

A RENEWABLE HYDROCARBON COMPOSITION

TECHNICAL FIELD

The present disclosure generally relates to hydrocarbon compositions. The disclosure relates particularly, though not exclusively, to renewable hydrocarbon compositions usable
5 as jet fuel components or as jet fuels. Further, the present disclosure relates to a process for producing said hydrocarbon compositions.

BACKGROUND

This section illustrates useful background information without admission of any technique described herein being representative of the state of the art.

10 There is an ongoing need to reduce greenhouse gas emissions and/or carbon footprint in transportation, especially aviation. Accordingly, interest towards renewable jet fuels and jet fuel components is and has been growing. Processes for producing jet fuel components from renewable raw materials have been proposed. However, the yield of jet fuel components (compared to other fuel components) has been relatively low in said
15 processes. Also, there is a need and interest towards producing jet fuel components that could be used in aviation in elevated amounts or even as neat, and thus certain product properties and requirements are crucial.

The conditions to which jet fuels are exposed are extreme. The ambient temperature at high altitudes drops very low whereas the operation as such requires high thermal oxidation
20 stability. Further, jet fuels must provide reliable performance.

Currently the yields of renewable jet fuels (also referred to as sustainable aviation fuel, SAF), even with the advanced hydrotreatment processes when renewable jet fuels are produced from renewable oils and fats, are lower than the corresponding yields of renewable diesel.

25 There is therefore a need to develop new hydrocarbon compositions, preferably usable as a jet fuel or jet fuel component. Additionally, there is a need for finding methods for production thereof with good yield and production efficiency.

SUMMARY

The appended claims define the scope of protection. Any example or description of product,
30 or process in the description, claim, and/or drawing which is not covered by the claims, is presented herein not as an embodiment of the invention but as background art or as an example useful for understanding the invention.

According to a first aspect is provided a hydrocarbon composition comprising n-paraffins and i-paraffins, wherein

- the sum amount of any C8-C16 i-paraffins is from 50 to 94 wt-% of the total hydrocarbon composition weight,
- 5 - said hydrocarbon composition has a kinematic viscosity at -20 °C as determined according to ASTM D445-21e2 within a range from 3.7 to 8 mm²/s, preferably from 3.7 to 5.5 mm²/s, and
- the weighted average carbon number of the hydrocarbons in the hydrocarbon composition is from 12.1 to 14.2.

- 10 The present inventors have found said hydrocarbon composition specifically suitable for jet fuel. It also provides a jet fuel which is lighter than corresponding jet fuels commercially available.

- According to a second aspect is provided a fuel or fuel component, preferably a jet fuel or jet fuel component comprising the hydrocarbon composition as defined here. The present
- 15 hydrocarbon composition blends well with aviation fuel components presently on the market. Said hydrocarbon composition provides properties specifically beneficial for aviation fuels for such blends.

- According to a third aspect, herein is provided a use of the hydrocarbon composition as defined here as a renewable jet fuel or as a renewable jet fuel component. The present
- 20 inventors have surprisingly found that when coproduced, the hydrocarbon composition usable as renewable jet fuel or renewable jet fuel component as the main product, and the renewable diesel obtainable as coproduct, both have improved properties. Hence, according to a fourth aspect is provided a method for the combined production of high-quality jet fuel component (which in some cases can even be used as neat fuel in aviation)
- 25 and high-quality winter-grade renewable diesel. Surprisingly in the combined production after recovery of the high-quality jet fuel component, the remaining yield still qualified as renewable diesel, which met strict requirements set for high-quality winter-grade renewable diesel fuel. More specifically, the renewable jet fuel or renewable jet fuel component has shown to have the desired light character with improved cold properties, and the renewable
- 30 diesel (RD) recovered simultaneously has shown excellent winter grade properties.

Commonly for said aspects, the present hydrocarbon composition provides surprisingly attractive thermal oxidation stability ie. high JFTOT break point temperature, kinematic viscosity at -20 °C, freezing point, density, and/or biogenic carbon content, some of which

are also experimentally evidenced by the results shown in the Examples.

BRIEF DESCRIPTION OF THE FIGURES

Some example embodiments will be described with reference to the accompanying figures, in which:

- 5 Figs. 1 – 10 show contents of n-paraffins, monobranched i-paraffins, various multiple-branched i-paraffins, naphthenes, and aromatics per carbon number (x-axis) as weight % (wt-%, y-axis) relative to total hydrocarbon composition weight analysed, i. e. sample in question. Said contents may be determined by a GCxGC-FID or a GCxGC-MS method.
- Fig. 11 shows simulated distillation graphs for two middle distillates (DistFeed1 and
- 10 DistFeed2) which were used as feeds for distillation, comparative hydrocarbon composition of comparative example 2, and two hydrocarbon compositions according to the present disclosure obtained from said distillations and further specified in the examples (SAF1 from DistFeed1 and SAF2 from DistFeed2).

DETAILED DESCRIPTION

- 15 In the following description, like reference signs denote like elements or steps. All standards and methods referred to herein are the latest revisions available at the filing date, unless otherwise mentioned.

- Unless otherwise stated, regarding distillation characteristics, such as initial boiling points (IBP), final boiling points (FBP), T10 temperature (10 vol-% recovered), T90 temperature
- 20 (90 vol-% recovered), and boiling ranges, reference is made to EN ISO 3405-2019. IBP is the temperature at the instant the first drop of condensate falls from the lower end of the condenser tube, and FBP is the maximum thermometer reading obtained during the test, usually occurring after the evaporation of all liquid from the bottom of the flask. For boiling point distribution reference may also be made to GC-based method (simdist) ASTM D2887-
- 25 22.

- As used in the context of this disclosure, jet fuel component refers to hydrocarbon compositions suitable for use in fuel compositions meeting standard specifications for aviation fuels, such as specification of ASTM D7566-22A. The specific requirements for said components are laid down e.g., in ASTM D7566-22A Annex A2. Typically, such jet fuel
- 30 components boil, i.e. have IBP and FBP, within a range from about 100 °C to about 300 °C, such as within a range from about 150 °C to about 300 °C, as determined according to EN ISO 3405-2019. Different components are typically blended to obtain a final jet fuel product. In specific occasions, a jet fuel component as here defined, may be used as jet fuel as such,

also referred to as "neat", without need to blend it with further component(s).

As used herein, the JFTOT breakpoint refers to Jet Fuel Thermal Oxidation Test and to result thereof. It is given as a temperature with °C as the unit. Improving said break point is understood as raising said temperature. The thermal oxidation stability is measured by the

5 JFTOT procedure (ASTM D3241-20c). In Test Method D3241, breakpoint is the highest control temperature at which the fuel meets heater tube rating and ΔP specification requirements. In other words, this definition of breakpoint describes the highest pass temperature for a fuel.

As used in the context of this disclosure, diesel fuel component refers to hydrocarbon

10 compositions suitable for use in fuel compositions meeting standard specifications for diesel fuels, such as specifications laid down in EN 590:2022 or in EN 15940:2016 + A1:2018 + AC:2019. Typically, such diesel fuel components boil, i.e. have IBP and FBP, within a range from about 160 °C to about 380 °C, as determined according to EN ISO 3405-2019. A diesel is often characterized by its cetane number, which may be determined e.g., with EN 15195-

15 2014. Net heat of combustion for diesel may be determined according to ASTM D4809-18.

In the context of the present disclosure, various characteristics of the feeds, streams, effluents, products, components, or samples are determined according to the standard methods referred to or disclosed herein, as properly prepared. For example, cloud point is determined according to ASTM D5773-21 from a product, component, or sample.

20 As used herein hydrocarbons refer to compounds consisting of carbon and hydrogen. Hydrocarbons of particular interest in the present context comprise paraffins, naphthenes (also referred to as cycloparaffins or cycloalkanes), and aromatics. Oxygenated hydrocarbons refer herein to hydrocarbons comprising covalently bound oxygen. The present product claimed in this invention is referred to as "hydrocarbon composition".

25 Preferably said hydrocarbon composition is a renewable hydrocarbon composition.

As used herein paraffins refer to non-cyclic alkanes, i.e. non-cyclic, open chain saturated hydrocarbons that are linear (normal paraffins, n-paraffins) or branched (isoparaffins, i-paraffins). In other words, paraffins refer herein to n-paraffins and/or i-paraffins. In the context of the present disclosure, i-paraffins refer to branched open chain alkanes, i.e. non-

30 cyclic, open chain saturated hydrocarbons having one or more alkyl side chains. Herein, i-paraffins having one alkyl substituent, i.e. alkyl side chain or branch, are referred to as monobranched i-paraffins. Consistently, i-paraffins having two or more alkyl side chains or branches are herein referred to as multiple-branched i-paraffins. In other words, i-paraffins refer herein to monobranched i-paraffins and/or multiple-branched i-paraffins. The alkyl side

chain(s) may for example be C1-C5 alkyl side chain(s), preferably methyl side chain(s). The amounts of monobranched and multiple-branched i-paraffins may be given separately. The term "i-paraffins" refers to sum amount of any monobranched i-paraffins and multiple-branched i-paraffins, if present, indicating the total amount of any i-paraffins present
5 regardless of the number of branches. Correspondingly, "paraffins" refer to sum amount of any n-paraffins, any monobranched i-paraffins, and any multiple-branched i-paraffins, if present.

As used herein, cyclic hydrocarbons refer to all hydrocarbons containing cyclic structure(s), naphthenes and aromatics. Naphthenes refer herein to cycloalkanes i.e. saturated
10 hydrocarbons containing at least one cyclic structure, with or without side chains. Naphthenes are compounds without aromatic ring structure(s) present. Aromatics refer herein to hydrocarbons containing at least one aromatic ring structure, i.e. cyclic structure having delocalised, alternating π bonds all the way around said cyclic structure.

In the context of the present disclosure, for compositions boiling at 36°C or higher (at
15 standard atmospheric pressure), contents of n-paraffins, i-paraffins, monobranched i-paraffins, various multiple-branched i-paraffins, naphthenes, and aromatics are expressed as weight % (wt-%) relative to the degassed weight of the feed, stream, effluent, product, component or sample in question, or , when so defined, as weight % (wt-%) relative to the (total) weight of paraffins, or (total) weight of i-paraffins of the feed, stream, effluent, product,
20 component, or sample in question.

Said contents as per carbon number may be determined by GCxGC-FID/GCxGC-MS method, preferably conducted as follows: GCxGC (2D GC) method was run as generally disclosed in UOP 990-2011 and by Nousiainen M. in the experimental section of his master's Thesis Comprehensive two-dimensional gas chromatography with mass
25 spectrometric and flame ionisation detectors in petroleum chemistry, University of Helsinki, August 2017, with the following modifications. The GCxGC was run in reverse mode, using a semipolar column (Rxi17Sil) first and a non-polar column (Rxi5Sil) thereafter, followed by FID detector, using run parameters: carrier gas helium 31.7 cm/sec ; split ratio 1:350; injector 280 °C; Column T program 40 °C (0 min) – 5 °C/min – 250 °C (0 min) – 10 °C/min
30 – 300 °C (5 min), run time 52 min; modulation period 10 sec; detector 300 °C with H₂ 40 ml/min and air 400 ml/min; makeup flow helium 30 ml/min; sampling rate 250 Hz and injection volume 0.2 microliters. Individual compounds were identified using GCxGC-MS, with MS-parameters: ion source 230 °C; interface 300 °C; scan range 25 - 500 amu. Commercial tools (Shimadzu's LabSolutions, Zoex's GC Image) were used for data

processing including identification of the detected compounds or hydrocarbon groups, and for determining their mass concentrations by application of response factors relative to n-heptane to the volumes of detected peaks followed by normalisation to 100 wt-%. The limit of quantitation for individual compounds of this method is 0.1 wt-%.

- 5 In the context of this disclosure, CX+ paraffins, CX+ n-paraffins, CX+ i-paraffins, CX+ monobranched i-paraffins, CX+ multiple-branched i-paraffins, CX+ hydrocarbons, or CX+ fatty acids refer to paraffins, n-paraffins, i-paraffins, monobranched i-paraffins, multiple branched i-paraffins, hydrocarbons, or fatty acids, respectively, having a carbon number of at least X, where X is any feasible integer. Reference to fatty acids and/or derivatives thereof means fatty acids, esters, such as glycerides or alkyl esters, or salts thereof. It is understood that every compound falling within the definition is not necessarily present.

- 10 In the context of this disclosure, CXY-CXZ (or CXY to CXZ) paraffins, CXY-CXZ n-paraffins, CXY-CXZ i-paraffins, CXY-CXZ monobranched i-paraffins, CXY-CXZ multiple-branched i-paraffins, CXY-CXZ hydrocarbons, or CXY-CXZ fatty acids refer to a range of paraffins, n-paraffins, i-paraffins, monobranched i-paraffins, multiple-branched i-paraffins, hydrocarbons, or fatty acids, respectively, where XY and XZ are feasible end-value integers, wherein the carbon numbers within such range is as indicated by the end-value integers and any integers between said end-values, if present. However, paraffins, n-paraffins, i-paraffins, monobranched i-paraffins, multiple-branched i-paraffins, hydrocarbons, or fatty acids, as the case may be, of all said carbon numbers within said range, particularly at or around the end points are not necessarily present, except when so expressly indicated. On the other hand, isomers, by definition, may comprise several compounds having the same carbon number, such as C15 isomers may comprise methyl tetradecanes (different position of the methyl-branch), dimethyl tridecanes (different positions of the two methyl-branches), etc, wherein "C15 isomers" comprise the sum amount of all such variants.

- 25 The sum amount by weight of C8-C16 n-paraffins, C8-C16 monobranched i-paraffins, and C8-C16 multiple-branched i-paraffins as used herein defines the total weight of n-paraffins, and i-paraffins (monobranched i-paraffins and multiple-branched i-paraffins) having a carbon number C8, C9, C10, C11, C12, C13, C14, C15, or C16, wherein the weight for any individual compound may be 0 (considering the detection limit). Further, i-paraffins, even within single carbon number, contain several individual compounds dependent on the position, number, and stereochemistry of the branch (mono-branched i-paraffins) or branches (multiple-branched i-paraffins) therein, and yet, a sum weight thereof is added to the present sum amount. In other words, if the carbon number is C8-C16 and the compound

is either n-paraffin or i-paraffin, it is counted in, and if the weight of said compound is 0, then 0 is added to said sum amount. It is hence understood that every compound falling within the definition is not necessarily present. Due to the selections made regarding the production process, for example C16 n-paraffins may be absent from the aviation fuel component. Nevertheless, a sum amount is obtainable by addition of 0 (referring to absent C16 n-paraffin) to the sum weight of all other C8-C16 n-paraffins and i-paraffins present. Isomerisation converts at least a certain amount of n-paraffins to i-paraffins, especially to monobranched i-paraffins. By (further) raising the isomerisation degree, for example by increasing severity of the hydroisomerisation conditions, more n-paraffins can be converted to i-paraffins, and monobranched i-paraffins can be converted to multiple-branched i-paraffins.

As used herein, the term renewable refers to compounds or compositions that are obtainable, derivable, or originating in full or in part from plants and/or animals, including compounds or compositions obtainable, derivable, or originating from fungi and/or algae, any of which can be wastes or residues. As used herein, renewable compounds or compositions may comprise gene manipulated compounds or compositions. Renewable feeds, components, compounds, or compositions may also be referred to as biological feeds, components, compounds, or compositions, or as biogenic feeds, components, compounds, or compositions.

As used herein, the term fossil refers to compounds or compositions that are obtainable, derivable, or originating from naturally occurring non-renewable compositions, such as crude oil, petroleum oil/gas, shale oil/gas, natural gas, or coal deposits, and the like, and combinations thereof, including any hydrocarbon-rich deposits that can be utilised from ground/underground sources.

The term circular refers to recycled material typically originating from non-renewable sources. For example, the term circular may refer to recycled material originating from waste plastics. Said renewable, circular, and fossil compounds or compositions are considered differing from one another based on their origin and impact on environmental issues. Therefore, they may be treated differently under legislation and regulatory framework. Typically, renewable, circular, and fossil compounds or compositions are differentiated based on their origin and information thereof provided by the producer.

Chemically the renewable character of any organic compounds, including hydrocarbons, can be determined by any suitable method for analyzing the content of carbon from renewable sources e.g. DIN 51637 (2014), ASTM D6866 (2020), or EN 16640 (2017). Said

methods are based on the fact that carbon atoms of renewable or biological origin comprise a higher number of unstable radiocarbon (^{14}C) atoms compared to carbon atoms of fossil origin. Therefore, it is possible to distinguish between carbon compounds derived from renewable or biological sources or raw material and carbon compounds derived from non-renewable or fossil sources or raw material by analyzing the ratio of ^{12}C and ^{14}C isotopes. Thus, a particular ratio of said isotopes can be used as a "tag" to identify a renewable carbon compound and differentiate it from non-renewable carbon compounds. The isotope ratio does not change in the course of chemical reactions. Therefore, the isotope ratio can be used for identifying renewable compounds, components, and compositions and distinguishing them from non-renewable, fossil materials in reactor feeds, reactor effluents, separated product fractions and various blends thereof. Numerically, the biogenic carbon content can be expressed as the amount of biogenic carbon in the material as a weight percent of the total carbon (TC) in the material (in accordance with ASTM D6866 (2020) or EN 16640 (2017)). In the present context, the term renewable preferably refers to a material having a biogenic carbon content of more than 50 wt-%, especially more than 60 wt-% or more than 70 wt-%, preferably more than 80 wt-%, more preferably more than 90 wt-% or more than 95 wt-%, even more preferably about 100 wt-%, based on the total weight of carbon in the material (EN 16640 (2017)).

According to a first aspect, herein is provided a hydrocarbon composition comprising n-paraffins and i-paraffins, wherein

- the sum amount of any C8-C16 i-paraffins is from 50 to 94 wt-%, such as from 86 to 92 wt-%, of the total hydrocarbon composition weight,
- said hydrocarbon composition has a kinematic viscosity at $-20\text{ }^{\circ}\text{C}$ as determined according to ASTM D445-21e2 within a range from 3.7 to 8 mm^2/s , preferably from 3.7 to 5.5 mm^2/s , and
- the weighted average carbon number of the hydrocarbons in the hydrocarbon composition is from 12.1 to 14.2.

The present inventors found said hydrocarbon composition particularly fitting for use as a component or as a renewable jet fuel, i.e. a high quality sustainable aviation fuel (SAF) suitable for use as aviation turbine fuel. Such fuel may also be referred to as light paraffinic kerosene (LPK). Without being bound to a theory, the present hydrocarbon composition provides the attractive paraffinic distribution, comprising predominantly C8-C16 i-paraffins contributing to surprisingly low kinematic viscosity at -20 and $-40\text{ }^{\circ}\text{C}$. Before the present hydrocarbon composition, the kinematic viscosity has been one of the factors limiting blend

percentages of renewable jet fuels in blends with conventional jet fuels. Fossil jet fuel component has been practically needed to improve the blend fuel's kinematic viscosity to meet the -40 °C and -20 °C kinematic viscosity limits per ASTM D7566-22A Table 1 for the blend used in aircraft. At least with some embodiments of the present hydrocarbon composition, the renewable fuel meets these limits as such.

Specifically interesting for jet fuels is the kinematic viscosity at temperatures below zero. Accordingly, the kinematic viscosity at -20 °C as determined according to ASTM D445-21e2 varies within a range from 3.7 to 8 mm²/s, preferably from 3.7 to 5.5 mm²/s. Experimentally the present hydrocarbon composition showed impressive kinematic viscosities determined by the same method also at -40 °C, such as about 9 mm²/s or about 10 mm²/s, which are compatible even with the limit given in ASTM D7566-22A Table 1.

In the hydrocarbon composition, the sum amount of any C8-C16 i-paraffins is from 50 to 94 wt-%, preferably from 86 to 92 wt-%, of the total hydrocarbon composition weight of the total hydrocarbon composition weight. The broad distribution of carbon numbers contributes to blending properties of the hydrocarbon composition with possible other jet fuel components to provide the final jet fuel product.

Preferably the i-paraffins in the hydrocarbon composition contain more than one alkyl substituent and thus are multiple branched i-paraffins. Said C8-C16 multiple branched i-paraffins may contain two, three, four, five, six or seven alkyl substituents, typically two or three. The most abundant alkyl substituents are methyl substituents. Accordingly, the sum amount of any C8-C16 multiple branched i-paraffins is from 35 to 65 wt-% preferably from 45 to 63 wt-%, more preferably from 55 to 60 wt-% of the total hydrocarbon composition weight.

Further, according to an embodiment, the ratio of multiple branched i-paraffins to n-paraffins in the hydrocarbon composition is from 3.6 – 12.0, preferably from 6.5 to 11.4. The presence of multiple-branched i-paraffins contributes to the specific and broad carbon number distribution, especially those of carbon numbers above C14. Interestingly, some of the compositions even had a weighted average carbon number greater than 14. Multiple branched i-paraffins of carbon numbers C15, C16 and even C17, provide advantages over composition limited to relatively lower carbon number compositions. Hence, due to highly isomerised product, the variation of individual hydrocarbons therein varies exceptionally.

However, the presence of n-paraffins and optionally also cycloparaffins in the hydrocarbon composition is believed to contribute to the combustion properties and usability of a fuel in aviation engines. Hence, according to some embodiments of the present hydrocarbon

composition, the sum amount of any C8-C16 n-paraffins is from 2 to 12 wt-%, preferably from 5 to 11 wt-%, more preferably from 6 to 8 wt-% of the total hydrocarbon composition weight. This was surprising, because good cold properties, specifically for the predominantly paraffinic compositions, are typically associated with very high i-paraffin content and minimizing the amount of n-paraffins is therefore aimed. The freezing points of pure C8 – C16 alkanes, i.e. n-paraffins, vary from -57 °C to 18 °C rendering the presence of n-paraffins, especially the relatively higher carbon number n-paraffins, in the present hydrocarbon composition somewhat unexpected.

In one embodiment, the sum amount of any i-paraffins and n-paraffins is from 96 to 98.5 wt-%, of the total hydrocarbon composition weight.

Although the present hydrocarbon composition mainly consists of i-paraffins and n-paraffins it was found that when the composition further comprises cycloparaffins, they contribute to fuel properties in aviation. In use as jet fuel, compositions low in aromatics benefit from cycloparaffins acting similarly to aromatics on hot surfaces of the aviation engine and fuel system in general. Hence, according to an embodiment, the amount of cycloparaffins in the present hydrocarbon composition varies from 1.0 to 5.0 wt-%, preferably from 1.8 to 3.1 wt-%.

According to a preferred embodiment, the hydrocarbon composition has specifically low content of any C17+ hydrocarbons. Hence, the sum amount of any C17+ hydrocarbons is less than 1.0 wt-%, preferably less than 0.8 wt-%, or less than 0.4 wt-% of the total hydrocarbon composition weight. In one experiment conducted to validate the present invention, the sum amount of any C17+ hydrocarbons was 0 wt-% within the limit of detection (LOD) of the analysis method used.

As used herein, the hydrocarbon composition is described by its weighted average carbon number. It has been based on GCxGC analysis calculated by multiplying weight-% of each carbon number present with said carbon number, dividing the sum of said products by 100. The present inventors have found the weighted average carbon number defining the hydrocarbon composition and correlating with the desired product properties when it is from 12.1 to 14.2. In the experiments conducted, the weighted average carbon numbers calculated for different samples were surprisingly close to one another varying from 12.1 to 12.8.

A specific embodiment according to the present invention may be characterized by even narrower limits of the features in combination, hence, the preferred hydrocarbon composition comprising n-paraffins and i-paraffins, comprises

- a sum amount of any C8-C16 i-paraffins from 85 to 94 wt-% of the total hydrocarbon composition weight,
 - a kinematic viscosity at -20 °C as determined according to ASTM D445-21e2 within a range from 3.7 to 5.5 mm²/s, and
- 5 - a weighted average carbon number of the hydrocarbons in the hydrocarbon composition from 12.1 to 12.8.

Present inventors have surprisingly found said hydrocarbon composition of said narrower limits being specifically suitable for jet fuel.

- 10 In an embodiment the hydrocarbon composition further has a density as measured using standard ASTM D4052-22 from 730 to 772 kg/m³, preferably from 750.0 to 772.0 kg/m³, more preferably from 753.0 to 770.0 kg/m³, even more preferably from 754.0 to 760.0 kg/m³.

- The present hydrocarbon composition has shown specifically good thermal properties. In aviation, the good thermal properties of fuel contribute to a lower deposits formed in the aviation engine fuel system on heating the fuel, improved heat absorption and more effective heat transfer in the fuel system.
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- Further, for combustion of the fuel in the aviation engine fuel system, the distribution of the carbon numbers and carbon chain characteristics in the present hydrocarbon composition are believed to be especially beneficial, as can be understood from figure 11. Said figure 11 shows simulated distillation graphs. The comparison is made between two middle distillates which were used as feeds for distillation into a high-quality diesel component and the hydrocarbon composition of the present disclosure.
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- The middle distillates used as the paraffinic hydrocarbon feed for distillation are referred to as DistFeed1 and DistFeed2 following the terminology used in the attached examples. As can be seen from figure 11, the T10 temperatures of DistFeed1 and DistFeed2 are relatively high, pushing the graph to a curve after which it levels with elevating temperature. This applies specifically to DistFeed2. For these samples, the T90 temperatures are close to T50 temperature and only at the very end of distillation, the temperatures rise again steeply.
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- For the two hydrocarbon compositions according to the present disclosure, namely SAF1 and SAF2, the simulated distillation curves have more linear character from the beginning to the end. The slope remains practically constant without notable curves or tilts. Considering the combustion in an aviation engine, such distillation behavior correlates with constant vaporisation during use. Further, practically no steepening of the graph at the end indicates combustion of all hydrocarbons of the product at aviation engine temperatures
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minimising deposit formation during use, and hence benefiting the maintenance.

In an embodiment the hydrocarbon composition further has a JFTOT breakpoint equal to or greater than 325 °C, preferably 360 °C, or even more preferably equal or greater than 380 °C as determined according to ASTM D3241-20C. The JFTOT breakpoint is indicative of

- 5 the specifically good thermal oxidation stability of the present hydrocarbon composition. Thermal oxidation stability is relevant in aviation fuels because of the complex fuel system of aviation engines. Further, thermal stability is directly related to low deposit formation specifically on the hot surfaces. This is appreciated in the aviation industry enabling prolonged service intervals.

- 10 In an embodiment the hydrocarbon composition further has a freezing point below -50 °C, preferably below -60 °C, more preferably below -64 °C. This is surprising considering the freezing points of alkanes (pure) may be even above zero °C: Considering the weighted average carbon number from 12.1 to 14.2, such low freezing points cannot be expected.

- 15 In an embodiment the hydrocarbon composition further has a biogenic carbon content, as determined according to EN 16640 (2017), of at least 50 wt-%, preferably at least 70 wt-%, more preferably at least 90 wt-% based on the total weight of carbon (TC) in the jet fuel component. The biocontent is valued especially regulatorily.

- The hydrocarbon composition may be further characterized by typical or common jet fuel qualities. Some samples according to the present disclosure were measured for existent
20 gum value. They were easily below 7 mg/100 ml, even as low as 1 mg/100 ml or <1 mg/100 ml as measured according to IP 540 (2008) air evaporation method.

- According to a second aspect, herein is provided a fuel/fuel component, preferably jet fuel comprising the hydrocarbon composition as defined here. The present hydrocarbon composition has been found to blend well with aviation fuel components currently on the
25 market. Without being bound to a theory, the breadth of the hydrocarbon distribution between carbon numbers C8-C16 is believed to contribute to said good blending. In other words, a composition containing several hydrocarbons of different chain lengths and substituents provides a better blend partner over e.g. an essentially pure compound, for example technical grade n-dodecane. Said hydrocarbon composition provides properties
30 specifically beneficial for aviation fuels for such blends as discussed in detail in relation to said hydrocarbon composition of the first aspect.

According to an embodiment, the fuel or fuel component is a jet fuel containing from 3 vol-% to about 100 vol-% of the present hydrocarbon component, and the balance is petroleum-

based jet fuel. According to some embodiments, the fuel or fuel component is a jet fuel which may contain about at least 3, at least 36, at least 50, at least 56, at least 75, at least 90 vol-% of the present hydrocarbon component, and the balance is petroleum-based jet fuel. According to a preferable embodiment, the fuel or fuel component is a jet fuel which
5 may contain from about 36 vol-% to about 90 vol-% or from about 36 vol-% to about 56 vol-% of the present hydrocarbon component, and the balance is petroleum-based jet fuel. In a specific embodiment the fuel or fuel component is a jet fuel which may contain about 100 vol-% of the present hydrocarbon component. As used here, "about 100 vol-%" refers to a real-life situation, where the fuel or fuel component consists of the present hydrocarbon
10 composition with traces or additives therein.

The additives applicable in the present jet fuel or jet fuel component or in use of the hydrocarbon composition in a jet fuel composition, may be selected from jet fuel approved additives listed in DEF STAN 91-091 specification such as antioxidants or lubricity improvers.

15 According to a third aspect is provided a use of the hydrocarbon composition as defined here as a renewable jet fuel or renewable jet fuel component.

In said use, the present hydrocarbon composition provides for the jet fuel composition excellent properties comprising at least one or more of thermal oxidation stability, JFTOT break point temperature, kinematic viscosity at -20 °C, freezing point, density, and/or
20 biogenic carbon content and blendability to aviation fuel components currently on market.

According to an embodiment of said use, the hydrocarbon composition as defined here may be used in a jet fuel composition for reducing emissions, more specifically for reducing exhaust NO_x emissions, exhaust CO₂ emissions or exhaust particle emissions compared to emissions from petroleum-based jet fuel. The hydrocarbon composition as defined here
25 may be used in a jet fuel composition to reduce at least one of the exhaust NO_x emissions by 10-15 %, CO₂ emissions by 2-5 % or particle (volume) emissions by 81-98 %, compared to emissions from petroleum-based jet fuel. Preferably at least two of said emissions are reduced simultaneously, and more preferably all three, the exhaust NO_x emissions by 10-15 %, CO₂ emissions by 2-5 % and particle (volume) emissions by 81-98 %, are all reduced
30 compared to emissions from petroleum-based jet fuel.

The present hydrocarbon composition is synthetic, hence produced in a refinery through several process steps. In embodiments, where the feedstock for said production is of non-fossil origin, the products thereof may be referred to as renewable products. Preferably the present hydrocarbon composition is a renewable hydrocarbon composition and the

coproduct obtained from said production is renewable diesel.

The stream, also referred to as distillation feed (in the examples referred to as DistFeed), to be distilled into diesel and the present hydrocarbon composition according to the invention can be produced by any suitable method. The description of the production here starts by first providing a paraffinic hydrocarbon feed to the fractionation phase.

In one embodiment n-paraffins are produced from renewable raw material, such as vegetable oil or animal fat, which is subjected to a deoxygenation process for removal of heteroatoms, mainly oxygen from the renewable oil, whereby a n-paraffinic hydrocarbon feed is obtained.

- 10 In a preferred embodiment, the deoxygenation treatment, to which the renewable raw material is subjected, is hydrotreatment. Preferably, the renewable raw material is subjected to hydrodeoxygenation (HDO) which preferably uses an HDO catalyst. Catalytic HDO is the most common way of removing oxygen and has been extensively studied and optimised. However, the present invention is not limited thereto. As the HDO catalyst, an HDO catalyst
- 15 comprising hydrogenation metal supported on a carrier may be used. Examples include an HDO catalyst comprising a hydrogenation metal selected from a group consisting of Pd, Pt, Ni, Co, Mo, Ru, Rh, W or a combination of these. Alumina or silica is suited as a carrier, among others. The hydrodeoxygenation step may, for example, be conducted at a temperature of 100-500 °C and at a pressure of 10-150 bar (absolute).
- 20 In an embodiment, the n-paraffinic hydrocarbon feed is produced through Fischer-Tropsch process starting from gasification of biomass. This synthesis route is generally also called BTL, or biomass to liquid. It is well established in the literature that biomass, such as lignocellulosic material, can be gasified using oxygen or air at a high temperature to yield a gas mixture of hydrogen and carbon monoxide (syngas). After purification of the gas, it can
- 25 be used as feedstock for a Fischer-Tropsch synthesis route in which paraffins are produced from syngas. The Fischer-Tropsch n-paraffins range from gaseous components to waxy paraffins and middle distillate boiling range paraffins can be obtained by distillation from the paraffinic hydrocarbon feed.

- The n-paraffins formed either through hydrotreating of renewable oils or Fischer-Tropsch
- 30 method need to be subjected to an isomerisation treatment. The isomerisation treatment causes branching of hydrocarbon chains, i.e. isomerisation, of the hydrotreated raw material. Branching of hydrocarbon chains improves cold properties, i.e. the isomeric composition formed by the isomerisation treatment has better cold properties compared to the hydrotreated raw material. Better cold properties refer to a lower temperature value of

a freezing point in case of an aviation fuel and a lower temperature value of a cloud point for diesels. The isomeric hydrocarbons, or isomerised paraffins, formed by the isomerisation treatment may have one or more side chains, hence, monobranched or multiple-branched respectively.

- 5 The isomerisation step may be carried out in the presence of an isomerisation catalyst, and optionally in the presence of hydrogen added to the isomerisation process, hence in a process referred to as hydroisomerisation. As used herein, "isomerisation" may preferably refer to hydroisomerisation. Suitable isomerisation catalysts contain a molecular sieve and/or a metal selected from Group VIII of the periodic table and optionally a carrier.
- 10 Preferably, the hydroisomerisation catalyst contains SAPO-11, or SAPO-41, or ZSM-22, or ZSM-23, or ferrierite, and Pt, Pd, or Ni, and Al_2O_3 , or SiO_2 . Typical hydroisomerisation catalysts are, for example, Pt/SAPO-11/ Al_2O_3 , Pt/ZSM-22/ Al_2O_3 , Pt/ZSM-23/ Al_2O_3 , and Pt/SAPO-11/ SiO_2 . The catalysts may be used alone or in combination. The presence of added hydrogen is particularly preferable to reduce catalyst deactivation.
- 15 In a preferred embodiment, the hydroisomerisation catalyst is a noble metal bifunctional catalyst, such as Pt-SAPO and/or Pt-ZSM-catalyst, which is used in combination with hydrogen. The hydroisomerisation step may, for example, be conducted at a temperature of 200-500 °C, preferably 280-400 °C, or 300 °C to 350 °C, and at a pressure of 5 -150 bar, preferably 10 – 130 bar, more preferably 30-100 bar (absolute).
- 20 The isomerisation step may comprise further intermediate steps such as a purification step and/or a fractionation step.

A product obtainable thereof is here referred to as a sequential HDO and hydroisomerisation product.

- 25 As a specific embodiment, as a product from such hydroisomerisation, a paraffinic hydrocarbon feed comprising at least 90 wt-% paraffins of the total weight of the paraffinic hydrocarbon feed, of which paraffins at most 30 wt-% are n-paraffins may be obtained.

As an example, said paraffinic hydrocarbon feed could be characterized by having a T10 temperature of 200 – 270 °C and FBP of 280-320 °C.

- 30 In an embodiment of the present process the paraffinic hydrocarbon feed is obtained from sequential HDO and hydroisomerisation, which is optionally followed by a distillation. Commercially mature processes are available for the sequential HDO and hydroisomerisation. Hence according to this embodiment, the present process is easily integrated thereto for producing the present hydrocarbon composition as a high-quality

product, such as a renewable aviation fuel component and the rest meeting the requirements for renewable diesel.

In an embodiment of the present process the paraffinic hydrocarbon feed is obtained from sequential HDO and hydroisomerisation, further comprising cracking isomerisation, either
5 before or after isomerisation, which is optionally followed by a distillation. It has been found that the cracking isomerisation increases the isomerisation degree efficiently and contributes to desired product characteristics.

In an embodiment of the present process the paraffinic hydrocarbon feed is obtained from sequential HDO and hydroisomerisation, wherein a cracking isomerisation step is
10 performed before the hydroisomerisation. It has been found that the combination of the cracking isomerisation and hydroisomerisation contributes to the yield of desired carbon numbers and branching in products obtainable.

In an embodiment of the present process the paraffinic hydrocarbon feed is obtained from sequential HDO and hydroisomerisation, wherein a cracking isomerisation step is
15 performed after the hydroisomerisation. It has been found that the cracking isomerisation contributes to the branching, producing among others multiple-branched i-paraffins.

Generally hydrocracking, if applied, is operated so that cracking reactions, especially those enhancing the degree of effective cracking, particularly to C8-C16 hydrocarbons, are more abundant than in the hydroisomerisation reactor. Preferably cracking reactions, especially
20 those enhancing the degree of effective cracking, prevail in the hydrocracking reactor, yet generally without excessive cracking and excessive fuel gas formation. Typically, the hydrocracking is conducted at a temperature within a range from 200 °C to 450 °C, preferably from 220 °C to 430 °C, more preferably from 280 °C to 350 °C, a pressure within a range from 0.4 MPa to 8 MPa, preferably from 1 MPa to 7 MPa, a H₂ partial pressure at
25 the inlet of the reactor within a range from 0.4 MPa to 8 MPa, preferably from 1 MPa to 7 MPa, a weight hourly space velocity within a range from 0.1 to 10, preferably from 0.2 to 8, more preferably from 0.4 to 6, even more preferably from 0.5 to 1.5 kg reactor feed per kg catalyst per hour, and a H₂ to reactor feed ratio within a range from 10 to 2000, preferably from 50 to 1000 normal liters H₂ per liter reactor feed.

30 In an embodiment of the present process the isomerised paraffins, also referred to as the paraffinic hydrocarbon feed, formed in the isomerisation process, is fractionated in order to obtain a diesel fuel fraction and a hydrocarbon composition according to the invention. The fractionation can be performed using any suitable method and is not limited to distillation. However, distillation is the most commonly used method for separating various fractions

from hydrocarbon compositions and is also suitable here.

More specifically, a method for producing a hydrocarbon composition as described herein comprises

- 5 - providing a paraffinic hydrocarbon feed to the fractionation phase comprising at least 90 wt-% paraffins of the total weight of the paraffinic hydrocarbon feed, of which paraffins at most 30 wt-% are n-paraffins,
- fractionating the paraffinic hydrocarbon feed to recover the hydrocarbon composition as defined in the foregoing.

10 The feedstock to the method, the paraffinic hydrocarbon feed, may be obtained by steps already discussed in detail,

- providing a renewable feedstock comprising fatty acids and/or derivatives thereof,
- deoxygenating the feedstock to produce paraffins,
- 15 - subjecting the produced paraffins to an isomerisation step to produce isomerised paraffins, and an optional cracking isomerisation, said cracking isomerisation either before or after isomerisation step; wherein the isomerisation is preferably hydroisomerisation; and
- recovering, optionally by product distillation, a fraction to be used as the paraffinic hydrocarbon feed.

20 According to a preferred embodiment, the hydrocarbon composition is obtained as a single fraction from said fractionation comprising one distillation. According to another embodiment, the hydrocarbon composition is obtained as a single fraction from said fractionation comprising two distillations. The residue is preferably recovered as diesel fuel fraction.

25 Considering the production of the feedstock to the method, according to an embodiment, the combined weight of said recovered hydrocarbon composition and said diesel fuel fraction is at least 65 wt-%, at least 70 wt-%, of the renewable feedstock comprising fatty acids and/or derivatives thereof fed to deoxygenation.

30 According to a specific embodiment, from distillation a fraction having a T10 temperature of 200 – 270 °C and FBP of 280-320 °C is recovered to be used as the paraffinic hydrocarbon feed.

In the prior art methods, where a product mainly suitable for use as an aviation fuel has been produced, one or more of its characteristics, specifically one or more of those regulated by standards, has fallen short and hence has necessitated further components for adjustment to meet all requirements.

- 5 Preferably, the hydrocarbon composition, jet fuel component and/or jet fuel meet(s) the current stringent limits for cold properties of fit-for-purpose fuel. One challenge related to production of sustainable jet fuel components has been that it was not possible to produce jet fuel components from renewable oils and fats even in the advanced hydrotreatment processes in as high yields as the corresponding yields of renewable diesel. Hence, an
10 advantage of the present combined production is that also by-products recoverable from jet fuel/jet fuel component production have good market value.

As a fourth aspect, the present invention describes a method for the combined production of high-quality jet fuel component (which in some cases can even be used as neat fuel in aviation) and high-quality winter-grade renewable diesel.

- 15 As shown in the attached examples, the present method enables high yield production of a high-quality hydrocarbon composition suitable as jet fuel or jet fuel component and a high-quality renewable diesel fuel or renewable diesel fuel component simultaneously from the fractionation, preferably distillation. Hence, according to a preferred embodiment, a diesel fuel fraction, preferably a renewable diesel fuel fraction is further recovered from said
20 fractionation. It is advantageous to recover said hydrocarbon composition as a single fraction and said diesel fuel as another single fraction directly from said fractionation. Preferably said diesel fuel fraction is recovered as a residue or bottom product. Even more preferably said hydrocarbon composition suitable as jet fuel or jet fuel component is recovered as a distillate and said diesel fuel fraction is recovered as a bottom product from
25 distillation such that essentially no other products or streams are recovered therefrom.

- According to an embodiment, the combined weight of said recovered hydrocarbon composition and said diesel fuel fraction is at least 80 wt-%, preferably at least 90 wt-%, more preferably at least 98 wt-% of the paraffinic hydrocarbon feed weight fed to fractionation. Recovery of as high as possible combined weight of said recovered
30 hydrocarbon composition and said diesel fuel fraction minimizes losses to other, lower value products.

The recovered diesel fuel fraction was characterized experimentally in example 5, where physico-chemical characteristics of the recovered diesel fuel fraction were determined and compared to a reference sample. The recovered diesel fuel fraction may be characterized

by one or more of characteristics selected from:

- cetane number of at least 74, preferably at least 76, more preferably at least 78, or even at least 80 as determined according to EN 15195-2104;
- cloud point temperature below -28 °C, preferably below -32 °C, more preferably below -36 °C as determined according to ASTM D5773-21;
- density at least 780 kg/m³, preferably at least 783 kg/m³ as determined according to ASTM D4052-22;
- net heat of combustion at least 33 MJ/l, preferably at least 34 MJ/l as determined according to ASTM D4809-18;
- flash point temperature at least 95 °C, preferably at least 115 °C, more preferably at least 130 °C as determined according to IP170-21.

Many of said characteristics are far better than for the current diesel fuel specifications, such as EN15940. When determining the net heat of combustion, the density is measured at 15 °C.

- 15 The present hydrocarbon composition, its suitability for use as a jet fuel component of neat jet fuel and the diesel fuel obtainable as a by-product are next discussed through experimental findings and sample characterisation.

EXAMPLES

- 20 The following examples are provided to better illustrate the claimed invention. They are not to be interpreted as limiting the scope of the invention, which is determined by the claims. To the extent that specific materials are mentioned, it is merely for purposes of illustration and is not intended to limit the invention. One skilled in the art may develop equivalent means or reactants without exercising inventive capacity and without departing from the scope of the invention. It shall be understood that many variations can be made in the
- 25 procedures described herein while remaining within the scope of the present invention. All exemplary materials and parameters used in the examples below are compatible with the present method and products.

Example 1. Production and obtaining of present hydrocarbon composition.

- 30 The hydrocarbon compositions studied herein were recovered from test runs, where several different feeds or cuts were distilled to divide them into the present hydrocarbon composition as the distillate and a diesel component as the residue. Surprisingly both said separated products were of high quality and had desirable product characteristics for respective renewable product categories, namely for aviation fuel (SAF) and diesel fuel.

The feeds for distillation were obtained by sequential HDO and isomerisation, or by sequential HDO, isomerisation, and cracking isomerisation, wherein isomerisation is preferably hydroisomerisation, followed by distillation and optionally second distillation step.

Some feeds for distillation were obtained by subjecting fatty feedstocks to hydrodeoxygenation (HDO) and gas-liquid separation to obtain hydrodeoxygenated feed comprising >95 wt-% paraffins based on the total weight of the paraffinic hydrocarbon feed. Said hydrodeoxygenated feed was further subjected to hydroisomerisation (HI) and/or partly to cracking isomerisation of different severities. Optionally a fraction of the isomerisation effluent or just a bottom fraction, was cracked, followed by degassing or degassing and stabilising the effluent from cracking. From the thus obtained (liquid) effluent at least a middle distillate was recovered as the main product with high yield. The process for producing middle distillate is highly optimised ensuring a high yield for middle distillate in relation to the renewable oil and/or fat as feedstock. Said middle distillate was divided into the present hydrocarbon composition (SAF 1 and SAF 2) and a diesel component by distillation.

Some of the feeds (DistFeed1 and DistFeed2) for distillation were obtained as the main product from sequential HDO and hydroisomerisation (as a middle distillate, yield over 80 wt-% from renewable oil/fat feed). The middle distillate fulfilled the EN 15940 specification, i.e. it can be used for paraffinic diesel fuels. This middle distillate was further distilled into two fractions. The distillate, i.e. present hydrocarbon composition, was obtained with the yield of about 10 wt-% from the distillation feed and it was found to fulfill the specification ASTM D7566-22A Annex A2 requirements for HEFA-SPK (renewable component) and to have an extremely low kinematic viscosity at -40 °C (11.77 mm²/s), which makes it highly interesting as a renewable jet fuel component /a sustainable aviation fuel component and even makes it possible to use as SAF for the neat use in the future. The heavier fraction was obtained with the yield of about 90 wt% from the distillation feed and it still fulfilled the EN 15940 specification. Furthermore, based on certain parameters (such as energy content per volume), it showed improved quality compared to the middle-distillate used as the feedstock for the distillation. All in all, this means that this is a method to produce high quality SAF and renewable diesel with a high (over 80 wt% from renewable oil/fat feed) combined yield. The produced SAF and renewable diesel can both be used as high blending ratio fuel components and even as neat fuel. In addition, it was surprisingly found that the cold properties of the distillation bottom (i.e. the renewable diesel) based on the analysis results of the distillation feed and the distillate (i.e. SAF) were much better than assumed. This was shown and discussed in more detail in Example 7 and Table 10 therein.

The obtained hydrocarbon compositions were renewable due to the starting material (different types of fatty feedstocks) of renewable origin.

- In these experiments a "Synthesis Pilot", a continuous distillation equipment was used for conducting distillations. The column used was 80 mm in diameter and 4m in height, with
- 5 appr. 40-100 theoretical plates. The column also contained structured packing. The distillate rate was roughly 8 to 80 g/min depending on the feedstock. The operational temperature of the bottom heater was 320 °C. The distillation column is suitable for fractionations up to true boiling point (Tbp) of ~560°C. The operational pressure in said equipment can generally range from atmospheric pressure down to 1 mbar.

10 **Example 2. Physico-chemical characteristics of present aviation fuel components.**

- Physico-chemical characteristics were studied for two hydrocarbon compositions (=aviation fuel components) obtained as distillates from fractionation of middle distillate reported in Example 1. The analysed values for Density (kg/m³), Flash point (°C), Kinematic viscosity at -20 °C (mm²/s), Kinematic viscosity at -40 °C (mm²/s), Freezing point (°C), Distillation
- 15 10% (°C), Distillation 50% (°C), Distillation 90% (°C), Distillation FBP (°C), are reported in Table 1 and Table 2.

- The hydrocarbon composition shown in Table 1 was obtained by fractionation from a sequential HDO and hydroisomerisation product that was further subjected to cracking isomerisation. The hydrocarbon composition (SAF1) is the IBP-265 fraction of which the
- 20 lightest 1 wt-% was removed in a separate distillation to get the flash point to meet the specification.

Table 1. Some physico-chemical characteristics for a hydrocarbon composition (SAF1) as compared to the feed (DistFeed1) to distillation.

	Method	DistFeed1	SAF1	ASTM D7566-22A Table 1
Density (kg/m ³)	ASTM D4052-22	776.0	756.0	775-840
Flash point (°C)	IP170-21	47.0	39.5	Min. 38
Viscosity at -20 °C	ASTM D445-21e2	13.85	4.92	Max. 8
Viscosity at -40 °C	ASTM D445-21e2	38.71	10.40	Max. 12
Freezing point (°C)	IP529-22	-40.4	-70.0	Max. -47 (for JET A-1)
Distillation 10% (°C)	ASTM D86-23	222.0	166.4	Max. 205

Distillation 50% (°C)	ASTM D86-23	277.1	221.7	Report
Distillation 90% (°C)	ASTM D86-23	290.3	252.4	Report
Distillation FBP (°C)	ASTM D86-23	294.3	267.2	Max. 300
Aromatics (wt-%)	GCxGC	N.D.	0.1	GCxGC
Weighted average carbon number	GCxGC	N.D.	12.72	GCxGC

In table 1 and in the following tables 2, 3 and 6, "viscosity" refers to the kinematic viscosity at -20 °C and at -40 °C as indicated. The weighted average carbon number is calculated based on carbon number distribution analysed by GCxGC and weight percentage of each carbon number measured thereby. The hydrocarbon composition analysed in Table 2 was

5 obtained from DistFeed2 via fractionation.

Table 2. Some physico-chemical characteristics for a hydrocarbon composition (SAF2) as compared to the feed (DistFeed2) to distillation.

	Method	DistFeed2	SAF2	ASTM D7566-22A Table 1
Density (kg/m ³)	ASTM D4052-22	780.4	758.1	775-840
Flash point (°C)	IP170-21	91.0	55.0	Min. 38
Viscosity at -20 °C	ASTM D445-21e2	19.13	5.40	Max. 8
Viscosity at -40 °C	ASTM D445-21e2	N.D.	11.77	Max. 12
Freezing point (°C)	IP529-22	-29.5	-64.7	Max. -47*
Distillation 10% (°C)	ASTM D86-23	263.3	185.0	Max. 205
Distillation 50% (°C)	ASTM D86-23	281.4	220.6	Report
Distillation 90% (°C)	ASTM D86-23	292.8	247.5	Report
Distillation FBP (°C)	ASTM D86-23	304.2	257.5	Max. 300
Aromatics (wt-%)	GCxGC	N.D.	0.1	GCxGC
Weighted average carbon number	GCxGC	N.D.	12.68	GCxGC

*(for JET A-1)

In addition to the selected ASTM D7566-22A Table 1 properties specified in Tables 1 and 2, both the hydrocarbon compositions met all the requirements of ASTM D7566-22A Annex A2 for paraffinic kerosene obtained from hydroprocessed fatty acid feedstocks. Their kinematic viscosities (both at -20 °C and at -40 °C) and freezing points were notably low.

- 5 From the distillation characteristics in Table 1, Table 2 and Figure 11 it can also be seen that the present aviation fuel component has relatively linear distillation behavior, which is beneficial for example for combustion characteristics.

As to the hydrocarbon composition of the sample in Table 2, the flash point is clearly higher than the required 38 °C, because of the high flash point of the distillation feed (DistFeed2).

- 10 Additionally, even though ASTM D7566-22A Annex A2 for paraffinic kerosene obtained from hydroprocessed fatty feedstocks does not set any requirement for viscosities at sub-zero temperatures, each of the present aviation fuel components reported in Tables 1 and 2 had very low kinematic viscosity at -20 °C, very clearly meeting the ASTM D7566-22A Table 1 requirements for Jet A1 aviation fuel composition, max. 8.0 mm²/s. The above
15 results clearly show that the present hydrocarbon composition could be incorporated in aviation fuel compositions in far higher proportions than typical paraffinic jet fuel components. The present hydrocarbon compositions might be incorporated in aviation fuel compositions in amounts of even over 50 vol-% of the total aviation fuel compositions volume. Depending on the development of jet fuel standards, it could also be speculated
20 that the present hydrocarbon composition could be used as 100 vol-% aviation fuel composition in future.

The improved properties of the present hydrocarbon compositions make them advantageous also for other uses where excellent performance in cold environments is required.

- 25 The present hydrocarbon compositions exhibit exceptionally low freezing points and kinematic viscosities compared to composition corresponding to a typical commercial renewable aviation fuel component, such as presented in comparative example 2. Notably, because the two example hydrocarbon compositions (SAF1 and SAF2) already comply with the ASTM D7566-22A Table 1 requirement for viscosity at -40 °C of maximum 12 mm²/s,
30 their blend ratio is not limited by the viscosity. Instead, their blend ratio is limited by the conventional jet fuel component's aromatics content, making it easy to attain specification compliant blends with 50 vol-% HEFA-SPK, or even up to 68 vol-% HEFA-SPK with suitable conventional jet fuels, as will be shown in Example 4 of this application.

Comparative example 2. Hydrocarbon composition of a commercial SAF-product currently available on market.

5 The same renewable paraffinic feed as in Example 2 (DistFeed1) was produced by hydrodeoxygenation and isomerisation of feedstock mixture of renewable origin, and further directed to a fractionation unit for distillation. In the fractionation unit, the renewable paraffinic product was divided into fractions selecting the conditions for maximizing the weight of the SAF yield. One of the fractions, said SAF, was analysed using various analysis methods the results of which are compiled in Table 3.

Table 3. Properties of the comparative hydrocarbon composition.

Analysis	Method	Unit	Value
Density	ASTM D4052-22	kg/m ³	771.8
Freezing point	IP529-22	°C	-49.5
Flash point	IP170-21	°C	47.0
T10 (°C) cut-off temperature	ASTM D86-23	°C	200.6
T90 (°C) cut-off temperature	ASTM D86-23	°C	279.5
Final boiling point	ASTM D86-23	°C	285.3
Viscosity at -20 °C	ASTM D445-21e2	mm ² /s	11.46
Viscosity at -40 °C	ASTM D445-21e2	mm ² /s	31.10
Aromatics	GCxGC	m-%	0.1
Weighted average carbon number	GCxGC	-	15.0

10 The analysed product in Table 3 fulfills the requirements of HEFA-SPK per ASTM D7566-22A Annex A2 but its freezing point is not exceptionally low. Importantly, even though the product practically does not contain any aromatic components, its blend ratio is limited by the kinematic viscosity at -20 °C and at -40 °C.

15 **Example 3. Hydrocarbon distribution of present hydrocarbon composition.**

Several hydrocarbon compositions obtained experimentally were analysed for their compositions by GCxGC-FID/MS. The results of wt-% n-paraffins, monobranched i-

paraffins, and multiple-branched i-paraffins (di-branched and tri-branched are each given in their respective columns) per carbon number in each sample, as well as content of aromatics and naphthenes, are reported in Table 4 for one exemplary hydrocarbon composition. The results of Table 4 correspond to those presented in figure 3. Several other

5 samples were analysed correspondingly and results thereof presented in figures 1-10. Based on the analysis results reported in said figures, several composition related characteristics were calculated and are reported in Table 5 for the total carbon number range C8-C16, so as to better identify factors possibly contributing to the excellent product properties.

- 10 Table 4. Compositional analysis results (wt-%) by GCxGC-FID/GCxGC-MS per carbon number for an exemplary hydrocarbon composition.

Carbon nro	nP	mono	di-me	tri-me	naphthenes	aromatics	Total
5 - 7	0.04	0.04			0	0	0.08
8	0.37	0.87	0.1		0.07	0	1.41
9	1.14	4.52	1.34		0.27	0.01	7.29
10	1.24	7.52	5.46	0	0.41	0.02	14.65
11	1.1	6.12	6.83	0.17	0.49	0.02	14.73
12	0.65	4.7	7.17	0.64	0.48	0.03	13.66
13	0.51	4.62	6.67	1.16	0.38	0.02	13.36
14	0.17	2.11	7.07	1.9	0.3	0.01	11.56
15	0.03	1.21	6.48	4.45	0.14	0	12.32
16	0	0.21	3.45	6.59	0.02	0	10.27
17 - 30	0	0	0	0.66	0	0	0.66
Total	5.25	31.94	44.58	15.55	2.56	0.12	100

Table 5. Compositional analysis results (wt-%) by GCxGC-FID/GCxGC-MS calculated for carbon number ranges C8-C16 for further exemplary hydrocarbon compositions like the one reported in Table 4.

Sample presented in	C8-C16						weighted average carbon number
	i-paraffins	n + i-paraffins	n-paraffins	i to n ratio	multi-i to n ratio	cyclo-paraffins	
Figure 1	89.45	96.58	7.13	12.55	6.88	1.78	12.72
Figure 2	86.56	96.50	9.94	8.71	3.63	3.09	12.68
Figure 3	91.36	96.57	5.21	17.54	11.40	2.56	12.46
Figure 4	91.13	96.99	5.86	9.69	9.69	2.50	12.45
Figure 5	90.84	96.32	5.48	10.76	10.76	2.91	12.21

- In Tables 4 and 5, i refers to i-paraffins, n to n-paraffins, multi-i to multiple-branched i-paraffins, mono to monobranched i-paraffins, i to n ratio refers to weight ratio of sum of any i-paraffins to any n-paraffins, all within carbon number range from C8 to C16. The weighted average carbon number is calculated based on detailed compositional results taking all carbon numbers and types into account, namely also carbon numbers 1-7 and 17-30 and naphthenes and aromatics, as presented for an exemplary composition in Table 4.
- From Figures 1-10 and from the exemplary composition in Table 4 it can be seen that all samples are highly paraffinic with only very low content of naphthenes and aromatics. Table 4 also shows that the carbon numbers C10, C11, C12 and C13 were most abundant in these samples. None of the carbon numbers (within detection limit) contained only n-paraffins, but for each carbon number at least monobranched, and for most carbon numbers also multiple-branched i-paraffins were detected (or were even predominant). This proves high isomerisation degree throughout the C8-C16 range.

- Generally, higher i-paraffin contents tend to improve cold properties of paraffinic hydrocarbon compositions, while n-paraffins generally have the opposite effect, and particularly longer n-paraffins may even solidify when temperature is decreased. From Table 5 it can be seen that each of the samples had very high C8-C16 i-paraffin contents, 86 wt-% or higher. At the same time each of the samples had notable C8-C16 n-paraffin contents, from 5 to 10 wt-%. Still the freezing points of the analysed samples were < -64°C.

Example 4. Blending.

- Blending properties were studied with different combinations of present hydrocarbon composition variants, conventional fossil jet fuel variants and a comparative commercial

SAF. First a conventional fossil jet fuel (CJF) was blended with both SAF1 (according to the present claims) and with a comparative commercial SAF (CHC) to highlight the differences to prior art solutions. The flow of the examples was designed so that after the first example 4.1, the present hydrocarbon composition of example 4.1 (SAF1) was in Example 4.2
5 blended with another conventional fossil jet fuel to show that the compatibility is not limited to one specific fossil jet fuel. After that, yet further variants were introduced one at the time to address the observations made to one variable only.

Example 4.1 Blending compared to commercially available SAF.

Considering the present hydrocarbon compositions of examples 2 and 3, and the
10 comparative example 2, their blends with conventional jet fuel are limited by different parameters. Table 6 provides characteristics of a conventional jet fuel (CJF), its blends with a comparative commercial SAF (CHC) on one hand and with a present hydrocarbon composition (PHC) on the other to the specification limitations.

Table 6. Conventional jet fuel and its blends with present and comparative hydrocarbon
15 compositions.

Property (unit)	Method	PHC	CHC	CJF	56:44 vol- % PHC : CJF	36:64 vol- % CHC : CJF	ASTM D7566- 22A Table 1 limits
Density (kg/m ³)	ASTM D4052-22	756.0	771.8	804.4	777.3	792.7	775-840
Freezing point (°C)	IP529-22	-70.0	-49.5	-52.1	-53.0	-50.0	Max. -47
Flash point (°C)	IP170-21	39.5	47.0	40.0	39.5	40.0	Min. 38
T10 cut-off T (°C)	ASTM D86- 23	166.4	200.6	167.4	166.4	167.4	Max. 205
T90 cut-off T (°C)	ASTM D86- 23	252.4	279.5	244.2	248.8	256.9	-
Final boiling point (°C)	ASTM D86- 23	267.2	285.3	265.9	267.2	285.3	Max. 300
Viscosity at -20 °C (mm ² /s)	ASTM D445-21e2	4.9	11.5	3.9	4.5	5.59	Max. 8
Viscosity at -40 °C (mm ² /s)	ASTM D445-21e2	10.4	31.1	7.7	9.1	12.03	Max. 12
Aromatics (vol-%)	ASTM D6379-21e1	0.1	0.1	19.0	8.4	12.2	8.4-26.5

*PHC=Present hydrocarbon composition (SAF1 from DistFeed1), CHC=Comparative hydrocarbon composition (Commercial SAF), CJF=Conventional Jet Fuel (Commercial fossil jet)

As can be seen from Table 6, the blend ratio of the present hydrocarbon composition is not limited by its cold viscosity but is instead limited to 56 vol-% by the conventional jet fuel's aromatic content requirements. In other words, the cold viscosity would allow for even higher share of the present hydrocarbon composition in blends. This is surprising, as in the case of comparative hydrocarbon composition, it fails to meet specifications for viscosity at -40 °C already at 36:64 vol-% CHC:CJF blend ratio.

Example 4.2. Blending with further variants.

Further data is provided for present hydrocarbon composition's (from example 2) blend with another conventional jet fuel, and for additional hydrocarbon compositions which properties closely align with present hydrocarbon compositions from examples 2 and 3, and their blends with conventional jet fuels, with an approach similar to example 4.1.

Table 7. Present hydrocarbon composition from example 2, another conventional jet fuel, and their blends with two blend ratios.

Property (unit)	Method	SAF1	CJF2	50:50 vol-% SAF1: CJF2	75:25 vol-% SAF1: CJF2	ASTM D7566-22A Table 1 limits
Density (kg/m ³)	ASTM D4052-22	756.0	801.4	778.7	767.4	775-840
Freezing point (°C)	IP 529-22	-70.0	-54.0	-58.2	-62.4	Max. -47
Flash point (°C)	IP 170-21	39.5	46.0	42.5	41.5	Min. 38
T10 cut-off T (°C)	ASTM D86-23	166.4	170.0	169.5	168.9	Max. 205
T90 cut-off T (°C)	ASTM D86-23	252.4	229.5	245.2	249.1	-
Final boiling point (°C)	ASTM D86-23	267.2	247.0	263.8	264.2	Max. 300
Viscosity at -20 °C (mm ² /s)	ASTM D445-21e2	4.9	3.8	4.2	4.6	Max. 8
Viscosity at -40 °C (mm ² /s)	ASTM D445-21e2	10.4	7.2	8.5	9.4	Max. 12
Aromatics (vol-%)	ASTM D6379-21e1	0.1	17.8	9.0	4.5	8.4-26.5

*SAF1=Present hydrocarbon composition (SAF1 from DistFeed1), CJF2=Conventional Jet Fuel 2 (Commercial fossil jet)

These results demonstrate that present hydrocarbon composition's blend ratio can be increased even above the currently approved 50 vol-% limit. Properties critical for aircraft operation such as freezing point, flash point, distillation properties and viscosities are all within current specification limits for the 75 vol-% blend, whereas density and aromatics content fall below the limits. With another, specifically selected conventional jet fuel even these limits could possibly still be met.

The conventional jet fuel (CJF2) shown in Table 7 was further used in a blend with a hydrocarbon composition according to the present invention (SAF3) whose characteristics align with those presented in examples 2 and 3. These blend results are shown in Table 8.

Table 8. Additional hydrocarbon composition, a conventional jet fuel and their blends with two blend ratios.

Property (unit)	Method	SAF3	CJF 2	75:25 vol-% SAF3 : CJF 2	90:10 vol-% SAF3: CJF 2	ASTM D7566- 22A Table 1 limits
Density (kg/m ³)	ASTM D4052-22	758.4	801.4	769.2	762.7	775-840
Freezing point (°C)	IP 529-22	-50.9	-54.0	-55.4	-53.0	Max. -47
Flash point (°C)	IP 170-21	38.5	46.0	41.5	40.0	Min. 38
T10 cut-off T (°C)	ASTM D86-23	183.3	170.0	179.9	182.5	Max. 205
T90 cut-off T (°C)	ASTM D86-23	244.4	229.5	243.1	243.8	-
Final boiling point (°C)	ASTM D86-23	255.5	247.0	257.2	255.9	Max. 300
Viscosity at -20 °C (mm ² /s)	ASTM D445-21e2	5.6	3.8	4.9	5.3	Max. 8
Viscosity at -40 °C (mm ² /s)	ASTM D445-21e2	12.1	7.2	10.3	11.4	Max. 12
Aromatics (vol-%)	ASTM D6379-21e1	0.1	17.8	4.5	1.9	8.4-26.5

These results demonstrate that while omitting the density and aromatics requirements that can be worked around in aircraft design, the present hydrocarbon composition can be blended into conventional jet fuel even at high 90:10 vol-% blend ratio.

Finally, the SAF3 shown in Table 8 was blended into yet another conventional jet fuel (CJF3), to which another hydrocarbon composition according to present invention (SAF4), whose characteristics align with those presented in examples 2 and 3, was additionally blended in. These fuels and their results are shown in Table 9.

Again, the requirements for present hydrocarbon composition are met, and even at high blend ratios of 50, 75 and even 90 vol-%, the requirements for semisynthetic jet fuel are met for the key properties.

Table 9. Additional hydrocarbon compositions, a conventional jet fuel and their blends with three blend ratios.

Property (unit)	Method	SAF3	SAF4	CJF3	50:50 vol-% SAF3: CJF3	50:50 vol-% SAF4: CJF3	75:25 vol-% SAF3: CJF3	75:25 vol-% SAF4: CJF3	90:10 vol-% SAF3: CJF3	90:10 vol-% SAF4: CJF3	ASTM D7566-22A Table 1 limits
Density (kg/m ³)	ASTM D4052-22	758.4	756.8	801.4	772.7	772.1	765.5	764.5	761.2	759.9	775-840
Freezing point (°C)	IP 529-22	-50.9	-72.8	-54.0	-64.3	-70.8	-58.9	-71.7	-54.3	-72.3	Max. -47
Flash point (°C)	IP 170-21	38.5	41.5	46.0	42.0	44.0	44.0	45.0	45.0	45.5	Min. 38
Viscosity at -20 °C (mm ² /s)	ASTM D445-21e2	5.6	5.2	3.8	3.7	3.5	4.5	4.2	5.1	4.8	Max. 8
Viscosity at -40 °C (mm ² /s)	ASTM D445-21e2	12.1	10.7	7.2	7.0	6.6	9.1	8.4	10.8	9.7	Max. 12
Aromatics (vol-%)	ASTM D6379-21e1	0.1	0.1	17.8	8.3	8.3	4.2	4.2	1.7	1.7	8.4-26.5

Example 5. Physico-chemical characteristics of the renewable diesel fuel obtained as side product.

As explained, the present hydrocarbon compositions suitable as SAF components were recovered from test runs, where several different feeds or cuts were divided by distillation. The surprisingly good quality of said hydrocarbon composition as a SAF component is

discussed in examples 2-4. Further, the diesel cut obtained from the same distillation was also of high quality and had desirable product characteristics for diesel fuel as shown next.

Physico-chemical characteristics were studied for two renewable diesel fuels/components obtained as residues or bottom fractions from distillations of middle distillates as reported in Example 1. The analysed values for Density (kg/m³), Flash point (°C), Cloud point (°C), Cetane number, Distillation IBP (°C), Distillation 50% (°C), Distillation 95% (°C), Net heat of combustion (MJ/l) are reported in Table 10.

Table 10. Some physico-chemical characteristics for renewable diesel fuels/components from different test runs, as compared to a reference renewable middle distillate (DistFeed2) obtained by conventional HDO+HI process.

	Method	Bottom from DistFeed1	Bottom from DistFeed2, 10 %-FBP	Reference DistFeed2	EN 15940 specification
Density (kg/m ³)	ASTM D4052-22	784.5	783.2	780.4	765-800
Flash point (°C)	IP170-21	136.5	134.5	91	> 55
Cloud point (°C)	ASTM D5773-21	-40.3	-32.8	-33.6	<-28 (class 3)
Cetane number	EN 15195-2104	78.4	80.5	73.5	> 70
Distillation IBP (°C)	EN ISO 3405-2019	272.7	264.2	200.7	Report
Distillation 50% (°C)	EN ISO 3405-2019	284.0	284.0	281.4	-
Distillation 95% (°C)	EN ISO 3405-2019	293.9	297.1	296.9	< 360
Net heat of combustion (MJ/l)	ASTM D4809-18	-	34.507	34.396	-

EN 15940 specification covers paraffinic diesel fuel used as such in vehicles, and it defines fuel properties at retail points. Paraffinic diesel is in this context defined as hydrotreated paraffinic renewable diesel fuel and synthetic Fischer-Tropsch products GTL, BTL and Coal-to-Liquid (CTL).

The reference renewable middle distillate, DistFeed2 meets the EN 15940 specification and thus also the distillation bottom fractions described in this invention were compared to that specification, to confirm that the required parameters were met.

Both renewable diesel bottom fractions exhibit higher density, cetane number and flash point compared to the reference renewable middle distillate. Furthermore, the bottom from DistFeed2 has a higher net heat of combustion than the DistFeed2 when measured as MJ per liter.

5 **Example 6. Hydrocarbon composition of the renewable diesel fuel obtained as side product.**

Several renewable diesel fuel samples obtained experimentally were analysed for their compositions by GCxGC-FID/MS in a similar manner as for the hydrocarbon compositions in example 3. The results of wt-% n-paraffins, monobranched i-paraffins, and multiple-
10 branched i-paraffins (di-branched, tri-branched and tetra-branched are each given in their respective columns) per carbon number in each sample, as well as content of aromatics and naphthenes, are reported in Table 11 for one exemplary renewable diesel fuel sample. Several further samples were analysed, but the results are not shown here in detail. Some composition related characteristics calculated based on said samples are reported in Table
15 12 for the total carbon number range C15-C22, so as to better identify factors possibly contributing to the excellent product properties of said renewable diesel fuel samples.

Table 11. Compositional analysis results by GCxGC-FID/GCxGC-MS per carbon number for an exemplary renewable diesel fuel sample.

Sum of w-%	n-paraffins	iso-paraffins	multiple-branched			naphthenes	aromatics	
Carbon number	nP	monobranched	dime	trime	tetra-me	N	Mono-A	Grand Total
5-13	0	0	0	0		0.01	0.01	0.02
14	0.05	0.07	0.03	0	0	0.01	0.01	0.16
15	0.15	1.52	1.1	0.04	0	0.18	0	2.99
16	0.58	6.87	11.63	2.69	0	0.3	0	22.08
17	0.33	2.57	12.55	1.93	0	0.33	0.01	17.72
18	0.65	9.44	29.75	14.83	0	0.26	0.01	54.94
19	0.01	0.13	0.3	0.26	0	0.02	0	0.72
20	0.01	0.17	0.57	0.21	0.03	0.01	0	1
21	0.01	0	0.05	0.03	0	0.01	0	0.09
22	0.01	0.01	0.05	0.12	0	0.01	0	0.2
23	0	0.01	0.01	0	0	0	0	0.02
24	0	0	0.01	0.01	0	0	0	0.02
25-30	0	0.01	0.01	0	0	0.01	0	0.03
Grand total	1.79	20.82	56.07	20.12	0.03	1.15	0.03	100

From the exemplary renewable diesel composition in table 11, it can be seen it contains predominantly multiple-branched i-paraffins. The most typical carbon numbers are C18, followed by C16 and C17.

- 5 Table 12. Compositional analysis results by GCxGC-FID/GCxGC-MS calculated for carbon number ranges C15-C22 for further exemplary renewable diesel fuel samples like the one reported in Table 11.

	sum i-paraffins	n + i-paraffins	n-paraffins	i to n ratio	multi-i to n ratio
Sample 1	97.04	98.83	1.79	54.21	42.58
Sample 2	95.38	98.45	3.07	31.06	18.68
Sample 3	98.05	99.1	1.05	93.38	88.30
Sample 4	98.09	99.21	1.12	87.58	79.04
Sample 5	97.51	98.7	1.19	81.94	76.61

The renewable diesel compositions were highly isomerised and contained especially high contents of multiple-branched i-paraffins. The hydrocarbon distribution and composition as presented in tables 11 and 12 is believed to contribute to the physico-chemical characteristics of renewable diesel fuels/components reported in table 10.

5 Example 7. Cold properties of the present hydrocarbon composition and the renewable diesel as its by-product.

Cold properties for paraffinic compositions can be estimated by calculations. Analysed and calculated cloud points (using linear calculation model for different distillation fractions) for the renewable diesel are presented in table 13.

- 10 Table 13. Cold properties of the present hydrocarbon composition and renewable diesel by the present invention.

Method		unit	SAF2	Diesel, Measured	DistFeed2	Diesel, Calculated
	Yield	wt-%	10.35	89.65		
EN ISO 12185-1996	Density	kg/m ³	758.1	783.2	780.4	783.0
ASTM D5773-21	Cloud point	°C	-67.7	-32.8	-33.6	-29.7
IP529-22	Freezing point	°C	-64.7	-28.1	-29.5	-25.4

Based on their cold properties, distillation characteristics, high paraffin concentration, and very high isomerisation degree, the present hydrocarbon compositions can be expected to have desired properties also for a wide range of other uses than in aviation fuels, such as

- 15 in solvents, in carriers, in dispersant compositions, in demulsifiers, in extractants, in detergents, in degreasing compositions, in cleaners, in thinners, in penetrating oils, in anticorrosion compositions, in multipurpose oils, in metal working fluids, in rolling oils especially for aluminium, in cutting oils, in drilling fluids, in lubricants, in extender oils, in

paint compositions, in coating fluids or pastes, in adhesives, in resins, in varnishes, in printing pastes or inks, in plasticizing oils, in turbine oils, in hydrophobisation compositions, in agriculture, in crop protection fluids, in construction, in concrete demoulding formulations, in electronics, in medical appliances, in feedstocks for industrial conversion processes, preferably in thermal cracking feedstocks and/or in catalytic cracking feedstocks, in compositions for car, electrical, textile, packaging, paper and/or pharmaceutical industry, and/or in manufacture of intermediates therefor.

Example 5. JFTOT and smoke point analyses.

The JFTOT breakpoint refers to Jet Fuel Thermal Oxidation Test and to result thereof. It is given as a temperature with °C as the unit. Improving said break point is understood as raising said temperature. The thermal oxidation stability was experimentally measured by the JFTOT procedure (ASTM D3241-20c). In Test Method D3241, breakpoint is the highest control temperature at which the fuel meets heater tube rating and ΔP specification requirements. However, measurements are conducted up to a practical upper limit to temperatures, namely 380 °C, above which the sample vial starts to melt. Hence, the upper limit is independent from analysis apparatus provider.

JFTOT breakpoint values were determined for two samples (SAF1 and SAF2) reported in the application as filed and two further samples (SAF3 and SAF4), all according to present invention. The results are given in the following table (Table 14) together with measured smoke points to the same samples.

Table 14. Results from JFTOT and smoke point analyses.

sample	analysis @ 340 °C ASTM D3241-20c	analysis @ 360 °C ASTM D3241-20c	exact* smoke point [mm] measured	smoke point [mm] ASTM D1322
SAF1	pass	pass	N.D.	
SAF2	pass	pass	N.D.	
SAF3	pass	pass	54.7*	>45
SAF4	pass	pass	53.0*	>45

*Values this high are outside the calibrated range and therefore it is recommended to give the result as >45 mm.

It can be concluded that all the samples of the hydrocarbon composition according to the present claim meet the requirement of a JFTOT breakpoint equal to or greater than 325 °C. When the temperature was further elevated, to 340 °C, 360 °C and even to 380 °C, the fuel met the heater tube rating and ΔP specification requirements.

Further, the excellent properties are confirmed with the smoke point results exceeding present specification requirements.

Various embodiments have been presented. It should be appreciated that in this document, words comprise, include, and contain are each used as open-ended expressions with no intended exclusivity.

5 The foregoing description has provided by way of non-limiting examples of particular implementations and embodiments a full and informative description of the best mode presently contemplated by the inventors for carrying out the invention. It is however clear to a person skilled in the art that the invention is not restricted to details of the embodiments presented in the foregoing, but that it can be implemented in other embodiments using equivalent means or in different combinations of embodiments without deviating from the characteristics of the invention.

10 Furthermore, some of the features of the afore-disclosed example embodiments may be used to advantage without the corresponding use of other features. As such, the foregoing description shall be considered as merely illustrative of the principles of the present invention, and not in limitation thereof. Hence, the scope of the invention is only restricted by the appended patent claims.

CLAIMS

1. A hydrocarbon composition comprising n-paraffins and i-paraffins, wherein
 - the sum amount of any C8-C16 i-paraffins is from 50 to 94 wt-% of the total hydrocarbon composition weight,
- 5 - said hydrocarbon composition has a kinematic viscosity at -20 °C as determined according to ASTM D445-21e2 within a range from 3.7 to 8 mm²/s, preferably from 3.7 to 5.5 mm²/s, and
- the weighted average carbon number of the hydrocarbons in the hydrocarbon composition is from 12.1 to 14.2.
- 10 2. The hydrocarbon composition according to claim 1, having a JFTOT breakpoint equal to or greater than 325 °C, preferably greater than 360 °C, or even more preferably equal to or greater than 380 °C as determined according to ASTM D3241-20C.
3. The hydrocarbon composition according to claim 1 or 2, wherein the density of the hydrocarbon composition as measured using standard ASTM D4052-22 is from 730-772
- 15 kg/m³, preferably from 750.0 to 772.0 kg/m³, more preferably from 753.0 to 770.0 kg/m³, most preferably from 754.0 to 760.0 kg/m³.
4. The hydrocarbon composition according to any of the preceding claims, wherein the sum amount of any C8-C16 n-paraffins is from 2 to 12 wt-%, preferably from 5 to 11 wt-% of the total hydrocarbon composition weight.
- 20 5. The hydrocarbon composition according to any of the preceding claims, wherein the sum amount of any C8-C16 multiple branched i-paraffins is from 35 to 65 wt-% preferably from 45 to 63 wt-%, more preferably from 55 to 60 wt-% of the total hydrocarbon composition weight.
6. The hydrocarbon composition according to any of the preceding claims, wherein the
- 25 composition has a freezing point as determined according to IP529-22, below -50 °C, below -60 °C, preferably below -64 °C.
7. The hydrocarbon composition according to any of the preceding claims, having a biogenic carbon content, as determined according to EN 16640 (2017), of at least 50 wt-%, preferably at least 70 wt-%, more preferably at least 90 wt-% based on the total weight of carbon (TC)
- 30 in the jet fuel component.
8. A fuel or fuel component comprising a hydrocarbon composition according to any of the

claims 1 - 7, which fuel or fuel component preferably is a jet fuel or a jet fuel component.

9. The fuel or fuel component according to claim 8, wherein the fuel or the fuel component is a jet fuel containing from 3 vol-% to about 100 vol-%, from 3, 36, 50, 56 vol-% to 50, 56, 75, 90 or 100 vol-% and even more preferably from 36 vol-% to 90 vol-% of the hydrocarbon component according to any of the claims 1 – 7 and the balance being petroleum based jet fuel.

10. The fuel or fuel component according to claim 8, wherein the fuel or the fuel component contains about 100 vol-% of the hydrocarbon component according to any of the claims 1 – 7.

11. Use of the hydrocarbon composition of any of claims 1 - 7 as renewable jet fuel or renewable jet fuel component.

12. Use according to claim 11 in a jet fuel composition for improving one or more product properties of the jet fuel composition.

13. Use according to claim 12, wherein said one or more product properties of the jet fuel composition comprise(s) at least one or more of thermal oxidation stability, JFTOT break point temperature, kinematic viscosity at -20 °C, freezing point, density, and/or biogenic carbon content.

14. Use according to claim 13 in a jet fuel composition for reducing at least one of the exhaust NO_x emissions by 10-15 %, CO₂ emissions by 2-5 % or particle (volume) emissions by 81-98 %, compared to emissions from petroleum-based jet fuel.

15. A method for producing a hydrocarbon composition of any of the claims 1 - 7, wherein the method comprises

- providing a paraffinic hydrocarbon feed to the fractionation phase comprising at least 90 wt-% paraffins of the total weight of the paraffinic hydrocarbon feed, of which paraffins at most 30 wt-% are n-paraffins,
- fractionating the paraffinic hydrocarbon feed to recover the hydrocarbon composition according to any of the claims 1 - 7.

16. A method according to claim 15, wherein hydrocarbon composition according to any of the claims 1 - 7 is obtained as a single fraction from said fractionation.

17. A method according to claim 15 or 16, wherein a diesel fuel fraction is further recovered from said fractionation, preferably as a bottoms product.

18. A method according to claim 17, wherein the recovered diesel fuel fraction is characterized by one or more of

- cetane number of at least 74, preferably at least 76, more preferably at least 78, or even at least 80 as determined according to EN 15195-2104;
- 5 • cloud point temperature below -28 °C, preferably below -32 °C, more preferably below -36 °C as determined according to ASTM D5773-21;
- density at least 780 kg/m³, preferably at least 783 kg/m³ as determined according to ASTM D4052-22;
- 10 • net heat of combustion at least 33 MJ/l, preferably at least 34 MJ/l as determined according to ASTM D4809-18;
- flash point temperature at least 95 °C, preferably at least 115 °C, more preferably at least 130 °C as determined according to IP170-21.

19. A method according to any of claims 15 - 18, wherein the paraffinic hydrocarbon feed is obtained by steps of

- 15 - providing a renewable feedstock comprising fatty acids and/or derivatives thereof,
- deoxygenating the feedstock to produce paraffins,
- subjecting the produced paraffins to an isomerisation step to produce isomerised paraffins, and an optional cracking isomerisation, said cracking isomerisation
- 20 either before or after isomerisation step; and
- recovering, optionally by product distillation, a fraction to be used as the paraffinic hydrocarbon feed.

20. A method according to one of claims 17 - 19, wherein the combined weight of said recovered hydrocarbon composition and said diesel fuel fraction is at least 80 wt-%, preferably at least 90 wt-%, more preferably at least 98 wt-% of the paraffinic hydrocarbon feed weight fed to fractionation or method according to claim 19, wherein the combined weight of said recovered hydrocarbon composition and said diesel fuel fraction is at least 65 wt-%, at least 70 wt-%, of the renewable feedstock comprising fatty acids and/or derivatives thereof fed to deoxygenation.

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