Modeling of lead (II) ion adsorption on multiwall carbon nanotubes using artificial neural network and Monte Carlo technique

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ABSTRACT

In this study, Pb^{2+} removal from wastewater using multiwall carbon nanotubes (MWCNTs) was investigated. XRD, SEM-EDX, BET, and FTIR were employed for MWCNT characterization. The effects of various parameters, including the solution pH, adsorbent dosage, initial concentration of Pb^{2+}, and contact time, on the Pb^{2+} removal from wastewater were investigated experimentally. Furthermore, the nonlinear relationship among the parameters was predicted using an artificial neural network (ANN) approach. The Levenberg–Marquardt training algorithm showed the best training performance, with a mean-square error of 2.200×10^{-5} and an R^2 of 0.998. Combining the ANN models and Monte Carlo simulation, Pb^{2+} removal efficiency of 99.8% was obtained under the optimum conditions (pH of 10, MWCNT dosage of 0.05 g, contact duration of 60 min, and Pb^{2+} concentration of 100 mg/L). The high removal efficiency can be attributed to the available adsorption sites (active sites). The results of the reusability of MWCNTs showed that the adsorption efficiency was higher than 90%. Thus, MWCNTs have great potential for recycling and managing Pb^{2+} from wastewater.

KEYWORDS

Artificial neural network; Batch adsorption process; Carbon nanotubes; Monte Carlo technique; Pb (II) ions; Wastewater treatment

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