Tactona grandis tree bark substrate used for the adsorption of Fe(II) metal ion from aqueous solution

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Abstract

Rapid industrialization and technological development enhance the concentration of heavy metal poisoning posing a significant threat to the environment and public health because of their toxicity, accumulation in the food chain and persistence in nature. Industrial wastes constitute the major source of various kind of metal pollution in natural water. Heavy metal ions are reported as priority pollutants owing to their mobility in natural water ecosystem and their toxicity. The heavy metals are stable and persistent environmental contaminants. Since they cannot be degraded and destroyed. These metal ions are harmful to aquatic life and water contaminated by toxic metal ions remain a serious health problem. Heavy metal removal from aqueous solution has been traditionally carried out by chemical precipitation. The presence of copper, zinc, cadmium, lead, mercury, iron, nickel and other metals have potentially damaging effect on human physiology and other biological system when the tolerance level are exceeded.

Keywords: *Tactona grandis* tree bark substrate, Iron removal, batch study, metal ion, spectrophotometer.

Introduction:

The term environment, which etymologically means surrounding is concerned as a composite term for the condition in which organisms live and thus consist of air, water, food and sunlight, which are basic need of all living beings and plant life, to carry out on their life function [1]. The environment also include other living things such as temperature, winds, electricity etc. on the other words environment consist of both biotic and abiotic substances.

Pollution of the environment is one of the most harmful ecological crisis 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 impossible for living organisms. But, the situation is just reversed today, because progress in science and technology is also leading to pollution of environment and serious ecological imbalance, which in the long run may prove disastrous for mankind. Environmental pollution is the result of urban, industrial, technological evolution and speedy exploitation causing fast deflation of every bit of natural resource.

Thus, pollution is generally defined as "addition of the constituents to water, air or land, which adversely alter the natural quality of the environment. Pollution is usually brought about by the addition of waste products of human activity to the environment. When the waste product are not efficiently assimilated, decomposed or otherwise removed by the natural, biological and physical processes of the biosphere, adverse effect may result as the pollutant accumulate or get converted into more toxic substances. Thus, the materials, which cause pollution of environment are called pollutants. Pollutant is harmful solid, liquid or gaseous substances present in such a concentration in the environment which tends to the injurious for whole living biota (Environmental Protection Act, 1986).

Salt of various heavy metals and other potentially hazardous materials are being discharged in increasing amounts into the aquatic environment. Water containing significant concentration of some of the heavy metal ions are toxic to human beings, animals as well as aquatic organisms. The toxicity of some heavy metal ions even at the trace level has been recognized with respect to public health for many years. Metals such as mercury, lead, cadmium, copper and chromium fall under this category. Many metals have been evaluated as toxic to aquatic life above certain threshold toxicity level. Exposure to heavy metal toxicity can result from every facet of natural activity such as agriculture, mining, transport, energy and industry. Continue release of metal wastes into the environment has been justified on the basis of dilution to undetectable level or to the levels below the toxicity level in the receiving water body.

Toxicity of iron overdose has been one of the leading causes of poisoning death in children younger than 6 years. Iron is used in pediatric or prenatal vitamin and mineral supplements and for tremens of anemia. Iron tablet are particularly tempting to young children because they look like candy .iron overdose in adults is typically is suicide attempt. Iron overload may developed chronically as well especially in patients requiring multiple transfusions of red blood cells this condition develop in patients with sickle cell diseases thalassemia and hematologic malignancies such as myelodysplastic syndrome.

Material and Methods:

Preparation of tree bark:

This chapter deals with the experimental techniques employed for binding of metal ions with *Tactona grandis* tree bark substrate. The *Tactona grandis* tree bark is dried and finally powdered in an electric grinding machine and sieved through mesh. 2 gm of powder was treated with 20 part of aqueous formaldehyde solution (39%) and five part by volume of 0.25 N Sulphuric acid. The whole mixture was stirred occasionally for 6 hours at 50°C and filtered. The residue was washed with double distilled water, the pH of this filtrate was 4-5 till it is free from sulphuric acid and then dried in an electric oven at 60°C till it becomes moisture free and then powdered. It was then polymerized with formaldehyde in an acidic medium.

Preparation and Estimation of Fe(II) ion solution:

10 ml of 0.0001 M Ferrous ammonium sulphate solution was taken in beaker and 2 ml of acetate buffer, 5 ml hydroxylamine hydrochloride and 4 ml orthophenanthroline was added in it to form a stable complex, absorbance was measured against blank spectrophotometrically. The curve for estimation of Fe(II) ions by this method by varying concentration of Fe(II) ion solution and measuring the absorbance. The concentration of unknown Fe(II) solution were determined from this method.

Results and Discussion:

Effect of pH:

1 gm of *Tactona grandis* bark substrate was agitated with 100 ml of Fe(II) solution for 1 hr. at room temperature. The pH of metal solution was varied between 2 to 9, it was observed that the adsorption of Fe (II) ions gradually increases. The final pH was found to be less than initial pH. The percentage removal of Fe(II) ions from the solution was found to be 80.2% at pH 4.5. For all further investigation, the pH of the Fe(II) solution is maintained at 4.5.

Effect of Contact / Agitated Time:

100 ml of Fe(II) ion solution is agitated with 1 gm of *Tactona grandis* tree bark substrate for different time interval varying from 5 min to 120 min. It is evident from the data that 83.0% of the metal ions removal from the solution occurred within 30 min showing that the metal ions adsorption on the substrate was very fast. The Fe(II) ion removal from solution after contact time 30 min and value remain constant even after the contact time of 24 hours. Hence approximately 45 min contact time was fixed in further studies.

Effect of initial Fe(II) ion concentration:

The adsorption of metal ions on *Tactona grandis* bark substrate was also carried out using various concentrations of Fe(II) ions in solution ranging from 73.7 to 156.3 ppm at room temperature using predetermined agitation time of 45 minutes. The % removal of Fe(II) from solution was naturally decreasing with increasing concentration.

Effect of adsorbent dosage

It was observed that the removal of Fe(II) ions increases with increase in the adsorbent doses from 0.5 to 4.0 gm in all experimental runs in aqueous solution of Fe(II) ions at their optimum pH of 4.5. However, 1 gm is chosen for further studies for sake of convenience.

Effect of Temperature

The adsorption of Fe(II) ions with effect of temperature by modifying bark substrate have been investigated at variable temperature from 30-70°C. The initial concentration of Fe(II) ions in the solution was kept at 4.5 pH. It was observed that with the increase in temperature the binding of metal ions decrease.

Conclusion:

It is emphasized that, each waste treatment problem should be regarded as a special case demanding a thorough study of the chemistry, technology and the ecological aspect involved, apart from the nature, concentration and association of the heavy metals concerned and the permissible discharge limits which guide the treatment process to be adopted. Further, whenever feasible, it is advantageous to integrate the waste treatment into the process sequence itself, as in the case of integrated waste-treatment system used in plating industry. The objective of this study is to develop and inexpensive and effective biosorbent that is easily available in large quantities and feasible economically for multiple metal ions in solution.

Table 1 Effect of pH on adsorption of Fe(II) using *Tactona grandis* bark substrate

Sr. No.	Initial pH	Final pH	Initial Conc. (ppm)	Final Conc. (ppm)	Conc. Adsorbed (ppm)	% Removal of Fe(II)
1	2	1.82	73.7	47.6	26.1	35.41
2	3	2.75	73.7	17.5	56.2	76.25
3	4	3.72	73.7	13.5	60.2	81.68
4	5	3.76	73.7	15.4	58.3	79.10
5	6	5.79	73.7	15.4	58.3	79.10
6	7	6.51	73.7	16.7	57	77.34
7	8	7.49	73.7	16.8	56.9	77.20
8	9	8.54	73.7	16.2	57.5	78.02

In each case 1 gm of substrate was agitated with 100 ml Fe(II) ion solution for 1 hour at room temperature

Table 2 Effect of Contact time on adsorption of Fe(II)

Sr. No.	Time of Agitation (min)	Initial Conc. (ppm)	Final Conc. (ppm)	% Removal of Fe(II)
1	5	73.7	56.1	23.88
2	10	73.7	48.9	33.64
3	15	73.7	41.5	43.69
4	30	73.7	14.1	80.86
5	60	73.7	14.1	80.86
6	120	73.7	14.1	80.86

In each case 1 gm of substrate was agitated with 100 ml Fe(II) ion solution at pH 4.5

Table 3 Effect of initial metal ion concentration on the adsorption of Fe(II) ion using *Tactona grandis* bark substrate

Sr.No	**Initial Conc. (ppm**	**Final Conc. (ppm)**	**Conc. Adsorbed (ppm)**	**% Removal of Fe(II)**
1	73.7	14.1	59.6	80.86
2	76.8	18.2	58.6	76.30
3	81.7	20.4	61.3	75.03
4	87.2	23.5	63.7	73.05
5	90.2	25.1	65.1	72.17
6	93.4	26.8	66.6	71.30
7	96.8	28.5	68.3	70.55
8	100.4	30.3	70.1	69.82

In each case 1 gm of substrate was agitated with 100 ml Fe(II) ion solution at pH 4.5 for 45 min

Table 4 Effect of Dosages of adsorbent on adsorption of Fe(II)

Sr. No.	**Substrate Dosages (gm)**	**Initial Conc. (ppm)**	**Final Conc. (ppm)**	**Conc. Adsorbed (ppm)**	**% Removal of Fe(II)**
1	0.5	73.7	19.7	54.0	73.27
2	1.0	73.7	14.1	59.6	80.86
3	1.5	73.7	13.5	60.2	81.68
4	2.0	73.7	12.8	60.9	82.63
5	2.5	73.7	11.6	62.1	84.26
6	3.0	73.7	9.7	64.0	86.83
7	3.5	73.7	8.0	65.7	89.14
8	4.0	73.7	6.8	66.9	90.77

In each case 100 ml Fe(II) ion solution at pH 4.5 was agitated for 45 min at room temperature

Table 5 Effect of Temperature on adsorption of Fe(II) using *Tactona grandis* bark substrate

Sr. No.	**Temperature (°C)**	**Initial Conc. (ppm)**	**Final Conc. (ppm)**	**Conc. Adsorbed (ppm)**	**% Removal of Fe(II)**
1	30	73.7	14.1	59.6	80.86
2	40	73.7	25.1	48.6	65.94
3	50	73.7	37.1	36.6	49.66
4	60	73.7	47.6	26.1	35.41
5	70	73.7	57.6	16.1	21.84

In each case 1 gm of substrate was agitated with 100 ml Fe(II) ion solution at pH 4.5for 45 min

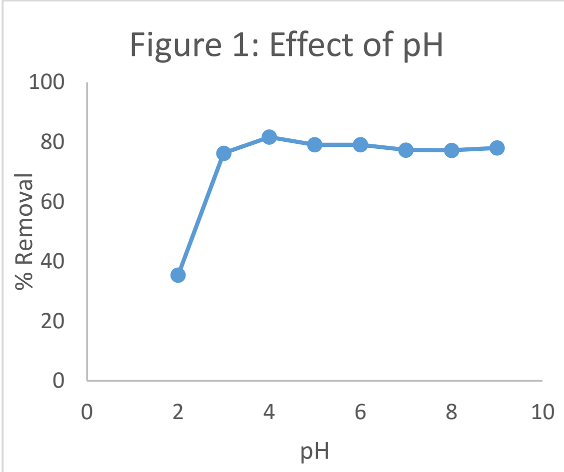
Figure 1: Effect of pH
% Removal
100
80
60
40
20
0
0
2
4
6
8
10
pH

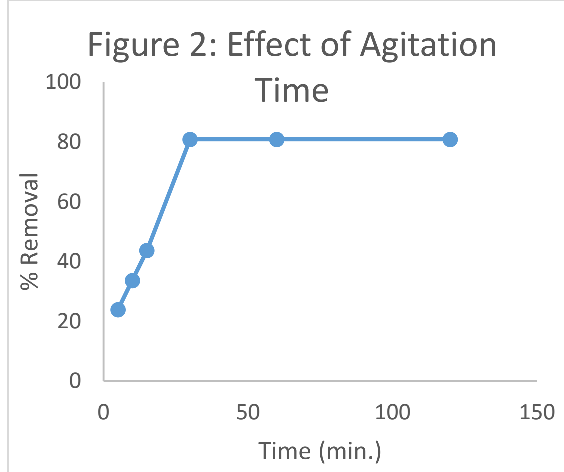
Figure 2: Effect of Agitation Time
% Removal
100
80
60
40
20
0
0
50
100
150
Time (min.)

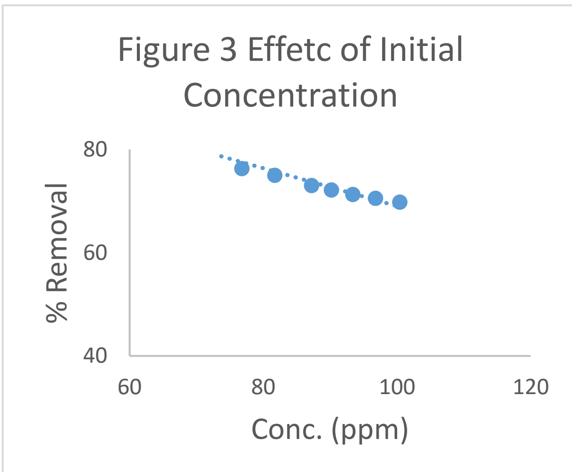
Figure 3 Effetc of Initial Concentration
% Removal
80
60
40
60
80
100
120
Conc. (ppm)

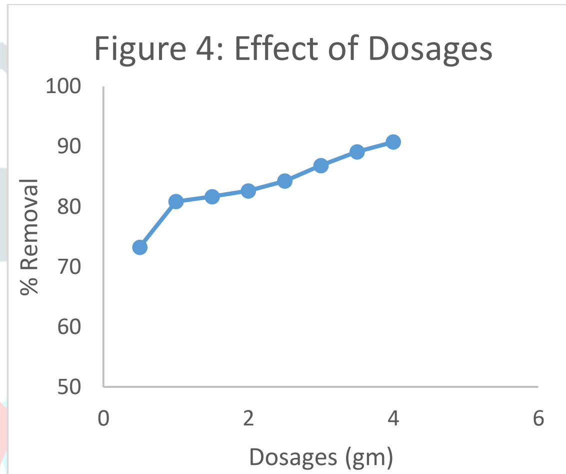
Figure 4: Effect of Dosages
% Removal
100
90
80
70
60
50
0
2
4
6
Dosages (gm)

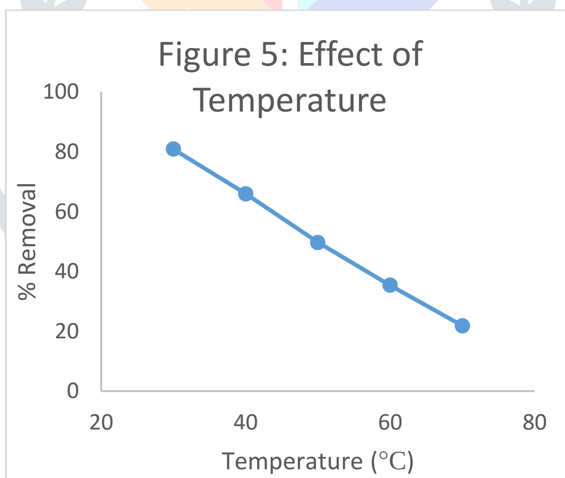
Figure 5: Effect of Temperature
% Removal
100
80
60
40
20
0
20
40
60
80
Temperature (°C)

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