Development of a four-layered ANN for simulation of an electrochemical water treatment process

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ABSTRACT

This work is dealing with the performance and modeling of an electrochemical water treatment process. A bench-scale electrochemical reactor with working volume of 0.5 L was applied to treat an azo dye, acid brown 14, as a typical pollutant in aqueous media. For the dye initial concentration of 50 mg/L, the experimental data showed the optimum conditions of the process as: [NaCl] = 5 g/L, pH 6.4, and \( V = 4 \) V. Under the conditions, after 18 min and consuming of low energy amount of 0.24 Wh/L, 92\% of decolorization efficiency (DE) was obtained. To model the process and simulate the obtained results, artificial neural network (ANN) method was used. Five effective operational parameters, i.e. reaction time, initial pH, applied voltage, supporting electrolyte, and the dye initial concentrations were considered as the network inputs; meanwhile, both of the DE and energy consumption (EC) criteria, were considered as the relevant network outputs. A four-layered feed-forward ANN, consisting of “\texttt{trainbfg}” learning algorithm and “\texttt{tansig}” as the transfer function in both hidden and output layers, was constructed. The neuron number structure of 5:4:6:2 and the iteration number of 600, showed best model-calibration ability. The K-fold cross-validation method showed high correlation coefficients \( R^2 \) of 0.988 and 0.983 for the simulation of the DE and EC criteria, respectively.

Keywords: Modeling; Four-layered ANN; Electrochemical oxidation; K-fold cross validation

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