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To Use Modified Tree Bark for the Adsorption of Metal Ions from Aqueous Solution

B. D. Gharde[1], A. B. Sahare[2*]

[1]Associate Professor, Department of Chemistry, S.S.E.S. Amravati's Science College, Pauni Dist. Bhandara, Maharashtra, India

[2]Assistant Professor, Department of Chemistry, S.S.E.S. Amravati's Science College, Pauni Dist. Bhandara, Maharashtra, India

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ABSTRACT

Tamarindus indica acts as good adsorbent for toxic metal ions like Cd(II), Pb(II) etc. In the present study the adsorption capacity of Tamarindus indica in removing Cd(II) ions from aqueous solution was investigated with different parameters like pH, time, temperature, initial metal ion concentration, effect of doses in a batch adsorption system. The Cd(II) removal from water was estimated over a wide range of initial Cd(II) concentration.

The retention capacity increases with contact time, pH and initial metal ion concentration but decreases with temperature. However, present study restricted to only such pH values, where the respective heavy metal ion do not get precipitated as hydroxide. Similarly effect of dosages of tree bark substrate also proved that the sorption of heavy metal ions increases with increase in dosages. Fruindlich adsorption isotherm was plotted that confirm the amount of adsorption.

KEYWORDS: Cadmium metal ion, Cadmium removal, Tamarindus indica bark substrate, water pollution, Metal ion removal.

I. INTRODUCTION

The term environment, which etymologically means surrounding, is concerned as a composite term for the conditions in which organisms live and thus consists of air, water, food and sunlight, which are the basic need of all living beings and plant life, to carry on their life function. The environment also includes other things such as temperature, wind, electricity etc. On the other words environment consists of both biotic and abiotic substances. It can be defined in a number of ways. Environment refers to the sum total of conditions which surrounds man at a given point in space and time. The complex of climatic edaphic and biotic factors that act upon an organism or an ecological community and ultimately determine its form and survival. Environment is the sum of all social, economic, biological, physical and chemical

factors which constitute the surrounding of man who is both creator and modular of his environment.

Pollution of the environment is one of the most horrible ecological crises to which human beings are subjected today. It is well known that three basic amenities are needed for living organisms- air, land or soil and water. Sometimes in the past, these amenities were pure, virgin, undisturbed, uncontaminated and basically most hospitable for living organisms. But, the situation is just reverse today, because progress in science and technology is also leading to pollution of environment and serious ecological imbalance, which in the long run, may provide disastrous for mankind. "Environmental Pollution" is the result of urban-industrial technological revolution and speedy exploitation causing fast depletion of every bit of natural resources.

Water pollution is any physical or chemical change in water quality that can adversely affect living beings. Water pollution becomes a global problem that affects both the developed and developing countries. Heavy metals, acids, sediments, animal and human wastes, synthetic organic compounds etc. are potential pollutants discharged into water resources and lead to pollution.

Intensive industrial and agricultural activities are the basic reason of enormous pollution of the environment with heavy metals. Such pollution is especially dangerous to open fresh water aquifers, which are used in man as a source of drinking water. The removal of heavy metals from drinking water is a complicated task due to their low concentration and complexation of natural and organic matter.

Cadmium and its compounds are highly toxic and must be handling with great care. Cadmium oxidizes slowly in moist air but burn when heated. Cadmium is often found in association with zinc ore. Cadmium is also found in greenockite are also contain zinc sulphite. In the earth crust cadmium holds 65 positions with 0.1 ppm. In Cd soil varies variety but on average, it consists of 1 ppm but some polluted soils contain as much as 1500 ppm. Cd occurs at various level/ concentration in different part of the human body, such as 5 ppt in blood, 5 ppm in bone and approximately 2 ppm in tissues. But, it tends to accumulate in the kidney and liver where level can be tenfold higher. Generally, Cd increases with age, and the rate of increase is around 20 milligram at the age of 50.

Cadmium is recognize as one of the most toxic element in the environment and is widely distributed on the earth surface. Its availability in the environment, rapid uptake and accumulation by food chain and crop contributes to its potential environmental hazard. It is present in various types of rocks and soil as well as in water, coal and petroleum. It is not found in pure state, and found as sulphide along with Zn ores. Cadmium is highly toxic and mainly responsible for several cases of poisoning through food. Chronic Cd poisoning produces proteinuria and causes the formation of kidney stones. High Cd/Zn ratio in the kidney of a man is greatly responsible for hypertension. The disease 'itai-itai' has been recognize in Japan, specially associated with Cd poisoning and is resulted to pollution from mining complex.

In the present study effective management and purification of synthetic wastewater using cheaper and locally available tree bark for the removal of Cd(II) as a substitute to conventional adsorbents has been studied.

II. MATERIAL AND METHODS

For the removal of metals from wastewater the general treatment method used.

Adsorption is the best technique which is broadly applied to remove metal ions. Adsorption is a surface phenomenon that may be defined in term of unit operation that utilizes surface forces. It is one of the most effective physical processes for the removal of toxic metals from wastewater. It is based on the concept of partition of a chemical species between a bark phase and an interphase or accumulation of a

substance near the interphase. The surface of a solid has free valances forces. Thus, it has tendency to attract and to retain molecule of other species with which such surface come in contact. This phenomenon is termed as adsorption which is a technical term kind to denote the taking up of gas, vapour or liquid by surface or interphase. The substance that adsorb on another substance is called adsorbent, while the substance that get adsorbed on the first substance is called adsobate. It is commonly refer to as physical and chemical adsorption. Ion exchange is chemical adsorption and adsorption due to electrostatic forces is physical adsorption.

The present study was performed in two phases: Preparation of adsorbent and Batch study.

A. Preparation of Adsorbent (*Tamarindus indica*bark substrate)

The dried bark of *Tamarindus indica* was powdered in an electric grinder and sieved to small size. The powder was taken in bottle and a mixture of 100 ml 0.1 N HNO_3 and 25 ml 39% HCHO. It was kept overnight and occasionally stirred. The powder was removed and washed with distilled water several times to remove acid residue. Finally it was sun dried and used for adsorption studies.

B. Batch Study

In the batch study optimum conditions for adsorption of Cd(II) has been fixed. All the experiments were performed by using synthetically prepared wastewater. 1 gm bark substrate of *Tamarindus indica* was agitated with 100 ml Cd(II) solution. The concentration of Cd(II) was analyzed before and after adsorption using standard methods. The experimental parameters studied include:

1) Effect of pH
2) Effect of contact time
3) Effect of initial metal ion concentration
4) Effect of doses
5) Effect of temperature
6) Effect of light metal ions

Freundlich Adsorption Isotherm has been plotted on the basis of batch study in order to estimate the adsorption capacity of *Tamarindus indica* bark substrate for Cd(II) ions.

III. RESULTS AND DISCUSSION

The results and discussion are given under relevant paragraphs for Cd(II) ions with the *Tamarindus indica* tree bark substrate.

Effect of pH

The pH affects solubility and is an important parameter for adsorption of metal ions [8, 9]. 1 gram of *Tamarindus indica* tree bark substrate was agitated with 100 ml of Cd(II) of concentration 56.87 ppm solution for 1 hrs at room temperature. The pH of metal ion was varied between 2 to 9. It has been observed that the sorption of Cd(II) ions gradually increases. The final pH is found to be less than initial pH of the solution. The percent removal of Cd(II) ions from the solution on the substrate was found to be 71.70% at pH 5. Again the final pH of solution was less than initial pH of solution. Therefore, the optimum pH of the solution was fixed to 5 for further experiments in order to prevent possibility of precipitation of the metal hydroxide.

Effect of Contact Time

100 ml of Cd (II) Metal ion is agitated with 1 gm of*Tamarindus indica* tree bark substrate for different time interval varying from 5 min to 120 min. It is evident from the data the metal ions removal from the solution occurred within 5 min showing that the metal ion adsorption on the substrate is very fast. The metal ions removal from solution after contact time 60 min and value remain constant. Even after a contact time of 120 min. Hence approximately 1 hrs contact time was fixed for further studies.

Effect of initial metal ion concentration

100 ml of Cd (II) metal ion solution was agitated with 1 gm substrate at pH=4 and 5 for 1 hr. at 32° C, It is observed that with increasing metal ions concentration, the percentage removal of metal ion decreases.

Effect of doses of bark substrate

100 ml of Cd (II) metal ion varying doses of bark substrate 0.5 to 4.0 gm. It is observed that the removal of metal ions increases, with the increases in the dosage of bark substrate. However 1 gm is chosen for further studies.

Using the data, Freundlich Adsorption isotherm has been drawn by plotting log x/m Vs log Ce (Residual concentration), Where x/m is concentration of Cd (II) , adsorbate per gram of adsorbent and Ce is the Residual concentration of the meta ions.

Effect of temperature

Metal ion solution on adsorbate on the 1 gm. of bark substrate at different temperature at 32, 50,70 and 85 ºC. It is evident that the Cd(II) meta lion removal decrease with increasing temperature. Hence all further studies were performed at 32 ºC. That means at R.T.

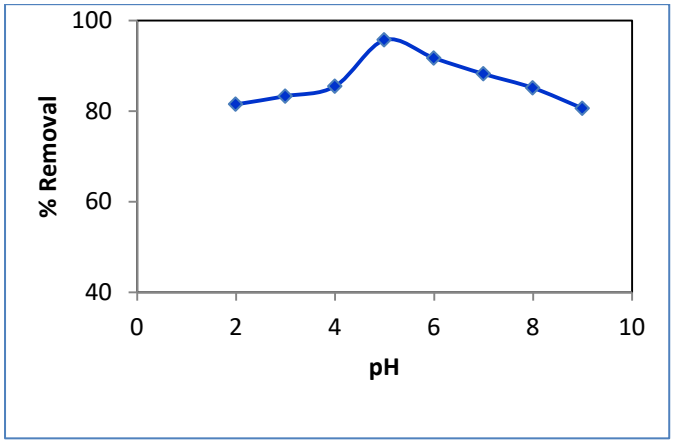

Fig. 1 Effect of pH on removal of Cd(II)

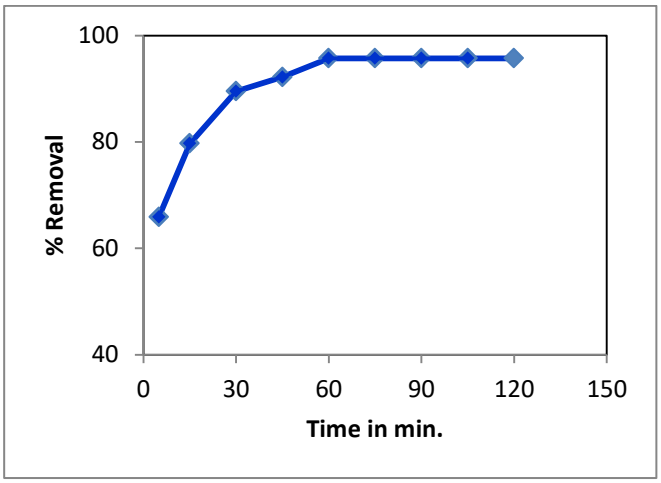

Fig. 2 Effect of Contact time on removal of Cd(II)

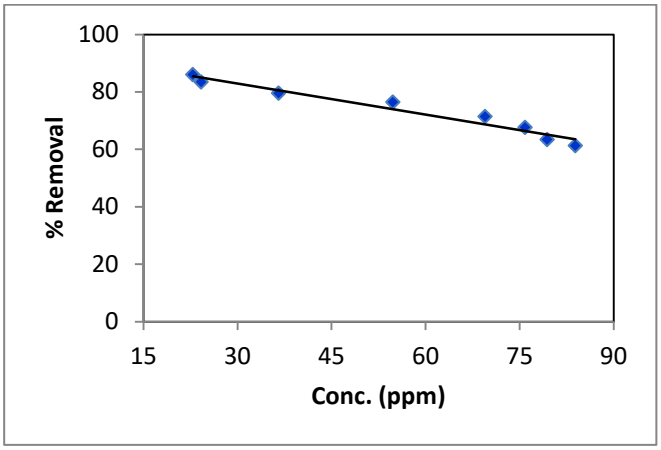

Fig. 3 Effect of initial conc. on removal of Cd(II)

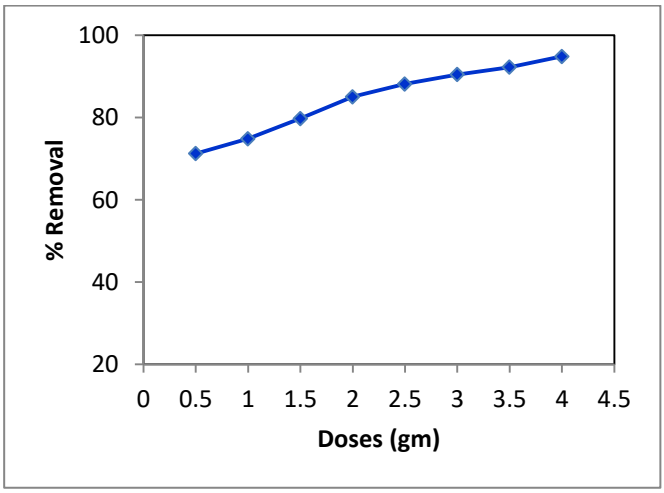

Fig. 4 Effect of Doses on removal of Cd(II)

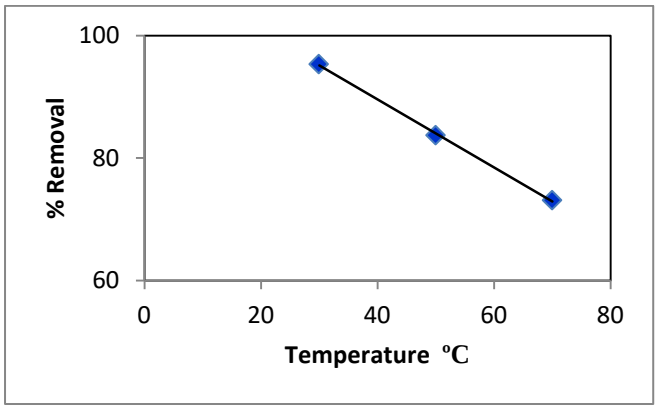

Fig. 5 Effect of Temperature on removal of Cd(II)

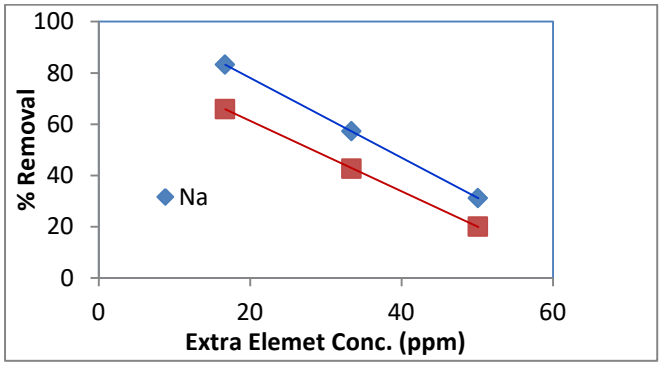

Fig. 6 Effect of light metals on removal of Cd(II)

Effect of extra element concentration

For this salt of Na^{+}, Mg^{2+}were taken. The effect of increasing concentration of light metal ions adsorption was studied. It is observed that with the increasing concentration of these light metal ions the adsorption of **Cd(II)** gradually decreases. Maximum adsorption was observed in the presence of these light metal ions. Thus light metal ions interfere in the adsorption process.

Freundlich Adsorption Isotherm

Freundlich Adsorption Isotherm have been tested in order to estimate the adsorption capacity of *Mangifera indica* bark substrate for Co(II). The Freundlich Adsorption Isotherm equation can be written in linear form as:

$$\log \frac{X}{M} = \log k + n \log Ce$$

Where, X/M - the concentration of metal ion adsorbed per g of tree bark.

Ce - residual concentration of the metal ion.

k - the sorption capacity (in mg/l).

n - intensity respectively.

The log X/M is plotted against log Ce. The value of n obtained from slope and that of k is intercept of the graph.

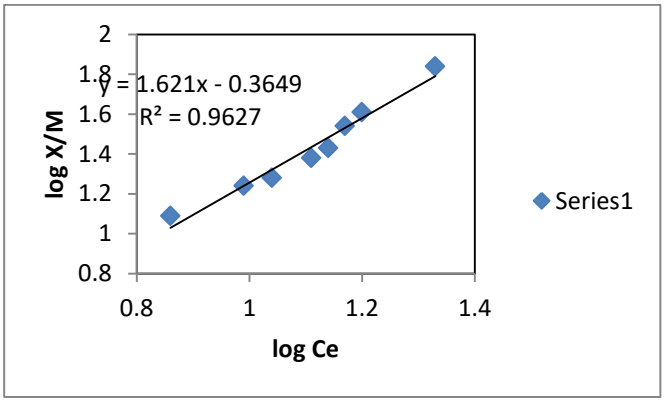

Fig. 7Freundlich Adsorption Isotherm for removal of Cd(II)

IV. CONCLUSION

The demand of water supply has been increasing tremendously due to increasing industrialization and exploding population. Moreover, considerable part of this limited quantity of water is polluted by sewage, industrial wastage and wide array of synthetic chemical. Thus the quality as well as quantity of clean water supply is of vital significance for the welfare of mankind. The water pollution problem has already become a serious issue in some part of the country, due to discharge of toxic industrial waste. Unplanned urbanization combined with modern technologies also increased pollution. It is clearly demonstrate that the adsorption by the substrate is very fast.

V. ACKNOWLEDGEMENT

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