

20 **EXAMPLES**

The invention will be described in greater detail by way of specific examples. The following examples are offered for illustrative purposes, and are not intended to limit the invention in any manner. Those of skill in the art will readily recognize a variety of non-critical parameters which can be changed or
25 modified to yield essentially the same results.

Example 1. Compositions of E-HFO-1336mzz and neopentane

The binary system of E-HFO-1336mzz/neopentane was explored for potential azeotropic and near-azeotropic behavior. To determine the relative
30 volatility of this binary system, the PTx method as described herein was used. The pressure in a PTx cell of known volume was measured at constant temperature of 29.88°C for various binary compositions. The collected experimental data are displayed in Table 1 below, where X₂ = liquid mole fraction of E-HFO-1336mzz;

Y₂ = vapor mole fraction of E-HFO-1336mzz; P_{exp} = experimentally measured pressure; and P_{calc} = pressure as calculated by NRTL model.

Table 1.

X ₂	Y ₂	psia, expt	psia, calc	(pcalc/pexp)-1
0	0	28.95	-	-
0.00365	0.01299	29.27	29.2493	-7.07E-04
0.00843	0.02925	29.67	29.6307	-1.32E-03
0.01809	0.05972	30.41	30.3664	-1.43E-03
0.06643	0.17653	33.42	33.4348	4.43E-04
0.14533	0.29412	36.81	36.8276	4.79E-04
0.24612	0.38547	39.39	39.3919	4.76E-05
0.34667	0.44894	40.83	40.8352	1.27E-04
0.44829	0.50201	41.62	41.6126	-1.78E-04
0.56542	0.56068	41.87	41.8789	2.12E-04
0.65475	0.60949	41.63	41.6328	6.73E-05
0.75779	0.67766	40.75	40.7363	-3.36E-04
0.85193	0.7619	39.11	39.0868	-5.94E-04
0.9333	0.86793	36.67	36.6737	1.02E-04
0.97972	0.95357	34.66	34.6996	1.14E-03
0.99014	0.97659	34.14	34.1806	1.19E-03
0.99356	0.98453	33.96	34.0032	1.27E-03
1	1	33.66	-	-

FIG. 1 displays a plot of the pressure vs composition data over the compositional range of 0-1 liquid mole fraction of E-HFO-1336mzz. The top curve of FIG. 1 represents the bubble point ("BP") locus, and the bottom curve of FIG. 1 represents the dew point ("DP") locus. FIG. 1 demonstrates the formation of an azeotrope at 29.88°C, of composition 0.552 mole fraction E-1,1,1,4,4,4-hexafluoro-2-butene and 0.448 mole fraction neopentane, as evidenced by the maximum in the P_x diagram at a pressure of 41.8 psia.

Based on these VLE data, interaction coefficients were extracted. The NRTL model was run over the temperature range of -40 to 120°C in increments of 10°C, allowing pressure to vary such that the azeotropic condition (X₂ = Y₂) was met. The resulting predictions of azeotropes in the E-HFO-1336mzz/neopentane system are displayed in Table 2.

Table 2.

Temp (°C)	Azeotrope Pressure (psi)	E-HFO-1336mzz Vapor Mole Fraction	Neopentane Vapor Mole Fraction
-40	2.0	0.40865	0.59135
-30	3.5	0.43624	0.56376
-20	5.9	0.46123	0.53877

Temp (°C)	Azeotrope Pressure (psi)	E-HFO-1336mzz Vapor Mole Fraction	Neopentane Vapor Mole Fraction
-10	9.3	0.48380	0.51620
0	14.1	0.50411	0.49589
10	20.9	0.52229	0.47771
20	30.0	0.53845	0.46155
30	41.9	0.55266	0.44734
40	57.4	0.56495	0.43505
50	77.0	0.57528	0.42472
60	101.7	0.58353	0.41647
70	132.5	0.58945	0.41055
80	171.2	0.59246	0.40754
90	220.8	0.59081	0.40919
100	278.1	0.58257	0.41744
110	331.2	0.57921	0.42079
120	389.6	0.57392	0.42608

The NRTL model was used to predict azeotropes over a pressure range of 1-30 atm at 1 atm increments, the results of which are displayed in Table 3.

Table 3.

Pressure (atm)	Azeotrope Temperature (°C)	Vapor Mole Fraction E-HFO-1336mzz	Vapor Mole Fraction Neopentane
1	0.9	0.5059	0.4941
2	19.4	0.5376	0.4624
3	31.6	0.5547	0.4453
4	40.8	0.5659	0.4341
5	48.4	0.5737	0.4263
6	54.8	0.5795	0.4205
7	60.4	0.5838	0.4162
8	65.4	0.5871	0.4129
9	69.9	0.5894	0.4106
10	74.0	0.5911	0.4089
11	77.7	0.5921	0.4079
12	81.2	0.5926	0.4074
13	84.3	0.5925	0.4075
14	87.2	0.5920	0.4080
15	89.9	0.5908	0.4092
16	92.4	0.5890	0.4110
17	94.6	0.5856	0.4144
18	97.3	0.5834	0.4166
19	100.2	0.5825	0.4175
20	103.1	0.5817	0.4183
21	105.9	0.5808	0.4192
22	108.6	0.5798	0.4202
23	111.2	0.5787	0.4213
24	113.8	0.5775	0.4225
25	116.3	0.5762	0.4238
26	118.8	0.5747	0.4253
27	121.2	0.5731	0.4269
28	123.5	0.5714	0.4286
29	125.8	0.5699	0.4301
30	128.0	0.5684	0.4316

The model was run over a temperature range from -40 to 120°C in 20°C increments, and also at 29.88°C for the purpose of comparison to experimentally measured results. At each temperature, the model was run over the full range from 0 to 1 of E-HFO-1336mzz liquid molar composition in increments of 0.002. Thus the model was run at a total of 5010 combinations of temperature and E-HFO-1336mzz liquid molar composition (10 temperatures x 501 compositions = 5010 combinations). Table 4 shows representative results in increments of 0.10 E-HFO-1336mzz liquid molar composition, or the boundaries of near-azeotropic behavior.

10

Table 4.

Temp (°C)	Liquid Mole Fraction E-HFO-1336mzz	Vapor Mole Fraction E-HFO-1336mzz	Liquid Mole Fraction Neopentane	Vapor Mole Fraction Neopentane	Bubble Point Pressure (psia)	Dew Point Pressure (psia)	[(BP-DP)/BP]* 100%
-40	0.000	0.0000	1.0000	1.0000	1.6172	1.6172	0.00%
-40	0.002	0.0071	0.9980	0.9929	1.6255	1.6196	0.37%
-40	0.018	0.0573	0.9820	0.9427	1.6864	1.6386	2.84%
-40	0.020	0.0629	0.9800	0.9371	1.6933	1.6409	3.09%
-40	0.038	0.1077	0.9620	0.8923	1.7499	1.6627	4.98%
-40	0.040	0.1121	0.9600	0.8879	1.7555	1.6651	5.15%
-40	0.230	0.3230	0.7700	0.6770	2.0094	1.9074	5.08%
-40	0.232	0.3242	0.7680	0.6758	2.0104	1.9099	5.00%
-40	0.282	0.3517	0.7180	0.6483	2.0309	1.9688	3.05%
-40	0.284	0.3527	0.7160	0.6473	2.0315	1.9710	2.98%
-40	0.300	0.3606	0.7000	0.6394	2.0361	1.9878	2.37%
-40	0.400	0.4050	0.6000	0.5950	2.0494	2.0490	0.02%
-40	0.500	0.4463	0.5000	0.5537	2.0410	2.0020	1.91%
-40	0.502	0.4472	0.4980	0.5528	2.0406	2.0001	1.99%
-40	0.524	0.4564	0.4760	0.5436	2.0359	1.9766	2.91%
-40	0.526	0.4573	0.4740	0.5427	2.0354	1.9743	3.00%
-40	0.528	0.4581	0.4720	0.5419	2.0349	1.9720	3.09%
-40	0.566	0.4747	0.4340	0.5253	2.0239	1.9241	4.93%
-40	0.568	0.4756	0.4320	0.5244	2.0232	1.9214	5.03%
-40	0.976	0.9109	0.0240	0.0891	1.4505	1.3774	5.04%
-40	0.978	0.9174	0.0220	0.0826	1.4429	1.3753	4.69%
-40	0.986	0.9450	0.0140	0.0550	1.4114	1.3667	3.17%
-40	0.988	0.9523	0.0120	0.0477	1.4033	1.3646	2.76%
-40	0.998	0.9916	0.0020	0.0084	1.3608	1.3541	0.50%
-40	1.000	1.0000	0.0000	0.0000	1.3520	1.3520	0.00%
-20	0.000	0.0000	1.0000	1.0000	4.4342	4.4342	0.00%
-20	0.002	0.0073	0.9980	0.9927	4.4582	4.4408	0.39%
-20	0.016	0.0533	0.9840	0.9467	4.6144	4.4873	2.76%
-20	0.018	0.0592	0.9820	0.9408	4.6352	4.4940	3.05%
-20	0.032	0.0973	0.9680	0.9027	4.7707	4.5412	4.81%
-20	0.034	0.1023	0.9660	0.8977	4.7888	4.5481	5.03%

Temp (°C)	Liquid Mole Fraction E-HFO- 1336mzz	Vapor Mole Fraction E-HFO- 1336mzz	Liquid Mole Fraction Neopentane	Vapor Mole Fraction Neopentane	Bubble Point Pressure (psia)	Dew Point Pressure (psia)	[(BP- DP)/BP]* 100%
-20	0.282	0.3758	0.7180	0.6242	5.7518	5.4616	5.05%
-20	0.284	0.3769	0.7160	0.6231	5.7544	5.4688	4.96%
-20	0.300	0.3856	0.7000	0.6144	5.7738	5.5252	4.31%
-20	0.332	0.4020	0.6680	0.5980	5.8056	5.6308	3.01%
-20	0.334	0.4030	0.6660	0.5970	5.8073	5.6370	2.93%
-20	0.400	0.4340	0.6000	0.5660	5.8469	5.8021	0.77%
-20	0.500	0.4784	0.5000	0.5216	5.8538	5.8357	0.31%
-20	0.592	0.5209	0.4080	0.4791	5.8059	5.6328	2.98%
-20	0.594	0.5219	0.4060	0.4781	5.8043	5.6267	3.06%
-20	0.600	0.5248	0.4000	0.4752	5.7991	5.6082	3.29%
-20	0.642	0.5464	0.3580	0.4536	5.7551	5.4677	4.99%
-20	0.644	0.5475	0.3560	0.4525	5.7527	5.4607	5.08%
-20	0.964	0.8941	0.0360	0.1059	4.5456	4.3150	5.07%
-20	0.966	0.8991	0.0340	0.1009	4.5285	4.3087	4.85%
-20	0.982	0.9425	0.0180	0.0575	4.3841	4.2584	2.87%
-20	0.998	0.9931	0.0020	0.0069	4.2241	4.2091	0.36%
-20	1.000	1.0000	0.0000	0.0000	4.2030	4.2030	0.00%
0	0.000	0.0000	1.0000	1.0000	10.3222	10.3222	0.00%
0	0.002	0.0073	0.9980	0.9927	10.3796	10.3379	0.40%
0	0.016	0.0539	0.9840	0.9461	10.7565	10.4483	2.86%
0	0.018	0.0600	0.9820	0.9400	10.8070	10.4642	3.17%
0	0.030	0.0937	0.9700	0.9063	11.0938	10.5606	4.81%
0	0.032	0.0989	0.9680	0.9011	11.1391	10.5768	5.05%
0	0.322	0.4155	0.6780	0.5845	13.8866	13.1876	5.03%
0	0.324	0.4166	0.6760	0.5834	13.8927	13.2051	4.95%
0	0.370	0.4405	0.6300	0.5595	14.0094	13.5832	3.04%
0	0.372	0.4415	0.6280	0.5585	14.0136	13.5983	2.96%
0	0.400	0.4552	0.6000	0.5448	14.0645	13.7933	1.93%
0	0.500	0.5022	0.5000	0.4978	14.1454	14.1449	0.00%
0	0.600	0.5508	0.4000	0.4492	14.0751	13.8675	1.47%
0	0.648	0.5764	0.3520	0.4236	13.9817	13.5701	2.94%
0	0.650	0.5775	0.3500	0.4225	13.9768	13.5562	3.01%
0	0.700	0.6073	0.3000	0.3927	13.8276	13.1823	4.67%
0	0.710	0.6137	0.2900	0.3863	13.7907	13.1028	4.99%
0	0.712	0.6150	0.2880	0.3850	13.7830	13.0868	5.05%
0	0.948	0.8743	0.0520	0.1257	11.7385	11.1494	5.02%
0	0.950	0.8782	0.0500	0.1218	11.7061	11.1339	4.89%
0	0.972	0.9259	0.0280	0.0741	11.3228	10.9651	3.16%
0	0.974	0.9306	0.0260	0.0694	11.2854	10.9499	2.97%
0	0.998	0.9941	0.0020	0.0059	10.7988	10.7698	0.27%
0	1.000	1.0000	0.0000	0.0000	10.7549	10.7549	0.00%
20	0.000	0.0000	1.0000	1.0000	21.1399	21.1399	0.00%
20	0.002	0.0073	0.9980	0.9927	21.2595	21.1727	0.41%
20	0.016	0.0537	0.9840	0.9463	22.0503	21.4048	2.93%
20	0.018	0.0598	0.9820	0.9402	22.1570	21.4382	3.24%
20	0.030	0.0938	0.9700	0.9062	22.7665	21.6408	4.94%
20	0.032	0.0990	0.9680	0.9010	22.8632	21.6748	5.20%

Temp (°C)	Liquid Mole Fraction E-HFO- 1336mzz	Vapor Mole Fraction E-HFO- 1336mzz	Liquid Mole Fraction Neopentane	Vapor Mole Fraction Neopentane	Bubble Point Pressure (psia)	Dew Point Pressure (psia)	[(BP- DP)/BP]* 100%
20	0.352	0.4450	0.6480	0.5550	29.3816	27.8860	5.09%
20	0.354	0.4461	0.6460	0.5539	29.3947	27.9239	5.00%
20	0.400	0.4701	0.6000	0.5299	29.6494	28.7384	3.07%
20	0.402	0.4711	0.5980	0.5289	29.6586	28.7708	2.99%
20	0.500	0.5195	0.5000	0.4805	29.9403	29.8645	0.25%
20	0.600	0.5700	0.4000	0.4300	29.9002	29.7282	0.58%
20	0.698	0.6265	0.3020	0.3735	29.4990	28.6171	2.99%
20	0.700	0.6278	0.3000	0.3722	29.4863	28.5883	3.05%
20	0.776	0.6821	0.2240	0.3179	28.8389	27.3994	4.99%
20	0.778	0.6838	0.2220	0.3162	28.8169	27.3663	5.03%
20	0.922	0.8431	0.0780	0.1569	26.2733	24.9483	5.04%
20	0.924	0.8462	0.0760	0.1538	26.2206	24.9152	4.98%
20	0.964	0.9172	0.0360	0.0828	25.0275	24.2620	3.06%
20	0.966	0.9213	0.0340	0.0787	24.9602	24.2297	2.93%
20	0.998	0.9948	0.0020	0.0052	23.7709	23.7203	0.21%
20	1.000	1.0000	0.0000	0.0000	23.6889	23.6889	0.00%
29.88	0.000	0.0000	1.0000	1.0000	28.9758	28.9758	0.00%
29.88	0.002	0.0072	0.9980	0.9928	29.1409	29.0215	0.41%
29.88	0.016	0.0534	0.9840	0.9466	30.2362	29.3445	2.95%
29.88	0.018	0.0595	0.9820	0.9405	30.3844	29.3912	3.27%
29.88	0.030	0.0934	0.9700	0.9066	31.2334	29.6733	5.00%
29.88	0.032	0.0986	0.9680	0.9014	31.3685	29.7208	5.25%
29.88	0.366	0.4575	0.6340	0.5425	40.9262	38.8602	5.05%
29.88	0.368	0.4586	0.6320	0.5414	40.9445	38.9135	4.96%
29.88	0.370	0.4597	0.6300	0.5403	40.9626	38.9666	4.87%
29.88	0.372	0.4608	0.6280	0.5392	40.9805	39.0194	4.79%
29.88	0.374	0.4618	0.6260	0.5382	40.9981	39.0720	4.70%
29.88	0.376	0.4629	0.6240	0.5371	41.0155	39.1243	4.61%
29.88	0.378	0.4640	0.6220	0.5360	41.0327	39.1763	4.52%
29.88	0.380	0.4650	0.6200	0.5350	41.0497	39.2280	4.44%
29.88	0.382	0.4661	0.6180	0.5339	41.0664	39.2794	4.35%
29.88	0.384	0.4672	0.6160	0.5328	41.0829	39.3305	4.27%
29.88	0.386	0.4682	0.6140	0.5318	41.0992	39.3814	4.18%
29.88	0.388	0.4693	0.6120	0.5307	41.1152	39.4319	4.09%
29.88	0.390	0.4703	0.6100	0.5297	41.1311	39.4820	4.01%
29.88	0.392	0.4714	0.6080	0.5286	41.1467	39.5319	3.92%
29.88	0.394	0.4724	0.6060	0.5276	41.1621	39.5814	3.84%
29.88	0.396	0.4735	0.6040	0.5265	41.1773	39.6305	3.76%
29.88	0.398	0.4745	0.6020	0.5255	41.1922	39.6793	3.67%
29.88	0.400	0.4756	0.6000	0.5244	41.2070	39.7278	3.59%
29.88	0.414	0.4828	0.5860	0.5172	41.3043	40.0558	3.02%
29.88	0.416	0.4838	0.5840	0.5162	41.3173	40.1010	2.94%
29.88	0.500	0.5260	0.5000	0.4740	41.6894	41.4985	0.46%
29.88	0.600	0.5774	0.4000	0.4226	41.6991	41.5591	0.34%
29.88	0.700	0.6359	0.3000	0.3641	41.1831	40.1523	2.50%
29.88	0.718	0.6478	0.2820	0.3522	41.0224	39.8037	2.97%
29.88	0.720	0.6491	0.2800	0.3509	41.0031	39.7638	3.02%

Temp (°C)	Liquid Mole Fraction E-HFO- 1336mzz	Vapor Mole Fraction E-HFO- 1336mzz	Liquid Mole Fraction Neopentane	Vapor Mole Fraction Neopentane	Bubble Point Pressure (psia)	Dew Point Pressure (psia)	[(BP- DP)/BP]* 100%
29.88	0.800	0.7104	0.2000	0.2896	39.9532	38.0322	4.81%
29.88	0.812	0.7211	0.1880	0.2789	39.7420	37.7579	4.99%
29.88	0.814	0.7229	0.1860	0.2771	39.7053	37.7120	5.02%
29.88	0.902	0.8206	0.0980	0.1794	37.5605	35.6725	5.03%
29.88	0.904	0.8233	0.0960	0.1767	37.4977	35.6263	4.99%
29.88	0.960	0.9133	0.0400	0.0867	35.4128	34.3478	3.01%
29.88	0.962	0.9171	0.0380	0.0829	35.3253	34.3028	2.89%
29.88	0.998	0.9951	0.0020	0.0049	33.5673	33.5026	0.19%
29.88	1.000	1.0000	0.0000	0.0000	33.4587	33.4587	0.00%
40	0.000	0.0000	1.0000	1.0000	39.1175	39.1175	0.00%
40	0.002	0.0071	0.9980	0.9929	39.3421	39.1803	0.41%
40	0.016	0.0529	0.9840	0.9471	40.8366	39.6247	2.97%
40	0.018	0.0590	0.9820	0.9410	41.0395	39.6889	3.29%
40	0.028	0.0873	0.9720	0.9127	42.0165	40.0121	4.77%
40	0.030	0.0927	0.9700	0.9073	42.2047	40.0772	5.04%
40	0.378	0.4681	0.6220	0.5319	56.1782	53.3429	5.05%
40	0.380	0.4692	0.6200	0.5308	56.2040	53.4172	4.96%
40	0.400	0.4800	0.6000	0.5200	56.4444	54.1395	4.08%
40	0.426	0.4936	0.5740	0.5064	56.7116	55.0067	3.01%
40	0.428	0.4947	0.5720	0.5053	56.7301	55.0694	2.93%
40	0.500	0.5315	0.5000	0.4685	57.2133	56.8210	0.69%
40	0.600	0.5837	0.4000	0.4163	57.3115	57.2081	0.18%
40	0.700	0.6429	0.3000	0.3571	56.6735	55.4940	2.08%
40	0.736	0.6674	0.2640	0.3326	56.2229	54.5604	2.96%
40	0.738	0.6688	0.2620	0.3312	56.1938	54.5054	3.00%
40	0.740	0.6702	0.2600	0.3298	56.1644	54.4501	3.05%
40	0.800	0.7176	0.2000	0.2824	55.0530	52.6872	4.30%
40	0.900	0.8239	0.1000	0.1761	51.9480	49.5417	4.63%
40	0.954	0.9060	0.0460	0.0940	49.3528	47.8448	3.06%
40	0.956	0.9095	0.0440	0.0905	49.2407	47.7826	2.96%
40	0.998	0.9953	0.0020	0.0047	46.5752	46.4927	0.18%
40	1.000	1.0000	0.0000	0.0000	46.4321	46.4321	0.00%
60	0.000	0.0000	1.0000	1.0000	66.7508	66.7508	0.00%
60	0.002	0.0069	0.9980	0.9931	67.1411	66.8632	0.41%
60	0.016	0.0516	0.9840	0.9484	69.7544	67.6585	3.00%
60	0.018	0.0575	0.9820	0.9425	70.1115	67.7734	3.33%
60	0.028	0.0854	0.9720	0.9146	71.8390	68.3526	4.85%
60	0.030	0.0907	0.9700	0.9093	72.1732	68.4694	5.13%
60	0.398	0.4842	0.6020	0.5158	99.4245	94.3842	5.07%
60	0.400	0.4853	0.6000	0.5147	99.4736	94.5224	4.98%
60	0.444	0.5092	0.5560	0.4908	100.4082	97.3428	3.05%
60	0.446	0.5102	0.5540	0.4898	100.4443	97.4591	2.97%
60	0.500	0.5388	0.5000	0.4612	101.2191	100.0780	1.13%
60	0.600	0.5927	0.4000	0.4073	101.6574	101.6166	0.04%
60	0.700	0.6531	0.3000	0.3469	100.6874	99.1097	1.57%
60	0.764	0.6989	0.2360	0.3011	99.1535	96.1892	2.99%
60	0.766	0.7004	0.2340	0.2996	99.0919	96.0881	3.03%

Temp (°C)	Liquid Mole Fraction E-HFO- 1336mzz	Vapor Mole Fraction E-HFO- 1336mzz	Liquid Mole Fraction Neopentane	Vapor Mole Fraction Neopentane	Bubble Point Pressure (psia)	Dew Point Pressure (psia)	[(BP- DP)/BP]* 100%
60	0.800	0.7284	0.2000	0.2716	97.9001	94.3058	3.67%
60	0.946	0.8988	0.0540	0.1012	88.7653	86.0797	3.03%
60	0.948	0.9020	0.0520	0.0980	88.5816	85.9667	2.95%
60	0.998	0.9956	0.0020	0.0044	83.3043	83.1736	0.16%
60	1.000	1.0000	0.0000	0.0000	83.0634	83.0634	0.00%
80	0.000	0.0000	1.0000	1.0000	106.7445	106.7445	0.00%
80	0.002	0.0067	0.9980	0.9933	107.3858	106.9363	0.42%
80	0.014	0.0441	0.9860	0.9559	111.1113	108.0998	2.71%
80	0.016	0.0499	0.9840	0.9501	111.7122	108.2958	3.06%
80	0.028	0.0828	0.9720	0.9172	115.2035	109.4849	4.96%
80	0.030	0.0880	0.9700	0.9120	115.7668	109.6852	5.25%
80	0.416	0.4950	0.5840	0.5050	167.0991	158.5962	5.09%
80	0.418	0.4962	0.5820	0.5038	167.1918	158.8495	4.99%
80	0.460	0.5194	0.5400	0.4806	168.8860	163.7680	3.03%
80	0.462	0.5205	0.5380	0.4795	168.9549	163.9796	2.94%
80	0.500	0.5412	0.5000	0.4588	170.0653	167.5014	1.51%
80	0.600	0.5968	0.4000	0.4032	171.1919	171.1762	0.01%
80	0.700	0.6587	0.3000	0.3413	169.5099	167.0483	1.45%
80	0.768	0.7084	0.2320	0.2916	166.4468	161.4755	2.99%
80	0.770	0.7100	0.2300	0.2900	166.3295	161.2920	3.03%
80	0.800	0.7350	0.2000	0.2650	164.3623	158.4508	3.60%
80	0.900	0.8391	0.1000	0.1609	154.5696	148.3564	4.02%
80	0.944	0.9001	0.0560	0.0999	148.3449	143.8749	3.01%
80	0.946	0.9032	0.0540	0.0968	148.0292	143.6728	2.94%
80	0.998	0.9959	0.0020	0.0041	138.7018	138.4930	0.15%
80	1.000	1.0000	0.0000	0.0000	138.2971	138.2971	0.00%
100	0.000	0.0000	1.0000	1.0000	162.0606	162.0606	0.00%
100	0.002	0.0063	0.9980	0.9937	163.0789	162.3803	0.43%
100	0.014	0.0421	0.9860	0.9579	169.0432	164.3232	2.79%
100	0.016	0.0477	0.9840	0.9523	170.0136	164.6512	3.15%
100	0.026	0.0743	0.9740	0.9257	174.7674	166.3096	4.84%
100	0.028	0.0793	0.9720	0.9207	175.6990	166.6450	5.15%
100	0.400	0.4784	0.6000	0.5216	270.4013	256.5804	5.11%
100	0.402	0.4796	0.5980	0.5204	270.5470	257.2455	4.92%
100	0.438	0.5005	0.5620	0.4995	272.9099	264.6125	3.04%
100	0.440	0.5016	0.5600	0.4984	273.0274	264.9359	2.96%
100	0.500	0.5355	0.5000	0.4645	275.9366	272.8608	1.11%
100	0.600	0.5928	0.4000	0.4072	278.2866	278.3577	-0.03%
100	0.700	0.6566	0.3000	0.3434	277.3187	274.7297	0.93%
100	0.756	0.6978	0.2440	0.3022	274.8945	266.7121	2.98%
100	0.758	0.6994	0.2420	0.3006	274.7739	266.2803	3.09%
100	0.794	0.7295	0.2060	0.2705	271.9438	258.5450	4.93%
100	0.796	0.7312	0.2040	0.2688	271.7221	258.1176	5.01%
100	0.888	0.8269	0.1120	0.1731	251.5621	238.9478	5.01%
100	0.890	0.8293	0.1100	0.1707	251.0532	238.5452	4.98%
100	0.952	0.9148	0.0480	0.0852	233.6140	226.4451	3.07%
100	0.954	0.9180	0.0460	0.0820	232.9938	226.0677	2.97%

Temp (°C)	Liquid Mole Fraction E-HFO-1336mzz	Vapor Mole Fraction E-HFO-1336mzz	Liquid Mole Fraction Neopentane	Vapor Mole Fraction Neopentane	Bubble Point Pressure (psia)	Dew Point Pressure (psia)	[(BP-DP)/BP]* 100%
100	0.998	0.9960	0.0020	0.0040	218.3357	217.9789	0.16%
100	1.000	1.0000	0.0000	0.0000	217.6210	217.6210	0.00%
120	0.000	0.0000	1.0000	1.0000	236.1168	236.1168	0.00%
120	0.002	0.0060	0.9980	0.9940	237.7196	236.6528	0.45%
120	0.004	0.0118	0.9960	0.9882	239.3178	237.1915	0.89%
120	0.006	0.0175	0.9940	0.9825	240.9116	237.7328	1.32%
120	0.008	0.0232	0.9920	0.9768	242.5012	238.2769	1.74%
120	0.010	0.0288	0.9900	0.9712	244.0867	238.8236	2.16%
120	0.012	0.0342	0.9880	0.9658	245.6682	239.3732	2.56%
120	0.014	0.0396	0.9860	0.9604	247.2460	239.9254	2.96%
120	0.016	0.0449	0.9840	0.9551	248.8201	240.4805	3.35%
120	0.024	0.0651	0.9760	0.9349	255.0835	242.7293	4.84%
120	0.026	0.0700	0.9740	0.9300	256.6420	243.2988	5.20%
120	0.370	0.4533	0.6300	0.5467	374.6714	355.8479	5.02%
120	0.372	0.4545	0.6280	0.5455	374.9127	356.3524	4.95%
120	0.426	0.4874	0.5740	0.5126	380.6432	369.0815	3.04%
120	0.428	0.4886	0.5720	0.5114	380.8278	369.5134	2.97%
120	0.500	0.5307	0.5000	0.4693	386.2785	382.5140	0.97%
120	0.600	0.5896	0.4000	0.4104	390.1957	390.4366	-0.06%
120	0.700	0.6549	0.3000	0.3451	389.6846	386.8445	0.73%
120	0.800	0.7341	0.2000	0.2659	383.6353	375.4644	2.13%
120	0.900	0.8404	0.1000	0.1596	369.4663	359.4971	2.70%
120	0.962	0.9304	0.0380	0.0696	353.7368	343.1236	3.00%
120	0.964	0.9337	0.0360	0.0663	353.0395	342.2334	3.06%
120	0.966	0.9371	0.0340	0.0629	352.3105	341.3537	3.11%
120	0.972	0.9475	0.0280	0.0525	349.7199	338.7722	3.13%
120	0.974	0.9511	0.0260	0.0489	348.1987	337.9295	2.95%
120	0.998	0.9960	0.0020	0.0040	329.1331	328.3877	0.23%
120	1.000	1.0000	0.0000	0.0000	327.6335	327.6335	0.00%

Near-azeotropes formed between E-HFO-1336mzz and neopentane at 1 atm are shown in Table 5. Table 5 shows representative data in increments of 0.10 E-HFO-1336mzz liquid molar composition, or the boundaries of near-azeotropic behavior.

Table 5.

Pressure (atm)	Temp (°C)	Liquid Mole Fraction E-HFO-1336mzz	Vapor Mole Fraction E-HFO-1336mzz	Liquid Mole Fraction Neopentane	Liquid Mole Fraction Neopentane	Bubble Point Pressure (psia)	Dew Point Pressure (psia)	[(BP-DP)/BP]* 100%
1.00	9.461	0	0	1	1	14.69595	14.69595	0.00%
1.00	9.305	0.002	0.01	1.00	0.993	14.696	14.636	0.41%
1.00	8.308	0.016	0.05	0.98	0.946	14.696	14.270	2.90%

1.00	8.177	0.018	0.06	0.98	0.940	14.696	14.225	3.21%
1.00	7.449	0.03	0.0938898	0.97	0.9061102	14.69595	13.98093	4.87%
1.00	7.336	0.032	0.0991343	0.968	0.9008656	14.69595	13.94488	5.11%
1.00	1.409	0.324	0.4177095	0.676	0.5822905	14.69595	13.95334	5.05%
1.00	1.195	0.37	0.4414781	0.63	0.5585219	14.69595	14.23698	3.12%
1.00	1.187	0.372	0.4424725	0.628	0.5575275	14.69595	14.24871	3.04%
1.00	1.180	0.374	0.4434643	0.626	0.5565357	14.69595	14.26035	2.96%
1.00	1.094	0.4	0.4561451	0.6	0.5438549	14.69595	14.40299	1.99%
1.00	0.946	0.5	0.5031367	0.5	0.4968633	14.69595	14.695	0.01%
1.00	1.065	0.6	0.5519321	0.4	0.4480679	14.69595	14.48902	1.41%
1.00	1.244	0.652	0.5800897	0.348	0.4199103	14.69595	14.2598	2.97%
1.00	1.252	0.654	0.5812312	0.346	0.4187688	14.69595	14.25034	3.03%
1.00	1.589	0.714	0.6181589	0.286	0.3818411	14.69595	13.96853	4.95%
1.00	1.603	0.716	0.6194943	0.284	0.3805057	14.69595	13.95961	5.01%
1.00	5.262	0.942	0.8666191	0.058	0.1333809	14.69595	13.95456	5.04%
1.00	5.325	0.944	0.8703764	0.056	0.1296236	14.69595	13.97141	4.93%
1.00	6.231	0.97	0.9241145	0.03	0.0758854	14.69595	14.24138	3.09%
1.00	6.308	0.972	0.9286651	0.028	0.0713348	14.69595	14.26647	2.92%
1.00	7.418184	0.998	0.9943818	0.002	0.00561824	14.69595	14.65994	0.25%
1.00	7.512796	1	1	0	0	14.69595	14.69595	0.00%

The detailed data in Tables 4-5 are broadly summarized in Table 6 below.

From the results in Table 5, azeotrope-like compositions with differences of 3% or less between bubble point pressures and dew point pressures exist from:

- 5 (1) 0.002 to 0.016 mole fraction E-1336mzz and from 0.984 to 0.998 mole percent neopentane at 1 atmosphere pressure boiling at from 8.31 to 9.31 °C;
- (2) 0.374 to 0.652 mole fraction E-1336mzz and from 0.384 to 0.626 mole percent neopentane at 1 atmosphere pressure boiling at from 0.95 to 1.24 °C; and
- (3) 0.972 to 0.998 mole fraction E-1336mzz and from 0.002 to 0.028 mole
- 10 percent neopentane at 1 atmosphere pressure boiling at from 6.31 to 7.42 °C.

Ranges of 3% azeotrope-like compositions (based on $[(BP-VP)/BP] \times 100 \leq 3$) are listed in Table 6.

Table 6.

Components	Temp (°C)	E-HFO-1336mzz Vapor Mole Percentage Range (Remainder Neopentane)
E-HFO-1336mzz / Neopentane	-40	0.002 to 0.018 and 0.284 to 0.524 and 0.988 to 0.998

Components	Temp (°C)	E-HFO-1336mzz Vapor Mole Percentage Range (Remainder Neopentane)
E-HFO-1336mzz / Neopentane	-20	0.002 to 0.016 and 0.334 to 0.592 and 0.982 to 0.998
E-HFO-1336mzz / Neopentane	0	0.002 to 0.016 and 0.372 to 0.648 and 0.974 to 0.998
E-HFO-1336mzz / Neopentane	20	0.002 to 0.016 and 0.402 to 0.698 and 0.966 to 0.998
E-HFO-1336mzz / Neopentane	29.88	0.002 to 0.016 and 0.416 to 0.718 and 0.962 to 0.998
E-HFO-1336mzz / Neopentane	40	0.002 to 0.016 and 0.428 to 0.736 and 0.956 to 0.998
E-HFO-1336mzz / Neopentane	60	0.002 to 0.016 and 0.446 to 0.764 and 0.948 to 0.998
E-HFO-1336mzz / Neopentane	80	0.002 to 0.014 and 0.462 to 0.768 and 0.946 to 0.998
E-HFO-1336mzz / Neopentane	100	0.002 to 0.014 and 0.440 to 0.756 and 0.954 to 0.998
E-HFO-1336mzz / Neopentane	120	0.002 to 0.014 and 0.428 to 0.962 and 0.974 to 0.998

Example 2. Compositions of Z-HFO-1336mzz and Neopentane

The binary system of Z-HFO-1336mzz/neopentane was explored for potential azeotropic and near-azeotropic behavior. To determine the relative volatility of this binary system, the PTx method described herein was used. The pressure in a PTx cell of known volume was measured at constant temperature of 29.90°C for various binary compositions. The collected experimental data are displayed in Table 7 below, where X_2 = liquid mole fraction of neopentane; Y_2 = vapor mole fraction of neopentane; P_{exp} = experimentally measured pressure; and P_{calc} = pressure as calculated by NRTL model.

Table 7.

X2	Y2	psia,expt	psia,calc	(pcalc/pexp)-1
0	0	12.98	-	-
0.00565	0.04447	13.53	13.5319	1.38E-04
0.00915	0.06959	13.88	13.8641	-1.14E-03
0.0182	0.12772	14.67	14.6968	1.83E-03
0.06537	0.32642	18.45	18.4289	-1.15E-03
0.14432	0.48593	22.92	22.9065	-5.87E-04
0.24575	0.58368	26.49	26.5246	1.31E-03

X2	Y2	psia,expt	psia,calc	(pcalc/pexp)-1
0.34458	0.63707	28.61	28.6679	2.02E-03
0.45163	0.67591	30.22	30.1073	-3.73E-03
0.55029	0.70455	30.96	30.9557	-1.38E-04
0.65079	0.73293	31.51	31.5177	2.45E-04
0.75045	0.76664	31.79	31.806	5.04E-04
0.8517	0.81802	31.66	31.6557	-1.37E-04
0.93498	0.8925	30.77	30.7664	-1.17E-04
0.98191	0.96298	29.6	29.6229	7.74E-04
0.99116	0.98103	29.26	29.3112	1.75E-03
0.99555	0.99022	29.1	29.1511	1.76E-03
1	1	28.98	-	-

The vapor pressure vs. neopentane liquid mole fraction data shown in Table 7 are plotted in FIG. 2, with the experimental data points shown as solid points. The solid line represents bubble point predictions using the NRTL equation. The dashed line represents predicted dew points. FIG. 2 demonstrates the formation of an azeotrope at 29.90°C of the composition containing 0.220 mole fraction Z-1,1,1,4,4,4-hexafluoro-2-butene and 0.780 mole fraction neopentane, as evidenced by the maximum in the P_x diagram at a pressure of 31.8 psia.

Based on these VLE data, interaction coefficients were extracted. The NRTL model was run over the temperature range of -40 to 120°C in increments of 10°C allowing pressure to vary such that the azeotropic condition ($X_2 = Y_2$) was met. The resulting predicted azeotropes in the Z-HFO-1336mzz/neopentane system, and the experimentally determined data at 29.90°C, are displayed in Table 8.

Table 8.

Temp (°C)	Azeotrope Pressure (psi)	Vapor Mole Fraction Z-HFO-1336mzz	Vapor Mole Fraction Neopentane
-40	1.6	0.07883	0.92117
-30	2.8	0.09995	0.90005
-20	4.6	0.12089	0.87911
-10	7.2	0.14154	0.85846
0	10.9	0.16187	0.83813
10	16.0	0.18187	0.81813
20	22.9	0.20154	0.79846
30	31.9	0.22092	0.77908
40	43.5	0.24008	0.75992
50	58.3	0.25908	0.74092

Temp (°C)	Azeotrope Pressure (psi)	Vapor Mole Fraction Z-HFO-1336mzz	Vapor Mole Fraction Neopentane
60	76.8	0.27803	0.72197
70	99.9	0.29709	0.70291
80	128.6	0.31656	0.68344
90	164.6	0.33709	0.66291
100	211.4	0.36145	0.63855
110	260.8	0.38626	0.61374
120	308.7	0.40156	0.59844

The model was used to predict azeotropes over a pressure range of 1-30 atm at 1 atm increments, the results of which are displayed in Table 9.

Table 9.

Pressure (atm)	Azeotrope Temperature (°C)	Vapor Mole Fraction Z-HFO-1336mzz	Vapor Mole Fraction Neopentane
1	7.7	0.17728	0.82272
2	27.5	0.21605	0.78395
3	40.4	0.24089	0.75911
4	50.3	0.25963	0.74037
5	58.3	0.27489	0.72511
6	65.2	0.28788	0.71212
7	71.1	0.29927	0.70073
8	76.4	0.30948	0.69052
9	81.1	0.31879	0.68121
10	85.4	0.32741	0.67259
11	89.3	0.33551	0.66449
12	92.8	0.34325	0.65675
13	96.0	0.35079	0.64921
14	98.9	0.35839	0.64161
15	101.6	0.36666	0.63334
16	104.3	0.37595	0.62405
17	107.6	0.38215	0.61785
18	110.8	0.38757	0.61243
19	114.0	0.39255	0.60745
20	117.0	0.39718	0.60282
21	120.0	0.40153	0.59847
22	122.9	0.40563	0.59437
23	125.7	0.40952	0.59048
24	128.4	0.41322	0.58678
25	131.0	0.41674	0.58326
26	133.6	0.42010	0.57990
27	136.1	0.42332	0.57668

Pressure (atm)	Azeotrope Temperature (°C)	Vapor Mole Fraction Z-HFO-1336mzz	Vapor Mole Fraction Neopentane
28	138.5	0.42640	0.57360
29	140.9	0.42935	0.57065
30	143.2	0.43191	0.56809

The model was run over a temperature range from -40 to 120°C in 20 deg. increments, and also at 29.90°C for the purpose of comparison to experimentally measured results. At each temperature, the model was run over the full range from 0 to 1 of Z-HFO-1336mzz liquid molar composition in increments of 0.002. Thus the model was run at a total of 5010 combinations of temperature and Z-HFO-1336mzz liquid molar composition (10 temperatures x 501 compositions = 5010). Table 10 shows representative results in increments of 0.10 Z-HFO-1336mzz liquid molar composition, or the boundaries of near-azeotropic behavior.

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Table 10.

Total Temperature (°C)	Liquid Mole Fraction Z-HFO-1336mzz	Vapor Mole Fraction Z-HFO-1336mzz	Liquid Mole Fraction Neopentane	Vapor Mole Fraction Neopentane	Bubble Point Pressure (psia)	Dew Point Pressure (psia)	[(BP-DP)/BP] * 100%
-40	0.000	0.0000	1.0000	1.0000	1.6172	1.6172	0.00%
-40	0.002	0.0031	0.9980	0.9969	1.6190	1.6184	0.04%
-40	0.100	0.0909	0.9000	0.9091	1.6437	1.6413	0.15%
-40	0.148	0.1110	0.8520	0.8890	1.6360	1.5870	2.99%
-40	0.150	0.1117	0.8500	0.8883	1.6356	1.5824	3.25%
-40	0.160	0.1150	0.8400	0.8850	1.6334	1.5550	4.80%
-40	0.162	0.1156	0.8380	0.8844	1.6329	1.5487	5.15%
-40	0.998	0.9546	0.0020	0.0454	0.3663	0.3510	4.18%
-40	1.000	1.0000	0.0000	0.0000	0.3503	0.3503	0.00%
-20	0.000	0.0000	1.0000	1.0000	4.4342	4.4342	0.00%
-20	0.002	0.0035	0.9980	0.9965	4.4412	4.4382	0.07%
-20	0.100	0.1085	0.9000	0.8915	4.5869	4.5823	0.10%
-20	0.192	0.1510	0.8080	0.8490	4.5692	4.4375	2.88%
-20	0.194	0.1516	0.8060	0.8484	4.5682	4.4267	3.10%
-20	0.208	0.1560	0.7920	0.8440	4.5608	4.3389	4.86%
-20	0.210	0.1566	0.7900	0.8434	4.5597	4.3248	5.15%
-20	0.996	0.9387	0.0040	0.0613	1.3342	1.2616	5.44%
-20	0.998	0.9682	0.0020	0.0318	1.2958	1.2592	2.82%
-20	1.000	1.0000	0.0000	0.0000	1.2568	1.2568	0.00%
0	0.000	0.0000	1.0000	1.0000	10.3222	10.3222	0.00%
0	0.002	0.0039	0.9980	0.9961	10.3431	10.3328	0.10%
0	0.100	0.1241	0.9000	0.8759	10.8575	10.7847	0.67%
0	0.200	0.1786	0.8000	0.8214	10.8959	10.8317	0.59%
0	0.238	0.1921	0.7620	0.8079	10.8625	10.5375	2.99%

Total Tem p (°C)	Liquid Mole Fraction Z-HFO- 1336mz z	Vapor Mole Fractio n Z-HFO- 1336mz z	Liquid Mole Fraction Neopentan e	Vapor Mole Fraction Neopentan e	Bubble Point Pressur e (psia)	Dew Point Pressur e (psia)	[(BP- DP)/BP] * 100%
0	0.240	0.1928	0.7600	0.8072	10.8603	10.5148	3.18%
0	0.256	0.1977	0.7440	0.8023	10.8415	10.3091	4.91%
0	0.258	0.1983	0.7420	0.8017	10.8390	10.2807	5.15%
0	0.994	0.9329	0.0060	0.0671	3.8553	3.6348	5.72%
0	0.996	0.9541	0.0040	0.0459	3.7760	3.6280	3.92%
0	0.998	0.9764	0.0020	0.0236	3.6957	3.6212	2.02%
0	1.000	1.0000	0.0000	0.0000	3.6144	3.6144	0.00%
20	0.000	0.0000	1.0000	1.0000	21.1399	21.1399	0.00%
20	0.002	0.0043	0.9980	0.9957	21.1914	21.1640	0.13%
20	0.100	0.1376	0.9000	0.8624	22.6006	22.2674	1.47%
20	0.200	0.2008	0.8000	0.7992	22.8812	22.8811	0.00%
20	0.282	0.2326	0.7180	0.7674	22.7823	22.1007	2.99%
20	0.284	0.2333	0.7160	0.7667	22.7778	22.0583	3.16%
20	0.302	0.2390	0.6980	0.7610	22.7337	21.6320	4.85%
20	0.304	0.2396	0.6960	0.7604	22.7284	21.5803	5.05%
20	0.992	0.9312	0.0080	0.0688	9.3530	8.8251	5.64%
20	0.994	0.9473	0.0060	0.0527	9.2073	8.8088	4.33%
20	0.996	0.9641	0.0040	0.0359	9.0599	8.7925	2.95%
20	0.998	0.9816	0.0020	0.0184	8.9109	8.7762	1.51%
20	1.000	1.0000	0.0000	0.0000	8.7600	8.7600	0.00%
29.90	0.000	0.0000	1.0000	1.0000	28.9936	28.9936	0.00%
29.90	0.002	0.0044	0.9980	0.9956	29.0702	29.0283	0.14%
29.90	0.100	0.1436	0.9000	0.8564	31.2508	30.6506	1.92%
29.90	0.200	0.2109	0.8000	0.7891	31.7848	31.7473	0.12%
29.90	0.300	0.2514	0.7000	0.7486	31.6654	30.7977	2.74%
29.90	0.302	0.2521	0.6980	0.7479	31.6593	30.7436	2.89%
29.90	0.304	0.2527	0.6960	0.7473	31.6530	30.6882	3.05%
29.90	0.326	0.2599	0.6740	0.7401	31.5767	29.9999	4.99%
29.90	0.328	0.2605	0.6720	0.7395	31.5691	29.9311	5.19%
29.90	0.990	0.9240	0.0100	0.0760	13.8642	13.0165	6.11%
29.90	0.992	0.9380	0.0080	0.0620	13.6749	12.9924	4.99%
29.90	0.994	0.9526	0.0060	0.0474	13.4836	12.9683	3.82%
29.90	0.996	0.9678	0.0040	0.0322	13.2902	12.9444	2.60%
29.90	0.998	0.9836	0.0020	0.0164	13.0946	12.9205	1.33%
29.90	1.000	1.0000	0.0000	0.0000	12.8968	12.8968	0.00%
40	0.000	0.0000	1.0000	1.0000	39.1175	39.1175	0.00%
40	0.002	0.0046	0.9980	0.9954	39.2292	39.1666	0.16%
40	0.100	0.1494	0.9000	0.8506	42.5267	41.5039	2.41%
40	0.200	0.2206	0.8000	0.7794	43.4682	43.2932	0.40%
40	0.300	0.2640	0.7000	0.7360	43.4226	42.8014	1.43%
40	0.324	0.2724	0.6760	0.7276	43.3303	42.0535	2.95%
40	0.326	0.2731	0.6740	0.7269	43.3215	41.9801	3.10%
40	0.348	0.2804	0.6520	0.7196	43.2138	41.0773	4.94%
40	0.350	0.2811	0.6500	0.7189	43.2030	40.9877	5.13%
40	0.990	0.9312	0.0100	0.0688	19.8257	18.7456	5.45%

Total Temperature (°C)	Liquid Mole Fraction Z-HFO-1336mz	Vapor Mole Fraction Z-HFO-1336mz	Liquid Mole Fraction Neopentane	Vapor Mole Fraction Neopentane	Bubble Point Pressure (psia)	Dew Point Pressure (psia)	[(BP-DP)/BP] * 100%
40	0.992	0.9440	0.0080	0.0560	19.5804	18.7109	4.44%
40	0.994	0.9572	0.0060	0.0428	19.3326	18.6763	3.40%
40	0.996	0.9710	0.0040	0.0290	19.0822	18.6418	2.31%
40	0.998	0.9852	0.0020	0.0148	18.8290	18.6075	1.18%
40	1.000	1.0000	0.0000	0.0000	18.5732	18.5732	0.00%
60	0.000	0.0000	1.0000	1.0000	66.7508	66.7508	0.00%
60	0.002	0.0048	0.9980	0.9952	66.9722	66.8431	0.19%
60	0.050	0.0964	0.9500	0.9036	71.2049	69.0695	3.00%
60	0.052	0.0994	0.9480	0.9006	71.3424	69.1623	3.06%
60	0.100	0.1599	0.9000	0.8401	73.9384	71.3675	3.48%
60	0.134	0.1919	0.8660	0.8081	75.1282	72.8669	3.01%
60	0.136	0.1936	0.8640	0.8064	75.1851	72.9523	2.97%
60	0.200	0.2385	0.8000	0.7615	76.4161	75.3962	1.33%
60	0.300	0.2873	0.7000	0.7127	76.8076	76.6796	0.17%
60	0.364	0.3117	0.6360	0.6883	76.4600	74.2548	2.88%
60	0.366	0.3125	0.6340	0.6875	76.4433	74.1332	3.02%
60	0.390	0.3209	0.6100	0.6791	76.2178	72.5078	4.87%
60	0.392	0.3216	0.6080	0.6784	76.1969	72.3602	5.04%
60	0.988	0.9319	0.0120	0.0681	37.8216	35.8393	5.24%
60	0.990	0.9424	0.0100	0.0576	37.4342	35.7723	4.44%
60	0.992	0.9532	0.0080	0.0468	37.0431	35.7055	3.61%
60	0.994	0.9644	0.0060	0.0356	36.6482	35.6390	2.75%
60	0.998	0.9878	0.0020	0.0122	35.8472	35.5067	0.95%
60	1.000	1.0000	0.0000	0.0000	35.4409	35.4409	0.00%
80	0.000	0.0000	1.0000	1.0000	106.7445	106.7445	0.00%
80	0.002	0.0050	0.9980	0.9950	107.1575	106.9093	0.23%
80	0.034	0.0737	0.9660	0.9263	112.9502	109.5782	2.99%
80	0.036	0.0773	0.9640	0.9227	113.2653	109.7468	3.11%
80	0.100	0.1694	0.9000	0.8306	121.0224	115.2064	4.81%
80	0.192	0.2498	0.8080	0.7502	126.6249	122.7885	3.03%
80	0.194	0.2511	0.8060	0.7489	126.6973	122.9397	2.97%
80	0.200	0.2551	0.8000	0.7449	126.9045	123.3872	2.77%
80	0.300	0.3092	0.7000	0.6908	128.6011	128.4880	0.09%
80	0.404	0.3519	0.5960	0.6481	127.9126	124.1362	2.95%
80	0.406	0.3526	0.5940	0.6474	127.8807	123.9332	3.09%
80	0.430	0.3617	0.5700	0.6383	127.4454	121.2404	4.87%

Total Temp p (°C)	Liquid Mole Fraction Z-HFO- 1336mz z	Vapor Mole Fraction Z-HFO- 1336mz z	Liquid Mole Fraction Neopentan e	Vapor Mole Fraction Neopentan e	Bubble Point Pressur e (psia)	Dew Point Pressur e (psia)	[(BP- DP)/BP] * 100%
80	0.432	0.3624	0.5680	0.6376	127.404 9	120.997 4	5.03%
80	0.986	0.9330	0.0140	0.0670	66.4262	63.0507	5.08%
80	0.988	0.9418	0.0120	0.0582	65.8393	62.9298	4.42%
80	0.992	0.9602	0.0080	0.0398	64.6508	62.6893	3.03%
80	0.994	0.9698	0.0060	0.0302	64.0491	62.5698	2.31%
80	0.998	0.9896	0.0020	0.0104	62.8306	62.3319	0.79%
80	1.000	1.0000	0.0000	0.0000	62.2136	62.2136	0.00%
100	0.000	0.0000	1.0000	1.0000	162.060 6	162.060 6	0.00%
100	0.002	0.0052	0.9980	0.9948	162.807 9	162.347 9	0.28%
100	0.024	0.0565	0.9760	0.9435	170.461 4	165.556 3	2.88%
100	0.026	0.0607	0.9740	0.9393	171.107 9	165.852 3	3.07%
100	0.050	0.1062	0.9500	0.8938	178.276 4	169.460 2	4.95%
100	0.052	0.1096	0.9480	0.8904	178.826 9	169.765 3	5.07%
100	0.100	0.1787	0.9000	0.8213	190.133 4	177.280 7	6.76%
100	0.200	0.2722	0.8000	0.7278	204.496 9	193.617 8	5.32%
100	0.208	0.2779	0.7920	0.7221	205.234 8	194.909 1	5.03%
100	0.210	0.2793	0.7900	0.7207	205.411 4	195.230 0	4.96%
100	0.256	0.3084	0.7440	0.6916	208.671 1	202.267 9	3.07%
100	0.258	0.3096	0.7420	0.6904	208.780 5	202.552 5	2.98%
100	0.300	0.3324	0.7000	0.6676	210.527 5	207.824 7	1.28%
100	0.400	0.3780	0.6000	0.6220	211.093 1	209.626 4	0.69%
100	0.440	0.3945	0.5600	0.6055	210.106 9	203.980 4	2.92%
100	0.442	0.3953	0.5580	0.6047	210.040 7	203.610 3	3.06%
100	0.984	0.9342	0.0160	0.0658	109.357 1	103.866 8	5.02%
100	0.986	0.9417	0.0140	0.0583	108.485 5	103.657 5	4.45%
100	0.990	0.9574	0.0100	0.0426	106.724 3	103.241 5	3.26%
100	0.992	0.9656	0.0080	0.0344	105.834 7	103.034 6	2.65%
100	0.998	0.9911	0.0020	0.0089	103.129 3	102.418 9	0.69%

Total Temp (°C)	Liquid Mole Fraction Z-HFO- 1336mz z	Vapor Mole Fraction Z-HFO- 1336mz z	Liquid Mole Fraction Neopentan e	Vapor Mole Fraction Neopentan e	Bubble Point Pressur e (psia)	Dew Point Pressur e (psia)	[(BP- DP)/BP] * 100%
100	1.000	1.0000	0.0000	0.0000	102.215 2	102.215 2	0.00%
120	0.000	0.0000	1.0000	1.0000	236.116 8	236.116 8	0.00%
120	0.002	0.0054	0.9980	0.9946	237.479 4	236.623 1	0.36%
120	0.018	0.0451	0.9820	0.9549	248.123 1	240.757 0	2.97%
120	0.020	0.0497	0.9800	0.9503	249.424 3	241.284 4	3.26%
120	0.032	0.0760	0.9680	0.9240	257.117 3	244.499 7	4.91%
120	0.034	0.0801	0.9660	0.9199	258.382 9	245.044 4	5.16%
120	0.100	0.1903	0.9000	0.8097	290.938 4	264.651 4	9.04%
120	0.160	0.2557	0.8400	0.7443	300.571 6	285.388 7	5.05%
120	0.162	0.2575	0.8380	0.7425	300.805 1	285.812 5	4.98%
120	0.200	0.2891	0.8000	0.7109	304.465 5	292.519 9	3.92%
120	0.232	0.3118	0.7680	0.6882	306.593 6	297.357 5	3.01%
120	0.234	0.3131	0.7660	0.6869	306.702 3	297.641 3	2.95%
120	0.300	0.3523	0.7000	0.6477	308.982 2	305.549 8	1.11%
120	0.400	0.4009	0.6000	0.5991	308.745 0	308.783 3	-0.01%
120	0.500	0.4448	0.5000	0.5552	305.044 5	295.995 2	2.97%
120	0.502	0.4457	0.4980	0.5543	304.936 0	295.592 3	3.06%
120	0.538	0.4618	0.4620	0.5382	302.732 8	287.678 2	4.97%
120	0.540	0.4627	0.4600	0.5373	302.596 1	287.207 2	5.09%
120	0.982	0.9354	0.0180	0.0646	171.335 2	162.517 8	5.15%
120	0.984	0.9420	0.0160	0.0580	170.026 2	162.159 8	4.63%
120	0.988	0.9556	0.0120	0.0444	167.391 7	161.448 5	3.55%
120	0.990	0.9627	0.0100	0.0373	166.066 0	161.095 2	2.99%
120	0.998	0.9922	0.0020	0.0078	160.706 4	159.697 5	0.63%
120	1.000	1.0000	0.0000	0.0000	159.352 0	159.352 0	0.00%

Near-azeotropes formed between Z-HFO-1336mzz and neopentane at 1 atm are shown in Table 11. Table 11 shows representative data in increments of 0.10 Z-HFO-1336mzz liquid molar composition, or the boundaries of near-azeotropic behavior.

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Table 11.

Pressure (atm)	Temp (°C)	Liquid Mole Fraction Z-HFO-1336mzz	Vapor Mole Fraction Z-HFO-1336mzz	Liquid Mole Fraction Neopentane	Vapor Mole Fraction Neopentane	Bubble Point Pressure (psia)	Dew Point Pressure (psia)	[(BP-DP)/BP]*100%
1.00	9.5	0.0000	0.0000	1.0000	1.0000	14.6960	14.6960	0.00%
1.00	9.4	0.0020	0.0041	0.9980	0.9959	14.6960	14.6793	0.11%
1.00	7.8	0.2540	0.2075	0.7460	0.7925	14.6960	14.2731	2.88%
1.00	7.8	0.2560	0.2082	0.7440	0.7918	14.6960	14.2473	3.05%
1.00	7.9	0.2740	0.2139	0.7260	0.7861	14.6960	13.9822	4.86%
1.00	7.9	0.2760	0.2145	0.7240	0.7855	14.6960	13.9495	5.08%
1.00	31.5	0.9900	0.9252	0.0100	0.0748	14.6960	13.8141	6.00%
1.00	31.9	0.9920	0.9393	0.0080	0.0607	14.6960	13.9794	4.88%
1.00	32.2	0.9940	0.9538	0.0060	0.0462	14.6960	14.1500	3.72%
1.00	32.6	0.9960	0.9687	0.0040	0.0313	14.6960	14.3261	2.52%
1.00	33.0	0.9980	0.9841	0.0020	0.0159	14.6960	14.5080	1.28%
1.00	33.4	1.0000	1.0000	0.0000	0.0000	14.6960	14.6960	0.00%

The data in Table 10-11 are broadly summarized in Table 12 which shows azeotrope-like compositions, based on the equation $[(BP-VP)/BP] \times 100 \leq 3$.

Table 12.

Components	Temp (°C)	Liquid Mole Percentage Range Z-HFO-1336mzz (Remainder Neopentane)
Z-HFO-1336mzz / Neopentane	-40	0.002 to 0.148
Z-HFO-1336mzz / Neopentane	-20	0.002 to 0.192
Z-HFO-1336mzz / Neopentane	0	0.002 to 0.238
Z-HFO-1336mzz / Neopentane	20	0.002 to 0.382 and 0.996 to 0.998
Z-HFO-1336mzz / Neopentane	29.90	0.002 to 0.302 and 0.996 to 0.998
Z-HFO-1336mzz / Neopentane	40	0.002 to 0.324 and 0.996 to 0.998
Z-HFO-1336mzz / Neopentane	60	0.002 to 0.050 and 0.136 to 0.364 and 0.994 to 0.998
Z-HFO-1336mzz / Neopentane	80	0.002 to 0.034 and 0.194 to 0.404 and 0.994 to 0.998
Z-HFO-1336mzz / Neopentane	100	0.002 to 0.024 and 0.258 to 0.440 and 0.992 to 0.998

Components	Temp (°C)	Liquid Mole Percentage Range Z-HFO-1336mzz (Remainder Neopentane)
Z-HFO-1336mzz / Neopentane	120	0.002 to 0.018 and 0.234 to 0.050 and 0.990 to 0.998

OTHER EMBODIMENTS

1. In some embodiments, the present application provides a composition, comprising:
 - 5 i) neopentane; and
 - ii) a compound selected from E-1,1,1,4,4,4-hexafluoro-2-butene and Z-1,1,1,4,4,4-hexafluoro-2-butene,

wherein the E-1,1,1,4,4,4-hexafluoro-2-butene or Z-1,1,1,4,4,4-hexafluoro-2-butene is present in the composition in an amount effective to form an azeotrope composition or an azeotrope-like composition with the neopentane.
- 10 2. The composition of embodiment 1, wherein the composition comprises neopentane and E-1,1,1,4,4,4-hexafluoro-2-butene, wherein the E-1,1,1,4,4,4-hexafluoro-2-butene is present in the composition in an amount effective to form an azeotrope composition or an azeotrope-like composition with the neopentane.
- 15 3. The composition of embodiment 1 or 2, wherein the composition comprises from about 40 to about 60 mol% neopentane and about 60 to about 40 mol% E-1,1,1,4,4,4-hexafluoro-2-butene.
4. The composition of any one of embodiments 1 to 3, which has a boiling point of from about -40°C to about 120°C at a pressure of from about 2 psi to about 390 psi.
- 20 5. The composition of any one of embodiments 1 to 4, which is an azeotrope composition.
6. The composition of embodiment 1 or 2, wherein the composition comprises from about 40 to about 50 mol% neopentane and about 60 to about 50 mol% E-1,1,1,4,4,4-hexafluoro-2-butene.
- 25 7. The composition of any one of embodiments 1, 2, and 6, which has a boiling point of from about 0.9°C to about 128°C at a pressure of from about 1 atm to about 30 atm.

8. The composition of any one of embodiments 1 to 7, which is an azeotrope composition.
9. The composition embodiment 1 or 2, wherein the composition comprises from about 98.4 to about 99.8 mol% neopentane and about 1.6 to about 0.2 mol% E-1,1,1,4,4,4-hexafluoro-2-butene.
10. The composition of any one of embodiments 1, 2, and 9, which has a boiling point of from about 8.3°C to about 9.3°C at a pressure of about 1 atm.
11. The composition of embodiment 1 or 2, wherein the composition comprises from about 38.4 to about 62.6 mol% neopentane and about 65.2 to about 37.4 mol% E-1,1,1,4,4,4-hexafluoro-2-butene.
12. The composition any one of embodiments 1, 2, and 11, which has a boiling point of from about 0.9°C to about 1.2°C at a pressure of about 1 atm.
13. The composition of embodiment 1 or 2, wherein the composition comprises from about 0.2 to about 2.8 mol% neopentane and about 99.8 to about 97.2 mol% E-1,1,1,4,4,4-hexafluoro-2-butene.
14. The composition of any one of embodiments 1, 2, and 13, which has a boiling point of from about 6.3°C to about 7.4°C at a pressure of about 1 atm.
15. The composition of embodiment 1 or 2, wherein the composition comprises:
- from about 99.8 to about 98.2 mol% neopentane and about 0.2 to about 1.8 mol% E-1,1,1,4,4,4-hexafluoro-2-butene; or
- from about 71.6 to about 47.6 mol% neopentane and about 28.4 to about 52.4 mol% E-1,1,1,4,4,4-hexafluoro-2-butene; or
- from about 1.2 to about 0.2 mol% neopentane and about 98.8 to about 99.8 mol% E-1,1,1,4,4,4-hexafluoro-2-butene; or
- from about 99.8 to about 98.4 mol% neopentane and about 0.2 to about 1.6 mol% E-1,1,1,4,4,4-hexafluoro-2-butene; or
- from about 66.6 to about 40.8 mol% neopentane and about 33.4 to about 59.2 mol% E-1,1,1,4,4,4-hexafluoro-2-butene; or
- from about 1.8 to about 0.2 mol% neopentane and about 98.2 to about 99.8 mol% E-1,1,1,4,4,4-hexafluoro-2-butene; or
- from about 62.8 to about 35.2 mol% neopentane and about 37.2 to about 64.8 mol% E-1,1,1,4,4,4-hexafluoro-2-butene; or

- from about 2.6 to about 0.2 mol% neopentane and about 97.4 to about 99.8 mol% E-1,1,1,4,4,4-hexafluoro-2-butene; or
- from about 59.8 to about 30.2 mol% neopentane and about 40.2 to about 69.8 mol% E-1,1,1,4,4,4-hexafluoro-2-butene; or
- 5 from about 3.4 to about 0.2 mol% neopentane and about 96.6 to about 99.8 mol% E-1,1,1,4,4,4-hexafluoro-2-butene; or
- from about 58.4 to about 28.2 mol% neopentane and about 41.6 to about 71.8 mol% E-1,1,1,4,4,4-hexafluoro-2-butene; or
- from about 3.8 to about 0.2 mol% neopentane and about 96.2 to about 99.8 mol% E-1,1,1,4,4,4-hexafluoro-2-butene; or
- 10 from about 57.2 to about 26.4 mol% neopentane and about 42.8 to about 73.6 mol% E-1,1,1,4,4,4-hexafluoro-2-butene; or
- from about 4.4 to about 0.2 mol% neopentane and about 95.6 to about 99.8 mol% E-1,1,1,4,4,4-hexafluoro-2-butene; or
- 15 from about 55.4 to about 23.6 mol% neopentane and about 44.6 to about 76.4 mol% E-1,1,1,4,4,4-hexafluoro-2-butene; or
- from about 5.2 to about 99.1 mol% neopentane and about 94.8 to about 0.9 mol% E-1,1,1,4,4,4-hexafluoro-2-butene; or
- from about 99.8 to about 98.6 mol% neopentane and about 0.2 to about 1.4 mol% E-1,1,1,4,4,4-hexafluoro-2-butene; or
- 20 from about 53.8 to about 23.2 mol% neopentane and about 46.2 to about 76.8 mol% E-1,1,1,4,4,4-hexafluoro-2-butene; or
- from about 5.4 to about 0.2 mol% neopentane and about 94.6 to about 99.8 mol% E-1,1,1,4,4,4-hexafluoro-2-butene; or
- 25 from about 56 to about 24.4 mol% neopentane and about 44.0 to about 75.6 mol% E-1,1,1,4,4,4-hexafluoro-2-butene; or
- from about 4.6 to about 0.2 mol% neopentane and about 95.4 to about 99.8 mol% E-1,1,1,4,4,4-hexafluoro-2-butene; or
- from about 57.2 to about 3.8 mol% neopentane and about 42.8 to about 96.2 mol% E-1,1,1,4,4,4-hexafluoro-2-butene; or
- 30 from about 2.6 to about 0.2 mol% neopentane and about 97.4 to about 99.8 mol% E-1,1,1,4,4,4-hexafluoro-2-butene.

16. The composition any one of embodiments 1, 2, and 15, which has a boiling point of from about -20°C to about 120°C at a pressure of about 1 atm.
17. The composition of any one of embodiments 1, 2, and 9 to 16, which is an azeotrope-like composition.
- 5 18. The composition of embodiment 1, wherein the composition comprises neopentane and Z-1,1,1,4,4,4-hexafluoro-2-butene, wherein the Z-1,1,1,4,4,4-hexafluoro-2-butene is present in the composition in an amount effective to form an azeotrope composition or an azeotrope-like composition with the neopentane.
19. The composition of embodiment 1 or 18, wherein the composition
10 comprises from about 60 to about 93 mol% neopentane and about 40 to about 7 mol% Z-1,1,1,4,4,4-hexafluoro-2-butene.
20. The composition of any one of embodiments 1, 18, and 19, which has a boiling point of from about -40°C to about 120°C at a pressure of from about 1.5 psi to about 310 psi.
- 15 21. The composition of embodiment 1 or 18, wherein the composition comprises from about 56 to about 83 mol% neopentane and about 44 to about 17 mol% Z-1,1,1,4,4,4-hexafluoro-2-butene.
22. The composition of any one of embodiments 1, 18, and 21, which has a boiling point of from about 5°C to about 145°C at a pressure of from about 1 atm
20 to about 30 atm.
23. The composition of any one of embodiments 1 and 18 to 21, which is an azeotrope composition.
24. The composition of embodiment 1 or 18, wherein the composition comprises from about 99.6 to about 79.2 mol% neopentane and about 0.4 to about
25 20.8 mol% Z-1,1,1,4,4,4-hexafluoro-2-butene.
25. The composition of any one of embodiments 1, 18, and 24, which has a boiling point of from about 7.8°C to about 9.4°C at a pressure of about 1 atm.
26. The composition of embodiment 1 or 18, wherein the composition comprises from about 3.2 to about 1.6 mol% neopentane and about 96.8 to about
30 98.4 mol% Z-1,1,1,4,4,4-hexafluoro-2-butene.
27. The composition of any one of embodiments 1, 18, and 26, which has a boiling point of from about 32.6°C to about 33.0°C at a pressure of about 1 atm.

28. The composition of embodiment 1 or 18, wherein the composition comprises:

from about 99.8 to about 85.2 mol% neopentane and about 0.2 to about 14.8 mol% Z-1,1,1,4,4,4-hexafluoro-2-butene; or

5 from about 99.8 to about 80.8 mol% neopentane and about 0.2 to about 19.2 mol% Z-1,1,1,4,4,4-hexafluoro-2-butene; or

from about 99.8 to about 76.2 mol% neopentane and about 0.2 to about 23.8 mol% Z-1,1,1,4,4,4-hexafluoro-2-butene; or

10 from about 99.8 to about 61.8 mol% neopentane and about 0.2 to about 38.2 mol% Z-1,1,1,4,4,4-hexafluoro-2-butene; or

from about 0.4 to about 0.2 mol% neopentane and about 99.6 to about 99.8 mol% Z-1,1,1,4,4,4-hexafluoro-2-butene; or

from about 99.8 to about 69.8 mol% neopentane and about 0.2 to about 30.2 mol% Z-1,1,1,4,4,4-hexafluoro-2-butene; or

15 from about 99.8 to about 67.6 mol% neopentane and about 0.2 to about 32.4 mol% Z-1,1,1,4,4,4-hexafluoro-2-butene; or

from about 99.8 to about 95.0 mol% neopentane and about 0.2 to about 5 mol% Z-1,1,1,4,4,4-hexafluoro-2-butene; or

20 from about 86.4 to about 63.6 mol% neopentane and about 13.6 to about 36.4 mol% Z-1,1,1,4,4,4-hexafluoro-2-butene; or

from about 0.4 to about 0.2 mol% neopentane and about 99.6 to about 99.8 mol% Z-1,1,1,4,4,4-hexafluoro-2-butene; or

from about 99.8 to about 96.6 mol% neopentane and about 0.2 to about 3.4 mol% Z-1,1,1,4,4,4-hexafluoro-2-butene; or

25 from about 80.6 to about 59.6 mol% neopentane and about 19.4 to about 40.4 mol% Z-1,1,1,4,4,4-hexafluoro-2-butene; or

from about 99.8 to about 97.6 mol% neopentane and about 0.2 to about 2.4 mol% Z-1,1,1,4,4,4-hexafluoro-2-butene; or

30 from about 74.2 to about 56.0 mol% neopentane and about 25.8 to about 44.0 mol% Z-1,1,1,4,4,4-hexafluoro-2-butene; or

from about 0.2 to about 0.8 mol% neopentane and about 99.2 to about 99.8 mol% Z-1,1,1,4,4,4-hexafluoro-2-butene; or

from about 99.8 to about 98.2 mol% neopentane and about 0.2 to about 1.8 mol% Z-1,1,1,4,4,4-hexafluoro-2-butene; or

from about 76.6 to about 50.0 mol% neopentane and about 23.4 to about 50.0 mol% Z-1,1,1,4,4,4-hexafluoro-2-butene; or

5 from about 1.0 to about 0.2 mol% neopentane and about 99.0 to about 99.8 mol% Z-1,1,1,4,4,4-hexafluoro-2-butene.

29. The composition of any one of embodiments 1, 18, and 28, which has a boiling point of from about -20°C to about 120°C at a pressure of about 1 atm.

30. The composition of any one of embodiments 1, 18, and 24 to 29, which is
10 an azeotrope-like composition.

It is to be understood that while the invention has been described in conjunction with the detailed description thereof, the foregoing description is intended to illustrate and not limit the scope of the invention, which is defined by the scope of the appended claims. Other aspects, advantages, and modifications
15 are within the scope of the following claims. It should be appreciated by those persons having ordinary skill in the art(s) to which the present invention relates that any of the features described herein in respect of any particular aspect and/or embodiment of the present invention can be combined with one or more of any of the other features of any other aspects and/or embodiments of the present
20 invention described herein, with modifications as appropriate to ensure compatibility of the combinations. Such combinations are considered to be part of the present invention contemplated by this disclosure.