



Hydrogen assisted catalytic biomass pyrolysis for green fuels

Stummann, Magnus Zingler; Høj, Martin; Gabrielsen, Jostein; Jensen, Peter Arendt; Jensen, Anker Degn

Published in:

Book of Abstracts Sustain 2017

Publication date:

2017

Document Version

Publisher's PDF, also known as Version of record

[Link back to DTU Orbit](#)

Citation (APA):

Stummann, M. Z., Høj, M., Gabrielsen, J., Jensen, P. A., & Jensen, A. D. (2017). Hydrogen assisted catalytic biomass pyrolysis for green fuels. In *Book of Abstracts Sustain 2017* Article E-1

General rights

Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

- Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
- You may not further distribute the material or use it for any profit-making activity or commercial gain
- You may freely distribute the URL identifying the publication in the public portal

If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.

Hydrogen assisted catalytic biomass pyrolysis for green fuels

Magnus Zingler Stummann¹, Martin Høj¹, Jostein Gabrielsen², Peter Arendt Jensen¹, Anker Degn Jensen^{1*}

1: DTU Chemical Engineering, Technical University of Denmark, 2800 Kgs. Lyngby (Denmark)

2: Haldor Topsøe A/S, 2800 Kgs. Lyngby (Denmark)

*Corresponding author email: aj@kt.dtu.dk

Fast pyrolysis of biomass produces a high yield of bio-oil through well-established technologies [1]. To utilize this oil as liquid transportation fuel the oxygen content must be reduced from 15-30 wt.% down to <1 wt.%, which increases heating value and stability and decreases acidity [1]. Upgrading bio-oil by hydrodeoxygenation (HDO) is challenged by severe coking upon heating the oil. Alternatively, performing fast pyrolysis in high-pressure hydrogen atmosphere in a fluid bed reactor with a HDO catalyst as bed medium, could immediately stabilize reactive pyrolysis vapors [2]. A schematic diagram for such a process is shown in Figure 1. A simplified bench scale setup has been constructed at DTU Chemical Engineering for proof-of-concept for the continuous conversion of solid biomass to low oxygen, fuel-grade bio-oil.

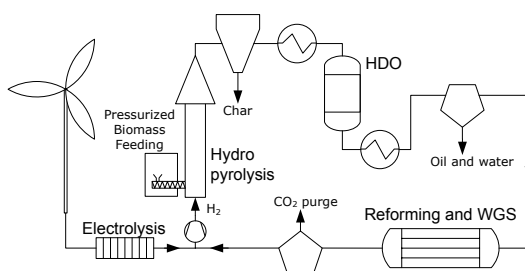


Figure 1: Simplified process diagram including fluid bed catalytic hydro-pyrolysis, char separation, temperature adjustment, vapor phase HDO reactor, cooling, condensation and liquid separation. Steam reforming and water gas shift (WGS) of non-condensable gasses to produce H₂ and wind-powered electrolysis of water to H₂ is envisioned.

Experiments were performed with a sulfided CoMo/MgAl₂O₄ catalyst in the fluid bed reactor and a sulfided NiMo/Al₂O₃ catalyst in the HDO reactor. Hydro-pyrolysis of beech wood was performed at 25 bar with gas composition 470 ppm H₂S, 6 % N₂ balance H₂. The effect of varying the temperature (365-511 °C) and hydrogen pressure (15-35 barg) on the product yield and organic composition was studied. The mass balance closed between 90 and 101 wt. % dry ash free basis (daf). The combined condensed organics and C₄₊ gasses yield varied between 17 and 22 wt. % daf (Figure 2), which corresponds to an energy recovery between 40 and 53 % in the organic product. The yield of non-condensable gasses varied between 24 and 32 wt. % daf and the char yield varied between 9.6 and 18 wt. %. GC simulated distillation showed that the condensed organics consisted of 20-40 vol. % naphtha and 60-80 vol. % diesel. The organics contain 42 to 75 wt. % aromatics, based on GCxGC-FID chromatographic peak area, and the remainder was primarily naphthenes. The condensed organics were essentially oxygen free (<0.001 wt. %) when both reactors were used. Bypassing the HDO reactor increased the oxygen content in the condensed liquid to 1.8 wt. %. In the ongoing work the effect of the choice of catalyst in the fluid bed is investigated and a combined organic and C₄₊ gas yield of 25 wt.% daf has been obtained. The results show that catalytic hydro-pyrolysis may be a viable way to process solid biomass into liquid and gaseous hydrocarbon fuels.

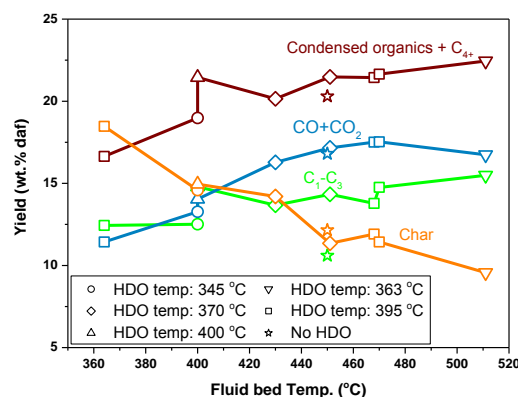


Figure 2: Effect of the fluid bed temperature.

[1] A. V. Bridgewater, *Therm. Sci.* 8 (2004) 21.

[2] T.L. Marker, L.G. Felix, M.B. Linck, M.J. Roberts, *Environ. Prog. Sustain. Energy* 31 (2012) 191.