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Biochar production from coffee residues: Optimization of surface characteristics and sorptive behavior

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Biochar with high surface area is a promising sorbent for environmental remediation and is produced by heating biomass in an oxygen-limited environment. Knowing the surface characteristics increases our understanding of biochar interactions with pollutants. The hypothesis of the present study is that by controlling pyrolysis conditions, the surface characteristics and subsequently the sorption behavior of produced biochars can be optimized. Coffee residues were dried overnight at 50oC and then pyrolized into a gradient furnace at 850oC. Different solid/oxygen ratios during pyrolysis were tested as well as the up scaling of the process. The biochars produced were systematically characterized for their surface characteristics such as BET surface area, open surface area, pore and micropore volume, and average pore size. The effect of pyrolysis on the biochar suspension pH was examined with the mass addition technique that involves the addition of increasing amounts of the biochar to bottles containing 0.1 M $NaNO_3$. FTIR analysis was used in order to determine the functional groups of the coffee residue and of the biochars. The macrostructure of the biochars was visualized by Scanning Electron Microscopy (SEM). Total Carbon (TC) in the samples was determined by Carlo Erba Elemental Analyzer CHNS, EO 1108 after calibration with standard samples. The sorption behavior of produced biochars was tested with two different pollutants (Hg(II), phenanthrene) using batch reactors with the same initial single-compound solution and the same mass of coffee residue and different biochars. The biochars produced exhibited a wide range of surface area from 21 to 770 m2/g and open surface area due to macropores from 21 to 65 m2/g. This suggests that the surface area in the biochars with high surface area results from the formation of pores. Actually for the biochar with the highest surface area, it was calculated that up to 90