Removal of Zinc Ions from Industrial Effluent by Using Cork Powder as Adsorbent

Sachin M.Kanawade and R.W.Gaikwad

***Abstract*—Rapid industrialization and urbanization have resulted in the discharge of various toxic pollutants into the water bodies. Heavy metals constitute the major part of toxic waste let out by many industries. These metals are toxic to both human beings and aquatic life when they exceed their permissible limits. There are several methods used for the removal of heavy metals in the wastewater such as chemical precipitation, ion exchange, reverse osmosis, electro dialysis, ultra filtration and phytoremediation. But these methods are either expensive or inefficient for the removal when the metals are at high concentration. The search for new technologies involving the removal of toxic metals from wastewaters has attracted attention to adsorption. The present study aims at the removal of zinc from electroplating industrial wastewater using a cheap adsorbent, cork powder. 98% of zinc removal was found in synthetic wastewater whereas the removal percentage for the electroplating industrial wastewater was observed to be 91%.**

***Index Terms*—Adsorption, Zn ion, Cork powder, Industrial effluent.**

I. Introduction

Heavy metal releases to the environment have been increasing continuously as a result of industrial activities and technological developments, posing a significant threat to the environment and public health because of their toxicity, accumulation in the food chain and persistence in nature. Metals of immediate concern include copper, zinc, chromium, arsenic, lead, nickel, iron. Living organisms require varying amounts of heavy metals viz Iron, cobalt, copper, manganese,etc in small quantities. But excessive levels can be damaging to the organism and their accumulation over time in the bodies of animals can cause serious illness [5]. Lead is a highly toxic metal to living organisms. It affects the red blood cells and causes damage to organs including the liver, kidneys, heart, and male gonads, as well as causes effects to the immune system[1]. It is therefore important to develop new methods for metal removal from dilute solutions and for the reduction of heavy metal ions to very low concentrations. Acute toxicity of zinc may result in sweet taste, throat dryness, cough, weakness, generalized aching, chills, fever, nausea and vomiting. Eating large amounts of zinc, even for a short time, can cause stomach cramps, nausea, and vomiting. The proposed limit of Zinc in drinking water is 5 ppm as proposed by FDA. Chromium compounds have been determined as carcinogens by the Department of Health and Human Services. Ingesting very large amounts of chromium can cause stomach upsets and ulcers, convulsions, kidney and liver damage, and even death. There are several methods used for the removal of heavy metals in the wastewater such as chemical precipitation, ion exchange, reverse osmosis, electro dialysis, ultra filtration and phytoremediation. But these methods are either expensive or inefficient for the removal when the metals are at high concentration. The search for new technologies involving the removal of toxic metals from wastewaters has attracted attention to adsorption [6].

Acharya et al.conducted a study on the removal of lead from wastewater from tamarind wood activated by zinc chloride and concluded that tamarind wood activated could effectively used to adsorb lead from aqueous solutions. Aslam et al. conducted a study on the removal of zinc using sand as adsorbent. The removal efficiency was quite high ranging from 71-87%. Kanimozhi et al. conducted a study on the removal of copper and zinc by adsorption on activated tapioca peel waste biomass. The removal efficiencies for copper and zinc were 82% and 84% respectively. Kicsi et al. conducted a study on the removal of zinc from aqueous solutions by romanian sphagnum peat moss. The sorption of Zn (II) was highest at pH 5.5, increased with peat dose and solution temperature and decreased with increase of concentration of solution; the required time for equilibrium establish was of maximum 2 hours [9]. Choudhary conducted a study on the removal of zinc using natural and synthetic adsorbents such as clarified sludge and rice husk ash and made a comparison on the effectiveness of the adsorbents on the removal. They found clarified sludge as the most effective adsorbent for Zn (II) removal. In this paper, the effectiveness of cork powder as an adsorbent has been studied for the removal of zinc from the wastewater of an electroplating industry. The main objective of the study was to optimize various parameters of adsorption using cork powder as adsorbent[16].

II. Experimental Set-Up

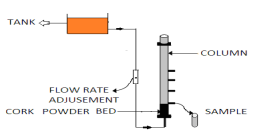

Fig. A. Experimental set-up of Adsorption Column

Manuscript received May 20, 2011; revised June 15, 2011.

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III. Characterisation of Wastewater

The wastewater collected was found to have high concentrations of dissolved solids and have a zinc concentration of 45mg/l.(15) (TABLE I.)

TABLE I. Characterisation of Raw Wastewater

Sr.No	Parameter	Results
1	Colour	Orange
2	Turbidity	200 NTU
3	pH	5.2
4	Total solids	60000 mg/l
5	Total Dissolved solids	38200 mg/l
6	Total Suspended solids	14200 mg/l
7	Acidity	6200 mg/l
8	Sulphate	900 mg/l
9	Zn	45 mg/l
10	Fe	5 mg/l
11	COD	7500 mg/l

IV. MATERIALS & METHOD

Fine cork powder of size 80µm sieve size was used for the adsorption studies. Wastewater was collected from an electroplating industry which produces 12 MT of zinc metal slabs a day. The industry discharges a volume of 2500m³ of wastewater daily. The extraction of the metal is from its sulphide ore which ultimately converted into zinc sulphate, is subjected to electrolysis using aluminum cathodes [7,10]. The effluent contains objectionably high concentrations of zinc.

The various physical and chemical parameters such as total solids, total dissolved solids, total suspended solids, pH, turbidity, COD, acidity, alkalinity, zinc content etc of wastewater (Table 1) were determined. Total solids, total dissolved solids and total suspended solids, COD, acidity and alkalinity were determined according to APHA standard methods for water and wastewater treatment [11,12]. Zinc concentrations were determined using an Atomic Absorption Spectrophotometer (AAS). A stock solution of zinc 100mg/l was prepared by dissolving ZnSO4.7H2O in deionised distilled water. The various parameters of adsorption such as pH, contact time, adsorbent dosage, and initial concentration of zinc were optimized [2]. The samples were taken in conical flasks and were agitated in a mechanical shaker. The optimised parameters were applied to the electroplating industrial wastewater and the maximum percentage removal of zinc, the percentage reduction of total solids and total dissolved solids were determined [3].

V. RESULTS AND DISCUSSIONS

A. Effect of pH

The initial concentration of the solution was taken as 10 mg/l and the contact time given was 1hour, pH was varied from 0-12. The maximum adsorption (92%) was obtained at a pH of 6 and the adsorption decreased with an increase or decrease in pH [5]. The results are shown in Fig 1

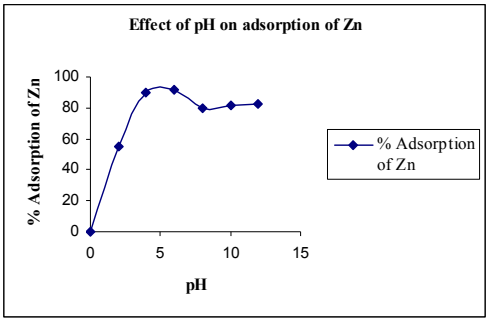

Fig 1. Effect of pH on adsorption of Zn

B. Effect of contact time on adsorption

The effect of contact time was studied using an initial concentration of 10mg/l of zinc and pH of 6. The maximum adsorption was found at a contact time of 100 minutes [12]. Increase in contact time shows some variable change in the results (Fig. 2)

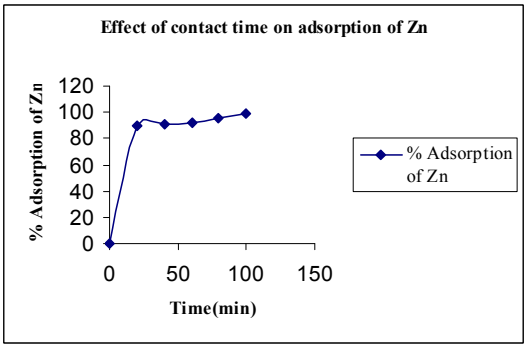

Fig 2. Effect of contact time on adsorption of Zn

C. Effect of initial concentration

The initial concentration of zinc was varied from 0-10mg/l.A contact time of 1 hour was provided and the obtained results are shown in Fig. 3 81% removal was observed at an initial concentration of 6mg/l. [13]

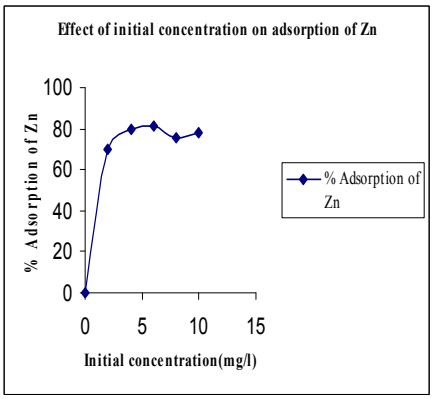

Fig 3. Effect of initial concentration on Adsorption

D. Effect of adsorbent dosage on adsorption

The adsorbent dosage was varied for an initial concentration of 10mg/l and a contact time of 1 hour. The maximum percentage removal of zinc of 100% was obtained at an adsorbent dosage of 100mg. Increase in adsorbent dosage produces some change in the results [8] (Fig. 4)

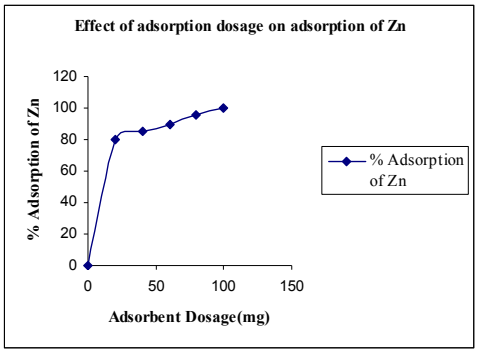

Fig 4. Effect of adsorbent dosage on Adsorption

VI. Characterisation of Effluent Wastewater

The electroplating industrial wastewater was treated with cork powder as adsorbent under the optimized conditions of pH, contact time, adsorbent dosage etc. 90% of the zinc content was found to be removed[10].

TABLE. II The Effluent Wastewater was Found to Have the Following Characteristics [14]

Sr.No	Parameter	Results
1	Total solids	12150 mg/l
2	Total Dissolved solids	6800 mg/l
3	Total Suspended solids	6500 mg/l
4	Turbidity	27.5
5	pH	6.5
6	Zn	4.9 mg/l

VII. Conclusions

Cork powder was found to be a good adsorbent for the removal of zinc from the wastewater. At optimum conditions of pH, contact time, initial concentration and adsorbent dosage, the removal of zinc was found to be 98% for synthetic wastewater and it was found to be 91% for industrial wastewater.

ACKNOWLEDGEMENTS

We are gratefully acknowledgements to Chemical Engg.Department of Pravara Rural Engg. College,Loni for experiment facility & their guidance,help in completion of this paper.

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