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Removal of Phenol from Synthetic Wastewater Using Modified Bagasse Activated Carbon

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ABSTRACT: In the present study bagasse was collected from Badagandi Sugar Factory Bilagi village, Bagalkot district and synthetic wastewater phenol removal has been investigated in this work considered four factors were (2-10),(30-150) min, (0.5-2.5)gm., (10-50)mg/L to the effect of pH, contact time, adsorbent dosage, and initial concentration on phenol in adsorption process. After Treating synthetic wastewater At pH 6, contact time 90 minutes, adsorbent dosage 2g and initial concentration is 40 mg/l removal of phenol efficiency occurred for Modified bagasse activated carbon (passing 75 μ) was 80%,70%,91%,95% respectively. At pH 4, contact time 120 minutes, adsorbent dosage 1.5g and initial concentration is 40 mg/l removal of phenol efficiency occurred for Activated Carbon (passing 75 μ) was 76%,65%,87%,95% respectively. Batch and Isotherm studies were carried out to evaluate the effect of pH, contact time, adsorbent dosage and initial concentration of phenol. A comparison of mathematical model applied to the adsorption of phenol was evaluated for the Langmuir, Freundlich and BET adsorption models. It was found that the equilibrium data agree very well with Langmuir, Frundlich and BET Isotherm models.

KEYWORDS: Phenol, Synthetic wastewater, Adoption, Modified Bagasse Activated Carbon

I. INTRODUCTION

Nowadays, water pollution represents a most important worldwide difficulty, wherever mainly of the pollutants upcoming from industrial and domestic activities are discharge into water bodies. phenol is a “class of aromatic compound in which one or more hydroxyl group attached directly to the benzene ring”. The phenol is white in color, crystalline mass which turns pink or red, adsorbs the water as of the air and liquefy. It gives distractive odor and sharp burning taste. It’s melting point is 42.5 to 43⁰C, boiling point is 182⁰C.

phenol types are consider as potentially poisonous with carcinogenic pollutant and the main source of phenols be from oil and petrochemical, coal processing, dyes, pesticides and pharmaceutical industries etc. So there is an increasing release of contaminants to the surface and ground water. Hence it is very much vital to check phenol before discharging into water bodies [1].

phenol have sharp with continual possessions on human health. Breathing with dermal contact to phenol is extremely frustrating to skin, eyes, and mucous. Phenol also can transform blood pressure and can reason liver and kidney harmed Adsorption process is in which various pollutants are removed from wastewater. With respect to other processes this method is simple and economical. This process consists of easy design and operating method at the end of process we get good quality effluent treated water. In this process various adsorbents are used such as bagasse, fly ash, rice husk and charcoal. The major advantage of this method is reversible process and adsorbents can be regained by suitable desorption process. At the present time adsorbents are economically and easily available and some adsorbents are naturally and artificially available.

“Adsorption process is surface phenomenon in which mass transfer of substance present in liquid phase on The surface of solid by physical and chemical process” [2].

The major factors which are influencing adsorption process are

- 1) Surface area of adsorbents: With increase surface area there will be increase in the adsorbent capacity.
- 2) Contact time; higher the contact time higher will be the adsorption.



- 3) Affinity of adsorbate to adsorbent: the adsorbent of surface is slightly polar in between affinity adsorbate and adsorbent.

II. RELATED WORK

Amit Bhatnagar., (2006) Studied that a comparative study has been carried over adsorbents prepared from several industrial wastes for the removal of 4-bromophenol, 2, 4-dibromophenol and 2-bromophenol has been carried out. The results demonstrate that highest adsorption on carbonaceous adsorbent prepared from fertilizer industry waste has been found to be 190.2 mg g⁻¹, 170.4 mg g⁻¹, 40.7 mg g⁻¹ and for 2,4-dibromophenol, 4-bromophenol, and 2-bromophenol respectively. As compared to carbonaceous adsorbent, The other three adsorbents (viz., slag, dust, and blast furnace sludge) adsorb bromophenols to a much smaller extent. A comparative study of adsorption results with those obtained on standard activated carbon sample shows that prepared carbonaceous adsorbent is about 45% as efficient as standard activated carbon in removing bromophenols. Column operations were carried out, To test the practical utility of standard activated carbon, the results were found acceptable in removing bromophenols by column study. Therefore the present experiment suggest the use of carbon slurry waste as economical adsorbent [3]. **Aretha Moreira de Olivira et al .,(2013)** studied that batch studies showed that the adsorption efficiency for 2,4-dichlorophenol(2,4,DCP) and 2,4,6 Trichlorophenol(2,4,6 TCP) follow the order chitosan >chitin>coconut shells in this study removal of 2,4 DCP and 2,4,6 TCP present in petrochemical wastewater was evaluated using low cost adsorbents. Freundlich and Langmuir models have been applied to experiment isotherm data to better know the adsorption mechanism using chitinous adsorbents, petrochemical wastewater with fixed bed columns showed percentage of COD removal (75%, Turbidity 74-89% and TOC 90%)[4]. **A.K. Jain et al.,(2002)**; Studied that comparative study on the adsorption of methyl phenols on adsorbents prepared from several industrial wastes has been done. The results show that extent of adsorption on carbonaceous adsorbent prepared from fertilizer industry waste has been found to be 88.5 mg/g, 65.9 mg/g, 37.3 mg/g and 40.5 mg/g for and 2,4,6-trimethylphenol, 2,4-dimethylphenol, 2-methylphenol and 4-methylphenol respectively. As compared to carbonaceous adsorbent, the other three adsorbents viz. blast furnace sludge, slag and dust adsorb methyl phenols to a much smaller extent [7].

III. METHODOLOGY

Preparation of synthetic solution containing phenol

A.R. grade of phenol is used to prepare a stock solution of concentration of 1000mg/ml by dissolving 1.0000g of phenol 1 litre of distilled water.

Reagents and Equipment

Chemicals used in the experiment were: 4-aminoantipyrine (C₁₁H₁₃N₃O), Phosphate buffer, Ammonium hydroxide (NH₄OH) (0.5N), Potassium ferricyanide A.R (Potassium hexacyano ferrate) with a chemical reaction K₃Fe(CN)₆ (99%). The equipments used for The experiments are Digital pH meter, U V Spectrophotometer, and weighing machine.

percentage of phenol removal

Batch adsorption experiment be conducted out at room temperature in stirring predetermined concentration of phenol stock clarification in beaker containing the ideal dose of adsorbent using stirrer. The sample from adsorbent was separated by filtration then the sample were analyzed for remaining phenol solution. Experiments passed out at optimal and minimum pH value the removal efficiency of phenol from solution was considered by equation under:

$$\text{Removal efficiency} = \frac{C_0 - C_i}{C_0} \times 100$$

Where,

C₀ is the Initial concentration of phenol

C_i is the Final concentration of phenol

Adsorption experiments

a. Determination of optimum pH

The synthetic phenol stock solution through constant concentration of 10 mg/L was taken in different beakers. the solution be variation of pH of 2,4,6,8 and 10 using NaOH (0.1N) and HCl(0.1N). adsorbent dosage 1 gram, contact time 60 minutes, concentration of 10 mg/L was use to get a optimum pH. In our laboratory test were done in room temperature. 200 ml of 10 ppm of phenol stock solution were taken in 5 different beakers of pH (2, 4,6,8 and 10), 1 gram of adsorbent is added and varied with by using agitator for 60 minutes. then after agitator take out into samples

were stored in 50 ml capacity of borosil bottle until test were carried out the concentration of the phenol samples were analyzed using ultra violet Spectrophotometer.



Figure 1.pH meter showing the pH value

b. Variation of contact time

in this case ,contact time was varied as 30,60,90,120 and 150 minutes and other parameters keep constant such as optimum pH which we find out the previous analysis with maximum removal of phenol, adsorbent dose 1 gram and phenol concentration of 10 mg/L was full in a set of beakers. And these beakers *were* agitated for contact time of 30,60,90,120 and 150 minutes take out the beaker by one by one using agitator. After providing mentioned contact time. then the samples were stored in borosil bottle until the test were carried out for remaining concentration of phenol solution in the solution using ultra violet spectrophotometer.



Figure 2.Samples being agitated at varying time

c. Variation of adsorbent dosage

The diluted phenol solution with initial concentration of 10 mg/L was taken in different beakers. the solution at constant optimum pH using NaOH (0.1N) and HCl (0.1N) which we got from previous analysis for maximum removal of phenol. Adsorbent dosage of 0.5, 1, 1.5, 2 and 2.5 gm of added for every beaker and agitated it for constant optimal contact time which we got from the preceding analysis for maximum removal of phenol and the samples were centrifuged and supernatant is separated and stored in borosil bottle until the test were carry out for residual phenol content using ultra violet spectrophotometer.

d. Variation of initial concentration of phenol

The concentrated phenol solution with varied from concentrations of 10, 20, 30, 40 and 50 mg/l was taken into 5 different beakers. the solution was maintained at optimum pH, adsorbent dosage and contact time which we got from the earlier analysis for most removal of phenol and then the solution were centrifuged for optimum contact time, after providing the required contact time the supernatant is separated and stored in borosil bottle the test were carried out for remains of phenol content using ultra violet Spectrophotometer.



Figure 3 variation of samples



Figure 4 Final phenol reading in spectrophotometer

IV. EXPERIMENTAL RESULTS

Effect of pH

MBAC (75 μ passing)

The effect of pH was studied with constant contact time of 60 min and initial concentration of 10 mg/l and adsorbent dosage of 1 gram. From the Figure 4.1.1 it can be showed that removal efficiency increased gradually from 2 to 6 pH and with further at pH 8 the adsorption decreases.

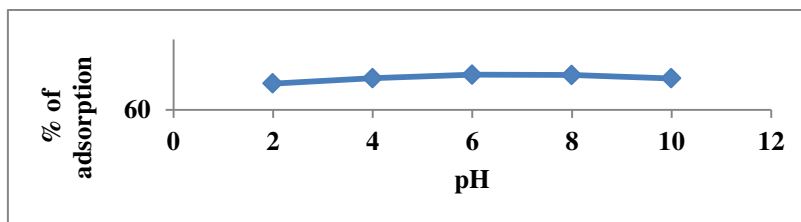


Figure 5. Effect of pH on adsorption of phenol on MBAC(75μ passing)

Activated carbon(75 μ passing)

The effect of pH was studied with constant contact time of 60 min and initial concentration of 10 mg/l and adsorbent dosage of 1 gram. From the Figure 4.1.2 show that that removal efficiency increased gradually from 2 to 4 pH and with further at pH 6 adsorption decreased.

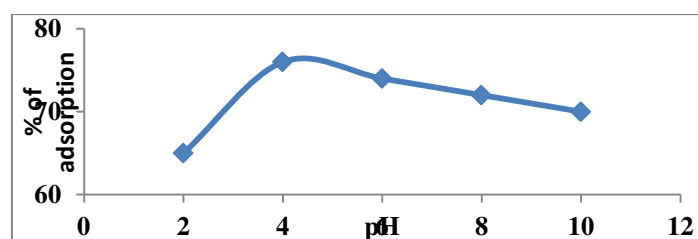


Figure 5 Effect of pH on adsorption of phenol on Activated carbon (75μ passing)



Effect of adsorbent dosage

MBAC (75 μ passing)

The effect of adsorbent dosage on removal of phenol is depicted in below fig 4.2.1 the study was carried out with constant 10 mg/l of phenol solution concentration, pH 6 and contact time of 60 minutes. And varying the dosage 0.5 to 2.5g. It can be showed that, increase in adsorbent dosage increase in adsorbent dosage increases the removal efficiency till 2 g adsorbent dosage further increase in dosage in no further increase in removal efficiency.

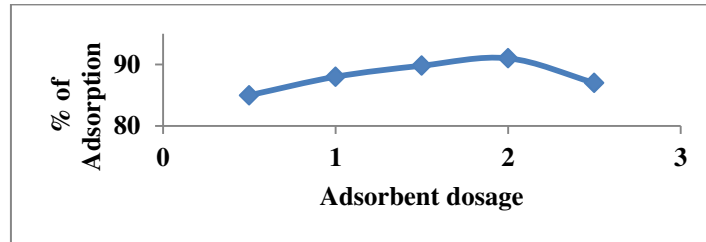


Figure 6 Effect of adsorbent dosage on adsorption of phenol on MBAC(75 μ passing)

Activated carbon(75 μ passing)

The effect of adsorbent dosage on removal of phenol is depicted in below Figure 4.2.2 the study was carried out with constant 10 mg/l of phenol solution concentration, pH 4 and contact time of 60 minutes. And varying the dosage 0.5 to 2.5g. It can be showed that, increase in adsorbent dosage increases the removal efficiency till 1.5 g adsorbent dosage further increase in dosage in no further increase in removal efficiency.

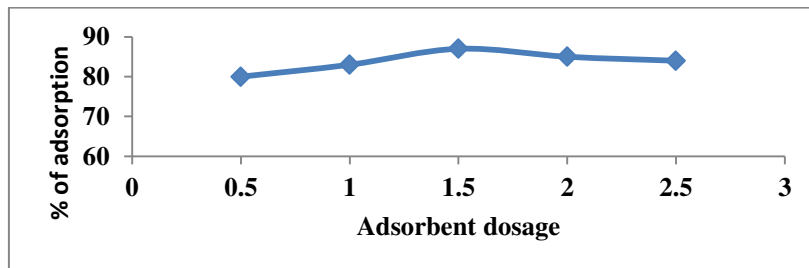


Figure 7 Effect of adsorbent dosage on adsorption of phenol on AC(75 μ passing))

Effect of contact time

MBAC(75 μ passing)

The effect of adsorbent on phenol removal investigated for The solution concentration of 10 mg/l with pH and dosing 1 g it can be experiential from The graph that efficiency increased in one and half hour further increase in contact time showed a steady decrease this effect may be explained as most of The adsorptive sites were occupied within 90 minutes, any increase in contact time decreased The adsorptive capacity. Hence contact time of 90 minutes was opted for further studies.

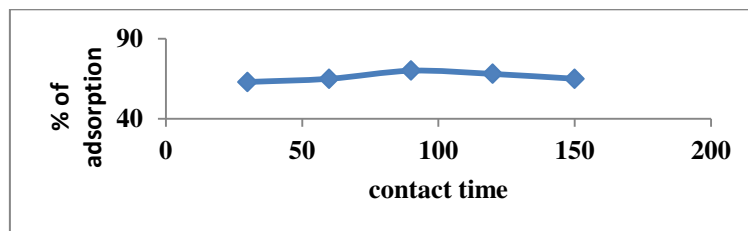


Figure 8 Effect of contact time on adsorption of phenol on MBAC(75 μ passing))

Activated carbon(75 μ passing)

The effect of adsorbent on phenol removal investigated for the solution concentration of 10 mg/l with pH 4 and dosing 1g it can be observed from the graph that efficiency increased in one and half hour additional increase in contact time



showed a continuing decrease this effect may be explained as most of the adsorptive sites were occupied within 120 minutes, any increase in contact time decreased the adsorptive capacity. Hence contact time of 120 minutes was opted for further studies.

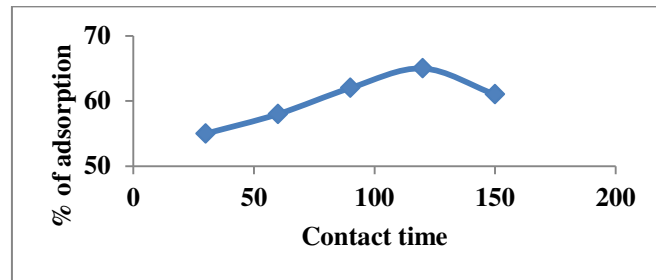


Figure 9 Effect of contact time on adsorption of phenol on AC (75µ passing)

Effect of phenol concentration

MBAC(75 µ passing)

The effect of concentration of phenol was investigated with opted valves contact time 90 minutes ,pH 6 and adsorbent dosage of 2 g from Figure 4.4.1 it can be show that, the removal efficiency increased gradually for first three concentrations and with further increase in concentration it almost reached equilibrium.

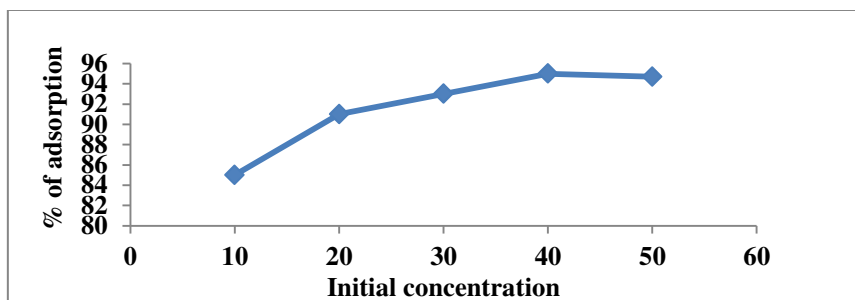


Figure 10 Effect of phenol concentration on MBAC(75µ passing)

4.4.2 Activated carbon(75µ passing)

The effect of concentration of phenol was investigated with opted valves contact time 90 minutes ,pH 4 and adsorbent dosage of 1.5 g from The graph it can be conditional that, The removal efficiency increased regularly for first two concentrations and with advance increase in concentration it almost reached stability.

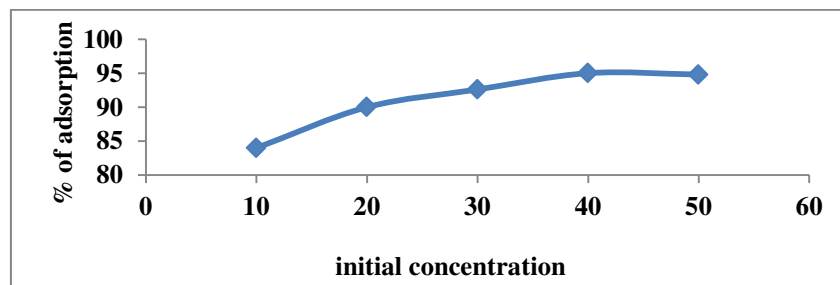


Figure 11 Effect of phenol concentration on AC (75µ passing)

V. CONCLUSION

The following conclusions were considered based on the experimental analysis carried out on phenol removal during adsorption by the use of MBAC (75 µ passing), AC(75 µ passing) and as adsorbents from synthetic phenol solution.



1. The activated carbon shows maximum adsorption capacity of 7.35 mg/g where as Modified activated carbon shows less maximum adsorption capacity of 4.85 mg/g
2. At pH 6 contact time 90 minutes adsorbent dosage 2g and initial concentration is 40 mg/l removal of phenol efficiency occurred for MBAC(75 μ passing) was 80%, 70%, 91%, 95% respectively
3. At pH 4, contact time 120 minutes, adsorbent dosage 1.5g and initial concentration is 40 mg/l removal of phenol efficiency occurred for activated carbon (75 μ passing) was 76%, 65%, 87%, 95%, respectively.
4. At optimum dosage the removal of adsorbate per gram of adsorbent for sampling 3 ports is 3.8 mg/g, 3.4 mg/g and 3.5 mg/g respectively.
5. The best of isotherm for The MBAC 75 micron is Freundlich isotherm and best isotherm for activated carbon is Freundlich isotherm and The best fit of Isotherm for the Modified bagasse activated carbon and Activated carbon is BET isotherm.
6. Regression coefficient (R^2) for Langmuir, Freundlich and BET isotherm for the phenol were found to be very near to 1 that implies that the adsorbent material used in the experiment was best fit for all three isotherm models that means the adsorbent shows monolayer as well as multi layer adsorption.

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