Nano Zero-Valent Zinc Immobilized on Pine Cone and Populous Leaf Biochars for Efficient Removal of Arsenite from Aqueous Solutions and Salt Lake Water

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Abstract

Use of biowastes for biochar production is an eco-friendly and cost-effective approach for the removal of arsenic (As) from water. However, low adsorption capacity of raw biochar could be a main concern for its practical application. Thus, we explored arsenite (As(III)) sorption to pristine pine cone biochar (PCBC), populous leaf biochar (PLBC) and nano zero-valent zinc-modified PCBC and PLBC (nZVZn-PCBC and nZVZn-PLBC) in aqueous solutions and naturally As-contaminated salt lake water. Biochars were characterized by advanced microscopic and spectroscopic techniques to delineate their surface morphology, chemical properties, and elemental composition. Sorption mechanism was investigated using X-ray photoelectron spectroscopy (XPS) and Fourier transform infrared (FTIR) spectroscopy, which indicated that As(III) adsorption mainly controlled by porous structure and ligand exchange of –OH ions on Zn–OH by forming Zn–O–As(III) complexes. The nZVZn-PCBC possessed a higher porous structure and exhibited higher sorption (2.87 mg g−1, 96%) in contrast to pristine PCBC (1.95 mg g−1, 65%) at pH 7. For sorption kinetics, pseudo-second-order adsorption has given a higher R2=0.99 value. Langmuir isotherm model well-described (R2=0.98) As(III) sorption on nZVZn-PCBC. The nZVZn-PCBC efficiently removed As (84%) from naturally As-contaminated salt lake water in the presence of co-occurring competing anions. In short, biochar modification with nano zero-valent zinc showed that As can be removed effectively from synthetic as well as real salt lake water.

Keywords

Arsenic, Biowaste, Drinking Water Treatment, Nanotechnology, Sustainability