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Iron Adsorption from Textile Industrial Effluent on Activated Carbon Prepared from Tamarind Seeds (Tamarindus indica L.)

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ABSTRACT

Water pollution contributes the major environmental pollution in many countries which shows great impact on human life and biodiversity. The important source of water pollution is industrial effluent. General contaminants in effluent water are heavy metals, phenols, dyes, harmful organics, ligands and suspended solids .Treatment of effluent water plays vital role in many industries, the treatment of adsorption proved to be most important well known and economical process. The ability of certain solids of preferentially concentrate specific substance on their surface is the basic principle for adsorption. Water with high content of iron can be very objectionable. In our research work the activated carbon prepared from tamarind seeds was employed to take up selected heavy metal that is iron ions. Tamarind seeds which are an agricultural waste and also waste product in many industries was activated by phosphoric acid treatment, is investigated for the removal of iron ions from textile industrial effluent sample.

Keywords : Adsorption, Iron, Activated Carbon, Tamarind Seeds, Industrial Effluent.

I. INTRODUCTION

Tamarind (*Tamarindus indica* L.) was planted on a large scale in countries like India, Thailand, Indonesia, Myanmar, and the Philippines. Tamarind fruit consists of pulp and hard-coated seeds. The seeds are 30–40% of fruit with a large quantity as agro-byproduct[1]. Tamarind seed powder has been used as a biosorbent for removal of dyes and ions of iron from simulated industrial wastewater. Tamarind seed has also been used as a raw material for granular activated carbon preparation by thermal induced chemical activation for the adsorptive treatment. In addition, tamarind seed powder was activated by phosphoric acid at 160°C. The activated carbon product could adsorb dye and iron present in industrial waste water.

Pollution of natural water resources by iron is one of the most important problems that threaten the environment. Fe contaminants are produced from liquid wastes discharged from a number of industries[1]. Textile wastewater is diverse in chemical composition and is considered as most polluted among all industrial sectors (Ali *et al.,* 2008). The aquatic environment is the ultimate destination for almost all industrial wastes and water quality gets seriously impacted by these waste products (Talapatra *et al*., 2006).

Water with high iron content can be very objectionable in taste, odour, or appearance. With severe iron poisoning, much of the damage to the gastrointestinal tract and liver may be the result of highly localized iron concentration and free radical production leading to hepatotoxicity through lipid

peroxidation and the destruction of the hepatic mitochondria. With this result, the liver becomes cirrhotic. Hepatoma, the primary cancer of the liver, has become the most common cause of death among patients with hemochromatosis.. Activated carbon has been proved to be an excellent adsorbent for removing organic or inorganic pollutants. It could be produced from agricultural byproducts with low cost and in large quantity[1].

II. MATERIALS AND METHOD

Preparing activated carbon

Tamarind seeds bought from the market were washed with distilled water, dried by roasting and powdered. It was soaked in phosphoric acid under a weight ratio of 1:1 followed by heating in the hot air oven at temperature of 160±5ºC for 24hr. The carbonized material was cooled to room temperature, washed with distilled water several times to remove excess acid and dried at 100±5ºC. The carbon was soaked in 1% sodium carbonate solution for 24hr, washed with distilled water to remove excess sodium carbonate, dried at 100±5ºC and sieved.

Preparation of solution

Stock solution of iron (1000mg/L) was prepared by dissolving 0.7022 grams of ferrous ammonium sulfate in distilled water. The stock solution was diluted with distilled water to obtain working solutions of desired concentration.

Column preparation

Adsorption experiment was conducted in cylindrical plastic bottles of 500ml capacity. The base of the bottle contains a cotton plug to hold the solid phase in place. At the base of the bottle muslin cloth is tied which facilitate proper filtration of sample. Filter papers were arranged on cotton plug. Activated carbon was then poured over the filter paper about one inch in layer. Then filter papers were arranged over activated carbon layer, sand was poured on filter paper forming three inch layer. Filter paper layer is again arranged over sand and pebbles were kept and arranged according to size (small to big).

Adsorption experiment

Column was prepared for dry method, where the column was first filled with dry stationary phase powder, followed by the addition of mobile phase, which was flushed through the column until it was completely wet, and from this point was never allowed to run dry[3].

The activated carbon prepared using 1:1 phosphoric acid to dried tamarind seed powder at 160ºC was used for Fe adsorption experiment. The textile industrial waste water was flushed through the column and collected at the bottom.

Iron determination

Any solution which is colored or can be made to be colored by adding a complexing agent can be analyzed using a spectrophotometer. Solutions containing iron ions are colorless but, with the addition of ortho-phenanthroline, the iron (II) ions in the sample are immediately complexed to produce orange color. More iron (II) ions in a sample will result in a deeper orange color. From data obtained from a series of iron (II) standards, it is possible to be able to determine the amount of iron in an unknown sample.

Samples can be analysed spectrophotometrically for iron by forming the reddish-orange tris complex of iron (II) and 1,10-phenanthroline, $C_{12}H_8N_2$. This complex absorbs light in the visible region rather strongly with a maximum absorbance occurring around 510nm[6].

III. RESULTS AND DISCUSSION

The characteristics of textile industrial effluent sample, filtrate and limits prescribed by CPCB, and other standards are given in Table 1.

Table 1 : Characterization of industrial effluent sample

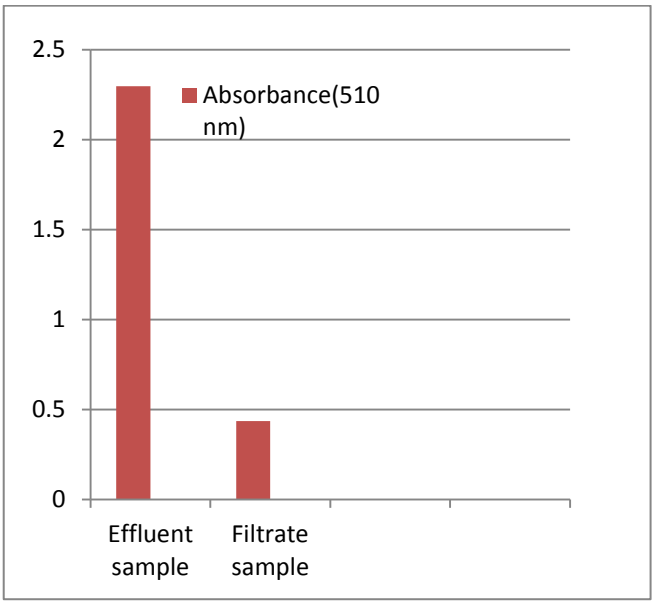
Parameters	Sample	Filtrate	Standards
pH	4.5	3.5	5.5 to 9.0
DO	268	92	4-15
BOD	76	72	100
COD	169	118	250
TDS	8000	6000	2100
TSS	1500	700	100
TS	6500	4500	20-500
Alkalinity	7300	1080	20
Hardness	60	23.9	75 - 85
Calcium	10.64	10.6	75
Magnesium	49.36	49.4	50
Oil and Grease	10000	8000	10
Iron	2.2965	0.4361	0.3

All the values except pH are in mg/L

Table 2 : Data Table of standard, effluent and filtrate samples for iron determination

Solution	Absorbance (510nm)
0ppm	0.0
2ppm	0.2417
4ppm	0.5643
6ppm	0.6353
8ppm	0.7205
Effluent Sample	2.2965
Filtrate sample	0.4361

Graph of comparison between Effluent and Filtrate Sample



The spectrophotometric technique is useful in determining concentration of an inorganic compound. Iron is inorganic compound due to lack of carbon atom. As expected, a more intensely colored effluent sample yielded a higher absorbance and faintly colored filtrate sample yielded lower absorbance as compared to absorbance of effluent sample at 510nm[7].

Phosphorylated tamarind nut carbon (PTNC) was prepared from agricultural waste and hence was found to have higher ash content. The higher decolorizing capacity and phenol number of PTNC make it applicable for organic adsorption. PTNC has high ion exchange capacity and was the main mechanism for the adsorption of the heavy metal[2].

IV. CONCLUSION

There is a growing interest in developing countries for using low cost adsorbents for dye and metal ion removal from waste water arising from textile industries. Low cost adsorbents can also be effective to remove organic pollutants from waste water. The present study describes the conversion of tamarind

seeds, a waste product into effective adsorbent by activation processes. Tamarind seeds can be used as a low cost precursor from which activated carbon can be derived using cost effective thermal and chemical activation processes. The prepared activated carbon shows that the tamarind seed can be used for preparing an efficient adsorbent for the removal of various pollutants from textile industrial waste water.

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