

Claims

1. A method for producing simultaneously renewable ketones and renewable alkenes from a feedstock of biological origin, the method comprising the following steps
 - 5 a) providing a feedstock of biological origin comprising fatty acids and/or fatty acid esters,
 - b) subjecting the feedstock to esterification reaction in the presence of a monohydric alcohol, wherein the monohydric alcohol has a carbon chain length of two or more, yielding esters of the fatty acids and the monohydric alcohol, *in proviso* that when the feedstock comprises esters of fatty acids and a monohydric alcohol, wherein the monohydric alcohol has a carbon chain length of two or more, step b) is optional,
 - 10 c) subjecting the esters of the fatty acid and the monohydric alcohol to ketonisation reaction in the presence of a metal oxide ketonisation catalyst, yielding an intermediate product stream comprising ketones, alkenes and carbon dioxide, and
 - 15 d) separating the alkenes from the intermediate product stream yielding alkene depleted intermediate product stream the separated alkenes.
2. The method according to claim 1 comprising subjecting the feedstock to prehydrogenation reaction in the presence of hydrogenation catalyst prior to step b).
- 20 3. The method according to claim 1 or 2, comprising purifying the feedstock prior to step b).
4. The method according to any one of claims 1-3, comprising purifying the ester of fatty acid and the monohydric alcohol prior to step c).
- 25 5. The method according to any one of claims 1-4, comprising subjecting the ester of fatty acid and the monohydric alcohol to prehydrogenation reaction in the presence of hydrogenation catalyst prior to step c).
6. The method according to any of claims 1-5, wherein the ketonisation catalyst comprises TiO_2 as active catalyst material.
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7. The method according to any one of claims 1-6, comprising performing the ketonisation reaction of step c) at least partially in liquid phase.
8. The method according to any one of claims 1-7, wherein the ketonisation reaction of step c) is 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.
9. The method according to any one of claims 1-8, wherein the ketonisation reaction of step c) is performed in the presence of gas flow, preferably in the presence of CO₂ flow of 0.5-1.0 kg CO₂ / kg ester feed.
10. The method according to any one of claims 1-9, wherein step c) comprises adding a monohydric alcohol having a carbon chain length of two or more to the ketonisation reaction.
11. The method according to any one of claims 1-10, comprising separating the carbon dioxide from the intermediate product stream.
12. A method for producing renewable wax, the method comprising
- producing alkene depleted intermediate product stream according to any one of claims 1-11, and
 - subjecting the alkene depleted intermediate product stream to hydrodeoxygenation reaction to yield renewable wax.
13. 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 , preferably fulfilling the API Group III+ base oil specifications having ≥ 90 wt% saturated hydrocarbons, ≤ 0.03 wt-% sulfur and a viscosity index of ≥ 140 , the method comprising
- producing alkene depleted intermediate product stream according to any one of claims 1-11, and
 - subjecting the alkene depleted intermediate product stream to both hydrodeoxygenation reaction and to hydroisomerisation reaction, simultaneously or in sequence, to yield a deoxygenated and isomerized product stream comprising renewable base oil components.

14. The method according to claim 12 or 13, 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.
15. The method according to claim 13 or 14, wherein subjecting to hydrodeoxygenation and to hydroisomerisation is made in sequence, and wherein the method comprises separating liquids from gases between hydrodeoxygenation and hydroisomerisation.
16. The method according to any one of claims 13-15, 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, such as a catalyst comprising a Group VIII metal and a molecular sieve, optionally on an alumina and/or silica support.
17. The method according to any one of claims 13-16, wherein the method comprises distilling the deoxygenated and isomerized product stream comprising the renewable base oil to obtain distilled renewable base oil and preferably one or more of liquified petroleum gas, naphtha and diesel/jet fuel.
18. The method according to any of claims 1-17, wherein the monohydric alcohol has a carbon chain length from 2 to 20, preferably from 2 to 10, more preferably the monohydric alcohol is ethanol, propanol or butanol.
19. The method according to any of claims 1-18 wherein the monohydric alcohol is renewable alcohol, preferably renewable ethanol.