Heavy Metals Removal from Industrial Wastewater by Activated Carbon Prepared from waste material

Rahul Rajput[1], Amarendra Singh[2], Dr. A.K. Shukla[3]

[1]*M.Tech, Student, Environmental Engineering, Institute of Engineering and Technology, Lucknow, Uttar Pradesh, India*

[2]*Ph.D, Research Scholar, Department of Civil Engineering, Institute of Engineering and Technology, Lucknow, Uttar Pradesh, India*

[3]*Professor, Department of Civil Engineering, Institute of Engineering and Technology, Lucknow, Uttar Pradesh, India*

ABSTRACT

Activated carbon produced from coconut shell, Banana peel, Rice Husk and Egg shell was used as adsorbent to remove Cr, Cd, $Fe^{2+,}$ Zn^{2+} and Pb^{2+} ions from industrial wastewater. The activated carbon produced artificially by waste material of various agricultural and vegetative. Batch adsorption experiment was conducted to examine the effects of adsorbent dosage, pH and stirring rate on adsorption of Cr, Cd, Fe^{2+}, Zn^{2+} and Pb^{2+} from the wastewater. The obtained results showed that, the adsorption of the metal ions was adsorbent dosage and stirring rate dependent. The optimum adsorbent dosage and stirring rate were found to be at 0.2g to 1.0g, 200 to 350 rpm respectively. Removal efficiency showed the adsorbents capacity to treat the industrial waste water at different dosage. Also it is noticeable that activated carbon of taken in study in which coconut shell and Egg shell shows the higher efficiency at low adsorbent dosages but in other adsorbent Banana shell and Rice Husk shows higher efficiency with higher dosage for removal performance in industrial wastewater to remove heavy metal from wastewater sample. The overall quality of the treated water is ideal for the various purposes such as for irrigation, discharge in to the canals. The re-origination of the various metals and adsorbent regeneration without any further techniques, also it will down the overall cost in the removal of any water/wastewater as compared to chemically treated The study also showed that activated carbon prepared from Banana peel, Rice Husk, coconut shell and Egg Shell can be efficiently used as low cost alternative for removal of Heavy metal ions

Keywords: *Heavy Metal, Industrial Wastewater, Adsorbents, Removal Efficiency*

Introduction

Wastewater from numerous industries such as paints and pigments, glass production, mining operations, metal plating, tannary and battery manufacturing processes are known to contain contaminate such as heavy metal. Heavy metals such as Pb, Cd, Cr, Ni, Zn, Cu and Fe are present in industrial wastewater, these heavy metals in wastewater are not biodegradable and their existence in receiving River, lakes and streams causes bioaccumulation in living organisms, which leads to several health problems in animals, plants and human beings such as cancer, kidney failure, metabolic acidosis, oral ulcer, renal failure and damage in for stomach of the rodent1. As a result of the degree of the problems caused by heavy metals pollution, removal of heavy metals from wastewater is important. Investigation into new and cheap methods of metal ions removal has been on the increase lately. Recently efforts have been made to use cheap and available agricultural wastes such as coconut shell, orange peel, rice husk, peanut husk, Rice husk, Egg shell and sawdust as adsorbents to remove heavy metals from wastewater.

For this study, activated carbon made from coconut shell was used as adsorbent to remove Cr, Cd, $Fe^{2+,}$ Zn^{2+} and Pb^{2+} present in electroplating wastewater. Parameters such as, adsorbent dosage, adsorbent capacities and Removal efficiency were investigated at 32^{o}C.

Material and Methods

Collection of Industrial effluent

Effluent wastewater sample were obtained from an industry outlet located near the popular Common treatment effluent plant in the district of Unnao, Uttar Pradesh, India. The wastewater sample were obtained according to standard procedures and transported promptly to the laboratory under standard conditions. Wastewater sample has been applied and tested by conventional processes

Adsorbent Preparation

All waste material was obtained from fruits selling source and in the local market lucknow, Uttar Pradesh. The waste materials such as Banana Peel, Coconut shell, Rice husk and Egg shell was cleaned using tap water to eradicate possible strange materials present in it (dirt and sands). Washed sample material was sun dried for 5-7 days and then crushed with a grinder and grind to reduce the size. 300g of the smaller pieces was carbonized at 400°C for 30 mins. The sample was then brought out of the muffle furnace and cooled in desiccators. The adsorbent was then dried in an oven at 105°C for a period of 24 h. The artificially prepared low-cost adsorbent ready to perform the removal of heavy metals ions present in industrial wastewater.

Analysis

The heavy metals present in the wastewater sample, were analyzed using the atomic-absorption spectrophotometer. It detected the concentrations of Cr, Cd, $Fe^{2+,}$ Zn^{2+} and Pb^{2+} The initial concentrations of the metal ions present in the waste water are shown in table 1.

Table-1 Initial concentration of metal ions in wastewater

Heavy metals	Initial concentration (mg/L)
Pb	0.277
Cr	8.272
Cd	11.286
Zn	2.273
Fe	14.247

Study of Adsorption

Adsorption analysis is done by measuring 25 ml of the wastewater sample and poured in to a 250 ml conical flask. The freshly prepared activated carbon is added to the wastewater .the conical flask containing the adsorbent and the waste water was placed on a rotator shaker and rotates at 200 rpm at room temperature of (32°C) for a period of 120 min to ascertain equilibrium. The suspension was filtered use what man filter paper. Atomic adsorption spectrophotometer (Atomic absorption spectrophotometer is a spectral statistical approach for quantitative assessment of radioactive compounds by absorbing free atoms in the gaseous state through radiation emitted) was used to determine the concentration of different metal ions and other instrument was used to determine the physical and chemical ions concentration the amount of ions adsorbed by the adsorbent was calculated by using equation.

The mass balance equation is used to determine the adsorbent efficiency (Q_A) from equation given below-:

$$Q_A = (B - C) \times \frac{D}{A} \qquad (1)$$

Where, B and C are the initial and final values, D is the volume in g/ml, A is weight of adsorbents in gram (g).

The percentage of different parameters and metal ions is removed by the equation as follows -:

$$\text{Removal Efficiency of Absorbent (\%)} = \frac{\text{Initial Values} - \text{Final Values}}{\text{Initial Values}} \times 100\% \quad (2)$$

Effects of Adsorbent Dosage:

The dosage of adsorbent taken in this study is in grams, starts from 0.2 to 1.0 grams in physical parameter and heavy metal in special condition because heavy metal ions absorb more dosage after saturation, then dosage is added in to 25 ml of wastewater solution, then this sample put in to the falcon tubes, and put in to the rotator shaker for 120 min at speed of 250 rotary per minute (rpm) at a room temperate of 27˚C. The falcon tube is then filtered by what man filter paper and analyze after given time period.

Results and Discussion

Effect of Adsorbent Dosage:

The availability and accessibility of adsorption site is controlled by adsorbent dosage. Adsorbent dosage was varied from 0.2 g to 1 g, under the specific conditions (contact time of 120min, 150-300 rpm shaking speed and at room temperature of 27^{o}C). Figure-1 shows that increased adsorbent loading increased the metal ions percentage removal. The removal of Pb^{2+} attained minimum removal even at a lower adsorbent dosage of 0.2 g with 7-27% removal, increase in adsorbent dosage, also increased.

the percentage removal of Fe until mass of the adsorbent reached 1 g, with 90.10% removal, while maximum removal of Cd and Cr was attained at 0.8 g to 1.0 with 70 to 98% and 80 to 98 %. The percentage removal of Zn until mass adsorbent reached maximum dosage of 1.0 g with 45% removal of metal ions respectively, after which further increase in adsorbent dosage, brought no increase in adsorption, which was as a result of overlapping of adsorption sites due to overcrowding of adsorbent particles18. Hence 1 g was chosen as the optimum adsorbent dosage for removal of Cr, Cd, Fe^{2+} Zn^{2+} and Pb^{2+} metal ions and for further investigation of the work.

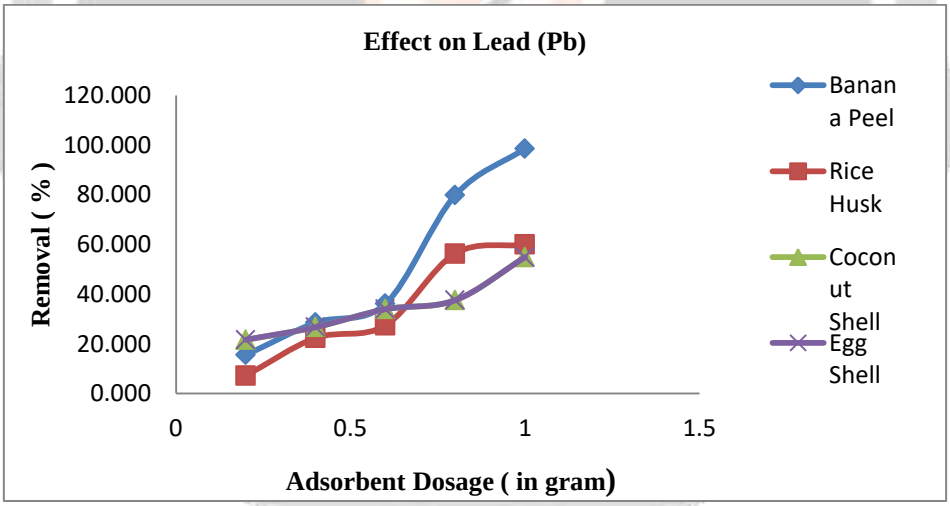

Fig:-4.1. Performance of various adsorbent to reduce the Lead (Pb) of industrial wastewater

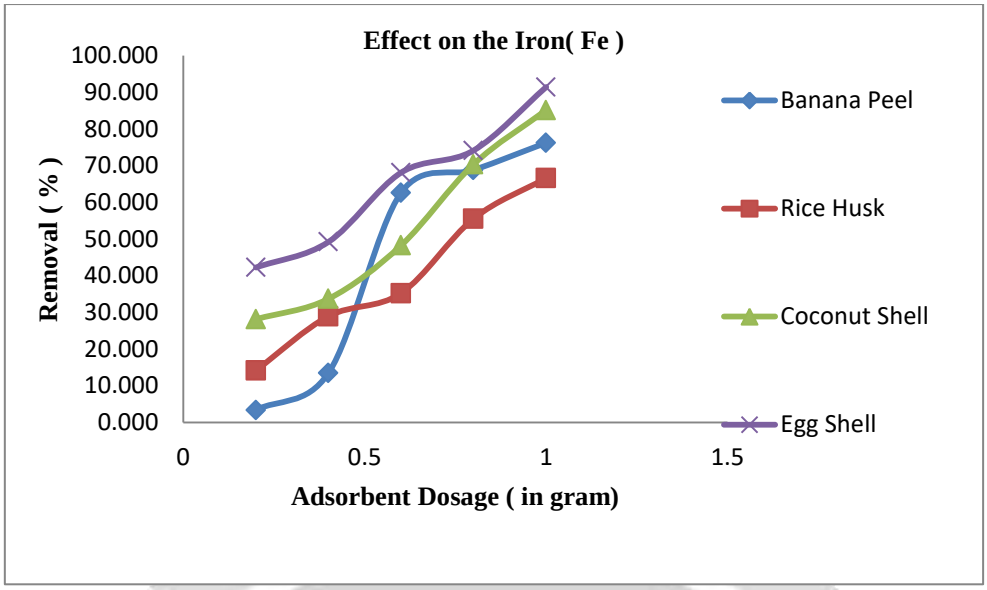

Fig:-4.2. Performance of various adsorbent to reduce the Iron (Fe) of industrial wastewater

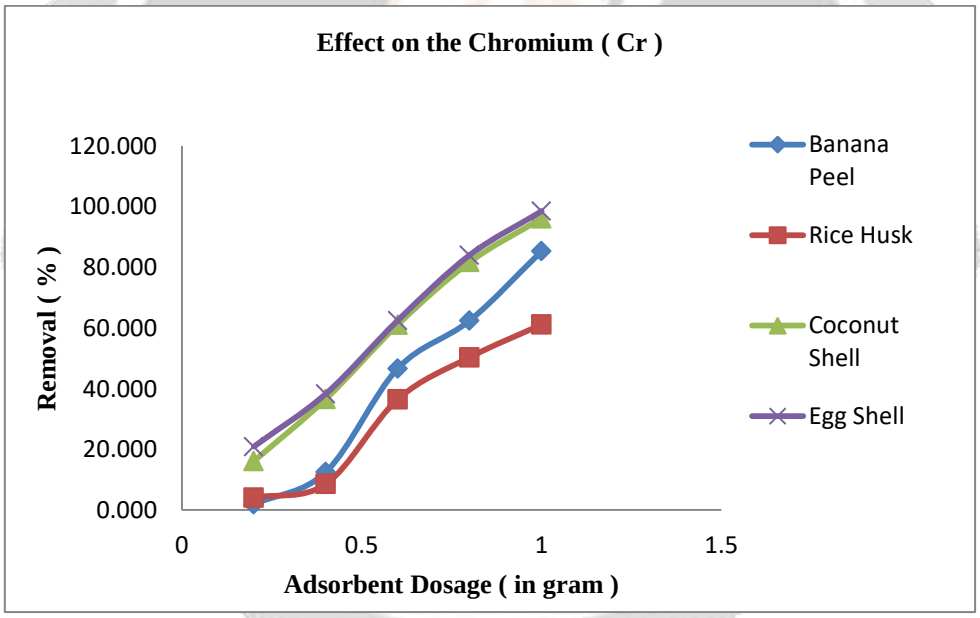

Fig:-4.3. Performance of various adsorbent to reduce the Chromium (Cr) of industrial wastewater

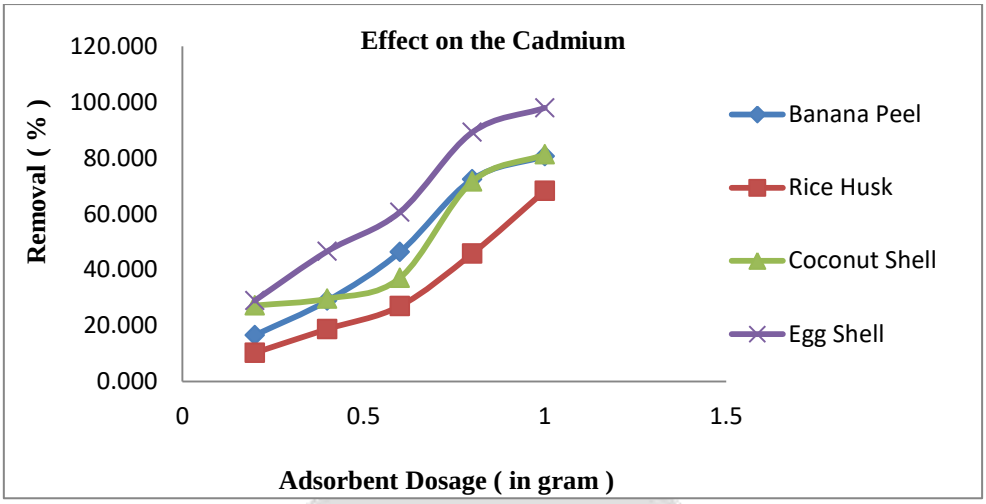

Fig:-4.4. Performance of various adsorbent to reduce the Cadmium (Cd) of industrial wastewater

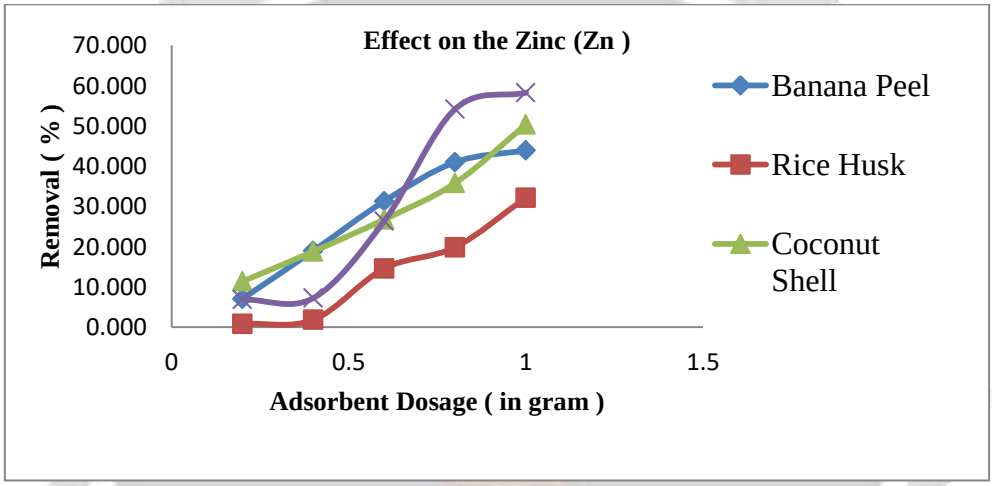

Fig:-4.5. Performance of various adsorbent to reduce the Zinc (Zn) of industrial wastewater

Conclusion

From the obtained results, it is evident that activated carbon produced from various waste materials is a good adsorbent for removal of lead, iron, chromium, cadmium and zinc ions. Batch experiments were conducted and showed that the adsorption of lead, iron, chromium, cadmium and zinc ions are time dependent, adsorbent dosage dependent and stirring speed dependent. Banana Peel, Coconut shell, Rice husk and Egg shell (a waste) is inexpensive and readily available, thus this study provide a cost effective means for removing metal ions from contaminated water or effluents. The overall quality of the treated water was ideal for the various purposes such as for irrigation, discharge in to the canals. The re-origination of the various metals and adsorbent regeneration without any further techniques, also it will down the overall cost in the removal any water/wastewater as compared to chemically treated.

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