Arab J Sci Eng (2015) 40:1553–1564
DOI 10.1007/s13369-015-1630-0

RESEARCH ARTICLE - CHEMICAL ENGINEERING

Removal of Colour (Direct Blue 199) from Carpet Industry Wastewater Using Different Biosorbents (Maize Cob, Citrus Peel and Rice Husk)

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Received: 16 October 2014 / Accepted: 3 March 2015 / Published online: 26 March 2015

Abstract Direct Blue 199 is used to colour carpets. In this study, adsorbents prepared from maize cob, citrus peel and rice husk (agricultural wastes) were used to study removal of Direct Blue 199 from its aqueous solution and a carpet industry's effluent. The adsorption equilibrium studies were carried out by varying the adsorbent dosage at a constant temperature of 28 °C. Adsorption of the dye varied with different adsorbents. Equilibrium adsorption data were correlated using Langmuir isotherms for all the three adsorbents. Kinetic study showed that it took about 2 h for 80–90 % removal. Kinetic data for all the systems studied could be correlated satisfactorily by pseudo-second-order rate equation. It is confirmed by statistical *t* test (paired two samples for means) that the predicted and observed data were not significantly different statistically. The studies indicated that the adsorbents, maize cob, citrus peel and rice husk powders can be used as low-cost alternatives for the dye removal.

Keywords Direct Blue 199 - Maize cob - Citrus peel - Rice husk

1 Introduction

A large group of dyes and pigment are used in carpet and textile industries. About 10,000 types of dyes are used in various industries like textile, carpet, food and pharmaceutical [1]. The trade in world market for Direct dyes and their preparations increased from 53,848 tonnes in 1992 to 1,81,998 tonnes in 2011 [2]. Water contaminated with residual dyes is ultimately discharged in nearby water bodies, and this causes ecological disturbances. Therefore, there is an urgent need for an advanced treatment of dye-contaminated water, for which primary and secondary treatments are found insufficient [3]. For treatment of dye-laden wastewaters, physico-chemical methods used are coagulation, electro-coagulation, flocculation, electro-flotation, precipitation, ion-exchange, membrane-filtration, irradiation and ozonation. To treat the wide range of dye-contaminated wastewaters, all these processes are relatively costlier.

Bio-adsorbent, which are readily available and inexpensive, may be an attractive alternative for dye wastewater treatment. Activated carbon has widely been used for treatment of the wastewater due to its high adsorption properties, including the capacity for colour removal, but the manufacturing cost and its regeneration make it more expensive [4]. Consequently, removal of various dyes and many pollutants applying low-cost adsorbents have been studied by many investigators [5–16]. Most of the reported works are related to removal of colours on activated carbon obtained from various biosorbents such as rice husk for acid dye removal [17], groundnut shell for removal of Malachite green [18], sawdust for removal of Malachite green [10], pine saw dust for removal of Malachite green [19], Borassus bark for removal of Malachite green [20], pine needles biochar for removal of Reactive Black-5 [21] and orange peel for removal of basic dyes methylene blue and Rhodamine B [22], methylene blue [23], Direct Blue-86 and Direct Yellow 12 [24,25]. However, some work has been reported for adsorption on organic support adsorbents like dried biogas waste slurry for removal of Direct Red 12B [26] and duckweed powder for removal of

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