Functionalizing Biochar with Layered Double Hydroxides for Phosphate Removal from Aqueous Solutions

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Both biochar and layered double hydroxides (LDH) have received substantial attention for their abilities to adsorb chemical contaminants, yet little research has been reported on LDH/biochar composites for phosphate (P) removal from aqueous solutions. To test my hypothesis that biochar functionalized with LDH may provide a novel absorbent for treatment of phosphate-laden waters, LDH/biochar composites were synthesized through liquid phase co-precipitation of Mg-Al and Mg-Fe LDH on varying amount of biochar derived from bamboo biomass. A phosphate absorption screening test indicated that after being functionalized with LDH, the biochar exhibited much higher phosphate absorption than its pristine counterpart and the enhancement of adsorption with 40% LDH in the composites was more than with 25% LDH. Mg-Al LDH/biochar composites had higher affinity to phosphate than Mg-Fe LDH/biochar composites. Kinetics adsorption experiments of the 40% Mg-Al LDH/biochar composite with 10 and 50 mg P/L solutions indicated that over 95% of adsorption was completed within 1 h of contact time, following the second-order kinetics model. Solution pH increased with contact time, indicating releases of hydroxide accompanied phosphate adsorption. The adsorption isotherm suggested a shift from chemisorption/inter-layer ion exchange at low phosphate concentrations to precipitation at high phosphate concentrations. The adsorption characteristics confirmed that the LDH/biochar composites can serve as an effective adsorbent for wastewater treatment. A final lettuce seedling bioassay further suggested that the spent LDH/biochar composites can be recycled as a slow-release fertilizer to enhance vegetation growth.

Awards Won:

Second Award of $2,000