COMPARATIVE STUDIES OF ADSORBENTS PREPARED FROM AGRICULTURAL WASTES LIKE BAGASSE, JACKFRUIT PEEL & IPOMOEA FISTULOSA (BESHRAM)

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ABSTRACT
The ability of some solids to remove color from solutions containing dyes has been known for over a century. Activated carbons are obtained from a carefully controlled process of dehydration, carbonization, and oxidation of organic substances such as bamboo, coconut shell, palm Kernel shell, wood chips, saw dust, corn cob, sugarcane bagasse etc. The present work is aimed to synthesize & compare the effectiveness of adsorbents developed from the agricultural wastes like Bagasse, Jackfruit peel & Ipomoea Fistulosa (Beshram) leaves using chemical activation method. Comparison of effectiveness of adsorbents developed with the commercial grade activated carbon is carried out. Estimation of adsorption isotherms for removal of methylene blue is the basis for performance comparison. The experiments are divided into two parts: a) The analysis of methylene blue samples is done by using Colorimeter. b) Batch Experiments are performed for Estimating Adsorption Isotherm. The highlight of the present work is utilization of agricultural waste Bagasse, Jackfruit peel & Ipomoea Fistulosa (Beshram) leaves in to useful activated carbon. It is worth mentioning that Ipomoea Fistulosa which is socially known as a shrub having no utility has been successfully been converted in to good quality activated carbon.

INTRODUCTION:
The ability of some solids to remove color from solutions containing dyes has been known for over a century. Similarly, air contaminated with unpleasant odours could be rendered odourless by passage of the air though a vessel containing charcoal. Although such phenomena were not well understood prior to the early twentieth century, they represent the dawning of adsorption technology which has survived as a means of purifying and separating both gases and liquids to the present day. Indeed, the subject is continually advancing as new and improved applications occur in competition with other well-established process technologies, such as distillation and absorption. [1]

Activated carbons are solid, porous, black carbonaceous tasteless materials. Activated carbon is a microcrystalline form of carbon with very high porosity and surface area.

Activated carbons are obtained from a carefully controlled process of dehydration, carbonization, and oxidation of organic substances such as bamboo, coconut shell, palm Kernel shell, wood chips, saw dust, corn cob, sugarcane bagasse etc. The thermal or chemical processing of the raw material should be such as to make it extremely porous and thus to have a very large surface area available for adsorption or chemical reactions.

Various authors have worked on preparation of activated carbon from agricultural waste such as: Chemically modified sugarcane bagasse as a potentially low-cost bio-sorben for dye removal[2], Effect of Activation Temperature and Heating Duration on Physical Characteristics of Activated Carbon Prepared from Agriculture Waste[3] Adsorption of acid dye onto activated carbons prepared from agricultural waste bagasse by ZnCl₂ activation [4], Removal of lead ions from aqueous solutions using powdered corn cobs [5]

PRESENT WORK:
The present work is aimed to synthesize & compare the effectiveness of adsorbents developed from the agricultural wastes like Bagasse, Jackfruit peel & Ipomoea Fistulosa (Beshram) leaves using chemical activation method.
powder with ortho-phosphoric ($H_3PO_4$) acid solutions is carried out.

- This impregnated powder is then carbonized in the furnace at various temperatures from 300 to 500°C.
- The washed product is then filtered out and dried at 120°C.
- The activated carbon thus obtained is used for the further analysis & experimentation.
- The carbonized powder is then washed with hot water at a rate of 20ml/gm of powder to remove the traces of phosphoric acid.

Table 1: Details of experimental runs for preparation of sugarcane bagasse Activated Carbon (SBAC), Jackfruit peel activated carbon (JFAC), Ipomoea Fistulosa leaves activated carbon (IPAC)

The observations giving the details of various operating parameters on the yield of adsorbent for different agricultural waste materials are tabulated as given in table1. [4, 6]

Part II [9]

A. Digital Colorimeter is used for analysis of colored solution of methylene blue in water. For standardization, known concentration of methylene blue in water solutions have been analyzed using colorimeter. Figure 2. shows the graph plotted between the concentration of methylene blue (MB) in water and the corresponding colorimeter reading as given below:

![Colorimeter Readings Vs Concentration of Methylene Blue](image)

B. Batch Experiments for estimation of adsorption isotherms [2].

I. Effect of Adsorbent quantity:
Adsorbent quantity from 1gm to 5gm are taken in 50ml solution each (100 ml for JF & IP samples) of methylene blue having concentration of 1gm/lit. The mixture is stirred for known time & the concentration of final solution is measured in terms colorimeter reading. Finally % of adsorption is calculated.

The details are shown in table 2 & the representation of the graph is shown in Figure 3.

Table 2: Observation for Effect of Adsorbent quantity for JFAC, IPAC & SBAC

<table>
<thead>
<tr>
<th>Name of Agricultural waste</th>
<th>Quantity of agricultural Waste powder (gm)</th>
<th>Quantity of $H_3PO_4$ for Impregnation (ml)</th>
<th>Carbonization Temperature in Furnace (°C)</th>
<th>Time (min)</th>
<th>Quantity of activated Carbon (gm) obtained</th>
<th>Yield %</th>
</tr>
</thead>
<tbody>
<tr>
<td>SB</td>
<td>143</td>
<td>143</td>
<td>300–400</td>
<td>30</td>
<td>188</td>
<td>87.5</td>
</tr>
<tr>
<td>JF</td>
<td>365</td>
<td>183</td>
<td>300–400</td>
<td>30</td>
<td>323</td>
<td>93.4</td>
</tr>
<tr>
<td>IP</td>
<td>295</td>
<td>87</td>
<td>300–400</td>
<td>30</td>
<td>238</td>
<td>88.4</td>
</tr>
</tbody>
</table>

Figure 3: Effect of Adsorbent Quantity for JF, IP & SB on % Adsorption

II. Effect of Initial MB Concentration:
The adsorption capacity of various adsorbents prepared is studied. MB in water Solutions having different concentrations is added with constant dose of 2, 5 & 5gms adsorbent each respectively for SB, JF & IP samples. After stirring the mixture for known time, it is filtered and colorimetric readings are noted for each solution. Finally %adsorption is calculated.

The details are shown in table 3 & the graph in Fig 4.

Table 3: Observation for Effect of Initial MB Concentration for JF, IP & SBAC

<table>
<thead>
<tr>
<th>X (gm)</th>
<th>Y (ml)</th>
<th>C_o (gm/lit)</th>
<th>C_f (gm/lit)</th>
<th>% adsorption</th>
</tr>
</thead>
<tbody>
<tr>
<td>SB</td>
<td>100</td>
<td>0.9</td>
<td>0.15</td>
<td>98</td>
</tr>
<tr>
<td>JF</td>
<td>100</td>
<td>0.8</td>
<td>0.11</td>
<td>99</td>
</tr>
<tr>
<td>IP</td>
<td>100</td>
<td>0.7</td>
<td>0.09</td>
<td>99.9</td>
</tr>
</tbody>
</table>

Where, $X$: Quantity of Adsorbent (gm), $Y$: quantity of methylene blue solution (ml), $C_o$: initial concentration of methylene blue solution (gm/lit), $C_f$: final concentration of methylene blue solution (gm/lit), $V$: volume of MB taken (ml)

Figure 4: Graph for % adsorption as a function of initial conc. of MB

Estimation of adsorption isotherm [8]
The generalized equation for Freundlich Adsorption isotherm is:
Where,

\[ q = K C_f^{1/n} \]

- \( q \) = weight adsorbed per unit wt of adsorbent
- \( n \) is coefficient and \( K \) is constant
- \( n \) is measure of adsorption Intensity while, \( K \) as Adsorption Capacity

The Freundlich Isotherm graph very closely resembles that for microbial specific growth rate coefficient versus substrate concentration. The data is further calculated & interpreted for estimation of adsorption isotherms. The table 4 gives the calculated values of mass of methylene blue adsorbed per mass of adsorbent for different initial values of concentration of methylene blue in water solution.

<table>
<thead>
<tr>
<th>X (gm/lit)</th>
<th>Y (gm)</th>
<th>Log CF</th>
<th>Log (Cf/C)</th>
<th>( 1/VX )</th>
</tr>
</thead>
<tbody>
<tr>
<td>2/5/5</td>
<td>100</td>
<td>0.9</td>
<td>2.322</td>
<td>0.735</td>
</tr>
<tr>
<td>2/5/5</td>
<td>100</td>
<td>0.8</td>
<td>2.176</td>
<td>0.602</td>
</tr>
<tr>
<td>2/5/5</td>
<td>100</td>
<td>0.7</td>
<td>1.903</td>
<td>0.550</td>
</tr>
<tr>
<td>2/5/5</td>
<td>100</td>
<td>0.6</td>
<td>1.477</td>
<td>0.410</td>
</tr>
<tr>
<td>2/5/5</td>
<td>100</td>
<td>0.5</td>
<td>0.662</td>
<td>0.300</td>
</tr>
</tbody>
</table>

A graph is plotted for estimation of the Freundlich adsorption isotherms for the system of MB adsorption on SBAC, JFAC & IPAC as shown in Figure 5. The constants & coefficients calculated from this graph are as tabulated in table no.5.

![Freundlich Isotherm Graph](image)

Table 4: Observation for Adsorption Isotherm

Table 5: comparative values of constants & coefficients for JF, IP, SB & CG Activated Carbon

<table>
<thead>
<tr>
<th>Compound</th>
<th>Present work</th>
<th>Literature survey</th>
</tr>
</thead>
<tbody>
<tr>
<td>SBAC</td>
<td>K</td>
<td>1.748</td>
</tr>
<tr>
<td>CGAC</td>
<td>K</td>
<td>8.77</td>
</tr>
<tr>
<td>IPAC</td>
<td>K</td>
<td>8.33</td>
</tr>
<tr>
<td>JFAC</td>
<td>K</td>
<td>7.75</td>
</tr>
</tbody>
</table>

RESULT, DISCUSSION & CONCLUSION:

It can be observed from table 1, that the present methodology is successful in obtaining more than 80% yield of activated carbon from agricultural waste materials like sugarcane bagasse, Jackfruit peel & Ipomoea Fistulosa leaves. Phosphoric acid used for impregnation has resulted in good quality adsorbent. The ratio of phosphoric acid to waste material varied between 0.5ml to 1ml per gram of the material. The carbonization temperature range is 300 – 400°C.

It can be inferred from figure 3, which all the three adsorbents developed in the present work have excellent adsorption capacity range from 78-98.3% Jackfruit peel, 86 – 98.9% for Ipomoea Fistulosa leaves & 73 to almost 100%for sugarcane bagasse. It can be observed from figure 4, that there is very little effect of initial concentration on % adsorption for IPAC & SBAC. However for JFAC there is some effect of concentration and % adsorption decreases 100 to 76% for initial concentration of 0.9 to 0.5 gm/lit. This is indicative that adsorption capacity of JF is smaller than that of IP & SB.

It can be observed from the figure 5, which depicts the adsorption isotherms for the various adsorbents developed in the present work, that the SBAC is the most effective amongst all. It is better in terms of its effectiveness than the commercial grade activated carbon. However it can also be said that, the other two adsorbents developed in present work namely IPAC & JFAC have potential to be excellent adsorbents. Development of commercial grade activated carbon from Ipomoea Fistulosa (Beshram) leaves is to be explored further as it is socially recognized as a nuisance shrub having no utility & grows even under adverse conditions. Commercial utilization of such a plant could be a major boost to cottage industries.

REFERENCES