

A METHOD FOR PRODUCING TRANSPORTATION FUELS AND COMPONENTS THERE TO

FIELD

The present disclosure relates to a method for producing transportation fuels or components thereto, in particular jet fuel, diesel or components thereto, from a paraffinic feed, in particular to methods comprising hydroisomerization of the paraffinic feed in the presence of a catalyst comprising active metal and EU-2 based zeolite.

BACKGROUND

Transportation fuels, such as avgas, jet fuel, gasoline, and diesel can be produced from various feedstocks including crude oil, coal, plant oils, animal fats, waste and residue oils and fats, municipal waste, waste plastics and even used tires. Moreover, production of transportation fuels starting from carbon dioxide reduction with renewable hydrogen through reverse water gas shift reaction followed by e.g., Fischer-Tropsch reaction for forming the required hydrocarbons has been suggested.

The processes include one or more steps for conversion of the feedstock to a paraffinic feed. The paraffinic feed is typically processed further by e.g., hydrocracking and/or hydroisomerization to achieve the desired properties for the transportation fuels or components thereto.

It is known that the type of transportation fuel can be controlled by the hydroisomerization reaction conditions. For example, EP 2138552B1 discloses a process for converting renewable feedstock to diesel by a hydrotreatment followed by hydroisomerization using catalyst comprising at least one metal of group VIII and/or at least one metal of group VIB and at least one monodimensional 10 MR zeolite molecular sieve selected from ZSM-48 and ZBM-30, alone or in admixture at a temperature ranging from 150 °C and 500 °C.

EP 2275514, in turn, converts renewable feedstock to light fuels by a process comprising deoxygenation of natural fats or derivatives thereof followed by hydrocracking and isomerization steps. The isomerization reaction was performed at a temperature ranging from 100 °C to 500 °C in the presence of a catalyst based on a hydrogen transfer component and an acid component. The hydrogen transfer

component was a transition metal selected from Groups 5-10 of the Periodic Table (IUPAC 1990), preferably selected from Ni, Pd, Pt, Co, Mo, and V, and the most preferable is platinum. The acid component was preferably an inorganic oxide compound having acid sites, more preferably selected from chlorinated alumina and
5 protonated 10- and 12-membered zeolites, even more preferably selected from protonated PSH-3, Beta- and MCM-22 zeolites. Most preferably the acid component is protonated mordenite, protonated beta-zeolite or protonated ZSM-12.

WO2023126565 discloses a method for producing renewable aviation fuel or components thereto from renewable feedstock, wherein the method comprises
10 separate hydrodeoxygenation and hydroisomerization step, wherein the hydroisomerization is catalyzed by a metal impregnated hierarchical ZSM-23.

SUMMARY

The present invention is based on the observation that when a feed including at least 90 wt.-% pretreated liquid paraffins is hydroisomerized using a catalyst
15 comprising an active metal selected from noble metals, nickel, and any combinations thereof and EU-2 zeolite on a support as the hydroisomerization catalyst, the product distribution can be adjusted to produce predominantly jet fuel or components thereto or to produce predominantly diesel or components thereto by the adjustment of hydroisomerization temperature.

20 Accordingly, it is an object of the present invention to provide a method for producing transportation fuel comprising jet fuel, diesel, or components thereto, the method comprising:

- a) providing a pretreated liquid feed including at least 90 wt.-% paraffins;
- b) subjecting the pretreated liquid feed to hydroisomerization reaction at a
25 pressure from 1 bar to 100 bar, preferably from 20 to 100 bar, more preferably from 20 bar to 90 bar, such as from 20 bar to 60 bar, in the presence of a hydrogen flow, and a hydroisomerization catalyst comprising an active metal selected from noble metals, nickel, and any combinations thereof, an EU-2 zeolite, and a support selected from alumina, silica, and
30 alumina-silica, wherein the content of the active metal in the catalyst is from 0.1 wt.-% to 7.0 wt.-%, wherein $\text{SiO}_2/\text{Al}_2\text{O}_3$ molar ratio of the EU-2 zeolite is from 10 to 100, preferably from 15 to 85, such as from 40 to 80, and

adjusting the hydroisomerization reaction temperature between 270 °C and 370 °C to provide a hydroisomerized stream comprising a desired hydroisomerized hydrocarbon composition, wherein

- 5 i. for a weight ratio of hydrocarbons suitable for use as jet fuel or components thereto and hydrocarbons suitable for use as diesel or components thereto to be more than 1, the adjusting is from 330 °C to 370 °C, preferably from 336 °C to 370 °C, more preferably from 336 °C to 360 °C and
- 10 ii. for a weight ratio of hydrocarbons suitable for use as diesel or components thereto and hydrocarbons suitable for use as jet fuel or components thereto to be more than 1, the adjusting is from 270 °C to 324 °C, preferably from 270 °C to 320 °C, more preferably from 280 °C to 320 °C and
- 15 c) recovering from the hydroisomerized stream by separation of the hydrocarbons suitable for use as jet fuel or components thereto or the hydrocarbons suitable for use as diesel or components thereto as a primary product.

It is also an object of the present invention to provide use of a catalyst comprising an active metal selected from noble metals, nickel, and any combinations thereof,
20 an EU-2 zeolite, and a support selected from alumina, silica, and alumina-silica, wherein the content of the active metal in the catalyst is from 0.1 wt.-% to 7.0 wt.-%, and wherein $\text{SiO}_2/\text{Al}_2\text{O}_3$ molar ratio of the EU-2 zeolite is from 10 to 100, preferably from 15 to 85, such as from 40 to 80 in hydroisomerization of liquid paraffinic hydrocarbons at a temperature from 270 °C to 370 °C, at a pressure from
25 1 bar to 100 bar, preferably from 20 to 100 bar, more preferably from 20 bar to 90 bar, such as from 20 bar to 60 bar, under a H_2 flow for adjusting product distribution of the hydroisomerization reaction to produce predominantly diesel or components thereto at 270-324 °C, preferably 270-320 °C, more preferably at 280-320 °C, and to produce predominantly jet fuel or components thereto at 330-370 °C, preferably
30 at 336-370 °C, more preferably at 336-360 °C.

A number of exemplifying and non-limiting embodiments of the invention are described in the accompanied dependent claims.

Various exemplifying and non-limiting embodiments of the invention together with additional objects and advantages thereof will be best understood from the following description of specific exemplifying and non-limiting embodiments when read in connection with the accompanying figures.

- 5 The verbs “to comprise” and “to include” are used in this document as open limitations that neither exclude nor require the existence of also un-recited features. The features recited in dependent claims are mutually freely combinable unless otherwise explicitly stated. Furthermore, it is to be understood that the use of “a” or “an”, i.e., a singular form, throughout this document does not exclude a plurality.

10 LIST OF THE FIGURES

Figure 1 shows an exemplary non-limiting flow chart of the method of the present invention for production of jet fuel or diesel from a liquid paraffinic feed.

- Figure 2 shows exemplary carbon number distributions of the products of hydroisomerization of a liquid paraffinic feed using the EU-2 based catalyst and a commercial catalyst at different hydroisomerization temperatures.
- 15

Figure 3 shows an exemplary product distribution of hydroisomerization of a liquid n-paraffinic feed using the EU-2 based catalyst as the function of hydroisomerization temperature.

- Figure 4 shows an exemplary product distribution of hydroisomerization of paraffinic feed using a commercial reference catalyst as the function of hydroisomerization temperature.
- 20

Figure 5 shows the cloud point of the hydroisomerization product as the function of hydroisomerization reaction temperature.

- Figure 6 shows the pour point (PP) of the hydroisomerization product as the function of hydroisomerization reaction temperature.
- 25

Figure 7 shows the freezing point of the hydroisomerization product as the function of hydroisomerization reaction temperature.

DESCRIPTION

- The present disclosure concerns conversion of a feed including at least 90 wt.-% liquid paraffins and having a suitable impurity profile to transportation fuels or
- 30

components thereto at specified reaction temperatures using a catalyst comprising an active metal selected from noble metals, nickel, and any combinations thereof and EU-2 zeolite on a support as the hydroisomerization catalyst.

The principle of the method is disclosed in the exemplary non-limiting flowchart shown in Figure 1 and it includes the following actions

- 101 provide a pretreated liquid feed including at least 90 wt.-% paraffins;
- 102 select desired product;
- 103 hydroisomerize the feed at a temperature producing predominantly the desired product;
- 10 104 separate the desired product.

In this disclosure jet fuel, i.e., aviation turbine fuel, is a type of aviation fuel designed for use in aircrafts powered by gas-turbine engines. Jet fuel as discussed herein typically contains hydrocarbons with a carbon number range from C8 to C16, dependent on the amounts of n- and i-paraffins and the degree of branching thereof.

15 Because the exact composition of jet fuel varies widely based on the feed and subsequent processing thereof, it is impossible to define jet fuel merely by the carbon number range of the hydrocarbons. Jet fuel is defined as a performance specification rather than as a chemical composition i.e. the product needs to be suitable for use as jet fuel. The range of molecular mass between hydrocarbons is

20 defined by the requirements for the product, such as cloud point or flash point, originating from the type of hydrocarbons present in the blend. A kerosene-type jet fuel typically contains paraffins with carbon number distribution between about 8 and 16.

In this disclosure diesel typically contains hydrocarbons with a carbon number range

25 from C12 to C21, dependent on the amounts of n- and i-paraffins and branching thereof and needs to have required properties rendering it suitable for use as diesel fuel.

It is generally known that alkane and paraffin are synonyms and can be used interchangeably. Isoparaffins (i-paraffins) are branched, non-cyclic paraffins, and

30 normal paraffins (n-paraffins) are unbranched linear paraffins. The term multibranched herein refers to i-paraffins which contain more than one branch, like dibranched, tribranched or tetrabranched i-paraffins, and is as opposed to

monobranched. In the context of this disclosure, the term “paraffin” refers to n-paraffins and/or isoparaffins. Similarly, the term “paraffinic” refers herein to compositions comprising n-paraffins and/or isoparaffins.

The feed needs to be suitable for hydroisomerisation, especially for the catalyst
5 used in the hydroisomerisation. Moreover, the feed needs to be in liquid form at the processing conditions. Typically, paraffinic feeds contain various impurity profiles depending on the origin of the feed and upstream processing needed to render a feedstock into a paraffinic hydrocarbon suitable for hydroisomerisation. By
10 impurities is meant herein any kind of elemental metals, such as alkali metals or alkaline earth metals or transition metals or compounds containing those; compounds containing heteroatoms, such as S, N, O, P, Si, halogens; aromatic compounds; or even excess amount of water and the like, which cannot be included into paraffinic hydrocarbon feed suitable for fuel applications. These impurities are typically removed, or at least their amount is decreased, using various purification
15 or pretreatment methods in various upstream processing steps eventually providing a pretreated paraffinic hydrocarbon feed.

Typically, the feed entering into the hydroisomerisation should not include more than

- 1 w-ppm, preferably not more than 0.5 w-ppm, alkali metal and alkaline earth metal impurities, calculated as elemental alkali and alkaline earth metals;
- 20 • 1 w-ppm, preferably not more than 0.5 w-ppm, other metals, calculated as elemental metals;
- 5 w-ppm, preferably not more than 1 w-ppm, more preferably not more than 0.2 w-ppm, nitrogen containing impurities, calculated as elemental nitrogen;
- 5 w-ppm, such as not more than 1 w-ppm phosphorus containing impurities,
25 calculated as elemental phosphorus;
- 1 w-ppm silicon containing impurities, calculated as elemental silicon;
- 10 w-ppm, preferably not more than 5 w-ppm, more preferably not more than 1 w-ppm, most preferably not more than 0.4 w-ppm sulphur containing impurities, calculated as elemental sulphur;
- 30 • 10 w-ppm, preferably not more than 5 w-ppm chlorine containing impurities, calculated as elemental chlorine.

The impurity amount typically depends on the prior processing of feedstock to isomerization. Starting from e-crude i.e., from CO₂ and H₂ via oligomerization or Fischer-Tropsch route renders the feed to isomerization free from several metal-, sulfur-, or nitrogen-containing impurities, but may include some water, which should
5 be removed, as well. If the feedstock is of biological origin, such as renewable material e.g., animal, plant or fish oils/fats, the amount of metal-, oxygen-, sulfur- or nitrogen-containing impurities may first be needed to be lowered before processing by separate pretreatment methods. The same applies to use of fossil feedstock.

In addition, the feed needs to be in liquid form at the processing conditions. Gasses
10 and vapors, such as water vapor or ammonia, are preferably removed from the feed before directing it into hydroisomerization.

The hydroisomerization is typically performed at a pressure ranging from 1 bar to 100 bar, preferably from 20 to 100 bar, more preferably from 20 bar to 90 bar, such as from 20 bar to 60 bar, in the presence of hydrogen flow. H₂ flow is typically from
15 100 to 800 N-L H₂/L feed (normal liters hydrogen per liter feed), preferably from 200 to 600 N-L H₂/L feed.

The hydroisomerization catalyst used in the method of the present invention comprises an active metal, an EU-2 zeolite, and a support selected from the group consisting of alumina, silica, and alumina-silica. The active metal is selected from
20 noble metals, such as Pt, Pd, Rh, and Ni, and any combinations thereof. The active metal content of the catalyst is from 0.1 wt.-% to 7.0 wt.-%, preferably from 0.1 wt.-% to 5.0 wt.-%. According to an embodiment, the active metal of the catalyst is reduced, preferably under H₂ flow at 360-380 °C and 35-45 bar.

The active metal promotes splitting of hydrogen in the catalyst. The support
25 functions as a diluent for the catalyst system, preferably three component catalyst system, and it finetunes the thermal behavior and provides mechanical robustness for the structure. The EU-2 zeolite determines mainly the isomerization and cracking performance. Activity and selectivity for isomerization and cracking are affected by the other components in this structure.

30 SiO₂/Al₂O₃ molar ratio of the EU-2 zeolite is from 10 to 100, preferably from 15 to 85 such as from 40 to 80, which has a balancing influence on the cracking and/or multibranching performance of the catalyst.

Preferably, the EU-2 zeolite further comprises one or more of the following features:

- o Crystallinity is from 50% to 95%, measured by X-ray diffraction (XRD) according to ASTM D5758-01 (2021).
 - o BET surface area is from 180 m²/g to 450 m²/g, such as from 200 m²/g to 300 m²/g, determined by nitrogen physisorption. A suitable porosity is needed for the active sites of the material to be readily accessible and to enhance the reaction efficiency.
 - o Acidity is from 80 μmol/g to 700 μmol/g, preferably from 150 μmol/g to 500 μmol/g, more preferably from 200 μmol/g to 400 μmol/g, such as from 350 μmol/g to 400 μmol/g measured by pyridine-FTIR method. Similarly, to the silica-alumina ratio the acidity influences the cracking and/or multibranching performance of the catalyst.
 - o Ratio of Brønsted acid sites to Lewis acid sites is from 0.5 to 22, preferably from 5 to 15, measured by the pyridine-FTIR. This allows tuning catalyst activity to balance isomerization/cracking ratio, enhancing cracking of the n-paraffins from the middle position thus favoring the formation of hydrocarbons suitable for use as jet fuel, diesel, or components thereto.
 - o Crystalline zeolite particles are essentially needle-like particles, meaning that the morphology is predominantly needle-like.
- During hydroisomerization n-paraffins are hydrocracked and/or converted to i-paraffins. The catalyst of the present invention was found to provide a higher multibranching tendency than e.g., commercial SAPO-11 based catalysts. Also, the cracking started at a lower temperature, which indicated that this catalyst has potential for the production of jet fuel and renewable diesel with improved cold properties.
- Moreover, cracking into light hydrocarbons (<C₄) can be avoided with the catalyst of the present invention despite a high isomerization temperature, i.e., the amount of cracked product remains in the transportation fuel range and still contains multibranched compounds ensuring the high quality. Other catalysts tend to crack the hydrocarbons, especially the i-paraffins, further down to C₁-C₃ products and enhance a high C loss and thus decreasing the carbon efficiency into the desired products.

According to the present method, the product distribution may be adjusted by performing the hydroisomerization reaction at different temperatures. The possibility to tailor the isomerization product renders the production to be flexible and based on the market demand. This flexibility allows specific production campaigns for renewable products, such as for diesel and for jet fuel and even for avgas and/or naphtha without requiring a different catalyst to be applied, i.e., a catalyst change performed in the reactor. Moreover, the possibility for adjusting the temperature aids in mitigating the effects of the varying feedstock quality over processing.

The use of same catalyst for producing jet fuel and diesel has operational advantages. For example, the use of a single catalyst in a hydroisomerization reactor allows for easier control of reaction temperature, gas and liquid flow distribution, and handling of catalyst deactivation since these parameters are catalyst dependent. Furthermore, using a single catalyst and a single reactor, the production modes between jet fuel and diesel can be changed more easily and in a safer manner than when the use of two different catalysts are needed. Naturally, the use of separate hydroisomerization reactors for producing jet fuel and diesel fuel is avoided also.

The hydroisomerization product distribution comprises mainly hydrocarbons from C5 to C22 which may be separated or fractionated into different products, preferably by distillation. Depending on the demand, fractionations may be made according to the need. The portion of jet fuel range and diesel range hydrocarbons may be varied using the catalyst of the present disclosure by varying the temperature of the isomerization reaction.

For example, increasing the processing temperature increases the yield of jet fuel range hydrocarbons clearly as shown in Table 1.

Table 1.

Processing temperature	JET fuel range hydrocarbon yield (wt.-%)	% increase
315 °C	about 40	0
325 °C	about 50	>60
330 °C	about 55	>70
340 °C	about 70	>80

The catalyst of the present method is able to hydrocrack the hydrocarbons suitable into jet fuel hydrocarbon range without producing an excess amount of light hydrocarbons, such as C1-C3 hydrocarbons. Moreover, the catalyst of the present method provides multibranching for the longer hydrocarbons thus enhancing the lowering of cold properties of the hydrocarbons formed.

The temperature range can be adjusted so that the desired product is the major component of the hydroisomerization reaction i.e., the primary product.

According to an embodiment, the hydroisomerization reaction is performed at a temperature ranging from 330 °C to 370 °C, preferably from 336 °C to 370 °C, more preferably from 336 °C to 360 °C. This temperature range produces predominantly hydrocarbons in the range suitable for use for jet fuel or components thereto, having an initial distillation boiling point at about 106 °C and a final distillation boiling point at about 280 °C, at atmospheric pressure (1 bar (a)). Pressure of the hydroisomerization reaction is from 1 to 100 bar, preferably from 20 to 100 bar, more preferably 20 to 90 bar such as from about 20 bar to 60 bar.

According to another embodiment, the hydroisomerization reaction is performed at a temperature ranging from 270 °C to 324 °C, preferably from 270 °C to 320 °C, more preferably from 280 °C to 320 °C. This temperature range produces predominantly hydrocarbons in the range suitable for use for diesel or components thereto, having initial distillation boiling point at about 170 °C at atmospheric pressure (1 bar (a)) and the final distillation boiling point at about 360 °C at atmospheric pressure (1 bar (a)). Pressure of the hydroisomerization reaction is from 1 to 100 bar, preferably from 20 bar to 100 bar, more preferably from 20 bar to 90 bar, such as from about 20 bar to 60 bar.

In an embodiment the hydroisomerized stream is subjected to a separation step to give rise to

a fraction boiling between 106 °C and 280 °C, at atmospheric pressure (1 bar (a)), thereby recovering jet fuel or components thereto or
a fraction boiling between 170 °C and 360 °C, at atmospheric pressure (1 bar (a)), thereby recovering diesel or components thereto.

Also, other fractions such as a fraction boiling between 36 °C and 135 °C, at atmospheric pressure (1 bar (a)), *i.e.*, avgas or components thereto can be recovered.

5 The separating may comprise one or more of: distilling, fractionating, evaporating, flash-separating, membrane separating, extracting, using extractive-distillation, using chromatography, using molecular sieve adsorbents, using thermal diffusion, complex forming, preferably at least distilling.

Any of the separated fractions may be subjected to one or more further purification and/or fractionation steps. The optional purification and/or fractionation steps or
10 treatments may be selected depending on the intended end use and/or desired degree of purity of the desired fractions.

According to one embodiment the method is directed to produce sustainable aviation fuel (SAF) or components thereto. SAF is an aviation fuel which satisfies criteria focused on environmental, social, and economic "triple-bottom-line"
15 considerations. The sustainable aviation fuel is produced from the paraffinic feed obtained from a renewable feedstock.

To date, few routes for producing sustainable aviation fuel (SAF) have been approved for blending with jet fuel under ASTM D7566 including Fischer-Tropsch hydroprocessed synthesized paraffinic kerosene and synthesized paraffinic
20 kerosene produced from hydroprocessed esters and fatty acids.

The feed to hydroisomerisation may originate from various diverse feedstocks and suitable upgrading processes thereto. The feedstock can be of biological origin, *i.e.*, renewable feedstock, such as from plant oils, fish oils and/or animal fat, typically containing triglycerides, esters of free fatty acids and fatty acids (see *e.g.*,
25 WO2023126562 for detailed feed materials). It can further comprise waste and residues, such as used cooking oil, palm oil mill effluent, acid oils, brown grease, municipal solid waste, etc. or it can originate from recycled material, such as solid or liquid biomass, end-of-life tyres, liquefied organic waste, or residue, etc. The feedstock may further comprise fossil oil or varying mixtures of fossil and renewable
30 oils. It may even originate from e-crude *i.e.*, using different grades of carbon dioxide and hydrogen as starting materials for synthetic hydrocarbons.

The renewable character of carbon-containing compositions, such as feedstocks and products of biological origin, i.e., renewable feedstock and products, can be determined by comparing the ^{14}C -isotope content of the feedstock to the ^{14}C -isotope content in the air in 1950. The ^{14}C -isotope content can be used as evidence of the renewable origin of the feedstock or product. Carbon atoms of renewable material 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-containing compounds derived from biological sources and carbon-containing compounds derived from fossil sources by analyzing the ratio of ^{12}C and ^{14}C isotopes. Thus, a particular ratio of said isotopes can be used to identify and quantify renewable carbon-containing compounds and differentiate those from non-renewable, i.e., fossil carbon-containing compounds. The isotope ratio does not change in the course of chemical reactions. Examples of a suitable method for analyzing the content of carbon from biological sources is ASTM D6866 (2020). An example of how to apply ASTM D6866 to determine the renewable content in fuels is provided in the article of Dijs et al., Radiocarbon, 48(3), 2006, pp 315-323. For the purpose of the present invention, a carbon-containing material, such as a feedstock or product is considered to be of renewable origin if it contains 90% or more modern carbon, such as 100% modern carbon, as measured using ASTM D6866.

As defined herein recycled feedstock or even e-crude may be based on reused and/or recycled renewable carbon from any source available.

The renewable feedstock may include animal and fish oils/fats, plant oils and/or vegetable oils and/or microbial oils typically contain oxygen, sulfur, nitrogen, phosphorus and/or silicon as heteroatoms and metals as major impurities. The resulting hydrocarbons after upgrading by hydrotreatment typically have carbon numbers from C12 to C22, or even C28, depending on the used feedstock, the hydrocarbon distribution peaking around C16-C18.

The oils originating from renewable feedstock are typically pretreated by various methods, such as degumming, bleaching, heat treatments, RBD (refined, bleached, and deodorized), depending on the type and content of heteroatoms and impurities.

If the feedstock contains fossil crude oil, the resulting hydrocarbons typically contain heteroatoms, mainly sulfur and, nitrogen, and metal impurities. Thus, this type of feedstock needs to be pretreated for purification similarly to the renewable feedstocks.

- 5 Synthetic hydrocarbons produced from carbon dioxide and hydrogen, typically via syngas, do not essentially contain any heteroatoms or metal impurities. Therefore, specific pretreatment methods are not necessarily needed. However, depending on the upgrading method the carbon number distribution of the resulting hydrocarbons may be wide, such as from light hydrocarbons, C1-C3, to waxes, C50+.
- 10 Typically, the waste and residue materials contain a wide variety of heteroatomic compounds, which often are more difficult to remove by conventional feedstock pre-treatments typically used for pre-treatment of matrices comprising triacylglycerols. The waste and residue materials may comprise accumulated alkali metals and alkaline earth metals, such as sodium, potassium, calcium, magnesium; other
15 metals such as iron or copper; nitrogen-containing compounds, such as amines and amides; phosphorus-containing compounds, such as phospholipids; silicon-containing compounds, such as siloxanes and polydimethylsiloxanes (PDMS); halides; sulfur-containing compounds etc. depending on the type of residue/waste. These materials are, especially in higher amounts, are typically harmful for the
20 catalyst used in hydrotreatment and/or in isomerization and need to be decreased or removed before entering the feedstock onto the catalysts.

Depending on the level of pre-treatment, fats, oils, and greases may contain high amounts of impurity materials, e.g., about 1-1000 w-ppm (ppm by weight) phosphorus; and about 1-500 w-ppm total metals, mainly sodium, potassium,
25 magnesium, calcium, iron, and copper. Nor is it uncommon that animal fat can contain, e.g., 1000 w-ppm or even higher nitrogen measured as elemental nitrogen.

There are several known methods to remove or decrease the amount of harmful materials and varying purification or pre-treatment methods are commonly applied. In general, any means for purifying the feed may be used.

- 30 Exemplary pre-treatment methods suitable for the present disclosure comprise treating with mineral acids, degumming, treating with hydrogen, heat treating,

deodorizing, washing with water, treating with base, demetallation, distillation, removal of solids, bleaching, and any combinations thereof.

Contaminating metals may be removed from the feedstock, e.g., by treatment with mineral acids. Phosphorus which mostly occurs in the form of phosphates may be removed by degumming. Triglycerides can also be pre-hydrogenated (pre-treated with hydrogen). Besides reducing the amount of oxygen containing compounds (HDO), unsaturation, sulfur, and nitrogen content (HDS, HDN) are reduced. Solid feedstocks such as fats, in turn should be liquified e.g., by heating prior to subjecting to hydrodeoxygenation. Pre-treatment of solid feedstocks may further include one or more of: grinding, agitating, filtering, and sonicating. The feedstock may further be bleached and/or deodorized.

The pre-treatment can be selected from heat treatment optionally followed by evaporation of volatiles; heat treatment with adsorbent (HTA), optionally followed by flash evaporation; degumming; bleaching. According to one embodiment the pre-treatment includes any one of, any combination of, or all of a degumming step, a chemical treating step, a water-wash step, a demetallation step, a bleaching step, a full (or partial) hydrogenation step, an acid gas removal step, and/or a water removal step. The pre-treatment also typically comprises a step of removing impurities from the feedstock, including any suitable removal of solids from a liquid, including filtration, centrifugation, and sedimentation; and removing volatiles from liquid, e.g., by evaporation. In the pre-treatment the feedstock comprising organic material of biological origin, as previously defined, is purified and a purified feedstock is obtained.

In one embodiment the pre-treatment is selected from heat treatment optionally followed by evaporation of volatiles, whereby the feedstock is heated at a temperature of from 80 °C to 325 °C, preferably 180 °C to 300 °C, more preferably 200 °C to 280 °C, in a residence time from 1 to 300 min. The heat treatment can be followed by an evaporation step, where especially silicon and phosphorus containing compounds are removed. An example of heat treatment of a feedstock comprising organic material can be found in WO 2020/016405. Heat treatment can also be followed by filtration as an addition or an alternative to evaporation. When the feedstock comprises brown grease or acidulated soap stock the pre-treatment

comprises typically heat treatment with or without a filter-aid (adsorbent) followed by filtration and possible bleaching.

In one embodiment the pre-treatment is selected from heat treatment with adsorbent (HTA) optionally followed by flash evaporation. HTA as pre-treatment is especially
5 suitable when the feedstock comprises CTO and/or TOP, but HTA is also suitable for other feedstocks. Heat treatment with adsorbent (HTA) can be performed in a temperature from 180 °C to 325 °C, preferably from 200 °C to 300 °C, more preferably from 240 °C to 280 °C, optionally in the presence of an acid. The
10 adsorbent can be selected from alumina silicate, silica gel and mixtures thereof and is typically added in an amount of 0.1 wt.-% to 10 wt.-%, such as 0.5 wt.-%. An example of HTA can be found in WO 2020/016410.

In one embodiment the pre-treatment is selected from bleaching. Bleaching can be conducted by acid addition in an amount of from 500 to 5000 ppm based on feed. The bleaching treatment can be performed in a temperature from 60 °C to 90 °C
15 and including a drying step in 110 °C to 130 °C. The bleaching is finished by a filtration step to remove formed solids and possible filter aids. In one example bleaching includes the following sequence

- (1) acid addition 1000-4000 ppm citric acid (50 wt.-% water) 85 °C, 10 min;
- (2) adsorbent/filter aid addition 0.1–1 wt.-%, 85 °C, 800 mbar, 20 min;
- 20 (3) drying 120 °C, 80 mbar, 25 min;
- (4) filtering 120 °C, 2.5 bar.

Both heat treatment (HT) and heat treatment with adsorbent (HTA) can be performed under pressure, the pressure can be 500 to 5000 kPa. Also, water can be added before or during HT and HTA to a level of up to 5 wt.-%, such as 1-3 wt.-%.
25 % The evaporation e.g., flashing can be performed after HT or HTA or any other pre-treatment stage and can be performed at about 160 °C, such as from 150 °C to 225 °C, in a pressure of 10 to 100 mbar.

In one embodiment the pre-treatment comprises heat treatment (HT) and bleaching.

30 In one embodiment the pre-treatment comprises heat treatment (HT) with alkali addition and bleaching.

In one embodiment the pre-treatment comprises heat treatment with adsorption (HTA) followed by flash (removal of light components comprising Si components etc. by evaporation) and bleaching.

5 In one embodiment the pre-treatment comprises mixing the feedstock with water and metal reactants, subjecting the mixture to hydrothermal purification, wherein heat, pressure, and turbulent flow induce reactions with the inorganic impurities resulting in salt formation. The salts may subsequently be separated and removed from the organic phase of the feedstock.

10 In addition, the pre-treatment may or may not include additional steps such as removal of solids (using technologies such as centrifugation or filtration) before and/or after HT or HTA, water washing, degumming, hydrolysis, distillation, strong acid treatment, 2nd bleaching or any combination of the mentioned methods.

Feedstock suitably purified by pre-treatment prolongs the catalyst life cycle in hydrodeoxygenation and the subsequent hydroisomerization reaction.

15 Pretreated renewable feedstock may be subjected to hydrotreatment for removal of oxygen (hydrodeoxygenation, HDO), sulfur (hydrodesulfurization, HDS), nitrogen (hydrodenitrogenation, HDN), and halogens (hydrodehalogenation HDX). Furthermore, some of the e.g., aromatic compounds and possible double bonds may also be removed by hydrotreatment. There are several ways to hydrotreat
20 feedstock.

In a preferred embodiment, renewable feedstock, comprising animal fats, plant oils, waste and/or residue materials, is first pretreated to a purity level suitable for directing said feedstock to hydrodeoxygenation for removal or depletion of heteroatoms and other impurities using a hydrodeoxygenation catalyst. The
25 hydrodeoxygenation of renewable oxygen-containing hydrocarbons is performed at reaction conditions comprising one or more of

- a. a temperature in the range from 250 °C to 400 °C, preferably from 280 °C to 380 °C, more preferably from 300 °C to 360 °C,
- b. a pressure in the range from 10 bar to 200 bar, preferably from 20 bar to 100
30 bar, more preferably from 20 bar to 80 bar,

- c. a weight hourly space velocity (WHSV) in the range from 0.25 h^{-1} to 3.0 h^{-1} , preferably from 0.5 h^{-1} to 3.0 h^{-1} , more preferably from 0.7 h^{-1} to 2.5 h^{-1} , most preferably from 1.0 h^{-1} to 2.0 h^{-1} , depending on the hydrogen consumption,
- d. a H_2 flow in the range from 350 to 1500 N-L H_2 / L feed, preferably from 350 to 1100 N-L H_2 /L feed, most preferably from 350 to 1000 N-L H_2 /L feed, wherein N-L H_2 /L means normal liters of hydrogen per liter of the feed into the HDO reactor, and
- e. a hydrodeoxygenation catalyst selected from Pd, Pt, Ni, Co, Mo, Ru, Rh, W, or any combination of these on a support, preferably Ni, Co, Mo, and W, on a support.

According to one embodiment the hydrodeoxygenation catalyst is selected from a group consisting of CoMo, NiMo, NiW, and CoNiMo on a support, wherein the support is preferably alumina and/or silica.

According to a particular embodiment the hydrodeoxygenation reaction conditions comprise temperature in the range from 250°C to 400°C , pressure in the range from 20 bar to 80 bar, a WHSV in the range from 0.5 h^{-1} to 3 h^{-1} , and H_2 flow of 350-1500 N-L H_2 /L feed, and a hydrodeoxygenation catalyst.

The hydrodeoxygenation reaction produces a hydrodeoxygenated effluent which is processed further by subjecting the hydrodeoxygenated effluent to a gas-liquid separation thereby producing a gaseous stream and a liquid hydrodeoxygenated effluent including at least 90 wt.-% paraffins.

Thus, a liquid hydrotreated effluent is obtained, comprising at least 90 wt.-% of paraffinic hydrocarbons. This effluent fulfills the purity requirements of the hydroisomerisation feed of the present invention. In an embodiment, the hydrodeoxygenated liquid stream originating the renewable feedstock comprises at least 92 wt.-%, more preferably at least 95 wt.-%, most preferably at least 99 wt.-% paraffins of the total weight of the hydrocarbons. The amount of n-paraffins may be high, preferably more than 85 wt.-%, more preferably more than 90 wt.-%, e.g., such as 95 wt.-%, especially when using NiMo/ Al_2O_3 as the hydrodeoxygenation catalyst for most of the feeds.

Producing synthetic hydrocarbons from carbon dioxide and hydrogen typically involves indirect conversion of the gas into syngas, i.e., a mixture of carbon

monoxide and hydrogen. Syngas can be prepared by a process that converts organic carbonaceous materials at high temperatures ($>700\text{ }^{\circ}\text{C}$), without combustion, with a controlled amount of oxygen and/or steam into a mixture of carbon monoxide and hydrogen with some carbon dioxide from which the syngas is
5 separated. The process is well known in the art.

In an embodiment, syngas is prepared from hydrogen and carbon dioxide by a reverse water gas shift (rWGS) reaction. According to a preferred embodiment, the hydrogen used in the method is green hydrogen generated by renewable energy, such as solar energy to power electrolysis of water and the carbon dioxide is CO_2
10 captured from industrial renewable processes. The processes are well known in the art.

If the syngas includes impurities derived from the feedstock such as carbon dioxide, methane, water, nitrogen, hydrogen sulfide, ammonia, hydrogen chloride, tar, and small particles such as ash and soot, syngas may be purified to render it suitable
15 for hydrocarbon synthesis. The purified syngas has preferably a molar ratio of hydrogen to carbon monoxide between 2.5 to 1 and 0.5 to 1, preferably between 2.1 to 1 and 1.8 to 1, more preferably about 2 to 1.

Syngas is further converted to hydrocarbons using suitable conversion processes, such as oligomerization processes, e.g., Fischer-Tropsch (FT) synthesis, Methanol
20 synthesis (MtJ) or any alternatives thereto. Fischer-Tropsch (FT) and Alcohol-to-Jet (AtJ) pathways are currently accepted by the ASTM D7566 jet fuel standard and allowed for production of aviation fuel.

In an embodiment, syngas is further converted into liquid hydrocarbons using a Fischer-Tropsch (FT) process. Reactions of the FT process occur in the presence
25 of metal catalysts, typically at temperatures of $150\text{--}300\text{ }^{\circ}\text{C}$ and pressures of one to several tens of atmospheres. The process is well known in the art. A typical FT effluent includes at least 50 wt.-% of hydrocarbons boiling above $370\text{ }^{\circ}\text{C}$, at atmospheric pressure, and the effluent typically has paraffinic content of at least 60 wt.-%, aromatics below 1 wt.-%, naphthenic content below 2 wt.-%, nitrogen content
30 below 0.1 wt.-%, and sulfur content below 0.1 wt.-%. Paraffinic hydrocarbons may be purified from the aromatic and naphthenic hydrocarbons. Typically, there is no need for pretreatment to remove the remaining heteroatoms.

In the method of the present invention, a fraction containing at least 90 wt-% of liquid hydrocarbon paraffins are separated from the FT effluent by e.g., distillation and directed to hydroisomerization.

In an embodiment, syngas is converted to alcohol, such as methanol or ethanol,
5 which is further reacted into corresponding olefins. Olefins, such as C2-C4 olefins, may be oligomerized i.e., dimerized, trimerized, tetramerized or co-oligomerized, into desired carbon length olefins using a heterogenous or homogenous catalyst suitable thereto. Typically, the olefins are subsequently hydrogenated into corresponding carbon chain length paraffinic hydrocarbons.

10 The effluent of the refining step may be purified further before directing it to the hydroisomerization. Typically, the purification includes subjecting the refining process effluent to a gas-liquid separation i.e., removing gasses such as carbon monoxide, carbon dioxide, water, possible hydrogen sulfide and ammonia and low boiling hydrocarbons, from the liquid hydrocarbon stream. In the gas-liquid
15 separation the refining process effluent is separated into a gaseous stream and into a liquid stream, which separation may be a stripping step, distillation, or flash.

The obtained feed stream directed to hydroisomerization is mainly in a liquid form.

In an embodiment, the liquid paraffinic hydrocarbon stream is obtained from syngas through FT conversion at 150–300 °C and 1-40 bar in the presence of a Fe or Co
20 based catalyst.

In an embodiment, the liquid paraffinic hydrocarbon stream is obtained from syngas through olefin oligomerization route over an acidic catalyst.

According to another aspect the present invention concerns use of a catalyst comprising an active metal selected from noble metals, nickel, and any
25 combinations thereof, an EU-2 zeolite, and a support selected from alumina, silica, and alumina-silica, wherein $\text{SiO}_2/\text{Al}_2\text{O}_3$ molar ratio of the EU-2 zeolite is from 10 to 100, preferably from 15 to 85, such as from 40 to 80, and wherein the content of the active metal in the catalyst is from 0.1 wt-% to 7.0 wt.-% for hydroisomerization of liquid paraffinic hydrocarbons at a temperature from 270 °C to 370 °C, at a pressure
30 from 1 bar to 100 bar, preferably from 20 to 100 bar, more preferably from 20 bar to 90 bar, such as from 20 bar to 60 bar, under a H_2 flow for adjusting product distribution of the hydroisomerization reaction to produce predominantly diesel or

components thereto at 270-324 °C, preferably 270-320 °C, more preferably at 280-320 °C, and to produce predominantly jet fuel or components thereto at 330-370 °C, preferably at 336-370 °C, more preferably at 336-360 °C.

The H₂ flow is preferably from 100 to 800 N-L H₂/L feed, more preferably from 200 to 600 N-L H₂ /L feed.

Preferably, the EU-2 zeolite further comprises one or more of the following features:

- o crystallinity is from 50% to 95%, measured by X-ray diffraction (XRD) according to ASTM D5758-01 (2021),
- o BET surface area is from 180 m²/g to 450 m²/g, such as from 200 m²/g to 300 m²/g, determined by nitrogen physisorption,
- o acidity is from 80 μmol/g to 700 μmol/g, preferably from 150 μmol/g to 500 μmol/g, more preferably from 200 μmol/g to 400 μmol/g, such as from 350 μmol/g to 400 μmol/g measured by pyridine-FTIR,
- o ratio of Brønsted acid sites to Lewis acid sites is from 0.5 to 20, measured by the pyridine-FTIR, and
- o crystalline zeolite particles are essentially needle-like particles.

EXPERIMENTAL

The physicochemical properties of the hydroisomerization catalyst are presented in Table 2. Commercially available Pt impregnated SAPO-11 based catalyst was used as a reference.

Table 2. Physicochemical properties of the EU-2 based (with 0.5 wt.-% Pt and no support), and a reference catalyst.

Zeolite	Si wt.-%	Al wt.-%	BET/ m ² g ⁻¹	S _{micro} / m ² g ⁻¹	V _{micro} / mLg ⁻¹	Lewis acidity μmol g ⁻¹	Brønsted acidity μmol g ⁻¹
EU-2	37	0.5	220	163	0.07	19	139
ref. catal.	1.8	32	189	29.6	0.01	60	20

Fresh catalysts were tested for isomerization reactions with areal feed originating from pretreatment and hydrodeoxygenation of a mixture of animal fat and plant oils and they were passivated before use. The samples were: (i) EU-2 based zeolite

impregnated with 0.5 wt.% of Pt, with alumina as support; (ii) the reference catalyst.

The used process parameters are summarized below:

- Drying: 125 °C, 8 h, N₂ flow
- Reduction: 370 °C, 2 h, 40 bar, H₂ flow
- 5 • Wetting: 150 °C, 2 h, 40 bar, H₂ flow
- Passivation: 150 °C, 2 h, 40 bar, H₂ flow, together with renewable alkanes and 0.2 wt.-% of tributylamine (TBA)
- Stabilization and reaction: 40 bar, H₂ flow, LHSV 1.4 h⁻¹, H₂/oil ratio 300 N-L/L, 1.5 mL of the catalyst (75-150 µm) was diluted with SiC F100 (106–
- 10 150 µm) in 1:1 volume ratio.

The liquid paraffinic hydrocarbon feed had a density of 758.3 kg/m³ at 50 °C and cloud point of 20 °C.

The renewable alkanes were hydroisomerized using Pt-impregnated commercial catalyst and Pt-impregnated EU-2 based catalyst for the hydroisomerization at

15 different temperatures. The wt.-% yield of fractions suitable for jet fuel, diesel, or components thereto at different hydroisomerization temperatures are collected in table 3.

Table 3

Reference catalyst			
T (°C)	JET fuel	Diesel	ratio: JET fuel/ Diesel
317	36.67	93.91	0.39
321	37.71	94.69	0.40
326	39.88	92.94	0.43
327	41.00	92.39	0.44
330	44.96	91.01	0.49
335	51.94	85.54	0.61
337	49.24	85.09	0.58
340	54.04	83.38	0.65

EU-2			
T (°C)	JET fuel	Diesel	Ratio: JET fuel/ Diesel
315	43.77	85.55	0.51
317	43.87	87.07	0.50
320	42.96	89.52	0.48
325	48.03	83.89	0.57
330	53.87	77.78	0.69
335	62.72	69.15	0.91
337	65.18	61.39	1.06
340	67.98	52.40	1.30

As seen from the table, hydroisomerization with EU-2 based catalyst produces significantly more jet fuel range hydrocarbons, and components thereto than the commercial reference catalyst over the whole hydroisomerization temperature range tested. Furthermore, the hydroisomerization using the commercial reference catalyst produced hydrocarbons suitable for diesel or components thereto as the predominant products whereas EU-2 allowed the selection of the predominant product by adjusting hydroisomerization temperature.

Figure 2 shows the carbon number distribution of hydroisomerization of a paraffinic feed at different temperatures using the commercial reference catalyst and the EU-2 based catalyst of the present invention. As clearly seen the catalyst of the present invention allows tuning the hydroisomerization reaction conditions to favor the formation of hydrocarbons suitable for use as jet fuel of components thereof simply by adjusting the reaction temperature.

Figures 3 and 4 show yields of hydrocarbons boiling at different temperature ranges at atmospheric pressure obtained by hydroisomerization as a function of hydroisomerization temperature using EU-2 based catalyst or the commercial

reference catalyst, respectively. As seen from the figures the product distribution using the reference catalyst was significantly less sensitive to hydroisomerization temperature.

i/n Ratios and the amount of multibranching, for the fraction suitable for jet fuel, diesel, and components thereto when the hydroisomerization reaction was performed at different temperatures and using the commercial hydroisomerization catalyst or EU-2 based catalyst as the catalyst are shown in table 4 and table 5, respectively. Although the products of hydroisomerization reaction obtained using the commercial catalyst had higher i/n ratio than those obtained using EU-2 based catalyst, for fractions suitable for jet over the whole hydroisomerization range tested, the use of EU-2 based catalyst produced more multibranched hydrocarbons suitable for jet fuel or components thereto.

Table 4. i/n ratios (wt.-%/wt.-%) and the amount of multibranching (wt.-%), for the fraction suitable for jet fuel, diesel, and components thereto when the hydroisomerization reaction was performed at different temperatures and using the commercial hydroisomerization catalyst.

T /°C	JET fuel	JET fuel	Diesel	Diesel
	i/n	multibranch	i/n	multibranch
317	10.02	8.98	18.56	35.73
321	12.65	13.02	25.26	47.37
326	15.45	16.87	34.08	54.41
327	19.94	16.55	44.92	52.39
330	19.00	21.39	47.68	61.70
335	18.45	24.76	62.99	67.19
337	18.89	25.49	75.16	66.21

Table 5. i/n ratios (wt.-%/wt.-%) and the amount of multibranching (wt.-%), for the fraction suitable for jet fuel, diesel, and components thereto when the hydroisomerization reaction was performed at different temperatures and using the EU-2 based hydroisomerization catalyst.

T /°C	JET fuel	JET fuel	Diesel	Diesel
	i/n	multibranch	i/n	multibranch
315	6.97	12.44	28.24	47.53
317	9.40	14.08	44.41	50.03

320	9.92	14.42	32.40	54.06
325	11.09	21.64	44.83	64.47
330	13.57	25.64	69.41	64.23
335	11.49	26.60	46.22	44.16
337	12.51	28.72	69.76	51.28

Regarding diesel produced, the i/n ratio and the amount of multibranching was better for a product obtained using the EU-2 based catalyst than the product obtained using the commercial catalyst when the hydroisomerization was performed at temperatures at 330 °C or below.

Figure 5 shows the cloud point of the liquid product samples for the tested catalysts. For all temperature ranges, the EU-2 based zeolite-containing catalyst led to liquid products with lower cloud points than the product obtained with the commercial reference catalyst. From $T > 325$ °C the difference between the cloud points values are very pronounced, which correlates with the C4-C9 formed. At 340 °C, for example, the products from the EU-2 based catalyst had cloud points around -80 °C, close to the detection limit, while the product hydroisomerized with the commercial reference catalyst had cloud points of -40 °C.

Figures 6 and 7 show exemplary pour points (PP) and freezing point of the liquid products, respectively, obtained using the EU-2 zeolite and the commercial reference catalyst as the hydroisomerization catalyst. The data confirmed that the EU-2 based catalyst favored the formation of a liquid product with improved cold properties. For the PP, at 330 °C for example, the products from the EU-2 based catalyst had pour points around -81 °C, close to the detection limit, while the product from the commercial reference catalyst had pour points of -65.8 °C.

CLAIMS

1. A method for producing transportation fuel comprising jet fuel, diesel, or components thereto, the method comprising the following steps:
- a) providing a pretreated liquid feed including at least 90 wt.-% paraffins;
- 5 b) subjecting the feed to hydroisomerization reaction, at a pressure from 1 bar to 100 bar, preferably from 20 to 100 bar, more preferably from 20 bar to 90 bar, such as from 20 bar to 60 bar in the presence of a hydrogen flow, and a hydroisomerization catalyst comprising an active metal selected from noble metals, nickel, and any combinations thereof,
- 10 an EU-2 zeolite, and a support selected from alumina, silica, and alumina-silica, wherein the content of the active metal in the catalyst is from 0.1 wt.-% to 7.0 wt.-%, and wherein $\text{SiO}_2/\text{Al}_2\text{O}_3$ molar ratio of the EU-2 zeolite is from 10 to 100, preferably from 15 to 85, such as from 40 to 80, and
- 15 adjusting the hydroisomerization reaction temperature between 270 °C and 370 °C to provide a desired hydroisomerized hydrocarbon composition, wherein
- i. for a weight ratio of hydrocarbons suitable for use as jet fuel or components thereto and hydrocarbons suitable for use as diesel or
- 20 components thereto to be more than 1, the adjusting is from 330 °C to 370 °C, preferably from 336 °C to 370 °C, more preferably from 336 °C to 360 °C; and
- ii. for a weight ratio of hydrocarbons suitable for use as diesel or components thereto and hydrocarbons suitable for use as jet fuel
- 25 or components thereto to be more than 1, the adjusting is from 270 °C to 324 °C, preferably from 270 °C to 320 °C, more preferably from 280 °C to 320 °C; and
- c) recovering from the desired hydroisomerized stream by separation the hydrocarbons suitable for use as jet fuel or components thereto; or the
- 30 hydrocarbons suitable for use as diesel or component thereto as the primary product.
2. The method according to claim 1, wherein the EU-2 zeolite further comprises one or more of the following features:

- crystallinity is from 50% to 95%, measured by X-ray diffraction (XRD) according to ASTM D5758-01 (2021),
 - BET surface area is from 180 m²/g to 450 m²/g, such as from 200 m²/g to 300 m²/g, determined by nitrogen physisorption,
 - 5 ○ acidity is from 80 μmol/g to 700 μmol/g, preferably from 150 μmol/g to 500 μmol/g, more preferably from 200 μmol/g to 400 μmol/g, such as from 350 μmol/g to 400 μmol/g, measured by pyridine-FTIR,
 - ratio of Brønsted acid sites to Lewis acid sites is from 0.5 to 20, measured by the pyridine-FTIR, and
 - 10 ○ crystalline EU-2 zeolite particles are essentially needle-like particles.
3. The method according to claim 1 or 2, wherein the pretreated liquid feed contains not more than
- 1 w-ppm, preferably not more than 0.5 w-ppm, alkali metal and alkaline earth metal impurities, calculated as elemental alkaline and alkaline earth metals;
 - 15 ● 1 w-ppm, preferably not more than 0.5 w-ppm, other metals, calculated as elemental metals;
 - 5 w-ppm, preferably not more than 1 w-ppm, more preferably not more than 0.2 w-ppm, nitrogen containing impurities, calculated as elemental nitrogen;
 - 20 ● 5 w-ppm, such as not more than 1 w-ppm phosphorus containing impurities, calculated as elemental phosphorus;
 - 1 w-ppm silicon containing impurities, calculated as elemental silicon;
 - 10 w-ppm, preferably not more than 5 w-ppm, more preferably not more than 1 w-ppm, most preferably not more than 0.4 w-ppm sulphur containing impurities, calculated as elemental sulphur;
 - 25 ● 10 w-ppm, preferably not more than 5 w-ppm chlorine containing impurities, calculated as elemental chlorine.
4. The method according to any one of claims 1 to 3, wherein the hydroisomerization temperature is adjusted between 330 °C and 370 °C, preferably between 336 °C and 370 °C, more preferably between 336 °C and 360 °C, thereby producing a hydroisomerized stream, wherein the weight ratio of hydrocarbons suitable for use as jet fuel or component thereto and hydrocarbons suitable for use as diesel or components thereto is more
- 30

than 1 and separating from the hydroisomerized stream at least a fraction boiling from 107 °C to 280 °C, at atmospheric pressure (1bar (a)) thereby recovering jet fuel or components thereto.

- 5 5. The method according to any one of claims 1 to 3, wherein the hydroisomerization temperature is adjusted between 270 °C and 324 °C, preferably between 270 °C and 320 °C, more preferably between 280 °C and 320 °C, thereby producing a hydroisomerized stream wherein the weight ratio of hydrocarbons suitable for use as diesel or component thereto and hydrocarbons suitable for use as jet fuel or components thereto is more than
- 10 1 and separating from the hydroisomerized stream at least a fraction boiling from 170 °C to 360 °C at atmospheric pressure (1 bar (a)) thereby recovering diesel or components thereto.
6. The method according to any one of claims 1 to 5 wherein in step b) H₂ flow is from 100 to 800 N-L H₂/L feed.
- 15 7. The method according to any one of claims 1 to 6, wherein the active metal is platinum, palladium, or rhodium, which is impregnated on the support, and wherein the active metal content of the hydroisomerization catalyst is from 0.4 wt.-% to 0.6 wt.-%, such as about 0.5 wt.-% of the catalyst.
8. The method according to any one of claims 1 to 7, wherein step a) comprises
- 20 i. providing renewable feedstock,
- ii. pretreating the renewable feedstock for reducing the amount of impurities therein not to include: more than 10 w-ppm alkali metal and alkaline earth metal impurities, calculated as elemental alkali metals and alkaline earth metals; more than 10 w-ppm other metals, calculated as elemental metals; more than 1000 w-ppm nitrogen containing impurities, calculated as elemental nitrogen; more than 30 w-ppm phosphorus containing impurities, calculated as elemental phosphorus; more than 5 w-ppm silicon containing impurities, calculated as elemental silicon; to produce a pre-treated renewable feedstock,
- 25 iii. subjecting the pre-treated renewable feedstock to hydrodeoxygenation reaction to produce a hydrodeoxygenated effluent, wherein the hydrodeoxygenation reaction comprises one or more of:
- 30

- a. a temperature in the range from 250 °C to 400 °C, preferably from 260 °C to 380 °C, more preferably from 280 °C to 360 °C, such as from 300 °C to 330 °C,
- b. a pressure in the range from 10 bar to 200 bar, preferably from 20 bar to 100 bar, more preferably from 20 bar to 80 bar,
- c. a WHSV in the range from 0.25 h⁻¹ to 3 h⁻¹, preferably from 0.5 h⁻¹ to 3.0 h⁻¹, more preferably from 0.7 h⁻¹ to 2.5 h⁻¹, most preferably from 1.0 h⁻¹ to 2.0 h⁻¹,
- d. a H₂ flow from 350 to 1500 N-L H₂/L feed, preferably from 350 to 1100 N-L H₂/L feed, more preferably from 350 to 1000 N-L H₂/L feed, and
- e. a hydrodeoxygenation catalyst selected from Pd, Pt, Ni, Co, Mo, Ru, Rh, and W or any combination thereof, on a support, to produce hydrodeoxygenated stream, and
- iv. subjecting the hydrodeoxygenated stream to a gas-liquid separation thereby producing a gaseous stream and the pretreated liquid feed including at least 90 wt.-% paraffins.
9. The method according to claim 8, wherein the hydrodeoxygenated stream comprises at least 92 wt.-%, preferably at least 95 wt.-%, more preferably at least 99 wt.-% paraffins based on total weight of hydrocarbon products.
10. The method according to any one of claims 1 to 7, wherein step a) comprises
- i. providing a feedstock comprising CO₂ and H₂;
- ii. converting the feedstock to syngas;
- iii. upgrading the syngas into hydrocarbons by oligomerization, preferably by Fischer-Tropsch synthesis or methanol synthesis, to produce an upgrading effluent,
- iv. subjecting the upgrading effluent to gas-liquid separation to produce a gaseous stream and liquid effluent; and
- v. separating the feed including at least 90 wt.-% paraffins from the liquid effluent.
11. Use of a catalyst, comprising an active metal selected from noble metals, nickel, and any combinations thereof, an EU-2 zeolite, and a support selected from alumina, silica, and alumina-silica, wherein the content of the active metal in the catalyst is from 0.1 wt.-% to 7.0 wt.-%, SiO₂/Al₂O₃ molar ratio of the EU-2 zeolite is from 10 to 100, preferably from 15 to 85, such as

- from 40 to 80 in hydroisomerization of liquid paraffinic hydrocarbons at a temperature from 270 °C to 370 °C, at a pressure from 1 bar to 100 bar, preferably from 20 bar to 100 bar, more preferably from 20 bar to 90 bar, such as from 20 bar to 60 bar, under a H₂ flow for adjusting product distribution of the hydroisomerization reaction to produce predominantly diesel or components thereto at 270-324 °C, preferably at 270-320 °C, more preferably at 280-320 °C, and to produce predominantly jet fuel or components thereto at 330-370 °C, preferably at 336-370 °C, more preferably at 336-360 °C.
- 5
- 10 12. The use according to claim 11, wherein the EU-2 zeolite further comprises one or more of the following features:
- o crystallinity is from 50% to 95%, measured by X-ray diffraction (XRD) according to ASTM D5758-01 (2021),
 - o BET surface area is from 180 m²/g to 450 m²/g, such as from 200 m²/g to 300 m²/g, determined by nitrogen physisorption,
 - 15 o acidity is from 80 μmol/g to 700 μmol/g, preferably from 150 μmol/g to 500 μmol/g, more preferably from 200 μmol/g to 400 μmol/g, such as from 350 μmol/g to 400 μmol/g, measured by pyridine-FTIR,
 - o ratio of Brønsted acid sites to Lewis acid sites is from 0.5 to 20, measured by the pyridine-FTIR, and
 - 20 o crystalline EU-2 zeolite particles are essentially needle-like particles.
13. The use according to claim 11 or 12, wherein the H₂ flow is from 100 to 800 N-L H₂/L feed, preferably from 200 to 600 N-L H₂/L feed.