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Removal of Zinc Metal Ions from Electroplating Industrial Waste Water by Using Bio-Sorbent

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Abstract— *The adsorption of Zinc from electroplating industrial effluent by banana peel powder was investigated. The influence of pH of sample, adsorbent dosage, temperature and contact time were evaluated on the bio-sorption studies. The present study aims to investigate efficiency of banana peel as an absorbent for removal of zinc from effluent by batch experiments. In order to investigate the bio-sorption isotherms, two equilibrium models, Langmuir and Freundlich isotherms were analyzed. This study focuses on optimization of contact time, pH, temperature and adsorbent dosage of banana peel for removal of heavy metals from effluent of electroplating industry.*

Keywords— Adsorption, Zinc, Banana Peel, Electroplating industry.

I. INTRODUCTION

Electroplating industrial waste water is one of the major contributors to heavy metal pollution in surface water. Removal of heavy metals from industrial waste water is important because they are not only contaminating water bodies but also toxic to human being and animals. For the removal of heavy metals from industrial waste water streams the bi-sorption process is used with use of natural, alternative and cheaper adsorbents. The purpose of this study is to check feasibility of bio-sorbent for removal of zinc ion from electroplating industrial waste water.

Problem Statement:

At present scenario industries directly discharge their effluent into municipal waste water because there is lack of regulations regarding disposal of such effluent and also due to costlier treatment techniques available. Objective of the study is to suggest economical and environment friendly technique by use of banana peels which is easily available as bio-sorbent for removal of zinc from electroplating industrial effluent.

II. EXPERIMENTAL ANALYSIS

Preparation of Adsorbent from Banana Peel:

The banana peels used to prepare adsorbent in form of powder. This adsorbent used for removal of zinc from the electroplating effluent. These are collected from various fruit juice centers. Firstly Banana peels washed with distilled water 3-4 times to remove other soluble substances. Then banana peels dried in sun light for 5days. Then this banana peels dried in an oven at 90^0C for 10 hrs. Afterword's this product again dried in an oven at 100^0C for 5 hrs. This banana peel product cooled at room temperature and grinded to powder.

Sampling:

The effluent samples were collected from the Electroplating industry, Super Auto Plating Pvt. Ltd, Bhosari Pune, Maharashtra, India.

Batch Adsorption:

All experiments are carried out at room temperature (25-30°C) in batch method. Batch method was selected because of its simplicity and reliability. The experiments were carried out by taking 100ml effluent sample in a flask and after pH adjustment a 1gm of dried adsorbent was added. The flask was agitated at near about 60 to 70 rpm for 60 minutes using a mechanical stirrer. After shaking, the suspension was allowed to settle. The residual biomass adsorbed with metal ion was filtered using whatman-1 filter paper. Metal ion estimation using Atomic adsorption spectrophotometer. The percent removal of metals from the solution was calculated by the following equation. Percent removal of metals from the solution was calculated by the following equation.

$$\%\boldsymbol{removal} = \frac{(\boldsymbol{Co} - \boldsymbol{Ce})}{\boldsymbol{Co}} \times \mathbf{100}$$

Where,

Co= is the metal ion concentration (mg/l)

Ce= is the final ion concentration (mg/l)

$$\boldsymbol{amount\ absorbed, qe} = \frac{(\boldsymbol{Co} - \boldsymbol{Ce})}{\boldsymbol{m}} \times \boldsymbol{V}$$

Where,

M= mass of adsorbent

Co= initial concentration of metal ion in the solution

Ce = Final concentration of metal ion in the solution (mg/lit)

V= volume of solution (lit),

q_e = amount of metal ion adsorbed per gram

Characteristics of Adsorbent (Banana Peel):

1. **Energy-dispersive X-ray spectroscopy - Scanning Electron Microscopy (EDX-SEM)**

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Element	Weight%	Atomic%
C K	51.04	59.70
O K	43.40	38.11
Mg K	0.18	0.10
Si K	0.68	0.34
P K	0.21	0.09
Cl K	1.00	0.40
K K	3.04	1.09
Ca K	0.46	0.16
Totals	100.00	

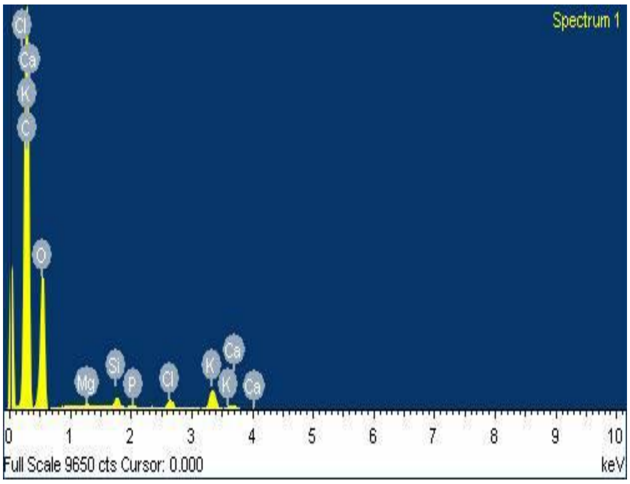

Fig.1: EDX-SEM analysis

1. Scanning Electron Spectroscopy (SEM)

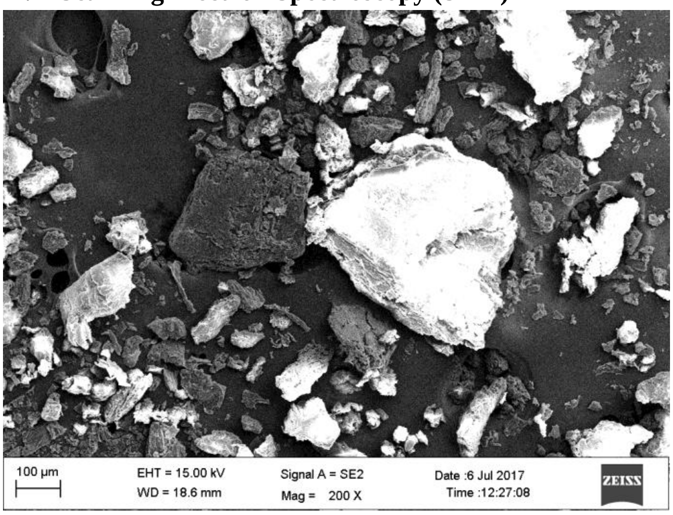

Fig.2: Before Adsorption

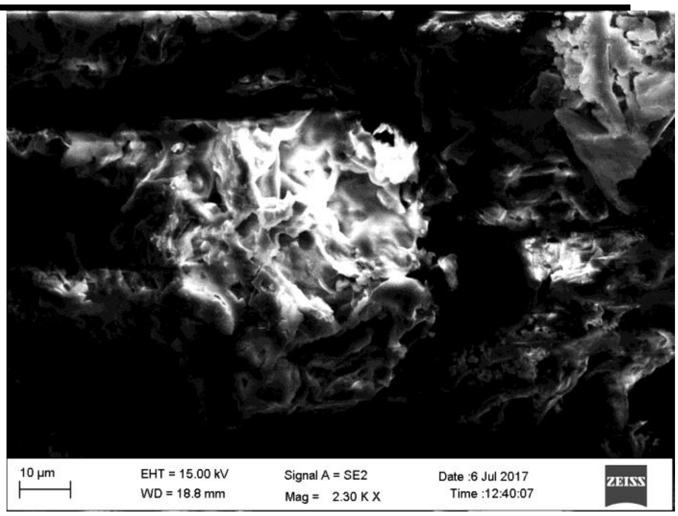

Fig.3: After Adsorption

Parameters affecting Adsorption Process:

1. Effect of pH

The effect of pH on percentage removal of zinc banana peel from effluent sample is shown in following figure. It is observed that the percentage removal of zinc increases slowly with increasing pH from 2 to 4 and thereafter drops slowly. The maximum percentage removal of zinc by banana peel was 97.15%. The optimum pH at which maximum removal of zinc is observed is to 4.0

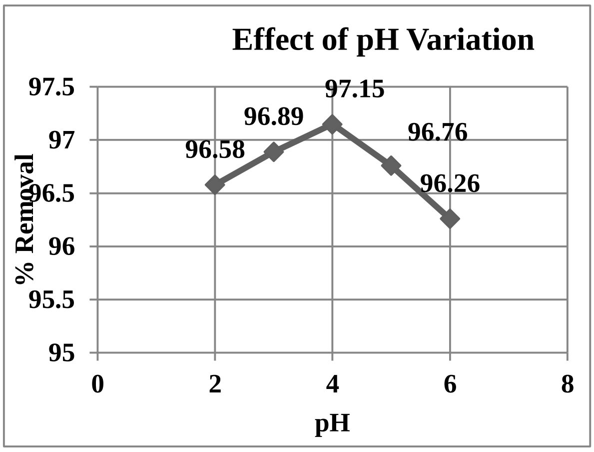

Fig.4: Relation between pH and percentage removal of zinc.

2. Effect of Adsorbent Dose

The effect of adsorbent dosage on percentage removal of zinc from effluent sample is shown in following figure no.2. It is observed that initially the percentage removal of zinc increased rapidly with an increase in adsorbent dosage, but after certain adsorbent dosage the removal efficiency did not increase.

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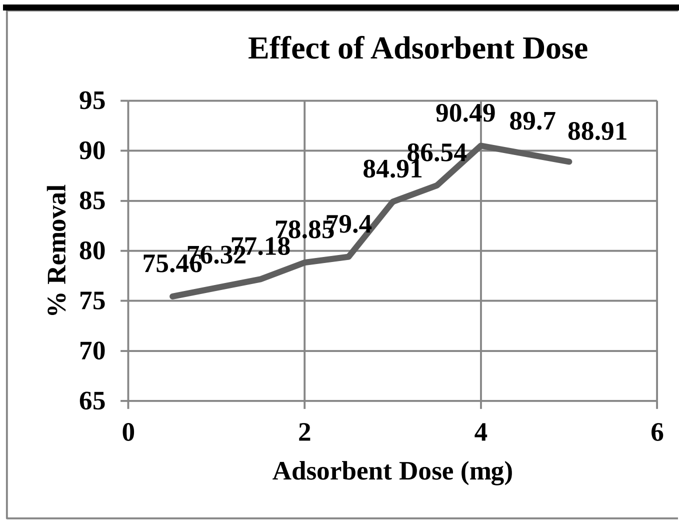


Fig.5: Relation between adsorbent dose and percentage removal of zinc.

3. Effect of Temperature

The effect of temperature on percentage removal of zinc from effluent sample is shown in following figure no.3. With the increase in temperature percentage removal of zinc decreased. For banana peel, zinc removal decreases from 85.05 % to 79.35 % due to the increase in temperature from 30° to 50°C.

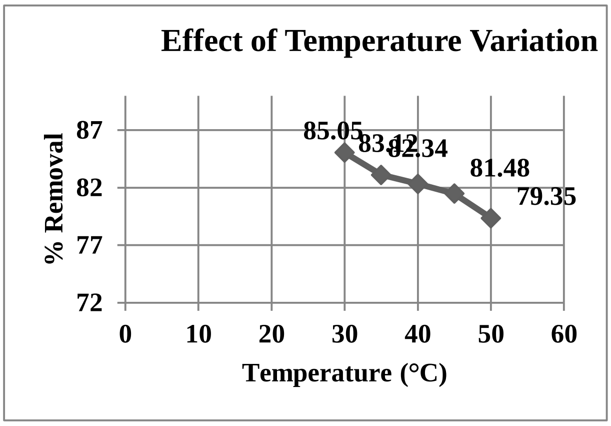


Fig.6: Relation between adsorbent dose and percentage removal of zinc.

The percentage removal is decreased with increase of temperature, so it was concluded that the adsorption reactions are exothermic. Bio sorption capacity also increased with decrease in temperature. The decrease of bio-sorption capacity at higher temperature may be due to the damage of active binding sites in the biomass. The maximum zinc removal is observed at 30°C.

4. Effect of Contact Time

The effect of contact time on batch adsorption of zinc at 30°C and at pH 4.0 by banana peel is shown in following figure. During the experiment contact time was varied from 0 to 270 min. The results showed that the percentage removal of metal ion by adsorbent increased by increasing contact time. The maximum removal of zinc is observed at 270 min.

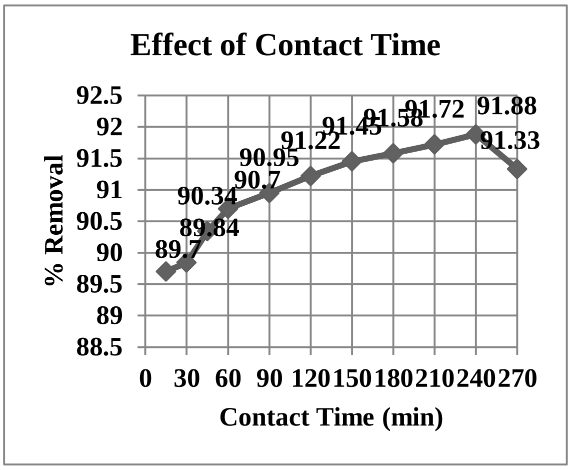


Fig.7: Relation between Contact Time and percentage removal of zinc.

III. ADSORPTION ISOTHERMS

Adsorption isotherms i.e. Langmuir and Freundlich isotherms are used to characterize the bio sorption.

Langmuir Isotherm:

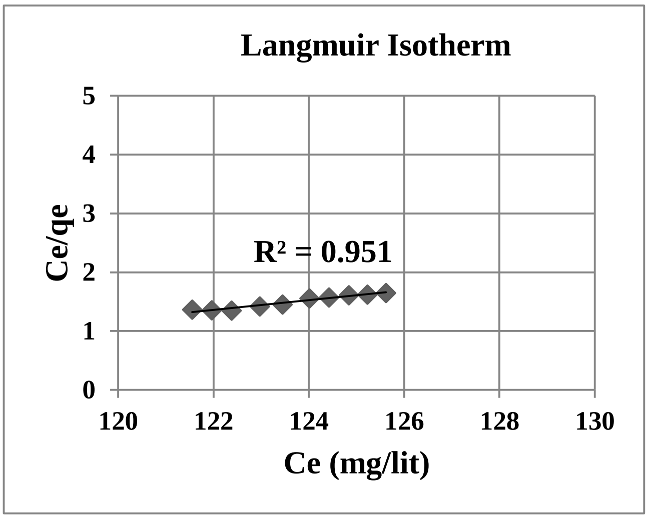
The Langmuir model makes assumptions such as monolayer adsorption and constant adsorption energy. Langmuir equation of adsorption isotherm is:

$$1/q = 1/q_{max} + 1/(b^* q_{max})\ (Cf)$$

Where,

q_{max} and b are the Langmuir constants.

The graph of isotherm is plotted below:



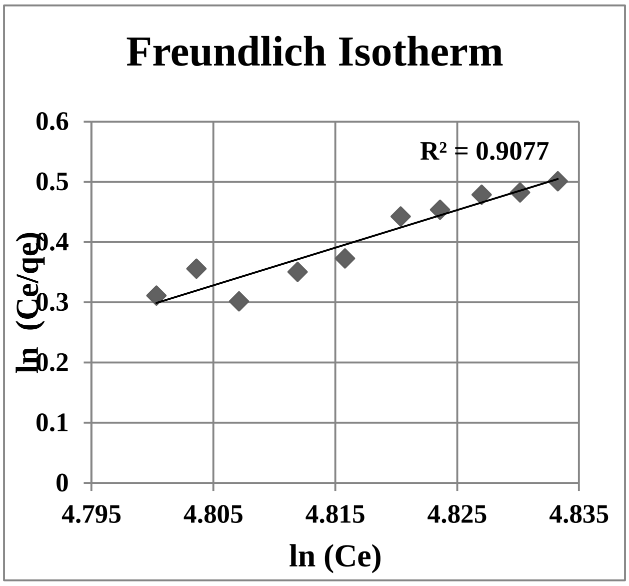
Graph.1: Langmuir Isotherm plots for removal of zinc for banana peel.

Freundlich Isotherm

Freundlich model deals with heterogeneous adsorption The Freundlich equation of adsorption isotherm is:

$$\log q = \log K + (1/n) \log Cf$$

Where q is the amount adsorbed per unit mass of adsorbent and Cf is equilibrium concentration. The graphs of isotherms are plotted below:



Graph.2: Freundlich Isotherm plots for removal of zinc

IV. CONCLUSION

The experimental data on batch study showed the maximum removal of 90% was obtained at 4gm of adsorbent and 100ml of zinc sample. The removal of zinc from sample strongly depends on pH of the solution, adsorbent dosage, temperature and contact time. The maximum adsorption of zinc was obtained at pH 4.0, adsorbent dosage of 4 gm, contact time 240 min and temperature at 30°C. The best fitting of experimental results to the proposed isotherms was observed in isotherm models that assume that ionic species bind first at energetically most favorable sites with multi layer adsorption taking place simultaneously. Values of correlation coefficient for Langmuir isotherm is 0.951 whereas for Freundlich isotherm is 0.907. It indicates that Langmuir isotherm's correlation coefficient value is near to 1 and hence Langmuir isotherm fit well for adsorption equilibrium. Decrease in percentage of adsorption with increase in temperature indicates that the process is exothermic in nature and increase in adsorbent dose gave increased adsorption for zinc. These findings will be used in further works for the optimization of the sorption experimental conditions using banana peel powder in continuous processes since this adsorbent may be an alternative to more costly materials as activated carbon for the treatment of liquid wastes containing metals.

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