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REMOVAL OF PHENOL FROM WASTEWATER USING TAMARIND NUT AND COMMERCIAL ACTIVATED CARBONS

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ABSTRACT

Many harmful compounds from chemical plants are released in waters continuously and at the same time, many solid by products are deposited onto the soil. Removal of these toxic compounds from waters is essential from the standpoint of environmental pollution control. Among the toxic compounds, that are released into the environment, phenol is one of the harmful organic compounds. Among the solid wastes that are release into the soil, can be utilized further are agricultural wastes. Value added product like activated carbon can be obtained from wastes like coconut shell, date seeds, tamarind nuts etc. This work deals with preparation of tamarind nut activated carbon and removal of phenol using this activated carbon. Comparative studies are made on the adsorption capacities of tamarind nut activated carbon and commercially available activated carbon. The effects of variables like adsorbent dosage, temperature and time on removal of phenol were studied.

Key words: Adsorption, Phenol, Activated carbon, Dosage, Temperature, Time.

INTRODUCTION

Sources of wastewater containing phenol

- The effluents from oil refineries, gas works, coke plants, and chemical industries contribute phenols and phenolic compounds in the water[1].
- Phenol is found in wastewaters of industry sectors include the pulp, paper and wood products sector, mineral (non-metallic) products sector, chemical products sector, steel and metal products sector, petroleum refining and products sector, coal conversion plants, municipal waste treatment plant discharges etc.[2]

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- Consumer products, which may contain phenol are agricultural chemicals, disinfectants (non-agricultural), general antibacterial and antiseptics, household hard surface cleaners (liquid), lubricating oils, automotive chemicals, paint and varnish removers, pharmaceutical preparations, synthetic resin and rubber adhesives, wood office work surfaces (modular systems) etc.[3]

Health effects of phenol[4]

- Phenol exerts a marked corrosive action on any tissue of contact when ingested, inhaled or after skin exposure. Its cellular uptake is both rapid and passive due to its lipophilic character, and systemic toxicity develops soon after exposure. Phenol's main target organs are the liver and kidney. It may also affect the respiratory cardiovascular systems.
- Systemic clinical effects of phenol are headache, dizziness, hypertension, ventricular arrhythmia, shallow respiration, cyanosis, pallor, excitation and convulsions. The most important effects in short-term animal studies are neurotoxicity, liver and kidney damage.
- Phenol is absorbed easily into the body through skin, lungs, and stomach. It may interfere with the brains control of regular breathing patterns.

Principles of adsorption[5]

In any heterogeneous systems consisting of atoms, molecules or ions, at the interaction between the phases begins with chemical or physical interaction the phase interface. When a molecule under kinetic motion hits a surface from random direction, it can bounce back from the surface elastically or it may stay at the surface for a period of time and come off in a direction unrelated to that form which it came.

Mechanism of adsorption[6]

In most of adsorption systems mass transfer of solute into and within the adsorbent particles affect the adsorption rate. Models are predicting the design of such systems are usually based on either a film resistance, describing the transport rate from the bulk phase to the particle surface or diffusion resistance describing the transport rate of solute with in particle is usually considered as either a pore diffusion or a surface diffusion mechanism.

Favorable properties of adsorbents[7]

Surface area: Since adsorption is surface phenomena, the adsorption ability is directly

proportional to surface area. So, favorable characteristic of adsorbents is that it should have as high surface area as possible.

Pore size distribution: This refers to the diameter of pores, if the percent of pores of larger diameter is large, even larger molecules can also be entrapped in the pores, on the other hand the larger molecules are prevented from entering smaller pores and when the percentage of smaller diameter pores is more the absorbability of larger molecules decreased.

Nature of adsorbent surface: Non-polar adsorbents adsorb non-polar substances in preference to polar substances and vice versa.

Activated carbon[8]

Activated carbon includes carbon materials mostly derived from charcoal. It denotes a material, which has an exceptionally high surface area, typically determined by nitrogen adsorption and includes a large amount of micro porosity. Sufficient activation for useful applications may come solely from the surface area, though often further chemical treatment is used to enhance the adsorbing properties of the material.

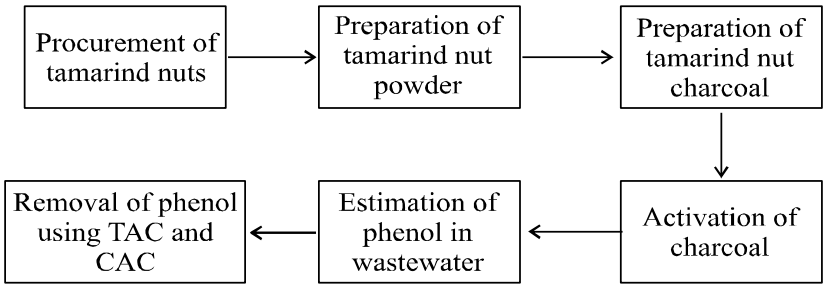
Preparation of activated carbon[9]

Activated carbon can be prepared from various cellulosic materials (agricultural wastes) like coconut shells, saw dust, coconut coir, ground nut shells, bagasse etc.

Chemical activation: Mostly acids are mixed with the source material in order to cauterize the fine process.

EXPERIMENTAL

Major steps involved in the experiments[10]



TAC-Tamarind nut activated carbon; CAC-Commercial activated carbon

Effect of dosage of adsorbent on % removal of phenol

It is found that with an increase in amount of adsorbent the % of phenol removal also increases upto adsorbent dosage of 0.5 g and constant afterwards. Temperature: 31^{o}C; Time: 1 hr; Concentration of phenol in feed: 10 mg/100 mL.

Table 1: Adsorbent dosage vs. % removal of phenol

Dosage of adsorbent (g)	Removal of phenol (%)
0.05	10.5
0.1	45.7
0.2	60.9
0.3	81.9
0.5	82.9

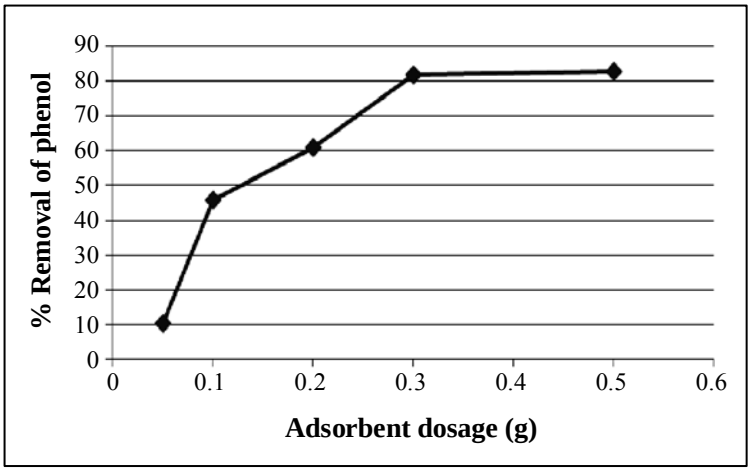


Fig. 1: Effect of adsorbent dosage on % removal of phenol

Effect of temperature on % removal of phenol

With an increase in temperature, decrease in the removal of phenol is observed.

Amount: 0.5 g; Concentration of phenol in feed: 10 mg/100 mL; Time: 1 hr

Table 2: Temperature vs. % removal of phenol

Temperature (^{0}C)	Removal of phenol (%)
28.5	82.9
45	80.1
55	78.5
60	70.2
65	68.4

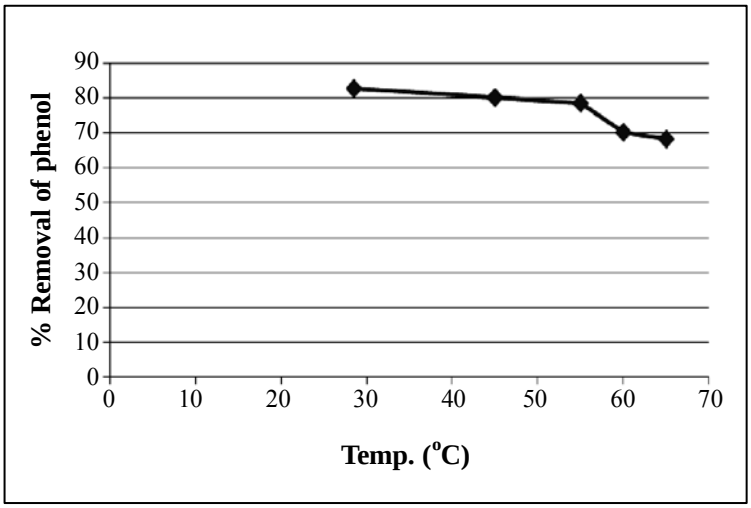


Fig. 2: Effect of temperature on % removal of phenol

Effect of equilibrium time on % removal of phenol

With an increase in equilibrium time, an increase in the removal of phenol is observed till 60 minutes and found constant afterwards.

Weight of adsorbent: 0.5 g; Temperature: 31^{o}C; Concentration of phenol in feed: 10 mg/100 mL.

Table 3: Time vs. % removal of phenol

Time (min)	Removal of phenol (%)
10	73.52
30	79.84
60	82.9
120	82.8

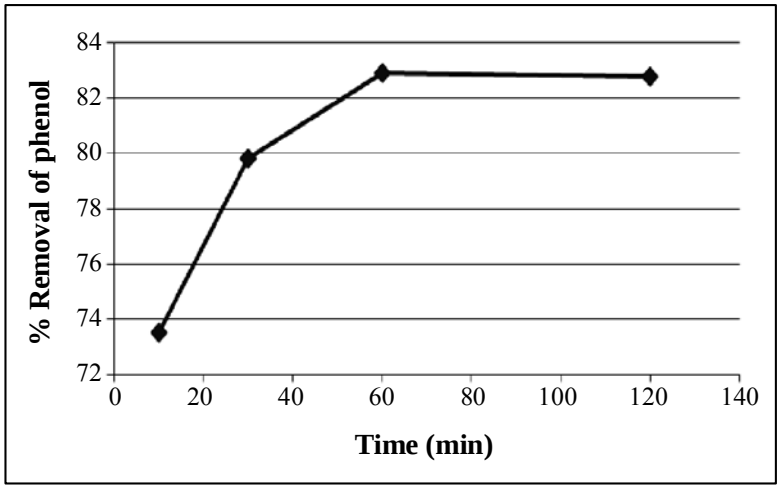


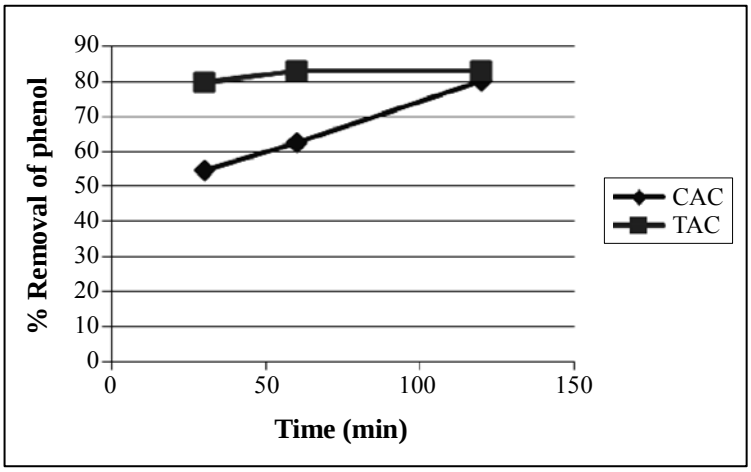
Fig 3: Effect of time on % removal of phenol

Comparison of adsorption characteristics of CAC with TAC

Amount: 0.5 g; Temperature: 31^{o}C; Concentration of phenol in feed: 10 mg/100 mL.

Table 4: Time vs. % removal of phenol by CAC and TAC

Time (min)	Removal of phenol by CAC (%)	Removal of phenol by TAC (%)
30	54.5	79.84
60	62.5	82.9
120	80.0	82.79



Graph 1: Effect of time on % removal of phenol by CAC and TAC

CONCLUSION

(i) Tamarind nut activated carbon is proved to be the best in removing phenol from wastewater compared to commercial activated carbon due to tamarind nut activated carbon has high surface area compared to commercial activated carbon.

(ii) As the amount of adsorbent increases percentage removal of phenol increases upto certain weight and after that percentage removal is found to be constant.

(iii) With increase of temperature percentage removal of phenol decreases and removal is observed maximum at room temperature.

(iv) With increase of agitation percentage removal increases upto certain time and it is found constant after that time.

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