Removal of dyes from polluted water by adsorption on maize cob

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Abstract

This research aimed to examine the effect of concentration of dyes stuff, contact time, temperature and ratio of adsorbent weight in (gm) to volume of solution in (ml) on the percentage removal. Two dyes were used; direct blue 6 and direct yellow and the adsorbent was the maize cob. Batch experiments were performed by contacting different weights of adsorbent with 50 ml of solution of desired concentration with continuous stirring at various temperatures.
The percentage of removal was calculated and the maximum percentage of removal was 80%. And as the concentration of solution, contact time, temperature and the ratio of adsorbent to volume of solution increase the percentage of removal increase.

Introduction

Dyes are a large group of chemicals used in chemical industries especially in textile industry. Dyes in use are so different compound and their environmental behavior is largely unknown (Albanis, 2000). Most of them are considered non –toxic, although some of them are not totally innocuous because they made of known carcinogens such as benzidine(Klimiuk, 1999) . Removal of dyes is difficult and poorly efficient upon the use of conventional physic-chemical and biological methods. Usually, dyes containing sewage are treated by means of absorption, ozonization, membrane processes, coagulation with flocculation and biological processes (Urszula, 2007).

The process of adsorption is one of the most efficient methods for dye removal from sewage especially when the adsorbent is cheap and easily available (Mahir, 1991). One of the effective techniques for removal of color from waste water is sorption by activated carbon. However, owing to expensive price of it, the use of activated carbon for removal of color is limited (James 1991).

Using agricultural by-products as adsorbents for the removal of pollutants such as dyes from waste solutions has been on the increase. This is because these agricultural by-products are naturally occurring; hence they are available at little or no cost. They also have advantages over the conventional adsorbent such as activated carbon particularly because of their low cost and high availability. There is also no need for complicated regeneration. One of these by-products is the maize cob (Hema 2007).

Experimental Work

1. The maize cob obtained was washed with water cut into small pieces, air dried, and crushed.
2. The sample of maize cob was washed again with distilled water to remove any contaminant that could affect the color measurement.
3. Stock of solution of dyes (1000 ppm) were prepared by dissolving 1gm of each dye in a liter of distilled water and subsequently diluted with distilled water to the required concentration 500 ppm , 250 ppm, 125 ppm , 75 ppm , and 50 ppm .
4. Step 3 was repeated for two dyes used for wool dying. The first was direct blue 6 and the second was direct yellow. The absorbency of each dye with the different concentration was measured using spectro

SC spectrophotometer using wave length suitable for each dye as shown in table 1.

Table 1:- structure and the wave length at extinction measurement of the dyes examined.

Dyes	Wave length, λ nm	structure
Direct yellow	430	
Direct blue 6	900	$C_{32}H_{24}N_6O_{14}S_4 \cdot Na_4$

There is approximately a linear relationship between the concentration of each dye and the absorbency so the concentration of each sample after treating with maize cob could be known by measuring the absorbency.

5. A 50 ml of each dye solution of known initial concentration was in contact with a required dose of maize cob. The sample was placed in a shaker and the absorbency after that was measured again.
6. The percentage removal was calculated by:-

$$\text{Percentage removal} = \frac{100(c_i - c_f)}{c_1} \quad (1)$$

Where
C_i = initial concentration ppm
C_f = final concentration ppm

Results and Discussion

Effect of contact time
The efficiency of adsorption of a dye from a solution was analyzed based on the changes in its concentration in the solution and the percentage of removal was calculated using equation (1).

Batch adsorption studies dyes were carried out by agitating in a shaker with rpm 75 min^{-1} 50 gm of maize cob particles in 50 ml dyes solution with concentration 250 ppm at different periods of time (3 hr,4 hr, 6 hr ,8 hr, one day).After adsorption , a liquot was separated by using a mesh with opening 125 μm to prevent any dust from maize cob to go with the liquot and the dye concentration was determined again .

As shown in figure (1), as the contact time increases the percentage removal increases and for one day 80% of the dye was adsorbed.
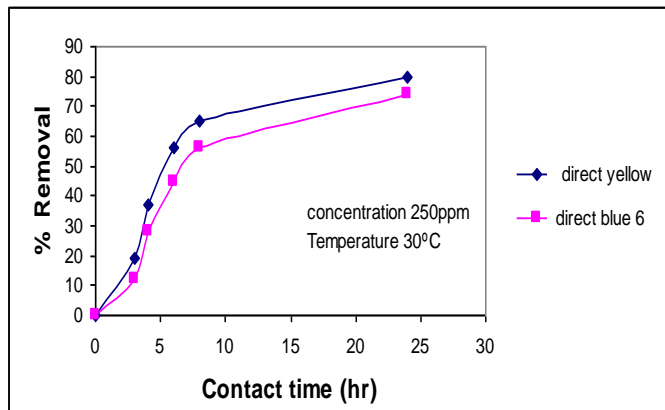
Fig(1) Effect of contact time on the percentage removal.
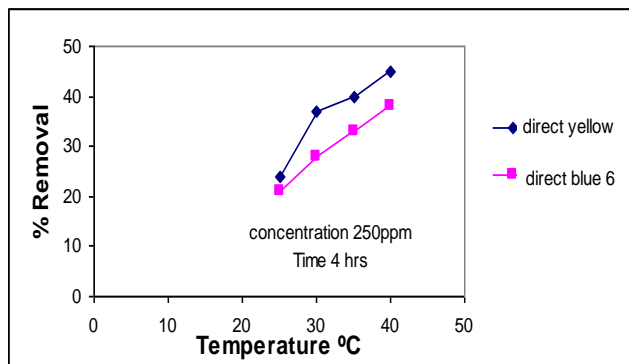
Effect of concentration

The effect of concentration on the percentage removal was studied using 50 gm of maize cob with50 of dyes solution with different concentration for four hours at 30 ˚c and the results shown in figure (2). As the concentration increases the percentage removal increases for both types of dyes.
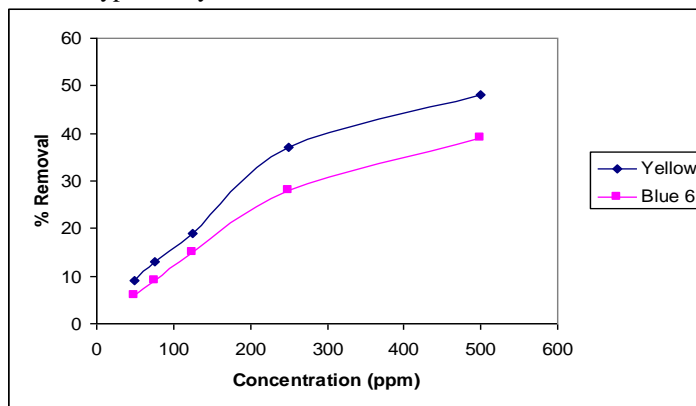
Fig(2) Effect of concentration on the percentage removal.

Effect of temperature
Increasing temperature has shown a less effect on the percentage of removal but also as the temperature increases the percentage of removal increases too as shown in figure (3). This was done by using magnetic stirrer with heater to reach different temperatures 25˚c , 30˚c, 35˚c and 40˚c during stirring 50 gm of maize cob with solutions with 250 ppm concentration .

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Fig(3) Effect of temperature on the percentage removal.

Effect of ratio of adsorbent weight to volume of solution

0.25, 0.5, 1, 1.25, 1.5 ratio of weight of adsorbent in gm to volume of solution with 250 ppm concentration in ml was used and the contact time was four hours at 30˚c. The result was better to increase the ratio to have high percentage removal. This is shown in figure (4).
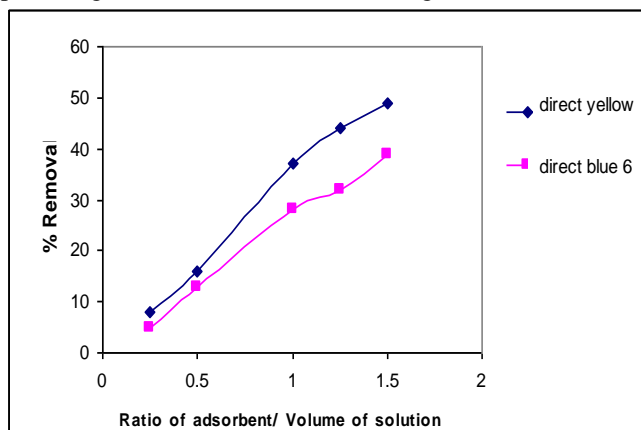
Fig(4) Effect of increasing ratio of weight of adsorbent(g) to volume of solution in (ml) on the percentage removal.

Conclusions

The following conclusions were detected from the present investigations:
1. The removal of dye by adsorption on to agricultural by-product has been found to be useful means for controlling water pollution.
2. Increases the ratio of adsorbent weight to the volume of solution show increasing in the percentage of removal.
3. Temperature shows a less effect on the percentage of removal.

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