

**ADSORPTION ON FLUORIDE REMOVAL BY USING BATCH TECHNIQUES**

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**ABSTRACT**

The removal of fluoride from synthetic sample by adsorption on activated carbon prepared from Phoenix Dactylifera (Date Plam) seeds was studied to determine the effects of time, dosages and pH. The removal of fluoride by adsorption was studied on two types of carbons i.e., physically activated and chemically activated (NaCl and CaCl$_2$) with I.R’s of 0.25, 0.50 and 0.75. Different different time, dosages and pH were studied. It was observed that as dosage increase the adsorption increased along with the increase in I.R. It was also noted that as I.R. increase the surface area of the activated carbon is increased. The maximum removal of fluoride is obtained at pH 7 ±0.20.

**KEYWORDS:** Contact time, Dosage, Fluoride, pH, Phoenix Dactylifera (Date Plam) seeds

Water is life for all living beings. But nowadays, pure drinking water is available to very few people. Others take more or less contaminated water. The concept of proving safe drinking water is assuming lot of concern globally in general, and developing and underdeveloped nations in particular. India being a developing nation, where the majority of people live in the villages with bare infrastructural facilities, high degree of illiteracy and lack of awareness of sanitation and hygiene, the concept of safe drinking water assumes greater significance. But most of the rural population depend on ground water sources for drinking purposes which are contaminated with a variety of slats and minerals. One among them is the excess content of fluoride which causes a deleterious impact on the health of the people. Fluoride has been described as more toxic than lead and less toxic than arsenic and is considered as an accumulative toxin. The continuous use of contaminated water results in dental and skeletal Fluorosis primarily and many other health effects like Gastrointestinal complaints secondarily. (Dinesh Cand, 1998) presented concise information about all possible sources of Fluorides and their impacts on human health. As the “Fluorosis” considered to be an incurable disease, prevention is the only solution to this problem. Thus, the studies regarding the defluoridation of water using a variety of adsorbents gained importance nowadays. Defluoridation can be done using different techniques viz., Reverse Osmosis, Electrodialysis and ion exchange methods. The Nalgonda technique of defluoridation developed by NEERI has become popular recently, but it has its own drawbacks as presented by (B.V. Appa Rat, 1990). (Kumar Swamy, 1990) have also descried various inter disciplinary approaches on defluoridation to control Fluorosis. Several adsorbents are also tried for the defluoridation activity. A (Arulanantham, 1992) used activated carbon prepared by coconut shell carbon and (R.S. Prakasam et. al., 1998) used different parts of water Hyacinth (Eichhornia species) as adsorbents. (D.V.R. Raju 2001) recommended cirtrous bio-food such as Tamarind, Nilkai and Lemon and (Mariappan et. al., 2002) studied Synthetic Alumina as adsorbents for defluoridation of drinking water among the adsorbents so far tried. Activated Alumina is reported to have high defluoridation capacity. But most of these techniques and methods are worked out to be expensive. Hence it is aimed in the present work, to study the suitability of the carbon prepared from Phoenixdactylifera (date palm) to be used as an adsorbent for the removal of the Fluorides from the drinking water.

**MATERIALS AND METHODS**

The scientific name was derived from “Phoenix, the legendary bird of ancient Greece. The specific name dactylifera came from the shape of the fruit, ‘dactylos’ being the ancient Greek word for finger. The Phoenixdactylifera (date palm) is believed to have originated in the lands around the Persian Gulf. The seed of date as an agro waste have potential to be a very good and cheap source for a carbonaceous raw material. So in present work phoenix dactylifera (date palm) seeds are used to prepare low cost activated carbon. Activated carbon made from phoenix dactylifera (date palm) seeds not import any colour, taste and odour to water, when it is added to it. So it is a suitable adsorbent for waste water treatment.

**(a) Preparation of Synthetic Sample**

The synthetic sample for the present study was prepared by dissolving 221.0mg anhydrous
sodium fluoride, in distilled water (1.0 litre) to get 100mg/mL fluoride concentration.

(b) Spectrophotometer

ELICO model UV-Visible spectrophotometer SL-159 model with 10mm cell path cuvettes was used for all measurements.

Preparation of Phoenix Dactylifera (Date Plam) seeds Activated Carbon

The Date plam seeds activated carbon used in this study was prepared by pulverizing the Date plam seeds into powder, washed in distilled water for about 8 to 9 times. The powder was then oven dried at 105±5°C for 24 hours and packed in polythene bags and stored in dessicator. And then activated by physical and chemical methods.

(a) Physical Activation

The stored material was filled in small container in three layers, by compacting each layer without any air space to avoid the loss in weight of the powder, otherwise it would result in burning of the material directly leaving behind only the ash. The small container was then placed into a bigger container, such that sand surrounded the small container completely, the lid of the bigger container was tightly fitted. Then the setup was kept in muffle furnace and heated at steady rate to attain the temperature of 800°C. After attaining the 800°C temperature the furnace was allowed to cool for about 10 hours and then the container is taken out. The Activated Carbon thus obtained was sieved to 300 Micron in size, then packed in polythene bags and stored in dessicator.

(b) Chemical Activation

The known quantity of washed and dried Phoenix dactylifera (Date Palm) seed powder of size 300 Micron was mixed with the activating agent(NaCl and CaCl2), in required quantity, depending upon the impregnation ratio (I.R)

\[ \text{Impregnation ratio} (I.R) = \frac{\text{Weight of the activating agent added}}{\text{Weight of carbonizing material}} \]

In that mixture, required quantity of distilled water was added and boiled on an hot plate till most of the water evaporated and slurry like mixture was retained. After that the mixture was oven dried in a clean tray for 24 hours maintained at 105 ± 5°C which helps in evaporation of moisture form the mixture. Preheated carbonizing material was filled in the small container for carbonising according to the above said procedure.

The activated carbon was washed with 0.1N HCl followed by hot distilled water for about 8 times to remove the activating agent and HCl respectively. Washed carbon was dried at 105°C and then sieved for required size (i.e., 300 micron) and packed in polythene bag.

Characteristics of Phoenix dactylifera (Date Palm) seed

Before using Phoenix dactylifera (Date Palm) seed carbon as an adsorbent, it is essential to know some of the characteristics such as moisture content, ash content, pH, decolorizing power and surface area of the prepared carbon using standard methods. The results are shown in table-1.

<table>
<thead>
<tr>
<th>SL. No.</th>
<th>Characteristics</th>
<th>Physically activated carbon</th>
<th>Chemically activated</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>NaCl 0.25</td>
<td>0.50</td>
</tr>
<tr>
<td>1</td>
<td>Moisture content (%)</td>
<td>4.00</td>
<td>4.00</td>
</tr>
<tr>
<td>2</td>
<td>Ash content (%)</td>
<td>11.77</td>
<td>14.00</td>
</tr>
<tr>
<td>3</td>
<td>Decolorizing power (mg/g)</td>
<td>3.00</td>
<td>14.00</td>
</tr>
<tr>
<td>4</td>
<td>Surface area (m²/g)</td>
<td>503.31</td>
<td>513.44</td>
</tr>
<tr>
<td>5</td>
<td>pH</td>
<td>9.50</td>
<td>7.24</td>
</tr>
<tr>
<td>6</td>
<td>Specific gravity</td>
<td>1.218</td>
<td>1.086</td>
</tr>
<tr>
<td>7</td>
<td>Bulk Density (g/cm³)</td>
<td>0.45</td>
<td>0.405</td>
</tr>
</tbody>
</table>

Batch Sorption Experiment

In batch sorption, a predetermined amount of adsorbent is mixed with a sample, stirred for a given contact time and subsequently separated by filtration. Powdered adsorbent is more suitable for the batch type of contact process. Fluoride removal affinity of activated carbon of Date Palm seed was determined from batch experiments as a function of...
contact time, dose of adsorbent and pH. Removal isotherms were drawn to these results.

**Batch Sorption Studies at Optimum Contact Time**

The adsorption is strongly influenced by the contact time. To study the effect of contact time, 100mL of 5mg/L fluoride solution was mixed with 100mg of activated carbon, stirred at different contact times varying from (10mins, 20mins, 30mins up to 120mins). Then filtrate was analyzed for fluoride concentration by using spectrophotometer.

**Batch Sorption Studies at Optimum Adsorbent Dosage**

To determine the optimum dosage of activated carbon of Phoenix dactylifera (Date Palm) seed, it was added to the conical flask in different dosages varying from (20mg, 40mg, 60mg up to 180mg), containing known concentration of fluoride solution 5 mg/L in 100mL. The solution in the conical flasks was subjected to stirring for optimum contact time, filtered and analyzed for residual fluoride concentration using spectrophotometer.

**Batch Sorption Studies at Optimum pH**

The extent of adsorption is strongly influenced by the pH at which adsorption is carried out. The effect of pH on fluoride adsorption was studied by performing equilibrium adsorption tests at different initial pH values. i.e. from 2.0 to 9.0. The pH of solution was adjusted by using 0.1N H₂SO₄ or 0.1N NaOH. The activated carbon of Phoenix dactylifera (Date Palm) seed were mixed and stirred to optimum contact time, filtered and supernatant was analyzed for residual fluoride concentration. The pH at which maximum fluoride removal forms optimum pH.

**RESULTS AND DISCUSSION**

**Effect of Contact Time**

Contact time has greater influence on the adsorption process. The effect of contact time on removal of Fluoride from synthetic sample is shown in fig1,2&3. It is observed that the extent of Fluoride adsorption increases with increase in time and attain equilibrium at particular time. Hence optimum contact time for all prepared carbons is listed in Table-2.
maximum removal is attained, is taken as optimum dosage. Hence optimum dosages for all prepared carbon are listed in Table-2 of adsorption removal efficiencies of Fluoride by prepared activated carbon at different pH values as shown as in figure 7, 8, & 9 and Table-2.

**Figure 4:** Effect of Contact Dosage on Fluoride Removal by Physically Activated Carbon

**Figure 7:** Effect of pH On Fluoride Removal by Physically Activated Carbon

**Figure 5:** Effect of Contact Dosage on Fluoride Removal by Chemically (NaCl) Activated Carbon

**Figure 8:** Effect of pH On Fluoride Removal by Chemically (NaCl) Activated Carbon

**Figure 6:** Effect of Contact Dosage on Fluoride Removal by Chemically (CaCl₂) Activated Carbon

**Figure 9:** Effect of pH On Fluoride Removal by Chemically (CaCl₂) Activated Carbon

**Effect of pH on phenol Removal**

The extent of adsorption is strongly influenced by pH at which adsorption is carried out. The pH of the solution as influenced on extent...
Table 2: Optimum time, dosage and maximum pH for prepared carbon

<table>
<thead>
<tr>
<th>Types of carbon</th>
<th>I.R.</th>
<th>Optimum time</th>
<th>Optimum dosage (mg)</th>
<th>Optimum pH</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Physically activated</td>
<td></td>
<td>40</td>
<td>140</td>
<td>7.00</td>
</tr>
<tr>
<td>2. Chemically activated NaCl</td>
<td>0.25</td>
<td>55</td>
<td>200</td>
<td>7.00</td>
</tr>
<tr>
<td></td>
<td>0.50</td>
<td>50</td>
<td>180</td>
<td>7.00</td>
</tr>
<tr>
<td></td>
<td>0.75</td>
<td>45</td>
<td>160</td>
<td>7.00</td>
</tr>
<tr>
<td>CaCl&lt;sub&gt;2&lt;/sub&gt;</td>
<td>0.25</td>
<td>50</td>
<td>180</td>
<td>7.00</td>
</tr>
<tr>
<td></td>
<td>0.50</td>
<td>45</td>
<td>160</td>
<td>7.00</td>
</tr>
<tr>
<td></td>
<td>0.75</td>
<td>40</td>
<td>140</td>
<td>7.00</td>
</tr>
</tbody>
</table>

**CONCLUSIONS**

Based on the experimental Study the following were drawn and presented in the following section.

- The statistical analysis shows that chemical activation of carbon (IR=0.75) increases surface area of the adsorbent and also the fluoride removal efficiency.
- The adsorption of fluoride is pH dependent. The removal efficiency of adsorbent increases with increase in pH value. It has been observed from the present study, that maximum adsorption takes place at pH 7.0 ± 0.2.
- By the experiment on optimization of dosage of adsorbents shows that increase in amount of adsorbent added, increases the removal of fluoride from the solution does for different I.R. This increase is mainly due to the enhanced total surface area of the adsorbent.

**REFERENCES**


