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Thermodynamic and Kinetic Study of the Intrinsic Adsorption Capacity of Graphene Oxide for Malachite Green Removal from Aqueous Solution

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ABSTRACT

Graphene oxide (GO) was produced from bare graphite (BGP) material and was used as an intrinsic adsorbent for the removal of malachite green (MG) from aqueous solution. In an optimization study, the effects of the initial concentration of MG, solution pH, adsorbent dosage, contact time and ionic strength were investigated in detail. The water-soluble dye was analyzed at a maximum wavelength of 618 nm. The optimum conditions for MG removal from aqueous solution included a 300 mg/L initial concentration with 0.02 mg adsorbent at pH 5.1, and complete adsorption equilibrium was reached within 40 min. The maximum adsorption capacity of GO for MG was 384.62 mg/g, dramatically higher (over 10 times) than that of BGP (28.73 mg/g).The adsorption process followed pseudo-second-order kinetics. Thermodynamic data demonstrated that dye adsorption onto the GO surface was mainly an exothermic spontaneous reaction. The remarkably different adsorption isotherms for GO and BGP fit well with the Langmuir and Freundlich models, respectively. It is therefore evident that the prepared GO can be used as a highly effective adsorbent for this toxic dye.

Key words: Graphene oxide; Malachite green; Adsorption isotherm; Thermodynamic;Kinetic

INTRODUCTION

Currently, many industries, including paper production, textiles, leather tanning, plastics, hair coloring and food technology, use synthetic dyes to color their final products. Malachite green (MG) is one of the most commonly used dyes for cotton, leather, silk, paper and printing inks[1], and it can also be used as an anti-parasitic and antifungal agent in aquariums[2].However, malachite green and its major metabolite, leucomalachite green, bothhave mutagenic, carcinogenic, genotoxic and teratogenic effects[3-4]. Whenever environmental contamination occurs, they bio-accumulatein aquatic life such as fish, crab, shrimp, mollusks and other animals[5-6] and cause detrimental effects in