Effective removal of lead ions from wastewater using multi-walled carbon nanotubes functionalized by organophosphonic acid

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**ABSTRACT**

Lead is one of the most common toxic pollutants found in industrial effluents, which can do harm to ecosystem and human health. In the present study, organodiphosphonic acid functionalized multi-walled carbon nanotubes (DPA-MWCNTs) have developed and efficiently been utilized to remove lead ions from wastewater. The relevant adsorption behaviors of DPA-MWCNTs for lead ions, such as the effect of pH, adsorption kinetics, adsorption isotherm, and thermodynamics as well, have also been investigated. The results indicate that the adsorption kinetics of DPA-MWCNTs for lead ions at different temperatures can be modeled by the pseudo second-order rate equation, the experimental data fit well with the Langmuir isotherm model, which indicates the monolayered way of the adsorption and the maximum adsorption capacities of DPA-MWCNTs for lead ions could reach 757.58 mg/g, which is much higher than that of other adsorbents reported in the literatures, and the excellent features of DPA-MWCNTs for lead ions removal can ensure their applicability and feasibility in the industrial scale. The evaluation of adsorption thermodynamic parameters (ΔG°, ΔH°, and ΔS°) suggests the spontaneous and endothermic nature of the adsorption process with the increase of the randomness. Moreover, the adsorption process optimization is performed using response surface methodology (RSM), and the analysis of variance (ANOVA) of the quadratic model demonstrated that the model is highly significant. From the obtained results, it has been found that DPA-MWCNTs can be used as a kind of adsorbent with high efficiency in wastewater treatment and water purification, which would provide a facile processing for lead removal.

**Keywords:** Adsorption; Lead ion removal; DPA-MWCNTs; Functionalization