Technical Reports

BC Coastal Forest Sector Hem-Fir Initiative

Fast Pyrolysis Study – Characterization of Pyrolysis Products & Marine Salts in Biomass (Status Report #2)

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Abstract

This is a study on using low value, salt-contaminated biomass obtained from coastal regions of British Columbia, Canada in fast pyrolysis processes, and the characteristics of the generated products. Of particular interest is tracking which products that the ions from marine salts are concentrated within. It was learned that Mg^{+2}, Ca^{+2} and K^{+1} ions derived from marine salts impregnated within wood, primarily report to the pyrolysis char. In most of the experimental trials, Na^{+2} also reported to the pyrolysis char. However, Cl^{-1} ions were measured in appreciable amounts in the char, pyrolysis oil and pyrolysis gas, making it more difficult to determine where the chloride ions preferentially report to. Chlorine and chloride ion concentrations in wood are indicative of the amount of oceanic salt contamination present. A rapid and portable method to approximately measure the chloride ion (or chlorine) concentration in hog fuel and sawdust was developed to facilitate further collection of feedstock samples. This method involved soaking wood in distilled water and measuring the concentration of chloride ions in solution. The method proved effective at identifying highly salt contaminated biomass relative to biomass sources having lower salt (also chlorine) contents, despite the magnitudes of the measurements differing to analytical laboratory measurements. The dry-basis chlorine concentrations of the collected biomass samples were 1485-5500 ppm_m or mg/kg_{dry} (equivalent to 0.15-0.55 wt% of the dry biomass).

The most abundant chemical compounds in pyrolysis oil were also studied. Acetic acid and levoglucosan were two of the compounds in greatest abundance in whole pyrolysis oil, measured in concentrations of 1.5-2.8 wt% and 0.5-0.6 wt% respectively. Some of the pyrolysis oil samples phase separated following manufacture. Within the aqueous phase acetic acid and 2,2-dimethoxyethanol occurred in the highest concentrations of 5.3-10.2 wt% and 0.5-1.2 wt% respectively. Within the tarry fraction of the phase separated pyrolysis oil, acetic acid was most abundant in concentrations of 2.4-6.2 wt%, with guaiacol and isoeugeno present in the next highest amounts. The re-occurrence of the same chemical compounds within different pyrolysis oils suggests that similar modes of thermal decomposition of the biomasses molecular structure occur, where certain molecular bonds preferentially break.

The char generated from the fast pyrolysis trials was also characterised. Surface area, pore size and pore volume, in addition to particle size distribution where all measured attributes. BET surface areas of 1.9-3.7 m^2/g were measured. Most of the pores in the char fell into the mesopore diameter range of 2-50 nm. The BJH cumulative pore volumes within the char were between 0.005-0.014 cm^3/g. Ongoing work involves executing six additional experimental pyrolysis trials to allow more in depth tracking of ions from marine salts, and for the effect of marine salts on the fast pyrolysis process and its generated products to be further evaluated.

Keywords: Fast Pyrolysis, Characterisation, Salts, Impregnation, Chlorine, Chloride, Sodium, Ions, Hog Fuel, Bark, Floated logs, Hemlock, Cedar, Douglas Fir, Chemical Compounds, Char, Surface Area, Pore Size, Pore Volume.

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