

CLAIMS

1. A method for production of bio-crude oil comprising the steps of:
 - (i). Providing lignocellulosic biomass, and
 - 5 (ii). Subjecting said biomass to thermochemical treatment at temperature between 250 and 450°C for residence time between 1 and 120 minutes as a slurry formed with re-circulated product oil obtained from previous thermochemical treatment of similar biomass to which is added a short-chain alcohol reactant in an amount corresponding to between 2% and 150% of the slurry dry weight,
- 10 wherein the ratio of biomass to re-circulated product oil is within the range 1:1 and 1:5 w/w and the ratio of biomass to added alcohol is within the range 1:9 and 5:1 w/w.
2. The method of claim 1 wherein the alcohol reactant is ethanol.
- 15 3. The method of claim 1 wherein thermochemical treatment is conducted under conditions where partial pressure of alcohol reactant is lower than 60 bar.
4. The method of claim 1 wherein the product oil obtained from previous thermochemical treatment of similar biomass is derived from distillation of whole product oil and has a boiling
- 20 point within the range 200 - 400° C.
5. The method of claim 1 further comprising use of a distillation system to separate reaction products into desired fractions.
- 25 6. The method of claim 5 wherein some fractions are used in the process as product oil obtained from previous thermochemical treatment of similar biomass while the remaining fractions are filtered and saved as final product oil for further processing.
7. The method of claim 1 wherein thermochemical treatment is conducted in the absence of
- 30 an effective amount of added catalyst.
8. The method of claim 1 conducted as a batch process.
9. The method of claim 1 conducted as a continuous process.

10. The method of claim 9 wherein a portion of product oil is removed as final product oil for further processing while a portion is cycled in the process.
11. The method of claim 10 wherein the portion recycled has a boiling point within the range
5 200 - 400° C.
12. The method of claim 10 wherein the portion recycled is within the range 50 to 95 wt.% and the portion removed as final product oil is within the range 5 to 50 wt.%.
- 10 13. The method of claim 10 wherein the ratio of biomass to added alcohol is selected as to maintain an alcohol reactant density at steady state of at least 17 kg/m³.
14. The method of claim 10 wherein the ratio of biomass to added alcohol is selected as to maintain an alcohol reactant density at steady state within the range between 2 to 52 kg/m³.
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15. The method of claim 10 wherein the product oil obtained from previous thermochemical treatment of similar biomass is cooled to 200° C or lower prior to use in the process.
16. The method of claim 10 wherein the product oil obtained from previous thermochemical
20 treatment of similar biomass is mixed with the lignocellulosic biomass and pumped into a pressurized system before adding alcohol reactant.
17. The method of claim 10 wherein unconsumed alcohol reactant is recovered from product oil and re-used in the process.
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18. The method of claim 1 further comprising the steps of recovering product oil and subjecting it to further processing.
19. The method of claim 18 wherein further processing comprises hydrodeoxygenation.
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20. The method of claim 18 wherein product oil is mixed and co-processed with petroleum refinery streams.
21. The method of claim 18 wherein all unspent alcohol is included within the product oil.
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22. The method of claim 21 wherein product oil is recovered in such manner that unspent alcohol reactant comprises between 0.1 and 15 wt. % of product oil.
23. The method of claim 1 wherein thermochemical treatment is conducted at temperature
5 between 300 and 400°C.
24. The method of claim 1 wherein the alcohol reactant is methanol.