Claims

1. A method for preparing fuel components from waste pyrolysis oil (WPO), comprising:
   a) providing a waste pyrolysis oil, comprising as the major part, such as at least 75 wt%, plastic pyrolysis oil (PPO) and/or tyre pyrolysis oil (TPO), the waste pyrolysis oil comprising as the major part hydrocarbons, and comprising impurities in the form of:
      - silicon compounds, comprising at least 20 mg/kg silicon of the WPO and optionally up to 2000 mg/kg,
      - chlorine compounds, comprising at least 20 mg/kg chlorine of the WPO and optionally up to 3500 mg/kg,
      - nitrogen compounds, comprising at least 50 mg/kg nitrogen of the WPO and optionally up to 10,000 mg/kg,
      - sulphur compounds, comprising at least 10 mg/kg sulphur of the WPO and optionally up to 15,000 mg/kg;
   b) purifying the waste pyrolysis oil by subjecting it to a hydrothermal treatment with water or with water having a pH above 7 at 150-450 °C, where the oil to water ratio is from 9:1 to 1:9 (weight/weight), such as from 4:1 to 1:1;
   c) separating the hydrothermally treated waste pyrolysis oil from the aqueous phase;
   d) preparing a hydroprocessing feed
      - consisting essentially of the hydrothermally treated waste pyrolysis oil; or
      - consisting essentially of a mixture of the hydrothermally treated waste pyrolysis oil and one or more feed(s) selected from the list consisting of oxygen-containing biological oils having less than 50 mg/kg chlorine and less than 1 mg/kg silicon and hydrocarbons having less than 50 mg/kg chlorine and less than 1 mg/kg silicon;

   e) hydroprocessing the hydroprocessing feed catalytically with hydrogen to cause hydrogenation, and optionally one or more of hydrodeoxygenation (HDO), hydrodesulfurisation (HDS), hydrodenitrification (HDN), hydrodechlorination (HDCl), hydrodearomatization (HDAr), and hydroisomerisation (HI), at a temperature between 200 and 450 °C and at a pressure between 1MPa and 25 MPa;

   f) recovering from the hydroprocessed product at least one hydrocarbon fraction boiling in the liquid fuel range.

   wherein in step b) the hydrothermal treatment is conducted so as to cause at least a 50% reduction of silicon compounds of the WPO.

2. The method according to claim 1, wherein the WPO further comprises ~~impurities in the form of silicon compounds, comprising at least 20 mg/kg silicon of the WPO and~~

~~optionally up to 2000 mg/kg, and/or~~ impurities in the form of bromine compounds, comprising at least 10 mg/kg bromine of the WPO and optionally up to 2000 mg/kg.

3. The method according to any of the claims 1 and 2, ~~wherein the WPO further comprises impurities in the form of silicon compounds, comprising at least 20 mg/kg silicon of the WPO and optionally up to 2000 mg/kg,~~ wherein in step b) the hydrothermal treatment is conducted so as to cause ~~at least a 50% reduction of silicon compounds of the WPO; or at least a 50% reduction of chlorine compounds of the WPO; or at least a 50% reduction of silicon compounds of the WPO, and~~ at least a 50% reduction of chlorine compounds of the WPO, optionally where the silicon in the hydrothermally treated WPO are below 20 mg/kg, and/or where the oxygen in the hydrothermally treated WPO are above 20 mg/kg.

4. The method according to any one of claims 1 - 3, wherein in step b) the water having a pH above 7 contain one or more cations selected from the list consisting of: alkali metals, such as Li, Na, K, Rb, Cs, alkaline earth metals, such as Mg, Ca, Sr, Ba.

5. The method according to any one of claims 1 – 4, wherein the hydroprocessing feed consists essentially of a mixture of the hydrothermally treated waste pyrolysis oil and one or more feed(s) selected from the list consisting of oxygen-containing biological oils having less than 50 mg/kg chlorine and less than 1 mg/kg silicon and hydrocarbons having less than 50 mg/kg chlorine and less than 1 mg/kg silicon.

6. The method according to any one of claims 1 – 5, wherein the hydroprocessing feed consists essentially of a mixture of the hydrothermally treated waste pyrolysis oil, oxygen-containing biological oils having less than 50 mg/kg chlorine and less than 1 mg/kg silicon, and hydrocarbons having less than 50 mg/kg chlorine and less than 1 mg/kg silicon.

7. The method according to any one of claims 1 – 6, wherein the hydroprocessing feed consists essentially of a mixture of:
   - 1-100 wt% of the hydrothermally treated waste pyrolysis oil,
   - 0-40 wt% of the oxygen-containing biological oils having less than 50 mg/kg chlorine and less than 1 mg/kg silicon; and
   - 0-99 wt% of the hydrocarbons having less than 50 mg/kg chlorine and less than 1 mg/kg silicon.

8. The method according to any one of claims 1 – 7, wherein the hydroprocessing feed consists essentially of a mixture of:
   - 1-10 wt% of the hydrothermally treated waste pyrolysis oil,

- 1-40 wt% of the oxygen-containing biological oils having less than 50 mg/kg chlorine and less than 1 mg/kg silicon; and
- 50-98 wt% of the hydrocarbons having less than 50 mg/kg chlorine and less than 1 mg/kg silicon.

9. The method according to any one of claims 1 – 8, wherein in step d) at least 80 wt% of the hydrocarbons having less than 50 mg/kg chlorine and less than 1 mg/kg silicon are recycled product obtained from step f).

10. The method according to any one of claims 1 – 9, wherein in step d) the hydrocarbons having less than 50 mg/kg chlorine and less than 1 mg/kg silicon further also have less than 1 wt% olefins.

11. The method according to any one of claims 1 – 10, wherein in step f) the at least one hydrocarbon fraction boiling in the liquid fuel range is diesel and/or gasoline and/or naphtha.

12. The method according to any one of claims 1 – 11, wherein in step e) the hydroprocessing is conducted in a fixed bed reactor.

13. The method according to any one of claims 1 – 12, wherein the hydroprocessing reaction conditions comprise a temperature in the range from 270 to 390 °C, a pressure in the range from 2 MPa to 8 MPa, a WHSV in the range from 0.1 – 10 h^{-1}, and a H_2 flow of 50-2000 nl H_2/l feed.

14. The method according to claim 13, wherein the reaction conditions comprise the presence of a hydrodeoxygenation catalyst, such as NiMo on an alumina support.

15. The method according to any one of claims 1 – 14, wherein the hydroprocessing reaction conditions comprise conditions suitable for isomerisation, which reaction conditions comprise a temperature in the range from 250 to 450 °C, a pressure in the range from 1 MPa to 6 MPa, a WHSV in the range from 0.1 to 10 h^{-1}, and a H_2 flow of 50 to 2000 nl H_2/l feed, in the presence of an isomerisation catalyst, such as a catalyst comprising a Group VIII metal and a molecular sieve, optionally on an alumina and/or silica support.

16. The method according to any one of claims 1 – 15, wherein the waste pyrolysis oil (WPO) comprises at least 75 wt% plastic pyrolysis oil (PPO) and/or tyre pyrolysis oil (TPO).