METHYLENE BLUE REMOVAL FROM SIMULATED WASTEWATER BY ADSORPTION USING TREATED OIL PALM EMPTY FRUIT BUNCH

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ABSTRACT

Many industries in Malaysia such as textile, paper, high-technology, paint, pharmaceuticals, food, leather, cosmetics, tannery, printing and plastics, use varies dye in order to color their product like batik and also consume substantial volumes of water. Among varies industries, textiles industry ranks first in usage of dyes for coloration of fiber. As a result, they generate a considerable amount of colored wastewater. The effectiveness of the adsorption for dye removal from wastewater has made it an ideal alternative to other expensive treatment methods. This study investigated the potential use of sugarcane bagasse, pretreated with formaldehyde and sulphuric acid for the removal of methylene blue dyes from simulated wastewater. The effect of the initial dye concentration was investigated. For the powdered activated carbon (PAC), the percentage of intake almost 100% for all initial dyes concentration. On the other hand, for formaldehyde treated empty fruit bunch (PCEFB), the highest percentage of removal (96.4%) was obtained for 50 mg/L of initial dyes concentration and 50.5% for initial dyes concentrations of 250 mg/L. For the sulphuric acid treated empty fruit bunch (PCEFB), the highest and the lowest percentages of dyes removal are 98.2% and 74.5%, respectively. The study shows that higher adsorption percentages were observed at lower concentrations of methylene blue and the result is compared with the commercially available activated carbon. From this study, we can conclude that sulphuric acid or formaldehyde treated empty fruit bunch can be attractive option for dye removal from dilute industrial effluent.

Keywords
Sulphuric acid, formaldehyde, empty fruit bunch, adsorption, methylene blue.

INTRODUCTION

Textile industries produce huge amounts of polluted effluents that are normally discharged to surface water bodies and groundwater aquifers. These wastewaters cause damages to the ecological system of the receiving surface water and create a lot of disturbance to the groundwater resources. Most dyes used in textile industries are stable to light and are not biodegradable. In order to reduce the risk of environmental pollution from such wastes, it is necessary to treat them before discharging to the receiving environments. Considerable efforts have been made by many researchers to find appropriate treatment systems in order to remove pollutants and impurities of wastewaters emanated from different industries, in particular, textile industry [1]. Today more than 9000 types of dyes have been incorporated in the color index. Due to their low biodegradability, a conventional biological treatment process is not very effective in treating dye wastewaters, especially the reactive dyes. Physical or chemical processes have been usually used to treat them. However these processes are costly and cannot be used effectively to treat the wide range of dye wastewater [2].

In order to remove hazardous materials, like dyes, adsorption is a method which has gained considerable attention in the recent past. Adsorption is such a useful and simple technique, which allows gathering of both kinetic and equilibrium data without needing any sophisticated instrument [3-4]. Although many mathematical models are available for predicting adsorption, the acquisition of equilibrium data remains fundamental for validating all such models. Consequently, there has been a growing interest in developing and implementing various potential adsorbents for the removal of specific organics from water [5] and researchers are always in a hunt for developing more suitable, efficient, cheap and easily accessible types of adsorbents, particularly from the waste materials.

Although many experimental works have been conducted to assess the capability and the performance of various adsorbents especially for the removal of dyes from the textile industry, little research has been done to model dye-removal process from the textile wastewaters and to evaluate the significance of the effect of major parameters on the percent of dye adsorption. Activated carbon use is limited due to its high cost [6]. This lead to search for cheaper substitutes such as Bottom Ash a power plant waste, Egg shell membranes and several agro-industrial wastes/ residue have also been investigated for the adsorption of dyes with varying success [7]. These include De-Oiled Soya, hard wood, banana pith, Indian Rosewood, waste coir pith, bagasse pith, neem leaf powder, banana and orange peels, barley husk, cassava peel, rice husk and Mahogany sawdust, etc [8]. New economical, easily available and highly effective adsorbents are still needed. Therefore this study will investigate the effectiveness of Empty Fruit Bunch (EFB) as the new adsorbent.

METHOD

Preparation of adsorbent

The powdered activated corabon (PAC) was supplied by S.D. Fine Chemical, Mumbai, India and was used without further grinding or sieving.

Formaldehyde treated empty fruit bunches (*PC*EFB*C*)

The empty fruit bunches (EFB) was collected from local palm oil mill at Kulim, Kedah, Malaysia. The collected materials was cut to a small sizes and dried in sunlight for 72 hours until all moisture content was evaporated and ground with kitchen blender to a small particle sizes. Then the material was sieved to obtain sizes of -300 µm for adsorption experiment.

The empty fruit bunches was treated with 1% formaldehyde in the ratio 1:5 (w:v) at 50˚C for 4 hours in an air oven. The empty fruit bunches was filtered out with Bunchner funnel, washed with distilled water, in order to remove free formaldehyde and was activated at 80˚C in an air over for 24 hours. Then, the material was stored in tight plastic container for further used.

Sulphuric Acid Treated Empty Fruit Bunch (EFBC)

One part of Empty Fruit Bunch (EFB) was mixed with one part of sulphuric acid and heated in a muffle furnace for 24 hours and at 150^{o}C. The heated material was washed with distilled water and soaked in 1 % $NaHCO_3$ (sodium bicarbonate solution) for overnight to remove residual acid. The adsorbent material was dried in an air oven at 105 ^{o} C for 24 hours. It was ground and sieved to -300 µm to + 450 µm and used for the study.

Dye solution preparation

Methylene blue is a heterocyclic aromatic chemical compound with molecular formula: $C_{16}H_{18}C_lN_3S$. Methylene blue has a molecular weight of 373.9 g mol^{-1}.

An accurate weighed quantity of the dye was dissolved in double distilled water to prepared stock solution (250 mg/L). Experimental solution of the desired concentration was obtained by successive dilutions. Dye concentration was determined by using absorbance values measured before and after the treatment, with Hitaichi UV Visible Spectrometer (Model No.: U2810).

Adsorption experiments

In each adsorption experiment, 100 mL of dye solution of known concentration and pH was added to 400 mg of adsorbents in 250 mL round bottom flask at room temperature (26 + 1 °C), and the mixture was stirred on a rotary orbital shaker at 160 rpm.

The sample was withdrawn from the shaker at the pre determined time intervals and an absorbent was separated from the solution by centrifugation at 4500 rpm for 5 minutes. The absorbance of the supernatant solution was estimated to determine the residue of dye concentration.

The experiment was done by varying initial concentration of dye solution (50 – 250 mg/L) at pH 2 and contact time of 2 hours.

RESULT AND DISCUSSION

The influence of the initial dye concentration of methylene blue in the solution on the percentage of dye adsorption on PAC, EFBC and EFB were studied. The experiment was carried out at fixed adsorbent dosage of 0.4 g/L in the test solution, at room temperature (27 °C), at pH 7 and at various initial dye concentration of methylene blue (50, 100, 150, 200, and 250 mg/L for different time intervals up to 2 hours. Dye removal for PAC was almost 100%. The percentage of dyes removal by EFB, EFBC and PCEFBC was decrease with increase in initial dye concentration. (Figure 2) Though the percentage adsorption was decreased with increased in initial dye concentration but the actual amount of dye adsorbed per unit mass of adsorbent was increased with increase in dye concentration in the test solution. The equilibrium was established within 15 minutes at all the studied concentration by PAC. However, EFB, EFBC and PCEFBC took about 60 to 80 minutes, respectively for equilibrium attainment.

This may be due to fact that EFBC and EFB have macro and micro pores. In the process of dye adsorption, initially dye molecules have to first encounter the boundary layer effect and then it has to diffuse from boundary layer film onto adsorbent surface and then finally it has to diffuse into the porous structure of the adsorbents. This phenomenon relatively need longer contact time.

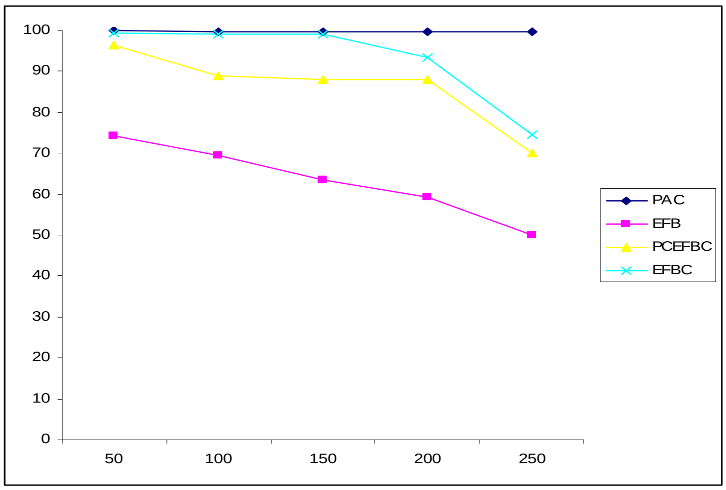

Figure 1: Effect of initial dyes concentration on dyes removal by PAC, PCSB and PCSBC (adsorbent dosage = 0.4 g/ 100 mL, temperature 26 °C, contact time = 120 minutes.

CONCLUSION

The removal of methyl red from simulated wastewater by using PAC, EFB, EFBC and EFBC has been investigated for various initial dyes concentration. From this study, it was found that EFB, EFBC and PCEFBC has a lower adsorption efficiency compared to powdered activated carbon (PAC) at the any given initial dye concentration. The adsorption efficiency can be arranged in the following order PAC > PCEFBC > EFBC > EFB. As empty fruit bunch of oil palm is easily available in the countryside, it has potential to be used for the small scale industries which produced dyes as their effluent, after it was being pretreated with formaldehyde and sulphuric acid. The data maybe useful for designing and fabrication of an economically cheap treatment process using batch or stirred tank flow reactors for the removal of methyl red from diluted industrial effluent.

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