CLAIMS

1. A process for producing an upgraded renewable oil from renewable carbonaceous material(-s) comprising:

a. Providing an oxygen containing renewable crude oil having:
   - an oxygen content in the range of 3.0 to 20 % by weight,
   - a water content of less than 1.5 wt. %
   - a total acid number in the range from 5 to 80 mg KOH/g,
   - a fraction of the oil having a boiling point below than 350 °C of less than 70 % by weight, and
   - a residue fraction having a boiling point of more than 450 °C of at least 10 % by weight,

b. Pressurising the oxygen containing renewable crude oil to an operational pressure in the range 60 to 200 bar;

c. Adding and mixing hydrogen to the pressurized oxygen containing renewable crude oil;

d. Contacting the pressurized mixture with at least one heterogeneous catalyst contained in a first reaction zone at a temperature of 260 to 350 °C having a weight based hourly space velocity (WHSV) in the range 0.1 to 1 h^{-1} so as to produce a partially hydrogenated and deoxygenated oil;

e. Separating water, gas and optionally a low boiling fraction from the partially hydrogenated and deoxygenated oil from the first reaction zone

f. Heating the partially hydrogenated and deoxygenated oil from the first reaction zone to a temperature in the range 350 to 400 °C;

g. Contacting the partially hydrogenated and deoxygenated oil with at least one heterogeneous catalyst in a second reaction zone at a temperature of 350 to 400 °C, at weight based hourly space velocity (WHSV) in the range 0.1 to 1.5 h^{-1},

h. Separating the product from the second reaction zone into a at least a gas fraction, a water fraction, a low boiling point renewable liquid hydrocarbon fraction and a high boiling point renewable liquid hydrocarbon fraction.

i. Contacting the low boiling point fraction from the second reaction zone with hydrogen and one or more heterogeneous catalysts at a temperature in the range 350 to 390 °C in a third reaction zone having a weight-based space velocity in the range 0.1 to 1 h^{-1}, thereby producing a first product stream and

j. Contacting the high boiling point oil fraction with hydrogen and one or more heterogeneous catalysts at a temperature in the range 360-420 °C in a fourth reaction zone having a weight-based space velocity in the range 0.1 to 1 h^{-1}, thereby producing a second product stream.

2. A process according to claim 1, where the first reaction zone comprises an initial stabilization zone for reducing the content of reactive oxygenated compounds and/or unsaturated compounds and/or aromatic compounds and/or metals of the low oxygen containing renewable crude oil where the weight-based space velocity of the initial stabilization zone is in the range 0.2 to 1 h^{-1} such as in the range from 0.2 to 0.5 h^{-1}.

3. A process according to any of the preceding claims where the reactor(-s) in the first reaction zone is/are graded bed(-s) comprising heterogeneous catalysts having an increasing activity.

4. A process according to any of the claims 1-3, where hydrogen is produced from the separated gas from step e and/or step h by contacting it with steam and a heterogeneous catalyst capable of performing a steam reforming reaction of hydrocarbons contained in the process gas in a fifth reaction zone.

5. A process according to claim 4, where the steam reforming of the separated process gas is performed at a pressure in the range 2 to 40 bar and a temperature in the range 350 °C to 600 °C and a weight-based space velocity in the range 0.1 to 2 $hours^{-1}$in a fifth reaction zone.

6. A process according to any of the preceding claims, where the step a of providing oxygen containing renewable crude oil comprises:

- Providing a carbonaceous material in the form of biomass contained in one or more feedstocks;
- Providing a feed mixture by slurring the carbonaceous material in one or more fluids, at least one of which comprises water;
- Pressurizing the feed mixture to a pressure in the range 150 to 400 bar;
- Heating the pressurized feed to a temperature in the range of 300 °C to about 450 °C
- Maintaining the pressurized and heated feed mixture in a reaction zone for a conversion time in the range 3 to 30 minutes;
- thereby causing the carbonaceous material to be converted; and
- Cooling the converted feed mixture to a temperature in the range from 25 °C to 200 °C;
- Expanding the converted feed mixture to a pressure in the range 1-120 bar, and separating the converted feed mixture into at least a low oxygen containing renewable crude oil, a gas phase and a water phase comprising water-soluble organics and dissolved salts;

thereby providing an oxygen containing renewable crude oil having an oxygen content in the range from 3.0 wt % to 20.0 wt %, a water content of less than 2.0 wt % a total acid number in the range from 5.0 to 80 mg KOH/g, a fraction of the oil having a boiling point below than 350 °C of less 70 % by weight, and a residue fraction having a boiling point of more than 450 °C of at least 10 % by weight.

7. A process according to claim 3, where the separated oxygen containing renewable crude oil is subjected to a polishing step for removal of inorganic contaminants prior to being pressurized in step b.

8. A process according to claim 7, where the polishing step for removal of inorganic contaminants comprises an ion exchange step comprising a cation resin.

9. A process according to any of the preceding claims, where the renewable oxygen containing crude oil provided in step a has an aromatics content in the range 20 to 70 % by weight such as in the range 30 to 70 %.

10. A process according to any of the preceding claims, where the renewable oxygen containing crude oil provided in step a has an H/C ratio of less than 1.5 such as less than 1.3.

11. A process according to any of the preceding claims further comprising

- Passing the first and second product streams from the third and/or fourth reaction zone to a further separation zone in which water and gases and optionally a low boiling fraction are separated from the product streams;
- Passing the dewatered and degassed product streams to a fractionation zone, where the product streams are separated into a gasoline fraction, an aviation fuel fraction, a diesel fraction, a gas oil fraction, and a residual fraction or any combination thereof.

12. A process according to any of the preceding claims, where the renewable crude oil is spiked with sulphur by addition of a sulphur containing compound and/or oil to the oxygen containing renewable crude oil prior to the pressurization step b.

13. A process according to claim 12, where the sulphur containing compound is selected from the group of hydrogen sulphide (H_2S), carbon disulphide (CS_2), dimethyl sulphide (DMS), dimethyl disulphide (DMDS), dimethyl sulfoxide (DMSO), light gas oil, heavy gas oil or a combination thereof.

14. A process according to any of the preceding claims, where the hydrogen consumption is in the range 2.0 to 10 % by weight of the incoming oil being upgraded such as in the range 2.0 to 6 % by weight of the incoming oil being upgraded; preferably in the range 2.5 to 4 % by weight of the incoming oil being upgraded such as 3.0 to 4.0 % by weight of the incoming oil being upgraded.

15. A process according to any of the preceding claims, wherein the hydrogen added is at least partly extracted from said process of producing an upgraded renewable oil e.g., is extracted from the step of providing the oxygen containing renewable crude oil and/or extracted from gas exiting the upgrading process.