Utilization of agricultural waste chestnut shell for the removal of Reactive Brilliant Red K-2G from aqueous solution

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Received 1 September 2010; accepted 11 May 2011

ABSTRACT
Chestnut shell, an agricultural residue, was used as a low-cost adsorbent to remove Reactive Brilliant Red K-2G (RBR) from aqueous solution. Batch adsorption experiments were conducted to study the effects of initial solution pH value, adsorbent dosage, initial dye concentration and temperature on the adsorption. It was proved that strong acidic condition was favorable for the adsorption process and the optimal pH value was 1.0. Freundlich isotherm was appropriate for describing the experimental data. The kinetics study revealed that the adsorption of RBR onto chestnut shell followed the pseudo-second order model well. The external mass transfer mainly governed the adsorption rate. Thermodynamic studies demonstrated the spontaneous and exothermic natures of the adsorption process. The FTIR analysis indicated that functional groups such as amine, hydroxyl and phenolic compounds on the chestnut shell may be the active binding sites for the adsorption of RBR.

Keywords: Adsorption; Reactive Brilliant Red K-2G; Chestnut shell; Isotherm; Kinetic

1. Introduction
Synthetic dyes are widely used in the textile, plastic, paper, pulp, color photography, pharmaceutical and food industries. Most of the dyes are used in textile processing, in which its loss in wastewaters could vary from 2% for basic dyes to as high as 50% for reactive dyes, resulting in large amounts of dye-containing wastewater [1]. Furthermore, dye producers and users are interested in stability and fastness and are continually producing dyestuffs which are more difficult to degrade after use [2]. Thus, it is imperative to develop clean-up technologies for the treatment of water contaminated with dyes.

It is well known that activated carbons are the most largely adopted adsorbents for this process. However, the high unit cost of the activated carbon (about 1 US dollar/kg) and the absence of reliable methods for adsorbent regeneration (thermal regeneration costs are about 1–2 US dollar/kg) restrict its application [3]. So people have been searching for low-cost, renewable, locally available and efficient alternative adsorbents on and on. Based on the principle of waste control by waste, some researchers attempt to use agricultural waste materials to remove dyes from wastewater, including rice husk [4], sugarcane bagasse [5], wood apple shell [6] and wheat shell [7].