

ISOPARAFFINIC KEROSENE COMPOSITIONS

FIELD

[0001] This disclosure relates to kerosene or jet boiling range compositions having high
5 isoparaffin content and methods for forming fuel compositions or fuel blending compositions
made from such kerosene or jet boiling range compositions.

BACKGROUND OF THE INVENTION

[0002] The aviation industry is looking for increasingly sustainable sources of jet fuel to
lower the carbon intensity of the fuel consumed during flight. While the aviation industry
10 today contributes 2-3% of global CO₂ emissions, this is expected to increase with the
anticipated growth of the aviation sector over the next 30 years. There are a number of
sustainable aviation fuel pathways that have been approved for use in commercial aviation.
The feedstocks used in these pathways include vegetable/animal fats, waste materials (e.g.,
municipal solid and forestry waste), and bio-derived alcohols such as ethanol and/or isobutanol.
15 However, there is a growing recognition that commercial aviation will require significant
volumes of fuels of non-biological origin to meet future demand.

[0003] Current Fischer-Tropsch (F-T) technologies enable production of jet fuels from
synthesis gas that can be derived from captured CO₂ and H₂, but F-T technologies are expensive
and the products from the F-T reaction require additional cracking and hydroisomerization to
20 make suitable aviation fuels. The required cracking reduces the yield of jet fuel from F-T.
Therefore, new high-yield technologies to convert CO₂ and H₂ to aviation fuels are needed to
improve availability of lower carbon intensity fuels for the aviation sector.

[0004] U.S. Patent 7,692,049 describes methods for oligomerizing olefins (including C₃
to C₈ olefins) to produce olefins and alkanes that include a high percentage of branched olefins
25 and alkanes. Compositions resulting from the method are described that include C₉ to C₂₀
hydrocarbons. A blend of 25 wt% of one of the compositions with a conventional jet fuel is
also described. Sources for the C₃ to C₈ olefins include conversion of methanol to olefins and
formation of olefins via steam cracking.

[0005] U.S. Patents 8,318,994 and 7,667,086 also describe methods for oligomerizing
30 olefins and corresponding compositions including branched olefins and alkanes formed via the
oligomerization methods.

[0006] A technical paper by Gulder et al. in a SAE Technical Paper Series (892073) describes a methodology for performing ^1H NMR and analyzing the resulting spectra to determine the amounts of hydrogens bonded to carbon atoms at various locations within a hydrocarbon-like sample. The paper is titled “A Rapid Cetane Number Prediction Method for
5 Petroleum Liquids and Pure Hydrocarbons Using Proton NMR”.

SUMMARY OF THE INVENTION

[0007] In various aspects, blended jet boiling range compositions are provided. The compositions can include an isoparaaffinic blend component and one or more additional components, such as mineral jet boiling range fraction(s) and/or synthetic jet boiling range
10 fraction(s). The isoparaaffinic blend component can include 80 wt% or more of isoparaaffins, 5.0 wt% or less of olefins, and 5.0 wt% or less of C_{19+} hydrocarbons. In some aspects, the resulting composition can include a T10 distillation point of 205°C or less and/or a final boiling point of 300°C or less.

[0008] In some aspects, the composition can include 1.0 wt% or more of $\text{C}_{17} - \text{C}_{18}$
15 hydrocarbons, or 1.5 wt% or more, or 2.0 wt% or more. In some aspects, the composition can include 10 wt% or more of C_9 hydrocarbons. In some aspects, the composition can include a flash point of 50°C or higher and/or a freeze point of -40°C or lower. In some aspects, the isoparaaffinic blend component and/or the composition can include an atypical distribution of types of hydrogens in the hydrocarbons of the isoparaaffinic blend component and/or the
20 composition.

BRIEF DESCRIPTION OF THE DRAWING

[0009] FIG. 1 shows compositional information for blends of an isoparaaffinic blend component with a conventional jet fuel.

[0010] FIG. 2 shows compositional information for blends of another isoparaaffinic blend
25 component with a conventional jet fuel.

[0011] FIG. 3 shows results from ^1H NMR characterization of iso-olefinic and isoparaaffinic blend components.

DETAILED DESCRIPTION OF THE INVENTION

[0012] In various aspects, kerosene boiling range and/or jet boiling range compositions
30 are provided that include at least a portion of an isoparaaffinic blend component, along with a

method for making such a blend component. The highly isoparaffinic nature of the blend component can allow the isoparaffinic blend component to be used in combination with both conventional / mineral jet fuel boiling range fractions as well as non-traditional feeds (such as Fischer-Tropsch fractions) to form jet fuel fractions and/or jet fuel blending component fractions. Optionally, a portion of the isoparaffinic blend product can correspond to iso-olefins rather than isoparaffins. Optionally, an iso-olefinic blend component can be formed in place of or in addition to an isoparaffinic blend component.

[0013] One of the barriers to reducing the use of aviation fuels derived from mineral fractions is simply a lack of available supply. One option for overcoming this barrier is to synthesize kerosene / jet boiling range compounds from a feedstock different from a mineral fraction. Synthesizing kerosene / jet boiling range components by oligomerization of olefins can provide such a pathway. For example, the olefins used for oligomerization can be formed by conversion of methanol to olefins. In this option, the problem of producing non-mineral jet boiling range compounds is converted into a problem of producing non-mineral methanol for subsequent conversion. (More generally, the olefins for oligomerization can be obtained from any convenient source of olefins, such as olefins formed by pyrolysis, including pyrolysis of a bio-derived feed.) Forming a jet fuel or jet fuel blending component from a bio-derived feedstock containing jet boiling range compounds (or higher boiling range compounds that are converted to jet boiling range) is another example of a pathway for “synthesizing” jet boiling range compounds.

[0014] With regard to forming jet fuel or a jet fuel blending component by synthesis of jet boiling range compounds from a methanol feedstock, a variety of options are available for producing such methanol. One option can be to use bio-derived methanol. Another option can be to synthesize methanol from CO₂ and H₂. For example, the CO₂ could correspond to CO₂ sequestered from air or another process, while the H₂ can correspond to H₂ formed in a renewable manner, such as by solar-powered electrolysis of water. Because methanol is readily synthesized feedstock, the source of the methanol (and therefore the source of the resulting olefins) can be modified over time to select an option that provides the highest overall benefits.

[0015] In addition to allowing for production of non-mineral kerosene / jet boiling range compounds, the synthesis method for forming the highly isoparaffinic blend component can provide a variety of other advantages. For example, in some aspects, the isoparaffinic nature of the blend component can allow for incorporation of an unexpectedly high content of C₁₇ and/or C₁₈ hydrocarbons into a jet fuel. The boiling point of C₁₇ and C₁₈ n-paraffins is above

the generally required final boiling point for jet fuel under standards such as ASTM D1655. However, a C₁₇ or C₁₈ paraffin that includes at least one branch point (i.e., an isoparaffin) can have a boiling point of lower than 300°C. Because the blend component has a relatively low content of n-paraffins, a blend component with up to 15 wt% C₁₇ and/or C₁₈ compounds can
5 be added to a potential jet fuel while still achieving a final boiling point of 300°C or less according to ASTM D86.

[0016] As another example, in some aspects, the isoparaffinic nature of the blend component can have beneficial cold flow properties. Although n-paraffins typically have relatively high values for properties such as cloud point or freeze point, various types of
10 isoparaffins generally have much lower values (i.e., cloud points and/or freeze points that correspond to lower temperatures). The beneficial cold flow properties of the isoparaffinic blend component can be used to balance out another kerosene / jet boiling range fraction that may have less favorable properties. For example, Fischer-Tropsch fractions can tend to be primarily composed of n-paraffins, and therefore can tend to have relatively unfavorable cold
15 flow properties. Blending an isoparaffinic blend component with a Fischer-Tropsch fraction can result in a blended synthetic fuel / fuel blending component with sufficient cold flow performance to meet one or more types of jet fuel specifications while still incorporating a substantial portion of the Fischer-Tropsch fraction. Similarly, some synthetic aviation fuel fractions as defined in ASTM 7566 (such as bio-derived aviation fuels), can have relatively
20 high freeze point temperatures. Blending an isoparaffinic blend component with such a synthetic aviation fuel fraction can improve the freeze point (and/or other cold flow properties) of the resulting jet fuel while potentially still substantially retaining the bio-derived character of the aviation fuel, depending on the source of the olefins that are oligomerized to form the isoparaffinic blend component.

25 **[0017]** As still another example, the isoparaffinic blend component can have a relatively high energy content (on a per weight basis). As a result, the isoparaffinic blend component can be a favorable blend component for blending with a variety of other fractions, including sustainable aviation fuel fractions as well as various types of challenged fractions that may have lower specific energy and/or less favorable cold flow properties.

30 **[0018]** In addition to the above, it has further been discovered that the hydrocarbons in an isoparaffinic blend component can have an unexpected distribution of types of carbon atoms, such as an unusual distribution of hydrogens on CH₃ groups relative to hydrogens on

CH₂ groups. This can allow for formation of blends that have similarly unexpected distributions of types of carbon atoms in the resulting blend.

DEFINITIONS

5 [0019] All numerical values within the detailed description and the claims herein are modified by “about” or “approximately” the indicated value, and take into account experimental error and variations that would be expected by a person having ordinary skill in the art.

10 [0020] In this discussion, a jet fuel or jet fuel blend component that contains at least a portion of synthesized jet fuel boiling range compounds (i.e., jet boiling range compounds not derived from processing a mineral source) is defined as a synthetic jet fuel or synthetic jet fuel blending component.

[0021] In this discussion, if methanol is used as a feedstock for forming olefins, methanol obtained by processing of a bio-derived feedstock and/or methanol obtained by fermentation of a feedstock can be referred to as “sustainable” methanol.

15 [0022] Current commercial standards for jet fuels typically specify a variety of properties. Examples of property specifications and/or typical properties for commercial jet fuels include a total acidity of 0.1 mg KOH/g or less, or 0.015 mg KOH/g or less, a sulfur content of 3000 wppm or less, a freezing point maximum of -40°C or -47°C, a viscosity at -20°C of 8.0 cSt or less, a flash point of at least 38°C, an initial boiling point of 140°C or more, 20 a T10 distillation point of 205°C or less, and/or a final boiling point of 300°C or less. Another example of a property specification is a specification for a maximum deposit thickness on the surface of a heater tube and/or a maximum pressure increase during a thermal stability test at 260°C (according to ASTM D3241), such as a maximum deposit thickness of 85 nm and/or a maximum pressure increase of 25 mm Hg. Still another example of a property specification 25 can be a water separation rating, such as a water separation rating of 85 or more, as measured according to ASTM D3948. A water separation rating provides an indication of the amount of surfactant present in a jet fuel boiling range sample. Petroleum fractions that have an appropriate boiling range and that also satisfy the various requirements for a commercial standard can be tested (such as according to ASTM D3241) and certified for use as jet fuels. 30 In some aspects, the kerosene boiling range fraction can correspond to a jet fuel fraction that satisfies the specification for a jet fuel under ASTM D1655. This can include a thermal stability breakpoint of 260°C or more, or 275°C or more, as defined by ASTM D3241.

[0023] Unless otherwise specified, distillation points and boiling points can be determined according to ASTM D86. It is noted that still other methods of boiling point characterization may be provided in the examples. The values generated by such other methods are believed to be indicative of the values that would be obtained under ASTM D86.

5 [0024] In this discussion, the jet fuel boiling range or kerosene boiling range is defined as 140°C to 300°C. A jet fuel boiling range fraction or a kerosene boiling range fraction is defined as a fraction with a T10 distillation point of 140°C to 205°C, and a final boiling point of 300°C or less. It is noted that jet fuel boiling range fractions can sometimes also have a flash point of 38°C or higher, although kerosene boiling range fractions do not necessarily have such
10 a requirement.

[0025] In this discussion, a hydroprocessed fraction refers to a hydrocarbon fraction and/or hydrocarbonaceous fraction that has been exposed to a catalyst having hydroprocessing activity in the presence of 300 kPa-a or more of hydrogen at a temperature of 200°C or more. Examples of hydroprocessed fractions include hydroprocessed distillate fractions (i.e., a
15 hydroprocessed fraction having the distillate boiling range), hydroprocessed kerosene fractions (i.e., a hydroprocessed fraction having the kerosene boiling range) and hydroprocessed diesel fractions (i.e., a hydroprocessed fraction having the diesel boiling range). It is noted that a hydroprocessed fraction derived from a biological source, such as hydrotreated vegetable oil, can correspond to a hydroprocessed distillate fraction, a hydroprocessed kerosene fraction,
20 and/or a hydroprocessed diesel fraction, depending on the boiling range of the hydroprocessed fraction.

[0026] With regard to characterizing properties of kerosene / jet boiling range fractions and/or blends of such fractions with other components to form kerosene / jet boiling range fuels, a variety of methods can be used. Density of a blend at 15°C (kg / m³) can be determined
25 according ASTM D4052. Sulfur (in wppm or wt%) can be determined according to ASTM D2622, while nitrogen (in wppm or wt%) can be determined according to D4629. Kinematic viscosity at either -20°C or -40°C (in cSt) can be determined according to ASTM D445. Pour point can be determined according to ASTM D5949. Cloud point can be determined according to D5773. Freeze point can be determined according to D5972. Flash point can be determined
30 according to ASTM D56. Cetane number can be determined according to ASTM D613. Aromatics content can be determined according to ASTM D1319.

[0027] In this discussion, the content of n-paraffins, isoparaffins, cycloparaffins, aromatics, and/or olefins can be determined according to test method UOP 990. With regard to

aromatics, ASTM D1319 is used for samples with an aromatics content of 5.0 wt% or more. Aromatics contents determined according to UOP 990 should only be used for characterization of aromatics contents of 1.0 wt% to 5.0 wt%, which correspond to aromatics contents that are not suitable for characterization according to ASTM D1319. It is noted that still lower
5 aromatics contents can potentially be determined by other methods, such as by UV-Visible spectroscopy.

[0028] As noted above, UOP 990 can be used to determine paraffin, naphthene, and aromatics content. It is noted that for some of the paraffin, n-paraffin, and isoparaffin contents described below, the contents were determined using gas chromatography according to the
10 Linear Paraffin method. The n-paraffin peaks from a hydrocarbon sample in gas chromatography are well known. The n-paraffin peaks can be separately integrated to determine the n-paraffin content of a sample using gas chromatography. The peaks in a GC spectrum between the n-paraffin peaks can be assigned as isoparaffins with the same carbon number as the lower peak, so that a total amount of paraffins having a given carbon number
15 can be determined. The isoparaffin content for a given carbon number can be determined by subtracting the n-paraffin content from the total paraffin content. It is believed that the values herein determined by the Linear Paraffin method are representative of the values that would be obtained according to UOP 990.

[0029] As noted above, UOP 990 can be used to determine paraffin, naphthene, and
20 aromatics content. It is noted that for some paraffin, naphthene, and/or aromatics contents described herein, supercritical fluid chromatography (SFC) was used. It is believed that the SFC characterization values are representative of what would be obtained according to UOP 990. For SFC characterization, the characterization was performed using a commercial supercritical fluid chromatograph system, and the methodology represents an expansion on the
25 methodology described in ASTM D5186 to allow for separate characterization of paraffins and naphthenes. The expansion on the ASTM D5186 methodology was enabled by using additional separation columns, to allow for resolution of naphthenes and paraffins. The system was equipped with the following components: a high pressure pump for delivery of supercritical carbon dioxide mobile phase; temperature controlled column oven; auto-sampler
30 with high pressure liquid injection valve for delivery of sample material into mobile phase; flame ionization detector; mobile phase splitter (low dead volume tee); back pressure regulator to keep the CO₂ in supercritical state; and a computer and data system for control of components and recording of data signal. For analysis, approximately 75 milligrams of sample

was diluted in 2 milliliters of toluene and loaded in standard septum cap autosampler vials. The sample was introduced based via the high pressure sampling valve. The SFC separation was performed using multiple commercial silica packed columns (5 micron with either 60 or 30 angstrom pores) connected in series (250 mm in length either 2 mm or 4 mm ID). Column
5 temperature was held typically at 35 or 40° C. For analysis, the head pressure of columns was typically 250 bar. Liquid CO₂ flow rates were typically 0.3 ml/minute for 2 mm ID columns or 2.0 ml/minute for 4 mm ID columns. The SFC FID signal was integrated into paraffin and naphthenic regions. In addition to characterizing aromatics according to ASTM D5186, a supercritical fluid chromatograph was used to analyze samples for split of total paraffins and
10 total naphthenes. A variety of standards employing typical molecular types can be used to calibrate the paraffin/naphthene split for quantification.

[0030] Carbon number distribution (CND) is obtained by injecting an appropriate sample of olefin containing reactor product into a hydrogenation GC. The hydrogenation GC is adapted with a zone containing Pt/Al₂O₃ or other suitable hydrogenation catalyst under
15 conditions such that the olefinic material is almost or totally saturated with hydrogen that is co-fed with the sample to the hydrogenation zone prior to entering the GC column. Thus the actual GC measurement is of the corresponding saturate molecules rather than a direct measurement of the olefin species. This provides a more accurate measurement of carbon number by reducing the volatility/retention time scatter that would be found among the various olefinic
20 species.

[0031] Regardless of the specific GC protocol (sample volume injected, specific column and detector, carrier gas type and rate, split levels and other details familiar to those skilled in the art), carbon number is differentiated by the GC retention times of normal linear paraffins. Typically in undertaking this analytical method the selected protocol will be
25 calibrated by feeding a calibration standard containing normal linear paraffins of various carbon numbers of interest, or all of carbon numbers from C5 to C20. An imperfect but reasonably accurate and useful approximation is made that the normal linear paraffin isomer of any given carbon number is the lowest volatility and thus highest retention time of all corresponding carbon number isomers. Thus for example, C8 species are those having a
30 retention time that excludes then immediately follows the peak of n-heptane through and including the peak at n-octane, C9 species are those having a retention time that excludes then immediately follows the peak at n-octane through and including the peak at n-nonane, etc. The imperfection is that certain highly branched paraffins of C_{n+1} may have a retention time that

overlaps with the normal linear C_n . For the modest branching level of the molecules produced by the inventive process this is a small error estimated at less than about 5% for any given carbon number.

5 [0032] An exemplary GC protocol will use an Agilent® 8190 GC instrument adapted with the aforementioned hydrogenation zone at appropriate conditions, sending the saturated material to an Agilent® DB-1 column with dimensions of 100 m x 250 mm x 0.5 mm with a hydrogen, nitrogen or helium carrier gas, an FID detector, and a temperature beginning at about 40 °C ramped up to a temperature of about 265 °C at a rate of about 1.5 to 3.5 °C/min, and a typical run will last about 80 minutes.

10 [0033] In this discussion, the term “paraffin” refers to a saturated hydrocarbon chain. Thus, a paraffin is an alkane that does not include a ring structure. The paraffin may be straight-chain or branched-chain and is considered to be a non-ring compound. “Paraffin” is intended to embrace all structural isomeric forms of paraffins. The term “n-paraffin” has the expected definition of a straight chain alkane (no branches or rings in the carbon chain). The term
15 “isoparaffin” is used herein to refer to any alkane that includes one or more branches in the carbon chain but does not include any ring structures.

[0034] In this discussion, the term “iso-olefin” is analogous to “isoparaffin”, but refers to an alkene rather than an alkane. Thus, an iso-olefin is defined as an alkene that includes at least one branch in the carbon chain but that does not include a ring structure.

20 [0035] In this discussion, the term “naphthene” refers to a cycloalkane (also known as a cycloparaffin). Therefore, naphthenes correspond to saturated ring structures. The term naphthene encompasses single-ring naphthenes and multi-ring naphthenes. The multi-ring naphthenes may have two or more rings, e.g., two-rings, three-rings, four-rings, five-rings, six-rings, seven-rings, eight-rings, nine-rings, and ten-rings. The rings may be fused and/or
25 bridged. The naphthene can also include various side chains, such as one or more alkyl side chains of 1-10 carbons.

[0036] In this discussion, the term “saturates” refers to all straight chain, branched, and cyclic paraffins. Thus, saturates correspond to a combination of paraffins and naphthenes.

30 [0037] In this discussion, the term “aromatic ring” means five or six atoms joined in a ring structure wherein (i) at least four of the atoms joined in the ring structure are carbon atoms and (ii) all of the carbon atoms joined in the ring structure are aromatic carbon atoms. Therefore, aromatic rings correspond to unsaturated ring structures. Aromatic carbons can be identified using, for example, ^{13}C Nuclear Magnetic Resonance. Aromatic rings having atoms

attached to the ring (e.g., one or more heteroatoms, one or more carbon atoms, etc.) but which are not part of the ring structure are within the scope of the term “aromatic ring.” Additionally, it is noted that ring structures that include one or more heteroatoms (such as sulfur, nitrogen, or oxygen) can correspond to an “aromatic ring” if the ring structure otherwise falls within the definition of an “aromatic ring”.

[0038] In this discussion, the term “non-aromatic ring” means four or more carbon atoms joined in at least one ring structure wherein at least one of the four or more carbon atoms in the ring structure is not an aromatic carbon atom. Non-aromatic rings having atoms attached to the ring (e.g., one or more heteroatoms, one or more carbon atoms, etc.), but which are not part of the ring structure, are within the scope of the term “non-aromatic ring.”

[0039] In this discussion, the term “aromatics” refers to all compounds that include at least one aromatic ring. Such compounds that include at least one aromatic ring include compounds that have one or more hydrocarbon substituents. It is noted that a compound including at least one aromatic ring and at least one non-aromatic ring falls within the definition of the term “aromatics”.

[0040] It is noted that that some hydrocarbons present within a feed or product may fall outside of the definitions for paraffins, naphthenes, and aromatics. For example, any alkenes that are not part of an aromatic compound would fall outside of the above definitions. Similarly, non-aromatic compounds that include a heteroatom, such as sulfur, oxygen, or nitrogen, are not included in the definition of paraffins or naphthenes.

Isoparaffinic Blend Component

[0041] In various aspects, an isoparaffinic blend component can be used to form blended products that can correspond to jet fuels and/or jet fuel blending components. Optionally, an iso-olefinic blend component can be used instead of or in addition to an isoparaffinic blend component.

[0042] In this discussion, to be either an isoparaffinic blend component or an iso-olefinic blend component, a fraction will contain 50 wt% or more of a combined weight of isoparaffins and iso-olefins, or 60 wt% or more, or 70 wt% or more, or 80 wt% or more, such as up to the fraction substantially being composed of isoparaffins and iso-olefins (i.e., less than 8.0 wt% of other types of hydrocarbons / compounds, or less than 5.0 wt%, or less than 3.0 wt%, or less than 1.0 wt%, such as down to zero). In addition to the above, an isoparaffinic blend component refers to a fraction containing less than 5.0 wt% iso-olefins and 80 wt% or more of isoparaffins (relative to the weight of the fraction), or 85 wt% or more, or 90 wt% or more, such as up to

having substantially all of the fraction correspond to isoparaffins. An iso-olefinic blend component refers to a fraction that a) satisfies the requirement for the combined amount of iso-olefins and isoparaffins, and b) contains 5.0 wt% or more of iso-olefins, or 25 wt% or more, or 50 wt% or more, or 70 wt% or more, such as up to having substantially all of the fraction
5 correspond to iso-olefins.

[0043] In various aspects, an isoparaffinic blend component and/or an iso-olefinic blend component can have one or more of the following properties. In some aspects, 80 wt% or more of the blend component, or 90 wt% or more, or 94 wt% or more, or 97 wt% or more, is composed of C₉ to C₂₀ iso-olefins, isoparaffins, or a combination thereof. In some aspects, 2.0
10 wt% to 25 wt% of the blend component is composed of C₉ hydrocarbons, or 2.0 wt% to 15 wt%, or 5.0 wt% to 25 wt%, or 5.0 wt% to 15 wt%, or 2.0 wt% to 10 wt%. In some aspects, 1.0 wt% to 15 wt% of the blend component is composed of C₁₇₊ hydrocarbons, or 2.5 wt% to 15 wt%. In some aspects, 1.0 wt% to 15 wt% of the blend component is composed of C₁₇ and/or C₁₈ hydrocarbons, or 2.5 wt% to 15 wt%, or 1.0 wt% to 10 wt%, or 2.5 wt% to 10 wt%. In
15 some aspects, the blend component can contain 5.0 wt% or less of C₁₉₊ hydrocarbons, or 3.0 wt% or less, or 1.0 wt% or less, such as down to having substantially no content of C₁₉₊ hydrocarbons. In some aspects, the blend component can include 5.0 wt% or less of C₈-hydrocarbons, or 3.0 wt% or less, or 1.0 wt% or less, or 0.5 wt% or less, such as down to 0.1 wt% or possibly still lower (i.e., substantially no C₈-content). In some aspects, the blend
20 component has a specific gravity at 15°C of 0.730 g/cm³ to 0.775 g/cm³.

[0044] In some aspects, the blend component can contain 60 wt% to 90 wt% of C₁₁ to C₁₈ isoparaffins, based on the weight of the blend component. Additionally or alternately, the blend component can contain 50 wt% to 75 wt% of C₁₂ to C₁₆ isoparaffins, based on the weight of the blend component. This is particularly advantageous for the flexible use of the
25 composition as an aviation or diesel fuel.

[0045] In various aspects, the blend component can contain a reduced or minimized amount of aromatics. This can correspond to containing 5.0 wt% or less of aromatics, or 3.0 wt% or less, or 1.0 wt% or less, or 0.5 wt% or less, or 0.1 wt% or less, such as down to having substantially no aromatics content.

[0046] In various aspects, the blend component can have a flash point of 38° C or higher, or 40° C or higher, or 45° C or higher, or 50° C or higher, or 55° C or higher, such as up to 60° C or possibly still higher. Additionally or alternately, the blend component, when tested alone (i.e., prior to blending with another fraction), can have a Jet Fuel Thermal Oxidation Test

(JFTOT) breakpoint result of 260°C or higher, or 270°C or higher, or 280°C or higher, such as up to 320°C or possibly still higher.

5 [0047] In some aspects, the blend component, prior to adding any additives, can have an electrical conductivity of 10 pS/m or less (according to ASTM Test Method D2624), such as down to having substantially no electrical conductivity. It is noted that an isoparaffinic blend component as described herein has a good response to conductivity additives. After addition of conventional additives for conductivity, an isoparaffinic blend component can have a conductivity of 50 pS/m to 600 pS/m.

10 [0048] An example of a suitable process for making the isoparaffinic blend component is described in U.S. Patent 7,692,049, which is incorporated by reference herein for the limited purpose of describing how to make the isoparaffinic blend component. Briefly, the blend component can be produced by oligomerizing a feed containing at least one C₃ to C₈ olefin together with an olefinic recycle stream containing no more than 10 wt. % C₁₀₊ non-normal olefins over a molecular sieve catalyst such that a) the recycle to fresh feed weight ratio is from 15 about 0.5 to about 2.0 and b) the difference between the highest and lowest temperatures within the reactor is 40°F (22°C) or less. The oligomerization product is then separated into an iso-olefinic stream and at least one light olefinic stream. At least part of the light olefinic stream(s) is then recycled to the oligomerization process. In various aspects, the iso-olefinic stream can be exposed to hydroprocessing conditions to produce an isoparaffinic stream.

20 [0049] The fresh feed to the oligomerization process can include any single C₃ to C₈ olefin or any mixture thereof in any proportion. Particularly suitable feeds include mixtures of propylene and butylenes having at least 5 wt%, such as at least 10 wt%, for example at least 20 wt%, such as at least 30 wt% or at least 40 wt% C₄ olefin. Also useful are mixtures of C₃ to C₅ olefins having at least 40 wt% C₄ olefin and at least 10 wt% C₅ olefin.

25 [0050] In one aspect, the olefinic feed is obtained by the conversion of an oxygenate, such as methanol, to olefins over a either silicoaluminophosphate (SAPO) catalyst, according to the method of, for example, U.S. Pat. Nos. 4,677,243 and 6,673,978, or an aluminosilicate catalyst, according to the method of, for example, WO04/18089, WO04/16572, EP 0 882 692 and U.S. Pat. No. 4,025,575. Alternatively, the olefinic feed can be obtained by the catalytic 30 cracking of relatively heavy petroleum fractions, or by the pyrolysis of various hydrocarbon streams, ranging from ethane to naphtha to heavy fuel oils, in admixture with steam, in a well understood process known as “steam cracking”.

[0051] In various aspects, the feed to the oligomerization process also contains an olefinic recycle stream containing no more than 10 wt% C₁₀+ non-normal olefins and/or having a final boiling point of 170°C or less. In some aspects, the olefinic recycle stream can include 30 wt% or less of C₉+ olefins, or 10 wt% or less and/or have a final boiling point of 140°C or less. Additionally or alternately, in some aspects, the olefinic recycle stream contains 30 wt% or less of C₄ hydrocarbons, or 5.0 wt% or less (therefore roughly corresponding to a de-butanized stream). The amount of olefinic recycle stream fed to the oligomerization process is such that the recycle to fresh feed weight ratio is from about 0.5 to about 2.0. More particularly, the mass ratio of olefinic recycle stream to fresh olefinic feedstock can be at least 0.7 or at least 0.9, but generally is no greater than 1.8, or no greater than 1.5 or no greater than 1.3.

[0052] In addition, the feedstock, the recycle or both may comprise other materials, such as an inert diluent, for example, a saturated hydrocarbon, or other hydrocarbon species, such as aromatics or dienes.

[0053] The catalyst used in the oligomerization process can include any crystalline molecular sieve which is active in olefin oligomerization reactions. In one embodiment, the catalyst includes a medium pore size molecular sieve having a Constraint Index of about 1 to about 12. Constraint Index and a method of its determination are described in U.S. Pat. No. 4,016,218, which is incorporated herein by reference. Examples of suitable medium pore size molecular sieves are those having 10-membered ring pore openings and include those of the TON framework type (for example, ZSM-22, ISI-1, Theta-1, Nu-10, and KZ-2), those of the MTT framework type (for example, ZSM-23 and KZ-1), of the MFI structure type (for example, ZSM-5), of the MFS framework type (for example, ZSM-57), of the MEL framework type (for example, ZSM-11), of the MTW framework type (for example, ZSM-12), of the EUO framework type (for example, EU-1) and members of the ferrierite family (for example, ZSM-35). In one preferred embodiment, the molecular sieve catalyst comprises ZSM-5.

[0054] Other examples of suitable molecular sieves include those having 12-membered pore openings, such as ZSM-18, zeolite beta, faujasites, zeolite L, mordenites, as well as members of MCM-22 family of molecular sieves (including, for example, MCM-22, PSH-3, SSZ-25, ERB-1, ITQ-1, ITQ-2, MCM-36, MCM-49 and MCM-56).

[0055] In one embodiment, the crystalline aluminosilicate molecular sieve has an average (d₅₀) crystal size no greater than 0.15 micron. In addition, the molecular sieve is preferably selected so as to have an alpha value between about 100 and about 600, conveniently between about 200 and about 400, or between about 250 and about 350. The alpha value of a molecular

sieve is an approximate indication of its catalytic cracking activity compared with a standard silica-alumina catalyst test (with an alpha value of 1). The alpha test is described in U.S. Pat. No. 3,354,078; in the Journal of Catalysis, Vol. 4, p. 527 (1965); Vol. 6, p. 278 (1966); and Vol. 61, p. 395 (1980), each incorporated herein by reference as to that description. The experimental conditions of the test used herein include a constant temperature of 538° C. and a variable flow rate as described in detail in the Journal of Catalysis, Vol. 61, p. 395. Conveniently the crystalline aluminosilicate molecular sieve having a silica to alumina molar ratio of about 20 to about 300, such as about 20 to about 150, for example about 45 to about 90.

10 **[0056]** The molecular sieve may be supported or unsupported, for example in powder form, or used as an extrudate with an appropriate binder. Where a binder is employed, the binder is conveniently a metal oxide, such as alumina, and is present in an amount such that the oligomerization catalyst contains between about 2 and about 80 wt. % of the molecular sieve.

15 **[0057]** The oligomerization reaction should be conducted at sufficiently high WHSV of fresh feed to the reactor to ensure the desired low level of C₁₇⁺ oligomers in the reaction product. This can correspond to a WHSV (weight hourly space velocity) of 1.5 or more on a weight of fresh feed versus weight of molecular sieve in the catalyst basis. With regard to the combined fresh olefin feed and recycle to the reactor, the WHSV can be 2.3 or more, again based on the amount of molecular sieve in the oligomerization catalyst.

20 **[0058]** The oligomerization process can be conducted over a wide range of temperatures, although generally the temperature within the oligomerization reaction zone should be between about 150°C and 350°C. It is, however, important to ensure that the temperature across the reaction zone is maintained relatively constant so as to produce the desired level of C₄ olefin conversion at a given WHSV and point in the reaction cycle. Thus, as discussed above, the difference between the highest and lowest temperatures within the reactor should be maintained at 40°F (22°C) or less.

25 **[0059]** The oligomerization process can be conducted over a wide range of olefin partial pressures, although higher olefin partial pressures are preferred since low pressures tend to promote cyclization and cracking reactions, and are thermodynamically less favorable to the preferred oligomerization reaction. Typical olefin partial pressures of olefins in the combined olefinic feed and light olefinic/recycle stream as total charge to the reactor comprise at least 400 psig (2860 kPa).

[0060] As synthesized, the resulting oligomerized product can correspond to an iso-olefinic blend component. The iso-olefinic blend component can be converted to an isoparaffinic blend component by any convenient olefin saturation process, such as a mild hydrotreatment process. Mild hydroprocessing can generally convert iso-olefins to isoparaffins with a reduced or minimized amount of reduction in the size of the carbon chains in a fraction. In addition to converting iso-olefins to isoparaffins, hydroprocessing of a kerosene fraction can also be used to remove sulfur, remove nitrogen, saturate olefins, saturate aromatics, and/or for other purposes.

[0061] During hydroprocessing, a feedstock that is partially or entirely composed of a jet fuel boiling range fraction is treated in a hydrotreatment (or other hydroprocessing) reactor that includes one or more hydrotreatment stages or beds. Optionally, the reaction conditions in the hydrotreatment stage(s) can be conditions suitable for reducing the sulfur content of the feedstream, such as conditions suitable for reducing the sulfur content of the feedstream to 500 wppm or less, or 100 wppm or less, or 10 wppm or less, such as down to 0.5 wppm or possibly still lower. The reaction conditions can include an LHSV of 0.1 to 20.0 hr⁻¹, a hydrogen partial pressure from about 50 psig (0.34 MPag) to about 3000 psig (20.7 MPag), a treat gas containing at least about 50% hydrogen, and a temperature of from about 450°F (232°C) to about 800°F (427°C). Preferably, the reaction conditions include an LHSV of from about 0.3 to about 5 hr⁻¹, a hydrogen partial pressure from about 100 psig (0.69 MPag) to about 1000 psig (6.9 MPag), and a temperature of from about 700°F (371°C) to about 750°F (399°C).

[0062] Optionally, a hydrotreatment reactor can be used that operates at a relatively low total pressure values, such as total pressures of about 200 psig (1.4 MPag) to about 800 psig (5.5 MPag). For example, the pressure in a stage in the hydrotreatment reactor can be at least about 200 psig (1.4 MPag), or at least about 300 psig (2.1 MPag), or at least about 400 psig (2.8 MPag), or at least about 450 psig (3.1 MPag). The pressure in a stage in the hydrotreatment reactor can be about 800 psig (5.5 MPag) or less, or about 700 psig (4.8 MPag) or less, or about 600 psig (4.1 MPa) or less.

[0063] The catalyst in a hydrotreatment stage can be a conventional hydrotreating catalyst, such as a catalyst composed of a Group VIB metal and/or a Group VIII metal on a support. Suitable metals include cobalt, nickel, molybdenum, tungsten, or combinations thereof. Preferred combinations of metals include nickel and molybdenum or nickel, cobalt, and molybdenum. Suitable supports include silica, silica-alumina, alumina, and titania.

[0064] In an embodiment, the amount of treat gas delivered to the hydrotreatment stage can be based on the consumption of hydrogen in the stage. The treat gas rate for a hydrotreatment stage can be from about two to about five times the amount of hydrogen consumed per barrel of fresh feed in the stage. A typical hydrotreatment stage can consume from about 50 SCF/B ($8.4 \text{ m}^3/\text{m}^3$) to about 1000 SCF/B ($168.5 \text{ m}^3/\text{m}^3$) of hydrogen, depending on various factors including the nature of the feed being hydrotreated. Thus, the treat gas rate can be from about 100 SCF/B ($16.9 \text{ m}^3/\text{m}^3$) to about 5000 SCF/B ($842 \text{ m}^3/\text{m}^3$). Preferably, the treat gas rate can be from about four to about five times the amount of hydrogen consumed. Note that the above treat gas rates refer to the rate of hydrogen flow. If hydrogen is delivered as part of a gas stream having less than 100% hydrogen, the treat gas rate for the overall gas stream can be proportionally higher.

Blended Jet / Kerosene Boiling Range Products

[0065] An isoparaffinic blend component can be blended with one or more other fractions to form a kerosene / jet boiling range product. Examples of fractions that can be blended with an isoparaffinic blend component include, but are not limited to, conventional jet fractions, mineral naphtha and/or jet and/or diesel boiling range fractions, and various types of synthetic naphtha, jet, and/or diesel boiling range fractions, such as sustainable aviation fuel fractions and/or Fischer-Tropsch fractions. Other challenged fractions where at least a portion of the fraction corresponds to jet / kerosene boiling range components can also be blended with an isoparaffinic blend component.

[0066] In various aspects, a blended product can contain 1.0 vol% or more of an isoparaffinic blend component, or 10 vol% or more, or 30 vol% or more, or 50 vol% or more, or 65 vol% or more, or 75 vol% or more, such as up to 99 vol% or possibly still higher. In some aspects, such a blended product can include 1.0 vol% to 20 vol% of an isoparaffinic blend component, or 1.0 vol% to 15 vol%, or 5.0 vol% to 20 vol%, or 5.0 vol% to 15 vol%, or 10 vol% to 20 vol%. In other aspects, such a blended component can include 30 vol% to 99 vol% of an isoparaffinic blend component, or 30 vol% to 95 vol%, or 30 vol% to 80 vol%, or 30 vol% to 60 vol%, or 30 vol% to 45 vol%, or 50 vol% to 99 vol%, or 50 vol% to 95 vol%, or 50 vol% to 80 vol%, or 70 vol% to 99 vol%.

[0067] In some aspects, 0.1 wt% to 15 wt% of the resulting blended product can be C_{17+} hydrocarbons, or 1.0 wt% to 15 wt%, or 2.5 wt% to 15 wt%, or 0.1 wt% to 10 wt%, or 1.0 wt% to 10 wt%, or 2.5 wt% to 10 wt%, or 1.0 wt% to 6.0 wt%, or 2.5 wt% to 6.0 wt%, or 1.0 wt% to 3.0 wt%, or 0.1 wt% to 6.0 wt%, or 0.1 wt% to 3.0 wt%. In some aspects, 0.1 wt% to 15

wt% of the resulting blended product can be C₁₇ and/or C₁₈ hydrocarbons. For example, the resulting blended product can include 0.1 wt% or more of C₁₇ – C₁₈ hydrocarbons, or 1.0 wt% or more, or 1.5 wt% or more, or 2.0 wt% or more, or 4.0 wt% or more, or 6.0 wt% or more, or 10 wt% or more, such as up to 15 wt%. In some aspects, the resulting blended product can contain 5.0 wt% or less of C₁₉₊ hydrocarbons, or 3.0 wt% or less, or 1.0 wt% or less, or 0.1 wt% or less, such as down to having substantially no content of C₁₉₊ hydrocarbons.

5 [0068] In some aspects, the resulting blended product can have an unexpectedly high content of C₉ hydrocarbons. In such aspects, the resulting blended product can contain 5.0 wt% or more of C₉ hydrocarbons, or 10 wt% or more, or 15 wt% or more, such as up to 25 wt% or possibly still higher.

10 [0069] In various aspects, the resulting blended product can have a specific gravity at 15°C of 0.775 g/cm³ to 0.840 g/cm³. Additionally or alternately, the resulting blended product can have a flash point of 38° C or higher, or 40°C or higher, or 45°C or higher, or 50°C or higher, such as up to 60°C or possibly still higher. Further additionally or alternately, the resulting blended product can have a Jet Fuel Thermal Oxidation Test (JFTOT) breakpoint result of 260°C or higher, or 270°C or higher, or 280°C or higher, such as up to 320°C or possibly still higher. Still further additionally or alternately, the resulting blended product can have a freeze point of -40°C or less, or -47°C or less, or -50°C or less, or -55°C or less, such as down to -70°C or possibly still lower.

20 [0070] In some aspects, the resulting blended product can have a final boiling point of 300°C or less, even though the resulting blended product contains 1.0 wt% or more of C₁₇₊ hydrocarbons.

[0071] In various aspects, the resulting blended product can contain a reduced or minimized amount of aromatics. This can correspond to containing 20 wt% or less of aromatics, or 15 wt% or less, or 10 wt% or less, or 5.0 wt% or less, or 3.0 wt% or less, or 1.0 wt% or less, or 0.5 wt% or less, or 0.1 wt% or less, such as down to having substantially no aromatics content. Additionally or alternately, the sulfur content can be 2000 wppm or less, or 1000 wppm or less, or 500 wppm or less, or 250 wppm or less, or 100 wppm or less, or 10 wppm or less, such as down to 0.5 wppm or possibly still lower.

30 [0072] In some aspects, the resulting blended product can include at least a portion of one or more conventional jet fuel(s). A conventional jet fuel is defined herein as a fraction that already qualifies as a jet fuel under at least one of ASTM D1655, UK Ministry of Defence Standard 91-091, and Canadian General Standards Board 3.23. In such aspects, the resulting

blended product can include 1.0 vol% to 99 vol% of a conventional jet fuel fraction, or 1.0 vol% to 90 vol%, or 1.0 vol% to 70 vol%, or 1.0 vol% to 50 vol%, or 1.0 vol% to 30 vol%, or 1.0 vol% to 10 vol%, or 10 vol% to 70 vol%, or 10 vol% to 50 vol%, or 10 vol% to 30 vol%, or 30 vol% to 70 vol%. Thus, the resulting blended product can, in some aspects, include 50
5 vol% or less of a conventional jet fuel fraction, or 30 vol% or less, or 10 vol% or less, such as down to 1.0 vol% or possibly still lower.

[0073] In some aspects, the resulting blended product can include at least a portion of one or more mineral kerosene / jet boiling range fraction(s). In such aspects, the resulting blended product can include 1.0 vol% to 99 vol% of a jet / kerosene boiling range fraction, or
10 1.0 vol% to 90 vol%, or 1.0 vol% to 70 vol%, or 1.0 vol% to 50 vol%, or 1.0 vol% to 30 vol%, or 1.0 vol% to 10 vol%, or 10 vol% to 70 vol%, or 10 vol% to 50 vol%, or 10 vol% to 30 vol%, or 30 vol% to 70 vol%. Thus, the resulting blended product can, in some aspects, include 50 vol% or less of a jet / kerosene boiling range fraction, or 30 vol% or less, or 10 vol% or less, such as down to 1.0 vol% or possibly still lower.

[0074] In some aspects, the resulting blended product can include at least a portion of one or more synthetic jet boiling range fraction(s), optionally as defined in ASTM D7566. In such aspects, the resulting blended product can include 1.0 vol% to 99 vol% of a synthetic jet boiling range fraction, or 1.0 vol% to 90 vol%, or 1.0 vol% to 70 vol%, or 1.0 vol% to 50 vol%, or 1.0 vol% to 30 vol%, or 1.0 vol% to 10 vol%, or 10 vol% to 70 vol%, or 10 vol% to 50
20 vol%, or 10 vol% to 30 vol%, or 30 vol% to 70 vol%. Thus, the resulting blended product can, in some aspects, include 50 vol% or less of a synthetic jet boiling range fraction, or 30 vol% or less, or 10 vol% or less, such as down to 1.0 vol% or possibly still lower.

[0075] It is noted that an isoparaffinic blend component and/or iso-olefinic blend component can be blended with a plurality of different types of fractions. For example, in some
25 aspects, a blended product can include two or more (or three or more) of a conventional jet fuel fraction, a mineral jet boiling range fraction, and a synthetic fraction. Examples of synthetic fractions include bio-derived fractions, sustainable aviation fuels, and/or a Fischer-Tropsch fractions.

[0076] In some aspects, after blending components together to form a kerosene / jet fuel
30 boiling range fraction, it may be desirable to further treat the kerosene / jet boiling range fraction for any convenient reason. Examples of further treatment methods can include, but are not limited to, wet treating, clay treatment, acid and/or caustic treatment, mercaptan oxidation, salt drying, and hydroprocessing.

Distribution of Carbon Atom Types in Isoparaaffinic Blend Component and Resulting Blends

[0077] In some aspects, an isoparaaffinic blend component can be formed according to the synthesis method described herein, where an iso-olefinic blend component is formed via olefin oligomerization, and then exposed to hydrotreating conditions to substantially saturate the olefins, resulting in an isoparaaffinic blend component. When an isoparaaffinic blend component is formed according to this method, the distribution of types of carbon atoms within the hydrocarbons of the blend component is distinct from a fraction containing isoparaaffins that are formed by another method, such as by isomerization of an n-paraffin feed. This difference in the types of carbon atoms can be characterized using various types nuclear magnetic resonance (NMR) analysis, including ^1H NMR and ^{13}C NMR.

[0078] In this discussion, analysis of types of hydrogen atoms within a hydrocarbon-like sample is performed according to the methodology described in a technical paper by Gulder et al. in a SAE Technical Paper Series (892073). The paper is titled "A Rapid Cetane Number Prediction Method for Petroleum Liquids and Pure Hydrocarbons Using Proton NMR".

[0079] Briefly, ^1H NMR can be used to roughly characterize the amount of hydrogen in a sample that is bonded to various types of carbon atoms. Under the analysis used herein, hydrogens are grouped into 6 categories. "Ha" hydrogens correspond to hydrogen atoms bonded to aromatic rings. "H α " hydrogens correspond to hydrogens bonded to a carbon atom that is in an "alpha" position relative to an aromatic ring. "Ho" hydrogens correspond to hydrogens bonded to a carbon atom that forms part of an olefinic bond. "Hc₁" hydrogens correspond to hydrogens that are part of a CH group or a CH₂ group that is "beta" to an aromatic ring, and hydrogens that are part of a naphthenic CH group or paraaffinic CH group. It is noted that based on the above definitions, hydrogens from a CH group or CH₂ group that is in an "alpha" position relative to an aromatic ring would be included in "H α ", and not as part of "Hc₁". "Hc₂" hydrogens correspond to hydrogens on paraaffinic CH₂ groups, naphthenic CH₂ groups, CH₂ groups that are in a "gamma" position or farther away from an aromatic ring, and hydrogens that are part of CH₃ groups that are in a "beta" position relative to an aromatic ring. "Hd" hydrogens correspond to hydrogens that are part of paraaffinic CH₃ groups as well as hydrogens that are part of CH₃ groups that are in a "gamma" position or farther away from an aromatic ring. Based on these definitions, the ratio of various types hydrogens in a ^1H NMR spectrum can be characterized. In particular, the peak areas corresponding to each type of hydrogen can be integrated to allow for determination of ratios of one type of hydrogen relative

to another. As an example, ^1H NMR can be used to determine the ratio of Hd hydrogens to Hc₂ hydrogens (or roughly the ratio of hydrogens in CH₃ groups to hydrogens in CH₂ groups).

[0080] In various aspects, an isoparaﬃnic blend component can have a ratio of Hd hydrogens to Hc₂ hydrogens (as determined based on ^1H NMR) of 1.01 to 1.35, or 1.01 to 1.25, or 1.01 to 1.15, or 1.10 to 1.35, or 1.10 to 1.25, or 0.95 to 1.25, or 0.95 to 1.15. By blending an isoparaﬃnic blend component with another fraction, a resulting blend can be formed that has a ratio of Hd hydrogens to Hc₂ hydrogens (as determined based on ^1H NMR) of 0.50 to 2.30, or 0.60 to 2.30, or 0.75 to 2.30, or 0.91 to 2.30, or 0.91 to 2.00, or 0.91 to 1.80, or 0.91 to 1.50, or 0.91 to 1.15, or 1.01 to 2.30, or 1.01 to 2.00, or 1.01 to 1.80, or 1.01 to 1.50, or 1.01 to 1.15, or 1.36 to 2.30, or 1.36 to 2.00, or 1.36 to 1.80, or 1.70 to 2.30. It is noted that the ratio of Hd hydrogens to Hc₂ hydrogens can vary depending on the type of fraction that is blended with an isoparaﬃnic blend component. Directionally, blending an isoparaﬃnic blend component with a mineral fraction and/or an n-paraﬃnic fraction will tend to produce blends with a lower ratio of Hd hydrogens to Hc₂ hydrogens. For example, blending an isoparaﬃnic blend component with a mineral jet boiling range fraction, a mineral distillate boiling range fraction, or a Fischer-Tropsch fraction and/or fraction with a high n-paraﬃn content, will tend to result in blends having a lower ratio of Hd hydrogens to Hc₂ hydrogens. By contrast, blending an isoparaﬃnic blend component with a fraction that has been highly isomerized in a catalytic dewaxing / isomerization process will tend to result in blends having a higher ratio of Hd hydrogens to Hc₂ hydrogens.

[0081] In addition to characterizing hydrogen for full samples, ^{13}C NMR was used to characterize the quaternary carbon content of the C₁₂ fraction of various samples. For this type of measurement, gas chromatography can be used to separate the C₁₂ compounds present in a sample from the remaining hydrocarbons. A straightforward method that can be used for forming a C₁₂ fraction is the normal paraﬃn (or linear paraﬃn) gas chromatograph method. That is, for an appropriate gas chromatograph with a separation column of adequate resolution, a normal paraﬃn of a given carbon number is assumed to delineate a peak, above which, species may be assumed to comprise the carbon number of the next higher carbon number normal paraﬃn peak. For example, all peaks for material eluting in between the peaks for n-decane and n-undecane are assumed to be C₁₁ species.

[0082] The resulting C₁₂ fraction can then be characterized using ^{13}C NMR. It has been discovered that the C₁₂ fraction of an isoparaﬃnic blend component made according to the methods described herein can have an unexpectedly low content of quaternary carbons relative

to a fraction made by catalytic isomerization of n-paraffins. In such aspects, the quaternary carbon content of the C₁₂ fraction of an isoparaffinic blend component can be 1.5% or less of the total carbons present in the C₁₂ fraction, or 1.4% or less, or 1.3% or less, such as down to 1.0% or possibly still lower.

5 EXAMPLES

Example 1 – Carbon Chain Length Distribution in Isoparaffinic Blend Component

[0083] One of the unusual features of the isoparaffinic blend component as described herein is that the isoparaffinic blend component can contain a substantial portion of C₁₇₊ hydrocarbons while still forming a blend with a final boiling point of 300°C or less, as measured according to ASTM D86. To illustrate this, several different samples of isoparaffinic blend component were formed using the synthesis methods described herein. Table 1 shows the volume percentage of the hydrocarbon chain lengths in the resulting isoparaffinic blend components. The samples are referred to as IPB 1, 2, and 3 (for Isoparaffinic Blend Component). For comparison, the hydrocarbon chain length distribution in a representative JET A-1 sample is also shown.

Table 1 - Hydrocarbon Chain Length Distribution

[wt%]	C8	C9	C10	C11	C12	C13/14	C15/16	C17/18	C19/20
JET A-1	2.0	3.9	8.8	15.4	18.4	33.2	16.3	1.8	0.0
IPB 1	0.4	5.0	8.7	16.1	31.6	18.7	14.0	3.8	1.8
IPB 2	0.3	20.0	7.3	13.6	26.6	15.7	11.8	3.2	1.5
IPB 3	0.2	12.6	12.6	14.3	22.8	18.6	13.0	4.3	1.6

[0084] As shown in Table 1, the representative JET A-1 sample includes less than 2.0 wt% of C₁₇ – C₁₈ components, and no C₁₉ or C₂₀ components. By contrast, each of the isoparaffinic blend components includes more than 3.0 wt% of C₁₇ – C₁₈ hydrocarbons, as well as more than 4.5 wt% of C₁₇₊ hydrocarbons.

- [0085] The increased concentration of C₁₇₊ hydrocarbons in the isoparaffinic blend components can result in a corresponding increase in C₁₇₊ hydrocarbons in blends that include a portion of an isoparaffinic blend component. Tables 2 – 4 show the weight percentage of hydrocarbons of various chain lengths that would be incorporated into a blended product that
- 5 included 70 vol% of a component (Table 2), 50 vol% (Table 3), or 30 vol% (Table 4).

Table 2 – Contribution to Blend at 70 vol%

[wt%]	C8	C9	C10	C11	C12	C13/14	C15/16	C17/18	C19/20
JET A-1	1.4	2.7	6.2	10.8	12.9	23.3	11.4	1.3	0.0
IPB 1	0.2	3.5	6.1	11.3	22.1	13.1	9.8	2.7	1.3
IPB 2	0.2	14.0	5.1	9.5	18.6	11.0	8.3	2.2	1.1
IPB 3	0.1	8.8	8.8	10.0	16.0	13.0	9.1	3.0	1.1

Table 3 – Contribution to Blend at 50 vol%

[wt%]	C8	C9	C10	C11	C12	C13/14	C15/16	C17/18	C19/20
JET A-1	1.0	2.0	4.4	7.7	9.2	16.6	8.2	0.9	0.0
IPB 1	0.2	2.5	4.3	8.0	15.8	9.3	7.0	1.9	0.9
IPB 2	0.2	10.0	3.7	6.8	13.3	7.9	5.9	1.6	0.8
IPB 3	0.1	6.3	6.3	7.2	11.4	9.3	6.5	2.2	0.8

Table 4 – Contribution to Blend at 30 vol%

[wt%]	C8	C9	C10	C11	C12	C13/14	C15/16	C17/18	C19/20
JET A-1	0.6	1.2	2.7	4.6	5.5	10.0	4.9	0.5	0.0
IPB 1	0.1	1.5	2.6	4.8	9.5	5.6	4.2	1.1	0.5
IPB 2	0.1	6.0	2.2	4.1	8.0	4.7	3.5	1.0	0.5
IPB 3	0.1	3.8	3.8	4.3	6.8	5.6	3.9	1.3	0.5

[0086] As shown in Tables 2 – 4, blends including 70 vol% of an isoparaﬃnic blend component can include 2.0 wt% or more of C₁₇ – C₁₈ hydrocarbons, or 2.5 wt% or more, such as up to 3.0 wt%. For a 50% blend, the isoparaﬃnic blend component can contribute 1.6 wt% or more of C₁₇ – C₁₈ hydrocarbons, such as up to 2.2 wt%. Based on a typical C₁₇ – C₁₈ content in a conventional jet fuel of roughly 1.8 wt%, it is clear that an isoparaﬃnic blend component as described herein can allow for incorporation of a higher weight percentage of C₁₇ – C₁₈ hydrocarbons into a potential blended jet fuel product.

Example 2 – Blends with Conventional Jet Fuels

10 [0087] The isoparaﬃnic blend components corresponding to IPB 1 and IPB 2 in Example 1 were used in combination with conventional jet fuels (JET A-1 or JP-5) to form blended jet boiling range products. Even for blends with 50 vol% or more of an isoparaﬃnic blend component, or 70 vol% or more, the resulting blended jet boiling range products still satisfied the specification for the corresponding type of jet fuel.

15 [0088] FIG. 1 shows results from characterization of a conventional JET A-1 sample, a sample of IPB 1, a blend formed from 30 vol% IPB 1 and 70 vol% JET A-1, and a blend formed from 70 vol% IPB 1 and 30 vol% JET A-1. As shown in FIG. 1, IPB 1 alone does not satisfy all of the standard requirements for a JET A-1 jet fuel. However, blending 70 vol% of IPB 1 with 30 vol% of a conventional JET A-1 resulted in a blended product that satisfied all of the JET A-1 requirements shown in FIG. 1. It is noted that the minimum aromatics content that can be characterized according to UOP 990 is 1.0 wt%. In FIG. 1, the aromatics content

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reported for the IPB 1 sample was determined by an alternative method involving UV-Visible spectroscopy.

[0089] As explained in Example 1, the blend containing 70 vol% IPB 1 included at least 2.0 vol% of C₁₇ – C₁₈ hydrocarbons even without considering the contributions from the JET A-1. The blend including 70 vol% IPB 1 also provided a higher JFTOT breakpoint temperature and a higher smoke point. In combination with the generally beneficial cold flow properties of an isoparaffinic blend component, FIG. 1 shows the value of an isoparaffinic blend component as described herein for potentially returning off-specification jet fuel samples back to specification.

10 [0090] A similar characterization was performed on a JET A-1 sample, IPB 2, a blend of 30 vol% IPB 2 with 70 vol% JET A-1, and a blend of 70 vol% IPB 2 with 30 vol% JET A-1. The results from characterization of these blend products are shown in FIG. 2. Similar to FIG. 1, blending of 50 vol% or more, or 70 vol% or more of an isoparaffinic blend component with a conventional jet fuel sample results in a blended product that can still satisfy all of the
15 required standards that are shown in FIG. 2.

Example 3 – Isoparaffinic Blend Component as Lubricity Improver

[0091] It has been discovered that in aspects where the resulting blended product includes at least 10 vol% of a mineral jet boiling range fraction and 40 vol% or more (or 50 vol% or more) of an isoparaffinic blend component, the resulting blended product can have an
20 unexpectedly improved lubricity. Lubricity can be measured based on wear scar diameter as determined according to ASTM D5001. For example, such a blended product can include 10 vol% - 50 vol% of a mineral jet boiling range fraction, or 10 vol% to 60 vol%, or 20 vol% to 50 vol%, or 20 vol% to 60 vol%. Such a blended component can also include 40 vol% to 90 vol% of an isoparaffinic blend component, or 50 vol% to 90 vol%, or 40 vol% to 80 vol%, or
25 50 vol% to 80 vol%.

[0092] The unexpected nature of the lubricity improvement when adding 50 vol% or more of an isoparaffinic blend component to a mineral jet boiling range fraction can be understood by comparing the lubricity behavior of the blends shown in Table 5. Table 5 shows results from testing various jet boiling range fractions under the method of ASTM D5001 to
30 determine a wear scar diameter. In Table 5, the first two samples correspond to neat samples of JET A-1 and JP-5. The remaining samples are blends of an isoparaffinic blend component (either IPB-1 or IPB-2) with the JET A-1 or JP-5. Conventionally, it would be expected that adding a highly paraffinic blend component to a mineral jet boiling range fraction would result

in poorer lubricity performance. For comparison, it is noted that some jet fuel standards have a maximum wear scar diameter under the ASTM D5001 of 0.85 mm or less.

Table 5 – Measured Lubricity Values for Jet Boiling Range Fractions

Fuel	Wear Scar Diameter	Test Method
100% JET A-1	0.72 mm	D5001
100% JP-5	0.62 mm	D5001
30% IPB-1 / 70% JET A-1	0.67 mm	D5001
70% IPB-1 / 30% JET A-1	0.52 mm	D5001
30% IPB-2 / 70% JET A-1	0.68 mm	D5001
70% IPB-2 / 30% JET A-1	0.53 mm	D5001
25% IPB-1 / 75% JP-5	0.63 mm	D5001
50% IPB-1 / 50% JP-5	0.60 mm	D5001

- 5 **[0093]** As shown in Table 5, addition of an isoparaffinic blend component to a conventional jet fuel results in a wear scar diameter under ASTM D5001 that is either similar to or smaller than the wear scar diameter produced by the conventional jet fuel alone. This is an unexpected outcome based on the nature of the isoparaffinic blend component. It is noted that for hydrocarbon fuels, lubricity is typically tied to the heteroatom content of a given fuel, with higher heteroatomic content being directionally attributed to a better lubricity (such as reduced wear scar diameter). The heteroatom content (sulfur, nitrogen, oxygen) is very low. Therefore, relative to a mineral jet fraction with a typical sulfur / nitrogen content, it would be expected that an isoparaffinic blend component would directionally have poor lubricity. Unexpectedly, the low heteroatom content isoparaffinic blend component is able to improve the lubricity of the mineral jet fuels. Without being bound by any particular theory, the blend results shown in Table 5 suggest that some other aspect of the isoparaffinic blend components, such as isoparaffinicity, may be contributing to the good lubricity performance. It is further noted that for blends of higher amounts of an isoparaffinic blend component with the JET A-1 sample (such as 50 vol% or more of an isoparaffinic blend component), the wear scar diameter for the blended composition is reduced by 10% or more relative to the wear scar diameter for the mineral jet boiling range fraction alone.

Example 4 – ¹H NMR Analysis of Blend Components

[0094] The isoparaffinic blend component IPB-1 was formed according to the method described herein, where an iso-olefinic blend component was formed by olefin oligomerization. A portion of the iso-olefinic blend component was then exposed to hydrotreating conditions to saturate the portion, thus forming the IPB-1 sample. Additionally, mixtures were formed corresponding to 30 wt% iso-olefinic blend component / 70 wt% isoparaffinic blend component and 70 wt% iso-olefinic blend component / 30 wt% isoparaffinic blend component.

[0095] The iso-olefinic blend component, the isoparaffinic blend component, and the two mixtures were characterized using ^1H NMR to characterize the ratio of Hd hydrogens to Hc_2 hydrogens, as determined from the ^1H NMR results. FIG. 3 shows results from the ^1H NMR analysis. In FIG. 3, the first column of data corresponds to data for the substantially fully saturated isoparaffinic blend component (IPB-1 – Column A). The second column and third column show the mixtures corresponding to 70 wt% isoparaffins (column B) and 30 wt% isoparaffins (column C), while the final column corresponds to data for the iso-olefinic blend component (column D), as made from the oligomerization process. As shown in FIG. 3, the isoparaffinic blend component had a ratio of Hd hydrogens to Hc_2 hydrogens of 1.19.

[0096] For comparison with the values shown in FIG. 3, a variety of other types of fractions were also characterized using ^1H NMR to determine the ratio of Hd hydrogens to Hc_2 hydrogens. Table 6 shows the values that were obtained for these various other types of fractions. Where a range is given, this indicates that multiple different samples were characterized, with the range corresponding to the minimum and maximum values.

Table 6 – Ratio of Hd / Hc_2 hydrogens as Determined by ^1H NMR for Other Components

Sample Type	Hd to Hc_2 Ratio
JET A-1	0.75
Diesel	0.57 – 1.00
Gas Oil	0.54
Primarily Isoparaffin Liquid (formed by catalytic isomerization)	2.50 – 3.21
Primarily N-Paraffin Liquid	0.24 – 0.33
Naphthenic Liquid (Petroleum Distillate)	2.35
Fischer-Tropsch Liquid	0.37

[0097] As shown in Table 6, liquids with high n-paraffin contents tend to have ratios of Hd hydrogens to Hc₂ hydrogens that are well below 1.00. Commercial fuel products generally have ratios below 1.00, although a high isoparaffin content / low aromatic content diesel can approach 1.00. Fluids containing high contents of naphthenes have ratios of Hd hydrogens to Hc₂ hydrogens above 2.30. Similarly, fractions with high isoparaffin content, where the isoparaffin content is formed by catalytic isomerization, have ratios above 2.30.

Example 5 – Quaternary Carbon Content

[0098] A sample of IPB-1 was separated using a gas chromatograph to form a C₁₂ fraction. The resulting C₁₂ fraction was analyzed using ¹³C NMR to determine the content of quaternary carbons in the sample. For comparison, C₁₂ fractions were also formed from samples derived from other traditional refinery processes. Table 7 shows the results from analysis of the C₁₂ fractions.

Table 7 – ¹³C NMR Analysis of C₁₂ Fractions

	C ₁₂ Comparative #1	C ₁₂ Comparative #2	C ₁₂ from IPB-1
Average Carbon Number (by GC)	11.95	11.88	12.0
Naphthenic Content	8	8	0
Number of Branches per Molecule	2.97	2.39	2.78
Quaternaries (% of total number of carbons)	1.64	1.77	1.35

[0099] As shown in Table 7, the quaternary carbon content of the C₁₂ fraction of IPB-1 was substantially lower than the other fractions. For both comparative samples, the C₁₂ fraction had a quaternary carbon content of greater than 1.60% relative to the total number of carbons in the sample, while the C₁₂ fraction from the isoparaffinic blend component has a quaternary carbon content of 1.60% or less, or 1.50% or less, or 1.40% or less, such as down to 1.20% or possibly still lower.

Additional Embodiments

[00100] Embodiment 1. A blended jet boiling range composition comprising: 30 vol% to 99 vol% of an isoparaffinic blend component containing 80 wt% or more of isoparaffins, 5.0

wt% or less of olefins, and 5.0 wt% or less of C₁₉₊ hydrocarbons; and 1.0 vol% to 70 vol% of a mineral jet boiling range fraction, the composition comprising a T10 distillation point of 205°C or less, a final boiling point of 300°C or less, a freeze point of -40°C or lower, and 2.0 wt% or more of C₁₇ – C₁₈ hydrocarbons.

- 5 **[00101]** Embodiment 2. A blended jet boiling range composition comprising: 1.0 vol% to 99 vol% of an isoparaffinic blend component containing 80 wt% or more of isoparaffins, 5.0 wt% or less of olefins, and 5.0 wt% or less of C₁₉₊ hydrocarbons; and 1.0 vol% to 99 vol% of a mineral jet boiling range fraction, the composition comprising a T10 distillation point of 205°C or less, a final boiling point of 300°C or less, a freeze point of -40°C or lower, and i) 10
10 wt% or more of C₉ hydrocarbons, ii) a flash point of 50°C or higher, or iii) a combination of i) and ii).

[00102] Embodiment 3. The composition of Embodiments 1 or 2, wherein the mineral jet boiling range fraction comprises a conventional jet fuel or kerosene component.

- [00103]** Embodiment 4. The composition of any of Embodiments 1 - 3, wherein the
15 composition comprises 50 vol% to 99 vol% of the isoparaffinic blend component.

[00104] Embodiment 5. The composition of any of Embodiments 1 - 3, wherein the composition comprises 30 vol% to 95 vol% of the isoparaffinic blend component.

- [00105]** Embodiment 6. The composition of any of Embodiments 1 - 3, wherein the composition comprises 50 vol% to 90 vol% of the isoparaffinic blend component and 10 wt%
20 to 50 wt% of the mineral jet boiling range fraction.

[00106] Embodiment 7. The composition of Embodiment 6, wherein the composition produces a smaller wear scar diameter under the procedure of ASTM D5001 than a wear scar diameter produced by the mineral jet boiling range fraction under the procedure of ASTM D5001.

- 25 **[00107]** Embodiment 8. The composition of Embodiment 7, wherein the wear scar diameter produced by the composition is 10% or more smaller than the wear scar diameter produced by the mineral jet boiling range fraction.

[00108] Embodiment 9. The composition of any of Embodiments 1 - 8, wherein the composition comprises a ratio of Hd hydrogens to Hc₂ hydrogens of 1.01 to 2.00.

- 30 **[00109]** Embodiment 10. The composition of any of Embodiments 1 - 8, wherein the composition comprises a ratio of Hd hydrogens to Hc₂ hydrogens of 1.01 to 1.35, the composition optionally comprising 40 vol% to 70 vol% of the isoparaffinic blend component.

[00110] Embodiment 11. The composition of any of Embodiments 1 - 10, wherein the isoparaffinic blend component contains 1.0 wt% or less of aromatics, or wherein the composition comprises 20 wt% or less of aromatics, or a combination thereof.

5 [00111] Embodiment 12. The composition of any of Embodiments 1 - 11, wherein the isoparaffinic blend component comprises 8.0 wt% or less, or 5.0 wt% or less, of compounds different from isoparaffins and iso-olefins.

[00112] Embodiment 13. The composition of any of Embodiments 1 - 12, wherein the composition comprises 0.1 wt% to 1.0 wt% of C₁₉₊ hydrocarbons.

10 [00113] Embodiment 14. The composition of any of Embodiments 1 - 13, wherein the composition comprises a fuel that satisfies the specifications for a jet fuel in accordance with at least one of ASTM D1655, UK Ministry of Defence Standard 91-091, and Canadian General Standards Board 3.23.

[00114] Embodiment 15. The composition of any of Embodiments 1 - 14, wherein the composition comprises 3.0 wt% or less of C₈- compounds.

15 [00115] Embodiment 16. The composition of any of Embodiments 1 - 15, wherein the isoparaffinic blend component comprises a T10 distillation point of 205°C or less, a final boiling point of 300°C or less, and a freeze point of -40°C or lower.

20 [00116] Embodiment 17. The composition of any of Embodiments 1 - 16, wherein the C₁₂ hydrocarbons in the isoparaffinic blend component comprise 1.5% or less of quaternary carbons, relative to the total number of carbons in the C₁₂ hydrocarbons of the isoparaffinic blend component.

[00117] Embodiment 18. A blended jet boiling range composition comprising: 1.0 vol% to 20 vol% of an isoparaffinic blend component, and 80 vol% to 99 vol% of a mineral jet boiling range fraction, the isoparaffinic blend component comprising 80 wt% or more of
25 isoparaffins, 5.0 wt% or less of olefins, and 5.0 wt% or less of C₁₉₊ hydrocarbons, the composition comprising a T10 distillation point of 205°C or less, a final boiling point of 300°C or less, and a freeze point of -40°C or lower.

[00118] Embodiment 19. The composition of Embodiment 18, wherein the blended jet boiling range composition comprises 1.0 wt% to 10 wt% of the isoparaffinic blend component.

30 [00119] Embodiment 20. The composition of Embodiment 18, wherein the blended jet boiling range composition comprises 5.0 wt% to 15 wt% of the isoparaffinic blend component.

[00120] Embodiment 21. The composition of any of Embodiments 18 to 20, wherein the composition comprises a ratio of Hd hydrogens to Hc₂ hydrogens of 0.9 to 1.1.

[00121] Embodiment 22. The composition of any of Embodiments 18 to 21, wherein the isoparaffinic blend component contains 1.0 wt% or less of aromatics.

[00122] Embodiment 23. The composition of any of Embodiments 18 to 22, wherein the isoparaffinic blend component comprises 5.0 wt% or less of compounds different from isoparaffins and iso-olefins.

[00123] Embodiment 24. The composition of any of Embodiments 18 to 23, wherein the composition comprises 0.1 wt% to 1.0 wt% of C₁₉₊ hydrocarbons.

[00124] Embodiment 25. The composition of any of Embodiments 18 - 24, wherein the composition comprises a fuel that satisfies the specifications for a jet fuel in accordance with at least one of ASTM D1655, UK Ministry of Defence Standard 91-091, and Canadian General Standards Board 3.23.

[00125] Embodiment 26. The composition of any of Embodiments 18 - 25, wherein the composition comprises 3.0 wt% or less of C₈ compounds.

[00126] Embodiment 27. The composition of any of Embodiments 18 - 26, wherein the isoparaffinic blend component comprises a T10 distillation point of 205°C or less, a final boiling point of 300°C or less, and a freeze point of -40°C or lower.

[00127] Embodiment 28. The composition of any of Embodiments 18 to 27, wherein the C₁₂ hydrocarbons in the isoparaffinic blend component comprise 1.5% or less of quaternary carbons, relative to the total number of carbons in the C₁₂ hydrocarbons of the isoparaffinic blend component.

[00128] Embodiment 29. A blended jet boiling range composition comprising: 1.0 vol% to 99 vol% of an isoparaffinic blend component containing 80 vol% or more of isoparaffins, 5.0 vol% or less of olefins, and 5.0 vol% or less of C₁₉₊ hydrocarbons; and 1.0 vol% to 99 vol% of a synthetic jet boiling range fraction, the synthetic jet boiling range fraction a) containing less than 80 wt% isoparaffins, b) having a ratio of Hd hydrogens to Hc₂ hydrogens of 1.6 or more, c) having a ratio of Hd hydrogens to Hc₂ hydrogens of 1.0 or less, d) a combination of a) and b), or e) a combination of a) and c), wherein the blended jet boiling range composition comprising a T10 distillation point of 205°C or less, a final boiling point of 300°C or less, a freeze point of -40°C or lower, and 1.0 wt% or more of C₁₇ - C₁₈ hydrocarbons.

[00129] Embodiment 30. A blended jet boiling range composition comprising: 1.0 vol% to 99 vol% of an isoparaffinic blend component containing 80 wt% or more of isoparaffins, 5.0 wt% or less of olefins, and 5.0 wt% or less of C₁₉₊ hydrocarbons; and 1.0 vol% to 99 vol% of a synthetic jet boiling range fraction, the synthetic jet boiling range fraction a) containing less

than 80 wt% isoparaffins, b) having a ratio of Hd hydrogens to Hc₂ hydrogens of 1.6 or more, c) having a ratio of Hd hydrogens to Hc₂ hydrogens of 1.0 or less, d) a combination of a) and b), or e) a combination of a) and c), the blended jet boiling range composition comprising a T10 distillation point of 205°C or less, a final boiling point of 300°C or less, a freeze point of
5 -40°C or lower, and i) 10 wt% or more of C₉ hydrocarbons, ii) a flash point of 50°C or higher, or iii) a combination of i) and ii).

[00130] Embodiment 31. The composition of Embodiment 30, wherein the composition comprises 1.0 vol% to 30 vol% of the isoparaffinic blend component.

10 **[00131]** Embodiment 32. The composition of any of Embodiments 29 – 31, wherein the composition comprises 30 vol% to 99 vol% of the isoparaffinic blend component, the composition optionally comprising 1.5 wt% or more of C₁₇ – C₁₈ hydrocarbons.

[00132] Embodiment 33. The composition of any of Embodiments 29 – 32, wherein the synthetic jet boiling range fraction comprises a bio-derived fraction, a Fischer-Tropsch fraction, or a combination thereof.

15 **[00133]** Embodiment 34. The composition of any of Embodiments 29 – 33, wherein the synthetic jet boiling range fraction comprises a jet boiling range fraction derived from a non-conventional source.

20 **[00134]** Embodiment 35. The composition of any of Embodiments 29 – 34, wherein the composition comprises 10 vol% or more of the isoparaffinic blend component, 10 vol% or more of the synthetic jet boiling range fraction, or a combination thereof.

[00135] Embodiment 36. The composition of any of Embodiments 29 – 35, wherein the composition further comprises 1.0 wt% or more of a conventional jet fuel, a mineral jet boiling range fraction, or a combination thereof.

25 **[00136]** Embodiment 37. The composition of any of Embodiments 29 – 36, wherein the composition comprises a ratio of Hd hydrogens to Hc₂ hydrogens of 1.10 to 2.20.

[00137] Embodiment 38. The composition of any of Embodiments 29 – 36, wherein the composition comprises a ratio of Hd hydrogens to Hc₂ hydrogens of 0.50 to 1.0.

30 **[00138]** Embodiment 39. The composition of any of Embodiments 29 – 38, wherein the isoparaffinic blend component contains 1.0 vol% or less of aromatics, or wherein the composition comprises 20 wt% or less of aromatics, or a combination thereof.

[00139] Embodiment 40. The composition of any of Embodiments 29 – 39, wherein the composition comprises 0.1 wt% to 1.0 wt% of C₁₉₊ hydrocarbons.

[00140] Embodiment 41. The composition of any of Embodiments 29 – 40, wherein the isoparaffinic blend component comprises 5.0 wt% or less of compounds different from isoparaffins and iso-olefins.

5 [00141] Embodiment 42. The composition of any of Embodiments 29 - 41, wherein the composition comprises a fuel that satisfies the specifications for a jet fuel in accordance with at least one of ASTM D1655, UK Ministry of Defence Standard 91-091, and Canadian General Standards Board 3.23.

[00142] Embodiment 43. The composition of any of Embodiments 29 - 42, wherein the composition comprises 3.0 wt% or less of C₈- compounds.

10 [00143] Embodiment 44. The composition of any of Embodiments 29 - 43, wherein the isoparaffinic blend component comprises a T10 distillation point of 205°C or less, a final boiling point of 300°C or less, and a freeze point of -40°C or lower.

[00144] While the present invention has been described and illustrated by reference to particular embodiments, those of ordinary skill in the art will appreciate that the invention lends
15 itself to variations not necessarily illustrated herein. For this reason, then, reference should be made solely to the appended claims for purposes of determining the true scope of the present invention.

CLAIMS

WHAT IS CLAIMED IS:

1. A blended jet boiling range composition comprising: 30 vol% to 99 vol% of an isoparaffinic blend component containing 80 wt% or more of isoparaffins, 5.0 wt% or less of olefins, and 5.0 wt% or less of C₁₉₊ hydrocarbons; and 1.0 vol% to 70 vol% of a mineral jet boiling range fraction, the composition comprising a T10 distillation point of 205°C or less, a final boiling point of 300°C or less, a freeze point of -40°C or lower, and 2.0 wt% or more of C₁₇ – C₁₈ hydrocarbons.
2. A blended jet boiling range composition comprising: 1.0 vol% to 99 vol% of an isoparaffinic blend component containing 80 wt% or more of isoparaffins, 5.0 wt% or less of olefins, and 5.0 wt% or less of C₁₉₊ hydrocarbons; and 1.0 vol% to 99 vol% of a mineral jet boiling range fraction, the composition comprising a T10 distillation point of 205°C or less, a final boiling point of 300°C or less, a freeze point of -40°C or lower, and i) 10 wt% or more of C₉ hydrocarbons, ii) a flash point of 50°C or higher, or iii) a combination of i) and ii).
3. The composition of claims 1 or 2, wherein the mineral jet boiling range fraction comprises a conventional jet fuel or kerosene component.
4. The composition of any of claims 1 - 3, wherein the composition comprises 50 vol% to 99 vol% of the isoparaffinic blend component.
5. The composition of any of claims 1 - 3, wherein the composition comprises 30 vol% to 95 vol% of the isoparaffinic blend component.
6. The composition of any of claims 1 - 3, wherein the composition comprises 50 vol% to 90 vol% of the isoparaffinic blend component and 10 wt% to 50 wt% of the mineral jet boiling range fraction.
7. The composition of claim 6, wherein the composition produces a smaller wear scar diameter under the procedure of ASTM D5001 than a wear scar diameter produced by the mineral jet boiling range fraction under the procedure of ASTM D5001.
8. The composition of claim 7, wherein the wear scar diameter produced by the composition is 10% or more smaller than the wear scar diameter produced by the mineral jet boiling range fraction.

9. The composition of any of claims 1 - 8, wherein the composition comprises a ratio of Hd hydrogens to Hc₂ hydrogens of 1.01 to 2.00.

10. The composition of any of claims 1 - 8, wherein the composition comprises a ratio of Hd hydrogens to Hc₂ hydrogens of 1.01 to 1.35, the composition optionally comprising 40 vol% to 70 vol% of the isoparaaffinic blend component.

11. The composition of any of claims 1 - 10, wherein the isoparaaffinic blend component contains 1.0 wt% or less of aromatics, or wherein the composition comprises 20 wt% or less of aromatics, or a combination thereof.

12. The composition of any of claims 1 - 11, wherein the isoparaaffinic blend component comprises 8.0 wt% or less of compounds different from isoparaaffins and iso-olefins.

13. The composition of any of claims 1 - 12, wherein the composition comprises 0.1 wt% to 1.0 wt% of C₁₉₊ hydrocarbons.

14. The composition of any of claims 1 - 13, wherein the composition comprises a fuel that satisfies the specifications for a jet fuel in accordance with at least one of ASTM D1655, UK Ministry of Defence Standard 91-091, and Canadian General Standards Board 3.23.

15. The composition of any of claims 1 - 14, wherein the composition comprises 3.0 wt% or less of C₈₋ compounds.

16. The composition of any of claims 1 - 15, wherein the isoparaaffinic blend component comprises a T10 distillation point of 205°C or less, a final boiling point of 300°C or less, and a freeze point of -40°C or lower.

17. The composition of any of claims 1 - 16, wherein the C₁₂ hydrocarbons in the isoparaaffinic blend component comprise 1.5% or less of quaternary carbons, relative to the total number of carbons in the C₁₂ hydrocarbons of the isoparaaffinic blend component.

18. A blended jet boiling range composition comprising: 1.0 vol% to 20 vol% of an isoparaffinic blend component, and 80 vol% to 99 vol% of a mineral jet boiling range fraction, the isoparaffinic blend component comprising 80 wt% or more of isoparaffins, 5.0 wt% or less of olefins, and 5.0 wt% or less of C₁₉₊ hydrocarbons, the composition comprising a T10 distillation point of 205°C or less, a final boiling point of 300°C or less, and a freeze point of -40°C or lower.

19. The composition of claim 18, wherein the blended jet boiling range composition comprises 1.0 wt% to 10 wt% of the isoparaffinic blend component.

20. The composition of claim 18, wherein the blended jet boiling range composition comprises 5.0 wt% to 15 wt% of the isoparaffinic blend component.

21. The composition of any of claims 18 to 20, wherein the composition comprises a ratio of Hd hydrogens to Hc₂ hydrogens of 0.9 to 1.1.

22. The composition of any of claims 18 to 21, wherein the isoparaffinic blend component contains 1.0 wt% or less of aromatics.

23. The composition of any of claims 18 to 22, wherein the isoparaffinic blend component comprises 8.0 wt% or less of compounds different from isoparaffins and iso-olefins.

24. The composition of any of claims 18 to 23, wherein the composition comprises 0.1 wt% to 1.0 wt% of C₁₉₊ hydrocarbons.

25. The composition of any of claims 18 - 24, wherein the composition comprises a fuel that satisfies the specifications for a jet fuel in accordance with at least one of ASTM D1655, UK Ministry of Defence Standard 91-091, and Canadian General Standards Board 3.23.

26. The composition of any of claims 18 - 25, wherein the composition comprises 3.0 wt% or less of C₈₋ compounds.

27. The composition of any of claims 18 - 26, wherein the isoparaffinic blend component comprises a T10 distillation point of 205°C or less, a final boiling point of 300°C or less, and a freeze point of -40°C or lower.

28. The composition of any of claims 18 to 27, wherein the C₁₂ hydrocarbons in the isoparaﬃnic blend component comprise 1.5% or less of quaternary carbons, relative to the total number of carbons in the C₁₂ hydrocarbons of the isoparaﬃnic blend component.