Dyes Removal From Textile Wastewater Using Orange Peels

Fahim Bin AbdurRahman, Maimuna Akter, M. Zainal Abedin

Abstract: *Use of various dyes in order to color the products is a common practice in composite knit industry. The presence of these dyes in water even at low concentration is highly visible and undesirable. This study was carried out for the utilization of orange peel as adsorbent for the removal of dyes from wastewater and to establish it as a standard wastewater treatment process for composite knit industry. This experiment was performed in the laboratory scale. The materials were obtained and treated for the removal of dyes at different doses. These materials also evaluated for different pH and contact time. This batch adsorption experiment was carried out for finding the effects of adsorbent's amount, pH and retention time on the removal of dyes from the wastewater. The experiment showed that the removal percentage was 60-70% at pH=7 with a retention time of 120 minutes. The optimum dose amount of adsorbent was 1.5g/25mL. The equilibrium adsorption behavior was examined by applying Langmuir adsorption isotherm model. The adsorption capacity of orange peel is low but comparable to the other available adsorbents.*

Index Terms: T *Wastewater characterization, Wastewater treatment, orange peel, orange peel, removal* efficiency

1 Preface

In Bangladesh, the textile industry is one of the largest manufacturing industries. In every stage of textile industry various types of dyes are used to color their products. The dye containing wastewater is usually released directly into the nearby drains, rivers, stagnant, ponds or lagoons. Such wastewater disposal may cause damage to the quality of the receiving water bodies, the aquatic eco-system and the biodiversity of environment. The dyeing industry effluents contain high BOD and COD value, suspended solids, toxic compounds and the color that is perceived by human eyes at very low concentration. Moreover, dyes may adversely affect the aquatic life because of the presence of aromatic materials, metals and chlorides etc. The color removal was extensively studied using different methods such as coagulation, flocculation, ultra-filtration, nano-filtration, photo oxidation, activated carbon etc. But these methods are very expensive. The removal of dyes from wastewater using adsorption process by agricultural waste provides an alternative treatment. At present physical, chemical and biological methods are generally used as a treatment process for removing dyes from textile wastewater. But all these methods are not cost-effective and environment friendly. As a result, an alternative environment friendly technology has become a necessity for the composite knit industry. Over the last few years adsorption has gained paramount importance in industry and environment protection. Adsorbents are normally used for its environment friendly behavior, availability in nature and are very much-cost effective. Orange peel is largely composed of cellulose pectin; hemi-cellulose, lignin and other low molecular weight compounds including limestone. It can be used as an efficient and cost effective bio-adsorbent for removing dyes metals and organic pollutants from industrial wastewater. In addition orange peel is alternative as a adsorbent for its abundance in nature, non-toxicity and bio-degradability. This study was performed to utilize the orange peel as a low cost natural adsorbent with respect to various parameters such as different doses, contact time and pH.

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2 Materials And Methods

2.1 Sample and Adsorbents Collection

The sample wastewater was collected from Sharp Knitting & Dyeing Limited situated in Pagar, Tongi. The sample contains three different reactive dyes: Golden yellow, Black B and Red 6BL. The adsorbents used for this study is orange peel. Orange peels were collected from local fruit stall.

2.2 Preparation of Adsorbents

Orange is used mainly in orange-juice and soft drinks industries all over the world. They discard a huge amount of orange peels. These discarded peels can be used as an adsorbent for the removal of dyes from the wastewater. Waste orange peel was obtained from a fruit stall. At first, the peels were cleaned with distilled water to remove dust particles and water-soluble impurities. After that, these were cut into small pieces, dried in sunlight for 2 days until the peels become crisp. Then using mortar until uniform size particle was obtained grounded the peels. Finally the grounded peels were packed in airtight container and labeled.

2.3 Preparation of Standard Solution

Deazol Black B EAN reactive dye is very common in textile industries. Stock solution was prepared by dissolving accurately 0.1g-weighed quantity of the dye in 1L-distilled water. Later, desired amount of solutions were taken from the mother solution and diluted using distilled water. pH was adjusted by adding 0.1M NaOH solution and 1M acetic acid solution.

2.4 Batch Adsorption Study

In this experiment, a batch adsorption technique was used. To study the effects of various important parameters such as amount of adsorbent, pH values, the contact time between adsorbate and adsorbent. 25 ml of sample wastewater was taken from 100ml airtight flask. A desired amount of adsorbent then added to the sample. This experiment was carried out at room temperature. The solutions were then subjected to magnetic stirrer for proper adsorption. Samples were withdrawn from the stirrer at different time intervals. Then the adsorbents were separated from the sample by using filter paper. The absorbance was measured for supernatant solution using UV-Spectrophotometer. The final concentration of dye was estimated with the help of these absorbance data. For determining the uptake of the dye, all-inclusive sets of experiments were performed at different time intervals (30, 60, 90, 120, 150 and 180 minutes) and pH (2~9) etc. [3]. A range from 0.5g to 2.0g of adsorbent was also used to perform this experiment.The amount of adsorption at equilibrium time, q_e(mg/g) was calculated using equation:

$$q_e = \frac{(C_0 - C_e)V}{W}$$

Where, C_0 for the liquid-phase concentrations of dye at initial (mg/L); Ce, for the liquid-phase concentrations of dye at equilibrium (mg/L); V represents the volume of the solution, (L); W =mass of dry adsorbent used, (g).

3 RESULTS AND DISCUSSION

3.1 Effects of amount of adsorbent

Figure.1 illustrates that the adsorption capacity was increased with the increment of adsorbent dosage. The waste removal percentage is rises from 30% to 60% while the adsorbent dosages were increased from 0.5g to 1.5g for 25 ml solution. At low amount of dosage higher uptake was obtained. This result indicated that more surface area was made due to increased mass of adsorbent. Therefore, total number of sites increases [2]. In addition the figure shows that, above 1.5g of dosage the removal percentage is decreased. So, 1.5g of adsorbent indicate the optimum amount.

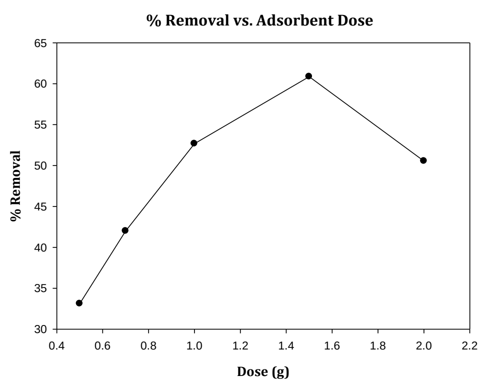

Figure-1: *Effect of orange peels dose on the removal of dyes by adsorption onto orange peel. (Initial concentration: 6g/L. pH value: 7 and contact time: 90 minutes.)*

3.2 Effects of pH

Figure.3 shows that the pH of the solution significantly affects the adsorption of dyes by orange peels. At average pH, the more effective dye adsorption capacity of orange peels was observed. The optimum adsorption capacity was achieved at pH 7. At lower pH, functional oxidized groups of the peels are promoted and thus active site of orange peels for binding of dye become less available. As a result, removal efficiency decreases.

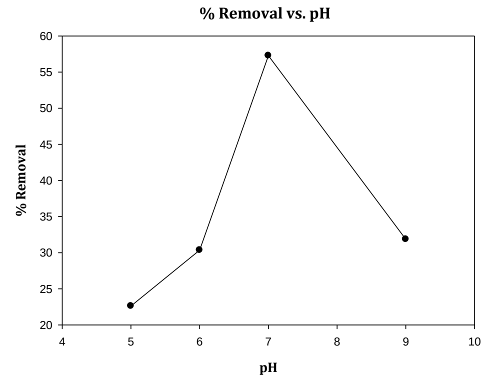

Figure-3: *Effect of pH on the removal of dyes by adsorption onto orange peel. (Initial concentration: 6 g/L, amount of adsorbent: 1.5 g and contact time: 90 minutes.)*

3.3 Effects of dye-adsorbent contact time

Effects of contact time on adsorption were studied and results are shown in figure.2. Figure shows that, increase in removal efficiency with increase in contact time between adsorbate and adsorbent. It can be attributed to the fact that more time becomes available for the dye to make an attraction complex with orange peels. The graph shows that, initial removal occurs rapidly as soon as the dye and peels in contact but after that when some of the easily available active sites engaged, dye needs time to find out more active sites for building. So, removal percentage is increased steadily over the period of experiment. It is concluded that dye and peels should be in contact for 120 minutes in order to get maximum removal percentage.

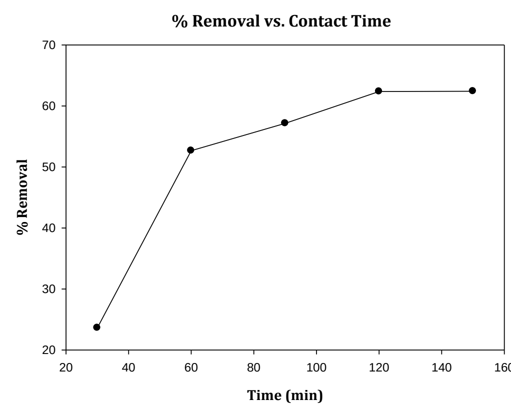

Figure-2: *Effect of contact time on the removal of dyes by adsorption onto orange peel. (Initial concentration: 6g/mL, Amount of orange peel: 1.5 g and pH value: 7)*

3.4 Adsorption Isotherm

In general, experimental isotherm is useful for describing adsorption capacity to facilate evolution of the feasibility of the process for a given application, for selection of most appropriate adsorbent and for p\preliminary determination of adsorbent dose requirements. The Langmuir isotherm is most frequently used to represent the data of adsorption from solution. The isotherm studied was carried out for optimum condition, which was obtained. The Langmuir isotherm assumes that the adsorption take places as homogeneous sites, all sites are equivalent and there are no interactions between adsorbate molecule and adjacent sites. The adsorption data were analyzed according to the linear form of the Langmuir isotherm equation. In order to establish the maximum adsorption capacity, the Langmuir isotherm equation of the following linearized form was applied to the sorption equilibrium at different adsorbents doses. The isotherm is described by following equation.

$$\frac{1}{q_e} = \frac{1}{q_m K_a} \cdot \frac{1}{C_e} + \frac{1}{q_m}$$

Where C_e represents the equilibrium dye concentration in solution (mg/L), q_e is the adsorption capacities (amount of dye adsorbed per weight of adsorbent, mg/g) q_m and $K_a$are Langmuir constant that can be determined from above Langmuir linear equitation. A graph of 1/qevs 1/Ce was plotted. The consantqm and KL can be evaluated from the intercept and slope of this linear plot. Figure.4 shows the Langmuir isotherm plot 1/qe versus 1/Ce. The slope of this plot is equivalent to (1/qm KL) when it intercepts 1/qm. Also, by comparing the correlation coefficient (R2 value) shown in table.1, the Langmuir isotherm model obtained a better fit of the experiment data.

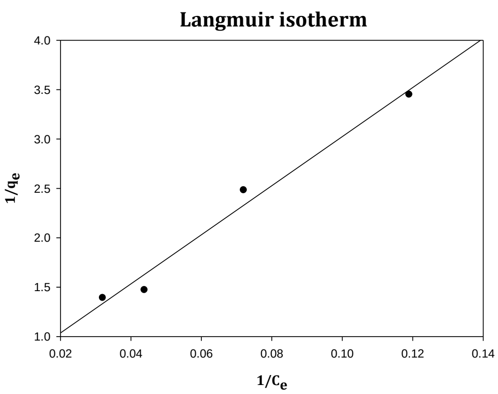

Figure-4: *Langmuir isotherm for Deazol Black B EAN reactive dye onto orange peel (initial concentration: 20-60 mg/L; time: 180 minutes, pH: 6.5-7; room temperature).*

Table-1: Parameters obtained from correlation of Langmuir adsorption isotherm for Deazol Black B EAN reactive dye.

Adsorbent	Dye	Langmuir isotherm equation		
		R^2	q_m(mg/g)	K_a (L/mg)
Banana peel	Black B reactive dye	0.968	1.744	0.0256

4 CONCLUSION

From this study, it may be concluded that the removal of various dyes from textile wastewater by adsorption on orange peels has been found to be useful for controlling water pollution due to dyes. From this experiment it is clear that, the adsorption of dyes onto orange peels is influenced by pH values, amount of adsorbents and contact time. Also, the adsorption of dyes onto orange peels follows the Langmuir isotherm model. In the review the efficiency of orange peels as an adsorbent has been studied. For higher removal of dyes from textile effluents adsorbent dose of 1.5g was favorable. The uptake of the dye increased with increasing contact time and the optimum contact time was obtained at 2 hours. Also, the adsorption was found to be higher for pH 7. From this research work it can be concluded that, the experimental data are well described by Langmuir isotherm model. Even though the removal efficiency of orange peels is not much higher than other bio-adsorbents, it is cheaply available. With this cheap and environment friendly adsorbent considerable dye removal can be achieved. So it can be substitute other expensive bio-adsorbents. With the experimental data obtained in this study, it is possible to design and optimize an economical treatment process for the dye removal from industrial effluents.

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