

Claims

1. A method for producing renewable base oil fulfilling the API Group III base oil specifications, having ≥ 90 wt% saturated hydrocarbons, ≤ 0.03 wt% sulfur and a viscosity index of ≥ 120 , and renewable fuel components from a feedstock of biological origin, **characterized** in that the method comprises the steps of
- 5 a) providing a feedstock comprising free fatty acids and glycerides, preferably originating from waste and residue materials,
- b) separating the feedstock to at least two effluent streams comprising
- 10 (i) a first effluent stream comprising free fatty acids,
- (ii) a second effluent stream comprising glycerides,
- c) hydrolyzing the glycerides of the second effluent stream to provide free fatty acids and glycerol, and
- d) recycling the free fatty acids obtained in step c) to the separating step
- 15 b).
2. The method according to claim 1, wherein the first effluent stream is a set of first effluent streams comprising
- (iii) a fatty acid fraction wherein the carbon chain length is C12-C16,
- (iv) an optional fatty acid fraction wherein the carbon chain length is at
- 20 least C17, and
- (v) an optional fatty acid fraction wherein the carbon chain length is C11 or less.
3. The method according to claim 2, further comprising a step
- e) subjecting at least part or all of the (iii) fatty acid fraction of the first effluent
- 25 stream to ketonisation reaction at a temperature in the range from 100 to 500 °C, preferably from 300 to 400 °C, and at a pressure in the range from atmospheric pressure to 10 MPa, preferably from 0.5 to 3 MPa, in the presence of a ketonisation catalyst to produce a ketone containing stream.
4. The method according to claim 3, wherein the ketonisation catalyst is a metal
- 30 oxide catalyst, and the metal of the metal oxide catalyst is preferably selected from one or more of Mg, K, Sc, Y, La, Ce, Fe, Co, Ni, Cu, Zn, Sr, Y, Zr, Mo,

Rh, Sn, Ti, Mn, Mg, Ca, Zr, more preferably Ti containing metal oxide catalyst, most preferably TiO₂ containing catalyst.

5. The method according to claim 3 or 4, wherein the ketonisation reaction is performed in presence of a gas in the range from 0.1-1.5 gas/feed ratio (w/w), the gas being selected from one or more of: CO₂, H₂, N₂, CH₄, H₂O, preferably CO₂.
6. The method according to any one of claims 3-5, further comprising step f) subjecting part of the ketone containing stream of step e) to hydrodeoxygenation reaction, to yield n-paraffin containing stream.
7. The method according to any one of claims 3-5, further comprising step g) subjecting at least part of the ketone containing stream of step e) to hydrodeoxygenation reaction and to hydroisomerisation reaction, simultaneously or in sequence, to yield a renewable base oil containing stream.
8. The method according claim 7, wherein the subjecting to hydrodeoxygenation reaction and to hydroisomerisation reaction is in sequence, and wherein the step g) further comprises separating liquids from gases between the hydrodeoxygenation and the hydroisomerisation.
9. The method according to claim any one of claims 6-8, wherein the hydrodeoxygenation reaction is performed at a temperature in the range from 100 to 500 °C, preferably from 250 to 400 °C; a pressure in the range from atmospheric pressure to 20 MPa, preferably from 0.2 to 8 MPa; preferably a WHSV in the range from 0.5 to 3 h⁻¹, and preferably a H₂ flow of 350-900 nl H₂/l feed, in the presence of a hydrodeoxygenation catalyst.
10. The method according to claim 9, wherein the hydrodeoxygenation catalyst is selected from Pd, Pt, Ni, CoMo, NiMo, NiW, CoNiMo on a support, wherein the support is preferably alumina and/or silica.
11. The method according to any one of claims 7 to 10, wherein the hydroisomerisation reaction is performed at a temperature in range from 200 to 450 °C, preferably from 250 to 400 °C; a pressure in range from 1 to 15

MPa, preferably from 1 to 6 MPa; preferably a WHSV in range from 0.5 – 3 h⁻¹, and preferably a H₂ flow of 100-800 nl H₂/l feed, in presence of an hydroisomerisation catalyst.

- 5 12. The method according to claim 11, wherein the hydroisomerisation catalyst comprises a Group VIII metal, preferably Pd, Pt or Ni and a molecular sieve, optionally on an alumina and/or silica support.
- 10 13. The method according to any one of claims 7-12, comprising subjecting the renewable base oil containing stream to separation, preferably by distillation, to yield renewable base oil, and preferably also one or more fuel components selected from renewable liquefied petroleum gas, renewable naphtha, renewable jet fuel and/or renewable diesel.
- 15 14. The method according to any one of claims 1-13, comprising treating the glycerol of step c) with hydrogen in the presence of catalyst, preferably Pt modified ZrO₂, at elevated temperature, preferably from 150 to 350 °C, more preferably from 150 to 270 °C, to produce renewable propanol, and optionally renewable propane diol.
- 20 15. The method according to claim 2, wherein the (iv) fatty acid fraction is converted to oleochemicals.
16. The method according to claim 2, wherein the (v) fatty acid fraction is converted to oleochemicals.
17. The method according to any one of claims 3-5, wherein part of the ketone containing stream of step e) is converted to oleochemicals.
- 25 18. The method according to claim 2 wherein the first effluent stream comprises the (iv) fatty acid fraction, the method further comprising subjecting at least part of the (iv) fatty acid fraction to ketonisation reaction at a temperature in the range from 100 to 500 °C, preferably from 300 to 400 °C, and at a pressure in the range from atmospheric pressure to 10 MPa, preferably from 0.5 to 3 MPa, in the presence of a ketonisation catalyst to produce a stream comprising ketones derived from the (iv) fatty acid fraction and converting at

least part of the ketones derived from the (iv) fatty acid fraction to oleochemicals.

19. The method according to claim 2 wherein the first effluent stream comprises the (v) fatty acid fraction, the method further comprising subjecting at least
5 part of the (v) fatty acid fraction to ketonisation reaction at a temperature in the range from 100 to 500 °C, preferably from 300 to 400 °C, and at a pressure in the range from atmospheric pressure to 10 MPa, preferably from 0.5 to 3 MPa, in the presence of a ketonisation catalyst to produce a stream comprising ketones derived from the (v) fatty acid fraction and converting at
10 least part of the ketones derived from the (v) fatty acid fraction to oleochemicals.
20. The method according to claim 18 or 19, wherein the ketonisation catalyst is a metal oxide catalyst, and the metal of the metal oxide catalyst is preferably selected from one or more of Mg, K, Sc, Y, La, Ce, Fe, Co, Ni, Cu, Zn, Sr, Y,
15 Zr, Mo, Rh, Sn, Ti, Mn, Mg, Ca, Zr, more preferably Ti containing metal oxide catalyst, most preferably TiO₂ containing catalyst.
21. The method according to any one of claims 18 to 20, wherein the ketonisation reaction is performed in presence of a gas in the range from 0.1-1.5 gas/feed ratio (w/w), the gas being selected from one or more of: CO₂, H₂, N₂, CH₄,
20 H₂O, preferably CO₂.
22. The method according to any one of claims 17-21 wherein the oleochemicals are selected from a group consisting of alkanes, amines, imines, enamines, acetals, secondary alcohols and tertiary alcohols.
23. The method according to any one of claims 1-22, wherein the renewable
25 base oil fulfills the API Group III+ base oil specifications, having ≥ 90 wt% saturated hydrocarbons, ≤ 0.03 wt% sulfur and a viscosity index of ≥ 140.
24. The method according to any one of claims 1-23, wherein the feedstock comprises 2-98% by weight, preferably 5-90% by weight free fatty acids and at least 2%, preferably at least 5% by weight fatty acid glycerols.

25. The method according to any one of claims 1-24, wherein the feedstock is selected from a group consisting of plant fats, plant oils, plant waxes, animal fats, animal oils, animal waxes, fish fats, fish oils, PFAD and fish waxes, preferably PFAD and animal fat.
- 5 26. The method according to claims 13 and 14, wherein the renewable propanol and the renewable naphtha are mixed together for use as gasoline components.