CHARACTERISTIC STUDIES ON THE WASTE BIOMASS-BASED BIOCHARS PRODUCED BY FAST PYROLYSIS

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Biochar, as carbonaceous product obtained from pyrolysis of biomass, has many applications in diverse areas due to its versatile physicochemical properties. Non-food biomass has a great potential to produce biochars. In the present study, pinewood sawdust (forest residue), wheat straw and flax straw (agricultural residues), and poultry litter (livestock manure) were used as precursors for pyrolysis. Focus of this study was on the effects of fast pyrolysis temperature (400, 475, and 550 ^{o}C) on the characteristics of biochars produced by means of a mobile pyrolysis unit. Different characterization techniques are used to study the physical, chemical, and structural characteristics of biochar products.

Characterization results confirmed development of compact aromatic structure in biochars with an increase in the pyrolysis temperature. Based on the elemental analysis results and Van Krevelen plot, with an increase in pyrolysis temperature, a decrease in H/C and O/C mass ratio values is observed for all biochars. Decrease in H/C and O/C ratios is related to severe dehydrogenation and formation of compact aromatic structure in biochar at high temperatures. This trend was also confirmed by a drastic increase in I_D/I_G (defect to graphitic carbon) ratio in the deconvolution results of Raman spectroscopy for bio-char samples produced at 550 ^{o}C. This is due to the enlargement of aromatic rings and dehydrogenation of hydroaromatics at higher pyrolysis temperature and increase in number of aromatic rings which include more than 6 rings. X-ray photoelectron spectroscopy (XPS) also confirmed the above mentioned results. Survey scan showed an increase in carbon concentration and a decrease in O/C mass ratio with an increase in the pyrolysis temperature for biochars obtained from three lignocellulosic precursors (wheat straw, saw dust and flax straw). In addition, high resolution scan for these biochars showed that aromatic/aliphatic carbon ratio increased in the corresponding bio-char with the pyrolysis temperature. Based on the spectra obtained for biochars using diffuse reflectance infrared Fourier transform spectroscopy (DRIFTS), the intensity of peaks at 2850-2950 cm^{-1} and ~1470 cm^{-1} ,indicating C-H stretching and deformation vibration from alkanes respectively, decreased with an increase in the pyrolysis temperature which can be due to the improvement of aromatic structure in biochars with temperature.

Results of thermogravimetric analysis (TGA) for all precursors and biochars showed that degradation of cellulose, hemicellulose and lignin is completed at ~550 ^{o}C and mass loss at higher temperatures is mainly related to dehydrogenation and aromatization of char as well as decomposition of inorganic compounds. Scanning electron microscopy (SEM) analysis of sawdust-derived biochar showed more intact and firm structure because of its woody nature. The biochars produced at higher temperatures had a more fragmented structure due to severe thermal cracking of their parent biomass at higher temperatures. Results from other characterization techniques such as XRD, ICP-MS, and electrical conductivity measurement will also be presented.