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A simple approach for the sonochemical loading of Au, Ag and Pd nanoparticle on functionalized MWCNT and subsequent dispersion studies for removal of organic dyes: Artificial neural network and response surface methodology studies

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Abstract

In this study, the artificial neural network (ANN) and response surface methodology (RSM) based on central composite design (CCD) were applied for modeling and optimization of the simultaneous ultrasound-assisted removal of quinoline yellow (QY) and eosin B (EB). The MWCNT-NH_2 and its composites were prepared by sonochemistry method and characterized by scanning electron microscopy (SEM), X-ray diffraction (XRD) and energy dispersive spectroscopy (EDS) analysis's. Initial dyes concentrations, adsorbent mass, sonication time and pH contribution on QY and EB removal percentage were investigated by CCD and replication of experiments at conditions suggested by model has results which statistically are close to experimented data. The ultrasound irradiation is associated with raising mass transfer of process so that small amount of the adsorbent (0.025 g) is able to remove high percentage (88.00 % and 91.00 %) of QY and EB, respectively in short time (6.0 min) at pH=6. Analysis of experimental data by conventional models is good indication of Langmuir efficiency for fitting and explanation of experimented data. The ANN based on the Levenberg–Marquardt algorithm (LMA) combined of linear transfer function at output layer and tangent sigmoid transfer function at hidden layer with 20 hidden neurons supply best operation conditions for good prediction of adsorption data. Accurate and efficient artificial neural network was obtained by changing the number of neurons in the hidden layer, while data was divided into training, test and validation sets which contained 70, 15 and 15% of data points respectively. The Average absolute deviation (AAD)% of a collection of 128 data points for MWCNT-NH_2 and composites is 0.58%.for EB and 0.55 for YQ.

Keywords

Artificial neural network (ANN), Central composite design (CCD), Sonochemistry, Simultaneous removal, Adsorption isotherms.

1. Introduction

The presence of poisonous dyes in environment is challenging subject due to their influences on animals and human life [1]. The complex (aromatic) structures of dyes generally which arise from industries such as plastics, leather, paper, textile, printing, cosmetics coloring and food lead to increasing their stability toward heat, oxidizing agent and breakdown by biological, physical and chemical treatments [2,3]. Moreover, the dyes and