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Effect of Pyrolysis Temperature on Biochar Chemistry and Metal Sorption Capability

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An increase in anthropogenic activities such as fracking, mining, and agriculture have led to a significant increase of toxic metal concentrations. Biochar, made of pyrolyzed biosolids, is an eco-friendly alternative for removing contaminants from the municipal and wastewater systems for future recycling and reuse. However, a knowledge gap exists on how the pyrolysis temperature can affect biochar chemistry and in turn, its ability to act as effective sorbents for toxic metals such as chromium in the environment. Therefore, the goal of this research is to focus on a) the physio-chemical property changes of a source biosolid and biochar obtained by pyrolyzing at different temperatures (300 °C, 500 °C, 700 °C); and b) how it, in turn, affects toxic metal sorption. Using biosolids from a wastewater treatment plant in Maui, Hawaii, we employed traditional wet chemical methods together with advanced molecular scale (spectro)microscopy approaches to answer our research questions. Interestingly, we observed that the biochar pyrolyzed at 300 °C had the highest specific surface area. Additionally, biochars had calcium phosphate-like aggregates indicating more stable inorganic forms of carbon persisted after pyrolysis while organic C and N content decreased. This was supported by a loss in organic functional groups as a function of pyrolysis temperature. To test the sorption efficacy of biochar, batch sorption experiments are currently being performed using a range of chromium (VI) concentrations typically found in waste- and ground-water samples. We hypothesize that the biochar pyrolyzed at 300 °C will be the most effective sorbent due to its high surface area and high amount of negatively charged functional groups. Overall, results from this study document how biosolids, when pyrolyzed at an optimal temperature, can serve as an effective sorbent for toxic metal removal in wastewater systems for future reuse.