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The study of the potential capability of sugar beet pulp on the removal efficiency of two cationic dyes

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ABSTRACT

This study utilizes sugar beet pulp as a low-cost absorbent to remove two different cationic dyes, methylene blue and safranin, in aqueous solutions. The effects of operational parameters on the efficiency of dye removal including pH, adsorbent mass, initial dye concentration and contact time have been investigated. All sets of experiments were carried out in batch mode. For both dyes, the maximum absorption was reached at pH 10 while point zero charge was known to be at pH 6. Boehm method showed that the amount of the acidic and basic groups have been 0.4075 mmol g^{-1} and 0.0089 mmol g^{-1}, respectively. Freundlich and Langmuir models were used to analyse the obtained experimental data. In comparison, Langmuir model was understood to be a better fit for the experimental data than Freundlich model. Pseudo first-order and pseudo second-order models were used to determine the adsorption kinetics and it was observed that pseudo second-order model was the most suited model for both dyes. The equilibrium state for both dyes was reached after 210 min of the absorption experiment with more than 93% removal of dyes. The absorption capacities were found to be 211 mg/g and 147 mg/g for methylene blue and safranin, respectively.

Keywords: Adsorption; Sugar beet pulp; Methylene blue; Safarnin; Dye removal

1. Introduction

Recently, it has been estimated that more than 100,000 of commercial dyes are produced by pigment industrials and are extensively used in industries such as textile, cosmetics, paper and food colouring (Robinson et al., 2001). The effluents of industries containing coloured water are considered to be hazardous to living species due to the considerable level of organic contaminants content which are highly toxic and have odour, colour and unpleasant taste. In addition, dyes consist of stable molecules that are resistant to light, chemical and other kinds of exposures which can be considered as mutagens to humans and can also easily accumulate in the living tissues (Crini, 2006). Various chemical, physical and biological processes have been used to remove and treat these dyes. Most of dyes are made up of a complex aromatic molecular structure and have synthetic origins. Therefore, biological treatment is not effective due to low biodegradability of these dyes (Seshdari et al., 1994). Chemical techniques cannot be seen as suitable methods due to the accumulation of concentrated sludge which itself poses a disposal problem after dye removal. However, dyes are often being removed by this costly method (Weng et al., 2008; Sharma et al., 2007). Physical methods such as membrane separation (nano-filtration, reverse osmosis, electro-dialysis) (Nataraj et al., 2009; Purkait and DasGupta, 2004), coagulation and flocculation (Panswed and Wongchaisuwan, 1986), oxidation or ozonation (Malik and Saha, 2003; Koch et al., 2002), membrane separation (Ciardelli et al., 2000) and adsorption techniques (Wu and Tseng, 2008; Thinakaran et al., 2008; Anbia and Moradi, 2008; Anbia and Mohammadi, 2009; Anbia et al., 2006, 2007), for dyes removal are being widely used. Among these methods, adsorption is

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