"Phenol Reduction by Waste Derived Activated Carbon"

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ABSTRACT

Abstract - ***Among the various pollutants present in wastewater there is a common pollutant known as "Phenol". There are various techniques for the reduction of phenol which are Distillation, Adsorption, Pre-Evaporation, Membrane Extraction, Oxidation etc. This paper presents phenol reduction by adsorption using various waste derived activated carbons i.e. Coconut Shell Activated Carbon, Wood Activated Carbon & Bagasse Activated Carbon. Experiment carried out by using waste derived activated carbon in column indicates that the reduction of phenol from wastewater was observed maximum in coconut shell activated carbon. The effectiveness and efficiency of these waste derived activated carbon was observed by Freundlich isotherms equations.***

Keyword: - *Adsorption, Waste Derived Adsorbents, Adsorption Model, Freundlich Isotherm*

I. INTRODUCTION

Due to increase in industrial activities has led to the discharge of large amount of wastewater. Phenol and its compounds are the one that are present in the wastewater as discharge from coal conversion, petroleum, oil refineries, phenolic resin plants etc. Due to its toxic nature it effects human beings as well as aquatic life even at very small concentration **[1, 8]**. There are various methods for removal of phenol from wastewater like distillation, adsorption, pre evaporation, membrane extraction, oxidation etc. **[2]**.

Adsorption is a simple and relatively economical method and is widely used technique in the removal of pollutants. The present paper presents the scope of adsorption as an effective phenol removal technique using various waste derived activated carbon as an adsorbent and also focuses on the various parameters affecting adsorption, i.e. pH, Phenol Conc. In feed, Bed Height or Surface Area of Adsorbent, Contact Time etc.

II. ADSORPTION

Adsorption has been found as a low cost physical process for the treatment of wastewater. It exploits the ability of certain solids to preferentially concentrate specific substance from solution onto their surfaces **[4]**. Adsorption using commercially activated carbon is the most commonly used method due to its porous nature and high adsorption capacity resulting from high surface area of the activated carbon surface. Various waste derived activated carbon as an adsorbent like saw dust, coconut shell, rice husk, wood, fly ash, baggase, tea leaves etc. have been tried by the researchers **[7]**.

III. PARAMETERS AFFECTING ADSORPTION

1. Effect of pH

The removal of phenol from wastewater by adsorption is highly dependent on pH. Results showed that the percent adsorption of phenol increases up to pH 6 and then decrease with further increase in pH [1, 5].

2. Effect of Adsorbent Dose

The results showed that the percentage removal of phenol increases with increase in adsorbent dosage. Because adsorption is mainly a surface phenomenon, the amount of surface available for adsorption process consequently the mass of adsorbent can considerably affect adsorption efficiency [3, 6].

3. Effect of Contact Time

The contact time between the adsorbate and adsorbent is one of the most important parameter that effects the performance of the adsorption. The results showed that the adsorption of adsorbate species is faster in the initial stage of contact period and become slow near equilibrium [1, 3].

4. Effect of Phenol Concentration

With increase in the initial phenol concentration, the removal percentage increases as excepted but after certain concentration, increase in the initial concentration has adverse effects on the removal percentage [3, 5].

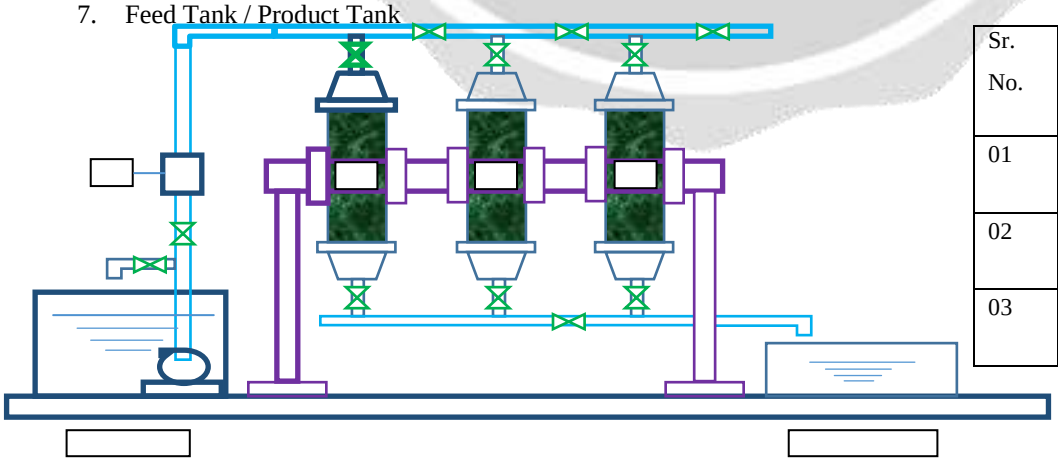
IV. COLUMN ADSORPTION EXPERIMENTAL SETUP

- Design of Adsorption Column involves two major steps:

1. Column Diameter
2. Column Height

- Material of construction (MOC) for pilot plant:

1. Glass Column Tubes
2. Adsorbent Supporting Disk
3. Piping and Conveyance System
4. Flow Meter
5. Skid for Mounting the Adsorption Column Assembly
6. Pump for feeding the system
7. Feed Tank / Product Tank



Sr. No.	Symbol	Description
01		Pump
02	M	Flow Meter
03		Control Valve

Figure 1: Schematic Line Diagram of the Experimental Setup Column Adsorption

EXPERIMENTAL WORK:

1. First all the three columns was checked for any leakage.
2. Filled all the three column with same wood activated carbon.
3. Then synthetic wastewater is collected in the feed tank. With the help of peristaltic pump constant flow rate was achieved. Small diameter tubing is used to transport phenol from feed tank to the column.
4. Flow rate was maintained by adjusting the knob of the peristaltic pump.
5. Column was filled with water, and then slurry in water was poured up to 30 cm height of column and then the sample was collected from product tank
6. Then by adjusting the valves in the column assembly the water was poured up to 60 cm height and the sample were collected from the product tank.
7. By increasing the height from 60cm to 90 cm the valves were adjusted and wastewater was poured and the sample was collected from the product tank.
8. Samples were collected at an interval of 5, 10 & 15 mins.
9. Samples were being checked for phenol concentration by ultraviolet spectrophotometer.
10. Similarly the same procedure was done by the coconut shell and bagasse activated carbon in the column assembly simultaneously.

V. RESULTS AND DISCUSSION

Results of the experiment on adsorption by wood activated carbon (WAC), Coconut shell Activated carbon (CAC) & Bagasse Activated carbon (BAC) are given below.

Sr. No.	Adsorption Media	Bed Height (cm)	Initial Conc. (µg/l)	Final Conc. (µg/l)	Percent Reduction (%)
1	WAC	30	1506	1356	9.96
2	WAC	60	1506	1103	26.76
3	WAC	90	1506	681	54.78
4	CAC	30	1506	1053	30.08
5	CAC	60	1506	658	56.30
6	CAC	90	1506	432	71.31
7	BAC	30	1506	1293	14.14
8	BAC	60	1506	937	37.78
9	BAC	90	1506	746	50.46
10	All three in series	90	1506	595	60.49

Table 1: Analysis results of adsorption on different adsorbents

Based on the analysis results Freundlich isotherm has been plotted on various parameters on adsorption:

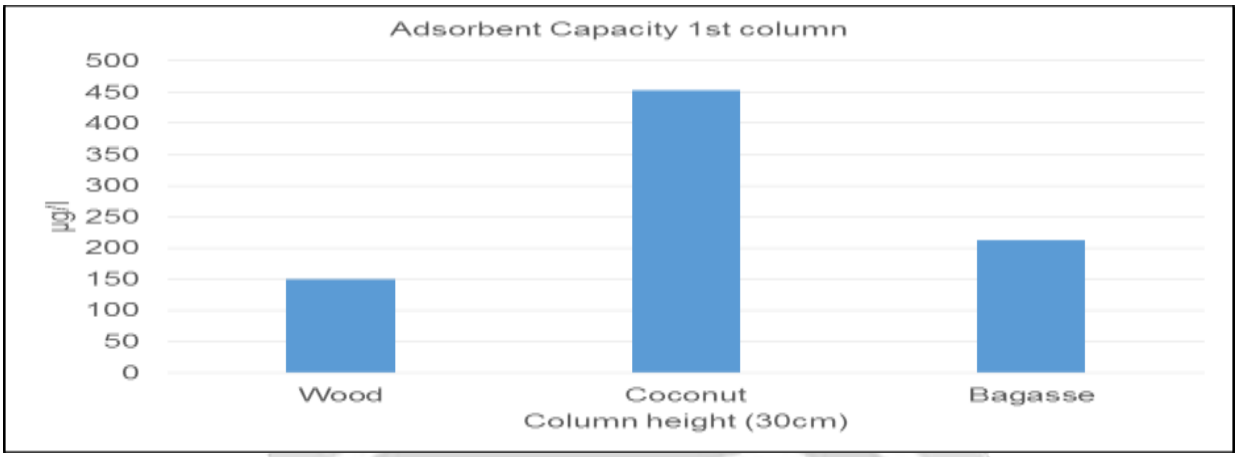


Figure 2: Adsorption capacity of phenol at 30 cm height

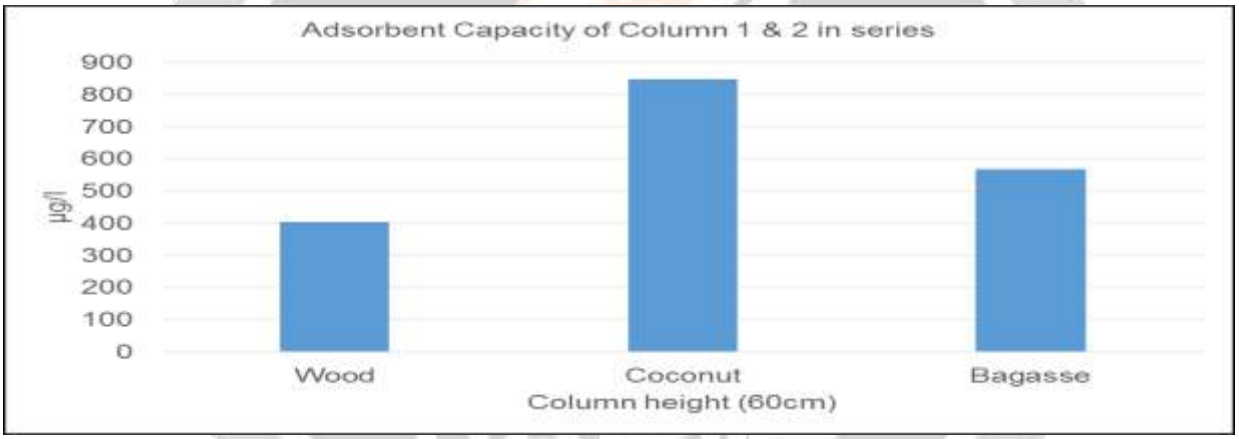


Figure 3: Adsorption capacity of phenol at 60 cm height

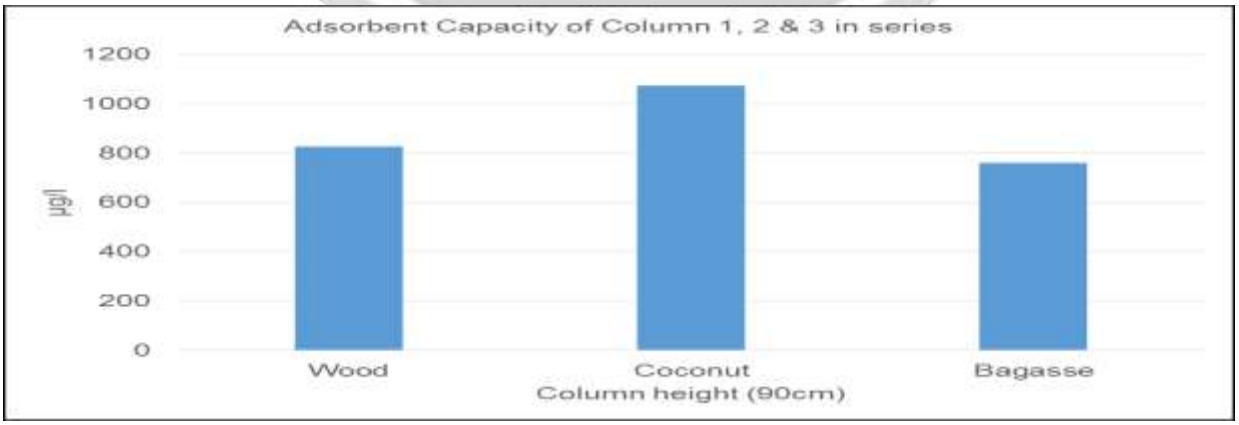


Figure 4: Adsorption capacity of phenol at 90 cm height

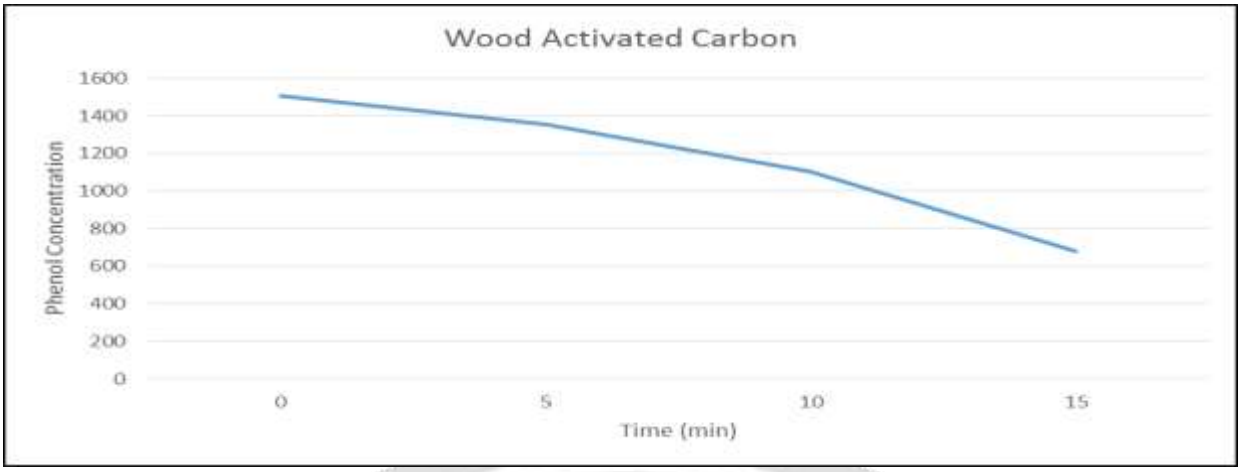


Figure 5: Adsorption of Pheno by WAC w.r.t time

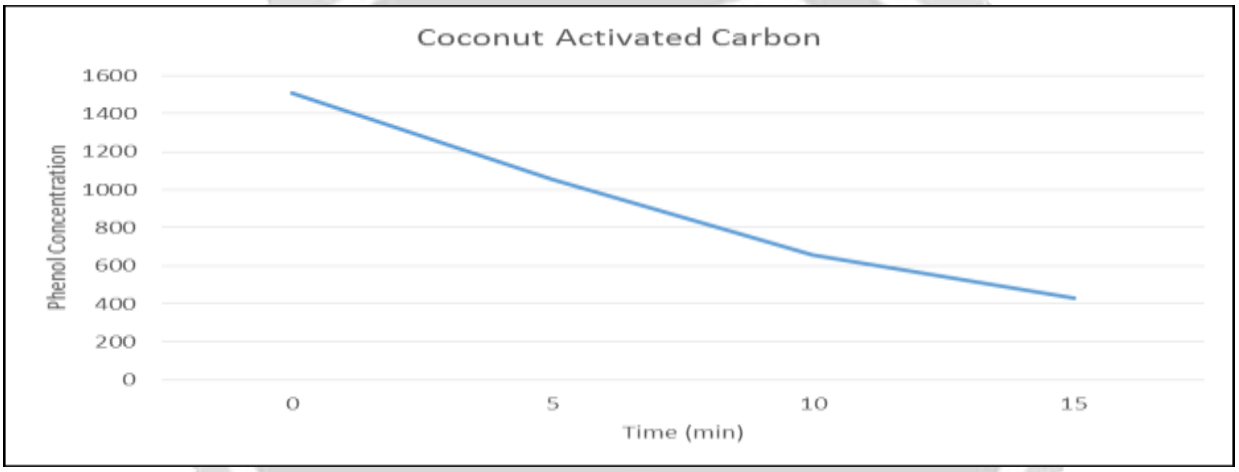


Figure 6: Adsorption of Phenol by CAC w.r.t time

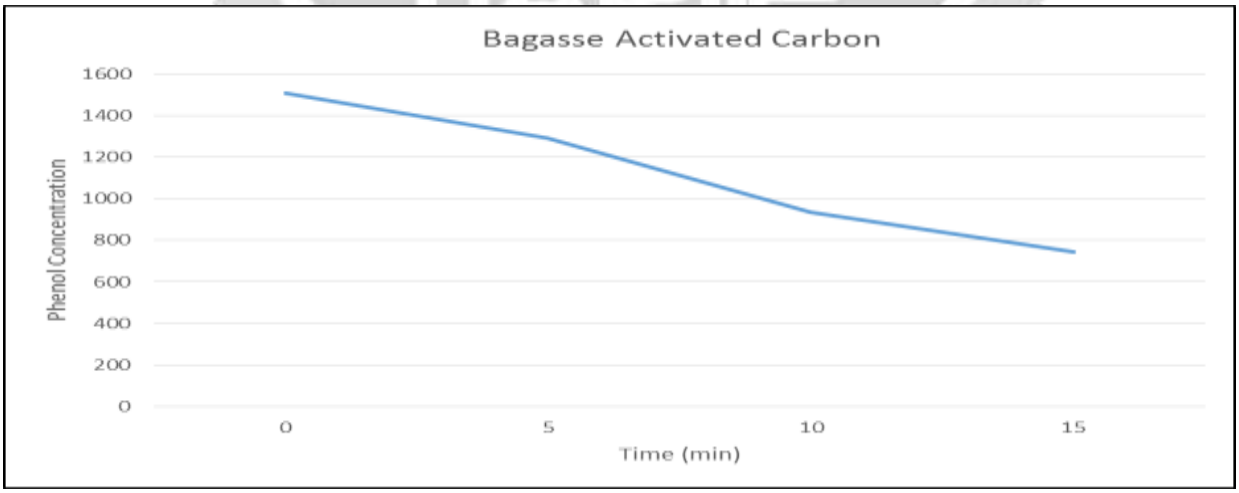


Figure 7: Adsorption of Phenol by WAC w.r.t time

Based on the experimental work it is concluded that:

- Adsorption of phenol on different adsorbents mainly depend on the surface area and contact time (bed height).
- From the isotherm plotted based on the analysis report it shows that phenol reduction is highest in coconut shell activated carbon.

VI. CONCLUSION

Experimental study on waste derived activated carbon is presented here to show a great potential for the reduction of phenol from wastewater through adsorption process. Various waste derived activated carbon has been effectively used in the studies for the reduction of phenol from wastewater and found that coconut shell activated carbon have shown the phenol reduction efficiency more than 70 percent. The effectiveness of adsorption for reduction of phenol is the effective method of regeneration of adsorbate. Adsorption in fixed bed by waste derived activated carbon is promising alternative for phenol reduction from wastewater.

VII. ACKNOWLEDGMENT

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VIII. REFERENCES

[1] Ishan Habib Dakhil, et al., "Removal of Phenol from Industrial Wastewater Using Sawdust." International Journal of Engineering And Science, Vol. 3, Issue 1 (May 2013) pp 25-31.

[2] Raymond A Wuana, Lami A Nnamonu & John O Idoko, et al., "Sorptive Removal of Phenol from Aqueous Solution by Ammonium Chloride- Treated and Carbonized Moringa Oleifera Seed Shells." International Journal of Science and Research (IJSR), Volume 4, Issue 6, June 2015.

[3] D N Jadhav & A K Vanjara, et al., "Removal of Phenol from wastewater using sawdust, polymerized sawdust and sawdust carbon." Indian Journal of Chemical Technology, Vol. 11, pp. 35-41, January 2004.

[4] M. W. Barve & P. V. Vijayababu, et al., "Some studies on removal of Phenol from wastewater using low cost adsorbent." International Journal of Scientific & Engineering Research, Volume 4, Issue 8, August-2013.

[5] Kulkarni Sunil J. & Kaware Jayant P., et al., "Batch and Column Studies for Phenol from Wastewater Using Low Cost Adsorbent." International Journal of Research in Chemistry and Environment, Vol. 4 Issue 3 (127-132) July 2014.

[6] Somnath Mukherjee, Sunil Kumar, Amal K. Misra, Maohong Fan., et al., "Removal of phenols from water environment by activated carbon, bagasse ash and wood charcoal." Chemical Engineering Journal 129 (2007) 133–142.

[7] Liana Alvares Rodrigues, Maria Lucia Caetano Pinto da Silva, Manoel Orlando Alvarez-Mendes, Aparecido dos Reis Coutinho, Gilmar Patrocínio Thim., et al., "Phenol removal from aqueous solution by activated carbon produced from avocado kernel seeds." Chemical Engineering Journal 174 (2011) 49– 57.

[8] Salim Bousba & Abdeslam Hassen Meniai, et al., "Removal of Phenol from Water by Adsorption onto Sewage Sludge Based Adsorbent." Chemical Engineering Transactions, VOL. 40, 2014.