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Cod Removal from Sewage by Activated Carbon from Rice Husk- An Agricultural By Product

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ABSTRACT: The study deals with utilization of an agricultural by-product, rice husk for the removal of Chemical Oxygen Demand (COD) from sewage. Rice husk was processed into Rice Husk Activated Carbon (RHAC), a more useful form, by using phosphoric acid. The characteristics of raw sewage like pH and initial COD and the characteristics of adsorbent were measured. The mechanism of removal of COD by adsorption onto RHAC was studied by Batch process, under varying adsorbent dosage and pH of the solution to find the optimum conditions. RHAC was found to remove 92.37 % COD at dosage 5 gm and pH 6

KEYWORDS: Activated Carbon, Adsorption, COD, dosage, pH, Rice Husk.

I. INTRODUCTION

Organic pollution is caused due to release of organic compounds into water bodies. The main sources are domestic sewage, urban runoff, industrial and agricultural wastes etc. Organic pollution in the receiving waters is indicated by the amount of Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD) and Total Organic Carbon (TOC). Organic pollution alters the condition of the receiving waters, such as depleted oxygen level, hindrance to passage of sunlight which in turn affects the photosynthetic activities, deteriorating the aquatic ecosystem.

Since this arises as a significant issue, there arises a need to treat the waste water before discharge. The treatment may be primary, secondary and tertiary. Many conventional treatment methods have been in use, such as ion exchange, reverse osmosis, membrane filtration etc., but the cost involved in all these methods have been reported to be very high. Of the tertiary treatment methods existing, adsorption has been proven to be effective due to the lesser land requirement and flexibility in raw material use. Adsorption can involve utilisation of several agricultural or industrial materials which if not properly disposed adds to pollution, to develop suitable carbonaceous substances that can be used to treat water and wastewater. One such product is Activated carbon. Activated carbon can be either commercial or the one synthesized from any renewable resource. Commercially activated carbon is very costly. Hence manufacturing activated carbon from low cost and easily available raw materials is an innovative idea. Agricultural materials like rice husk, neem leaves, fruit peels etc. are being extensively used for research in wastewater treatment, which prevents several types of pollution due to dumping or open burning. Utilization of low cost renewable materials like agricultural and industrial wastes, which are sources of material and energy recovery stresses on the principle of waste minimization and cleaner production. In this study, rice husk which is an agricultural waste, was used to prepare activated carbon to remove COD from raw sewage.

II. MATERIALS AND METHODS

A. SAMPLE COLLECTION

Raw sewage was collected from the inlet of a local sewage treatment plant (STP). It was analysed for pH and COD.

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B. MANUFACTURE OF RICE HUSK ACTIVATED CARBON

Rice husk was procured from a local rice mill. It was washed thoroughly to remove dust and other impurities and oven-dried at $100\pm 5^{\circ}\text{C}$ for 24 hours. It was later crushed to smaller size to ensure uniform impregnation with the activating agent. It was then treated with 3M phosphoric acid at 80°C for 3 hours. The pre-treated rice husk was washed thoroughly and oven-dried at $100\pm 5^{\circ}\text{C}$ for 24 hours. The pre-treated rice husk was carbonised at 450°C for 2 hours [6]. Rice Husk Activated Carbon (RHAC) obtained was stored in air tight containers for further use. The process was repeated till substantial amount of carbon was obtained.

C. METHODS

1) **Characteristics of wastewater:** The characteristics of wastewater like pH and COD were analysed as per the methods prescribed by APHA. COD after treatment with Rice Husk Activated Carbon (RHAC) was also measured

2) **Characterisation of adsorbent:** Properties of rice husk activated carbon, like pH and moisture content, surface area and pore volume were measured. Surface morphology was studied by employing Scanning Electron Microscopy (SEM). RHAC with particle size less than $250\ \mu\text{m}$ was used for further experiments.

3) **Batch Adsorption Studies:** Batch experiments were conducted to study the mechanism of adsorption on RHAC. The experiments were conducted in 250 ml Erlenmeyer flasks. The effect of operating parameters like adsorbent dosage and pH on the adsorption mechanism was studied. An average

speed shaker was employed to ensure proper mixing. The desired pH was maintained using dilute NaOH or dilute HCl solutions.

For studying the effect of adsorbent dosage, 100 ml sample was taken in each flask. The pH of the solution was maintained at 7. RHAC dosage varying from 2 gm to 10 gm was mixed with each sample. A contact time of 100 minutes was maintained after which the solution was filtered and tested for residual COD.

For studying the effect of pH, 100 ml of sample was taken in each flask with RHAC dosage of 5 gm. pH was varied from 2 to 8. Contact time of 100 minutes was maintained after which the samples were filtered and analysed for residual COD.

III. RESULTS AND DISCUSSIONS

A. CHARACTERISTICS OF RAW SEWAGE

The characteristics of raw sewage are shown in the table below.

Table 1: Characteristics of raw sewage

	Value	Desirable limit for discharging onto inland surface as per IS 2490-1981
pH	6.69	5.5-9.0
COD (mg/l)	328	250

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B. CHARACTERIZATION OF RICE HUSK ACTIVATED CARBON

The characteristics of RHAC were obtained as follows.

Table 2: Characteristics of RHAC

Characteristics	Value
pH	5.78-6.01
Moisture content (%)	1.8596
Surface Area(m ² /gm)	217.23
Pore Volume(cm ³ /gm)	0.136

Surface morphology of raw rice husk and RHAC was done using Scanning Electron Microscopy to analyse the pore development after activation.

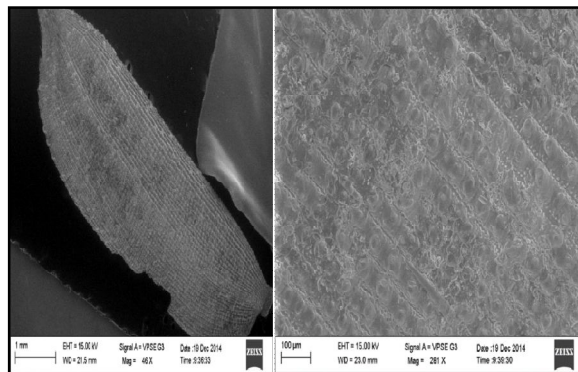


Fig 1(a) :SEM of raw rice husk

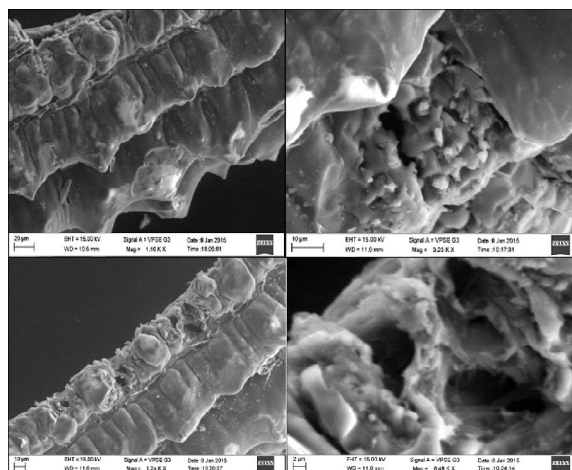


Fig 1(b): SEM of RHAC

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C. EFFECT OF DOSAGE ON COD REMOVAL

The percentage reduction was found to increase for COD when the dosage of RHAC was increased from 2 gm upto 5 gm per 100 ml of sample. The maximum reduction was obtained corresponding to 5 gm which was 89.02 % (Fig 2). When the dosage was increased beyond 5 gm, the COD reduction ceased.

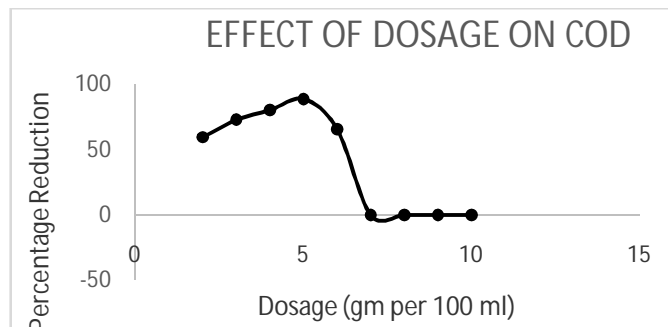


Fig 2: Effect of adsorbent dosage on COD removal

D. EFFECT OF pH ON COD REMOVAL

When pH of the sample was increased from 2 to 6, the percentage reduction of COD was found to increase subsequently. The maximum removal of 92.37 % was observed corresponding to pH 6. When the pH was further increased, removal was observed to decline.

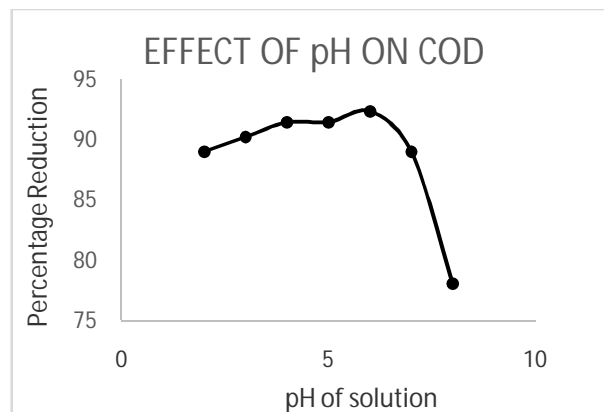


Fig 3: Effect of pH of solution on COD removal

IV. CONCLUSION

The use of low-cost adsorbents in the present scenario is emerging as a novel approach to waste minimisation and safer environment. Rice Husk used in this study to develop activated carbon in the laboratory scale using phosphoric acid has proven to be effective in reducing COD in raw sewage. A reduction of 92.37 % was achieved at dosage of 5 gm and pH 6. With improved processing techniques applied in large-scale treatment processes, greater efficiency in COD removal can be achieved. Such carbons developed from low-cost renewable resources can be used as substitute to commercial carbons. Use of agricultural wastes for such productive and innovative purposes boosts up the agro-industries, which in turn adds to the revenue and also provides a cleaner and safer environment for us to live in by reducing the pollution caused by the existing practices of disposing the agricultural wastes.

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