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The Performance of Coconut Husk and Shell for the Removal of Methyl Red from Aqueous Solution: Adsorption Equilibrium and Kinetic Study

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Abstract: Removal of methyl red from aqueous solution onto coconut husks and coconut shell, a low cost agricultural waste material in a batch process was investigated. Adsorption and removal was studied as a function of amount of adsorbent (0.02-0.08 g), pH (2.0-12.0) and initial concentration (200-800 mg L^{-1}). Adsorption data were modeled using Langmuir, Freundlich and Tempkin adsorption isotherm models. Equilibrium data of the biosorption process fitted very well into Langmuir isotherm model. The maximum adsorption capacity was approximately 71 mg g^{-1} for both coconut husks and coconut shell at an optimum pH 12. Adsorption kinetic was verified by pseudo-first order and pseudo-second order kinetic models. The results indicated that the dye uptake process followed the pseudo-second order which suggest that adsorption of the dye was through a chemical sorption. From the removal experiments, the results indicated that coconut husks and coconut shell could not effectively be employed as a low-cost adsorbent for the removal of basic dyes (methyl red) from aqueous solution as its removal is concentration dependent.

Key words: Adsorption, methyl red, coconut husk, coconut shell, equilibrium, isotherm, kinetics

INTRODUCTION

Removal of dye from effluents of chemical industries such a s plastics, dyestuffs, textile, pulp and paper has remained a problem of increasing concern to the environmentalists. It is estimated that 2% of dyes produced annually are discharged as effluents from manufacturing operations whilst 10% are discharge from textile and associated industries. Most of these dyes are already known to be suspected carcinogenic and genotoxic to human and nature. The presence of these dyes even at very low concentrations is highly observable and undesirable. Thus, dye removal has been a very important and challenging task of wastewater treatment. Many health related problems such as allergy, dermatitis, skin irritation, cancer and mutations in humans are associated with dye pollution in water. They impart colour to water which is visible to human eye and therefore highly objectionable on aesthetic grounds. Not only this, they also interfere with the transmission of light and upset the biological metabolism processes which cause the destruction of aquatic communities present in ecosysystem. Further the dyes have a tendency to sequester metal and may cause micro toxicity to fish and other organisms.

Conventional wastewater treatment methods for removing dyes include physicochemical, chemical and biological methods such as coagulation and flocculation, adsorption, ozonation, electrochemical techniques and fungal decolorization. Among these methods adsorption has gained favour in recent years due to proven efficiency in the removal of pollutants from effluents. Activated carbon as an adsorbent has been widely investigated for the adsorption of dyes but its high cost limits its commercial application. In recent years, there has been growing interest in finding inexpensive and effective alternatives to carbon such as rice husks, chitin, orange waste, lemon peel, raw barley straw, coconut coir pith, durian seed and etc., (Namasivayam *et al*., 2001; Ho *et al*., 2005; Azhar *et al*., 2005; Ofomaja and Ho, 2007; Xue *et al*., 2008; Lakshmi *et al*., 2009; Tamez-Uddin *et al*., 2009; Amin, 2009; Ahmad *et al*., 2015).

Methyl Red (MR) is a commonly used monoazo dye in laboratory assays, textiles and other commercial products. It may cause eye and skin sensitization and pharyngeal or digestive tract irritation if inhaled or swallowed. Furthermore, MR is mutagenic under aerobic conditions and it undergoes biotransformation into 2-aminobenzoic acid and N-N'-dimethyl-p-phenylene diamine. Of latter, there has been increasing interest to

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