Optimization of process parameters for rapid adsorption of Pb(II), Ni(II), and Cu(II) by magnetic/talc nanocomposite using wavelet neural network

ABSTRACT

Artificial neural networks have been widely used to solve problems because of their reliable, robust, and salient characteristics in capturing nonlinear relationships between variables in complex systems. In this study, a wavelet neural network (WNN) based on the incremental backpropagation (IBP) algorithm was used in conjunction with an experimental design. To optimize the network, independent variables including ion concentration, adsorbent dose, and removal time were used as input parameters, while the removal percentage of Pb(II), Ni(II), and Cu(II) by magnetic/talc nanocomposite were selected as outputs. The network was trained by the IBP and four other algorithms as a model. To determine the number of hidden-layer nodes in the model, the root-mean-square error of a testing set was minimized. After minimizing this error, the topologies of the algorithms were compared based on the coefficient of determination and absolute average deviation. This comparison indicated that the IBP algorithm had the minimum root-mean-square error and absolute average deviation, and maximum coefficient of determination, for the test dataset. The importance values included 35.16 % for initial ion concentration, 32.74 % for adsorbent dose, and 32.11 % for removal time, showing that none of these were negligible. These results show that the WNN has great potential ability for prediction of removal of heavy-metal ions from aqueous solution with residual standard error less than 1.2 %.

Keyword: Heavy metals; Incremental backpropagation (IBP) algorithm; Magnetic nanocomposite; Talc [Mg3Si4O10(OH)2]; Wavelet neural network (WNN)