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STUDY ON EFFECT OF DIFFERENT PARAMETERS ON ADSORPTION EFFICIENCY OF LOW COST ACTIVATED ORANGE PEELS FOR THE REMOVAL OF METHYLENE BLUE DYE

Tesfaye Teka and Semegn Enyew

Chemistry,
Adigrat University P.O. Box 50, Adigrat, Ethiopia

ABSTRACT: Activated orange peels as an adsorbent was prepared by agitating in H_2SO_4 for 12 hours and washed with distilled water and again socked with2%$NaHCO_3$ solution over night to remove excess acidity. It was calcined at a temperature of 350^oC for 2:30 hours. Then the effect of adsorbent dosage, initial dye concentration, and contact time and particle size on the adsorption efficiency of the sample was tested using methylene blue as a target pollutant. The adsorption efficiency of the adsorbent for the removal of methylene blue was found as follows. adsorbent dosage and contact time was found to be directly proportional to the efficiency of adsorption of the prepared sample but up to a certain optimum value (82, 88.01 respectively) while initial dye concentration and particle size was found to be inversely related but still up to optimal amount or size.

KEYWORDS: Activated orange peels, Adsorption, Methylene blue, Operational parameters.

1 INTRODUCTION

The chemical industries make products with much beneficial usage; however, they do also have negative impacts on human health and the environment. They release hazardous, calcitrant and toxic chemical substances such as phenolic compounds, high molecular weight polymeric surfactants, herbicides and pesticides from industrial wastewater effluent which are well known to be not easily biodegradable [1]. Traditionally, industrial wastewater treatments for these effluents include different techniques such as biological treatment, reverse osmosis and activated carbon adsorption [2].

Adsorption is the transferring of adsorbate (dye) from the gas or liquid phase on to the surface of solid. Basically there are two types of adsorption, namely:

- Chemical adsorption (chemisorptions) and
- Physical adsorption (physisorption)

Physical adsorption occurs when weak antiparticle bonds such as Vander Waals, hydrogen bond and dipole-dipole interactions exist between the adsorbate and adsorbent. Chemical adsorption occurs when strong enter particle bonds such as covalent and ionic bonds are present between the adsorbate and adsorbent due to exchange of electrons. A molecule that undergoes adsorption is referred to as the adsorbate and the solid that adsorbs is the adsorbent. During adsorption, there is the formation of layer of gas, liquid or solid to the surface of solid or less frequently a liquid [3]. The term adsorption is often confused with absorption. Absorption refers to a phenomenon when something is taken up throughout the bulk such as sponge absorbs water. Adsorption refers to a phenomenon where something is taken up only at the surface, such as carbon powder adsorbs a dye. The general term for adsorption and absorption is sorption.

Adsorption can occur between solid-solid, gas- solid, liquid-liquid and liquid-gas interfaces. The removal of colored and colorless organic pollutants from industrial waste water is considered as an important application of adsorption process. The

Corresponding Author: Tesfaye Teka

most efficient and also commonly used absorbent is commercially activated carbon which is expensive and has regeneration problems. Activated carbons are prepared from coal (anthracite or brown coal), lignite, wood, nut shell, petroleum and sometimes synthetic high polymers [14].

Therefore, it is important to use low cost absorbents and less expensive to generate and use. In this project Methylene blue was chosen as target pollutant Methylene blue is basic aniline dye [13]. It is cationic dyes having molecular formula of $C_{16}H_{18}N_3Scl$ with molecular weight of 319.85. At room temperature, it appears as a solid, odorless, dark green powder. When hydrated ($C_{16}H_{18}N_3Scl.\ 3H_2O$) gives deep blue colour. The chemical name of methylene blue dye is 3, 7- bis (Dimethyl amino) phenothizin- 5- ium chloride or tetra metheyln thionine. Metheylene blue is the most commonly used material for dying cotton, wood and silk [10].

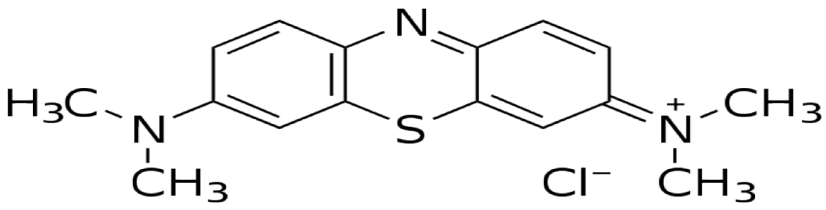

Figure. The chemical structure of methylene blue

Table 1: Properties of methylene blue (Velmurugan, 2011)

Chemical formula	$C_{16}H_{18}N_3SCl$
Molecular weight	319.85 g/mol
CI number	C.I. 52015
Type of dye	Basic blue
Melting point	100 – 110 °C
Boiling point	Decomposes
λmax	665 nm

So the aim of this work is to see the adsorption efficiency and effect of different parameters on adsorption efficiency of low cost activated orange peels for the removal of Methylene blue.

2 MATERIALS AND METHODS

2.1 2.1. EXPERIMENTAL SITE

The experiments were carried out at Adigrat University Chemistry Laboratory

2.2 EQUIPMENT AND APPARATUS

The equipment and apparatus used in this study were: UV/vis spectrophotometer, Furnace, centrifuge, analytical balance and test tubes and flasks.

2.3 CHEMICALS AND REAGENTS

In this study the following chemicals were used:

Methylene Blue dye ($C_{16}H_{18}N_3SCl$) (M.W. 319.85 g/mol), Concentrated H_2SO_4 , 2% sodium bicarbonate [$NaHCO_3$]

All were analytical grade and used with no further purification.

2.4 EXPERIMENTAL METHODS

2.4.1 SAMPLE PREPARATION

The sample that was used to conduct this project was low-cost activated orange peel. This sample was collected from different shops in Adigrat and then it was washed and dried in oven at 105^{o}c over night. Then it was agitated by 1:1 of H_2SO_4 and distilled water for 12 hours. Then it was washed with distilled water until it attained neutral PH and it was again socked with 2% $NaHCO_3$ over night in order to remove excess of acid present in it. Then it was washed again with distilled water and dried in oven at 105^{o}c. then it was calcined 350^{o}c in a muffle furnace for 2:30 hrs [19]. Finally the sample was grinded depending on the desired size and it was sieved by using appropriate mesh size (5mm, 10mm, 15mm and 20mm).

2.4.2 EFFECT OF VARIOUS PARAMETERS ON REMOVAL OF METHYLENE BLUE DYE

In order to see the effect of different parameters; a stock solution of 50 ppm solution was prepared by dissolving 50 mg of methylene blue dye in 1000 ml of distilled water and then desired amounts were taken in each step.

2.4.2.1 EFFECT OF ADSORBENT DOSAGE

To evaluate the effect of the amount of catalyst loading on the adsorption efficiency of the activated orange peels for removal of methylene blue; the experiment was carried out by varying the amount of catalyst to be loaded from 0.125-2g in 150 ml of the prepared solution [18] . Then the mixture was agitated and mechanically shacked for 6 hrs and then it was filtered using centrifuge at 150 rpm at room temperature. The adsorption efficiency was then determined by spectrophotometer. The percentage adsorption was calculated and other parameters were kept constant [18].

2.4.2.2 EFFECT OF INITIAL DYE CONCENTRATION

To evaluate the effect of the amount of initial dye concentration on the adsorption efficiency of the activated orange peels for removal of methylene blue; the experiment was carried out by varying the initial concentration of the dye from 10 - 50 ppm. Then the mixture was agitated with 0.5g of the sample and mechanically shacked for 6 hrs and then it was filtered using centrifuge at 150 rpm at room temperature. The adsorption efficiency was then determined by spectrophotometer. The percentage adsorption was calculated and other parameters were kept constant.

2.4.2.3 EFFECT OF CONTACT TIME

0.5 g orange peel was mixed with 50 ppm dye solution for various intervals of time (5 hrs, 8 hrs, 12hrs and 24 hrs) at room temperature. Similarly the adsorption efficiency was then determined by spectrophotometer. The percentage adsorption was calculated and other parameters were kept constant.

2.4.2.4 EFFECT OF PARTICLE SIZE

To evaluate the effect of particle size on the adsorption efficiency of the activated orange peels for removal of methylene blue; the experiment was carried out by using 5mm, 10mm, 15mm and 20mm particle size of the adsorbent . Then the mixture was agitated with 0.5g of each sample and mechanically shacked for 6 hrs and then it was filtered using centrifuge at 150 rpm at room temperature. The adsorption efficiency was then determined by spectrophotometer. The percentage adsorption was calculated and other parameters were kept constant

3 RESULTS AND DISCUSSION

3.1 EFFECT OF VARIOUS PARAMETERS ON REMOVAL OF METHYLENE BLUE DYE

To test Effect of various parameters on removal of methylene blue dye and the adsorption efficiency of the prepared sample the experiment was carried out as follows in a sequential manner. The percentage adsorption of the activated orange peels were measured and the percent adsorption was calculated for each case using the following equation

Adsorption (%) = [A0-At / Ao] X 100 (eq 3.1)

Where, Ao is the initial absorbance of the solution

At is the absorbance of the solution after adsorption

3.1.1 EFFECT OF ADSORBENT DOSAGE

To evaluate the effect of the amount of catalyst loading on the adsorption efficiency of the activated orange peels for removal of methylene blue; the experiment was carried out by varying the amount of catalyst to be loaded from 0.125-2 g in 150 ml of the prepared solution. The results were found to be follows.

Table1 Effect of dosage on adsorption efficiency of activated orange peels for removal of methylene blue

Amount of Adsorbent in gram	% of absorbance
0.125	40
0.25	55
0.5	82
1	71
2	50

The adsorption efficiency of the activated orange peels for removal of methylene blue increases with increasing the loading from 0.125 g - 0.5 g as shown in table1 above. But further increase up to 2 g was found to decrease the adsorption efficiency. Such patterned results have been reported from previous studies for other dyes [18]. This observation can be explained by the number of active sites as the main cause for the differences. Indeed, the total number of active sites increased with increasing adsorbent dosage. But further increase up to 2 g was found to decrease the adsorption efficiency. This may be due to the fact that as the adsorbent increase above the optimal amount the active sites may close with each other [19]

3.1.2 EFFECT OF INITIAL DYE CONCENTRATIONS

Table 1. Effect of initial dye concentration on adsorption efficiency of activated orange peels for removal of methylene blue

Amount of methylene blue dye in soln in ppm	% Absorbance
10	88
20	86.6
30	85.2
40	83.5
50	82

Based on the result shown in table 2, it is possible to conclude that percentage adsorption of methylene blue was found to decrease with increase in initial dye concentration. But the actual amount of methylene blue dye adsorbed per unit mass of carbon increased with increased in dye concentration of dye [8]. Basically this phenomenon can be explained interns of available active sites. At low adsorbate concentration, the ratio of surface active sites to total dye is high. Hence the dye ions could interact with the sorbent to occupy the active sites on the carbon surface sufficient and can be removed from the solution [5]. But with the increase in adsorbate concentration, the number of active adsorption sites is not enough to accommodate dye ions and this agrees with the literatures.

3.1.3 EFFECT OF CONTACT TIME

0.5 g orange peel was mixed with 50 ppm dye solution for various intervals of contact time (5 hrs, 8 hrs, 12hrs and 24 hrs) at room temperature. The percentage adsorption was as follows

Table1. Effect of contact time on adsorption efficiency of activated orange peels for removal of methylene blue

Agitation time (contact time)	%Absorbance
5 hrs	78`
8 hrs	85
12 hrs	88
24 hrs	88.01

The extent of dye removal by activated orange peels was found to increased with the increased of contact time. The removal of dye by adsorption using activated orange peels was found to be rapid at the initial period of contact time and then become slower with the increase of contact time [8]. This may be due to the strong attractive forces between the dye molecules and the adsorbent. As contact time increased, initially percentage removal also increased, but after some time it gradually approached almost constant value at after equilibrium was reached [12]. The changes in the rate of removal with time might be due to the fact that initially all adsorbent sites were vacant and the solute concentration gradient was high.

3.1.4 EFFECT OF PARTICLE SIZE

Table 4.Effect particle size on adsorption efficiency of activated orange peels for removal of methylene blue

size of Adsorbent	%Absorbance
20mm	40
15mm	74.65
10mm	83
5mm	70

From the result in table 4, it is possible to conclude that as the mesh size decrease, the efficiency increase up to optimal point. This may be due to the presence of large number of smaller particles which provide the sorption system with larger surface area available for the dye adsorption [8].

4 CONCLUSION AND RECOMMENDATION

4.1 CONCLUSION

In this piece of work, activated orange peels was prepared as adsorbent and used for removal of methylene blue dye. The effects of

Some selected operating parameters (effect of dosage of adsorbent, initial dye concentration, and contact time and particle size) have been studied. It was found that adsorbent dosage and contact time was found to be directly proportional to the efficiency of adsorption of the prepared sample but up to a certain optimum value (82, 88.01 respectively) while initial dye concentration and particle size was found to be inversely related but still up to optimal amount or size.

Therefore, optimizing the various operational parameters is of paramount importance from the design and the operational as well as economical points of view as these could affect the degree of adsorption efficiency of the adsorbent.

4.2 RECOMMENDATION

Since there are different peels which are thrown through out every streets which may be used as adsorbents, other researchers should study such kind of work. Other operational parameters should also be optimized.

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