Removal of Cr(VI) in Aqueous Solutions Using KOH-modified biochar/ polypyrrole/Al2O3 Composite.

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Abstract

Contamination of water sources by potentially toxic metal ions such as Cr(VI) is becoming a significant threat to many organisms. Among Cr compounds, Cr(VI) which exists as CrO_4^{2-}, $Cr_2O_7^{2-}$and $HCrO_4^-$ in aqueous media is a known potent carcinogen. Many technologies were adapted for the removal of Cr(VI) from aqueous solutions. Based on literature , pristine biochar has many limitations in removing Cr(VI). Mainly, pristine biochar has a negative surface charge which decreases the efficiency of adsorbing negative ionic species such as $HCrO_4^-$. We developed a novel KOH-modified biochar/ Polypyrrole/ Al_2O_3 composite for the efficient removal of Cr(VI) ions. This work utilizes a simple synthesis method with minimal use of chemicals and experimental results suggest that this composite is a promising low-cost adsorbent of Cr(VI). The composite before and after removal of Cr(VI) was characterized by Scanning Electron Microscope(SEM), X-ray Diffraction Spectroscopy (XRD) and Fourier Transform Infra-Red Spectroscopy(FTIR). The removal of Cr(VI) in the aqueous phase was monitored by UV-Visible spectroscopy at 350 nm. pH, contact time, initial Cr(VI) ions concentration were optimized using batch adsorption method for the maximum removal of Cr(VI) ions. Composite exhibited maximum Cr(VI) removal percentage of 91.5% within 80 min at pH 2. It was found that percent removal efficiency increased from 73 to 91 when pH decreased from 8 to 2. The adsorption process between biochar composite and Cr(VI) reached an equilibrium within 80 minutes showing a rapid removal rate of over 73% within the first 20 minutes. Point of zero charge of composite was found to be about 4.0 and at pH less than 4.00, surface is positively charge which attracts negatively charge $HCrO_4^-$ electrostatically. The negative values of $\Delta G°$ calculated at different temperatures indicate that the adsorption process is spontaneous at each temperature and positive $\Delta H°$ value (36.36 kJ $mol^{-1)}$ shows that the adsorption process is endothermic. $\Delta G°$ value increases with increase of temperature thus, spontaneity increases with temperature; indicated that adsorption of Cr(VI) was endothermic and spontaneous in nature. Isotherm data showed that the adsorption followed the Langmuir model where the maximum Langmuir adsorption capacity of composite was found to be 113.97 mg/g. In addition, a higher R^2 value of 0.9923 obtained in the Langmuir model indicates that the surface of the adsorbent material is homogenous where the adsorption takes place via monolayer formation. Kinetics data followed the pseudo-second order kinetics model, which favored chemisorption.

***Keywords**: Adsorption, Hexavalent Chromium, composite, KOH-modified biochar*

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