REMOVAL OF REACTIVE RED 3B FROM AQUEOUS SOLUTION BY USING TREATED ORANGE PEEL

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ABSTRACT

In this study modified agricultural residus, orange peel was examined as sorbent to remove reactive red 3BF from aqueous solution. To modify its sorptive characteristics, orange peel was treated with HCL. This study on adsorption of reactive red 3B was conducted by using batch experiment by varying various parameters such as contact time, PH and amount of adsorbent. The percentage of adsorption of RR3B on top was found to be 93.6 at initial concentration of (50PPM).

Treated orange peel was found to be very effective and reached equilibrium in the 2.5hr. The percentage of adsorption decreased with increase in the PH and showed the maximum removal of reactive red in the range (4-6) pH, Also it was observed that the removal efficiency of reactive dye increase with increasing adsorbent dose and contact time. The freundlich and Langmuir isotherm was employed and their isotherm constant wascalculated. The experimental data fitted well with the Langmuir and freundlich adsorption isotherm. The result indicated that the treated orange peel could be alternative material of more costly adsorbent used for dye removal.

Keywords: Orange Peel, Reactive Red, Isotherm Model.

1- INTRODUCTION

Dyes are chemicals, which on binding with material will give colour to them. Dyes are ionic aromatic organic compound with structure including aryl rings, which have delocalized electron system. The colour of dye provided by the presence of chromophore groupe. A chromophore is a radical configuration consisting of conjugated double bond containing delocalized electrons. The Chromogen, which is aromatic structure normally containing benzene, naphathalen or anthracene ring, is a part of chromogen –chromophore structure along with an auxochrom. The presence of the
ionizing groups known as auxochrom result in a much stronger alteration of maximum absorption of compound and provide bonding affinity (Velmurugan, P., 2011).

Many dyes and their breakdown products may be toxic for living organism therefore decolourization of dyes is an important aspect of wastewater treatment before discharge. conventional method such as a chemical precipitation, chemical oxidation or reduction, filtration, electrochemical treatment, ion exchange, adsorption, membrane processing and electrolytic methods, have been traditionally employed for colour and heavy metal removal from industries waste water, (Tobin and Roux, 1998).

However the shortcoming of most of these methods are of high operational and maintenance costs, generation of a toxic sludge and complicated procedure in the treatment involved in the treatment. Comparatively, adsorption process is considered better in the water treatment because of the convenience, ease operation and simplicity of design, (Faust and Ally, 1987).

A number of non-conventional low cost adsorbent used for dyes removal include fruit waste of the prosopis juliflora, wood, waste orange peel, banana pith and bagasse pith etc. Utilisation of agricultural waste as low cost adsorbent, (M. C. Somasekhara Reddy, 2006) the present study is to explore the feasibility of orange peel as low cost natural adsorbent with respect to the various parameter such as colour adsorbent capacity of material with initial concentration at different doses and pH. The adsorption isotherm are plotted to study the removal capacity of material, the study shows that the material has good potential for the removal of colour from aqueous solution.

Orange peel principally consists of cellulose, pectin, hemicel luloses, lignin, chlorophyll pigments and other low molecular weight hydrocarbons (Liang, et al., 2010). These components contain various functional groups, such as carboxyl and hydroxyl groups which make the orange peel to be a potential adsorbent material for removing metal ions from aqueous solution (Arami, A. et al., 2005).

R.S. Mane and V.N. Bhusari (2012) studies the adsorption process by using the banana and the orange peel to remove the colour from the waste effluent of textile industry. The material was obtained and treated for the removal colour at different doses and evaluated for removal of the colour at different PH.

Gurusamy Annaduria et al. (2002) use the low cost banana and orange peels were prepared as a adsorbent for the adsorption of dyes from aqueous solution.

A. G. El-Said a and A.M. Gamal b (2012) use the low cost and eco- friendly adsorbent has been investigated as ideal alternatives to the current expensive methods for removing dyes from waste water. Orange peel (OP) was used as a low cost natural waste adsorbent for removal of textile effluent.

RESEARCH OBJECTIVE

The main objectives of this study can be summarized in the following option:

1- Investigating the removal of the (Reactive Red 3B) from the aqueous solution by using orange peel as adsorbent material bed with different operational conditions.

2- Modify orange peel by pretreatment of row orange peel with HCL acid to enhance adsorption capacity and to investigate the adsorption of RR3BF dye on it. The study including the characteristics of adsorbent and determination the factors affecting the sorption such as contact time, PH and initial dose.

3- Calculation of the adsorption capacity and intensity using langmuir and freundlich isotherm models for the adsorbent.
2- MATERIALS AND METHODS

2-1- Adsorbate

The chemical structure of the dye is shown in figure (2-1).

![Chemical structure of RR 3B dye](image)

Table (2-1) shows some of specification of reactive red dye. Some suppliers consider these specification of their product as know how due to commercial reasons.

<table>
<thead>
<tr>
<th>Item</th>
<th>Reactive Red 3 B (Abood W. M., (2012))</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trade name</td>
<td>Red 3B</td>
</tr>
<tr>
<td>origin</td>
<td>China</td>
</tr>
<tr>
<td>phase</td>
<td>Solid / Powder Package 25 kg</td>
</tr>
<tr>
<td>Wave length (nm)</td>
<td>540</td>
</tr>
<tr>
<td>Solubility g/l</td>
<td>100</td>
</tr>
<tr>
<td>pH</td>
<td>6.2 - 6.5</td>
</tr>
<tr>
<td>Molecular weight g/mol</td>
<td>881.5</td>
</tr>
</tbody>
</table>

Dye solution preparation an accurately weighted quantity of the dye dissolved in distilled water to prepared stock solution (50 PPM).

Solution used in the experiment for the desired concentration obtained by successive dilutions. Dye concentration was determined by using absorbance values measured after the treatment, at (540 nm) with double beam u v visible spectrophotometer (model: 6800 UV / VIS. Spectrophotometer JE.NWAY). Experiments were carried out at Initial ph value is (6.4) and was controlled by addition of sodium hydroxide Or Hydrochloric acid with (0.1 N).

2-2 Adsorbent

Orange peel was selected and washed with water several times to remove ash and other contamination and dried at(90° c)for (24hr) the product was then crushed and sieved through screen
to an average size less than 600mm and was designated as op. After drying the op treatment with (1N) for 5 hrs of HCL and they were washed with distilled water to remove excess acid and dried and used for the study.

Orange peel principally consists of cellulose, pectin, hemicelluloses, lignin, chlorophyll pigments and other low molecular weight hydrocarbons (Liang, s.et.al.2010). These components contain various functional groups, such as carboxyl and hydroxyl groups which make the orange peel to be a potential adsorbent material for removing metal ions from aqueous solution (Arami. A.et.al.2005)

Depending on this phenomenon, this work was aimed on studying the potential adsorption of orange peel as natural waste material that could provide a successful eco friendly low cost solution for removing reactive red 3B from aqueous solution. The effective parameters of pH, and contact time and initial dose of adsorbent were investigate.

2-3 Adsorption studies

Batch adsorption experiments were carried out by agitation at speed of (250 rpm) accurately weighted amount of adsorbent (orange peel) with (100 ml) aqueous solution dye concentration in (250 ml). Conical flasks placed on a shaker set. After the shaking samples were filtered through watt man 42 filters papers and analyzed.

2-4 Determination of MB

The concentrations of RR3B in aqueous solutions were determined by measuring the absorbance of the solution at 540 nm using a uv-visible spectrophotometer. Aqueous solutions of the dye within the concentration range (5-30) mg/l were used for calibration. Plots of absorbance against concentration were linear as shown in figure (2-2).

![Fig.(2-2): Calibration curve](image)

2-5 Adsorption parameters studied

- Adsorbent dosage (0.5,1.1.5,2,2.5,3)gm
- Contact time (0.5,1.1.5,2,2.5,3) hour
- Solution PH (4,6,8,10)
3- EXPERIMENTAL PROCEDURES

3-1 Effect of adsorbent concentration on dye adsorption:
Different amounts of orange peel (0.5, 1.5, 2, 2.5, 3) g were mixed with reactive red solution at concentration (50 mg/l) and pH (6.4). The mixture was agitated at 28°C for two and half hour. The dye concentration was determined by measuring the absorbance of the solution at 540 nm.

3-2 Effect of contact time on dye adsorption:
To study the effect of contact time on efficient removal of color from aqueous solution, the study was carried out for (0.5, 1, 1.5, 2, 2.5, 3) hour at pH (6.4).

3-3 Effect of PH on dye adsorption:
Adsorption test was carried out by mixing 3 gm of orange peel ‘600 Mm particle size with reactive red solution that adjusted by using a few drops from (H CL) and (Na OH) to (4, 6, 8 and 10). The mixtures were agitated at 28°C for two and half hour. The dye concentration was determined by measuring the absorbance of the solution at 540 nm.

4- EQUILIBRIUM ISOTHERM PROCEDURE
Adsorption experiments were carried out in batch conditions. For isotherm studies, accurately weighted amount (0.5-3) gm at adsorbent were continuously stirred at 250 rpm with 100 ml of 50 mg/l reactive red3bf aqueous solution. The mixture was agitated. For predetermination period of time at room temperature at the end of the equilibrium period the residual dye concentration was determined by using uv/visible Spectrophotometer.

The amount of reactive red adsorbed at equilibrium, q e (mg/g),

\[ q_e = \frac{(c_0 - c_e) \times v}{m} \] ........................ (1)

\(c_0\) and \(c_e\) (mg/l): are the initial and equilibrium concentration of dye Solution respectively.
M (g): is the amount of adsorbent used
V (L): is the volume of solution.
The removal efficiency can be calculated as follows:

\[ R(\%) = \frac{(C_0-C_e)}{C_0} \times 100 \] ........................ (2)

5- RESULTS AND DISCUSSIONS
5.1 Introduction
The behavior of treated orange peel as an adsorbent was studied by evaluating the equilibrium isotherm and removal efficiency of reactive red (3B) in batch. Equilibrium data is fitted to Langmuir and Freundlich models. The applicability of the isotherm equation was compared by calculating values (R^2). The effect of various initial dose concentration, pH, and contact time also was studied.

5.2 Effect of contact time
Figure (5-1) depicts the amount of RR3B removed by treated orange peel at 28°C and PH (6.4) as a function of contact time. The figure shown dye adsorption at initial stage is quit rabid but it gradually slows down unit (it reaches the equilibrium).
This is due to the fact that a large number of vacant surface sites are available for adsorption during the initial stage, and after a lapse of time the remaining vacant surface sites are difficult to be occupied due to repulsive forces between the solute molecules on the solid and bulk phases (Ahmad et al, 2009). The equilibrium was attained after shaking for (2.5) hr.

![Figure 5-1: Effect of initial contact time of RR3B on the equilibrium adsorption capacity of treatment orange peel (TOP)](image)

### 5-3 Effect of initial solution PH

The pH of the solution affects the surface charge of the adsorbents as well as the degree of ionization of different pollutants. The hydrogen ion and hydroxyl ions are adsorbed quite strongly and therefore the adsorption of other ions is affected by the pH of the solution.

The effect of pH on the adsorption of RR3B on orange peel is presented in figure (5-2). It shows that the percentage removal of RR3B was maximum at the (pH =4) and decreased with further increase in pH.

![Figure 5-2: Effect of initial PH solution of RR3B on the equilibrium adsorption capacity of treatment orange peel (TOP)](image)
5-4 Effect of adsorbent dosage

Variation of adsorbent dose showed that although increasing of TOP dose in aqueous solution can result to increased pollutant removal, but this deviation of TOP leads to decreasing of adsorbed dye per unit of adsorbent (qe), this phenomenon may relate to the use of surface area as unsaturated form. The q_e (mg/g) decreasing from 7.23 mg/g to 1.5 mg/g (figure 5-3).

This result indicates that although mass elevation of adsorbent can provide large or available surface area, but the adsorption pattern of the pollutant as unsaturated form leads to unfavorable using of adsorbent.

This phenomenon is the most important point for the design of economical and large scale adsorption devices (Ehrampoush et al, 2011).

![Fig.(5-3): Effect of dosage of treatment orange peel (TOP) in adsorption process](image)

5-5 Adsorption Isotherm

Application of Langmuir and Freundlich models to the adsorption isotherm, showed that the Freundlich and Langmuir isotherm models provided excellent satisfactory with the highest (R^2) value (0.995 and 0.978). The estimated values for the parameters of these and freundlich are shown in figures (5-4) and (5-5) respectively.

<table>
<thead>
<tr>
<th>Table (5-1): characteristics of adsorption isotherm</th>
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<tbody>
<tr>
<td><strong>Freundlich</strong></td>
</tr>
<tr>
<td>K (mg/g) (l/mg)^(1/n)</td>
</tr>
<tr>
<td>1/n</td>
</tr>
<tr>
<td>0.995</td>
</tr>
</tbody>
</table>
The Freundlich and Langmuir isotherms are compared to each other for treatment orange peel (TOP) experiment and are given in figure (5-6), from figure can be noticed that the adsorption isotherm for RR3BF agreed with both Langmuir and Freundlich models.
REFERENCES


