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Effect of acid modification on adsorption of hexavalent chromium (Cr(VI)) from aqueous solution by activated carbon and carbon nanotubes

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ABSTRACT

The present study addresses the application of raw and modified carbon nanotubes (CNTs) and activated carbon (AC) for the removal of hexavalent chromium (Cr(VI)) from aqueous solution. Surfaces of both the adsorbents were modified by acid treatment. Nitric acid was used to remove impurities and to introduce carboxylic functional groups on the surfaces of CNTs and AC. Raw and modified adsorbents (CNTs and AC) were characterized by scanning electron microscopy, Brunauer–Emmett–Teller surface area analysis, and thermogravimetric analysis. The influence of adsorbent dosage, contact time, agitation speed, and solution pH were evaluated on the Cr(VI) removal efficiency using batch adsorption experiments. The optimum pH for maximum adsorption of Cr(VI) was found to be 3 and 4 for AC and CNTs, respectively. Modified and raw AC were able to remove 99 and 92% of Cr(VI) ions, respectively, at 75 mg adsorbent dosage, agitation speed of 200 rpm, initial Cr(VI) concentration of 1 mg/L, contact time of 4 h, and solution pH 3, while the removal of Cr(VI) ions recorded maximum values of 87 and 80% for modified and raw CNTs under same treatment conditions. However, acid modification of CNTs was found to have no major effect on the percentage removal of Cr(VI) ions at low adsorbent dosage. Adsorption capacities of both the adsorbents were determined using batch adsorption experiments and experimental data were described by Langmuir and Freundlich adsorption isotherm models. However, Langmuir isotherm model was able to best describe the adsorption of Cr(VI) ions on raw and modified forms of CNTs and AC. Maximum adsorption capacity (q_e) was found to be 2.024 and 1.805 mg/g for raw and modified AC, while 1.021 and 0.964 mg/g for raw and modified CNTs.

Keywords: Hexavalent chromium; Adsorption; Carbon nanotubes; Activated carbon; Water treatment

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