Geophysical Research Abstracts
Vol. 16, EGU2014-949, 2014
EGU General Assembly 2014

Biochar from Coffee Residues: A New Promising Sorbent

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Biochar is a carbon-rich material produced by heating biomass in an oxygen-limited environment. Biochar is mainly used as an additive to soils to sequester carbon and improve soil fertility as well as a sorbent for environmental remediation processes. Surface properties such as point of zero charge, surface area and pore volume, surface topography, surface functional groups and acid-base behavior are important factors, which affect sorption efficiency. Understanding the surface alteration of biochars increases our understanding of the pollutant-sorbent interaction. The objective of the present study was to characterize the surface properties of biochar produced, and to investigate the effect of thermal treatment conditions on key characteristics that affect sorptive properties. The espresso coffee residue was obtained after the coffee was brewed through espresso machines in coffee shops. The coffee residue was dried and kept in an oven at 50oC until its pyrolysis at 850oC. Pyrolysis with different coffee mass and containers were tested in order to find optimum biochar characteristics.

Detailed characterization techniques were carried out to determine the properties of the produced biochar. The surface area, the pore volume, and the average pore size of the biochars were determined using gas (N2) adsorption-desorption cycles using the Brunauer, Emmett, and Teller (BET) equation. Open surface area and micropore volume were determined using the t-plot method and the Harkins & Jura equation. Total organic carbon was also determined because it is an important factor that affects sorption. The results were compared with the corresponding properties of activated carbons.

The biochar produced exhibited a wide range of surface area from 21 to 770 m2/g and open surface area from 21 to 65 m2/g. It is obvious that the surface area results from the formation of pores. Actually it was calculated that up to 90% of the porosity is due to the micropores. More specifically the average size of the pores for the high surface area biochars was 32 A. Finally, the organic carbon content of the produced biochar ranged from 45 to 75%.