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Application of response surface methodology for statistical analysis, modeling, and optimization of malachite green removal from aqueous solutions by manganese-modified pumice adsorbent

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ABSTRACT

It is hard to remove malachite green from aquatic environments due to its low degradability and other features. Based on the effect of manganese on physical and chemical characteristics of scoria, the aim of this study is to evaluate the manganese–coated pumice performance in removing malachite green (MG) from aquatic environments. Response surface methodology (RSM) based on the central composite designs (CCD) was used to assess the effects of independent variables including pH (3, 5, 7, 9, and 11), adsorbent dosage (0.2, 0.5, 0.8, 1.1, and 1.4 g/L), contact time (15, 30, 45, 60, and 75 min), and constant concentration of the dye (85 mg/L) on the response function and the best response values were predicted. The results indicated that the dye removal increases with increasing the pH value, absorbent dosage and contact time, whereas MG concentration has an antagonistic effect on sorption system. Moreover, the optimum dye removal efficiency (99.9%) was achieved in pH = 11, adsorbent dose = 1.4 g/L, and contact time = 75 min. The adsorption process fitted well with the Langmuir model which, indicated the presence of heterogeneous sites for to adsorption MG dye and also this process followed the pseudo-second-order model. According to the results, the modified pumice with manganese could be successfully used for MG adsorption in the aqueous solution rather than natural scoria due to wide chemical changes of adsorbent structure.

Keywords: Adsorption; Malachite green dye; Manganese-coated pumice; Response surface methodology

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