Title: Method for production of aviation fuel

Conversion of renewables in hydroprocessing has so far been focused on making diesel, since the paraffins corresponding to the typical fatty acids of biological materials such as vegetable oils and animal fats (C14, C16 and C18) typical boil from 250°C to 320°C, corresponding well with typical diesel products boiling from 150°C to 380°C. Jet fuel products require a boiling range of 120ºC to 300ºC or 310°C, which means that the heavy part of a paraffins from renewable feedstocks needs to be converted into lighter materials to produce only jet fuel. A further challenge in the production of jet fuel from renewables is the discovery of a surprisingly high production of aromatics, during hydrotreatment of renewable feedstocks. The present disclosure relates to a process having a high yield of renewable jet fuel meeting typical product requirements by converting the heavy material to lighter material and by limiting the amount of aromatics in the product.

Summary

In an aspect of the present disclosure, there is provided a process for production of a hydrocarbon fraction suitable for use as jet fuel ~~(80, 224)~~ from an oxygenate feedstock ~~(2, 202)~~, comprising the steps of

a. combining the feedstock ~~(2, 202)~~ with an amount of a hydrocracked intermediate product ~~(14, 206)~~ to form a combined feedstock ~~(6, 204)~~, directing the combined feedstock ~~(6, 204)~~ to contact a material catalytically active in hydrodeoxygenation (HDO) under hydrodeoxygenation conditions to provide a hydrodeoxygenated intermediate product ~~(22, 212)~~,

b. defining a fractionation boiling point, fractionating said hydrodeoxygenated intermediate product ~~(22, 212)~~ in at least two fractions, including a first fraction ~~(80, 224)~~ of which at least 90% boils below said~~a~~ defined fractionation boiling point and a second fraction ~~(72, 226)~~ of which at least 90% boils above said defined fractionation boiling point,

c. directing at least an amount of said second fraction ~~(72, 226)~~ to contact a material catalytically active in hydrocracking (HDC) under hydrocracking conditions to provide the hydrocracked intermediate product ~~(14, 206)~~,

d. directing at least an amount of said first fraction to contact a material catalytically active in isomerization (ISOM), comprising one or more elemental noble metals, a molecular sieve and an amorphous refractory support, under isomerization conditions,

e. providing said first fraction as said hydrocarbon fraction suitable for use as jet fuel.

In another aspect of the present disclosure, there is provided a process plant for production of a hydrocarbon fraction ~~(80, 224)~~ from an oxygenate feedstock ~~(2, 202)~~, said process plant comprising a hydrodeoxygenation section (HDO), a hydrocracking section (HDC) and a fractionation section (FRAC), said process plant being configured for

a. directing the feedstock ~~(2, 202)~~ and an amount of a hydrocracked feedstock ~~intermediate product (14, 206)~~ to the hydrodeoxygenation section (HDO) to provide a hydrodeoxygenated intermediate product ~~(22, 212)~~,

b. separating the hydrodeoxygenated intermediate product ~~(22, 212)~~ in said fractionation section (FRAC) to provide at least two fractions, including a low boiling product fraction ~~(80, 224)~~ and a high boiling product fraction ~~(68, 226)~~,

c. directing at least an amount of the high boiling product fraction ~~(68, 226)~~ to the hydrocracking section (HDC) to provide said ~~a~~ hydrocracked intermediate product ~~(14, 206),~~

~~d. directing at least an amount of said hydrocracked intermediate product (14, 206) as said further feedstock~~.

Description

It is known to produce jet fuel from renewable feedstocks by co-producing some jet fuel in a unit designed for making diesel. However, there is an interest in making a full conversion from renewable feedstocks boiling mainly in the diesel range to jet fuel products, which requires significant conversion.

The standard controlling the quality of jet fuel originating from hydroprocessed oxygenates such as esters and fatty acids is ASTM D7566, A2.1, which inter alia specifies the boiling point curve and composition. Most of these properties can be easily met by hydrotreating and fractionation. However, special care need to be taken to meet the freezing point (FP) requirement of max -40°C and the total aromatics content of max 0.5wt%. In addition, the standard requires an amount of low boiling product by requiring T_{10}, i.e. the temperatures at which 10% has been distilled according to ASTM D86, to be below 205°C. The final boiling point (FBP) is specified as 300ºC, according to ASTM D86, which means that all material distilling above 300ºC according to ASTM D86 needs to be converted into lighter components to fall into the jet fuel range.

Claims:

1. A process for production of a hydrocarbon fraction suitable for use as jet fuel ~~(80,224)~~ from an oxygenate feedstock ~~(2,202)~~, comprising the steps of
    a. combining the feedstock ~~(2,202)~~ with an amount of a hydrocracked intermediate product ~~(14,206)~~ to form a combined feedstock ~~(6,204)~~, directing the combined feedstock ~~(6,204)~~ to contact a material catalytically active in hydrodeoxygenation (HDO) under hydrodeoxygenation conditions to provide a hydrodeoxygenated intermediate product ~~(22,212)~~,
    b. defining a fractionation boiling point, fractionating said hydrodeoxygenated intermediate product ~~(22,212)~~ in at least two fractions, including a first fraction ~~(80,224)~~ of which at least 90% boils below ~~a~~ said defined fractionation boiling point and a second fraction ~~(72,226)~~ of which at least 90% boils above said defined fractionation boiling point,
    c. directing at least an amount of said second fraction ~~(72,226)~~ to contact a material catalytically active in hydrocracking (HDC) under hydrocracking conditions to provide the hydrocracked intermediate product ~~(14,206)~~,
    d. directing at least an amount of said first fraction to contact a material catalytically active in isomerization (ISOM), comprising one or more elemental noble metals, a molecular sieve and an amorphous refractory support, under isomerization conditions,
    e. providing said first fraction as said hydrocarbon fraction suitable for use as jet fuel.

2. The process according to claim 1 wherein step b comprises separating the hydrocracked intermediate product ~~(22, 212)~~ according to boiling point, to provide a hydrocracked intermediate jet product ~~(80, 224)~~ having T10 above 205°C and final boiling point below 310°C according to ASTM D86.

3. The process according to claim 1 or 2, wherein the total volume of hydrogen sulfide relative to the volume of molecular hydrogen in the gas phase of the total stream ~~(4,204)~~ directed to contact the material catalytically active in hydrodeoxygenation is at least 50 ppm_v, 100 ppm_v or 200 ppm_v, possibly originating from an added stream comprising one or more sulfur compounds, such as dimethyl disulfide or fossil fuels.

4. The process according to claim 1, 2 or 3 wherein said feedstock ~~(2,202)~~ comprises at least 50%wt triglycerides or fatty acids.

5. The process according to claim 1, 2, 3 or 4, wherein hydrodeoxygenation conditions involve a temperature in the interval 250-400°C, a pressure in the interval 30-150 Bar, and a liquid hourly space velocity (LHSV) in the interval 0.1-2 and wherein the material catalytically active in hydrodeoxygenation comprises molybdenum or possibly tungsten, optionally in combination with nickel and/or cobalt, supported on a carrier comprising one or more refractory oxides, such as alumina, silica or titania.

6. The process according to claim 1, 2, 3, 4 or 5 , wherein hydrocracking conditions involve a temperature in the interval 250-400°C, a pressure in the interval 30-150 Bar, and a liquid hourly space velocity (LHSV) in the interval 0.5-4, optionally together with intermediate cooling by quenching with cold hydrogen, feed or product and wherein the material catalytically active in hydrocracking comprises (a) one or more active metals taken from the group platinum, palladium, nickel, cobalt, tungsten and molybdenum, (b) an acidic support taken from the group of a molecular sieve showing high cracking activity, and having a topology such as MFI, BEA and FAU and amorphous acidic oxides and (c) a refractory support, such as alumina, silica or titania, or combinations thereof.

7. The process according to claim 1, 2, 3, 4, 5 or 6 wherein the process conditions are selected such that the conversion, defined as the difference in the amount of material boiling above 310ºC in said hydrocracked intermediate product ~~(14,206)~~ and the amount of material boiling above 310ºC in said second fraction ~~(72,226)~~, relative to the amount of material boiling above 310ºC in said second fraction ~~(72,226)~~, is above 20%, 50% or 80%.

8. The process according to claim 1, 2, 3, 4, 5, 6 or 7 wherein at least an amount of said first fraction ~~(80,224)~~ is directed to contact a material catalytically active in hydrodearomatization (HDA) under hydrodearomatization conditions to provide a hydrodearomatized product ~~(86,218)~~ comprising less than 1 wt/wt%, 0.5 wt/wt% or

0.1 wt/wt%, calculated by total mass of aromatic molecules relative to all hydrocarbons in the stream.

9. The process according to claim 8, wherein hydrodearomatization conditions involve a temperature in the interval 200-350°C, a pressure in the interval 20-100 Bar, and a liquid hourly space velocity (LHSV) in the interval 0.5-8 and wherein said material catalytically active in hydrodearomatization comprises an active metal taken from the group comprising platinum, palladium, nickel, cobalt, tungsten and molybdenum, preferably one or more elemental noble metals such as platinum or palladium and a refractory support, preferably amorphous silica-alumina, alumina, silica or titania, or combinations thereof.

10. The process according to claim 8 or 9 wherein a hydrogen rich stream ~~(84)~~ comprising at least 90 vol/vol% hydrogen is directed to contact the material catalytically active in hydrodearomatization (HDA).

~~11. The process according to claim 1, 2, 3, 4, 5, 6, 7, 8, 9 or 10, wherein at least an amount of said first fraction or said hydrodearomatized product is directed to contact a material catalytically active in isomerization (ISOM) under isomerization conditions.~~

~~12~~11. The process according to claim 1, 2, 3, 4, 5, 6, 7, 8, 9, or 10 ~~or 11~~, wherein isomerization conditions involves a temperature in the interval 250-350°C, a pressure in the interval 20-100 Bar, and a liquid hourly space velocity (LHSV) in the interval 0.5-8 and wherein the material catalytically active in isomerization comprises an active metal taken from the group comprising platinum, palladium, nickel, cobalt, tungsten and molybdenum, preferably one or more elemental noble metals such as platinum or palladium, an acidic support preferably a molecular sieve, more preferably having a topology taken from the group comprising MOR, FER, MRE, MWW, AEL, TON and MTT and an amorphous refractory support comprising one or more oxides taken from the group comprising alumina, silica and titania.

~~13~~12. The process according to claim 1, 2, 3, 4, 5, 6, 7, 8, 9, or 11 ~~or 12~~ wherein said first fraction or the ~~treated~~ hydrodearomatized product ~~(86)~~ is directed to a gas/liquid separator (SEP4) to provide a second stage gaseous fraction ~~(78)~~ and a treated intermediate jet product ~~(88)~~ which is directed to a further means of separation (STAB), to provide said hydrocarbon fraction suitable for use as a jet fuel ~~(96)~~ and a treated product off gas ~~(98)~~.

~~14~~13. A process plant for production of a hydrocarbon fraction ~~(80, 224)~~ from an oxygenate feedstock ~~(2, 202)~~, said process plant comprising a hydrodeoxygenation section (HDO), a hydrocracking section (HDC) and a fractionation section (FRAC), said process plant being configured for

a. directing the feedstock ~~(2, 202)~~ and an amount of a hydrocracked ~~intermediate product~~feedstock ~~(14, 206)~~ to the hydrodeoxygenation section (HDO) to provide a hydrodeoxygenated intermediate product ~~(22, 212)~~,
b. separating the hydrodeoxygenated intermediate product ~~(22, 212)~~ in said fractionation section (FRAC) to provide at least two fractions, including a low boiling product fraction ~~(80, 224)~~ and a high boiling product fraction ~~(68, 226)~~,
c. directing at least an amount of the high boiling product fraction ~~(68, 226)~~ to the hydrocracking section (HDC) to provide ~~a~~ said hydrocracked intermediate product ~~(14, 206),~~
~~d. directing at least an amount of said hydrocracked intermediate product (14, 206) as said further feedstock~~.