FAST PYROLYSIS BIO-OIL UPGRADING VIA HYDROTREATMENT FOR REFINERY INTERMEDIATES PRODUCTION

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Abstract

Biomass-based fast pyrolysis bio-oil is a low-quality liquid product that is unsuitable for use as transportation fuel, however after a mild upgrading step it can be used as a reliable co-feed in underlying refineries for the production of hybrid transportation fuels. The current study investigates the upgrading of bio-oil to high-quality refinery intermediates via catalytic hydrotreatment, as part of the BioMates[1] project. The bio-oil used in this research was produced via ablative fast pyrolysis of a mixture made from barley and wheat straw at 50 wt.% each[2]. The aim was to examine various operating hydrotreating conditions such as pressure, temperature and H_2/oil ratio. For this study, a small pilot hydroprocessing plant of Centre for Research & Technology Hellas (CERTH) was utilized. Three reaction temperatures were investigated (300°, 330° and 360°C), two reaction pressures (580 and 1000 psi) and two H_2/oil ratios (3,000 and 5,000 scf). The catalyst employed is a custom-made $NiMo/Al_2O_3$ based catalyst that was developed as part of the BioMates[1] project. The results have shown that mild hydrotreating conditions are preferable from a product quality viewpoint and performance of the process. Catalytic hydrotreatment achieved total removal of oxygen and dissolved water from the initial bio-oil feed. The water instead formed a second product phase (40% v/v). Furthermore, the properties of the targeted organic phase product were improved as far as viscosity, density and Total Acid Number (TAN) are concerned. From the evaluation of the three hydrotreating temperatures, it is concluded that higher reaction temperatures favor HDO reactions and decrease the viscosity of the products. Moreover, lower reaction pressures favor catalyst deactivation and Δp creation. Finally, lower H_2/oil ratio results in catalyst life reduction. The proposed technology is a very promising pathway for pyrolysis bio-oil upgrading to high-quality refinery intermediates with minimal oxygen and water content.

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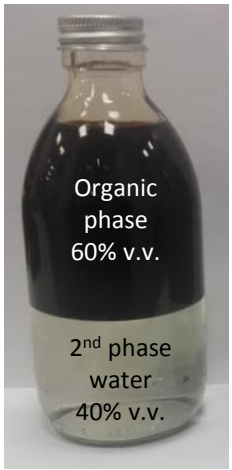
Biooil



Total product

Properties	Bio-oil	Product (organic phase)
Density 15°C (gr/ml)	1.024	0.920
Sulphur (ppm)	1183	341
Hydrogen (wt%)	8.32	11.68
Carbon (wt%)	53.92	85.79
Oxygen (wt%)	37.64	2.49
Dissolced water (wt%)	21.86	0.0
2nd phase water (% κ.ο.)	0	40
TAN (mgKOH/g)	79.92	0
Kin. viscosity (cSt)	116	8.9

[1] http://www.biomates.eu/

[2] www.biomates.eu/images/deliverables/D1_01_Straight-run_AFP_products.pdf