Removal Mechanism of Hexavalent Chromium using Wheat Straw Biochar

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Biochar has received recent attention as an innovative sorbent for heavy metals contamination due to its sorption capacity, high surface reactivity, ease of manufacture and low cost. Most studies involving chromium removal from solution by biochar have focused on removal rates and extent, which largely ignores the mechanisms of sorption and electron transfer that occur during Cr immobilization. For this reason, a comprehensive Cr-biochar study that couples adsorption and reduction kinetics to spectroscopic data to elucidate the Cr binding environment and speciation on the biochar, was conducted.

Wheat Straw biochar (WSBC), produced by the Alberta Biochar Initiative, was used to reduce hexavalent chromium (Cr(VI)) over the course of days at a range of acidic pH (between 2 – 3). Sorption and reduction kinetics were monitored and concentration-independent intrinsic rate constants for both phenomena were calculated. To understand the Cr binding environment on the surface of WSBC following metal reduction, X-ray adsorption spectroscopy, synchrotron-based X-ray fluorescence mapping, Fourier transform infrared spectroscopy, Raman microscopy and scanning electron microscopy were performed. The results show that (1) the reduction and sorption of Cr(VI) with WSBC is possible, especially in acidic media, (2) that the distribution of Cr on the WSBC surface is heterogeneous, which can be correlated to high Si content in the form of crystalline Si and SiC nodules, and (3) the Cr(III) binding to WSBC surface is purely dominated by O-containing functional groups with hydroxyl groups comprising the majority of the Cr binding, followed by binding at carboxyl and carbonyl groups

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