December 2009 Volume 4 Issue 6

Trade Science Inc.

Environmental Science

An Indian Journal

Current Research Papers

ESAIJ, 4(6), 2009 [512-515]

Casuarina equisetifolia bark as a natural ion exchanger for removal of heavy metal from industrial effluent

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Received: 16th July, 2009 ; Accepted: 26th July, 2009

ABSTRACT

The effluent samples from electroplating and metal tool making industry were analyzed for heavy metal like iron, chromium, nickel, zinc and copper. Bark of Casuarina equisetifolia tested for efficiency. The bark was dried and treated with 39 % formaldehyde and 0.2 N sulphuric acid. Column was prepared using this treated material and used as ion exchanger in column. Effluent was passed through column and the eluent was analyzed for heavy metals concentration using standard AAS method. It is observed that iron, chromium, zinc and nickel were removed from electroplating and metal tool industry effluent. The removal efficiency of heavy metals such as chromium, nickel, iron and zinc was found to be 42.5 %, 59.8 %, 93.7 % and 58.8 % respectively. The results revels that, Casuarina equisetifolia is natural ion exchanger for removal of heavy metals from effluent.

KEYWORDS

Casuarina equisetifolia;
Ion Exchanger;
Removal;
Heavy Metals.

INTRODUCTION

The heavy metals which are much essential for the human body are manganese, copper and zinc. Most of the heavy metals act as a micronutrient. They are required in very small quantities and are required for functioning of the body in healthy way. Generally the heavy metal defined as the metallic elements of high atomic weight (more than 50) and relative density above 7. When the metals enter into the environment they influencing the biological system. They become toxic and causes serious diseases like cancer; kidney failure, brain tumor, siderosis, and many more diseases caused due to heavy metal pollution. So the removal of heavy metal is become essential task for avoiding damage to the biological functioning of the environment[1]. All over world industry is forced to diminish down to acceptable levels contents of heavy metal in water and industrial waste water. The ion exchange method is a convenient method for the removal of heavy metal. The rapid industrialization which causes the problem of industrial effluent has grown significantly since majority of these release large volume of effluent or waste water. This uncontrolled industrialization ignored environmental protection at global level. As industrial effluent varies in nature with industry, the problem gets aggravated as, so no standard treatment carried out

by industries themselves. Effluent is generally discharge into water course either untreated or inadequately treated and create problem of water pollution[2-4]. The tremendous increase in use of heavy metal has invitably resulted in increase flue of metallic substance in aquatic environment. The metals are special concern because of their persistence. The industrial waste constitutes the major source of various kinds of toxic metals which are significantly toxic to human being and biological environment. It include the heavy metals like chromium(VI), copper(II), lead(II), mercury(II), manganese(II), cadmium(II), nickel(II), zinc(II) and iron(II) etc.[5]. The removal of heavy metal from waste water is essential due to their toxicity. The main source of water contamination with chromium ions are industrial waste water from the surface metal treatment plants and from tannery. The release of large quantities of heavy metals into the natural environment has resulted in a number of environmental problems. The main manmade pathway through which heavy metals enter into environment is via waste water from industrial processes. Most of the industries do not have satisfactory waste disposal system or treatment plants. The present methods used by industries can not be removed completely heavy metal from waste water. The ion exchange and adsorption are common operations used for the waste water treatment. In ion exchange processes Zeolites and resins are used for the removal of heavy metals such as Pb^{2+}, Cr^{3+}, Fe^{3+} and Cu^{2+} and ammonia[7]. The electro plating industries are releases the huge amounts of heavy metals were discharging in to the environment. In our laboratory we have done work of removal of heavy metals by using water hyacinth as natural tool[6]. Present work is the extension of our previous work the effluent samples from electroplating and metal tool making industry were analyzed for heavy metal like iron, chromium, nickel, zinc and copper.

EXPERIMENTAL

Apparatus: A Chemato atomic absorption spectrophotometer model AA-203 was used for absorbance measurements.

Materials and methods: The 5 Kg bark of casuarina equisetifolia was cut down from trees bark and dried in sun light in open air for one month. Small size pieces of dried bark have been grinded for 200 mesh powder. This powder were chemically treated with 39 % formaldehyde and 2 N sulphuric acid at 80°C for half an hour, after cooling and washing with doubled distilled water subtract allow to dry for overnight in open air. Dried powder was used for preparation of column[8-10]. Effluent was collected from Electroplating and metal tool industry for the present study

Reagents: All chemicals used were of analytical reagent grade. Hydrochloric acid, sulphuric acid, formaldehyde (Quligens and fine chemicals. Pvt. Ltd. India). The standard metal ion solution of Zinc sulphate, Ferric ammonium chloride, Ammonium nickelsulfate hexahydrate and potassium dichromate (Loba. Chem. Laboratories and fine chemical India) were prepared by dissolving respective salts with dilute hydrochloric acid.

Chemical composition of plant casuarina equisetifolia: The bark consists of 16-18% of cathenol tannin, casurin and D- form of gallo-catechol and tree yields resin[11-13].

Botanical classification

Class- Gymnosperm, Flowering Plant, Monocot
Order- casuarinalance
Family- Casuarinacea
Genus- Casuarina
Species- equisetifolia

Scheme: Bark powder → formaldehyde 700 ml → 0.2 N sulphuric acid 10 ml → heat for half hour at 80°C → cool substrate → filter Substrate → wash with doubled distilled water → dried at open air → use this substrate as insoluble ion exchange resin.

Phenol formaldehyde resin: This resin also called a Navioc resin, chemical reaction occurs during formation of resin is as follows (Figure 1). Bark contain polyphenols; when these are treated with formaldehyde and H_2SO_4 they from phenol formaldehyde resin which acts as an ion exchanger.

Preparation of column and elution of effluent: The slurry of poly phenolic resin was prepared in distilled water and packed into chromatographic column to give a bed height of 10 cm. The bed was then cov-

ered with glass wool plug in order to do not disturb upper bed of column. The resin was activated with 0.2 N hydrochloric acid washing to form cationic resin. A set of experiment was performed for removal efficiency of heavy metal. The 50 ml effluent of electroplating and metal tool industry was passed through column. The fractions before and after elution were analyzed by AAS.

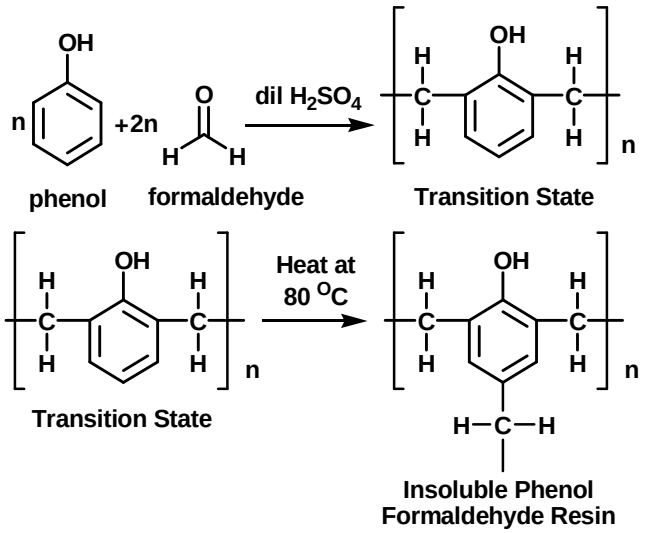

Figure 1 : Chemical reaction of formation of resin

RESULT AND DISCUSSION

The chromium concentration in electroplating and metal tool industry effluent was 17.35 ppm. After passed through column of natural ion exchanger it reduces up to 9.96 ppm. The permissible limit of discharge of effluent in water body is 3.0 ppm for chromium. The concentration of nickel in effluent was 6.68 ppm and after passed it through the ion exchanger its concentration was reduced to 2.68 ppm, which was under permissible limit given by C.P.C.B (TABLE 1). The iron from the electroplating and metal tool industry effluent have permissible limit 5.0 ppm. The concentration of iron in effluent was 58.2 ppm and after passed through ion exchanger concentration of metal was found 3.65 ppm. The concentration after elution was within permissible limit given by C.P.C.B. (Central pollution control board). The zinc generally found in metal tool making industries which have permissible limit of 3 ppm. The concentration of zinc in effluent was 6.52 ppm while after passed through column containing ion exchanger; the concentration of zinc was 2.68 ppm, which is within permissible limit given by C.P.C.B. This is one of the best eco-friendly techniques to minimize the pollution. Regeneration of this ion exchanger resin is possible by washing it with Sulphuric acid. The removal efficiency of heavy metals such as chromium, nickel, iron and zinc was found to be 42.5%, 59.8%, 93.7% and 58.8% respectively.

TABLE 1 : Concentration of heavy metal in effluent before and after passed through ion exchanger

Metal ion	Before treatment ppm	After treatment ppm	Permissible limit in ppm (CPCB)	Removal Efficiency,%
Cr	17.35	9.96	5.00	42.5
Ni	6.68	2.68	3.00	59.8
Fe	58.02	3.65	5.00	93.7
Zn	6.52	2.68	3.00	58.8

CONCLUSION

This technique with proper physical and chemical treatment to the casuarina equisetifolia bark powder can give one of efficient, economic and ecofriendly technique for removal of heavy metal ions from industrial waste water. Raw material used for the preparation of substrate is widely available and inexpensive hence Casuarina equisetifolia bark substrate due to that offer a very cheap and useful product for effective removal and recovery of heavy metal ion from industrial waste water effluent. It is cheaper than available polymeric resin in market. These heavy metals after removing from effluent can be regenerated using treatment with hydrochloric acid. It is solving problem of toxic effect in waste water on living organism. It is also help to solve water pollution problem.

ACKNOWLEDGEMENT

Authors are thankful to management of Pravara Rural Education Society and Principal of P. V. P. College, Pravaranagar for providing necessary facilities in department.

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