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Removal of Phenol from Textile Wastewater Using Natural Adsorbent

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***Abstract*- Phenol is a major pollutant in the wastewater because of its presence in the effluent of major processing and refining plants. In this study wastewater is collected from Textile Industry at Arakkonam and Phenol has been extracted from textile waste water by using steam distillation method and analyzed using UV Visible Spectrophotometer. Banana Peel Ash Powder and Lemon Peel Ash Powder are used as a Natural adsorbent for reducing the phenol concentration present in effluent and it has been investigated under different operational conditions such as Adsorbent Dosage, Contact Time, pH and Initial Phenol Concentration for the maximum removal of phenol from textile waste water. Based on Batch adsorption studies, maximum adsorption was observed at room temperature under acidic condition of pH 8 and pH 6 with a contact time 90 minutes and 150 minutes. The effectiveness of the Adsorbent is measured by finding out the concentration of phenol in the treated solution by the use of UV Visible Spectroscopy. Based on the study, Banana Peel Ash Powder is used as an effective Natural Adsorbent for reducing the Phenol Concentration present in textile effluent compared to the Lemon Peel Ash Powder.**

***Index Terms*-Activated Carbon, Agricultural Waste, Mango Peel, Phenol Removal, Wastewater Treatment**

I.INTRODUCTION

Waste water released from various industries is the major concerns for environmentalists now days. Industrial effluents contain various toxic metals, harmful gases, and several organic and inorganic compounds. Phenol is major pollutant included in the list of EPA (1979). Aqueous phenolic effluents are relatively common industrial wastes, being produced in several industries and operations such as petroleum refineries, gas and coke oven industries, phenolic resins, explosive manufacture, plastic and varnish industries, textiles units using organic dyes, and smelting and related metallurgical operations .Acute exposure of phenol causes central nervous system disorders, myocardial depression. Phenol causes a burning effect to on skin. It can also cause hepatic damage. In these perspectives central pollution control board set the minimum permissible level for phenol in environment as 0.05 to 0.1mg/l. Adsorption is a low cost and important physical process for the treatment and renovation of waste water. Among these adsorption process have been proposed as potential methods for removal of phenol from the environment and adsorption is considered to be most promising process for removing hazardous and environmentally undesirable chemicals.

II. METHODOLOGY

A. Preparation Of Adsorbent

Banana peel and lemon peel were collected from the local area and washed repeatedly with water to remove dust and soluble impurities. It was dried in natural sunlight for a period of almost 1week. The Adsorbent was carbonized by heating it upto a temperatures of around 200˚C in the absence of oxygen. We then used a ball mill to crush the adsorbent to reduce its size into smaller particles. The adsorbent was then sieved and activated by the procedure shown below.

B. Activation Of Adsorbent

20gms of adsorbent was taken in three different beakers. To these; 20ml of Concentrated Hydrochloric acid, 20ml of concentrated Sulphuric acid, and 20ml of Orthophosphoric acid were added respectively, and kept for 48 hours with regular stirring every hour. The beakers were then heated for 6 hours at a temperature of about 160℃. The contents of the beakers were washed with tap water to remove impurities, decanted and washed again and decanted again. The process was repeated 2-3 times until a pH ofround 7 was maintained. The adsorbent was then filtered and dried.

C. Determination Of Phenol

Phenols were determined by Chloroform Extraction method using UV Visible spectrophotometry after Steam Distillation process. The analytical procedure was similar to that recommended by CPCB (Central Pollution Control Board) guide manual & APHA (American Public Health Association) standards methods.

Obtained phenol absorbance value

Sample	Concentration	Absorbance
Original sample	400ml	2.77
Phenol in sample	400ml	4.316

D. Preparation Of Phenol Solution

A 1000ppm phenol solution was made by adding 0.94ml of 100% phenol in a 1 liter standard flask and made up to the mark with distilled water. From this, 20ppm, 40ppm, 60ppm, 80ppm and 100 ppm solutions were made by pipetting out 2ml, 4ml, 6ml, 8ml, and 10ml of the base solution, respectively into 100ml standard flasks.

E. Preparation Of Standard Curve

The equipment used for the measurement of phenol concentration was an Ultraviolet-Visible Spectrometer. To establish a reference for measurements, a base line correction was carried out by filling both the cuvettes with the blank solution and using the option of base line correction on the spectrometer. The phenol solution was then placed into the sample cuvette to get a graph of the ultraviolet absorption of the solution over the range 0nm to 600nm. The value at the peaks which gives the wavelength of absorption for the given concentration of phenol was found out. The process was repeated for all concentrations of phenol and a graph of absorbance vs. concentration of phenol was plotted. The results are shown in Table 1.

Table 1 Concentration vs. Absorbance

Concentration (ppm)	Absorbance
20	0.112
40	0.192
60	0.870
80	0.950
100	1.130

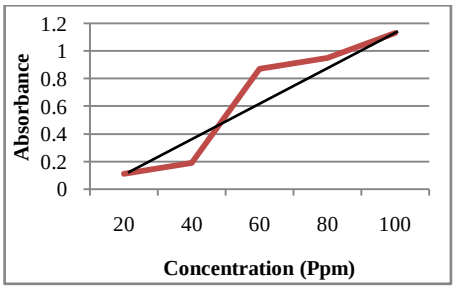

Fig. 1 Standard curve of phenol solution

III.RESULTS AND DISCUSSION

1.BATCH RESULTS OF BANANA PEEL ASH POWDER AND LEMON PEEL ASH POWDER

1. Effect of Dosage

Five conical flask containing 100ml 0f 100ppm concentrated phenol solution. The Adsorbent Dosage of 0.25gm, 0.5gm, 0.75gm, 1gm, 1.25gm (Activated Adsorbent) of raw BPAP was added in each conical flask. These conical flasks were kept in Orbital shaker for agitation at 120 rpm of about 24 hours. Samples were taken out and filtered. It was tested in UV-Visible spectrophotometer at 600 nm for finding the phenol concentration in the solution. Then the graph was drawn with adsorbent added against the percentage of phenol removal. Table –2 illustrates the optimum dosage for against percentage of phenol removal. The maximum removal was Obtained 91% at 1.25 gm of banana peel ash powder. The same procedure repeated to use in lemon peel ash powder Table – 6 illustrates the optimum dosage for against percentage of phenol removal. The maximum removal was Obtained 89% at 1.25 gm of lemon peel ash powder.

2. Effect of initial concentration

Five conical flask containing 100ml 0f 30ppm concentrated phenol solution. About 0.5gm of Banana Peel Ash Powder was added in each conical flask and samples were treated for 90 minutes with raw Banana Peel Ash Powder. The pH was adjusted to 8. These conical flasks were kept in orbital shaker for agitation at 120rpm. Samples were taken out and filtered. It was then tested in UV-VIS spectrophotometer at 600 nm for the phenol concentration in the solution. Then the graph was drawn with adsorbent added against the percentage of phenol removal. Table – 3 illustrates the optimum dosage for against percentage of phenol removal. The maximum removal was obtained 98% for 10ppm of banana peel ash powder.The same procedure repeated to use in lemon peel ash powder. Table – 7 illustrates the optimum dosage for against percentage of phenol removal. The maximum removal was obtained 88% for 10ppm of lemon peel ash powder.

3. Effect of pH

Five conical flask containing 100ml 0f 100ppm concentrated phenol solution. About 0.4gm of Banana Peel Ash Powder was added in each conical flask and samples were treated for 90 minutes with raw Banana Peel Ash Powder. The pH was varied from 4,6,8,10,12. These conical flasks were kept in orbital shaker for agitation at 120 rpm. Samples were taken out and filtered. It was tested in UV-Visible Spectrophotometer at 600 nm for finding the phenol concentration in the solution. Then the graph was drawn with adsorbent added against the percentage of phenol removal. Table – 4 illustrates the optimum dosage for against percentage of phenol removal. The maximum removal was obtained 86% at pH 8 of banana peel ash powder.The same procedure repeated to used in lemon peel ash powder Table – 8 illustrates the optimum dosage for against percentage of phenol removal. The maximum removal was obtained 79% at pH 6 of lemon peel ash powder.

4. Effect of Contact time

Five conical flask containing 100ml of 100 ppm concentrated phenol solution. About 1.25 gm of Banana Peel Ash Powderwas added in each conical flask and samples were treated for every 30 minutes with raw Banana Peel Ash Powder. These conical flasks were kept in Orbital shaker for agitation at 120 rpm for about 30 minutes. Samples were taken out and filtered. It was tested in UV-Visible Spectrophotometer at 600 nm for finding the phenol concentration in the solution. Then the graph was drawn with adsorbent added against the percentage of phenol removal. Table – 5 illustrates the optimum dosage for against percentage of phenol removal. The maximum removal was obtained 86% at 90 minutes of banana peel ash powder. The same procedure repeated to use in lemon peel ash powder .Table – 9 illustrates the optimum dosage for against percentage of phenol removal. The maximum removal was obtained 84% at 150 minutes of lemon peel ash powder.

Table 2 Effect of different Adsorbent Dosage Banana peel ash powder

Initial phenol concentration C_0 (mg/l)=10mm

	Dosage (g/l)	Residual phenol Concentration C_e (mg/l)	Phenol uptake (C_0 - C_e)	% Removal [(C_0-C_e)/ C_0]*100
H_2SO_4	0.25	9.760	0.240	2.401
	0.50	4.316	5.684	56.84
	0.75	3.624	6.376	63.76
	1.00	2.321	7.679	76.79
	1.25	2.140	7.860	78.60
H_3PO_4	0.25	8.321	1.679	16.79
	0.50	5.613	4.387	43.87
	0.75	4.323	5.677	56.77
	1.00	3.671	6.329	63.29
	1.25	2.147	7.853	78.53
HCL	0.25	6.721	3.279	32.79
	0.50	4.316	5.684	56.84
	0.75	2.641	7.359	73.59
	1.00	2.126	7.874	78.74
	1.25	**0.866**	**9.134**	**91.34**

Table 3 Effect of different initial concentrationusing BPAP

	Initial concentration C_0	Residual phenol concentration C_e (mg/l)	Phenol uptake (C_0 - C_e)	% Removal [(C_0-C_e)/ C_0]*100
HCL	**10**	**1.064**	**8.936**	**98.36**
	20	12.058	7.942	79.42
	30	25.119	4.881	48.81
	40	36.120	3.880	38.80
	50	46.117	3.883	38.83

Table 4 Effect of different pH using BPAP

Initial phenol concentration C_0 (mg/l) =10mm

	pH	Residual phenol concentration C_e (mg/l)	Phenol uptake (C_0 - C_e)	% Removal [(C_0-C_e)/ C_0]*100
HCL	4	2.125	7.875	78.75
	6	2.074	7.926	79.26
	8	**1.324**	**8.676**	**86.76**
	10	6.192	3.808	38.08
	12	7.144	2.856	28.56

Table 5 Effect of different Contact time using BPAP

Initial phenol concentration C0 (mg/l) =10mm

	Time (minutes)	Residual phenol concentration C_e (mg/l)	Phenol uptake (C_0 - C_e)	% Removal [(C_0-C_e)/ C_0]*100
HCL	30	4.62	5.38	53.8
	60	3.14	6.86	68.6
	90	**1.35**	**8.68**	**86.8**
	120	1.34	8.62	86.2
	150	1.31	8.69	86.9

Table 6 Effect of Different Adsorbent Dosage using lemon peel ash powder

Initial phenol concentration C_0 (mg/l)=10mm

	Dosage (g/l)	Residual phenol concentration C_e (mg/l)	Phenol uptake (C_0 - C_e)	% Removal [(C_0-C_e)/ C_0]*100
HCL	0.25	4.907	5.093	51
	0.50	3.175	6.825	68
	0.75	2.722	7.278	73
	1.00	1.822	8.178	82
	1.25	1.554	8.446	84
H_2SO_4	0.25	4.610	5.390	54
	0.50	4.429	5.571	56
	0.75	3.607	6.393	64
	1.00	2.013	7.987	79
	1.25	1.327	8.673	87
H_3PO_4	0.25	4.607	5.393	53
	0.50	3.826	6.174	62
	0.75	2.141	7.859	79
	1.00	1.743	8.257	85
	1.25	**1.124**	**8.876**	**89**

Table 7 Effect of different initial concentrationusing LPAP

	Initial concentration C_0	Residual phenol concentration C_e (mg/l)	Phenol uptake (C_0 - C_e)	% Removal [(C_0-C_e)/ C_0]*100
HCL	**10**	**1.193**	**8.807**	**88**
	20	14.041	5.959	60
	30	25.753	4.247	43
	40	36.467	3.533	36
	50	47.523	2.477	25

Table 8 Effect of different pH using LPAP

Initial phenol concentration C_0 (mg/l) =10mm

	pH	Residual phenol concentration C_e (mg/l)	Phenol uptake (C_0 - C_e)	% Removal [(C_0-C_e)/ C_0]*100
H_3PO_4	4	3.196	6.804	68
	6	**2.149**	**7.851**	**79**
	8	3.653	6.347	54
	10	5.016	4.984	50
	12	6.942	3.058	31

Table 9 Effect of different Contact timeusing LPAP

Initial phenol concentration C_0 (mg/l)=10mm

	Time (min)	Residual phenol concentration C_e (mg/l)	Phenol uptake (C_0 - C_e)	% Removal [(C_0-C_e)/ C_0]*100
H_3PO_4	30	3.94	6.06	61
	60	3.15	6.85	69
	90	**2.71**	**7.29**	**73**
	120	2.32	7.68	77
	150	1.65	8.35	84

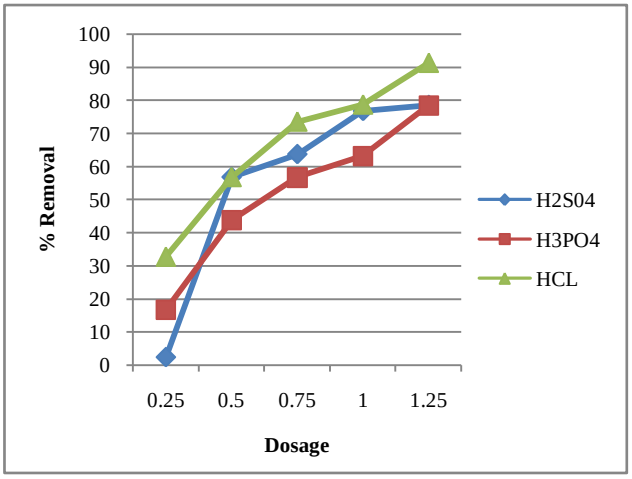

Fig 2 Dosage Vs % Removal of Phenol using BPAP

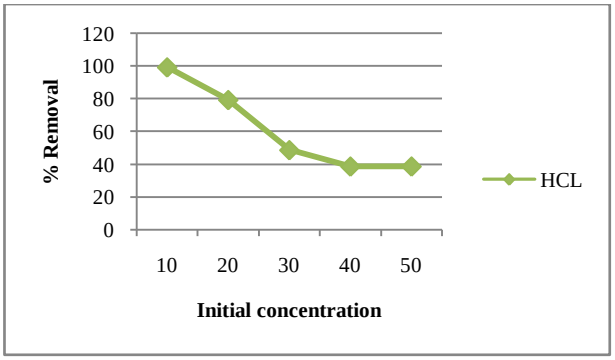

Fig. 3 Initial Concentration Vs % Removal of Phenolusing BPAP

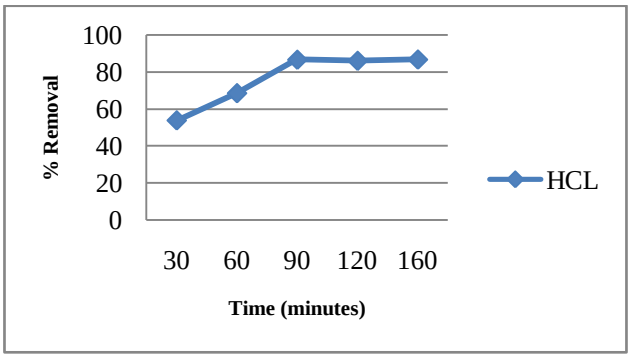

Fig. 5 Contact time Vs % Removal of Phenolusing BPAP

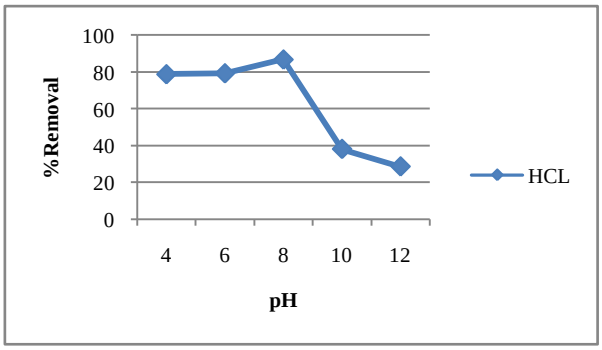

Fig. 4 pH vs % Removal of phenol using BPAP

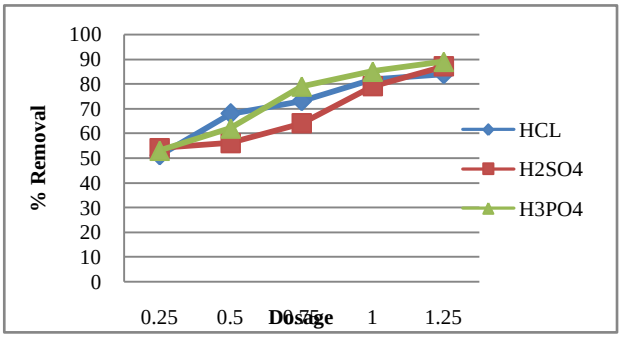

Fig. 6 Dosage vs Removal of phenol using LPAP

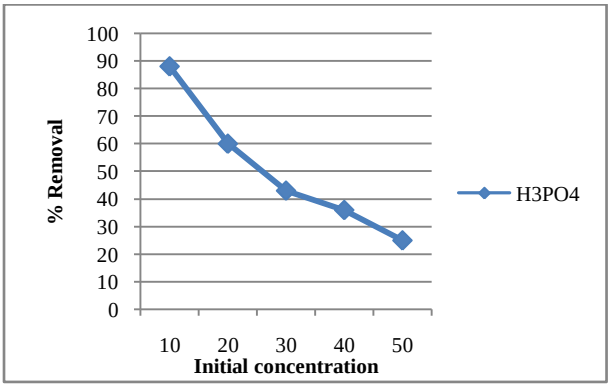

Fig. 7 Initial Concentration Vs % Removal of Phenolusing LPAP

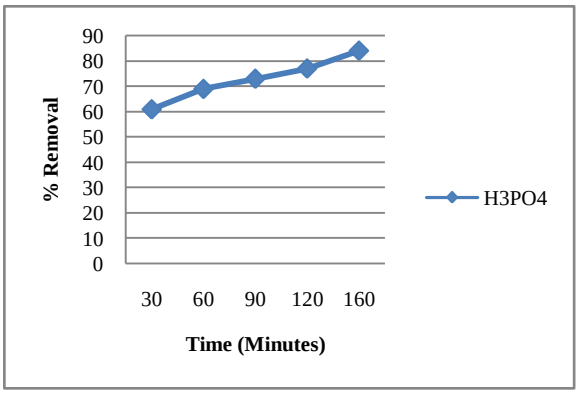

Fig. 9 Contact time Vs % Removal of Phenolusing LPAP

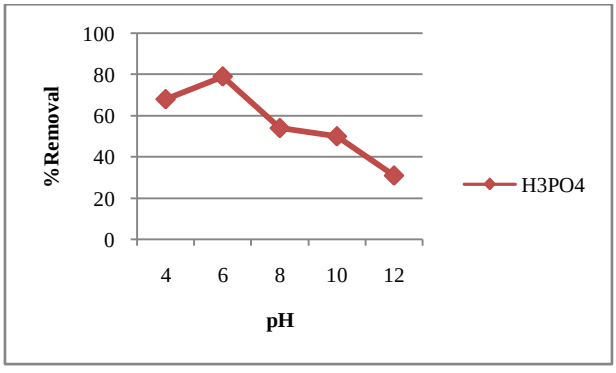

Fig. 8pH Vs % Removal of Phenolusing LPAP

VCONCLUSION

The following conclusions were drawn from the present studies on the removal efficiency of the adsorbent.

- From the dosage adsorption study, using Banana Peel Ash Powder the percentage(BPAP) of Phenol removal was found to be increase while increasing the dosage level (increasing milligrams), the maximum amount of removal percentage obtained was 91% at 1.25 grams. Hence an initial dosage of 0.5grams was taken for the whole experiments.

- From the initial concentration adsorption study, using Banana Peel Ash Powder, the percentage removal of phenol was found to decrease while increasing the concentration, the maximum removal obtained was 98% at initial concentration of 10ppm.

- From the pH study, using Banana Peel Ash Powder the percentage removal of phenol was found to decrease while increasing the pH, the maximum removal obtained was 86% at the pH 8.

- From the contact time study, using Banana Peel Ash Powder the percentage removal of phenol was found to increase while increasing the contact time, but the percentage removal was decreasing after lapse of 90 minutes, the maximum, removal obtained was 86% at the time of 90 minutes.

The following conclusions were drawn from the present studies on the removal efficiency of the adsorbent.

- From the dosage adsorption study, using Lemon Peel Ash Powder (LPAP)the percentage of Phenol removal was found to be increase while increasing the dosage level (increasing milligrams),the maximum amount of removal percentage obtained was 89% at 1.25 grams. Hence an initial dosage of 0.5grams was taken for the whole experiments.

- From the initial concentration adsorption study, using Lemon Peel Ash Powder, the percentage removal of phenol was found to decrease while increasing the concentration, the maximum removal obtained was 88% at initial concentration of 10ppm.

- From the pH study, using Lemon Peel Ash Powder the percentage removal of phenol was found to decrease while increasing the pH, the maximum removal obtained was 79% at the pH 6.

- From the contact time study, using Lemon Peel Ash Powder the percentage removal of phenol was found to increase while increasing the contact time, but the percentage removal was decreasing after lapse of 150 minutes, the maximum, removal obtained was 84% at the time of 150 minutes.

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