Performance of Soil Aquifer Treatment (SAT) with Tamarind Fruit Shells Adsorbent to Remove Lead

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Abstract- *In the present work, Tamarind Fruit Shell was used to enhance the removal efficiency of Soil Aquifer System (SAT) for the removal of Lead(Pb). The column studies were carried out using 3 different concentrations for Pb metal in Synthetic wastewater (5, 15, 25mg/L) and varying adsorbent heights (20%, 40%, 60%, and 80%) in 0.8m soil depth. Soil properties were determined and Loamy Sand soil was used. The efficiency of SAT to remove Pb without Tamarind Fruit Shell resulted in 38.4%, 44.5%, 43% for Pb. The conjunction of Tamarind Fruit Shell in SAT resulted in increased removal efficiency. Whereas the efficiency was observed maximum at 80% height of adsorbent resulting 82.8%, 84.4%, 75.3% for Pb. Comparison studies show that SAT in conjunction with Tamarind Fruit Shell showed better performance than without adsorbent one.*

Keywords- Lead, Tamarind Fruit Shell, SAT, Synthetic wastewater.

I. INTRODUCTION

Pure and safe drinking water is very essential for healthy life. Various pollutants can enter the human bodies through food and beverages. The presence of organic pollutants can deplete oxygen content of water. The presence of heavy metals and organic matter can cause various short term and long term diseases. The removal of these pollutants can be carried out by various physical, chemical and biological and advanced methods [1].

Elimination of toxic heavy metals from industrial wastewater has been done by several conventional methods like electro precipitation, membrane separation, evaporation, ion exchange, etc., which are expensive and inefficient for low concentrations of heavy metals. Novel technologies in treatment of industrial wastewater for reuse have been elaborated. Soil Aquifer Treatment (SAT) is one of the techniques with high infiltration system. Numerous studies have established positive and effective results for treatment of wastewater by SAT [2].

Lead poisoning is one of the commonest occupational diseases, although in recent years there has been a decline in both the number of reported cases and the severity of the symptoms presented, hence lead poisoning has shifted from an industrial hazard to an environmental one. Lead affects the red blood cells and causes damage to organs including the liver, kidneys, heart, and male gonads, as well as effects to the immune system.[3].

This study infuses SAT with Tamarind Fruit Shell to remove heavy metal Pb as it is always preferred to aim at working with low cost process. Various authors have contributed studies to this method and shown positive results which prove that wastewater can be effectively renovated by SAT. Following papers are typically reviewed.

II. RELATED WORK

Lokendra Singh Thakur,et al. [3] studied the adsorption of heavy metal (Cd^{2+}, Cr^{6+} and Pb^{2+}) from Synthetic Waste Water by Coconut husk Adsorbent. The experiment results showed that maximum removal of Chromium ion by coconut husk adsorbent is 83% and for Cadmium & Lead ion are 94% at optimum condition at optimum condition (6 pH, 120 min. contact time, 3 gm adsorbent dose and 4 ppm concentration).

Ghanshyam G et al. [4] studied the adsorption performance of low-cost adsorbent such as Neem leaves powder in the removal of Cadmium (II) and Lead (II) ion from aqueous solution. It was observed that maximum metal uptake of 95.03% for cadmium and 98.83%for Lead respectively.
Manish Singh Rajput et al.[5] studied the batch mode of adsorption performance using Orange peel adsorbent to remove Lead from aqueous solution. Experimental results showed that maximum removal of Pb (II) by orange peel at optimum condition parameter 7Ph, 90 min. contact time, 0.6g/100ml adsorbent dose and 10 ppm concentration is 78%.

III. METHODOLOGY

A. Adsorbent Preparation

Tamarind Fruit Shell powder was prepared as per procedure given by Pandharipande et al.,(2013). Tamarind fruit shell was washed repetitively with tap water and also with distilled water to evacuate dust and dissolvable pollutant.

Furthermore it was kept for sun drying followed by drying in the oven at 90°C. Then using a hammer mill dried Tamarind Fruit Shell is converted into powder and the powder is sieved to get average size of 1205μ(1.2mm).

Then for 5min the powder is put in a furnace at a temperature of 90°C. To remove the color followed by drying the leftovers are washed with hot water for various times for about of 2 hr at a temperature range of 90-100°C.

B. Preparation of Metal Solution (Synthetic water)

Analytical rated reagents were utilized for preparing metal solution. Pb^{2+} solutions were arranged by diluting merck grade stash solutions with deionised water to a desired concentration. concentrated H_2SO_4 and NaOH was applied to adjust neutral pH values of samples. The solution was diluted to different known concentrations viz. 5, 15 and 25mg/L for testing performance of SAT system. It was prepared and filled in 20 litres influent tank.

C. Preparation of Soil

Loamy Sand was characterized by the geotechnical properties obtained by the experiments. The dry density of soil was found to be 1.68 g/cm^3 and it was maintained by mixing water and compaction. Experiments were carried for single depth of soil 0.8m and 4 heights of adsorbent. A layer of 10 cm adsorbent was introduced in the soil column at 20%, 40%, 60% and 80% in different trials and experimented.

D. Experimentation

Column studies were conducted in PVC columns of 6 inches diameter and 1.1m length. Loamy Sand was used for SAT and filled up to 0.8m depth. When conducting experiment with adsorbent, 4 adsorbent heights were tried from bottom at 20%, 40%, 60% and 80% of 0.8m soil depth. Synthetic wastewater to be tested for removal efficiency was passed through the overhead tank and a ponding depth of 0.3m was maintained above the soil mass. The effluent sample was collected from the bottom of the column and the metal concentrations were tested using Atomic Absorption Spectrophotometer (AAS). For each predetermined condition of experimentation, the soil was filled afresh in the column. Effluent samples in duplicate were prepared and analyzed for metal concentration using AAS.

IV. EXPERIMENTAL RESULTS

A. Performance of Loamy Sandy soil without Tamarind Fruit Shell adsorbent

Table.1. Shows the performance of Loamy Sand soil of 0.8mdepth without adsorbent.

Sl No.	Parameter	Influent Conc. (mg/L)	Effluent Conc. (mg/L)	Removal Efficiency, %
1	Lead	5	3.08	38.4
2		15	8.32	44.5
3		25	14.24	43

Table.1 shows the performance of SAT system without adsorbents. The Loamy Sand soil was used for removing Lead. It was recorded that Loamy Sand removed maximum Lead from 15mg/L influent concentration which is 44.5% . The values were recorded at optimum values which were calculated by saturation studies. The least removal was 38.4% which is not much significant. Hence average values can be taken for consideration for different influent concentration. Overall average performance of SAT for Lead is 42% in without adsorbent case.

B. Performance of Loamy sandy soil with Tamarind Fruit Shell as adsorbent at 20%, 40%, 60%, 80% of 0.8m depth soil

Fig.1 shows optimum removal of Lead at 20% adsorbent height for influent concentrations of 5, 15, and 25 mg/L. Lead removal efficiencies were obtained as 78.2%, 79% and 76.1% respectively. Maximum removal efficiency at 20% height of adsorbent for Lead was found as 79% for15mg/L.

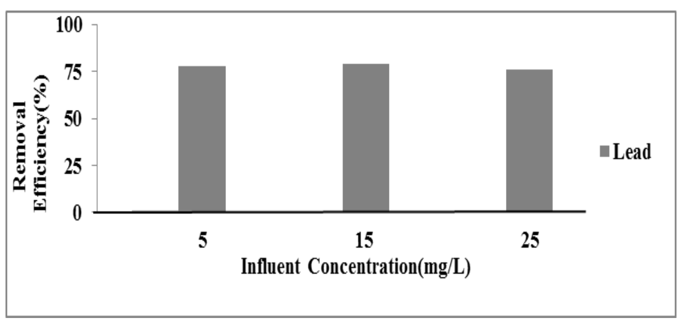

Fig.1. Removal Efficiencies of Pb for Loamy Sand Soil with Tamarind Fruit Shell adsorbent at 20% height.

Fig.2 shows optimum removal of Lead at 40% adsorbent height for influent concentrations of 5, 15, and 25 mg/L. Lead removal efficiencies were obtained as 77.2%, 78.9% and 76% respectively. Maximum removal efficiency at 40% height of adsorbent for Lead was found as 78.9% for15mg/L.

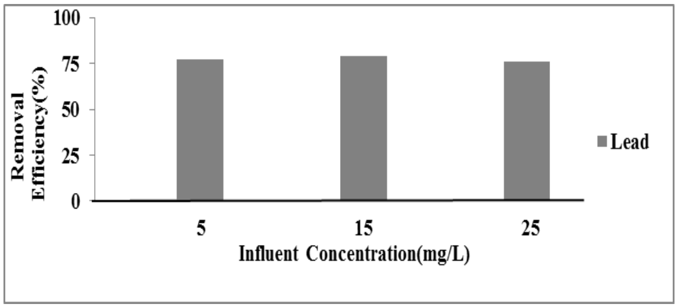

Fig.2. Removal Efficiencies of Pb for Loamy Sand Soil with Tamarind Fruit Shell adsorbent at 40% height.

Fig.3 shows optimum removal of Lead at 60% adsorbent height for influent concentrations of 5, 15, and 25 mg/L. Lead removal efficiencies were obtained as 79.6%, 81.2% and 77% respectively. Maximum removal efficiency at 60% height of adsorbent for Lead was found as 81.2% for15mg/L.

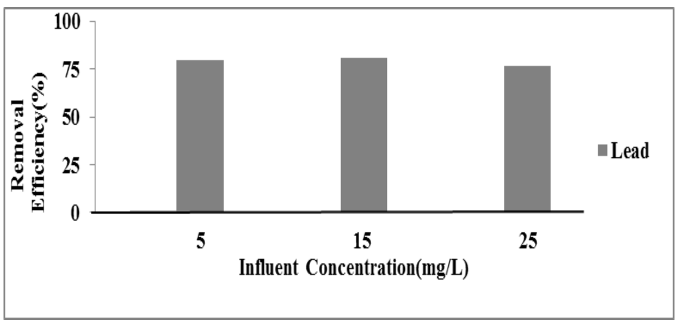

Fig.3. Removal Efficiencies of Pb for Loamy Sand Soil with Tamarind Fruit Shell adsorbent at 60% height.

Fig.4 shows optimum removal of Lead at 80% adsorbent height for influent concentrations of 5, 15, and 25 mg/L. Lead removal efficiencies were obtained as 82.8%, 84.4% and 75.3% respectively. Maximum removal efficiency at 80% height of adsorbent for Lead was found as 84.4% for15mg/L.

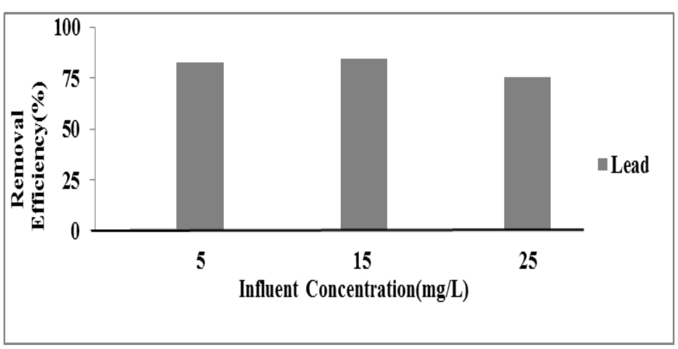

Fig.4. Removal Efficiencies of Pb for Loamy Sand Soil with Tamarind Fruit Shell adsorbent at 80% height.

The study of results indicates that there is no significant change in removal efficiency of Pb for different influent concentrations i.e., 5,15and25 mg/L. This constant removal can be studied for further increased concentrations of influent, though maximum efficiency was obtained in the 80% height of Tamarind Fruit Shell. Fig.5. shows the comparison for performance of SAT for Pb removal without adsorbent and adsorbent at 80% height. From the statistics, Lead removal is significantly increased by combining it with Tamarind Fruit Shell.

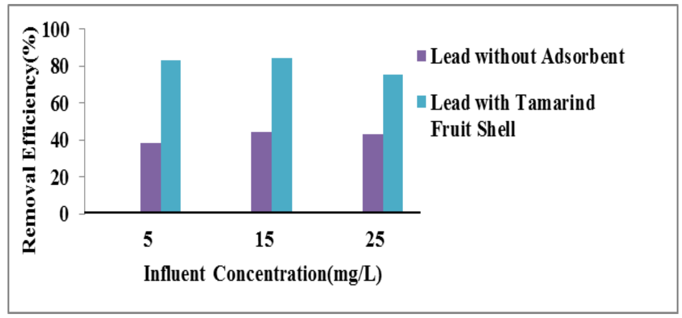

Fig.5. Comparison of removal of Lead by SAT without and with adsorbent (at 80% height).

C. Removal Efficiency of Lead

Results showed that Tamarind Fruit Shell was found to increase the removal efficiency of SAT by 47% which is admirable. It was observed that Loamy Sand soil is more effective in removing Lead when coupled with Tamarind Fruit Shell.

V. CONCLUSIONS

The experimental studies shows that Loamy Sand soil increases the removal efficiency of Lead in conjunction with Tamarind Fruit Shell as adsorbent in between the soil columns. Removal efficiency was observed maximum at the adsorbent height of 80%, showing 84.4% for Lead. Loamy Sand soil can be merged with Tamarind Fruit Shell and can used to treat Lead contaminated effluents more effectively. Thus results obtained can be utilized for further studies by increasing the concentration and also it can therefore be used in treatment of effluents from industries, thereby reducing the level of water pollution from Lead industries.

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