Catalyzed fixed bed pyrolysis of Poplar biomass

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1. Introduction

Biofuels help to mitigate global warming issues and socio-economic instability due to the oil markets volatility. Lignocellulosic biomass is the most abundant renewable material in the world to produce biofuels. Thermochemical conversion of wood biomass by pyrolysis produces bio-oil, which can be upgraded to transportation fuels 0. The high acidity and oxygen content are reported to be drawbacks of pyrolysis bio-oil. Catalyzed pyrolysis can help to improve the bio-oil quality 0.

2. Experimental

The biomass (wood chips) received from nine different poplar (*Populus*, L.) genotypes was reduced to sawdust and sieved. The fixed bed pyrolysis was carried out using a granulometric fraction of 750 μm composed by equal amounts of all poplar genotypes. Before pyrolysis tests, the biomass was characterized by thermogravimetry (TG) to select the working temperature. The thermograms were collected at 30 ºC/min under N_2 flow using 30–60 mg of powdered biomass. The lignocellulosic composition of biomass was evaluated from TG data considering separated degradation processes for hemi-cellulose, cellulose and lignin.

The catalyzed pyrolysis tests were performed using 10 % (w_{catal}/w_{wood}) of catalyst at 500 ºC for Na_2CO_3, $MgCO_3$, HZMS5 and FCC catalyst. After pyrolysis, the solid bio-char was removed from the reactor and weighed. The dark liquid with a pungent smell was dried in a rotavapour to obtain high viscosity dark-brown bio-oil, which was characterized by FTIR in ATR mode. Details on the pyrolysis and bio-oil characterization are given in 0.

3. Results and discussion

The thermograms of poplar biomass (Fig.1) showed processes identified with water and extractives weight loss for temperatures below 450 K followed by degradation of hemicellulose, cellulose and lignin. A xylan (*Eucalyptus globulus*) and Whatmam paper filter were used as hemicellulose and cellulose standards. The obtained lignocellulosic composition by thermogravimetry agrees with published data obtained by conventional wet methods (0). The thermal decomposition profile was used to select the pyrolysis temperature. Uncatalyzed pyrolysis tests performed in the range 698–773 K showed increasing yields of bio-oil with increasing temperatures. Catalyzed pyrolysis was carried out at 773 K using 10 % w/w of powder catalyst mixed with the biomass (Fig. 2). The $MgCO_3$ and HZMS5 catalysts promoted significant decrease of the bio-oil yield accompanied by increase of gas yield.

4. Conclusions

TG is a smart technique to evaluate the lignocellulosic composition of wood biomass. Low temperature (< 773 K) fixed bed pyrolysis of poplar wood provides bio-oil yields in the range 30–50 % with large amounts of oxygenated compounds. Such undesirable characteristic of pyrolysis bio-oil can be ameliorated using cheap catalysts such as alkaline earths carbonates.

References

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