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Adsorption characteristics of graphene oxide in the removal of Cu(II) from aqueous solutions

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ABSTRACT

The aim of this study was to investigate the adsorption characteristics of graphene oxide (GO) to remove Cu(II) from aqueous solutions. Batch experiments were performed to examine the effects of adsorbent dose, solution pH, competing Ni(II) ions, reaction time, initial Cu(II) concentration, and temperature on the adsorption of Cu(II) onto GO. Equilibrium, kinetic, and thermodynamic models were used to analyze the sorption data. Fourier-transform infrared (FTIR) and X-ray photoelectron spectroscopy (XPS) analyses were also performed to characterize the adsorption of Cu(II) onto GO. Results showed that the Cu(II) sorption capacity remained relatively constant between pH 3 and 5 (12.26–12.88 mg/g), which was higher than that at pH 2 (5.43 mg/g). In a binary solution of Cu(II) and Ni(II), the Cu(II) sorption capacities (6.61–9.79 mg/g) were higher than those (5.17–7.88 mg/g) of Ni(II). The maximum Cu(II) sorption capacity of GO was determined from the Langmuir isotherm model to be 39.58 mg/g. Sorption model analyses demonstrated that the Langmuir isotherm was best fit to the equilibrium data, whereas the pseudo-first order model was most suitable at describing the kinetic data. Thermodynamic analysis showed that the adsorption of Cu(II) onto GO was endothermic and spontaneous (ΔH° = 0.627 kJ/mol, ΔS° = 2.717 J/K/mol, ΔG° = –0.142 ~ –0.251 kJ/mol). FTIR spectra demonstrated that after the adsorption of Cu(II), the broad band (O=C–OH, carboxyl group) weakened and shifted to 3181 cm^{-1}, whereas the peak at 1164 cm^{-1} (C–OH, hydroxyl group) disappeared . XPS spectra showed that the Cu2p peak appeared in a wide scan of GO after the adsorption of Cu(II). Within a high-resolution scan of the Cu2p region, $Cu2p_{3/2}$ and $Cu2p_{1/2}$ peaks appeared at 932.8 and 953.1 eV, respectively.

Keywords: Adsorption; Copper ions; FTIR; Graphene oxide; XPS

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