DYES REMOVAL FROM AQUEOUS SOLUTION BY USING CHEMICAL TREATED EMPTY FRUIT BUNCH AT VARIOUS PH

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ABSTRACT

There is a considerable need for the removal of color from wastewater/effluents. The discharge of dye-bearing wastewater into natural streams and rivers from the textile, paper, carpet, leather, distillery, and printing industries poses severe problems. Nowadays, about 9000 types of dyes have been incorporated in the colour index. Due to low biodegradability of dyes, the discharge of coloured wastewater from these industries had caused many significant problems, such as increasing the toxicity and COD (chemical oxygen demand) of the effluent. Most of the dyes are very stable, either to photodegradation, bio-degradation or oxdizing agents. Currently, several physical and chemical processes are used for dyes wastewater treatment. However, these processes are highly cost and not efficient for the treatment of wide range of dye wastewater. Empty fruit bunch is an agro-waste from the oil palm industries, which used as a fuel for the boiler, to generate heat to the factory. In this study, empty fruit bunch is pretreated with sulphuric acid. The treated empty fruit bunch adsorption on the methylene blue was investigated for the various initial pH at room temperature. The finding was compared with the commercial powdered activated carbon (PAC). The result shows that the removal of dyes was unaffected by pH for PAC, and the pH range 5-8 was favorable for dyes removal by chemical treated empty fruit bunch.

Keywords

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

INTRODUCTION

The African Oil Palm was introduced to Sumatra and the Malaya area in the early 1900s; many of the largest plantations of oil palms are now in this area, with Malaysia growing over 20,000 square kilometres. Malaysia claims that in 1995 it was the world's largest producer with 51% of world production. In this area, the destruction of natural rainforest to grow oil palm plantations is an issue of major environmental concern.

Empty fruit bunches (EFB) of oil palm is one of the major solid wastes from oil palm industry in Malaysia The empty fruit bunch fibre (EFB) was identified as the first of the series of standards on oil palm fibres because of logistic reasons. The EFB has the highest fibre yield and is the only material commercially utilized for fibre extraction but there are good potentials for the exploitation of the other two materials (oil palm fronds and trunks).

Among various industries, textile industry ranks first in usage of dyes for colouration of fiber. Today more than 9000 types of dyes have been incorporated in the colour index. Due to low biodegradability of dyes, a conventional biological treatment process is not very effective in treating the dye wastewater. Adsorption on activated carbon (ACR) has been found to be an effective process for dye removal, but it is too expensive [1]. Dyes are used in large quantity in many industries including textile, leather, cosmetics, paper, printing, plastic pharmaceutical, food, etc to colour their product [2].
Dyes laden wastewater is usually treated by physical and chemical processes. These include flocculation, electro-flotation, precipitation, electro-kinetic coagulation, ion exchange, membrane filtration, electrochemical destruction, irradiation, ozonation and Katox treatment method involving the use of activated carbon and air mixture. However, these processes are costly and cannot effectively be used to treat the wide range of dye wastewater. Adsorption has been found to be superior to other techniques for wastewater treatment in terms of initial cost, simplicity of design, ease of operation and insensitivity to toxic substance. Activated carbon (granular or powder) is the most widely used adsorbent with great

success because of its large surface area, microporous structure, high adsorption capacity, ect. But it is limited due to high cost [3].

Adsorption techniques are widely used to remove certain classes of pollutants from waters, especially those that are not easily biodegradable. Amongst the numerous techniques of dye removal, adsorption is the procedure of choice and gives the best results as it can be used to remove different types of coloring materials. If the adsorption system is designed correctly it will produce a high-quality treated effluent. Most commercial systems currently use activated carbon as sorbent to remove dyes in wastewater because of its excellent adsorption ability.

Recently, numerous approaches have been studied for the development of cheaper and effective adsorbents. Many non-conventional low-cost adsorbents, including natural materials, biosorbents, and waste materials from industry and agriculture, have been proposed by several workers. These materials could be used as sorbents for the removal of dyes from solution. Some of the reported sorbents include clay materials (bentonite, kaolinite), zeolites, siliceous material (silica beads, alunite, perlite), agricultural wastes (bagasse pith, maize cob, rice husk, coconut shell), industrial waste products (waste carbon slurries, metal hydroxide sludge), biosorbents (chitosan, peat, biomass) and others (starch, cyclodextrin, cotton) [4-5].

METHOD

Preparation of Adsorbents

Powdered activated carbon was supplied by S.D. Fine Chemicals, Mumbai, India. The adsorbent was used directly without any further grinding or sieving. Untreated Empty Fruit Bunch (EFB) was obtained from local palm oil mill, was dried in sunlight until all of the moisture contents evaporated.

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^oC. 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

For this study, methylene blue was used and it was obtained from the local supplier. Figure 1 shows the structural formula of methylene blue.

An accurately weighed quantity of the dye was dissolved in double-distilled water to prepare stock solution (500 mg/L). Solution of desired concentrations was obtained by successive dilutions. Dye concentration was determined using adsorbance values measured before and after treatment. Experiment was carried out at initial pH value from 2 to 14. Initial pH was controlled by addition of diluted HCl and NaOH solution.

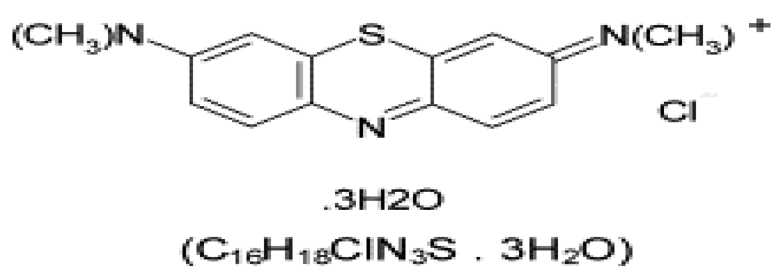

Figure 1: The structural formula of methylene blue

Adsorption Experiment

In each adsorption experiment, 100 mL of dye solution of known concentration and pH was added to 400 mg of adsorbent in 250 mL round bottomed flask at room temperature and the mixture was stirred on a rotary orbital shaker at 160 rpm. The sample was withdrawn from the shaker at the predetermine time intervals, and adsorbents was separated from the solution by centrifugation at 4500 rpm for 5 minutes. The adsorbent of the supernatant solution was estimated to determine the residual dye concentration. The experiment is done by varying the initial pH (2 - 14) for 2 hours.

RESULT AND DISCUSSION

To study the effect of pH on methylene blue adsorption on PAC, EFBC and EFB, the experiment was carried out at initial dye concentration of 250 mg/L with adsorbent mass of 0.4g/L at room temperature (27 ˚ C) for 2 hours contact time. The dye adsorption by PAC was increased by pH changes in the range of 2 - 14. However, the increment was quite small compare to EFBC and EFB. EFBC had maximum dye adsorption, which is 93.7 % at pH of 12 and decreased to 40.5% at pH of 2. Nevertheless for EFB, the dye removal was 20.2% at the pH of 2.0 which increased to 93.6% at the pH of 12 (Figure 2). Low pH of 2 - 6 was unfavorable for methylene blue adsorption by EFBC and EFB.

It was suggested that the increase in sorption depended on the properties of the adsorbents. At higher pH, more protons will be available and increasing electrostatic attractions between positively charged dye and negatively charged adsorbents sites and causing an increase in dye adsorption. It is like that positive charge develops on the surface of adsorbents in a basic medium, resulting in a higher adsorption at higher pH.

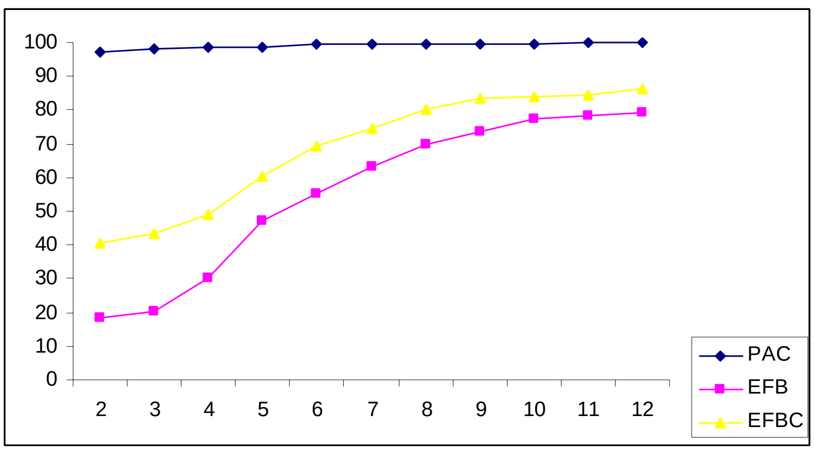

Figure 2: Effect of pH on methylene blue adsorption (dye concentration of 250 mg/L, adsorbent dosage= 0.4 g/ L and contact time = 2 hours.)

CONCLUSION

The removal of methylene blue from wastewater using PAC, EFBC and EFB has been investigated under different experimental conditions. The adsorption of methylene blue was dependent on adsorbent surface characteristic, adsorbents dose and methylene blue concentration in wastewater. Initial dye solution of pH over the range of 2-5 decreased the adsorption efficiency if EFBC and EFB. Initial pH over the range 7-12 was optimum for dye removal by EFBC and EFB. PAC is an expensive materials and regeneration is essential, whereas EFBC and EFB are cheap so regeneration is not necessary. As EFB 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 treated with hydrochloric acids.

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