Chromium adsorption onto functionalized sewage sludge biochar

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Sewage sludge is a waste product produced in large quantities by sewage treatment plants. Alternative solutions for the reuse of this type of waste can add value to the material and contribute to sustainable development and the environment. Heavy metals, such as chromium, are of great concern due to their accumulation in the environment and toxicity for plants and humans. Metals accumulate in the environment for years and pose long-term risks to life. In this work, biochar has been prepared from sewage sludge of a municipal wastewater treatment plant. We aimed at studying the adsorption of chromium onto biochar and active biochar that has been treated with H_3PO_4, which is a cost-effective method to improve the biochar surface in order to increase active sites for Cr adsorption. The effects of adsorbent dose, pH, contact time and temperature were investigated. The surface of the biochar was functionalized with phosphorus functional groups, resulting in an active biochar with higher Cr(VI) removal capacity when compared to non-active biochar. XPS data indicate that the biochars are rich in surface functional groups, which was also supported by FTIR. Chromium (VI) removal increases under acidic conditions and equilibrium data (at 25°C) fitted well with SIPS isotherm. Temperature and pH are determinant factors for the removal of Cr(VI) from solution, which strongly increases at lower pH values and increases with the increase of temperature. Both Cr(III) and Cr(VI) was found on the biochars surface. The adsorption mechanism onto the biochar surface involves both complexation and electrostatic reactions. Sewage sludge biochars hold promising adsorption characteristics for chromium and can be used as a suitable adsorbent. Future studies can be focused on surface characterization using synchrotron radiation sources (eg. XAFS/XANES) in order to better understand adsorption mechanisms.

Keywords: Hexavalent chromium, sewage sludge biochar, surface functionalization